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The Hidden Geometry of the Architecture of Herzog & de Meuron
Digital Tools and Design Practice

Alexandra Castro

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Alexandra Castro. The Hidden Geometry of the Architecture of Herzog & de Meuron, Digital Tools and Design Practice

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Digital Tools and Design Practice

Alexandra Castro

FACULDADE DE ARQUITECTURA

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The Hidden Geometry of the Architecture of Herzog & de Meuron

Digital Tools and Design Practice

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Faculdade de Arquitectura da Universidade do Porto (FAUP)
Programa de Doutoramento em Arquitectura (PDA)
November 2023

To my father

U.PORTO
FACULDADE DE ARQUITECTURA
UNIVERSIDADE DO PORTO

Declaração de Honra

Eu, Maria Alexandra Correia de Castro, natural de S.to Ildefonso, Porto, inscrita no Programa de Doutoramento em Arquitectura da Faculdade de Arquitectura da Universidade do Porto com o número de estudante 199602431, declaro, nos termos do disposto na alínea a) do artigo 14.º do Código Ético de Conduta Académica da U.Porto, que o conteúdo da presente tese, com o título "The Hidden Geometry of the Architecture of Herzog & de Meuron, Digital Tools and Design Practice" e orientada pelos Prof. Dr. João Pedro Xavier, Prof. Dr. José Miguel Rodrigues e Dr. Kai Strehlke, reflete as perspetivas, o trabalho de investigação e as minhas interpretações no momento da sua entrega.

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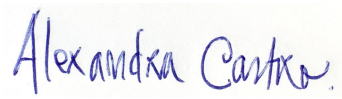

A autora, Alexandra Castro.

Porto, 13 de Novembro de 2023

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Abstract

The present dissertation investigates the work of Herzog & de Meuron (HdM) from a perspective that, as the title suggests, is concerned with the relationship between geometry, architecture and design tools. The aim is to determine how the Basel architects have dealt with geometry over the years, and how they consider it in both their design theory and practice, to ultimately infer what changed in their architecture from the moment they introduced digital technologies into their work process.

It is known and widely documented that, in the last thirty years, design software and numerical fabrication machines have recast the role of geometry in architecture, opening it up to conspicuous possibilities. This happened at a technical and methodological level, with the processes for representing and generating architectural shapes being fully overturned. What used to rely on a two-dimensional approach and on the drafting possibilities of descriptive geometry has shifted into a more comprehensive and dynamic method, with digital modelling lying at the core of the creative process and promoting a direct link from design to manufacturing. Moreover, this has also been reflected in conceptual and formal terms. The computer has allowed architects to apply new mathematical knowledge in architecture and enabled a new level of experimentation with complex geometric shapes, as free forms, which have entered the lexicon of many contemporary architects. Indeed, authors who often reflect on the argument recognise that, besides the more procedural aspects, avant-garde digital architecture has manifested a new materiality and a specific aesthetic expression.

HdM are not protagonists in the history of the digital in architecture. Over the years, they did not contribute to the rise of the "new architectural styles", instead setting themselves apart from contemporary digital experimentalism and following their own path, ingrained in the fundamentals they settled on in the early years of their career. Nevertheless, as we argue, geometry has always played a crucial role in the work of these Swiss architects in terms of methodological processes and compositional strategies, and also in their specific idea about architecture. In the same way, technological means, of which digital design and fabrication methods are a part, have always been present in their work, standing out as a critical factor for their highly research-oriented practice.

This dissertation delves into the work of HdM, approaching it from two complementary perspectives. The first asserts itself as a macrohistory of the Basel office. The recognition and characterisation of five moments marking their architectural practice offers a critical narrative of what happened in HdM's work—from 1978 to recent times (2020)—focused on the importance of geometry and digital tools in their architecture. The second part addresses one of these specific moments and involves the accurate, in-depth study of a single project. The extension to the Tate Modern in London, from a period in which digital design and manufacturing techniques were fully consolidated in the office's practice, is analysed in deep detail. And it is precisely in the apparent paradox that this project represents that the thesis we intend to argue is reinforced. How can a classic building—with an archaic character and built with a traditional material such as brick—demonstrate that geometry is relevant in the practice of the Basel architects and that digital design methods and tools play an essential part, expanding how geometry is explored in their work process without breaking the continuity of their architectural research?

Resumo

A presente dissertação investiga a obra de Herzog & de Meuron (HdM) a partir de uma perspectiva que, como o título sugere, incide na relação entre geometria, arquitectura e ferramentas de projecto. O objectivo é reconhecer como os arquitetos de Basileia trabalharam ao longo dos anos com a geometria e a consideram na sua teoria e prática de projecto, para, no final, identificar o que mudou na sua arquitectura a partir do momento em que introduziram as tecnologias digitais no seu processo de trabalho.

É conhecido e amplamente documentado como, nos últimos trinta anos, os softwares de desenho e a fabricação digital reformularam o papel da geometria na arquitectura, abrindo-a a possibilidades notáveis. Isto aconteceu do ponto de vista técnico e metodológico, com os processos de representação e geração de formas arquitetónicas a serem totalmente invertidos. O que anteriormente assentava numa abordagem bidimensional e estava dependente das possibilidades de desenho da geometria descritiva mudou para uma abordagem mais abrangente e dinâmica, com a modelação digital no centro do processo criativo e a promover uma ligação direta do projecto para a fabricação. Para além disto, este fenómeno refletiu-se também em termos conceptuais e formais. O computador permitiu aos arquitectos aplicar novos conhecimentos matemáticos na arquitectura, do mesmo modo que possibilitou um novo nível de experimentação com formas geométricas complexas, como as formas livres, que passaram a fazer parte do léxico de muitos arquitetos contemporâneos. De facto, os autores que frequentemente reflectem sobre o tema reconhecem que, para além dos aspectos mais processuais, a arquitectura digital de vanguarda revela uma nova materialidade e uma expressão estética específica.

HdM não são protagonistas na história do digital na arquitectura. Ao longo dos anos, não contribuíram para o surgimento dos "novos estilos arquitectónicos", distanciando-se do experimentalismo digital contemporâneo e seguindo um caminho próprio enraizado nos princípios que consolidaram nos primeiros anos da sua carreira. No entanto, como defendemos, a geometria sempre desempenhou um papel crucial na obra destes arquitectos suíços, tanto na relação com os processos metodológicos e estratégias de compositivas, como também no seu entendimento específico da arquitectura. Do mesmo modo, os meios tecnológicos, dos quais os métodos digitais de desenho e fabricação são apenas uma parte, sempre estiveram presentes no seu trabalho, destacando-se como elemento crítico de uma prática arquitectónica altamente voltada para a pesquisa.

Esta dissertação analisa, assim, o trabalho de HdM a partir de duas abordagens complementares. A primeira afirma-se como uma espécie de macro-história do escritório de Basileia. O reconhecimento de cinco momentos cruciais oferece uma narrativa crítica do que aconteceu na prática de projecto de HdM—de 1978 até recentemente—a partir da importância da geometria e das ferramentas digitais na sua arquitetura. A segunda foca-se num dos momentos do escritório e envolve o estudo preciso e aprofundado de um único projecto. A extensão da Tate Modern em Londres, que resultou de um processo de projecto onde as ferramentas digitais se revelaram cruciais para concretizar a ideia arquitectónica e resolver as complexas questões geométricas que marcam a singularidade da

expressão arquitectónica do edifício, é analisada em detalhe. E é precisamente no suposto paradoxo que este projecto coloca que a tese que pretendemos demonstrar se reforça.

Como pode um edifício clássico—de carácter arcaico e construído com um material tradicional como o tijolo—ser considerado caso de estudo para demonstrar que a geometria é realmente relevante na prática dos arquitectos de Basileia e que os métodos e ferramentas digitais, actualmente incontornáveis, ampliaram o modo como essa é explorada no seu processo de trabalho, sem quebrar a continuidade de sua pesquisa arquitectónica?

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" 'The Hidden Geometry of Nature' [...] is the expression of an approach, a search for perception and meaning, a search of something hidden, something that is integral to nature, that occurs in nature. A search that must fail at the moment I believe I have found my geometry."[1]

Jacques Herzog, 1988

[1] Jacques Herzog, "The Hidden Geometry of Nature," in *Herzog & de Meuron 1978-1988. The Complete Works.* vol. 1, ed. Gerhard Mack, (Basel, Boston, Berlin: Birkhäuser, 1997), 207.

1.
Introduction

State of the Art · Structure and Methodology · Bibliography and Sources

In the Fall 2020 lecture series of the School of Architecture at the University of Texas, Mario Carpo, along with Peter Eisenmann, discoursed under the title "Architecture or Computation".

In this lecture, Carpo remarked that "architecture is a notational art."[1]

This is not an odd or even new argument within the topics the author usually addresses in his writings.[2] Indeed, for an architectural historian and critic such as him, concerned with the history of cultural technologies and with a focus on the early modern period and contemporary digital design theory, the idea of the architect as a maker of drawings—which emerged around the mid-15th century with Leon Battista Alberti—is a central point in his critical approach. However, in this lecture Carpo presented the argument in a particularly direct way.

As mentioned, Carpo observed that architecture is an art based on notation instruction. "In architecture, we do not make buildings", he said.

> We make notations of buildings, [which] are given from us to someone else who will make the building without our responsibility, but following our notation. This makes architecture an art instead of a [...] craft or a mechanical process. But, the side effect of this notational mediation is that whatever we do in the domain of architecture is determined by the potency and the performance of the notational tools at our disposal. And these tools are mostly geometrical because, to give the instruction, we must use plans, elevations and sections.[3]

Carpo then proceeds with his discourse by pointing out some differences between notating three-dimensionally the surface of a "shoe box"—a very simple drawing reduced to only three axes and three measurements—and a "potato", which instead requires, a massive number of points, a massive amount of data and involves a lot of effort to do manually. So he concludes that today, "with the digital, what used to be impractical and almost impossible became eminently practical and possible. For the digital, notating a 'shoe box' or notating a 'potato' is basically the same [...]. Both processes are equally easy."[4]

Despite some irony and the inevitable simplification implied in Carpo's comments, we can draw from them two key ideas that underlie the questioning and argumentation raised in this work.

The first one is related to the understanding of geometry as a device that stands at the core of the architect’s practice. When looking at architecture with an emphasis on its notational character, geometry emerges as the language of the architect, as a structured system of communication—with its own grammar and vocabulary—that enables architects to express themselves rationally throughout the conception, representation and construction process of the imagined objects.

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1 Peter Eisenmann and Mario Carpo, “Architecture or Computation,” Jessen Lecture, University of Austin, Texas, September 9,

2 Mario Carpo also addresses this argument in the article "The Art of Drawing." In this essay, the author explains that "at the dawn of modernity, a clique of intellectually minded Italians […] thought that architects should make drawings of buildings, not buildings. Around the mid-15th century, Leon Battista Alberti, the universal man of the early Renaissance, was the first to claim that architecture is first and foremost an idea: conceived in the mind of its author, notated in drawings, then built by manual workers who must comply with the instructions they receive (through drawings and models), and follow them without change. In Alberti's theory of design, the architect's drawing is the original act of creation; the physical building that may follow is only a copy, devoid of any intellectual added value." Mario Carpo, “The Art of Drawing,” in *Architectural Design. Drawing Architecture,* volume 83, issue 5, guest-ed. Neil Spiller, September/October 2013,128.

3 Eisenmann and Carpo, “Architecture or Computation,” 38:25.

4 Ibid., 40:02.

The second point concerns the intrinsic relationship that exists between geometry and the means architects have at their disposal to formulate and describe their ideas. Modes of notation are generally related to specific ways of thinking about architecture,[5] in the same way that the tools themselves affect the methodological processes of architecture and interfere with how geometry is explored in design practice. It is known and widely documented that, in the last thirty years, design software and numerical fabrication machines have recast the role of geometry in architecture, opening it up to conspicuous possibilities.

Therefore, departing from these two premisses, the present dissertation focuses on the relationship between geometry and architecture in the work of Herzog & de Meuron (HdM).[6] It is based on the hypothesis that geometry has always been relevant in the practice of these Swiss architects and that digital design methods and tools, currently ineludible, have expanded the way that it is explored in their design process without breaking the continuity of their architectural research.

The practice of the Basel office, from 1978 until recent times (2020), is thus critically examined in an approach that investigates the continuous intersection of architecture, geometry and design tools in their work. The aim is to register how the architects have dealt with geometry over the years and how they consider it in both their design theory and practice, to ultimately infer what in their architecture has changed from the moment they introduced digital technologies into their work process. The extension to the Tate Modern in London, developed between 2005 and 2016, is analysed in deep detail. This project by HdM—in which computational methods played a crucial part, assisting in the design of one of its most distinctive elements, the brick facade—was chosen as the case study that will contribute to the hypothesis to be developed in this thesis.

State of the Art

To address the architecture of HdM with an eye on their work methodology, and especially on the influence that digital technologies have in their design process, implies, in the first instance, inscribing

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5 Bernard Tschumi delivers this topic in an article on the "paperless" studios—an experiment in teaching in the computer studios conducted at Columbia University in 1994 while he was the dean. "My second ambition", Tschumi says, "had to do with how you express yourself, knowing that the expression of an architect is generally related to a way of thinking. For example, the argument has often been made that Renaissance architecture was very much related to perspective, a mode of representation. Similarly, Auguste Choisy's invention of a certain form of axonometric in the nineteenth century had an effect on the way architects think about architecture. In this sense, the relationship between the mode of notation and the way of thinking is fundamental to architecture." Bernard Tschumi, "The Making of a Generation: How the Paperless Studios Came About," in *When is the Digital in Architecture?* ed. Andrew Goodhouse (Montréal, Berlin: Canadian Centre for Architecture, Sternberg Press, 2017), 408.

6 The present dissertation is part of a broader research interest that stems from our academic activity as a lecturer of "Geometry and Architecture" in the Architecture Master Degree's at the Faculty of Architecture of the University of Porto.
For the last eight years, we have been reflecting on how to revise the course syllabus to introduce the topics that present as more relevant for an architectural context highly marked by the possibilities of the digital medium and in which the role of geometry, when compared to traditional approaches, has profoundly changed.

Among the several activities developed, we have conducted didactic experiments with the students, organised national discussion meetings with colleagues and made presentations of the research results at international conferences. In this sense, the present doctoral dissertation is the opportunity to go beyond the strict academic world to investigate from within the discipline and acknowledge the implications of our problem from an architectural practice point of view.

them in the context of the so-called "digitally intelligent architects"[7] and acknowledging how their practice is considered by those who write histories of the digital.

A good indicator for our analysis is *Architectural Design* (AD), a British magazine committed to the digital cause and renowned for being at the cutting edge of new technologies that has published some of the most influential articles on the subject.

When going through the issues of the last thirty years of AD, HDM are not often referred to.

They are only briefly mentioned in very few articles by authors who take some of the office's leading projects as examples to illustrate their research and ground their reflections on the contemporary phenomenon of the digital in architecture, which immediately suggests that HdM's work is practically left out of the literature on the topic. However, despite being small in number, the references to HdM in the British magazine are made from two complementary perspectives that we mulled over differently in our argumentation. The first is theoretical and is conducted mainly by architectural historians and critics who analyse the facts while being concerned with their impact from a disciplinary point of view. The second comes from a more practical position, led by experts with extensive practice-based experience who deal directly with the technological systems and are interested in the topic from a methodological and instrumental approach.

From the first-mentioned perspective, Antoine Picon looks at HdM as a practice whose work has played an influential part in the context of the last thirty years by questioning ways of making and destabilising some key notions in architecture.[8] Concerned with the notion of materiality—that he comprehends beyond the usually employed terms of "non-standard", "parametricism", or "discretism"—and the shift that digital design has been expressing in it, Picon often includes HdM in his discussions on the return of ornament and the crisis of tectonics that have accompanied the rise of digital culture in contemporary architecture.[9]

Buildings such as the Eberswalde Technical School Library, Eberswalde (1994–1999), the De Young Museum, San Francisco (1999–2005) and the National Stadium, Beijing (2005–2008), are seen by the French architectural historian as emblematic of the new features of today's ornament. If, on the

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7 "Digitally intelligent architects" is a term that Mario Carpo often uses in his writings while referring to those designers who soon adopted digital tools and embraced digital change in their practice, contributing to the emergence of a visuality or a style, as he himself states, that is specific to a "digitally intelligent architecture."

8 From the several published works by Antoine Picon that refer to the work of HdM, we highlight: Antoine Picon, *Ornament. The Politics of Architecture and Subjectivity* (West Sussex: Wiley, 2013); Antoine Picon, "Histories of the Digital: Information, Computer and Communication," in *When is the Digital in Architecture?* ed. Andrew Goodhouse 79–98 (Montréal, Berlin: Canadian Centre for Architecture, Sternberg Press, 2017); Antoine Picon, "Beyond Digital Avant-Gardes: The Materiality of Architecture and Its Impact," in *Architectural Design. Impact*, volume 90, issue 5, guest-ed. Ali Rahim and Hina Jamelle, 118-125, September/October 2020.

In addition to Antoine Picon, Branko Kolarevic also considers that, among contemporary design practices, HdM stand out in their "unapologetic exploration of pattern and relief and the resulting material and surface effects they can produce". A shift towards the reintroduction of pattern, relief and texture onto architectural surfaces that the author believes to be a consequence of the emergence of the new digitally based techniques of design and production. See Kolarevic, Branko, "Manufacturing Surface Effects." Synthetic Landscapes (Proceedings of the 25th Annual Conference of the Association for Computer-Aided Design in Architecture) pp. 95–103. http://papers.cumincad.org/cgi-bin/works/paper/acadia06_095.

9 Antoine Picon's research on the influence of the digital in architecture is not restricted to computing. The author has a broad understanding of the term "digital", which he considers something that extends to an array of dimensions of the world in which we live. In this sense, he advocates for the importance of avoiding techno-determinism, believing that the machine, as he mentions, "is not the ultimate cause but rather something that reveals and accelerates." In his opinion, "above all, the technology mediates between architecture and the shifting social and cultural background." So, in other words, as he remarks, "what is primarily happening is a huge cultural change." Antoine Picon, "Histories of the Digital: Information, Computer and Communication," in *When is the Digital in Architecture?* ed. Andrew Goodhouse (Montréal, Berlin: Canadian Centre for Architecture, Sternberg Press, 2017), 90.

1.01
National Stadium, Beijing (2002–2008).

one hand, the repetitive pictures imprinted on the library's facade and the immense protruding and depressed dots of the museum's envelope are revealing of the widespread use of patterns in architecture and the renewed autonomy of texture as a dimension imbued with an ornamental character, on the other hand, the stadium's net of beams possesses, as Picon remarks, "a surprisingly ornamental turn, which is somewhat detrimental to traditional structural legibility, as if traditional tectonic principles did not matter anymore"[10] ***(1.01)***. Therefore, according to Picon, architecture by HdM expresses not only the tactile character of contemporary ornament and its strong appeal to the senses but also the blurring between the ornamental and the structural—all of them qualities that the author recognises as part of a new definition of materiality that has emerged from the transformation digital technologies are making to our experience and understanding of the physical world.

However, Antoine Picon's approach to the contemporary phenomenon explores a facet of the digital in architecture that is not the one we seek to delve into in our investigation. Questions such as ornament, tectonics and materiality will only intersect with our argument marginally. As they are intrinsically linked to HdM's idea about architecture and stand at the basis of some of the most distinctive features of their designs, they will inevitably end up entering our discourse, but not thoroughly. Our attention is instead focused on methodological topics related to the challenges and opportunities that digital tools have brought into the design practice of HdM from the point of view of geometry. We will consider when and how they have adhered to technological methods and discuss whether these have reshaped the form-making processes of their architecture. For this reason, we find greater affinity with the second perspective by the authors mentioned above, who elaborate on the work of HdM from a more technical standpoint. In addition to providing us with strategic hints about the

10 Antoine Picon, *Ornament. The Politics of Architecture and Subjectivity* (West Sussex: Wiley, 2013), 31.

effective use of digital tools in the development of their projects, they, in a way, share with us the conviction that HdM are a highly technological practice whose architectural ambitions have placed their work at the cutting-edge of design and manufacturing processes.

In the corpus of the British magazine, three articles by three authors approach the subject from this particular angle.

The more assertive one is by Brady Peters, who clearly considered HdM to be among the world's most forward-thinking practices using computation as a design method. In 2013, he guest-edited with Xavier de Kestelier an AD issue on "Computation Works",[11] where they presented state-of-the-art uses of computation in the practice of architecture. HdM were then portrayed as one of the firms whose structure was changing in response to the work of computational designers. Peters asserted that computational design and fabrication methods were part of the toolbox of HdM and that the firm had created an internal specialist department to support these techniques. Based on a conversation with Kai Strehlke[12]—at that time head of the Digital Technologies Group (DTG)—Peters mentioned the digital tools and methods used then in the office. He referred to the interaction between the DTG and the design teams and alluded to the added value these technologies have brought into the creative process of HdM.

Despite being a concise report that depicted a specific moment of the firm's practice, Peters' article is, above all, relevant as one of the few pieces documenting the use of digital tools and methods at HdM. On this rare occasion, the guest editors placed the Swiss practice side by side with renowned technological architecture firms such as Foster+Partners, UNStudio, Aedas R&D and Skidmore, Owings & Merrill, even though Peters then conveyed the idea—while paraphrasing Kai Strehlke—that, unlike highly experimental research groups, HdM remain a practice that is all about architecture. The methodological processes implemented at the Basel office are focused on realising the architectural idea, which, as we will argue later, is a crucial aspect of HdM's approach to design practice that extends to any of the tools, analogue or digital, that they use to develop their ideas.

Of the two other articles in AD that complement Brady Peters' report on the practice of HdM, one was published seven years before his piece and the other seven years later.

In 2006, Achim Menges[13] included the pneumatic roof and facade system of HdM's proposal for the Allianz Arena, Munich (2002–2005), among other recent developments in digital fabrication and computer-aided manufacturing carried out through world-leading construction companies. Menges singled out the planning and production process for the 2,816 individual rhomboid cushions of the Munich stadium as an instance of the growing number of geometrically complex designs that have become feasible thanks to innovative means of digital production supported by advanced digital design and engineering approaches.

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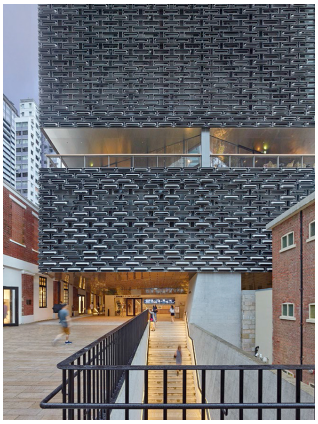
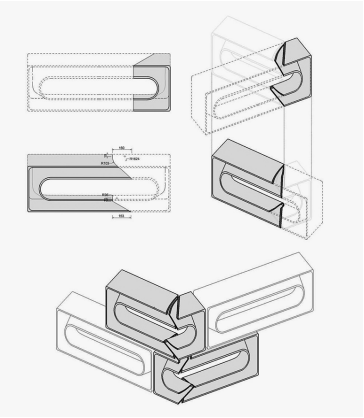
11 Brady Peters and Xavier de Kestellier, guest-eds. *Architectural Design. Computation Works: The Building of Algorithmic Thought.* Volume 83, Issue 2. March/April 2013.

12 Brady Peters, "Realising the Architectural Idea: Computational Design at Herzog & de Meuron," in *Architectural Design. Computation Works: The Building of Algorithmic Thought, v*olume 83, issue 2, guest-eds. Brady Peters and Xavier de Kestellier, 56–61, March/April 2013.

13 Achim Menges, "Manufacturing Diversity," in *Architectural Design. Techniques and Technologies in Morphogenetic Design*. Volume 76, Issue 2, guest-eds. Michael Hensel, Achim Menges and Michael Weinstock, 70–77, March/April 2006.





1.02
Tai Kwun Centre for Heritage and Arts, Hong Kong (2006–2018). The cast aluminium facade.

1.03
Detail of how the pieces meet at the corner.

Recently, in 2020, a senior partner of HdM, Ascan Mergenthaler, wrote on the project for the Tai Kwun Centre for Heritage and Arts, Hong Kong (2006–2018), providing a brief insight into the design process for the unconventional interlocking system of the facade[14] ***(1.02 / 1.03)***. Mergenthaler asserted that the development of the cast aluminium perforated blocks forming the building's envelope was undertaken, as usual in the practice of HdM, in an intensely creative and constructive dialogue with the manufacturing industry and exploiting the advantages of a CAD/CAM integrated system. The senior partner noted that defining details that sit at the crossroads of analogue and digital processes is something HdM have always been interested in and for which digital design and fabrication methods inevitably present as very powerful tools.

Indeed, when looking at HdM's practice from the earliest years, one realises—as Mergenthaler seemed to imply—that one of the fundamental factors that lends their architecture an identity of its own has, in reality, led them to continuously work at the forefront of technology. And in a way this happened long before and with no direct relationship to the emergence of real computing in their architecture, which took place around the 2000s. HdM's particular fascination for the tactile quality of surfaces and their consequent interest in searching for materials that, as Jacques Herzog and Pierre de Meuron affirmed, "not only tickle the retina of the astonished art critic, but that are really efficient and appeal to all of our senses"[15] presents as one of the factors that had turned them into a highly researched practice constantly dealing with the question of how to achieve odd materialities and realise them technically. This means that almost every building by HdM is rich in sophisticated details and innovative

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14 Ascan Mergenthaler, "Material Intricacy," in *Architectural Design. Impact*. Volume 90, Issue 5, guest-eds. Ali Rahim, Hina Jamelle, 110–117, September/October 2020.

15 Jacques Herzog and Pierre de Meuron. "[acceptance speech] 2001 Pritzker Architecture Prize," in *El Croquis. Herzog & de Meuron 1998–2002. The Nature of Artifice*, vol. 109/110, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2002), 14.

systems for articulating both forms and materials that defy conventions and inevitably require the support of advanced design and manufacturing methods. However, strangely enough, this is relatively unexplored and somewhat underestimated by the literature on the topic.

The publication of only three articles worthy of mention that touch on this particular aspect of the work of HdM in thirty years of AD is clear evidence of that. Therefore, resuming our departure point, we can argue, as the British magazine openly reveals, that HdM are not protagonists in the history of the digital in architecture. This is further corroborated when looking, for instance, at the writings by Mario Carpo, one of the few historians, as Picon noted,[16] trying to make sense of very recent events and who has firmly identified, since the rise of the digital in architecture, two turns led by two generations of designers with distinct repercussions for the physicality of architecture.

HdM do not feature in the author's narratives, which is understandable since they did not contribute in the 1990s to "the most conspicuous avatar of the first digital turn in architecture and design [which] was the creation of a new architectural style [...] of smooth and curving, 'spliny' lines and surfaces",[17] as recognised by Mario Carpo and many others. In the same way, HdM are not in the group of those designers who, for the last ten years or so, as the Italian architectural historian and critic noted, "have been busy coping and dealing with the new processes of [the recent technical paradigm] trying to compose with them and putting them to task."[18]

The architects from Basel work the other way around, which is perhaps what makes them particularly non-consensual in the realm of digital culture.

In this regard, the seminal writing by Jeffrey Kipnis, “The Cunnings of Cosmetics”,[19] in which he revised his former position towards HdM's work, could not be more clear as to the architects' specific way of addressing architecture and their inevitable detachment from the supposed precepts of a digital architecture. The author, “advocate of the architectural avant-garde, intellectual apologist for the extreme, the exotic [and] the subversive,"[20] as he described himself, argued, in 1997, that HdM worked from an opposite stance to the more overtly radical designers who, some years before, he had recognised as contributing to the formulation of a new framework for a “New Architecture”.[21]

"While one branch of the avant-garde proposed exotic form as a vector of architectural resistance,” the American critic acknowledged, “HdM offered flagrantly simple Cartesian volumes. While another branch cultivated event theory into seditious programming techniques, HdM indulged contentedly in expedient, reductive planning."[22]

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16 “There have been relatively few historians trying to make sense of these very recent histories. Mario Carpo, Georges Teyssot, me and probably a few others.” Picon, “Histories of the Digital,” 90.

17 Mario Carpo, *The Second Digital Turn: Design Beyond Intelligence* (Cambridge: The MIT Press, 2017), 131.

18 Carpo, *The Second Digital Turn*, 6–7.

19 Jeffery Kipnis, “The Cunnings of Cosmetics: A Personal Reflection on the Architecture of Herzog and de Meuron,” in *El Croquis. Herzog & de Meuron 1981–2000. Between the Face and the Landscape. The Cunning of Cosmetics*, vol. 60+84, eds. Fernando Márquez Cecilia and Richard Levene, 22–28 (Madrid: El Croquis, 2005).

20 Kipnis, “The Cunnings of Cosmetics,” 22.

21 See Jeffery Kipnis, “Towards a New Architecture,” in *Architectural Design. Folding in Architecture*, volume 63, issue 3/4, guest-ed. Greg Lynn, 57–65, 1993.

22 Kipnis, “The Cunnings of Cosmetics,” 22.

In addition to claiming that he has redeemed himself from his early snide dismissal of the work of HdM in favour of an infatuation that reprogrammed his architectural thoughts and feelings, Kipnis recognised, after all, that in the contemporary context, the architecture by HdM was simply the most refreshing around. By taking the example of the Signal Boxes, where the Swiss architects adhered so closely to the box and explored the transformative power of "cosmetics", Jeffrey Kipnis revealed that HdM were not interested in the same topics as the proponents of the exotic form and remarked that, instead, their technique was architectural to the point of fanatism. "In the firm's entire body of work to date", Kipnis said,

> there is not a single use of form, structure or material that does not belong to the strictest canon of the architectonic. Every experiment is an effort to reanimate and update that canon, never to augment it with new entries, certainly not with new forms or programs, but not even with new materials. [...] What makes the firm so interesting is that, unlike the avant-garde, HdM derives its critical edge from an assumption of architecture's basic adequacy and an ease with the controversial proposition that architecture has no other more profound project than to fabricate a new sensibility from its own palette.[23]

As Kipnis made very clear, HdM do not fit into contemporary experimentalism and its distinctive ambition, which is to search for a new form as an expression of the new technological paradigm. Their work is on the fringes of the digital avant-gardes, which makes them, for many, a seemingly non-obvious choice to delve into from this particular standpoint.[24] However, it is exactly this strangeness and the absence of their oeuvre from mainstream discourse on the subject that particularly sparks our interest and stimulates us to look into a design practice that is averse to contemporary trends and has no other pretension than to consistently work from their own precise ideas about architecture.

In this sense, we do not find ourselves discussing geometries that derive from a practice trying to make design sense of what the most cutting-edge technologies allow and might even suggest. We are viewing an architecture whose fundamentals were largely refined in the early works, and that has continually evolved hand in hand with technological advancements, not as a search for something else but to explore their potential for its own benefit, to enhance and to expand the possibilities of the form-making process while staying true to its convictions.

In addition, as the Swiss architects set themselves apart from contemporary digital experimentalism, as Kipnis suggested, observing how they integrate digital design and manufacturing into their work process is an opportunity to gain an accurate idea of the effective operation of these techniques in a practice that is only concerned with architecture. To be more precise, and quoting Giorgio Grassi's words from his essay on the avant-garde, a practice that is about "works, artefacts [and] concrete

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23 Ibid., 27.

24 When we met Steffen Riegas for the first time in August 2019 and explained our interest in investigating HdM's work from the perspective of the impact that digital tools have had on the way they work with geometry, he was taken aback. For the head of the Design Technologies department, HdM were not the most relevant example. In his opinion, it would make more sense to study the practice of architects such as UNStudio and Zaha Hadid, whose architectural forms openly express a new aesthetic and geometric paradigm. However, throughout our conversations, in which we discussed many HdM projects and exchanged several ideas, Steffen Riegas changed his opinion, especially when he realised that we did not intend to restrict the study to the digital period but to extend it to the early practice. The richness of HdM's works—for the variety of representational means and compositional themes explored—was enough to prove the opposite.

proposals interested in serving, not [...] more or less fantastic or extemporaneous [experiments], critical ideas, polemical pretexts, etc., but always [architectural] works."[25]

On a more specific level, the subject of our research leads us to focus on the work of HdM from within. It takes us closely into their architectural practice to ascertain how they regard geometry and have explored it over the years in connection with methodological processes and instrumental means, but also with their specific idea about architecture.

Jacques Herzog was the first to suggest the existence of an important correlation between these topics in their design theory and practice.

In 1988, in "The Hidden Geometry of Nature",[26] one of his most relevant essays to date, Herzog addressed some of the themes that, at that time, outlined their understanding of what architecture should be. In this text, Jacques Herzog particularly emphasised his strong belief in the immaterial quality of the surrounding reality as a higher value that has led them to pursue consistently in each work the unity of the architectural whole and, in this sense, to be closer to nature as a model for architecture.

From his reflections, geometry emerges as the inner structure, like that of all chemical elements, from which form arises; a structure, Jacques Herzog said, "that sometimes becomes visible, but very often remains invisible",[27] strongly affecting the physical appearance of the objects but also their spiritual quality. Therefore, from this perspective, geometry is the device that assists architects to deal with the challenging issue of how to prompt the generative processes. It provides architects with compositional strategies from which forms can be produced and settled rationally, very often synthesising and allowing one to experience the conceptual idea of the project.

Moreover, in "The Hidden Geometry of Nature", Jacques Herzog also referred to “presentation” as an integral part of the process for the communication of the architectural object. While claiming his discomfort with conventional white architectural models and perspective drawings, intended as naturalistic images, Herzog asserted that different modes of representation communicate disparate insights into architecture, calling up specific images of the architectural expression, both visible and invisible. In saying this, the architect from Basel reinforced his conception of representation as something that must be developed from the structure of architecture itself and anticipated the crucial role that representational means would play in their design process as tools that should collaborate with the architectural idea and might contribute to expanding creative possibilities. Over the years, HdM continually demonstrated their interest in a work process characterised by the variety of employed instruments as a condition for going beyond the conventional, allowing them to explore unexpected design ideas and communicate them up to the construction phase.

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25 “E, poiché parliamo di avanguardie in architettura, diciamo anche di passaggio una cosa che viene spesso dimenticata, ricordiamoci sempre che stiamo parlando di opere, di manufatti, di proposte concrete destinate a servire, non di trovare più o meno fantastiche o estemporanee, non di spunti critici, di pretesti polemici, ecc., ma sempre di opera.” Giorgio Grassi, “A proposito di avanguardia (1980),” *Scritti scelti, 1965–1999*, ed. Giorgio Grassi (Milano: Franco Angeli, 2000), 217.

26 Jacques Herzog, “The Hidden Geometry of Nature,” in *Herzog & de Meuron 1978–1988. The Complete Works.* vol. 1, ed. Gerhard Mack, 207-211 (Basel, Boston, Berlin: Birkhäuser, 1997).

27 Jacques Herzog in conversation with the author, “We are surrounded by things that exist, but we don’t see them, we don’t hear them, we cannot smell them...”, FaceTime, Porto-Basel, May 6 and 12, Porto-Tenerife, June 3, 2021.

In her writings on the work of HdM, Theodora Vischer has always expressed a particular concern for these topics, appearing as the author who most consistently delved into these relationships and whose approach is thus the closest to the research we have pursued.

Others[28] have also considered them, but briefly and especially only after the 2000s when the architects began to overtly expose their work process as an integral part of the resulting architecture. Theodora Vischer, in turn, has followed the practice of HdM since the early years, paying particular attention, in her reflections, to their specific approaches to the design method.

Knowing the importance that Jacques Herzog and Pierre de Meuron assign to exhibitions as moments they use to reflect on their own ways of doing, it is interesting to notice that all her critical contributions have happened within the context of three major exhibitions by HdM that took place in 1988, 1994 and 2004,[29] which reinforces the relevance of her writings for the discussion on the subject.

On these occasions, based on conversations with Jacques Herzog, Vischer elaborated on the role that the representation of architecture played for the Swiss architects, relating it to their concern to continuously find adequate ways of depicting the imagined objects that meet their architectural interests. In the first two interviews with the founding partner, among other arguments, Vischer insisted on the idea of "presentation" that he had articulated in the 1988 essay, seeking to clarify and deepen its connection with how they regarded architecture and approached the process for developing the design. The art historian questioned Jacques Herzog about specific modes of representation and discussed with him whether these responded to their ambition of allowing the architectural object to be fully perceived even before it is built.

Underlying Vischer's approach is an awareness that a richer and more comprehensive understanding of HdM's architecture can arise when looking into the methods through which forms come into being, something that we also share and take as a presupposition in our investigation.

Like her, we argue that HdM's ever-so-involved design process plays a fundamental part in their architecture. In some cases, it is even the key to reading some of the most intriguing details of the

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28 William JR Curtis is one of these. In 2001, he noticed an evident change of direction in the work of HdM, arguing that this had taken place in coherence with old recurrent themes of their practice that stemmed from the idea of taking the structures of nature as a possible inspiration for architecture. In a conversation with Jacques Herzog, Curtis asked him about the compositional strategies of recent projects, where a greater complexity of space and geometry seemed to result, the author said, from the meeting between schemes of order sensed in natural phenomena and the artificiality of modern technology. Questions of language, geometry, abstraction and working process in their relationship with HdM's idea about architecture then came to the discussion.

Philip Ursprung also stressed, in a way, the relevance HdM assign to the working methods by which formal strategies are triggered and then developed as the curator in 2002 and 2003 of their exhibition at the Canadian Center for Architecture. Entitled "Archaeology of the Mind", this exhibition worked as an explicit exaltation of the processes that attend the creation of architecture by only displaying the physical documents HdM produced to set mental processes in motion.

29 Theodora Vischer conducted two interviews with Jacques Herzog, in May 1988 and March 1994, that were published in the catalogues of the exhibitions "Architektur Denkform" at Architekturmuseum, Basel (1988) and "Architecture of Herzog & de Meuron. Portraits by Thomas Ruff" at the Peter Blum Gallery, New York (1994). The first had as a background theme the heterogeneity of external appearance with regard to form, material and character that one may notice when confronting the early buildings by HdM. The second occurred in connection with the photographs Thomas Ruff had taken of their buildings and the interaction with exponents of the fine arts that, in those years, was particularly integral to HdM's working process.

In 2004, Theodora Vischer curated with Jacques Herzog their exhibition at the Schaulager in Basel, "Herzog & de Meuron. No. 250 An Exhibition", which primarily focused on showing elements that documented their design process instead of the completed projects or finished buildings. She was also the editor of the published vademecum. Cf. Jacques Herzog, "Conversation between Jacques Herzog and Theodora Vischer, May 1988," by Theodora Vischer, in Herzog & de Meuron 1978–1988. The Complete Works. vol. 1, ed. Gerhard Mack, 212–217 (Basel, Boston, Berlin: Birkhäuser, 1997); Jacques Herzog, "Interview by Theodora Vischer with Jacques Herzog," by Theodora Vischer, in *Architectures of Herzog & de Meuron. Portraits by Thomas Ruff*, 28–33 (New York: Peter Blum, 1995); Theodora Vischer, *Herzog & de Meuron: No. 250 An Exhibition* (Münchenstein/Basel: Schaulager, 2004).

architectural object, presenting itself as symptomatic of the conceptual idea they try to achieve in each design and the compositional strategies they experiment with. We consider that in the work of HdM there is an intimate relationship between the modes of representation and the architecture itself, where both affect each other, and from which geometry—the orderly system that triggers and regulates the creation of forms—emerges as the connecting link in the whole process.

Jacques Herzog himself hinted at a reason for this in one of his conversations with Vischer.

"Just as we have not developed a kind of corporate identity or a typical H & de M style," he said, "we have not settled on one single valid means of representing our work that we would consider binding. We have to keep finding new forms, just as we do for the building itself."[30]

HdM do not work from preconceived ideas or pre-established languages, which means that in their practice, the challenging uncertainty of generating forms and finding the right compositional devices from which those can emerge and later be developed is placed every time in a particularly pressing way. Therefore, in a highly research-oriented practice like theirs, means of representation play a crucial role. These work as the tools with which the architects literally create and refine the architectural objects in their details, supporting the development of design ideas and even suggesting possibilities, always in an intimate relationship with the developed architecture. As Jacques Herzog argued, "the variation and multiplication of working methods is […] a crutch for [them] in order to find a path which eventually leads to a piece of architecture."[31]

The aim of our thesis is thus to provide the coordinates for an in-depth reading of the work of HdM from this perspective. We depart from Jacques Herzog's words from 1988—which we assume to be revealing for the deep understanding of their practice—and place ourselves in the same line of inquiry as Theodora Vischer, but with the intent to take it forward by looking very closely at how they have addressed architectural practice throughout the whole range of their 40 years of work.

We will cross modes of representation and work methodologies with design interests and a precise idea about architecture, relating them to the processes for geometrically describing objects from conception to construction. An interaction that in the case of HdM is revealed to be particularly rich insofar as they have continually reinvented themselves over the years with form-making processes that rarely repeat and design methods and tools constantly evolving hand-in-hand with technological advancements. Indeed, what began as a traditional office—with hand drawing as the tool par excellence of architectural practice and the forms settled on classical geometric constructions—has developed by gradually incorporating the design and productive capabilities of the digital medium, taking advantage of these to reformulate ways of doing, explore unforeseen composition strategies and push forward the design.

Within this process, one of the central issues in our questioning arises.

Theodora Vischer is again the author who overtly pointed to this factor at its origin. In 2004, as the curator of HdM's exhibition at the Schaulager, Vischer asserted that as a consequence of the

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30 Herzog, "Interview by Theodora Vischer," 28.

31 Herzog, "We are surrounded."

1.04
View of the walls of the sourcebook room at the “Herzog & de Meuron. No. 250 An Exhibition” (2004).
Illustrations associated with the development of Project No.169: Schaulager.

possibilities the computer has opened up in design as well as in building, the architecture of the Basel office had changed.[32]

Her argumentation was precise in what concerned their work process. The author gave some examples of how the digital medium affected HdM’s methodology, providing them with new tools for approaching design. The "sourcebook"—a collection of hundreds of digital images that the architects began to gather during the course of a project as a kind of virtual picture dictionary and a stimulus for the entire development process of the design—was one of these invaluable instruments ***(1.04).*** Vischer affirmed that HdM had embraced with fascination and pleasure the full potential of the computer-based digital possibilities in the execution and planning of their projects, which happened in the transition of the millennium. Nevertheless, in her writing, the extent to which this new work process impacted their architecture remained obscure and was not discussed.

There is no doubt that the early 2000s were, for HdM, a moment marked by a significant change in direction in their work, promoted by the coincidence of several factors—like the increase in the scale of the projects and the reformulation of the office's internal organisation into a ramified structure of partners—in which the computer, as mentioned above, played a prominent part. "If you see what is in the pipeline," Herzog said in 2003, "you can see the dramatic changes in outlook that are taking place, arising from our increased experience, the technology of computers—which has given us new tools—, and the new understanding that comes from working in different geographies and circumstances."[33]

The work in this thesis focuses on this major argument. It seeks to recognise what in the architecture of HdM actually changed from the moment they began to explore digital technologies in

32 Vischer, *No. 250 An Exhibition*.

33 Luis Fernández-Galiano, “Dialogue and Logo: Herzog Thinks Aloud,” in *Arquitectura Viva. H&deM del natural*, no. 91, July-August 2003, 125.

both design and construction, and also questions whether this was disruptive in their practice. Did the introduction of digital means create a cleavage in how HdM addressed design and understood architecture? Or did this happen in line with their way of thinking about architecture, and should it be seen as a consistent evolution that aimed to respond to the challenges of the contemporary context?

Some authors[34] emphasise this moment in HdM's career as the beginning of renewed architectural interests that, combined with the new instruments, have led to the revision of their vocabulary and some losses—the authors regret—compared to their initial designs.

Let's focus on Rafael Moneo, who has frequently commented on the architecture of HdM and has included them in the group of a few notable contemporary architects for whom he has a respectful admiration.[35]

According to the Spanish architect, the work of HdM subdivides into two phases. The first is characterised by private and intimate architectures, deliberately strange in expression and in which the iconic value seemed to be the only thing that mattered to the architects, and the second one is marked by the international recognition of HdM, which has led them to become immersed in the more exuberant and exaggerated context of large-scale commissions. While in the early works, Moneo argues, the Swiss architects took "construction" as the visual substance of what shapes architecture and recognised "order" as a valuable factor for the definition of form—illustrated in the building process—after the 2000s he considers that the attention paid to the envelope, as a critical element of architecture, and the enhancement of surface texture are the topics that then came into play.

For Moneo, the Schaulager Laurenz Foundation, Basel (1998–2003), is the project that embodies this inflexion point. The building for the storage and display of works of art is one of HdM's designs that, in the author's opinion, better synthesises the first 25 years of their career, at the same time as it already alludes to the themes that would become the substance of their architecture.

Rafael Moneo regards the Schaulager as one of the most successful buildings by HdM for the clarity of the typological approach—as it provided a convincing answer to what a museum can be today—and also for its great spatial and plastic interest ***(1.05)***. However, the geological treatment that the architects gave to the window openings—as if these were almost naturalistic fissures directly resulting from the modelling of clay—is, instead, something for which he feels some discomfort ***(1.06)***. The Spanish architect sees this detail as belonging to a figurative world that came from digitalisation and would become recurrent in HdM's practice, reappearing in several later projects, especially related to the treatment of the envelope and the texture of the external surfaces. A kind of new ornamentation that the

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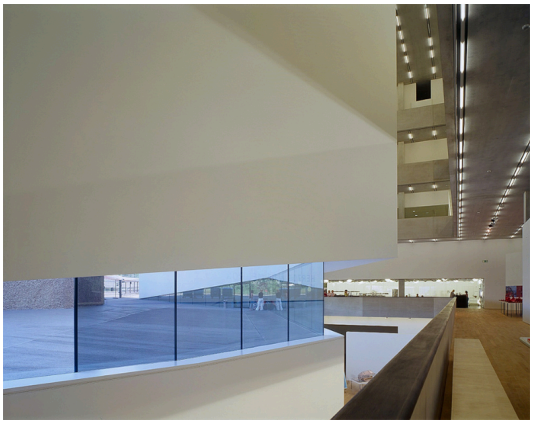
34 One of the most extreme criticisms of HdM's work in recent years came from William JR Curtis. In 2001, the author conducted an intriguing interview with Jacques Herzog. However, in 2015, while commenting on HdM's design for the Triangle, Paris (2006–...), which he described as an outrage and an irrelevant extravaganza, he asserted that their architecture has radically changed. "As for Herzog and de Meuron, there was a time when you could count upon them to formulate subtle architectural responses to questions of place, time and society. But in the past 15 years, they have become more and more involved with sensationalist images as ideological advertising for their clients." William JR Curtis, "Outrage: Herzog & de Meuron's 'Tour Triangle' in Paris is an irrelevant extravaganza," *The Architectural Review*, March 11, 2015. https://www.architectural-review.com/essays/outrage/outrage-herzog-de-meurons-tour-triangle-in-paris-is-an-irrelevant-extravaganza.

35 Rafael Moneo has discussed the architecture of HdM in two books published in 2004 and 2019. See Rafael Moneo, *Inquietud Teórica y Estrategia Proyectual en la Obra de Ocho Arquitectos Contemporáneos* (Barcelona: ACTAR Barcelona, 2004) and Rafael Moneo, *Nuevos interesses otros discursos* (Pamplona: T6 Ediciones, 2019).



1.05
Schaulager Laurenz Foundation, Basel (1998–2003).

1.06
The windows geological treatment.

computer made possible, in both design and building terms, and for which the architects felt particularly attracted, even methodologically.

For Rafael Moneo, it is thus clear that, at that time, HdM were exploring new production means in architecture, which also implied that their focus had, to some extent, been redirected. "From now on," he said, "the problem of HdM will not be so much to show us the materials in their essentiality until converting them into the substance of their architecture, but to begin using more arbitrarily chosen figures as a reference for the constructive support that we already know."[36] A way of doing, typical of this second phase and that, according to the Spanish architect, is often associated—to his displeasure—with compositional details that he finds somewhat unnecessary and even capricious in the architectural work as a whole.

At this point, other questions might also be formulated.

Should these new topics be considered, as Moneo seems to argue, actual losses in the architecture of HdM? Do these observations mean that the interest in material and construction refinement, so intrinsic to their first designs, has somehow been replaced by mechanised ornamentation produced by the computer's indifference? Or, do these experiments reveal, after all, that HdM were looking for a new artisanal quality that the digital enables and that simultaneously responds to contemporaneity?

Without intending to reveal the results of the developed study, our work questions some of Rafael Moneo's assumptions, adding a more comprehensive vision to his ideas in two specific aspects.

We agree that much happened in the career of HdM between the 1990s and the 2000s with relevant implications for their architectural practice. Nevertheless, addressing their work as if it were

36 "De ahora en adelante, el problema de Herzog y De Meuron no sera tanto mostrarnos en su esencialidad los materiales hasta convertilos en sustancia de la arquitectura, sino que empezerán a pedir ayuda a figuras más arbitrariamente elegidas para que sirvan de referencia al soporte constructivio que ya conocemos." Moneo, *Nuevos interesses*, 125.

made of two distinct moments implies contrasting ways of doing and accepting that there is a before and an after that inevitably differs. From our viewpoint, an in-depth look at the design methods and sculptural strategies the architects from Basel have experimented with over the years suggests the opposite. It shows that more subtle and complex interactions have occurred in their oeuvre, leading to several inflexions that, together, make one regard their architecture and approach to design as something that has steadily adapted to the world as it changes.[37] Therefore, instead of accepting this supposed fracturing moment and base our thesis on a twofold relationship, our work considers that the architecture of HdM has evolved coherently through several kinds of design research that, in their apparent diversity, illustrate the restless character of these architects and end up reinforcing the idea of continuity on which we believe their work stands.

Likewise, a similar idea of continuity must also be observed with regard to the impact the computer had in their practice and the supposed detachment that it may have caused in relation to their early fundamentals. Indeed, the architecture of the Basel office cannot be understood today without considering the digital medium, nor would it have followed the direction it did without the possibilities that this technological instrument has brought into their design practice. However, we argue that within the consistent evolution of their work the vision of their first architecture has yet to be lost.

Jacques Herzog has, in a way, reinforced this argument when he described—interestingly—the Schaulager as a statement against the flashiness of some buildings from the end of the nineties, when architecture became a political instrument, coming closer, he said, "to the branding moment than to the research moment."[38] For Herzog, the Schaulager is the project in which they fully adhered to the digital, but with an awareness that allowed them to proceed critically without giving up their early convictions. "The kind of earthly power it boasts," he argued,

> makes it a significant statement against bubble architecture, although not a generational statement against digital architecture. Because the Schaulager has this earthy side, but is almost digitally produced, almost out of genetic engineering. So it has these two sides, and it is interesting that it contains this computerized world, these new materials, and at the same time shows an extreme firmitas and an almost stupidly simple way to build a building.[39]

It is this specific idea that our work ultimately seeks to prove while bringing to the discussion the project for the extension to the Tate Modern (TM2) in London ***(1.07)***.

Developed between 2005 and 2016, the pyramidal tower that rises adjacent to the southwest corner of the former power station by Giles Gilbert Scott is a project that corresponds to the moment in the office in which digital design and manufacturing techniques were fully consolidated. Therefore, in the

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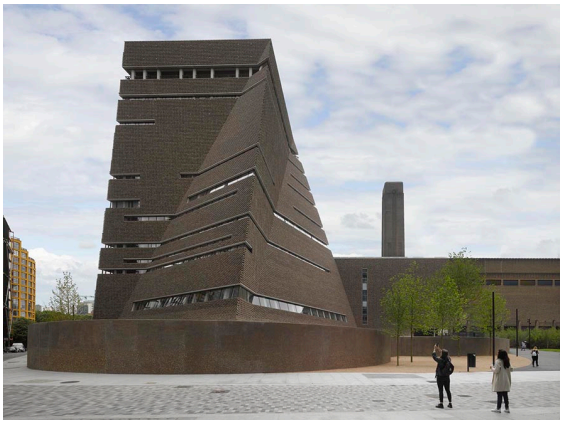
37 In our conversation with Jacques Herzog, he revealed a particular awareness that things naturally change just because of the passage of time and implied that this notion is crucial for them in their approach to architecture. Herzog said, "we are also much more dependent on the spirit of the time than we believe. Look at what your dresses are. If you looked back ten years ago, you would think, "How is this possible?" But you are the same person; you didn't have a better taste ten years ago or a better taste now. So you change all the time. And in architecture, the reason why we always experiment with new technologies or new sculptural strategies is so that we are fitter, and we have a larger array of options." In the edited version of the conversation with Jacques Herzog in the appendix to this dissertation, this quote was not published.

38 Galiano, "Dialogue and Logo," 125.

39 Galiano, "Dialogue and Logo," 126.



1.07
The Tate Modern Project, London (2005–2016).

first instance, the intricate design process that underlies the conception of this building—from the outlining of the architectural strategy to the definition of construction details—offers the opportunity to delve into a work methodology marked by the support of highly technological means and in which questions of geometry also became particularly pressing.

Especially for the design of the brick facade, this project required the backing of computational means that, combined with other tools and methods, were revealed to be fundamental to solving an architectural detail of great complexity in both geometric and construction terms. From this perspective, TM2 is one of those HdM designs that counted on the invaluable support of the DTG, with Kai Strehlke himself guiding the digital process.

In the long course of its development, there is thus a story that deserves to be reconstructed and told that clearly illustrates the research-oriented practice of the office, as well as the dogged spirit of the architects in deeply testing solutions until the one that fully grasps the architectural idea is achieved. Furthermore, as the result of intense and rich interaction between the design team and the DTG, the example of TM2 also allows one to ascertain how HdM have incorporated the digital means into their toolbox and have combined this with a methodology that does not dispense with the sensory input that only more analogue and traditional approaches can provide. It reveals how the computer was indeed critical for HdM to respond to the increasing size and complexity of the projects, allowing them to expand the limits of their research at the same time as it emphasised the role of geometry by placing it at the core of the architectural process.

An in-depth look at some of HdM's projects from this period, and from a perspective that is also interested in showing how digital means were integrated into the design process of the Basel office and contributed to the accomplishment of the architectural ideas, was provided by Kai Strehlke when he

was the head of the group. In a few articles and lectures,[40] Strehlke presented some of the projects in which he was directly involved, elaborating on the functioning and the logic underlying the tools the group created to assist the architects in achieving their design goals and taking them to construction. From this perspective, Kai Strehlke's considerations are particularly valuable as they reveal a whole world of information, with intimate details of the projects that only those who took part in the processes get to know and which are very rarely disclosed.

Although Strehlke did not disregard the small scale—having referred to the design of objects like the Bird's Nest Lamp (2009) and the chairs for the Volkhaus Basel, Basel (2011–2012)—in his articles and presentations, he mainly focused on major projects such as the ornamental facade for Ciudad del Flamenco, Jerez de Frontera (2003–2011), the frit-pattern for the glazing of Elbphilharmonie, Hamburg (2001–2016) and the arrangement of the unevenly sized windows for the Südpark Basel, Basel (2002–2012). All are examples of where the digital came into play to solve design issues related to ornamental and functional aspects of the building with a high level of complexity and that by more traditional means would have been challenging to accomplish.

In his discourse, Strehlke often sought to convey two aspects he considered crucial in the approach to the digital in the practice of HdM. In addition to arguing that the success of the tasks in which the group was involved implied a high knowledge of geometry and an ability to reduce the issues to very simple and straightforward logic, the head of the DTG singled out the fact that in the Basel office the computer was never used as a tool for finding form. The digital instrument did not replace the creative design process of dialogue and exchange within the teams, nor could it substitute for conceptual thinking or intuitive vision. As he often mentioned, for the Swiss architects, the computer was merely an addition to the broader set of tools used in their work methodology.

However, although Kai Strehlke closely followed the design process for TM2, in his reflections he did not consider this example, nor did he discuss how the new approaches related to the early practice of the office. Whether the original fundamentals of HdM's architecture—the ones that Rafael Moneo praises so much—could have been reinterpreted within the digital processes or whether technological methods and tools could eventually have contributed to recast and to improve them were not issues at the heart of his discourse. Nevertheless, in our view, this particular point is precisely what an examination of the Tate Modern extension might bring about. One of the most significant features of this project lies exactly in the fact that it perfectly combines highly technological aspects—related to the drafting and building process—with archaic architectural issues, which makes one realise how architecture can indeed prevail as a pure expression of construction.

When HdM decided to clad the new pyramid with a brick veil, after having worked for two and a half years on concepts that stood in stark contrast to the existing building, weren't they showing us that the uniqueness of the architectural object might also arise from the idea of creating a coherent whole with

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40 We highlight as having been particularly relevant for our investigation the following lecture and articles by Kai Strehlke: Kai Strehlke, "The Digital Toolbox of Herzog & de Meuron," Zurich, Institute of Technology in Architecture- Faculty of Architecture, January 28, 2013, video, accessed April 17, 2016, https://vimeo.com/72031563; Kai Strehlke, "Digital Technologies, Methods, and Tools in Support of the Architectural Development at Herzog & de Meuron," in *ACADIA 09: reForm ( ) Building a Better Tomorrow*, eds. Tristan D'Estrée, Russel Loveridge and Douglas Pancoast 26–29 (Chicago: ACADIA, 2009); Kai Strehlke, "4.6 Ciudad del Flamenco," in Kai Strehlke, "Das Digitale Ornament in der Architektur, seine Generierung, Produktion und Anwendung mit Computer-gesteuerten Technologien" (PhD diss., ETH Zürich, Zürich, 2008), 94–118.

the existing context? Weren't they, in the same way, proving that one can be contemporary and technological while working with such a traditional material as the brick?

When HdM spent more than half a year testing how the brick stones could combine in a facade detail, making use of geometry and computational techniques to achieve a solution that responded to architectural and construction demands, weren't they revealing once again that the material can become the substance of architecture? Weren't they reducing architecture to its original condition of building, making the construction speak for itself without the slightest formal impact?

The arguments implied by these questions make TM2 one of the most emblematic projects by HdM, in which they have revisited the fundamentals of their architecture with a contemporary tone. Therefore, when looking at how the Basel architects worked with the brick, intensely exploring its tectonic qualities to find the essence of the building's architectural expression, the words of Rafael Moneo on the Plywood house could not be more appropriate. As in the wooden pavilion of the 1980s, concepts such as specificity, material and construction reappear in the London project as the guiding lines for the architecture.

> "Having said this, and emphasising […] the specificity that will be present in their works, we would have to immediately draw attention to how much this house is a construction lesson," Moneo argued. "Construction becomes the visual substance that shapes architecture. An idea of what construction is that is undoubtedly linked to materials. And when we refer to materials, we come across another of the characteristics of Herzog & de Meuron's work, which we are faced with from the beginning, as much of their architecture comes from understanding that the materials can have an expression of their own: making the materials speak for themselves is an integral part of architecture. Even when, as in this case, the material used is relatively current. Simple wooden panels."[41]

Which, in the case of TM2, is a specially produced brick.

Structure and Methodology

In addition to the introduction and conclusion, our work is divided into two main parts, preceded by a chapter dedicated to framing the problem.[42] Together, section 2, Part I and II, correspond to a methodological approach that, proceeding from general to particular, intends to cover the following aspects: the broad contextualisation of the theme; its characterisation within the work of HdM; and, in the end, its demonstration supported by an example.

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[41] "Dicho esto, y haciendo hincapié en toda esta mención a la especificidad que va a estar presente en sus trabajos, tendríamos que llamar la atencíon inmediatamente después sobre cuánto esta casa es una lección de construcción. La construccíon se convierte en la sustancia visual de aquello que da forma a la arquitectura. Una idea de lo que es la construccíon que indudablemente va ligada a los materiales. Y al decir los materiales, nos vamos a encontrar con otra de las características de la obra de Herzog Y De Meuron, con la que nos encontramos desde el principio, como mucha de su arquitectura procede de entender que cabe dotar de expresión propria los materiales: hacer que los materiales hablen por sí mismos es consustancial con la arquiectura. Incluso cuando, como ocurre en este caso, el materiale que se utiliza es relativamente vulgar. Simples paneles de madera." Moneo, *Nuevos interesses*, 88.

[42] To ease the reading of the work, we decided, regardless of the two parts, to number the sections sequentially from the introduction—section 1— to the conclusion—section 13.

The images are numbered section by section, while the footnotes follow the overall structure of the thesis, being renumbered in Part I and II. The footnotes are thus sequential in sections 1–2, Part I (sections 3–8), Part II (sections 9–12), and section 13.

Section 2 provides an overview of the relationship between geometry and architecture in the contemporary context. It asserts itself as a brief state of the art appraisal on the digital in architecture, in which we circumscribed the phenomenon methodologically and gathered some of the architects whose work marks the debate on the contemporary context.

The central body of the thesis is dedicated to the work of HdM and is organised into two parts that look differently at the practice of these Swiss architects and result, methodologically, from research strategies that are also diverse.

Part I asserts itself as a kind of macrohistory of the Basel office.

It offers a narrative of what happened in HdM's design practice—from 1978 until recently—focusing on the importance of geometry and digital tools in their architecture, and following a chronological sequence. Based on the combination of mainly published sources and the precious evidence that the projects unveil, the critical analysis and interpretation of HdM's oeuvre that were carried out led to the recognition of five moments that mark the office's long history and signal the cadence of its continuous evolution.

These moments are directly reflected in the sections of Part I.

These provide a structured view of the work of HdM over the years that arises when putting together geometry, architecture and design tools. By title, they point to the most relevant representation techniques—or some of their associated concepts—that the architects used in each period and that also allude, in their broader meaning, to specific geometric approaches for conceiving shapes.

Although we know that transitions in the work of HdM never occurred abruptly, happening instead through innovative experiments followed by a smooth integration, for a clearer systematisation, we have delimited these moments within precise years related to significant events.[43] An exhibition at the end of 1988, a project from 1997, and the collaboration in the office of the two heads of the digital technologies department in 2005 and 2015 are the episodes on which we set the boundaries for our classification. These factors announced, in the practice of HdM, that new architectural research was about to come. While the first two directly involve compositional strategies and architectural themes, the last two concern the design process and working methodology.

Design tools are what primarily distinguish the five moments. The instruments and techniques for approaching the design differ in each period, marking with their steady evolution the rhythm with which the various turns have happened. However, as their name implies, they are just tools, which means that by themselves, and especially in the case of HdM, they are not enough to promote direction changes in the architectural practice. They assist architects to pursue their design aims and interests, allowing them to represent, visualise and communicate the imagined objects to construction. In the same way, they might open new research paths or suggest novel compositional strategies by improving the overall control of the objects in their multiple facets and expanding the possibilities for experiencing them. Thus, in addition to the design tools and their resulting ways of dealing with geometry and approaching the work process, each moment was defined by also taking into account the architectural research topics

[43] The delimitation of each moment within precise years is indicated on the HdM Chronology Map. However, knowing that the transitions happened progressively, we decided not to mention the dates in the sections so that the idea of apparent shifts would not be imprinted in the discussion.

that underlie HdM's different approaches to form-making. Indeed, despite the apparent diversity that the works of HdM reveal, by carefully reading the projects and comparing proximate details, patterns ultimately emerge, showing that large, long-term trends exist in the architecture of the Basel office and that these have, in a way, followed—which is interesting to notice—what was happening on the methodological side.

After an introductory section on the HdM atelier, which touches on important topics for the reflection that follows, Part I depicts our critical interpretation of their architectural practice based on five crucial moments: “Sketches and Plans” (1978–1988); “Collage and Perspective” (1989–1997); “Pixellation and Digital Modelling” (1998–2004); “Scripting and Parametric Design” (2005–2014); and “Data and Interaction” (2015–2020).

These sections share the same writing structure, which we later slightly adjusted according to the specificity of each moment. They are all organised into three subsections.

The first frames the work of HdM in the given period, discussing their theoretical thinking and introducing the compositional interests that marked the architects' approach to design and guided the developed experiments. The other two subsections focus on the architecture itself and the methods and tools that assisted the creative process. By looking at built and unbuilt projects in detail, we analyse how HdM made use of geometry and its relationship with the working method and the representational means supporting it, as well as their ideas about architecture and the desire to achieve specific formal intentions.

Together, the five sections cover HdM's work from hand-drawing and the subsequent introduction of CAD systems, through the delicate moment when digitalisation, as a novelty, presented to the architects a whole world of enticing creative possibilities, until today, where digital technologies assert themselves as unavoidable tools, necessary for responding to increasingly demanding design processes. At the same time, they also emphasise how HdM's architecture has evolved through various compositional strategies that, as in a crescendo, tended towards ever-growing geometric complexity only to return recently to renewed simplicity.

Part II focuses on one of the office's moments and involves the accurate, in-depth study of a single project.

As one of the main objectives of our work is to consider the impact of the digital in the practice of HdM, we decided to concentrate on the fourth period—"Scripting and Parametric Design"—which corresponds to the years in which Kai Strehlke worked in the office. By this time, computational design techniques and digital fabrication methods were part of HdM's working process, which means that the complexity that often characterised the projects from these years—mostly related to geometric issues—greatly benefited from these processes. Moreover, focusing on a period from about fifteen years ago also made it possible to opt for a built project as the case study and thus to extend our critical analysis from the early concept design phase to construction.

Although the criteria for the selection of the building to take as an example were clear—as these were critical for us to meet the assumptions of the thesis we intend to demonstrate—the final decision to study the pyramid for TM2 and to delve into the intricate issues that the construction of its outer skin

in brick brought to the design process was supported by Kai Strehlke.[44] Having followed closely the most cutting-edge projects from these years, Strehlke knew exactly from within the practice, how the interplay between the teams had worked in this project and how much the digital processes had contributed to the decision-making. He was perfectly aware of how the whole process had developed—at least concerning the use of digital tools—and the grounded knowledge he had of this example, also by comparison with other projects, was decisive and reinforced our initial intuition that the extension to the Tate Modern could indeed bring the right topics to the discussion.

The chosen project should have resulted from a design process in which digital tools had been crucial in realising the architectural idea and in solving all those complex geometric issues that, arising from the search for the rational construction logic, ended up marking the uniqueness of the building's architectural expression. However, in addition to the digital component, the building should be considered from a formal point of view, so enduring architectural topics—such as how to draw a window, how to finish the volume on top or how to turn a corner—should also have been addressed in its design. The extension to the Tate Modern had all of that, with the additional factor that, in the same complex, two interventions by HdM from different periods stood side by side and entered into dialogue.

Indeed, when we were already investigating the TM2, in November 2020, HdM published a brief description revisiting the project that fully validated our reasoning and strengthened the decision to have taken this building as the central case study of the thesis.

"The Tate Modern might be described as the centerpiece of all our work," HdM asserted.

> No other project has remained an ongoing challenge for a long time. No other project has so profoundly changed a place, a client—in fact, an institution, the Tate—and ourselves. No other project demonstrates so clearly how the work of architects has changed, their public coverage, their methodology and, in particular, the transition from analog to digital production. Digitalisation not only comprises planning but also construction itself, the physical implementation on the construction site. This was particularly and impressively conspicuous in constructing the brick facade of the pyramid extension of Tate Modern (TM2). The position of every single brick had a number that corresponded to its computer-generated placement.
>
> It is an inconceivable development on looking back at the 1990s and the working conditions in those days when we submitted our competition proposal for the Tate Modern (TM1) project. With our staff, we worked with collages and other manual techniques to express our vision and ideas for refurbishing the colossal industrial building.[45]

The second part of the work is thus dedicated to the extension of TM2. It is organised into four sections where we critically analyse the building from different angles, following an approach that goes from the general framework of the project to the investigation of one of its most peculiar construction details.

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[44] The conversation with Kai Strehlke, in which we discussed the decision for the TM2, is included in the thesis appendix. See Kai Strehlke, in conversation with the author, "I would choose Tate Modern," Zurich, August 7, 2019.

[45] Herzog & de Meuron, "No. 263 The Tate Modern Project," in Gerhard Mack, ed., *Herzog & de Meuron 2005-2007. The Complete Works*, vol. 6, (Basel: Birkhäuser, 2018), 117.

Unlike Part I, Part II results from a research methodology mainly based on unpublished primary sources. The reports, elaborated by the architects for the several design stages, and the conversations we had with the leading players of the process were crucial. They provided information on the facts we had to assemble in a coherent sequence to proceed with our interpretation.

Throughout the four sections of Part II, the project for TM2 is deconstructed into a series of sub-themes that aim to reveal the design process in its most intrinsic factors and to deeply comprehend it, especially in those details where questions of geometry became particularly delicate. Departing from the masterplan—realised before the building project and in which HdM set the general direction for the future intervention—the study of TM2 addresses the intricate process of the schematic design stage, where three different projects for the sheer volume were fully developed, to finally focus on the brick stone, the ultimate construction element from which some of the major design issues of the building ended up emerging.

Both parts of the work conclude with two diagrams—the HdM Chronology Map (Part I) and the TM2 Chronology Map (Part II)—that visually complement the written reflection. They provide an overall view of the addressed subject and clarify some developed reasoning. However, their great relevance lies in the fact that they have been crucial investigation instruments. They followed the whole research process and were progressively assembled as the data collection, study and thesis writing moved forward. Initially thought of as a strategy to graphically structure the immense amount of information coming from the readings and the recognition of the sources, they soon contributed to our analysis by making the relationship between the various elements more overt. In addition to ensuring control of the whole, the diagrams, by showing the data visually formatted and being chronologically arranged, highlighted previously unnoticed facts and suggested unexpected analogies, allowing new judgments and connections to be drawn.

In Part II, the Chronology Map is followed by an Architectural Reference Map that we put together as we studied the project for TM2 and correlations with previous HdM designs began to emerge.

This map is organised into some architectural themes that characterise the project for the Tate Modern extension and have been explored by the Swiss architects in other designs that sometimes date back to the beginning of their career. Therefore, in addition to contributing to the broader comprehension of the topic in question, the map clarifies how there are specific recurrent themes in the HdM practice that, like a kind of genetic code, run through their oeuvre, standing out as distinctive signs of their approach to architecture.

At the end of Part II, a set of floorplans and sections, prepared specifically by the office for publications, was also included, contributing to the understanding of the Tate Modern project—TM1 and TM2— as a whole.

Bibliography and Sources

As the title of the thesis suggests, our work is built from three domains that are reflected in the major thematic groups into which the bibliography may be subdivided.

We refer to the writings that address the subject of geometry from a disciplinary perspective; the publications that investigate the topic of the digital in architecture, both from a theoretical and practical point of view; and lastly, the written and audiovisual material that, in different ways, focus on the practice of HdM.

The publications that occupy more than half of the bibliography regard the Basel office and can be grouped into three types depending on the approach they take to the work of the Swiss architects and, consequently, on how they have supported our investigation and thinking. Without intending to explain it in detail, we will briefly refer to how these three types have contributed to the documentation and analysis developed.

The first genre includes critical essays by authors who, like us, look at the architecture of HdM from a perspective that mainly serves their theoretical thinking. Above all, these kinds of reflections allowed us to take on a sharper and more comprehensive interpretation of the architecture by HdM. Most often, these publications are by architects who examine and comment, with a professional eye, on the work of their Swiss colleagues. The writings by Rafael Moneo, from the two books that collect the author's lessons on the practices of some contemporary architects he admires, and the short reflections by Eduardo Souto Moura, Rem Koolhaas and Steven Holl, are examples that fit into this type of bibliography. They all have provided us with acute personal insights into the architecture of HdM that, in addition to supporting some of our convictions, broadened our comprehension of the projects by often drawing attention to perspectives that made us aware of previously unnoticed architectural dimensions.

Despite not being an architect, the writings by Philip Ursprung also enter into this group. In his several reflections on the work of HdM—with the catalogue for the exhibition at the CCA as the most inspiring—Ursprung takes us into the universe of relationships that the practice of the Swiss architects unconditionally establishes with the field of art and whose perception is crucial to fully understand some of the unconventional details that mark their approach to architecture.

The second type of bibliography concerns the publications that, both as primary and secondary sources, have contributed to our structured view of the work of HdM over time. We refer to authors who, assuming a kind of role as chroniclers, have followed the practice of HdM, reporting and analysing the evolution of their architecture with a certain sense of continuity. Their particular closeness to Jacques Herzog and Pierre de Meuron makes them strategic sources that provided us with relevant original information that would otherwise be very difficult to access.

The six volumes of the HdM monograph edited by Gerhard Mack in collaboration with the office are one of the most significant examples of this second genre. In addition to the projects' descriptions by the architects, these books contain a well-structured and rich synthesis of the addressed period compiled by the editor. They include a wealth of original photographic material, coming from the architects' digital archives, that documents the design and construction process of the buildings. From this perspective, these images are highly revealing as they point to singular details and underlying information that the written documentation often fails to mention.

The conference "Jacques Herzog y Pierre de Meuron" by Luis Fernandez-Galiano and the essays he has published since the 1990s in "El Pais" and the "Arquitectura Viva" issues dedicated to HdM, the book "From Basel" by Jean-François Chevrier, and the two articles by Rowan Moore in "The Guardian"

and "The Architectural Review" were a crucial complement to Mack's publications, providing us with the macro view of HdM's work. They allowed us to articulate a common thread in the history of the Basel architects that we later improved throughout the research process with facts, analogies and reflections, progressively moving away from the authors' initial references and building our own interpretation.

The third type of bibliography concerns the theoretical production by Jacques Herzog and Pierre de Meuron, scattered in their writings of the beginning of their career and the always very precise descriptions of the projects, but also in the many interviews and lectures they gave over the years. These primary sources allowed us to get closer to the architects' thinking and, in this way, to access the ultimate reasons for what we have studied.

However, in addition to the published sources, we also developed our research from direct contact with the buildings, the office, the archive and the people involved in the processes.

At a given point in our research, the available documentation was revealed to be insufficient to go further in our study. The subject we wanted to investigate was not published, and we knew that personal experience in the functioning and atmosphere of the office would be crucial for arguing about and discussing the ideas in a sustained and confident way. Therefore, we approached the office. We went several times to Basel—where we visited a significant number of HdM's buildings in the region—frequented the Campus in Rheinschanze, visited the architects' archive in Dreispitz, and, with their crucial support, we got access to first-hand information.

We also had several conversations with people who currently work in the office or had collaborated with HdM in the past. They shared their invaluable knowledge, especially concerning the following two topics: the integration of digital tools into the work methodology of HdM and the design process of TM2.

The many hours of conversation, exchange of ideas and discussion of points of view with the interviewees are scattered throughout the dissertation, especially in sections of Part I and II. They are reflected in many of the facts presented and underpin many of our arguments. Nevertheless, we also decided to edit most of the conversations and compile them in the appendix of the thesis.

In addition to the two heads of the digital technologies department, Kai Strehlke and Steffen Riegas, we talked to Volker Helm—a former collaborator who also took part in the implementation of the digital processes in the office—and Harry Gugger, Nicholas Serota, Wim Walschap and Andreas Reeg, all of them strategic players differently involved in the project for TM2.

The series of interviews concluded with that of Jacques Herzog.

This occurred when the investigation was already at an advanced stage, with the overall structure of the thesis well-defined and a great part of the content documented. The interview was thus not the beginning of the investigation, but it happened when this was in a mature state, confirming some perspectives that the work opened up.

And it could never have been otherwise.

Structuring the topics of the interview, determining its sequence and defining the exact questions to ask Jacques Herzog involved a great deal of preparatory work and implied that a consistent knowledge of their architecture and design practice over their forty years of work had already been acquired.

In the contemporary context, HdM are among the most interviewed architects and their theoretical discourse in many conferences is easily retrievable. However, the existing interviews did not fulfil our yearnings and investigative desire, nor did they answer the questions and doubts that our work posed. Thus, the conversation with Jacques Herzog worked as an extraordinary opportunity to question him about facts that intrigued us, to confront him with some of our ideas, and to let him directly express his opinion on the argument. And indeed, the assertion with which he closed our conversation launches an absolute certainty about their architectural practice that we could not find more revealing to open this work. More than an assertion, it is, in fact, a paradox that the project for TM2 makes very clear in its design process. The assurance that regardless of the technological means that HdM have employed to make the architectural idea buildable, in the end, they "still like straightforward architecture, which appeals to all our human senses."[46]

[46] Herzog, “We are surrounded.”

2.
Geometry and Architecture in the Contemporary Context

2.1 _ A Shifting Relationship
2.2 _ A Few Notes on the Digital Turn
2.3 _ Contemporary Approaches to Geometry

2.1 _ A Shifting Relationship

In a brief reflection on the question "can there be any relationship between architecture and mathematics?" Mario Salvadori, after considering several responses, concludes that architecture simply cannot exist without mathematics.[47] Even if at first sight, as he argues, it might seem theoretically inconceivable "to look for relationships between as abstract a science as mathematics and as concrete an art as architecture", in fact, connections between the two "are so many and so important that if mathematics had not been invented, architects would have had to invent it themselves."[48]

History reminds us that geometry and architecture have always been closely connected, as architects—unlike sculptors when shaping or modelling material—have been constantly faced with the difficulty of understanding their design and communicating it to others, not least the builder, in order to realise the project. In architecture, geometry is the device that allows shapes to emerge and be rationally outlined according to a set of predefined rules that, in addition to fulfilling the architect's compositional aspirations, allow the general description of the object to be more accurately templated.

Hugh Whitehead from Foster+Partners' Modelling Specialist Group, while referring to the use of digital media, emphasises the primary role of geometry in endowing shapes with a measurable structure using an analogy with clay modelling that fully renders the idea. "One of the best materials for sculpting is clay", he asserts, "but the results are free form and have no descriptive geometry. However, when clay is placed on a potter's wheel, it inherits geometry from the mechanism that drives the wheel and a highly geometric form is produced."[49] The same happens when architects must translate their initial, vague design idea, somehow still formless, into a concrete set of shapes. Geometry is then called up to generate the forms, to enable the designer to visualise and communicate the project, and to rule the several parameters and relationships that come into play, remaining as a crucial design instrument throughout the entire process until the final detailing of solutions.

Dennis Shelden and Andrew Witt reinforce the same concept in an essay [50] where they discuss the apparent contemporary disjunction between the enthusiasm that is explored for geometry in architecture and the disparate manner in which it is applied spatially. When concluding that an embedded logic of mathematical design is required in architecture, the authors stress that the promise

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47 A brief remark on the distinction between mathematics and geometry should be made. As Jane Burry and Mark Burry clarify, the terms 'mathematics' and 'geometry' are not synonymous. Mathematics and architecture have always been closely related, with both having their deepest roots embedded in geometry. While "mathematics is gathered from different activities [,] geometry was one of the seven liberal arts belonging to the Quadrivium, along with arithmetic, astronomy and music. [...] To geometry and arithmetic, add algebra, and you have the basis of mathematics as it developed since Renaissance. But it is clear that these three disciplines, while closely related, developed in response to different impulses and practical needs."

Specifically, about geometry, the authors assert that "'geometry' is a word of Greek origin meaning 'land measurement' or 'earth measurement'. [...] So geometry is considered to be descended from the concrete subdivision and organization of space. In this sense, architecture and geometry are mutually implicated in their conception and development. Both have the power to express and organize space using concepts outside the constraints of a direct mapping to a physical representation. The principal distinction lies in their levels of abstraction and generality. Geometry looks for generalities and, once established (demonstrated or proved), offers them up for use; architecture employs these general relationships constructively to underpin and create specific spatial relationships." Jane Burry and Mark Burry, *The New Mathematics of Architecture*, (London: Thames & Hudson, 2010), 8–9.

48 Mario Salvadori, "Can There Be Any Relationship Between Mathematics and Architecture?" in *Architecture and Mathematics from Antiquity to the Future. Volume I: Antiquity to the 1500s*, eds. Kim Williams and Michael J. Ostwald (Basel: Birkhäuser, 2015), 28.

49 Hugh Whitehead, "Laws of Form," in *Architecture in the Digital Age, Design and Manufacturing*, ed. Branko Kolarevic (London: Taylor & Francis, 2003), 83, 84.

50 Dennis R. Shelden and Andrew J. Witt, "Continuity and Rupture," in *Architectural Design. Mathematics of Space,* volume 81, issue 4, guest-ed. Georges L. Legendre, 36–43, July/August 2011.

of mathematics is that the diverse relationships of parts to the whole that characterise the architectural object can be made conceptually and notationally explicit, at the same time as their manipulation also becomes precise.

Indeed, if, on the one hand, geometry implies recognising the laws of form and subduing the composition to the relational constraints of numbers and drawing, on the other hand, this mechanism that at first sight might seem to limit creativity by ruling it, in reality ends up freeing the design, allowing it to evolve consistently and to be worked out within a sense of order, control and rigour. Thus, in the work of the architect, geometry is occasioned around thoughts of facilitating the object's making. It emerges as a strategy capable of providing buildability and a greater economy of means, along with a contingent poetic and intellectual value.

However, throughout history, the relationship between geometry and architecture has changed, with various periods characterised by certain dominant types of interaction between the two.[51]

Referring specifically to the topic of measure[52]—a sub-theme under the large umbrella of geometry—Robert Tavernor asserts that systems of measurement, although they must be practical and useful, most having their origins in everyday experience, are highly representative of the values of the culture that defines them. In the essay, the author means explicitly to demonstrate that, beyond the accepted practical reasons for measurements, these are symbolic and rarely as universal as they seem, advocating, in a certain sense, reconsideration of the metre in art and architecture in favour of a more embodied and less abstract use of the measures.

Nevertheless, Tavernor's reflection allows for a second reading while emphasising that measure, as he argues, "is a statement and record of a changing balance of power and independence."[53] It then becomes clear that systems of measurement are a product of a particular cultural setting. They are rooted in the civilisations' theological beliefs, political values and scientific knowledge, being, therefore, likely to evolve over time. The adoption of the metric system during the Enlightenment, replacing the human, male, body-referenced system that remained valid through the civilisations of ancient Greece and Rome down to the European Renaissance, is revealing of this involved interaction. By the late eighteenth century, modern science and a new political and social intellectual basis rejected the previous system of numerical perfection, which was imbued with a sense of quality and proportion, for more rational and universal measures. Tavernor describes:

> While for thousands of years the body was seen to reflect and embody universal harmony and was consequently related qualitatively to a prevailing artistic canon, since the Enlightenment, scientists—in

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51 The two-volume book "Architecture and Mathematics from Antiquity to the Future", edited by Kim Williams and Michael Ostwald, provides a very accurate insight into the complex interplay of connections between the two disciplines—"the art or practice of designing and constructing buildings" and "the abstract science of number, quantity and space"—throughout history. It brings together essays by authors with backgrounds both in and outside of architecture and mathematics, which reveal, in the rich diversity of the approaches, the longstanding, intricate, shifting character of this relationship. See: Kim Williams and Michael J. Ostwald, eds. *Architecture and Mathematics from Antiquity to the Future. Volume I: Antiquity to the 1500s*, (Basel: Birkhäuser, 2015); Kim Williams and Michael J. Ostwald, eds. *Architecture and Mathematics from Antiquity to the Future. Volume II: The 1500s to the Future*, (Basel: Birkhäuser, 2015).

52 Robert Tavernor addresses this subject in “Measure, Metre, Irony: Reuniting Pure Mathematics with Architecture,” in *Architecture and Mathematics from Antiquity to the Future. Volume I: Antiquity to the 1500s*, eds. Kim Williams and Michael J. Ostwald, (Basel: Birkhäuser, 2015).

53 Ibid., 245.

> tandem with philosophers—have scrutinised the human body with detachment. It is now something to be dissected, analysed and quantified in ever-smaller microscopic and atomic detail as is the metric system, a product of revolution and modern scientific knowledge.
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> The measurements of the internationally controlled metric system are precisely calibrated abstract quantities, verified scientifically. They make no reference to everyday experience or to art and symbolism, and have no obvious relation or relevance to human form, ideal or otherwise. Indeed, the metric system is deliberately anti-body. It developed from Enlightenment scientific concerns for precision and international uniformity, and the demands of ordinary people—originally mainly in France—for an equitable system that would provide uniformity across the civilised world.[54]

In the history of mathematics and geometry, this relatively straightforward example—which inevitably impacted architecture, cancelling the symbolic content that for millennia enriched compositions with a harmonious order and opening a new approach to the idea of what measure represents—is one of the many instances that mark the evolution of the discipline and prove how this continually reconfigures itself in response to shifts in thinking, knowledge or technique.

Lino Cabezas Gelabert, who elaborates on the role of geometry in art and architecture, also reiterates that the contents of geometry are not immutable. Contradicting the misunderstanding that, in his opinion, exists in art—which affirms that the thought and knowledge of classical geometry is stabilised and has been concluded in the past, without giving rise to new expectations, and posing its transmition or the search for new applications as the only problems—he remarks that geometry is a discipline whose topics constantly adapt to scientific, technological and cultural evolution.

According to the author, when geometry historically achieved a scientific status, this quality would explain the phenomena of its scientific accumulation and disciplinary diversification, as well as the development of its sub-themes. Lino Cabezas asserts that it is difficult today to speak about geometry without adjectives, specifying that these are "as abundant as heterogeneous: metric geometry; sacred geometry; descriptive geometry; analytic geometry; projective geometry; constructive geometry; differential geometry; non-euclidean geometry..." And he adds, "likewise, any of these branches has not been or is something immutable, both for its contents and for its practical or symbolic functions."[55]

Therefore, through various forays into history, in addition to demonstrating that the link between geometry and architecture is longstanding and complex, with the two tied together by a multitude of practical, representational and intellectual ways,[56] Lino Cabezas emphasises the innate character of this relationship, stressing that despite the recent profound changes in design raised by the technological

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54 Ibid.

55 "Por ello, hoy es muy dificil hablar de geometría sin adjetivarla. Los adjetivos utilizados son tan abundantes como heterogeneous: geometría métrica; geometría sagrada; geometría descriptive; geometría analítica; geometría proyectiva; geometría constructive; geometría diferencial; geometría no euclideana…Asimismo, cualquiera de las parcelas de la geometria no ha sido o es algo inmutable, tanto por sus contenidoscomo por sus funciones prácticas o simbólicas." in Lino Cabezas, "Geo-Metria; Forma y Mediación; Representacíon y Expresión," *Boletim da Aproged 31*, May 2014, 3.

56 Lino Cabezas considers that the main functions geometry assumes and has historically assumed concerning art and architecture can be described as follows: geometry as a model for the intellectual and rational discourse of form; geometry as a technical instrument for the solving of practical problems arising from the building construction process; geometry as a set of formal repertoires that might acquire symbolic meaning and aesthetic qualities in accord with a specific spiritual world. See: Lino Cabezas, "De la Geometría fabrorum a la geometría constructiva," *Fabrikart: arte, tecnologia, industria, sciedad,* nº 10, 2011-2012, 70–71.

advances in computing, geometry still asserts itself today in architecture as "the model of reality to represent the natural forms and build other imagined ones."[57]

2.2 _ A Few Notes on the Digital Turn

When reflecting on the relationship between geometry and architecture in the contemporary context, it is inevitable to consider the computer and how it strongly affected the interaction between the two when it became the working tool of choice in architectural practice.

The literature on the topic is vast and has been addressed from different perspectives. However, regardless of the specific focus adopted, the understanding that digital computation and its many outcomes have reformulated the traditional role of geometry in the design process often emerges as a consensual point. Some authors[58] even compare the contemporary phenomenon to the Renaissance and the impact that the invention of perspective had on architecture by reconfiguring its premisses from a representation point of view, but also in spatial and composition terms. The digital has become the basis for architectural processes and the means of communication through which design ideas are conceived, flow and proliferate, so the logic underlying its functioning—which differs from the traditional compass and ruler approach—has necessarily reshaped the working methods and offered architects new creative possibilities.

Mario Carpo, who for a long time has been discussing the influence of cultural technologies in architectural practice and, in a way, pioneered the theoretical reflection on "the digital revolution in architecture"[59] caused by the rise of CAD-CAM technologies, argues that "parallel projections, long favored by the technical and design professions, have already been mostly replaced by computer-based 3-D modelling."[60] Indeed, this particular point is one of the most immediate and encompassing effects of digital systems in architecture, with a very significant impact from a methodological point of view.

In his reflection, Mario Carpo remarks that in recent years, due to the steady technical advancement and the capacity of computers to take on bigger and bigger data, the demise of projected images may be happening for good. The Italian author asserts that any representation system based on verbal, visual or spatial operations always presupposes the need for compressing 3D information, which in turn relies on the processing capacity of the available technological means. Therefore, as he argues, "the art of compressing 3-D objects onto small flat sheets of paper"—the well-known parallel projections in

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57 Cabezas, "Geo-Metria," 8.

58 See: Mario Carpo, "Building with Geometry, Drawing with Numbers," in *When is the Digital in Architecture?* ed. Andrew Goodhouse, 33–44 (Montréal, Berlin: Canadian Centre for Architecture, Sternberg Press, 2017).

59 Mario Carpo has explicitly used this expression in the essays: "Tempest in a Teapot," *Log*, No. 6, 99–106, Fall 2005 and "Building with Geometry, Drawing with Numbers," in *When is the Digital in Architecture?* ed. Andrew Goodhouse, 33–44 (Montréal, Berlin: Canadian Centre for Architecture, Sternberg Press, 2017). However, this refers to a concept the author usually addresses in his reflections on the influence of the digital in contemporary practice, and which translates his belief that technical development, namely new information technologies, has the potential to disrupt the way architects design and calculate almost everything. Carpo recognises that, since the 1990s, a "digital turn", as he called it, has been taking place—a shift from mechanical to digital technologies that gave rise to some critical transformations in the work process of architects and that he thoroughly characterised in two seminal publications: *The Digital Turn in Architecture 1992-2012*, (West Sussex: John Wiley & Sons, 2013) and *The Second Digital Turn: Design Beyond Intelligence*, (Cambridge: The MIT Press, 2017).

60 Carpo, *The Second Digital Turn,* 99.

plans, elevations and side views that Alberti recommended to architects in the fifteenth century and Gaspard Monge mathematically formalised at the end of the eighteenth century—is increasingly unwarranted today given that, the author says, "using digital technologies we can already keep not only a huge number of planar drawings but also full 3-D avatars of buildings on a single memory chip—including all that we need to simulate that building in virtual reality or to build it in full."[61]

With this argument, however, Mario Carpo does not mean that drawings are disappearing or will disappear from architectural practice. On the contrary, he believes in the critical use of drawing as an essential component of contemporary architectural discourse, in the same way that he considers that planar drawings, in many cases are, and will remain for a while, the best way to record and transmit some visual ideas, as they still have some practical advantages over 3D models. So, in his discussion, Carpo questions the primacy of two-dimensional projective images, noticing that new technologies have challenged them, as today, in most cases, as he states, "spatial data are recorded in 3D from the start, then kept, processed, visualised or even 3D printed without the mediation of planar projections."[62]

Indeed, it is a fact that the computational tool and the logic underlying its system, based on digital modelling, have reconfigured the traditional role of descriptive geometry in design practice and reversed the working method of architects. The science to represent, as Monge described, "on a drawing sheet, which has only two dimensions, namely, length and width, all the bodies of nature that have three, length, width and depth",[63] and used by architects until recently as the primary means to notate 3D objects and to provide insight into their structure and metric properties,[64] has ceased to assert itself as the main device to assist spatial reasoning and to mediate the interplay between the designer's intuitive grasping of forms and their rigorous logical representation.

Figures in space are no longer exclusively studied from their projection onto a surface.

Planar representation ceased to be at the origin of geometric description, nor is it the means by which the shape of an object is deduced and fully comprehended. In architectural practice, the process of imagining and analysing forms occurs nowadays the other way around. The construction of a 3D digital model often precedes the two-dimensional representation, becoming the prevailing environment where real or imagined forms are conceived and find their own geometric logic. In this scenario, traditional descriptive geometry has been surpassed by different geometric thinking resulting from the

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61 Ibid., 117.

62 Mario Carpo, "The New Science of Form-Searching." In *Architectural Design. Material Synthesis: Fusing the Physical and the Computational, v*olume 85, Issue 5, guest-ed. Achim Menges, September/October 2015, 24.

63 "La Géométrie descriptive a deux objects: le premier, de donner les methods pour représenter sur une feuille de dessin qui n'a que deux dimensions, avoir, longueur et largeur, tous les corps de la nature qui en ont trois, longueur, largeur et profondeur, pourvu néanmoins que ces corps puissant être defines rigoureusement.
Le second objet est donner la manière de reconnoitre, d'après une description exacte, les forme des corps, et d'en déduire toutes les verities qui resultant et de leur forme et de leurs positions respectives." Gaspard, Monge, Géométrie Descriptive, ed. M. Brisson (Paris: Libraire pour les Mathématiques, 1827), retrieved from https://books.google.pt/books, 1.

64 It is, however, important to mention, as Xavier and Pinho noted, regarding the birth of descriptive geometry by Gaspard Monge and his teaching courses at the École Centrale des Travaux Publiques (1797) and the École Normale (1798), that "the connections between descriptive geometry and several applications were structural features of the envisaged education—in the first years, more than an abstract language of representation, it was taken as an efficient tool for solving many constructive problems. And, in fact, descriptive geometry was widespread as the common language of all engineers, due to the prominent role of Monge and of the two referred schools." João Pedro Xavier and Eliana Manuel Pinho, "Olivier string models and the teaching of descriptive geometry," in *"Dig Where You Stand" 4 Proceedings of the Fourth International Conference on History of Mathematics Education*, ed. by Kristín Bjarnadóttir, Fulvia Furinghetti, Marta Menghini, Johan Prytz and Gert Schubring (Roma: Edizioni Nuova Cultura, 2017), 400.

functioning of information technologies. The original objectives of the graphic science saw their meaning revised when radically challenged by the development of digital tools.

Therefore, and calling up again into our discourse Lino Cabezas, as he remarks, "compared to that geometry conceived to analyse graphically and to describe objectively existing or projected objects, the new media resolve the construction and generation processes of form. For this reason, it has been proposed to talk about 'constructive geometry' or 'generative geometry' instead of describing it in a more restrictive way as 'descriptive'".[65]

In fact, when grasping the shape of an object and looking for its geometric structure by directly manipulating a 3D model, concerns about representation issues are set aside. Planar drawings, which used to stand at the core of the creative process as the graphic language that enabled architects to translate their ideas into a measurable and buildable design, have been relegated to the background by CAD software, which automated them.

From a practical point of view, this technical shift has significantly impacted the work of the architect while overturning the process of thinking, generating and notating the forms.

"In CAD software," Lino Cabezas says, "when working in three dimensions, the mental attitude is very similar to that one can have when contemplating, through a glass, an object kept in a display case equipped with a mechanism that allows it to be moved in any position and that when manipulating it, it is possible to observe it from different angles."[66]

In addition to offering architects a more comprehensive and interactive approach to spatial reasoning mainly focused on the construction processes of forms and the geometric relationships that emerge between the parts, computing technologies have liberated designers from the projective conventions of drawing, from their "fragilities"[67] and the constraints that these inevitably place on representing and conceiving forms, especially those of higher complexity. This, of course, has opened up new questions in architectural practice and particularly challenged architects' knowledge of geometry and new methods of geometric design.[68] Nevertheless, the jump from the somewhat strict

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65 "Frente a aquella geometría pensada para analizar gráficamente y describir objetivamente los objetos existentes o proyectados, los nuevos medios sirven para resolver los procesos de construcción y generación formal. Por ello, se ha venido proponiendo hablar de 'geometría constructiva' o 'geometría generativa' en lugar de adjectivarla de manera más restrictiva como 'descritiva'." Cabezas, "Geo-Metria," 9.

66 Cabezas, "De la Geometría fabrorum," 51.

67 Lino Cabezas notes that descriptive geometry is somehow limited and insufficient in what concerns, for instance, the control of the three-dimensional geometric properties of elementary curved surfaces and, even more, those of free generation, such as free forms, while reducing their representation to the apparent contour. "É sobradamente coñecido o feito de que, no debuxo, o control dunha forma tridimensional que non está limitada por arestas se realiza mediante a representación dos seus contornos aparentes. Esta metodoloxía, tan utilizada na xeometría de proxeccíon na representacíon das formas curvas elementais, reduce drasticamente as posibilidades de controla-las súas propriedades xeométricas tridimensionais, e é realmente insuficiente cando se traballa con superficies de xeracíon libre, aquelas que a informática introduciu baixo a denominación de *free forms*.

Non hai dúbida de que os novos sistemas xeométricos implantdos pola informática permiten establecer un rigoroso control visual e metric das supeficies de forma libre, máis aló dos contornos aparentes que se obteñen coa xeometría de proxeccíon." Ibid., 54.

68 "Architectural Geometry" is the title of a book by Helmut Pottmann and the subject of a series of conferences promoted by him between 2008 and 2012, whose name refers to a new area of research he suggested to implement in response to the geometry revolution that modern computing technologies have led to in the architectural design process.

Helmut Pottmann considers that the onset of digital design has enabled a new level of experimentation with free-form shapes that challenged the traditional use of geometry as a design language based on rules of descriptive geometry. In his opinion, the trend towards a higher level of geometric complexity, which resulted from the effective use of powerful geometric design software, requires further knowledge of geometry. Thus, the research in architectural geometry, as he mentions, "aims [exactly] at the development of new tools for the creation of digital models for architecture which meet the requirements in the shape creation and

two-dimensional drafting paper to the dynamic virtual space of the computer has offered a more ambitious approach to geometry in design practice.

The method for defining shapes and working out architectural compositions became more wide open and, in a certain sense, gained freedom and a kind of intuitiveness. It is indisputable, as Cameron Wu notes, "that the power of the computer enabled new potentials and outcomes so differentiated and complex that many ensuing forms could not be conceived a priori of their 3-D digital representation." [69] With CAD-CAM technologies, the formal repertoire has expanded, and higher geometric complexity has become possible as computational tools, unlike traditional representational means, in addition to enabling the accurate mathematical description of any shape and its straightforward manipulation, provide a direct link between design and fabrication, which is crucial for the accomplishment, in particular, of those more intricate and custom-made objects.

The first sign of this new paradigm in architecture was the profusion of curved surfaces—of "forgotten geometries lost to us because of the difficulties of their representation,"[70] Rafael Moneo asserted.

Indeed, the trend towards curvilinearity, called by some authors the "new aesthetics of free form",[71] that sprawled in the early 1990s in contemporary practice has been long debated as the quintessential architectural embodiment of the new digital technologies. According to Mario Carpo, the fact that computers made differential calculus available to the masses—an invention of the seventeenth century that empowered numbers to describe continuity and that through analytical geometry enabled curves to be written down as algebraic equations—brought formal continuity back to the centre stage of architecture.[72] That is why, in the author's opinion, spline modellers—"those magical instruments […] that translate every random cluster of points, every doodle or uncertain stroke of the hand, into perfectly smooth, curving, and continuous lines"[73]—can be said to be the protagonist tools of the first digital turn in architecture. Even though the mathematics of spline modellers predates the rise of today's digital technologies, having had its origin in the late 1950s and early 1960s, its manipulation was greatly promoted in the 1990s when CAD software made it accessible through graphic user interfaces, through "control points and vectors that anyone could easily edit, move, and drag on the screen with the click of

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design phase and already incorporate basic aspects of the actual construction including materials, manufacturing technologies and structural properties." (Helmut Pottmann, "Architectural Geometry as Design Knowledge," in *Architectural Design. The New Structuralism: Design Engineering and Architectural Technologies,* volume 80, issue 4, guest-ed. Rivka Oxman and Robert Oxman, July/August 2010, 74)

In this context, his book clearly demonstrates how modern computing has deeply revised the geometry lexicon. It is an exhaustive compendium that focuses on efficient CAD construction methods and explains the new geometries available in CAD systems following the increase in technical possibilities. See, Helmut Pottmann, Andreas Asperl, Michael Hofer and Axel Kilian, *Architectural Geometry,* (Exton: Betley Institute Press, 2007).

69 Cameron Wu, "Ellipse, Parabola, Hyperbola: Ellipsis, Parable, Hyperbole," in *Log 43: The Issue of Geometry*, eds. Cynthia Davidson and Cameron Wu, Summer 2018, 63.

70 Rafael Moneo quoted in Branko Kolarevic, "Introduction," in *Architecture in the Digital Age, Design and Manufacturing*, ed. Branko Kolarevic (London: Taylor & Francis, 2003), 4.

71 Mario Carpo, "The Ebb and Flow of Digital Innovation: From Form Making to Form Finding – and Beyond." In *Architectural Design. The Innovation Imperative: Architectures of Vitality, v*olume 83, Issue 1, guest-eds. Pia Ednie-Brown, Mark Burry and Andrew Burrow, January/February 2013, 58.

72 Mario Carpo, "Building with Geometry, Drawing with Numbers," in *When is the Digital in Architecture?* ed. Andrew Goodhouse (Montréal, Berlin: Canadian Centre for Architecture, Sternberg Press, 2017), 42.

73 Mario Carpo, "Breaking the Curve: Big Data and Design," In *ArtForum*, February, 2014, Vol.52, Nº6. https://www.artforum.com/print/201402/breaking-the-curve-big-data-and-design-45013.

a mouse." Therefore, Mario Carpo adds, "as this game turned out to be faster and more intuitive than the high school calculus on which it was based, spline modelers soon became hugely popular among digital designers, and a swooping, spline-based style famously became the hallmark of early computer-based design."[74] The same style that Cameron Wu described as somewhat controversial for having arisen, he said, "as an arbitrary aesthetic enabled by the capabilities of digital design tools, while the discipline conflated the rhetoric of the visual with the metrics of performance without any verifiable connection."[75]

However, apart from these formal concerns, when looking at the contemporary phenomenon from a technical standpoint, detached from questions of style or aesthetic preferences, reality shows that the computer is a powerful tool that augments the designer's ability to deal with complexity in general and to speculate about problems, allowing any geometries, whatever these may be, to be explored. And this is something that goes beyond the issue of curved lines and surfaces. It is something that develops from within, that is structural in architectural practice, impacting working methods—from design to fabrication—and the way shapes are generated and defined, which brings us to another crucial point of the subject.

As explicitly asserted by Ostwald and Williams, "advances in computing have placed mathematical techniques and processes at the fingertips of every young architect in the world." In our day, the authors add, "algorithmic and computational approaches to architecture have embedded mathematics in every line of every CAD model or BIM file, and in every form or shape evolved or generated in the computer."[76]

Indeed, as a general-purpose computation machine, the computer is programmable and can automatically carry out sequences of arithmetic or logical operations, which means that it can solve any kind of problem that can be logically encoded. In turn, digital programs, as Russel Loveridge mentions, "are instruction sets to solve complex logical problems. [These] are encoded with mathematical representation, and software is used as a 'translator' to contextualise input for the computer and output for the user."[77] Therefore, if, on the one hand, the computation machine has allowed the designer to mostly forget about the numbers and freely create, manipulate and transform geometric representations

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74 Ibid.

On the general assumption that the digital turn in the nineties was marked by a famously streamlined style of smooth and curvy lines and surfaces, Mario Carpo remarked more than once that this trend towards curvilinearity cannot be seen as a direct consequence of the arrival of digital technologies in architecture. Instead, this phenomenon derives from an ideological process already in motion—which reversed the preceding trend towards angularity and aimed for forms that could change, morph and move—and that computational tools, when they came up, simply contributed to making it possible.

"The notion of a direct causal correspondence between digital technologies and complex geometries (including the most general of all, topology) was built on a truism, but generalised into a fallacy. True, without computers some of those complex forms could not have been conceived, designed, measured, or built. However, computers per se do not impose shapes, nor do they articulate aesthetic preferences. One can use computers to design boxes or folds, indifferently. In fact, the story that we have been tracing indicates that the theory of folding created a cultural demand for digital design, and an environment conducive to it. Consequently, when digital design tools became available, they were embraced and adopted—and immediately put to process what many architects at the time most needed and wanted: folds." Mario Carpo, "Ten Years of Folding," in *Architectural Design. Folding in Architecture*, volume 63, issue 3/4, guest-ed. Greg Lynn, 1993, 16.

75 Wu, "Ellipse, Parabola, Hyperbola," 66, 67.

76 Michael J. Ostwald and Kim Williams, "Relationships Between Architecture and Mathematics," in *Architecture and Mathematics from Antiquity to the Future. Volume I: Antiquity to the 1500s*, eds. Kim Williams and Michael J. Ostwald, (Basel: Birkhäuser, 2015), 5, 7.

77 Russel Alexander Loveridge, "Process Bifurcation and the Digital Chain in Architecture" (PhD diss., ETH Zürich, Zürich, 2008), 36.

of spatial objects using the tools provided in the graphic user interface—without necessarily having the most basic awareness of where the forms are coming from or what rules, geometric or numeric, are shaping them—on the other hand, when the designer is proficient in programming and capable of diving into the coding language of the computer, a whole world of programmed design methods suddenly opens up.[78] Through the use of text-based "scripts"—"sets of explicit instructions, which may be a basic operation or a complex procedure using logical operands and variables to control processing"[79]—the designer is able to bypass the graphic user interface, directly submitting command instructions to the software and, in this way, to automate complex design processes and customise any geometric relationships.

This explains the increasing mathematical focus that has manifested in design and built projects, with algebra providing the language that couches the spatial and proximal relationships of forms, along with the consequent understanding of the shapes as a process, as the result of a series of interdependencies and progressive transformations regulated by geometrical-topological and mathematical laws.

In this regard, George Legendre, while trying to clarify the role that mathematics has played in the revolution caused by the advent of computation and information technology in design practice, argues that contemporary architectural geometry—"a discipline on its own right, forming a long and complex continuum subdivided into distinct historical segments with vastly different instrumental properties"[80]—differs from that of other periods, above all, by how the processes are implemented. When comparing it directly with the Renaissance, Legendre states that the main difference "is not only that we no longer believe in the ideal figure of the circle, but that when we do use it, we choose to construct it with Cartesian and polar (parametric) coordinates, rather than a ruler and a compass." [81] Hence, the difference is not only technical once it surpasses the mere instrumental aspect, extending to the very logic underlying the generation and description of forms, now supported by a geometry of symbols and operators rather than lines and figures. This is why, in contemporary cutting-edge digital practices, as the author asserts, many designs "can be said to be calculated rather than figured, and written rather than drawn."[82]

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78 For an overview of the digital technologies and processes that exist in industry or research and how each tool fits into the digital chain, see Loveridge, "Process Bifurcation."

79 Ibid., 40.

80 George L. Legendre, "The Mathematics of Sensible Things," in Architectural Design. Mathematics of Space, volume 81, issue 4, guest-ed. George L. Legendre, July/August 2011, 11.

81 Ibid.

82 Ibid., 12.

It is worth noting that the relationship between calculus and drawing, as two intimate complementary ways of notating geometric forms, had already been seen as critical by Gaspard Monge.

The interdependence Monge recognised as existing between these two branches of mathematics stands at the core of the philosophy of his course at the École Normale, in which he included in the theoretical part an introduction to differential geometry. For him, geometry and algebra share a very close relationship. In his twelfth lesson, as Sakarovitch mentions, the French mathematician asserts: "There is no descriptive Geometry construction that cannot be translated into Analysis; and when the questions have no more than three unknowns, each analytical operation can be regarded as the writing of a spectacle in Geometry. [...] Descriptive Geometry would carry in the most complicated analytical operations, the evidence which is its character; and, in its turn, Analysis would bring into Geometry the generality which is proper to it." Sakarovitch adds that when Monge lectured at the École Centrale des Travaux Publiques, he took this analogy further by directly intersecting his course in Analysis applied to Geometry with that of Descriptive Geometry. "The two courses articulated one on the other where the same problems are treated in two different ways", the author says. See: Joël Sakarovitch, *Épures d'architecture. De la coupe des pierres à la géométrie descriptive XVI-XIX siècles*, (Basel: Birkhause, 1998), 214–215, 260–261.

By using programmed design techniques, such as parametric and algorithmic design, it is not the final shape of an object that is declared but its components and compositional relationships through the explicit encoding of the geometric problem and the procedural instructions to solve it. In this way, designers focus on the generative rules and interdependencies that govern a particular geometry rather than on the shape as a given.

Thus, when combined with the computer's computational capacity, this algorithm-based approach to forms—an enduring architectural lineage Mario Carpo[83] considers as deriving from classical antiquity and the Middle Ages—gave way to unprecedented generative design methods, which, by allowing experiments with new mathematical knowledge, have placed geometry at the centre of the debate on the shift caused by the digital in contemporary architecture.

2.3 _ Contemporary Approaches to Geometry

In "The New Mathematics of Architecture", Jane and Mark Burry brought together a series of contemporary projects that illustrate, composition and methodological-wise, the new mathematical focus that has manifested in design since the mid-1990s, following the new creative opportunities offered by digital computation.

In addition to embodying the new wave of interest in the relationship of mathematics to space-making, the selected projects are revealing of the growing power and complexity that the mathematical processes have been featuring in architecture.

Underlying this collection of designs is the conviction of the authors that digital computation has given architects the tools to access and explore the geometrical space opened up by post-17th-century mathematicians. Therefore, the selected architectural projects have been grouped into mathematical thematic chapters that go beyond Euclidean geometry and are particularly concerned, the authors say, with "the embrace by architecture of geometry's expanded definition to the multiple geometries espoused in Felix Klein's Erlangen programme (1872)."[84]

The topics of the several chapters range from curved surfaces and seriality, fractals and self-similarity, tilings and the phenomenon of aperiodicity, optimisation applied as a method to search for spatial solutions and to rationalise forms, topology understood from its concepts of non-orientability and interconnection, and datascapes and multi-dimensionality—all of these are relatively recent areas of mathematics that have been given architectural expression in the designs.

The projects presented in the book are from different places around the world. In their majority, they refer to large public facilities—such as airports, train stations, museums, concert halls, and sports buildings—and among the various architects are some of those whose work is often part of the discussion on the impact of digital technologies in architecture. Foster+Partners ***(2.01 / 2.02 / 2.03)***, Gehry Partners, Arup AGU, Daniel Liebskind, FOA, Arata Isozaki, Toyo Ito ***(2.04 / 2.05 / 2.06)***, UN Studio, DECOI

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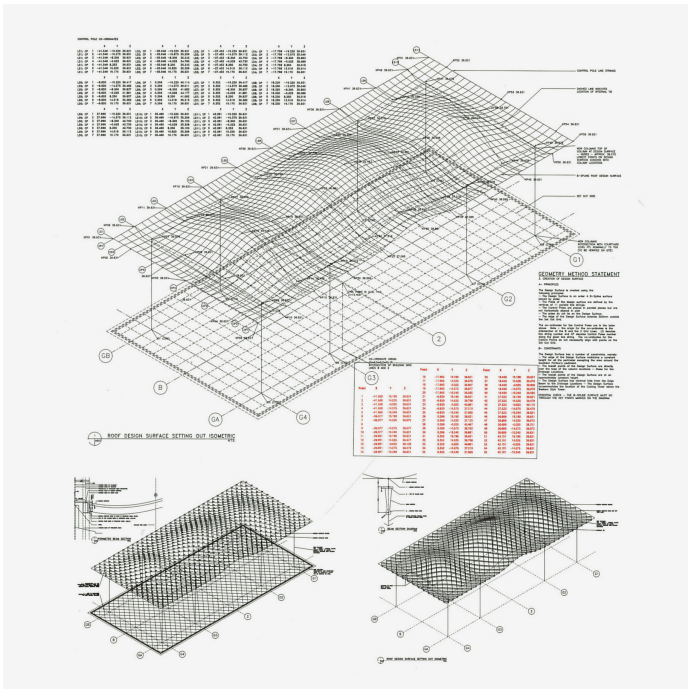
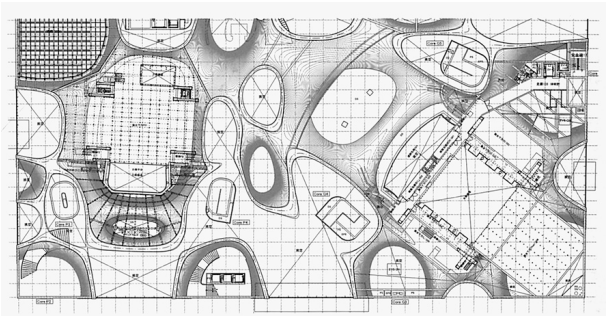
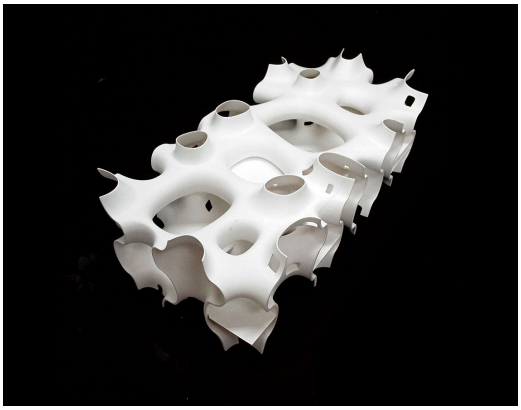
83 Mario Carpo, "Parametric Notations: The Birth of the Non-Standard," in *Architectural Design. Parametricism 2.0: Rethinking Architecture's Agenda for the 21st Century*, volume 86, issue 2, guest-ed. Patrik Schumacher, 24–29, March/April 2016.

84 Burry and Burry, *The New Mathematics of Architecture*, 8.





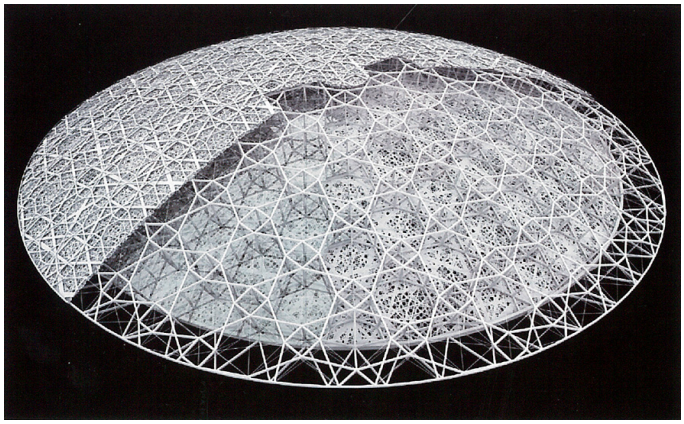


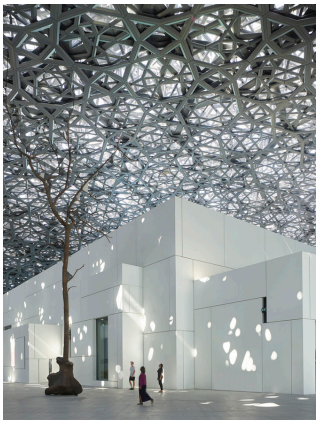
2.01
Smithsonian Institution Courtyard by Foster + Partners, Washington (2004–2007). The programmed model for the roof.

2.02 / 2.03
Exterior view of the roof's undulating surface. Interior perspective of the building's grand central courtyard.

2.04
Metropolitan Opera House by Toyo Ito, Taichung (2006–2013). Floor plan.

2.05 / 2.06
Study model. Interior view of the building.





2.07
Louvre Abu Dhabi by Jean Nouvel, Abu Dhabi (2006–2017). Illustration of the automated pattern-generation process for the dome.

2.08
The large, shallow dome with its intricate, perforated screen pattern, floating above the collection of buildings.

Architects, Greg Lynn, Jean Nouvel ***(2.07 / 2.08)*** and NOX Architects are some of the most eminent practices that, according to the authors, have contributed to the re-animation of the relationship between architecture and mathematics.

Linking the several projects is an explicit interest in mathematics, sometimes taken as the primary constituent of an idea and in others as the problem solver. However, as the authors assert, even though in some examples, "the two roles are balanced or combined, [...] in all, the mathematical idea or problem-solver is also instrumental in the design process and to the form of the architectural outcome."[85] It then becomes clear, as implied by the authors, that the mathematical focus underlying the design processes ends up manifesting at a formal level in the particular visuality that all these architectures somewhat share.

This brings us to a crucial point that intuitively emerges when observing architectural designs from the last thirty years by the practices that have taken the digital as part of their agenda. A fact that, in a certain sense, is also corroborated by some critics and historians in their reflections on the contemporary phenomenon and to which Antoine Picon genuinely refers in a very direct comment.

When discussing the contemporary relationship between architecture and mathematics, Picon asserts that "under the influence of digital tools architecture has never used so many mathematical objects, from Bézier curves and algorithms, while remaining indifferent to the question of its relation to mathematics." [86]

With this statement, the French author means explicitly to remark on today's paradoxical situation characterised, in his opinion, by the estrangement of mathematics from architecture, caused by the

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85 Ibid., 13.

86 Antoine Picon, “Architecture and Mathematics. Between Hubris and Restraint,” in *Architectural Design. Mathematics of Space,* volume 81, issue 4, guest-ed. George L. Legendre, July/August 2011, 30.

diffusion of calculus at the end of the 18th century, and the consequent loss of balance between invention and control, which was previously ensured by geometry and arithmetic. Nevertheless, while directing his discourse towards the need to reestablish in architecture this polarity—understood as the factor that can make mathematics appear again as a foundational knowledge and a practical tool—Picon notes that, nowadays, mathematics is mainly on the side of invention. Mathematical procedures that architects have to deal with, from calculus to algorithms, are on the side of power, which inevitably reflects on the character of architecture itself.

As he remarks, "in contemporary cutting-edge digital practices, mathematical entities and models are most of the time mobilized in a perspective that has to do with emergence, with the capacity to amaze, to thwart received schemes." [87] A good example of this orientation, he explains, is the way topology has been generally understood by contemporary architects. This branch of mathematics has above all fascinated designers for its aesthetics and formal singularities, like the Möbius strip or Klein bottle, rather than for what mathematicians consider as its principal objectives, namely the study of invariance.

Therefore, by intersecting the collection of examples gathered by Jane and Mark Burry with the insight by Antoine Picon, it emerges that contemporary digital practices, in particular the ones that mark the debate on the subject, are characterised by a visuality that, in its strong reference to the mathematical and computational processes underlying the design, ends up evincing its profoundly digital basis.

Exploring the digital processes in architecture and being at the forefront of their possibilities seems to imply an allusion in formal terms to a whole world of mathematical entities, subjects and methods that computation has made possible and that directly stem from the operating logic of the applied technologies. When looking at the so-called digital architectures, their formal expression is revealing of the new technological paradigm. Their usually intricate, conspicuous shapes—often recalling a sense of emergence and complexity—and the concepts underlying the geometric strategies result from an exploration keen on what the digital design and fabrication processes continually bring about.

Over the last thirty years, the already mentioned architectural journal AD has been following the digital scene closely with a relevant collection of issues that approach the topic from different perspectives and bring together a vast set of protagonists and works that, in addition to providing an awareness of the affinities that mark the phenomenon, allow a reading of its evolution over time.

AD profile 185, guest-edited by Rahim and Jamelle on “Elegance”, and AD profile 258, guest-edited by Gilles Retsin on “Discrete: Reappraising Digital in Architecture”, are two publications that discuss the aesthetic implications of the computational ways of working in architecture, recognising that among the digital-based practices, there are indeed some formal tendencies that are the expression of the processes digital technologies enable and, in a way, inspire the designer to explore. In their temporal difference of twelve years—the first is from 2007 and the second from 2019—these issues point to two different moments in the history of the digital in architecture, the same moments Mario Carpo refers to as the first and second digital turns.

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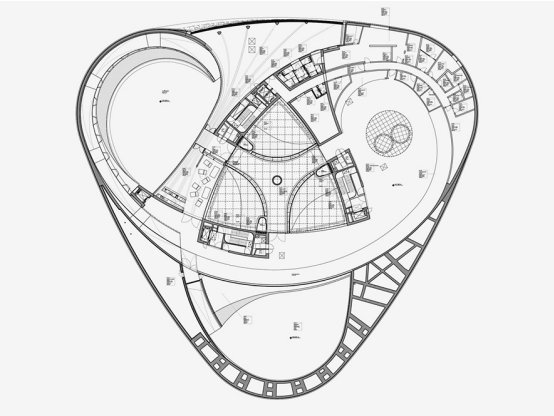
87 Ibid., 33.



2.09
Mercedez Benz Museum by UN Studio, Stuttgart (2001–2006). The trefoil-shaped floor plan.

2.10
Exterior view of the building.

In “Elegance”, the editors depart from the somewhat pretentious consideration that digital architecture, in its exuberant curvilinearity, has reached a solid maturity characterised by elegance, a concept they relate to refinement, precision and formal opulence and to which designers can aspire only after a solid mastering of technique. The works and critical essays presented in the journal are about an architectural practice in which the use of relational equations and scripting mediated by digital techniques—as the “tools that incorporate the most advanced results of experimentation in digital designs”[88]—have enabled architects to realise nuances that, according to the editors, exude elegance within the formal development of their projects.

Along with the Marsa Dubai Residential Tower, Dubai (2005), by Zaha Hadid Architects, the Herta and Paul Amir Building, Tel Aviv (2003–2009), by Preston Scott Cohen, and among some other very curvy, smooth-lined designs, the Mercedes-Benz Museum, Stuttgart (2001–2006), by UN Studio is one that overtly depicts this formal tendency towards continuous lines and surfaces.

In "Everything is Curved", Ben van Berkel and Caroline Bos describe how the spatiotemporal experience at the heart of the museum's organisational strategy was achieved by a curvilinear geometry, generated from the mathematical model of the trefoil, that resulted in a highly continuous form with no transitions or discontinuities (***2.09 / 2.10)***.

"The geometry of the plan, with its three overlapping circles, is suggestive of a trajectory subject to centrifugal forces which propel the visitor around," the architects assert.

> The trefoil is a variation of the same mathematical model belonging to the field of knot theory on which the Möbius strip and its three-dimensional variant, the Klein bottle, are based. As a model, it

88 Ali Rahim and Hina Jamelle, “Elegance in the Age of Digital Technique,” in *Architectural Design: Elegance,* volume 77, issue 1, guest-eds. Ali Rahim and Hina Jamelle, January/February 2007, 6–7.

> suggests the infrastructure of architecture, the way in which a building can be constructed according to how one moves through it. The trefoil possesses topological qualities: movement, orientation, and direction are intrinsic to its structure. Within it the visitor is always located at some point on a curve, thus there are no abrupt transitions, no discontinuities. […] Stacking several trefoils on top each other, rotating the petals and alternating between single- and double-height floors has resulted in a solid, curving masses of concrete that embrace voids and steer gaze in all directions, except straight ahead.[89]

By contrast, in 2019, Gilles Retsin introduced the recent counterpoint to these spline-driven design explorations, focused on the paradigm of continuity, that spread through the first two decades of digital work. According to the editor, discreteness—"a notion that comes from the sciences, referring to what is individual and separate [and as such] opposite of the continuous, that which is uninterrupted and seamless"[90]—came prominently to the forefront in architecture through computation, as this operates essentially with discrete data.

As he remarks, discrete refers to "an emerging body of works that seeks to redefine the entire production chain of architecture by accelerating the notion of discreteness in both computation and the physical assembly of buildings. It asserts that a digital form of assembly, based on parts that are accessible and versatile as digital data, offers the greatest promise for a complex yet scalable open-ended and distributed architecture."[91] And even though Retsin argues that the concept of discrete should not be seen as merely another computational process but rather as crucial in terms of a production chain and its social implications, once it relates—as he himself affirms—to Mario Carpo's theory of the second digital turn, it implies that a different visual environment has emerged in architecture, characterised, Carpo says, as "disjointed, disconnected and fragmentary—often voxellised, filamentous or chunky."[92]

Today's "digitally intelligent architecture no longer looks the way it did", and this is the consequence, in the words of Carpo, of the "big data"[93] approach to computation.

Not only has the paradigm of fabrication hardware changed—while, in the 1990s, the technical protagonist of digital fabrication was the CNC milling machine, a subtractive fabrication technology that favours the milling of smooth, streamlined curves, today's industrial-grade 3D printers and the robotic assembly of prefabricated components suggest an aggregational way of building—the computational method now used to calculate is also different. The big data capacity of the computer makes it possible to notate reality as it appears at any scale, without having to convert it into simplified and scalable

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89 Ben van Berkel and Caroline Bos, "Everything is Curved: The Mercedes-Benz Museum, Stuttgart, Germany," in *Architectural Design: Elegance,* volume 77, issue 1, guest-eds. Ali Rahim and Hina Jamelle, January/February 2007, 46–48.

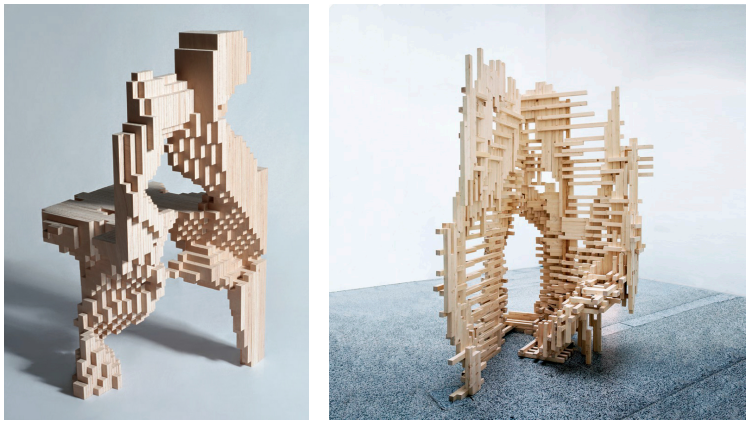
90 Rahim and Jamelle, "Elegance in the Age," 8.

91 Ibid.

92 Mario Carpo, "Particlised. Computational Discretism, or The Rise of the Digital Discrete," in *Architectural Design. Discrete: Reappraising the Digital in Architecture*, volume 89, issue 2, guest-ed. Gilles Retsin, March/April 2019, 88.

93 See: Carpo, "Breaking the Curve."

"Big data", Carpo asserts, "a disorderly offspring of postmodern digitally, is a tool for coping with, managing, and some would even say extolling complexity. Yesterday's spline-dominated environment was elegant and modern; today's data-driven design environment is messily postmodern: disconnected, broken, fragmentary, rickety, patchy and aggregatory. […] indeterminacy and nonlinearity are now a fact of our daily life, embedded in most digital technologies we use. We may pretend it is not so, but many designers are not pretending anymore. This is why today's digital style looks messy and rough. This is the way 'big data' looks, because we have no clue how to interpret it, and this is the way computation works, even if we cannot say why, or how."



2.11
Computational Chair by Philippe Morel, EZCT Architecture & Design Research (2004). Chair 'Model T1-M', after 860 generations (86,000 structural evaluations).

2.12
Styx by Igor Pantic, Christoph Klemmt and Andrei Gheorghe, AA Visiting School at Vienna (2018). The installation is based on a discrete cellular growth simulation.

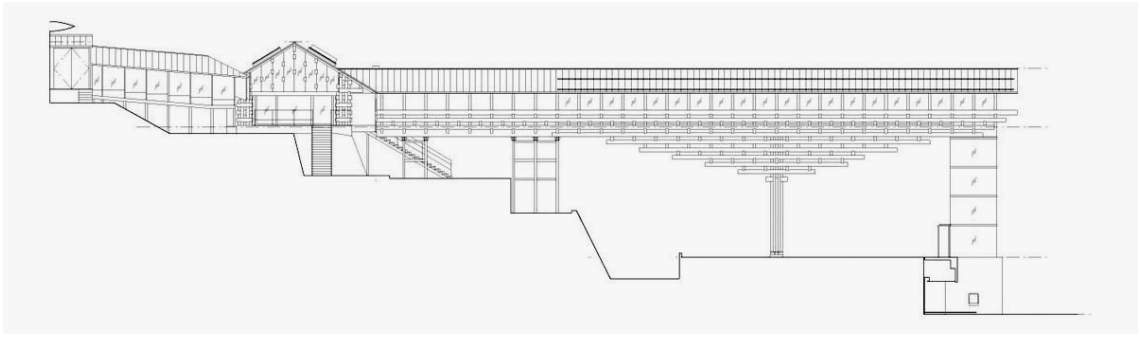
mathematical notations or laws, as well as to test complex quantitative phenomena by trial and error, using the power of digital simulations to predict and understand how an object might behave under various physical conditions. Therefore, as Carpo argues, this new scientific paradigm, "which is the reverse and nemesis of the old science we knew",[94] has been given visible form in the rising style of discrete computation ***(2.11)***.

AD profile 258 is about all this. The many articles in the magazine reveal that the discussion on current reality has been done, both from theoretical and practical points of view, above all within the academic sphere. Hence, beyond some critical essays concerned with historically framing the contemporary context by tracking its antecedents and relating it to previous architectural paradigms, the works featured in the issue come from research carried out by some design computation labs in schools of architecture that are deeply investigating the subject to discern how to compose with this data opulence and to make design sense of this new technological paradigm ***(2.12)***.

Among the many relatively small-scale computational experiments driven at leading schools in places such as London, Paris, Lausanne, Stuttgart, Innsbruck, Massachusetts and Los Angeles, Kengo Kuma is the only contemporary architect whose work is briefly commented on in the journal because of its similarities with the "particlised" style ***(2.13 – 2.17)***.

According to Carpo, "it is impossible not to notice that some of Kuma's world-famous buildings look at times remarkably similar to some of the experiments pursued by the young digital avant-garde featured in this issue."[95] In a way, both explore the same compositional strategy that for the Japanese architect is more than a mere architectural style. For Kuma, particlisation—a "mess of specific particles

94 Carpo, "Particlised," 88.
95 Ibid., 93.



2.13
GC Prostho Museum Research Center by Kengo Kuma & Associates, Kasugai-shi (2010). Exterior view.

2.14
The wood grid structure originated in the traditional system of Cidori seen from the inside.

2.15
Yusuhara Wooden Bridge Museum, by Kengo Kuma & Associates, Kasugai-shi (2010). Elevation.

2.16 / 2.17
Detail of the laminated wood members. Overall view of the cantilever bridge structure.

without the introduction of structure, hierarchy or assembly"[96] — is a view of the world, a philosophy itself that only contemporary technology has made possible to process.

Arriving at this point, the reader may ask, why did we choose to focus on the work of HdM?

If the contemporary context demonstrates that the relationship between geometry and architecture has been strongly affected by computational tools and that the challenges and opportunities that arise from it have been mainly tackled by the so-called digitally intelligent designers, then why did we opt for an architectural office decidedly outside of these specific investigation circles? Instead, why didn't we decide to study the design process of one of the protagonists coming from the often self-referential precincts of the digital avant-garde in which all the critical issues regarding information technologies are at the core of the applied methodologies and are overtly expressed in the character of architecture itself?

As the title of the dissertation suggests, we are interested in the hidden side of the phenomenon.

HdM are an architectural practice in which both geometry and the associated digital modelling processes are deeply concealed in the design; these are not taken as an end in themselves, but as part of the broad set of tools the architects use to achieve their aspirations, and within this work we propose to unveil them.

96 Ibid., 91.

Part I

The Digital as a Design Tool in the Architecture of Herzog & de Meuron

3.01
The HdM office at Rheinschanze, Basel.

3.
Herzog & de Meuron Atelier

3.1 _ Cabinet of Thought Processes
3.2 _ Matter and Form
3.3 _ Local / International / Global
3.4 _ Hand Drawing / 2D CAD / 2D CAD+3D Data / BIM

3.02
The Helsinki Dreispitz building, Münchenstein/Basel (2007–2014).

3.1 _ Cabinet of Thought Processes

In the former goods storage area of Dreispitz, located on the borderline between the two Basel cantons and not far from the Schaulager, the Helsinki Dreispitz building (2007–2014), designed by HdM, rises in a narrow plot, heading, with its odd, tapered volume, a row of existing warehouses (***3.02***). Inside this brutalist freestanding tower, in its lower levels, enclosed by the concrete walls of the plinth, is the carefully stored collection of a wide range of materials that have been produced by the office since it was founded by Jacques Herzog and Pierre de Meuron in 1978.

The aim of the architects was to assemble in one single place the many plans, drawings, texts, pictures and models that were previously kept in different locations, ensuring in this way not only the preservation of the full documentation, but also its accessibility for research and study purposes. Deciding to take an active part in the transformation of the Dreispitz site into a vibrant, mixed neighbourhood that they themselves had drawn up in the urban study developed a few years before,[1] HdM built this raw structure that houses their archive and is topped by a grid-framed block of cantilevered apartments. Their holdings, together with a collection of artworks and including some workplaces and the big workshop with the CNC machines, are arranged over the lower levels of the building, occupying a substantial part of it.

Entering the two floors of the archive, entirely dedicated to the physical models, mock-ups and experiments with materials, is an unforgettable experience and one of the most enriching introductions that one can have to the work of HdM (***3.03***).

[1] In 2001, HdM initiated the urban study listed as “204. Basel Dreispitzaerial, Urban Study. Basel, Switzerland. Project 2001–2002, 2003”.

3.03
The HdM Kabinett. Room dedicated to the office's architecture models.

The architects say that the archive echoes the spirit of 19th-century natural history collections[2] and, in fact, it is the idea of the cabinet, which dates back to the Renaissance and may be seen as a precursor to the museum, that is at the basis of its concept, a room where notable products of nature were accumulated, classified and displayed. As HdM have mentioned, their archive, like a cabinet, "stands for something intimate, something that has emerged and been preserved with great care over the course of many decades and, above all, something that should remain fruitfully workable",[3] having been installed for viewing more in the nature of a showroom than a warehouse.

However, the analogy with this example from history also continues in the character of the multiform and intriguing artefacts displayed inside the vitrines. Grouped by project and following a chronological sequence, the many objects arranged on the shelves are often real wonders. Just like those curious items that once were collected for scientific purposes, these are exotic, fantastic and even bizarre. They are difficult to comprehend. Odd and enigmatic, they make sense when seen as crystallised stages of a thought process.

As HdM explained when some of these objects were on display in an exhibition at the Canadian Centre for Architecture in 2002 and 2003, these physical experiments are just an "accumulation of the documents that we have produced in order to initiate and accelerate mental processes or, on the contrary, to arrest and propel them in another direction." [4]

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2 "Natural History" is also the name of the catalogue of the exhibition "Herzog & de Meuron: Archaeology of the Mind" held at the Canadian Centre for Architecture in 2002 and 2003, curated by Philip Ursprung. See Philip Ursprung, ed, *Herzog & de Meuron: Natural History* (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002).

3 Jacques Herzog and Pierre de Meuron, "Kabinett," Herzog & de Meuron, accessed October 24, 2018. https://www.herzogdemeuron.com/index/projects/kabinett.html.

4 Herzog & de Meuron, "Just Waste," in *Herzog & de Meuron: Natural History*, ed. Philip Ursprung (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002), 74.

Therefore, entering this place that, in the words of Charles Jencks, "is unique in the history of architecture",[5] is not only an opportunity to witness the development of the architectural production of HdM, but, more importantly, to become immersed in their inventive realm.

Walking along the rows of showcases takes one on a remarkable route through the work and history of HdM. In the beginning, we may see the delicate wooden model of the Ebelstrasse building. A little further, we find samples of the imprinted concrete panels of the Eberswalde library and the 1:1 scale foam moulds for the concrete organic shape of the Schaulager window apertures. A few more rows ahead, we discover the many plaster and iron frame experiments for the Beijing stadium or the dozens of variations for the chiselled volume of Prada Aoyama. We come across the impressive one-metre-high model of the first Roche tower; we see the light pink models for the Natividade church, and, unexpectedly, we discover the large-scale model of an entire corner of the Bordeaux stadium.

Almost every study and project developed by the office has some physical traces here. So, in this sense, this collection is a precious, almost archaeological, source of information about the work of HdM. Together, these objects not only reveal the incredible variety of their oeuvre across the years, something that, as mentioned by Charles Jencks, has "a pre-history, then a history, then an early-renaissance, a renaissance and a late-renaissance",[6] but they also give a hint of how the introduction of new techniques, as observed by Rowan Moore,[7] has changed the direction of their work.

These intriguing artefacts are a product of the mind, however, so they embody, in their singularity, a particular way of thinking about architecture. They allow us to go beyond the chronological narrative of the work of HdM, being the key to an understanding of their working methodology. They are unique in the sense that they are specific to HdM and are one of the distinguishing features of their practice, revealing much not only about how they see the architecture, but above all, about how they approach the creative process.

One of the aspects that immediately stands out from this vast collection is the great importance the construction of physical models has in their work. Made using different techniques, at all possible scales and throughout the whole range of design stages, these models go from pure experiments with materials or abstract volumes that capture the design idea and translate it into the world of shapes to more detailed objects that describe the project with accuracy or are even developed as tests for material samples.

Together with other tools, such as sketches, visualisations or digital models, these objects help to envisage untold possibilities and to anticipate as precisely as possible a not-yet-built reality. However, in contrast to seductive digitally produced images, Jacques Herzog regards physical models as "honest objects in the sense of archaic and ancient." As he mentioned in 2004, "if we start with virtual images, we don't know how they relate to real, to experienced physical reality. In that respect, the models are

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5 Charles Jencks, Jacques Herzog and Pierre de Meuron, "RIBA Jencks Award 2015: Herzog & de Meuron," London, RIBA. October 29, 2015, video, accessed January 18, 2017, https://www.youtube.com/watch?v=wOroNTX2qO8, 1:10:54.

6 Jencks, "RIBA Jencks Award 2015," 1:11:51.

7 Rowan Moore, "Herzog & de Meuron: Tate Modern's architects on their radical new extension," *The Guardian*, May 15, 2016, https://www.theguardian.com/artanddesign/2016/may/15/herzog-de-meuron-interview-tate-modern-switch-house-extension.

3.04
Preliminary models for the tower of the De Young Museum, San Francisco (1999–2005).

also testimony to an archaic understanding of body and reality." [8]

Therefore, they retain this traditional method of defining the architectonic object based on the construction of models that are manipulated in a dynamic process. Since the perceptual dimension of architecture is at the core of the HdM practice, in the sense of how a building should both read, look and feel, physical models are the means that allow them to go beyond a strictly visual experience and to set up the design process using an imperatively tactile approach. As though they were sculptures, models can be chiselled by hand and sensed from all angles so that every proportion or cut can be meticulously adapted down to the very last detail. Once constructed, these working models become particularly interesting, as noted by Jacques Herzog, and sometimes "have an aura that is much more effective in communicating the architectural idea than a perfectly detailed replica of future structures."[9]

However, besides revealing HdM's fascination with manipulating and exploring physical matter as a privileged means to catch the full sense of the architectonic object, these models, in their surprising variety, are also witness to the fresh view with which HdM always approach architecture (***3.04***).

This is true within each single project. The many variations tested on the same topic, or the very different versions often produced for a project, are a clear testimony to their obstinate and profound desire to investigate and continuously question the reason for things while in search of the ideal form. "We have often tried out stupid things", Jacques Herzog has said. "You never know where it will go, but sometimes it leads to unexpected results."[10]

This same diversity is also evident throughout their work. There are, of course, affinities between the projects, and this suggests a coherence of principles underpinning HdM's architecture. However, each building or project has its very own character, which comes, as Nicholas Serota observed, from their distinctive "ability to rethink a project from their first principles and to come up with unexpected

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8 Jacques Herzog quoted in Theodora Vischer, *Herzog & de Meuron: No. 250 An Exhibition* (Münchenstein/Basel: Schaulager, 2004).

9 Jacques Herzog, "Interview by Theodora Vischer with Jacques Herzog," by Theodora Vischer, in *Architectures of Herzog & de Meuron. Portraits by Thomas Ruff* (New York: Peter Blum, 1995), 29.

10 Oliver Wainwright, "Lofts and Caves," in *Tate Modern, building a museum for the 21st century*, eds. Chris Dercon and Nicholas Serota (London: Tate Publishing, 2016), 42.

solutions, exploring both volume and surface".[11] The steady unpredictability of their responses to commissions is also a reflection of the non-style conception they have of architecture as something that should not be determined by the author's personal character nor restrained by an unequivocal approach. They cultivate open-mindedness as well as embrace a need for freedom, so their method relies on a wide-ranging experimentation. As Rémy Zaugg described, "their method varies according to the project. It springs from the project, is subordinate to it, and not the reverse. If they have a method, it consists in asking themselves again and again: Exactly what are we doing there? Hence the precision, functional appropriateness, and diversity of skin, facade and aspect in their creation. They belong to no movement. Like myself, they are their own school."[12]

However, even though this attitude may lead one to consider them as difficult to classify or include in a particular lineage, their ideas are very clear, and the consistency of their practice over the years can only be seen as an explicit testimony to this.

3.2 _ Matter and Form

In his introductory essay to the catalogue of the exhibition "Herzog & de Meuron: Archaeology of the Mind", Philip Ursprung focuses part of his discourse on the art-or-architecture question that the projects of HdM over the years have propelled their public to discuss.

Even though the Swiss art historian has some doubts that their architecture is rooted in art, explaining that arguments both in favour and against this so far unsolved dilemma are ready to hand,[13] he considers that "the attempt to understand the phenomenon of Herzog & de Meuron virtually compels interpreters to enter new territory."[14]

Indeed, since their very first works, the conspicuous novelty that has always distinguished their buildings clearly reveals that something from outside architecture was brought into its disciplinary field.

One of the reasons for this odd specificity certainly lies in the fact, often mentioned by Jacques Herzog, that his attention has never been much caught by the world of contemporary architects. Rather than basing his work on concrete examples of buildings, he is influenced by images that come from existing reality and are informed by his extremely curious observation (***3.05 / 3.06***). Understood as a strategy that frees the creative process from preconceived references that, in his opinion, may limit the design of a given project, Jacques Herzog explains that "that's why I was never honestly interested in what other architects of my generation, of my time, or even the 20th century were producing.

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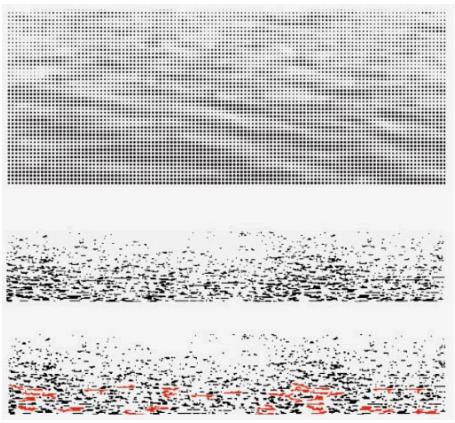
11 Nicholas Serota, in conversation with the author, "Tate Modern 2 is a post-digital building," Zoom meeting, Porto-Helston, June 25, 2020.

12 Rémy Zaugg, "Architecture in Itself Doesn't Interest Me," by Philip Ursprung, in *Herzog & de Meuron: Natural History*, ed. Philip Ursprung (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002), 231.

13 As Philipp Ursprung argues, even though many arguments are "in favour of the claim that the architectural work of Herzog & de Meuron is inextricably bound up in the art praxis, […] it is as easy to come up with arguments against this. Herzog himself has long since ceased his activities as an artist, because "it is impossible to do art and architecture at the same time," and because, for him, as he himself says, there was no longer any need to express himself other than in architectural terms. For Herzog & de Meuron, the practice of applying the notion of art to architecture is simply absurd. Indeed, they state very explicitly that their architecture is not art and that, in any case, they are in favour of the autonomy of different genres." Philip Ursprung, "Exhibiting Herzog & de Meuron," in *Herzog & de Meuron: Natural History*, ed. Philip Ursprung (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002), 13–14.

14 Ursprung, "Exhibiting Herzog & de Meuron," 15.



3.05
Tenerife Espacio de las Artes, Tenerife (1999–2008). Photo of a water surface and its abstraction by a pixellation process.

3.06
Construction of the facade mock-up.

Historically, I know relatively little and I couldn't name so many buildings that I find important. What I know about past architecture is much more based on my daily experience."[15]

This, however, doesn't imply that their buildings are not forged in the logic and reality of architecture. It just hints that the broad influences feeding the creative practice go beyond the concrete world of architecture, extending to images that they had collected somewhere else, even in the alluring realm of nature. On the other hand, this also proves that when HdM look at the surrounding context they do it from an embracing and unprejudiced perspective. According to Jacques Herzog, the less that reality is judged aesthetically or classified in categories, the more it becomes richer and full of attractive elements that can be used and transformed into architecture. Regardless of whether these elements are ugly or beautiful or belong to high or low culture, by the fact that they simply exist, they have the right and dignity to be appropriated. "Our approach is phenomenological", said Jacques Herzog. "All that we have designed comes from observation and description. All that we have ever done has been found on the street. All of our projects are products of our perceptions projected onto objects. This is why our buildings are each so different from one another. Because we turn our heads in different directions, the buildings arise from changing perceptions."[16]

However, and at the risk of being caught up in the debate referred to by Ursprung, we cannot help mentioning the relationship HdM have with art as something that has always been present in their practice and is specific to them. In fact, it is not by chance that authors so close to them, such as Luis Fernández-Galiano or Gerhard Mack, opened their critical reflections on the architectural work of HdM

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15 Jacques Herzog, Fredi Fischli and Niels Olsen, "Jacques Herzog, Fredi Fischli and Niels Olsen: Retail Apocalypse," online meeting, May 20, 2020, video, accessed November 18, 2020, https://www.herzogdemeuron.com/index/projects/talks/gta-retail-apocalypse.html, 49:10.

16 Jacques Herzog, "Poesis-Production," Herzog & de Meuron, accessed November 24, 2018, https://www.herzogdemeuron.com/index/projects/writings/essays/poesis-production.html.

3.07
Jacob Burckhardt walking across Basel Münsterplatz to the University.

by presenting arguments that point exactly to this particular relationship with art. The fascination HdM have with the world of some contemporary artists has influenced how they see and make architecture, at the same time as that constantly feeds their experimental interest in the field outside the discipline.

Basel, the native city of Jacques Herzog and Pierre de Meuron, internationally renowned for its world-class art institutions, is also, as Luis Fernández-Galiano[17] remarked, the city where Jacob Burckhardt, the art historian who rediscovered the Italian Renaissance, was born, lived and taught (***3.07***). So, the core of this tri-national conurbation, besides being one of the most vibrant centres of art in the world, is also a place for thinking and critical reflection on art.

Jacques Herzog himself has been an artist, with a few exhibitions held in the initial years of his carreer. This early engagement with art praxis and the involvement of the two architects in the rich intellectual world of Basel have, therefore, surely left a mark on their attitudes from the moment they chose architecture to express themselves. Remembering a conversation he had with Jacques Herzog, Rémy Zaugg talked about Herzog's affinity with artists as a relationship the Swiss architect considers inspiring, and from which he sometimes gets even more than he can find in the realm of architects. "Jacques did tell me that he had no architect colleagues with whom he could speak as he does with artists. This might possibily mean that discussion with artists enables him to see architecture with the benefit of the hindsight, or that some artists have a critical way of thinking that interests him."[18]

Artists have no programme of requirements from a client. So, this total freedom that, in the opinion

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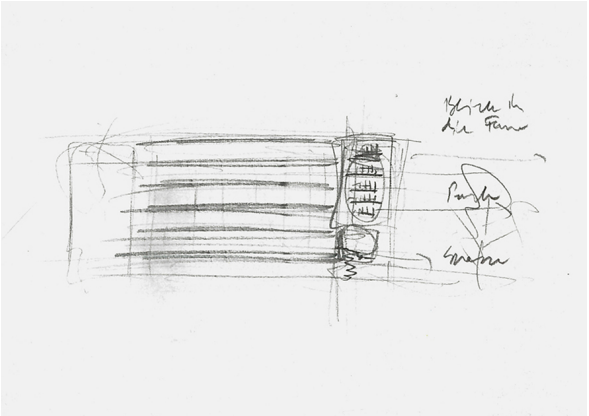
17 Luis Fernandéz-Galiano, "Jacques Herzog y Pierre de Meuron," *Protagonistas de la Arquitectura del Siglo XXI*, Madrid, Fundacíon Juan March, Madrid, October 25, 2011, audio, accessed May 24, 2017, https://canal.march.es/es/coleccion/jacques-herzog-pierre-meuron-1781, 03:35.

18 Zaugg, "Architecture in Itself," 232.



3 08
Roche Building 92, Basel (1993–2000). Preliminary design sketch for the building.

3.09
The 30-metre high wall painting by Rémy Zaugg.

of Jacques Herzog, most architects could not live with, despite being the scariest thing, is, at the same time, the most liberating and is what he somehow also seeks to pursue in his design practice. Even though architecture does not lend itself so much to this, in their work, HdM try, in a similar way, to diminish the boundaries of the creative act by opening up their methodology towards a divergent thinking.

Their collaborations with artists are a clear testimony to this. These collaborations witness the continuous will of HdM to expand the imaginative inputs to a project, as well as the strong interest they have in keeping the two disciplines, art and architecture, intertwined. Working with an artist means having someone from another field being part of the project and contributing to it with a fresh view, but it also means, as explained by Jacques Herzog, the possibility "to look at the world through the eyes of an artist",[19] and therefore improve the project by adding extra quality to it.

The evidence of these collaborations recurs over their carreer. In some of them, the work of the architect and that of the artist remain somehow recognisable, even though they are intimately linked to each other in such a way that one is unthinkable without the other. This is the case for the wall painting by Rémy Zaugg at the Roche Pharma-Research Building 92, Basel (1993–2000) (***3.08 / 3.09***), the pictures chosen by Thomas Ruff for the figurative ornamented facade of the Eberswalde Technical School Library, Eberswalde (1994–1999), or the curtains designed by the artists Rosemarie Trockel and Adrian Schiess for the Ricola Marketing Building, Laufen (1997–1999).

In other collaborations, the compromise between the architect and the artist went further. From the very beginning, the artist was part of the design team alongside the architect, conducting, in a kind of

[19] Jacques Herzog, "Collaborations with Artists, Museum Projects, and our first Building in America," Herzog & de Meuron, accessed November 26, 2020, https://www.herzogdemeuron.com/index/projects/lectures/collaborations-with-artists-museum-projects-and-our-first-building-in-america.html.

co-authorship, the development of a unitary project. In these cases, contributions from both sides merged in such a way they are no longer separable or aknowledged as such. This happened in many of the collaborations with Rémy Zaugg, like the Master Plan and Student Housing for the Université de Bourgogne, Dijon (1989–1992), the Urban Study for Basel (1991–1992) or the Artist's Studio in Mulhouse (1995–1996), as well as with the Chinese artist Ai Weiwei in the project for the National Stadium, Beijing (2002–2008) and the Serpentine Gallery Pavillion in London (2011–2012).

However, one of the most significant impacts of art on their practice may be seen in the foundational years of their career. There, we may also find the reason for Herzog's statement that "no architect has been as important to us as the whole field of visual arts".[20]

Indeed, in a time of uncertainty and consumer styles, such as that of the 1980s, in which the two architects were developing their first projects and questioning how architecture could be recreated as a contemporary tool of expression, the hint of the direction they could take came from Minimalist art.

Jacques Herzog has always been very clear that both postmodernism and deconstructivism, understood as stylistic approaches, have never been on their agenda. Furthermore, as he often describes, architects in this particular period of history were experiencing a completely disorienting situation. "All the former security and self-evidence of the architectural work in traditional culture has vanished", he notes, leading to a condition in which one could no longer rely on anything. Making an object, as Herzog remarked, was a new problem each time, so "the architect [had] to base his or her work on something else, on something that he or she [should] bring to the project." [21]

For Jacques Herzog and Pierre de Meuron, this something else was found in art. To incorporate lessons from works of art in their practice has allowed them to break away from the early references coming from their masters and progressively consolidate their own architectural language.

The Stone House in Tavole (1982–1988) is probably the first of their buildings in which a totally different approach to architecture emerged with more consistency, signalling the beginning of their own path. Located in the undulating landscape of the Ligurian coast, this three-storey house embodies, in the geometric simplicity of its design, a radical departure with no counterpoint within the architectural production of that time (***3.10***). "Minimal art was like a way for us to go into the world of architecture", Jacques Herzog said. "At that time, nobody was interested in minimal, and the term of minimal architecture came up only later."[22]

The reduction of forms to an elementary condition and the experiences with boxes and regular shapes, particularly recurrent in their first projects, does not mean, however, that their architecture is necessarily "abstract" in the sense of being disassociated from any specific stance. On the contrary, their buildings are quite expressive and allude very often to an underlying imagery. In the Stone House this ambivalence is quite evident. The crystalline structure of the concrete skeleton that reflects the simple cross-shaped ground plan and the elevations is counterbalanced by the richly textured dry-stone

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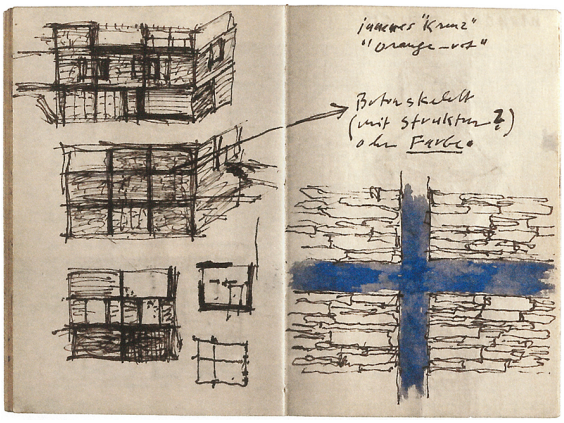
20 Jacques Herzog, "The Nature of Artifice [a conversation with Jacques Herzog]," by William J. R. Curtis, in *El Croquis. Herzog & de Meuron 1998–2002. The Nature of Artifice*, vol. 109/110, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2002), 26.

21 Herzog, "Poesis-Production."

22 Jacques Herzog, "Viernes de Fábrica 2. Jacques Herzog," Fábrica de Ciudad, October 9, 2020, video, accessed December 10, 2020, https://www.herzogdemeuron.com/index/projects/talks/viernes-de-fabrica.html, 10:09.



3.10
The Stone House, Tavole (1982–1988). Sketches by Jacques Herzog.

3.11
The building's concrete skeleton with the textured dry-stone infill.

infill of the outer surface (***3.11***). Like a drawing, the lines of the structure are artificial, contrasting with the natural stones collected from old vineyards in the vicinity and stacked without mortar that endow the building with a particular vernacular character. Besides witnessing HdM's recurrent rejection of Modernism's ideological emphasis on novelty, the stones, in this particular work, are also the device that promotes the relationship with the site, the local landscape and nature itself.

Resuming the essay by Philip Ursprung and the art-or-architecture question addressed by him, at a certain point the author mentions that, in his opinion, this "discussion simply—unintentionally—distracts us from another theme for which there is as yet no language."[23]

Interested in reflecting on the architecture exhibitions that, as a genre, have always played a central part in the work of HdM, and of course in identifying what this other theme might be, Philip Ursprung goes back to 1978 and the well-known story of the encounter between the two architects and the German artist Joseph Beuys on the occasion of the Basel carnival.[24] Ursprung argues that the idea of inviting Beuys to Basel, not to make a "parody of a sculpture" but rather to "create a new sculpture", points to the fact "that their efforts were directed towards the sphere of representation."[25]

Therefore, according to Ursprung, this same idea informs the way in which HdM conceive their exhibitions. For them, says the art historian, "exhibitions of architecture are like a test run". They "make it

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23 Ursprung, "Exhibiting Herzog & de Meuron," 20–21.

24 The story of the encounter between Jacques Herzog, Pierre de Meuron and Joseph Beuys and the realisation of the carnival action in Basel in 1978 is described by Gerhard Mack in the introductory essay of the HdM monograph, volume 1. See Gerhard Mack, "Architecture in a Post-Romantic World. About the designs by Herzog & de Meuron 1978–1988." in *Herzog & de Meuron 1978–1988. The Complete Works*. vol. 1, ed. Gerhard Mack (Basel, Boston, Berlin: Birkhäuser, 1997), 7.

It is also mentioned by Jacques Herzog in Jean-François Chevrier, *From Basel. Herzog & de Meuron* (Basel: Birkhauser, 2016), 85.

25 Ursprung, "Exhibiting Herzog & de Meuron," 21.

possible for the architects to involve visitors in experiments that they otherwise could not realize."[26] Exhibitions are about the direct contact between the public and certain objects put on display, so, in this sense, they are envisaged by HdM as an opportunity to test the effects of some research topics that afterwards might reappear and be explored in their own architecture.

As such, this unlikely analogy that Ursprung makes between the architecture exhibitions, as they are seen by HdM, and the concept of representation is particularly relevant, as it points to a theme that we consider decisive in their architectural practice. The idea of thinking out and realising an action to be then experienced and sensed by the public, like that of the Basel carnival, which later became an actual work by Joseph Beuys—the "Feuerstätte II"—is not restricted, in the work of HdM, to the realm of the exhibition, but is instead something that extends to the architecture itself.

"The perceptual experience generated by the object has always interested these two architects",[27] Jean-François Chevrier remarked. And, indeed, the idea of perception as a creative act, as expressed by Rémy Zaugg, has strongly influenced, from the very beginning, the Swiss architects for whom architecture is intimately embedded in the concept of perception. This means that their projects are closely tied with how they perceive and absorb a particular situation or site, but it also implies that the buildings themselves are seen as objects of perception by others, which is what, in turn, lends the projects a specific character.

"Posing a challenge to the perception of others", Jacques Herzog said, "is therefore vital for us, an artistic strategy that we apply to architecture and that has certainly left its mark on our work ever since."[28]

This particular focus on perception has influenced how HdM relate to architecture and see it as a perceptual object that appeals to all five senses[29] of those who experience it, revealing it as also crucial for the understanding of how they approach the creative act.

In fact, matter and form, two of the most relevant design topics in their architecture, are intimately linked to this idea of perception as a means to explore the physical world and can only be fully decoded when seen within this same perspective. If, on the one hand, matter and form are the devices that allow HdM to emphasise the sensitive features of a building in their architecture, on the other, they witness, in the singular way in which they are considered by the Swiss architects, their strong engagement with the perceptual experience of existing reality.

Their attention to the tactile and visual qualities of surfaces through the use of materials, together with intensive research on the shape and geometric composition of volumes, are a hallmark of their architecture, endowing each building with a clear identity of its own. Luis Fernández-Galiano, who

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26 Ibid.

27 Chevrier, *From Basel*, 25.

28 Jacques Herzog, "Très difficile. Ein Gespräch mit dem Basler Architekten und Pritzkerpreisträger Jacques Herzog," by Ulf Meyer, Herzog & de Meuron, accessed November 24, 2018, https://www.herzogdemeuron.com/index/projects/writings/conversations/tres-difficile-de.html.

29 In the acceptance speech for the Pritzker Prize, Jacques Herzog and Pierre de Meuron, referring specifically to materials, said that they "look for materials that are as intelligent as virtuoso, as complex as natural phenomena, materials that not only tickle the retina of the astonished art critic but that are really efficient and appeal to all of our senses — not just the eyes, but also the nose, the ears, the sense of taste and the sense of touch." Jacques Herzog and Pierre de Meuron. "[acceptance speech] 2001 Pritzker Architecture Prize," in *El Croquis. Herzog & de Meuron 1998–2002. The Nature of Artifice*, vol. 109/110, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2002), 14.

3.12
Feuerstätte II (Hearth II), Joseph Beuys (1978–1979). Installation view, Kunstmuseum, Basel.

considers matter and form key topics for reading the work of HdM, places these two subjects at the origin of their architectural practice, suggesting that both have been inherited from two crucial figures.

"These two young men had two spiritual fathers", the Spanish architect said. "One of them, an architect, Aldo Rossi who was their professor at the ETH of Zurich. The other, an artist, Joseph Beuys who was at the time considered a great guru; in the art world he was a reference figure in the Germanic world. [...] Beuys gave them the matter and Rossi gave them the forms."[30]

Joseph Beuys and his work, as Jacques Herzog mentioned more than once, has played an especially important role. The experience of the Basel carnival, their first collaboration with an artist, has brought them closer to the northen, romantic world of Beuys and to his totally new and unexpected way of using materials (***3.12***). "Beuys detached a whole series of materials from their usual functional contexts and offered them as art", Gerhard Mack notes. "The precondition for this was a perspective that allowed for a basic questioning of the factual world and for discovering qualities in materials that were not canonized. With a comparably fresh glance, Herzog & de Meuron have rediscovered various materials for contemporary architecture or provided them with a new use."[31]

Since the Blue House, Oberwil (1979–1980), in which the Yves Klein blue was chosen to paint the concrete block walls, endowing this suburban house with a fragile and almost immaterial appearance, their buildings have been distinguished by an impressive use of materials. Among many others, projects such as the two Signal Boxes wrapped with copper bands, Basel (1989–1994/1994–1999), the Dominus Winery enclosed by translucent stone gabions, Napa Valley (1995–1998), the crystalline

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30 "Estos dos jóvenes tuvieron dos padres espirituales. Uno, un arquitecto, Aldo Rossi que fue su profesor en la ETH de Zurique. Otro, un artista, Joseph Beuys che entonces era un gran gurú; dentro el mondo del arte era la figura de referencia en todo este mondo germánico. [...] Beuys les dio la materia, pero Rossi les dio las formas." Galiano, "Jacques Herzog y Pierre de Meuron," 06:30.

31 Mack, "Architecture in a Post-Romantic World," 8.

Elsassertor II made of transparencies and reflections, Basel (2000–2005), or the recent extension to the Unterlinden Museum clad with traditional broken bricks, Colmar (2009–2015), are clear testimonies to this singular approach.

HdM do not privilege one material over the other, and besides considering that they play an important role in the notion of a place, the Swiss architects believe that the materials' interest and effective quality lies in the work itself, on "how they are joined together and in what manner they are used",[32] as Jacques Herzog remarked. As such, and as a reaction to their recognition of the loss of traditional craftsmanship in contemporary culture,[33] HdM are constantly challenging the traditional usage of materials and trying to subvert this in search of new, striking meanings.

By doing so, they question prejudices towards the nature of materials and play with paradoxes, such as gravity and lightness, opacity and transparency, emphasising qualities in the buildings that are a challenge to one's perception by offering different interpretations. According to Jacques Herzog, this is also a way in which the material attains its specific value, leaving its bare physical reality behind. An operation, as he refers to it, comparable to what "is almost an axiom in the fine arts, be it the paint for painting or any substance for traditional sculpture. What interests us beyond this is that a part of the intellectual quality of the design lies in the fact that a material is no longer a purely representative means and therefore no longer restricted to its visual surface."[34]

When Luis Fernández-Galiano speaks about the influence that Aldo Rossi had on HdM, he remarks on the critical reflection on Modernity undertaken by the Italian architect and his interest in retrieving some lost ideologies, but he also mentions the fascination Rossi had for the rationality of vernacular architecture. In Galiano's opinion, besides a convergent rejection of some Modernist ideas, HdM developed from Aldo Rossi a similar interest in the elementary shapes one can find in daily life.

However, more than the shapes in themselves, such as the gabled roof, as argued by the Spanish architect, HdM certainly gained from Rossi an awareness of the primacy of form as the raw material of architecture. "The seductiveness of form is very important", Jacques Herzog said. "It engages all the senses; it makes perception more intense. That is how an iconic building takes on monumental "permanence" [as] described by Aldo Rossi." [35]

Furthermore, when referring to their professor at ETHZ, Jacques Herzog noted that Rossi helped them to develop their own experience of a place (***3.13***). Aldo Rossi's ideas on the city and architectural design as an autobiographical process in which the memory of previously seen realities plays a crucial role have indeed contributed to their engagement with the site as a point of departure for the design of a given architecture within a very individual approach. With Rossi, HdM started to incorporate different perceptions of reality, expanding the notion of a place to something beyond the concrete physical

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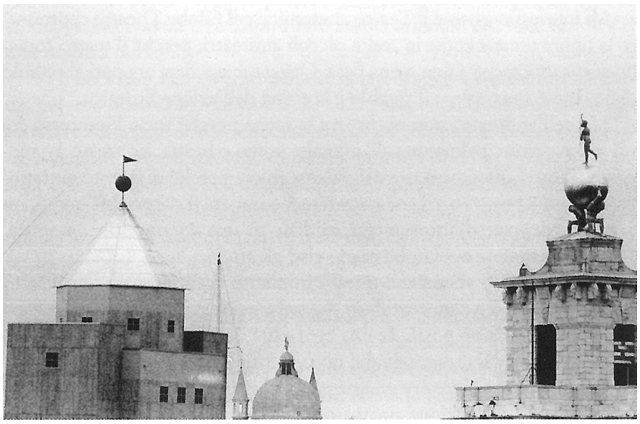
32 Jacques Herzog, "Conversation between Jacques Herzog and Theodora Vischer, May 1988," by Theodora Vischer, in *Herzog & de Meuron 1978–1988. The Complete Works*. vol. 1, ed. Gerhard Mack (Basel, Boston, Berlin: Birkhäuser, 1997), 215.

33 This issue is addressed in the essay written by Jacques Herzog in 1988 "The Hidden Geometry of Nature", cf. Jacques Herzog, "The Hidden Geometry of Nature," in *Herzog & de Meuron 1978–1988. The Complete Works.* vol. 1, ed. Gerhard Mack (Basel, Boston, Berlin: Birkhäuser, 1997), 207–211.

34 Herzog, "Conversation between Jacques," 216.

35 Jacques Herzog, "Ornament, Structure and Space [A Conversation with Jacques Herzog]," by Jean-François Chevrier, in *El Croquis. Herzog & de Meuron 2002–2006. The Monumental and the Intimate*, vol. 129/130, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2006), 30.



3.13
Theatre of the World by Aldo Rossi in Venice (1979).

dimension, and largely concerned with images coming from its perceptual experience.

For HdM, it is thus important to find the right architecture for each place. And, in a way, this is what explains the constant heterogeneity of the external appearance of their buildings. Formal strategies and compositional devices always vary from project to project as the result of a response that is intended to be specific rather than generic and deeply bonded to the ground.

"We have no desire to set up new establishments", Jacques Herzog said in the very first years of their career, "but on the contrary, we want to pursue existing perceptions in order to complete the city".[36]

Therefore, the overall shape of the buildings is quite often the result of a recognition of the given site factors. It often arises from a deep reflection on the surrounding conditions, becoming meaningful while trying to resume relationships, promote urban integration, and reinforce the existing reality, instead of simply introducing new and extraneous signs.

From this point of view, the recent unbuilt project for the Stamford Bridge stadium, London (2013–2017), is a significant example. In this building, the imperative to create a recognisable landmark has been skilfully reconciled with the specificities of the local surroundings. The resulting shape is that of an architectonic object that is both iconic and contextual. With a distinctive character that made it stand out from the urban profile, the stadium's volume was also, in its fine formal details—such as the irregular carving of the outer shape, the radial structure of brick piers or the circular roof ring that unified the whole volume—a response to the immediate context, with which it sought to establish a conciliatory dialogue.

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[36] Herzog, “Conversation between Jacques,” 213.

This duality of the architectonic form as something that should have its own autonomy and, at the same time, rely on the site, from which it gets its specific identity, is recurrent in the work of HdM, being adjusted each time according to the demands of the project.

The deep investigation of the shape, carefully combined with a rigorously researched use of materials, is what endows their work with a singular geometric and tactile quality, with both factors—matter and form—responsible for how the building sits on the site and presents itself as an odd interpretation of it. Referring to Andy Warhol as an artist who transcended categories to say something new, Jacques Herzog explained, "that is exactly what we are interested in: to use well known forms and materials in a new way so that they become alive again. We would love to do [...] architecture which looks familiar, which does not urge you to look at it, which is quite normal, but at the same time, it has another dimension, a dimension of the new, of something unexpected, something questioning, even disturbing. We love to destroy the clichés of architecture."[37]

3.3 _ Local / International / Global

When looking at the chronology of the works of HdM and the type of commissions they received over the past forty years, the increasing growth of the practice and its development from a small office to a global company becomes evident.

Two specific projects, both resulting from competitions, may be seen as the key moments that, in a way, mark the evolution of their career. While the Tate Modern in London (1994–2000) signals the transition from a local to an international scale practice by the end of the 1990s, the National Stadium in Beijing (2002–2008) embodies, in the first years of the 2000s, the full engagement of the office with projects of global-scale impact.

To win the competition, in 1995, of such an important project as the Tate Modern represented an opportunity for the Basel-based office to stand side by side with the great names in architecture at that time, such as Renzo Piano, Tadao Ando, David Chipperfield, Rafael Moneo and Rem Koolhaas (***3.14***). From this moment, the work of HdM gained visibility, contributing to the progress of their career beyond the narrow borders of Switzerland. "Tate Modern was a huge success that pushed us forward", Jacques Herzog said. "It helped us, as architects, in getting other projects, but also in making it easier to design ideas and take chances."[38]

If, before the conversion of the Bankside power station, the projects for HdM came, above all, from private investors within their native country, with the opening of the new modern art gallery to the public in 2000 their practice broadened in scope, spreading, through numerous large-scale commissions, across Europe and to countries such as the United States and China.

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37 Jacques Herzog, "A Conversation [with Jacques Herzog]," by Jeffrey Kipnis, in *El Croquis. Herzog & de Meuron 1981–2000. Between the Face and the Landscape. The Cunning of Cosmetics*, vol. 60+84, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2005), 31, 32.

38 "En la Tate Modern, tuvimos mucha suerte. Este caso fue un grande éxito que nos ayudó e nos empujó mucho non solo a tener otros proyectos como arquitectos, peró a tener más facilidad en proyectar ideas o arriescarlo." Jacques Herzog and Luis Fernandéz-Galiano, "Jacques Herzog: Arquitectura inspirada en el arte," Madird, Fundacíon Juan March, November 14, 2017, video. https://www.march.es/videos/?p0=11320, 40:10.

3.14
The architects who took part in the first stage of the 1994 competition for Tate Modern with Nicholas Serota in the Turbine Hall.

3.15
The National Stadium, Beijing (2002–2008).

In his critical overview of two decades of HdM, Rowan Moore, in 2015, was quite explicit in considering Tate Modern to be the crucial turning point in which they switched from "architects with a reputation of a quiet kind" to "Pritzkerised stars [such] as Hadid or others [too] superfluous to name."[39] According to the British architecture critic, the art gallery in London opened up the practice of HdM to large new-build commissions, but it also led them to deal, inevitably, with the world of globalisation.

"As their career progressed", Rowan Moore said, "and they worked for more money and more power, they have found themselves engaging with issues which, with the smaller earlier projects, were less pressing. In particular, they had to deal with the society of the spectacle—it being harder to achieve suggestive muteness with a donor-led museum or an Olympic stadium than with a storage facility—which they did with some gusto."[40]

Along with the many museum commissions that the Swiss architects began receiving right after Tate Modern, in such different places as Duisburg, Madrid, Minneapolis, San Francisco, Tenerife or Basel, HdM also became involved in the realisation of global projects. As noticed by Gerhard Mack, "the first years of the millennium brought projects that quickly achieved iconic status."[41]

The National Stadium, built for the 2008 Olympic Games in China, as the building that is most emblematic of HdM and with the greatest worldwide impact, is, in a way, the milestone that announces this ultimate leap in scale in their career (***3.15***). From this moment, the architectural practice of HdM was continuously marked by large-scale projects that, besides being strategic pieces that impacted the urban fabric, often triggering new developments, also became important landmarks capable of

39 Rowan Moore, "Two decades of Herzog & de Meuron," *The Architectural Review*, March, 2015, http://www.architectural-review.com/archive/viewpoints/two-decades-of-herzog-and-de-meuron/8678985.fullarticle.

40 Ibid.

41 Gerhard Mack, "For the City", in *Herzog & de Meuron 2002–2004. The Complete Works*. vol. 5, ed. Gerhard Mack (Basel: Birkhäuser, 2020), 16.

enhancing the city's image and its international standing. The Allianz Arena in Munich (2001–2005), the Elbphilarmonie in Hamburg (2001–2016) or the Beijing Stadium itself are just some of the first signs that foreshadow what would be to come.

When putting the initial works and recent ones side by side, like, for example, the Apartment Building in Hebelstrasse, Basel (1984–1988), and the residential high-rise tower 56 Leonard Street in New York (2006–2017), or the Sammlung Goetz gallery in Munich (1989–1992) and the M+ Museum in Hong Kong (2012–2021), the enlargement of the office over the years becomes evident in this cleavage between private and collective, small and big, simple and complex.

In the same way, the continuous growth of the firm is also evident in the exponential increase in the number of commissions received over the past twenty years, which is easy to follow, as they number their projects, as Philip Ursprung remarks, "in the manner of Paul Klee or Gerhard Richter."[42] In 1995, nearly twenty years after they started their practice, the Tate Modern was numbered project 126, while in the second half of their career, according to their website and the last project published at the end of 2021—the 547 UCS Helen Diller Medical Center, San Francisco (2020–...)—they received around 420 commissions.

Together with the rising number, size, and complexity of the projects, the dimensions and structure of the firm also reflects this increasing development (***3.16 / 3.17***). What started as a small traditional office established by two young architects is currently an international team of about 500 collaborators with site offices in London, New York, Hong Kong, Berlin and Copenhagen. While in the very first years of practice, Jacques Herzog and Pierre de Meuron directed the whole design process for projects such as the Frei Photographic Studio, Weil Am Rhein (1981–1982), the Stone House in Tavole (1982–1988) or the competition for the Visp Theatre, Visp (1984), over time, the office has gradually evolved into a partnership with a ramified hierarchical structure. Besides the two founding partners, there are now an additional 15 partners[43] who take responsibility for the development of projects and the organisation of the firm. "Each partner", said Jacques Herzog, "has responsability for certain projects whose progress they follow on a daily basis and for which they organise the work to be done by the teams. Our role, Pierre and myself, is to inspire and assist all the projects." [44]

However, despite the increasing growth of the office, HdM managed to respond to their prestige as protagonists in the global architecture scene without losing their principles or moving away from their original disciplinary beliefs.

In this regard, Rowan Moore mentions that "simultaneously with these grand global projects the practice has continued to work in and near Basel, usually on quieter buildings". [45] For the British critic, these local projects, working as a kind of laboratory, "serve to explore and develop ideas to be expanded elsewhere",[46] allowing HdM to deal with the particular Swiss urban conditions and functioning

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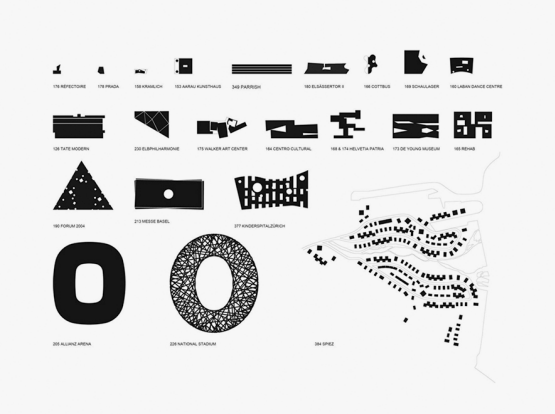
42 Ursprung, "Exhibiting Herzog & de Meuron," 13.

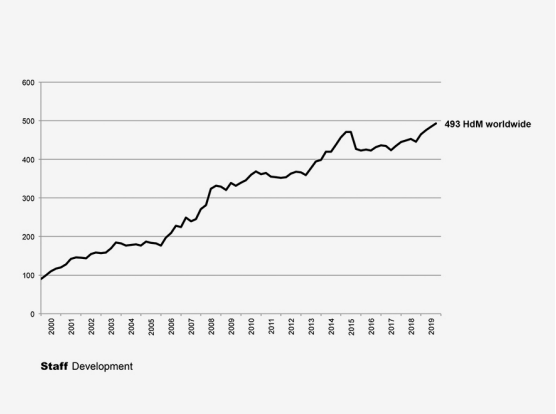
43 As we write, by December 2021, according to the HdM website, besides the two founding partners, there were five senior partners, six partners and four associate partners.

44 Herzog, "Ornament, Structure and Space," 26.

45 Moore, "Two decades."

46 Ibid.





3.16
From small to big, the range of scales in the works of HdM.

3.17
Staff development at HdM, from nearly 100 collaborators in 2000 to 493 in 2019.

as an opportunity to consolidate their vision on the unavoidable specific differences of cities. Furthermore, this balance that they constantly seek to strike between global and local is as well a sign of their will to preserve, together with the adaptation "to an industrial production scale [...], the 'artisanal' dimension of their first projects."[47]

"We will never become a 'corporate' office "HdM" like a brand with local offices in every corner of the world", Jacques Herzog said in 2001. "Our work is extremely research oriented and research is the key thing to keep us alive here, to survive and withstand the terrible machinery and bureaucracy of the business."[48]

In a similar way, Luis Fernández-Galiano also mentioned the particular connection HdM have with their cultural basis, describing Jacques Herzog and Pierre de Meuron as people from Basel. "Of course, they have travelled all over the world and built all over the world", the Spanish architect explained. "But their roots are clear. [...] They could never move the office because they are so ingrained in this Swiss reality that it is impossible to contemplate them anywhere else."[49] In another critical essay,[50] the author remarked that over these forty years, since 1978, HdM had stubbornly remained in their office in Rheinschanze.

This issue, which seems of minor importance at first glance, is particularly relevant once their office facilities are themselves seen as a reflection of how they carry out the development of the projects within

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47 Chevrier, *From Basel*, 17.

48 Herzog, "The Nature of Artifice," 30.

49 "Lejos de ser cosmopolitas, son gente de Basilea. Por supuesto que han viajado por todo el mundo e construydo por todo el mundo, pero su raíces las tienem claras. Eles jamas podrían trasladar el estudio porque están tan arraigados en esta realidad suiza que es impossible contemplarlos en ningun otro lugar." Galiano, "Jacques Herzog y Pierre de Meuron," 3:00.

50 We refer to the essay "Patrón oro. Mirando atrás a los 70." published in Luis Fernández-Galiano, *Herzog & de Meuron* (Madrid: Arquitectura Viva, 2021), 87–92.

3.18
The HdM office at Rheinschanze, Basel. The entrance courtyard.

the firm. Grown over time through the gradual acquisition of neighbouring properties, the campus in Rheinschanze is an aggregate of different buildings arranged around a central courtyard, often used to build large-scale mock-ups and test material samples (***3.18***).

Inside, the space has a labyrinthine character. Of a relatively small dimension, the rooms are intimate and often interconnected by narrow gaps that allow the passage between previously independent spaces (***3.01***). Each design team, responsible for the development of an individual project, sits in one specific room so that when entering some of these spaces, due to their restricted size, it seems almost as if we were in a typical office of young architect friends. There are physical models everywhere. The walls are full of drawings, and it is common to find, leaning in a corner, the posters prepared by the teams with the design issues to be discussed with the partners. All the former collaborators with whom we spoke have been unanimous in saying that the spirit of the office is like that of a university. "The project is controlled in dialogue", Harry Gugger said. "This is inherent to the fact that Jacques and Pierre have started the practice together, which allowed them to open up to other partners. Very often, it is a review process, like in school. I don't know how it is right now, but Jacques and Pierre used to play an important role because they were the only ones connected to every single project."[51]

The practice of the office is the result of a collaborative work process in which the skills of the partners and their individual cultural backgrounds are encouraged as a means to bring challenging discussions of different points of views into the projects and to achieve the diversity that has always distinguished the architecture of HdM. However, in this participatory methodology, the two founding partners, who "see each team once a week or every fortnight and later at larger intervals",[52] as

[51] Harry Gugger in conversation with the author, "This is too generic; this is not the Tate!", Basel, February 20, 2020.

[52] Chevrier, *From Basel*, 10.

explained by Jacques Herzog, have kept their role as crucial figures in the development of some of the projects.

"Ideally a partner will bring so much to a project that Pierre or I don't have to intervene", Jacques Herzog said. "On the other hand, sometimes we are confronted with situations in which the teams become closed to our intervention. At that point it is absolutely necessary to take action, add a dimension, or even jettison everything developed up to that point."[53]

Indeed, HdM grew to a size that is as large as many commercial offices. Nevertheless, their projects reveal a continuity that interrelates the different types of research undertaken over the years and ensures the consistency of their language. "Our work does not follow a linear progression but deals with several themes that run parallel and dovetail with each other as well",[54] Jacques Herzog said in 1993, in answer to a provocative question from Theodora Vischer, who recognised a shift in their approach to architecture from volume to surface. In a way, these several themes appear as though they were their "own obsessions or passions, even a DNA",[55] as Jacques Herzog recently described; they are what makes one go back to their origins; above all, to the two founding partners and the first years in which they settled the bases of what would become the architecture of HdM.

3.4 _ Hand Drawing / 2D CAD / 2D CAD+3D Data / BIM

In 1988, in a conversation with Theodora Vischer, Jacques Herzog elaborated on his conception of the physical model as an idea that, according to the art curator, "allows the model to collaborate with the prospective, sensuous pattern of relations [created in his architecture]".[56]

"In the end", Jacques Herzog said, "the decisive factor for us is that every object we create—the drawing as well as the model—is part of the resulting architecture from the standpoint of the object's own image or material structure, allowing the conceptual idea to be experienced and not merely serve as an illustration."[57]

Six years later, in another dialogue with the same curator and art historian, Jacques Herzog clarified his viewpoint on this subject, putting the emphasis on some of the concepts that he had written down a few years before in one crucial essay about their design theory.[58] Although these two interviews were triggered by Herzog's arguments about the presentation of the architectural work, whether in competitions or in publications or exhibitions, they focused on his idea of the different forms of architectural representation, and gave an insight into the approach of HdM to the means by which they develop the design of a building.

One of the strongest ideas to emerge from Jacques Herzog's statements is that, for HdM, thinking about the representation of architecture is identical to thinking about the architecture itself. "The

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53 Chevrier, *From Basel*, 11.

54 Herzog, "Interview by Theodora Vischer," 29.

55 Herzog, "Retail Apocalypse."

56 Herzog, "Conversation between Jacques," 214.

57 Herzog, "Conversation between Jacques," 215.

58 We refer to the text Jacques Herzog wrote in 1988, "The Hidden Geometry of Nature".

architectural plan and the architectural work", Jacques Herzog wrote, "interest us as tools for the perception of reality and confrontation with it."[59]

As described in the previous sections,[60] for the Swiss architects, the perceptual aspect of a building and each individual's experience play decisive roles in their understanding of architecture. The immaterial quality of an architectural object, which one may find in all those elements, physical and conceptual, that contribute to the atmosphere and non-neutral character of a building, is crucial for them, as much as a well-thought-out abstract plan. Therefore, since the architecture they aim for has so much to do with perception, its representation makes sense when it "collaborates" with the design idea and calls up other images through its expression.

In this sense, means of representation are seen by HdM as technical instruments that serve to translate an abstract idea into the rational world of shapes, but they are also explored as expressive tools to investigate the individual character of a project, communicate a particular insight into it and provide the experience of it in terms of structure, materials, space and image. This explains why, in the conversation with Theodora Vischer, Jacques Herzog described the traditional graphic means of representation, that is, projections of three-dimensional data onto a plane, as somehow limited. Although they are precise and suitable for conveying quantifiable data, these purely technical tools fail to communicate the atmosphere of a building. A similar remark was made by Jacques Herzog about those "ubiquitous large-scale models, painted white, which we look down upon as if we were giants".[61] Constructed as detailed replicas of future structures, these political models, as Herzog called them, have a neutral character, reducing, as he explained, "the entire world of images, so decisive for [their] architecture [...] to a stereometric, uniform expression, which does not have paramount relevance in our attitude."[62]

Therefore, the inadequacy of some conventional tools for translating the conceptual dimension of their projects or even supporting the development of their design ideas has taken HdM to seek alternative modes of representation that would fit their very personal way of seeing and doing architecture. For instance, at the beginning of their career, video recordings of models, later crystallised

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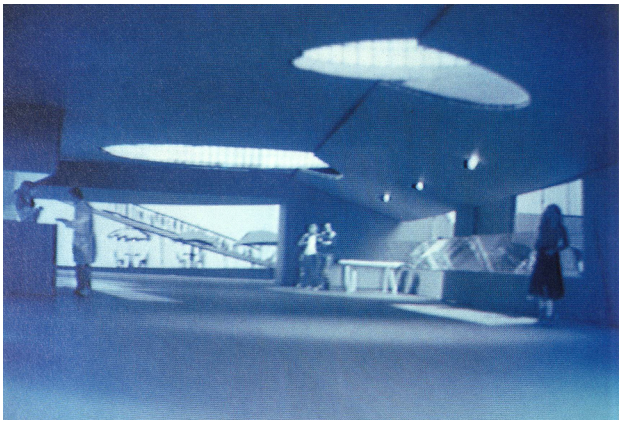
59 Herzog, "Hidden Geometry of Nature," 209.

60 We address the centrality of the concept of perception in HdM's understanding of architecture in section "*3.2 _ Matter and Form*".

61 Herzog, "Conversation between Jacques," 214.

62 Ibid.

It is, however, interesting to notice how Jacques Herzog's position concerning the "white models" is somehow diametrically opposite to Alberti's way of considering these. "There is a particularly relevant consideration that I feel should be mentioned here: the presentation of models that have been colored and lewdly dressed with the allurement of painting is the mark of no architect intent on conveying the facts; rather it is that of a conceited one, striving to attract and seduce the eye of the beholder, and to divert his attention from a proper examination of the parts to be considered, toward admiration of himself. Better then that the models are not accurately finished, refined, and highly decorated, but plain and simple, so that they demonstrate the ingenuity of him who conceived the idea, and not the skill of the one who fabricated the model. The difference between the drawings of the painter and those of the architect is this: the former takes pains to emphasize the relief of those objects in paintings with shading and diminishing lines and angles; the architect rejects shading, but takes his projections from the ground plan and, without altering the lines by maintaining the true angles, reveals the extent and shape of each elevation and side—he is one who desires his work to be judged not by deceptive appearances but according to certain calculated standards. It is advisable then to construct models of this kind, and to inspect and re-examine them time and time again, both on your own and with others, so thoroughly that there is little or nothing within the work whose identity, nature, likely position and size, and prospective use you do not grasp." Leon Battista Alberti, *On the Art of Building in Ten Books*, trans. Joseph Rykwert, Neil Leach, Robert Tavernor (Cambridge, Massachusetts, London: The MIT Press, 1988), retrieved from https://books.google.pt/books, 34.



3.19
TV still of a video simulation of the project for the indoor and outdoor swimming pool Am Mühleteich, Riehen (1979–1982).

into a few still pictures, were explored as a complement to plans and models to express the ambience of the architecture (***3.19***).

Throughout the years, this inventive approach towards the means of representation and the ability to continually find unconventional ways of exploring these in response to the demands of a project became a distinctive feature of their methodology. In a certain sense, the fundamental openness with which they approach architecture and develop every commission by reacting to the context is the same openness that determines how they look at the tools that support the creative act. Just as HdM "reject classifications in architecture [...] and keep [themselves] open to approach architecture in as many ways as [they] can",[63] as Jacques Herzog mentioned, in relation to the means with which they develop the design of a project, they do not privilege one method over another or restrict themselves to the realm of a single tool.

Therefore, when looking at their work, either over the years or at a specific moment in time, the great variety of tools and means used to support the design idea, to grasp it and take it further, is one of the aspects that is immediately striking. As Jacques Herzog noted, they "use all the available tools to imagine [their] architectures",[64] and the spirit of the office is one of never neglecting any given possibility. They are totally open to any strategy that may contribute to the accomplishment of the project's conceptual idea or even enrich it by suggesting unforeseen directions. This is particularly evident, for instance, in how they experiment with the physical models, a key component throughout the whole creative process, and whose scope they have especially broadened.

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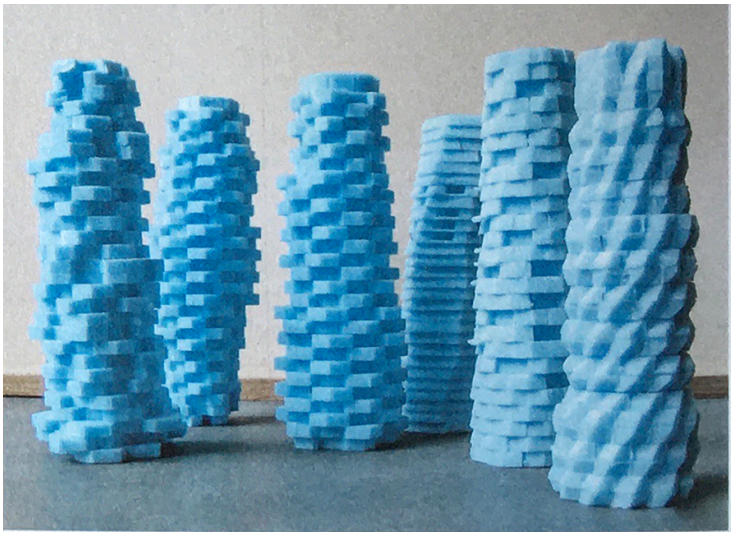
63 Jacques Herzog,"Continuities [Interview with Jacques Herzog]," by Alejandro Zaera, in *El Croquis. Herzog & de Meuron 1981–2000. Between the Face and the Landscape. The Cunning of Cosmetics*, vol. 60+84, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2005), 25.

64 Herzog, "The Nature of Artifice," 29.



3.20
Schatzalp, Davos (2003–2005). Objects from the natural world of the mountains.

3.21
Study models for the cylindrical tower of Schatzalp.

3.22
The National Stadium, Beijing (2002–2008). Sketch by Jacques Herzog.

3.23
Objects from Chinese cultural history.

3.24
The red sugar landscape of “Sweet Dreams”, Basel (2004).

In the early design stages, when it is about catching the design idea and finding the right approach to the project, HdM let their creativity flow in many directions and concept models multiply in dozens of resourceful variants. Common objects from outside architecture embodying the project's conceptual basis are also included as a specific genre in this topic. Seen as acute references to the result to be achieved, they are often brought into the process, triggering disparate research into the building's formal structure. This is the case with the Japanese Akari lamps that served as inspiration for the sun blinds of the Roche Building 92, Basel (1993–2000); the objects from the mountainous natural world, like minerals and pine cones, that suggested different formal approaches to the crystalline structure of the Schatzalp tower in Davos (2003–2006) (***3.20 / 3.21***); or even the Chinese cord brought by Ai Weiwei and used as a reference for both the round bowl shape of the National Stadium in Beijing (2000–2008) and its seemingly chaotic mesh of columns and beams (***3.22 / 3.23***).

At other times, physical models are freely built as pure experiments in shape contributing to the projects as simple fomal inputs. One of the most extreme examples is the red sculptural sugar landscape built and presented for the first time in the exhibition "Herzog & de Meuron. No. 250. An Exhibition", at the Schaulager in 2004 (***3.24***).

Unrelated to a particular project, these shapes were made at Ricola and designed by the architects as a result of their fascination with the production machines for herbal drops and the shapes of the waste products from the manufacturing process. At the exhibition, this artefact formed a counterpoint to the material on display produced within the design process as it followed, as HdM mentioned, "the trail of formal ideas that preoccupy the architects like a vague obsession".[65] When describing this suggestive landscape, Gerhard Mack explained that it was made by simple processes such as heating, turning,

[65] “256. Sweet Dreams,” Herzog & de Meuron, accessed March 3, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/251-275/256-sweet-dreams.html.

dripping and bubbling, and in a certain sense he considered it emblematic of the traditional way in which HdM address the creative process, somehow in contrast to the emerging digitally produced architecture. "Depending on the scale they envisioned, viewers were able to identify a variety of different architectures", Gerhard Mack said. "At exactly the same time when state-of-the-art CAD systems were introduced, allowing the calculation of the wildest conceivable blob architecture, Herzog & de Meuron showed playful, indeed childlike verve in developing an analog model for a visionary urban scenario".[66]

Nevertheless, this very personal and analogue way of dealing with the design tools was always combined with the particular interest of HdM to exploit the full potential of the computer's digital possibilities and use them as productive tools that enabled them to push architecture forward. "Because Pierre and I did not grow up with the computer", Jacques Herzog said in 2001, "we would also not be able to generate architecture out of the computer, with the computer being the main generative energy in the design process. [...] On the other hand, we see a huge potential for the computer in the very hybrid and eclectic design processes we have developed over the last twenty years, which combine all the techniques from primitive to technologically advanced with no personal preferences."[67]

Therefore, when looking at the current design tools of the office, besides the great diversity of means employed to support the design development, it becomes evident that the digital is nowadays present in all of the topics, directing the approach taken in each one of them.

Until the early 2000s, the integration of digital technologies in the office happened gradually in an almost natural adaptation to the media evolution, particularly when demanded by specific issues in the development of the projects. However, around 2005, with the growing size and complexity of the commissions, HdM decided to create an in-house specialist department named, at the time, "Digital Technologies Group" (DTG).[68] Consisting of about 13 people, and now called "Design Technologies" (DT), the group works as an internal team that supports all the technological needs of the design process, acting in three main branches: project delivery, which is about CAD and BIM management and geometric support, visualisation and virtual reality, and digital fabrication. From the moment this department was set up, the capabilities of the digital medium were structurally introduced in the office, having been explored from the design to the production of architecture.

For physical models, HdM implemented a digital workshop with CNC machines that are easily incorporated into the analogue methods, supporting and expanding the making processes of both models and mock-ups. Simultaneously, the group's specialised expertise has opened up architectural design to the possibilities of digital fabrication. It became possible to work on a "file to factory" system, allowing, when appropriate, specific components of a project to be mapped into a digital chain in which the design data are directly transferred onto production processes.

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66 Gerhard Mack, ed., *Herzog & de Meuron 2002–2004. The Complete Works*. vol. 5, (Basel: Birkhäuser, 2020), 210.

67 Herzog, "The Nature of Artifice," 29.

68 There is no precise date when the "Digital Technologies Group" was officially created. However, since HdM asked Kai Strehlke to set up the group two or three years after he joined the office in 2005, we consider 2005 to be the relevant date when computational tools began to be used more consistently in the office's design practice. Thus, between 2005 and 2015, this internal department was called "Digital Technologies Group" and was headed by Kai Strehlke. Since 2014, Steffen Riegas has been responsible for the group, whose name has recently changed to "Design Technologies".

As the role of images in the working methodology of the office have become increasingly relevant, along with the continuous improvement of the rendering methods, HdM have been dealing in recent years with the challenges that the emerging virtual and augmented reality pose in the design practice.

Concerning the drawing methods, the approach in the office is now highly model-based. As Kai Strehlke explained in 2009, "a suite of generic CAD and graphic software tools is used in the office to develop the architectural design",[69] allowing the production of traditional CAD drawings and 3D modelling. Nevertheless, for specific complex geometric tasks, the DT department is particularly able to create, in a flexible manner, customised parametric tools based on scripting that respond to the specific requirements of the design teams, facilitating the architecture and enhancing the creative abilities of the office as a whole. Furthermore, and with a particular focus over the last six years, the BIM methodology has been largely applied to almost every project, impacting how the complete design cycle is managed.

Therefore, an in-depth look at the chronology of the works of HdM reveals that the increasing growth of the practice, from a small office to a global company, has been followed by a steady evolution of the means and tools used in support of the design process.

While working as head of the DTG, Kai Strehlke made a diagram showing the different drawing methods used at HdM from 1978 to 2012 (***3.25***). This diagram was part of an internal exhibition he prepared when responsible for CAD management, in which architectural drawings from different periods in time and different phases of work were presented to show how people in the office changed their way of drawing from very early projects to recent ones.

This diagram was particularly significant in our research as it documents very clearly when the different drawing methods were introduced at HdM. It clarifies how the shift from one to another happened and what relevance each of them had at a given moment in time.

In the diagram, the dots represent the projects of the office and are filled with a colour that specifies the method by which they were mainly developed. Kai Strehlke classified the drawing methods into four categories: hand-drawing, 2D CAD, 2D CAD + 3D Data and BIM. One of the aspects that emerges from this diagram is that the office timeline may be subdivided into three main periods.

The first one, which corresponds to the initial years of their career, between 1978 and 1990, coincides with a pre-digital phase in which traditional hand-drawn plans played a preeminent part in the development and control of the design process. Then, in 1990, Computer-Aided-Design was introduced. After a transition period, in which both methods were used simultaneously, CAD has completely replaced hand-drawing by digitising the analogue processes in an approach to design where the output remained however, just as before, a two-dimensional plan.

According to Kai Strehhlke's diagram, the expansion into the third dimension was fully achieved around 2005, when parametric tools such as scripting—which he considers to be 3D Data—were introduced and BIM started to be explored in some specific projects. Even though this shift did not eclipse 2D CAD, as opposed to what happened previously with hand-drawing, it placed virtual 3D

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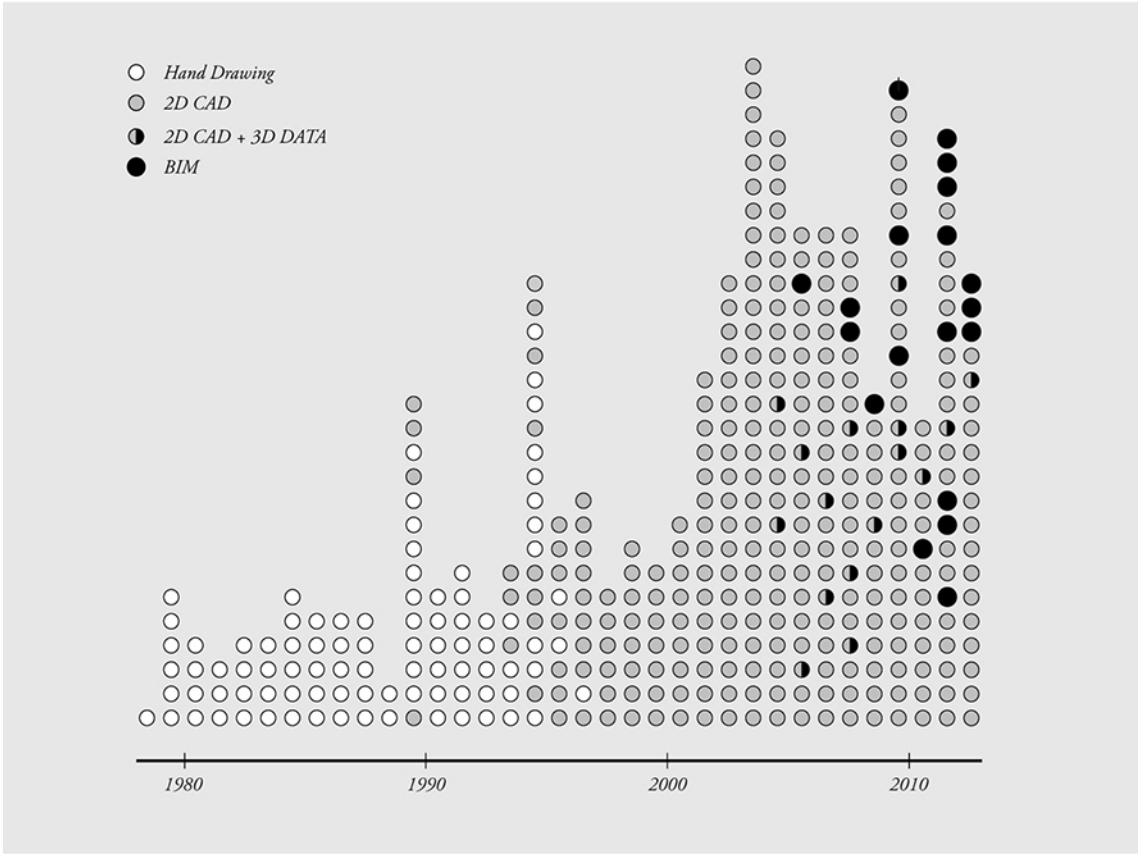
69 Kai Strehlke, "Digital Technologies, Methods, and Tools in Support of the Architectural Development at Herzog & de Meuron," in *ACADIA 09: reForm ( ) Building a Better Tomorrow*, eds. Tristan D'Estrée, Russel Loveridge and Douglas Pancoast (Chicago: ACADIA, 2009), 26.



3.25
Drawing methods at HdM from 1978 to 2012. Diagram by Kai Strehlke (around 2013).

modelling at the core of the design process and marked the beginning of the use of the computer, no longer as just a drawing machine but as a computational tool.

However, in the opinion of Kai Strehlke, these methods, which imply different kinds of mindsets, should not be seen as an evolution in one single direction. Sometimes, as he has said, "a particular technique is absolutely valid even nowadays."[70] This is a judgment that fits completely into the case of HdM as a practice that cultivates diversity and specificity in architecture and, in that sense, as mentioned by Kai Strehlke, "would never hype any kind of technology for the sake of technology."[71]

Indeed, the integration of digital tools into the HdM workflow is intimately linked to the enlargement of the office, and it could even be seen as an inevitable effect of the increasing size and complexity of the projects as well as the transition of the office, over the years, from a local-scale to a global-scale practice. As Harry Gugger mentioned, when questioned about the impact that digital tools had in the design process at HdM, in their role as tools, they had "certainly allowed for processes to be feasible and economical which otherwise would not have been, and of course, they had a huge impact on the evolution of the office." [72]

Nevertheless, on closer inspection, this overview gains a richer dimension when combined with the projects in themselves and particularly with the different interests that, over the years, have directed the design practice towards distinct architectonic explorations. It then becomes clear that some of the moments in the work of HdM marked by research on specific compositional themes are sometimes associated with a particular drawing method, and that the jumps from one moment to another are usually connected with the improvement of the tools and techniques that support the design. Brought into the processes when needed to translate, describe and control, graphically and physically, a particular idea, digital tools turned out to be instrumental by opening up the design to an increasing geometric complexity and, above all, by allowing the practice to move forward in new directions.

Therefore, if we take Kai Strehlke's diagram as a reference and relate the architecture that has been produced, as well as the many different compositional approaches, to it, a denser and more complex perspective on the work of HDM emerges (***see HdM Chronology Map***). By putting architecture, design practice and digital tools together, we have been able to structure our own view of their work and subdivide their chronology into five distinct phases. Each of these periods, delimited in time by facts that somehow ended up as turning points in their approach to design—like the realisation of a significant project or exhibition, the investigation of a specific architectonic subject, or the introduction of a particular technology or drawing method—is marked by a specific set of tools that assisted the development of the projects. Together they provide an overview of the architecture of HdM from the inside, from the working methodology, with a particular focus on how digital tools became operative in the design process and have impacted the role of geometry in the definition of architectonic objects.

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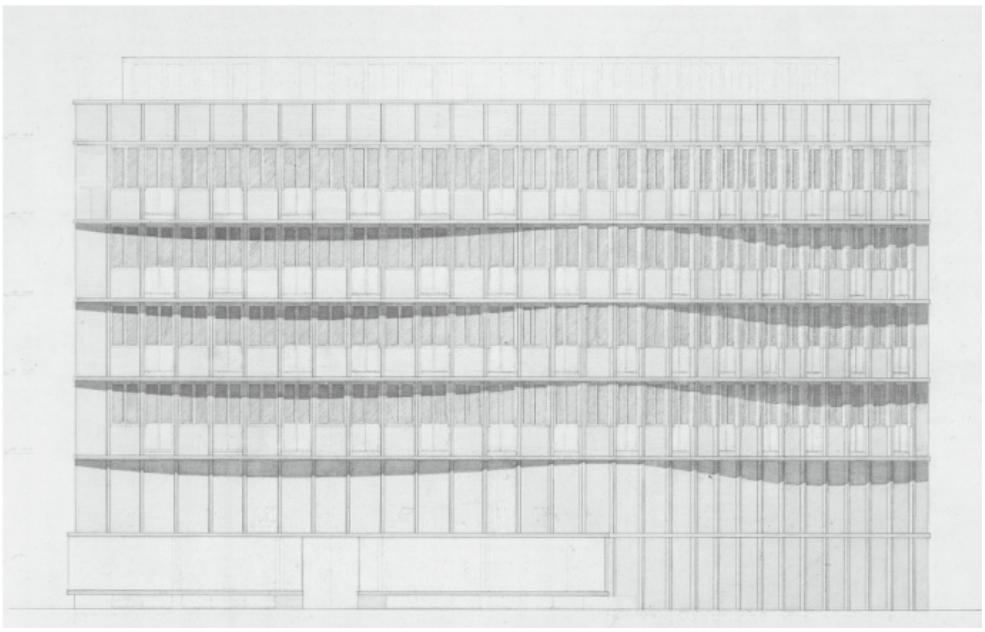
70 Kai Strehlke in conversation with the author, "I see it as a little bit like an orchestra," Zurich, April 16, 2019.

71 Ibid.

72 Gugger, "This is too generic."



4.01
Schwitter Building, Basel (1985–1988). Facade Allschwilerstrasse.

4.
Sketches and Plans

4.1 _ Geometry and Nature

4.2 _ A Classical Sense of Order

4.3 _ "The Reality of Images"

4.02
Blue House, Oberwil (1979–1980).

4.03
Villa Arpel. Still from the movie "Mon Oncle" by Jacques Tati (1958).

4.1 _ Geometry and Nature

Jacques Herzog often refers to the initial years of HdM's career as a time in which they were searching, as young inexperienced architects, for a way into the world of architecture.

This was a period in which they "were full of doubts about how to do even the most basic things, such as design a wall or a window, or how to use colour",[73] as Jacques Herzog said recently in an interview. So, their very early projects, like the Blue House in Oberwil (1979–1980), the Swimming Pool in Riehen (1979–1982) or the Frei Photographic Studio in Weil am Rhein (1981–1982), worked as a kind of experimental field in which HdM tested design topics and tried to enlarge their boundaries, with the aim of understanding what architecture is. That is why, in these years, every project, as Jacques Herzog has noted, "was radically different from the others [and] no traces of style or authorship were recognisable".[74] Indeed, these reflect a not-yet crystallised language, and their particular heterogeneous appearance resulted from overt references and images that came together in a collage-like process rather than in a firmly established approach to architecture.

About their early work, Jacques Herzog also explained that they were more influenced by other architects, like Alvar Aalto or Hans Scharoun, whose work they found "ugly, strange, very real and unreal at the same time."[75] In fact, the skylights of the Frei Photographic Studio were originally supposed to be clad in gold like the aluminium gold cladding of the Philharmonic in Berlin, in the sameway that the Blue House was painted with the Yves Klein blue and its circular windows recalled those of the modernist Villa Arpel from a movie by Jacques Tati (***4.02 / 4.03***).

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73 Jacques Herzog, "Significant Difference. Jacques Herzog talks with Julian Rose," by Julian Rose, ArtForum, accessed December 31, 2020, https://www.artforum.com/print/201803/jacques-herzog-talks-with-julian-rose-74308.

74 Ibid.

75 Herzog, "A Conversation," 36.

However, along with the continuous experimentation developed through design practice, the exercise to set up the basis for a coherent thinking about architecture was supported by a theoretical reflection that HdM undertook in a series of small essays.[76] The activity of thinking and writing, for which Jacques Herzog reserved the mornings, as he revealed to Eduardo Souto de Moura,[77] was considered in itself important as a search for lucidity.

Written by Jacques Herzog and Pierre de Meuron, with some presented as lectures at international institutions and with projects used as illustrations, these texts were about questioning the nature of architecture and trying to find its fundamentals as a creative practice. For Jacques Herzog, these writings "are a mixture of romantic and poetic".[78] Nevertheless, they express a specific point of view, underscore particular concerns, and try to clarify concepts so that an individual and emotional idea about architecture ends up emerging out of them.

Even though each one points to slightly different topics, they all focus on the contemporary post-modern condition. They start from a critical reflection on the cultural and architectonic situation of the time to set up, based on this, the question of how architecture could be recreated in a context profoundly marked by the loss of tradition.[79] Therefore, like brief insights into the consciousness of Jacques Herzog and Pierre de Meuron, these essays reveal aspects that were of interest to them; show how they regarded architecture and what they pursued in it, complementing each other and collecting the main subjects from which the architecture of HdM has somehow emerged and has also continuously been reinvented over time.

Among these roughly seven essays, one in particular stands out for the broad spectrum of topics it addresses and their relevance to an understanding of the essence of HdM's approach to architecture.

Frequently mentioned over the years by critics and the architects themselves, "The Hidden Geometry of Nature", from 1988, is a seminal essay that contains many of the premisses, still valid today, for what we can consider to be HdM's design theory. With a strong autobiographical character, this text reveals an awareness of the surrounding reality, largely influenced by Jacques Herzog's personal fascination with the natural sciences, such as biology and chemistry, and particularly crystallography, which ultimately resulted in geometry and nature being placed at the core of their architectural practice.

"I was interested in understanding how crystals come to exist as a result of ideal conditions where they can literally express their inherent geometries", Jacques Herzog has said. "Each matter, each

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76 In the eighties and first half of the nineties, Jacques Herzog and Pierre de Meuron put down some of their ideas about architecture practice in some of the following essays: "The Specific Gravity of Architecture" (1981), "The Piece and the Entirety" (1987), "The Hidden Geometry of Nature" (1988), "The City and its State of Aggregation" (1989), "Passionate Infidelity" (1990), "Poesis: Production" (1993) and "Firmitas" (1996).

77 Eduardo Souto de Moura, "Notes to a Synthesis of a Text," in *Architectures of Herzog & de Meuron. Portraits by Thomas Ruff* (New York: Peter Blum, 1995), 16.

78 Jacques Herzog in conversation with the author, "We are surrounded by things that exist, but we don't see them, we don't hear them, we cannot smell them...", FaceTime, Porto-Basel, May 6 and 12, Porto-Tenerife, June 3, 2021.

79 For a better understanding of the meaning implied in the concept of "loss of tradition", Jacques Herzog wrote that "building technology offered [the worker/craftman] another, probably better, detail and he accepted it because he believed that such things must change because they are subject to development, which must be identified with progress. [...] The construction industry has thus changed craftsmanship and has suppressed the craft tradition the world over. Actually, traditions in the uncompromising and comprehensive sense of the word no longer exist." See Herzog "Hidden Geometry of Nature," 207.

chemical element, has its own geometrical structure that sometimes becomes visible but very often remains invisible."[80] Jacques Herzog's interest in finding out more about this underlying world made him especially sensitive to the system of relationships existing in nature that, despite not being always recognisable or perceived by the human senses, nevertheless exists and is responsible for the outer appearance of things[81] as well as for their immaterial quality.

In the text from 1988, Jacques Herzog extended this same idea to objects from everyday life, describing contemporary culture as a culture of blending and mixing substances whose final products are a kind of "synthetic conglomerate" that can be barely decomposed into its original forms. These reflections, which the Swiss architect developed as a critique to explain his personal discomfort towards society's daily production, reinforced the fact that, for them, natural and artificial processes are not opposed to each other, but are rather seen as a single thing, being parts of the same continuous whole. Although people "understand "reality" as something they can see and hold in their hands",[82] Herzog explained in another essay, and constantly tend to separate the visible and invisible worlds, there is always a link between them, whether it be in natural or artificial objects.

Therefore, architecture, which is considered by HdM "as a thinking model for a critical perception of our whole culture",[83] should emerge from the recognition of phenomena, even if these are not visible at first sight. Architecture, as Jacques Herzog says in the "Hidden Geometry of Nature", is about "breaking through the deceptive, visible and familiar guise to take it apart, to atomise it, before relating to it anew";[84] it is about looking carefully at the invisible structures and trying to find a form for them in the visible world.

In addition to this, when Jacques Herzog affirms that he is interested in exploring, within the realm of art and society, the complexity of the system of relationships that exists in nature, he is reinforcing his belief—like that of Joseph Beuys[85]—that natural processes have an equivalent in society and, at the same time, is expressing his enduring desire to work with them by analogy. The concept of nature he has in mind is not related to its outer appearance, which explains, as Ulrike Stump pointed out, "why natural forms do not feature as such in the architecture of Herzog & de Meuron".[86]

Although nature sometimes appears in their projects as a crucial complementary element (***4.04***), or by means of an ornamental integration[87] (***4.05***), Jacques Herzog is, above all, attracted by natural

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80 Herzog, "We are surrounded."

81 About this specific topic, Jacques Herzog explained in an interview that they "were curious about knowing more about things that, although invisible to the naked eye, are becoming extremely effective and that, ultimately, are responsible for such things as the shape, color or physical stability of an object. For example, largely due to the different mineral qualities of their crystallographic structures, a mountain of granite takes another shape than a mountain of limestone does." See Herzog, "Continuities," 14.

82 Herzog, "Poesis-Production."

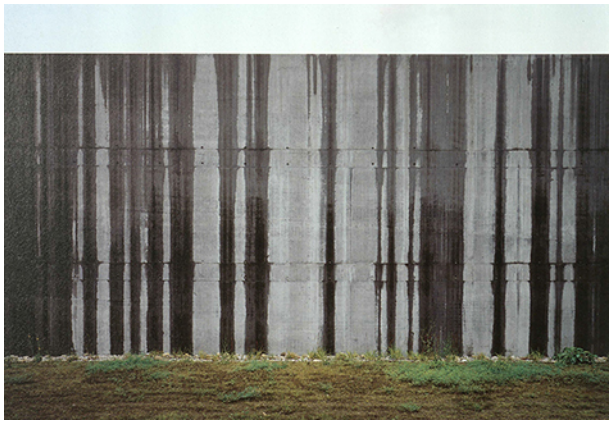
83 Herzog "Hidden Geometry of Nature," 210.

84 Ibid.

85 Chevrier, *From Basel*, 43.

86 Ulrike Meyer Stump, "Models of a Hidden Geometry of Nature: Karl Bloosfeldt's 'Meurer Bronzes'," in *Herzog & de Meuron: Natural History*, ed. Philip Ursprung, (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002), 305.

87 The projects by HdM show different appropriations of nature. These include nature as an element with which architecture interacts and establishes a dialogue: Plywood House, Bottmingen (1984–1985), Ricola Storage Building, Laufen (1986–1987); nature as an integral part of the architecture: Fünf Höfe, Munich (1994–2003), Ricola Marketing Building, Laufen (1997–1999); nature as an ornamental motif: Ricola-Europe SA, Mulhouse (1992–1993), Studio Rémy Zaugg, Mulhouse (1995–1996).



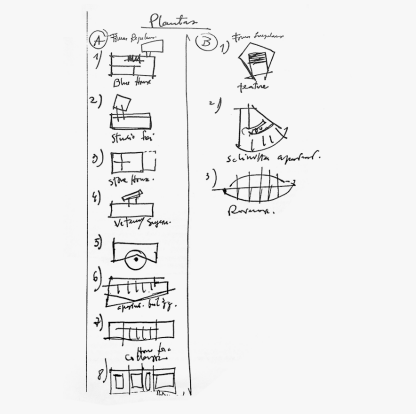
4.04
Plywood House, Bottmingen (1984–1985). The pavilion with its curved facade and the Pawlonia tree.

4.05
Ricola-Europe SA, Mulhouse (1992–1993). Rain painting on the concrete wall.

formation processes. He is fascinated by how forms can emerge as if by themselves, in a spontaneous and organic development arising from a hidden geometrical structure, which he uses as a model for the creative process in architecture.

The primary interest of Herzog in crystallography has shaped the way in which he perceives the surrounding reality, but it has also influenced how he looks at architecture as a human creation that must be generated and brought somehow into existence. This has turned his attention to how architectural forms can be produced and has made him particularly keen to continuously explore in design practice the countless possibilities of form-making.

Just as the three-dimensional, ordered arrangement of atoms, ions and molecules is responsible for the form and many physical properties of crystals, so, in architecture, underlying geometrical strategies, analogous to a crystalline base, may prompt the generative process and direct the formation of both the inner structure and final shape of the architectonic object. Therefore, in the work of HdM, the creative process is frequently marked by specific compositional procedures from which the attempts to capture the form are propelled and developed. Working as a kind of “excuse” to trigger the first design experiments and send the investigation in different directions, reinventing the projects every time, these geometrical systems help to overcome the uneasiness of being face-to-face with the white sheet of paper, lessening the subjectivity in which the creative sphere of architecture is inevitably embedded. They provide a concrete, real and measurable basis from which the formal repertoire may arise and be explored with freedom and great openness; to disappear in the end, hidden in the spontaneity of the built forms. Used by HdM to conceive the shape of the architectural object, this methodology allows them to achieve specific formal intentions, which they would have liked sometimes to emerge as if by themselves, as in nature, with a kind of involuntary naturalness.



4.06
Some initial projects by HdM. Sketch by Eduardo Souto Moura.

4.2 _ A Classical Sense of Order

In 1994, Eduardo Souto de Moura synthesised the architecture of HdM in ten short notes,[88] describing their "simple" design method as imbued with efficiency. According to the Portuguese architect, the early projects by Jacques Herzog and Pierre de Meuron stood out for the simplicity of their shapes, which were sometimes combined together as a response to more complex briefs (***4.06***), "The use of more complex forms than rectangles, such as curves, pentagons and ellipses are the exception which confirm the above rule", Souto Moura remarked, and the design of the building's structure, "shaped by conforming to the brief, and always stretched to the limits of the material",[89] was usually repetitive.

However, other adjectives, such as orthogonal, regular, rational or essential, may be added to this description, complementing the sense underlying the concept of repetition and emphasising the idea of an architecture that has emerged from a kind of reboot; from the desire to start anew in search of an original condition for the discipline. Indeed, the early work by HdM was noticed in the global architectural context for its divergent approach to architecture. In the 1980s, Jacques Herzog and Pierre de Meuron surprised others by their detachment from the architectural debates of the time and for their "absolute resistance to the formal intricacies of their contemporaries", [90] as Rem Koolhaas pointed out, by coming up with a fresh architecture that contrasted in its formal restraint and minimalist character with that of a decade full of excesses and complexities of style.

Steven Holl defined the architecture of HdM as "elegant", a word that he chose, "not in its architectural sense but as a mathematician uses the term to describe the simplest and purest solution

88 Souto de Moura, "Notes to a Synthesis," 16.

89 Ibid.

90 Rem Koolhaas, "New Discipline," in *Architectures of Herzog & de Meuron. Portraits by Thomas Ruff* (New York: Peter Blum, 1995), 23.

to a problem". [91] By using this word, the American architect was pointing to the same elementary formal quality that Eduardo Souto de Moura underscored, but he also touched on the fact that the architecture of HdM was "honest" in the sense that it presented itself without "masks".

As opposed to the various complexities of artifice that characterised most of the architecture of the post-modernist period, the buildings of the Swiss architects had a straightforward appearance. Along with reducing the forms to a condition of great clarity, their work focused on the tactile quality of the materials and retrieved the primitive significance of construction by placing it at the core of architectural practice. During the first decade, the projects by HdM presented themselves as a genuine and refined expression of how the building elements were assembled according to a particular formal intent and following the logic of their construction, which explains, in itself, the raw direct experience of architecture that Steven Holl spoke about. Their architectural language was thus the result of intense work spent exploring and questioning the nature of the materials that afterwards became tangible in the building's structure. However, as a necessary counterpoint to this honesty of construction, the architecture of HdM was refined from a compositional point of view. Their buildings alluded to a classical sense of order, having in geometry the device that helped to rule the relationship between all the members and ensure the proportion and unity of the composition as a whole.

In a small text from the end of the 1990s, Luis Fernández-Galiano underlined the fact that "the Swiss partners have time and again merged the geometric discipline of architecture with the unpredictable emotion of art". [92]

The warehouse in Laufen for Ricola (1986–1987) is one of the most intense works by HdM, where the thoughtful arrangement of the construction elements in a coherent architectural whole fully expresses the union between visual order and tactile seduction that Galiano recognised as one of the distinctive signs of their practice.

Jacques Herzog considers this commission, developed for the Swiss manufacturer of herbal drops, as one of the most special buildings of their career. First, for its programmatic nature—unusual at the time in the field of architecture—which led the architects to design an outer skin for this fully automated warehouse, giving it a special condition without betraying its conventional industrial character.

The clear-cut rectangular box and its dimensions—length, width and height—were all predetermined, so the work of HdM focused on the development of the solution for the protective shell of the galvanised sheet-metal container made of insulating cassettes.

The facade, which determined the object-like appearance of the storage building, would become both structure and form. It was built using identical Eternit panels and an underlying supporting structure of vertical and horizontal wooden ribs, which the architects played with in the search for an assemblage system and construction detail that, while focusing on the precise constraints of these

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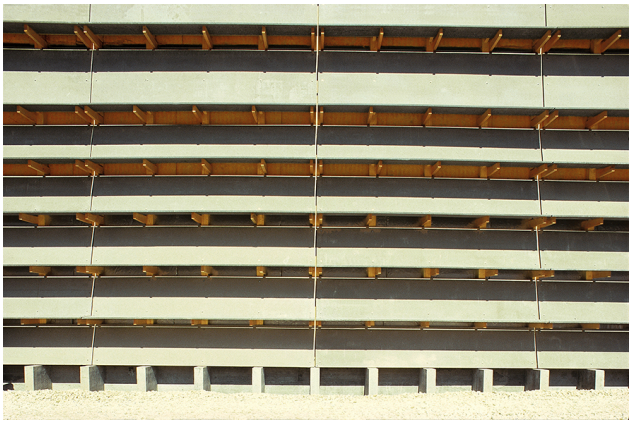
91 Steven Holl, "Raw Experience," in *Architectures of Herzog & de Meuron. Portraits by Thomas Ruff* (New York: Peter Blum, 1995), 25.

92 Luis Fernández-Galiano, "Tú a Rotterdan, yo a Basilea. Rotterdam for You, Basel for Me", in *AV Monografías 191–192. Herzog & de Meuron 2013–2017*, ed. Luis Fernández-Galiano (Madrid: Aquitectura Viva SL, 2017), 284.



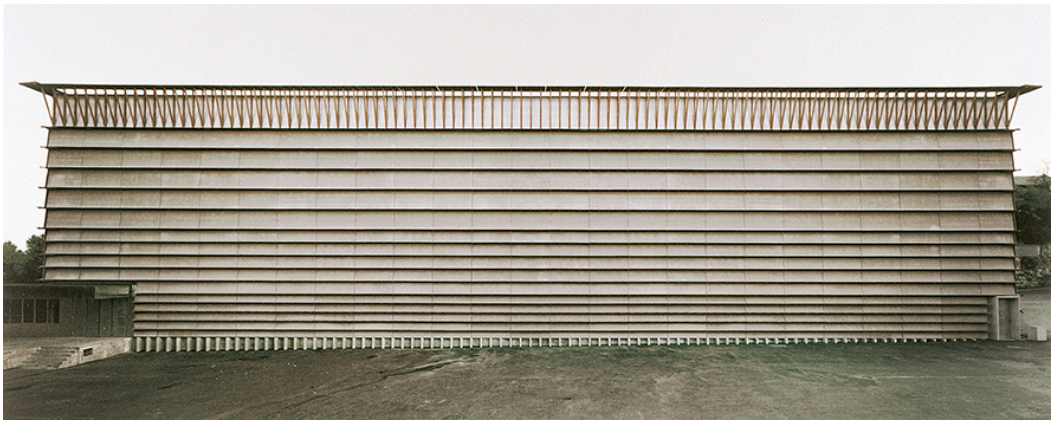
4.07
Ricola Storage Building, Laufen (1986–1987). Facade detail.

4.08
The construction assemblage system made by the Eternit panels and the supporting wooden structure.

materials, would end up exalting them. Instead of dissimulating the horizontal joints of the fibre cement boards, Jacques Herzog and Pierre de Meuron chose to emphasise these by alternating the vertical plates with others cantilevered horizontally, conceiving the entire formal composition of the facade based on this structural solution (***4.07***).

While scoring the elevations with a series of repetitive horizontal lines, this detail conferred a minimalist and abstract character on the building, with a strong conceptual dimension that allowed for a set of relationships to be perceived. It is widely known, from descriptions of the building, that the idea of stacking and layering that underlies the compositional system is related to both the image of the stacked wooden boards frequently seen in the sawmills of the Laufen valley and the layered geological structure of the quarry wall on the site where the building has been located. As Jacques Herzog has mentioned, in this building the architects also pursued "the coincidence between the representative and representing elements",[93] a quality they sought in works of sculpture from the 1960s and brought into architecture, exploring it as something that was totally new at the time. This means that the solution of alternating vertical and horizontal panels was also envisaged by the architects as like a shelving system that itself embodied the building's program for the storage of goods (***4.08***). However, beyond the analogies and relationships that are at the basis of the thinking and idealisation of this system, the whole composition expresses a well-balanced geometrical order that, in addition to harmonising the various parts, recalls an archaic way of making architecture that endows the building with an enduring quality (***4.09***).

93 Herzog, "Conversation between Jacques," 214.



4.09
"Haus Nr. 4 II (Ricola Laufen)", Thomas Ruff (1991). Photo of the storage building.

Referring to the warehouse for Ricola, Rafael Moneo observed that "the wise handling of a material—laminated wood—gave rise in that slender wall to the introduction of timeless formal components of architecture".[94] According to the Spanish architect, number, proportion and rhythm, as attributes that architecture has always used, appeared in these elevations as parameters for the drawing. In fact, the horizontal lines of the facade are not all set at the same distance as initially proposed and as a first model reveals (***4.10***). They are structured into three groups, each one consisting of five rows of panels, whose height becomes wider as they get closer to the rooftop. The three measures are related to each other by a proportional relationship that endows the composition with a smooth progression that attenuates the perception of the original subdivision of the facade into three lengthwise sections.

Gerhard Mack, one author who is perhaps the closest to HdM and their design practice, presented contrasting versions of how the heights of the panels have been regulated in two publications[95] in which he discussed the building. In 1997, the German editor specified that the boards for the building's two bottom sections were cut to a ratio following the Golden Mean, while in 2014 he noted that the sheets of Eternit become broader by a third in three steps at a time.

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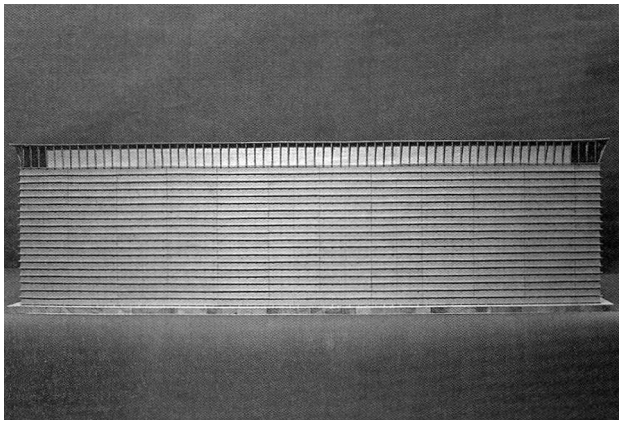
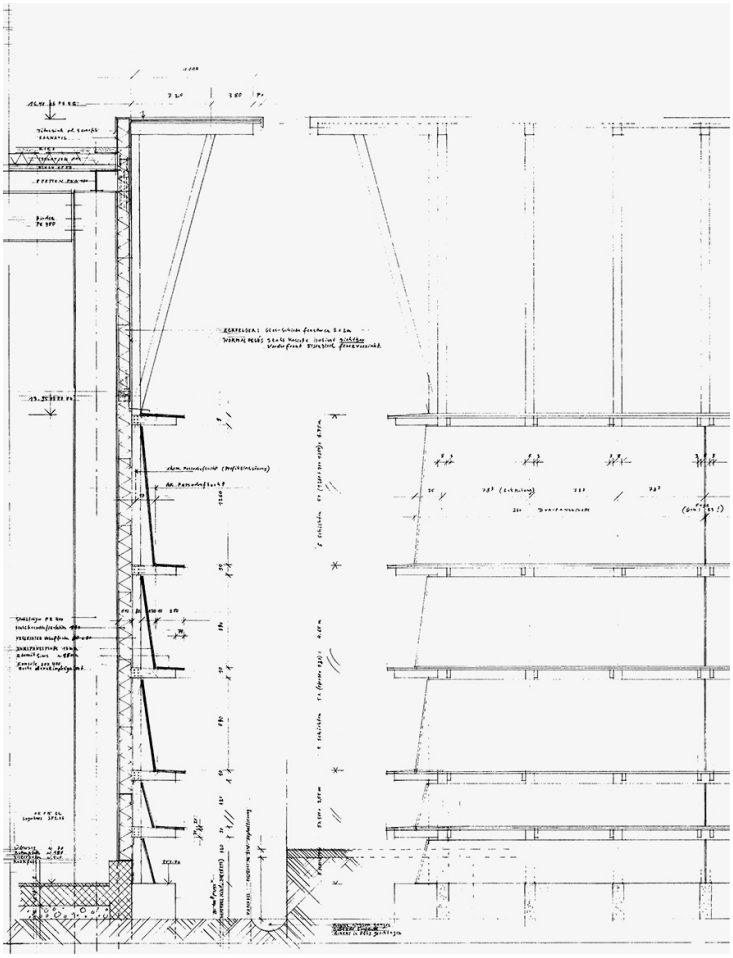
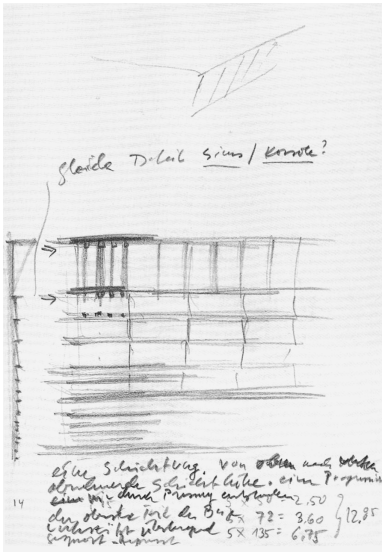
94 "El sabio manejo de un material—a madera laminada—daba lugar a que se introdujesen en aquella pared ligera componentes formales de la arquitectura de sempre." Rafael Moneo, Inquietud Teórica y Estrategia Proyectual en la Obra de Ocho Arquitectos Contemporáneos (Barcelona: ACTAR Barcelona, 2004), 362.

95 The two publications by Gerhard Mack are: Gerhard Mack, ed., Herzog & de Meuron 1978–1988. The Complete Works. vol. 1, (Basel, Boston, Berlin: Birkhäuser, 1997), 153, and Gerhard Mack, Ricola, Herzog & de Meuron, Sieben Bauten, Seven Buildings 1983–2014 (Laufen: Ricola, 2014), 22.







4.10
A first model for the warehouse showing the Eternit panels at an even height.

4.11
Section and elevation.

4.12
Sketch of the vertical subdivision of the facade.

Indeed, the drawings of this project—sketches and plans—that are available[96] do not clarify which solution was built in the end. Different proposals were outlined in the drawings, reflecting the architects' reasoning while researching the most appropriate solution.

One construction detail for the whole facade that interrelates a section with the corresponding elevation shows that the height of the Eternit plates from the top, where entire boards were applied, decreases by relying on the geometrical partition of the original dimension of 1:3, giving 126/84/42cm. If a ratio following the Golden Mean had been applied to regulate the height of the middle and bottom rows, compared to the previous solution, the dimensional difference between the two lower parts would be smaller, and, by contrast, the upper section of the facade would visually stand out a bit more, at 126/78/48cm. When tracing lines of both solutions on the final drawings of the facade, the "divine" proportional system appears to be the one that best matches the elevations. Indeed, in another full section of the facade, the dimensions indicated in the drawing are approximate to the exact numbers of the Golden Mean—126/76/50cm—which suggests that these may probably even rely on the ratio 5:3 (***4.11 / 4.12***).

However, apart from the proportional system that the architects might have followed, this building shows that there is a geometrical thinking behind it. It proves that, although architecture may be based on elementary shapes and rely on repetition, by making use of geometry, it is possible to achieve a whole that, instead of being rigid, is the expression of an harmonic composition.

The growing height of the panels, a fundamental strategy to break any trace of austerity that may derive from an overly direct geometrical structure, is also in itself a reaction to the distorting effect of perspective.[97] By implementing this gradation, the architects, as if they were stretching the facade, avoided an oppressive sensation, endowing the composition with a lightness that makes it seem to fade into the sky. In addition to the subtle tripartition in the sequence of rows, the volume is exquisite in the way it touches the ground and is topped with an elegant cornice, which recalls, as Jacques Herzog mentioned, the classical architecture of the Renaissance. "I think the Ricola warehouse", Jacques Herzog said, "is conceptually so interesting because, at the time, it was totally new to do something, which [...] has a kind of classical aspect. From a certain distance it looks almost like a Florentine palazzo of the 16th century".[98] There is a concrete socle that "supports" the fibre cement boards and lifts them up from the ground, in the same way that, in the upper part, a high projective cornice crowns the whole building, lending the facade gravity, in the sense of dignity and seriousness.

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96 We refer to the drawings published in Mack, *Herzog & de Meuron 1978–1988,* and those we were able to consult in HdM's digital archive.

97 The completion of the Farnese Palace by Michelangelo is also an example in which the architect decided to alter Sangallo's original project, introducing compositional strategies that reduced the effect of perspective distortion and made the facade more well-proportioned. James Ackerman described how Michelangelo "made only three changes in Sangallo's project, designing a new cornice, raising the height of the third storey and altering the form of the central window. The first two were closely related; we know from the complaints of Sangallo's supporters that Michelangelo substantially increased the size of the cornice; in order to avoid an oppressive effect he increased the distance between the window pediments and the top of the wall to a height equal to that of the cornice itself. The third storey now became equal in height to those below." See James Ackerman, *The Architecture of Michelangelo* (Harmondsworth: Penguin Books, 1970), 183.

98 Herzog, "We are surrounded."

4.13 / 4.14
Schwitter Building, Basel (1985–1988). The outer curved facade and the internal courtyard.

4.15
Ground plan of attic with superimposed geometric constructions by the author.

Other projects from the same period reinforce this particular way of responding to a brief, as a search for a naturalness regulated by geometric relationships in their shapes. Projects like the Plywood House, Bottmingen (1984–85), the Hebelstrasse Building, Basel (1984–1988), or the Schwitter Building, Basel (1985–1988), are examples of rational compositions imbued with an organic sense, where the adjustment of the individual parts to each other and to the whole was achieved by fine work on drawings.

Located at the confluence of three streets, the mixed-use Schwitter building is particularly conspicuous for how the architects have used the curve and explored its geometrical properties, solving the circular bend of the volume through a consistent combination of superimposed arches (***4.13 / 4.14***).

Gerhard Mack mentioned that "Herzog & de Meuron achieved this physical movement [of turning the corner] by making the parcel more geometric."[99] Indeed, when looking at the apartment floorplans, the four centres from which the circumferences of the drawing are traced are marked as if they were the original signs from which the whole composition find its reason and may be graphically retrieved with rigour (***4.15***). Everything in the drawing is ordered and well-calibrated, revealing that, to solve the intersection between two different directions by a curved figure, it is necessary to work with the notions of bisector, tangency or similarity.

The result is a coherent whole. A geometrical logic underlying the drawing unifies every gesture and gives sense to each of the traced curves, endowing the composition with firm integrity. The refinement of the geometrical relations between the several elements is fully revealed in the sculptural character of the outer facade. Here, the overlapping of the curved projecting floor slabs onto the arched volume of the building produces a dynamic vibration that gets denser with the swinging movement of the resulting shadows.

In this project, the architecture strongly derives from a series of relationships set out in the floorplan.

While in the Ricola building, the search for the proper measurements and the refinement of the design was done, above all, on the section and elevation, in the Schwitter building the geometric composition was settled in the floorplan. The elevation, in this case, allowed the effect produced by the shadows and the rhythm of the vertical concrete ribs to be confirmed, both coming from the traced lines in the horizontal projection (***4.01***). Nevertheless, in both cases, and generally in the projects from this period where hand-drawing was the tool par excellence in the development of the design, architecture arose from in-depth reasoning and investigation on the plan. It was mainly conceived and tested from a bi-dimensional approach to the shapes provided by the orthogonal projections, which are abstract conventions that indicate, as James Ackerman mentioned, "something literally invisible"[100] and unverifiable by the eye. Therefore, the metric and proportional control of the forms and the ability to capture part of their three-dimensional effect were dependent on the continuous crossing of plans, elevations and sections.

In the early work of HdM, this awareness that the design process relied on the planar description of shapes was particularly explored and, in a way, taken to its limit in the project for the Stone House,

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[99] Mack, *Herzog & de Meuron 1978–1988*, 121.

[100] James Ackerman, "Introduction: the Conventions and Rhetoric of Architectural Drawing," in *Conventions of Architectural Drawing: Representation and Misrepresentation*, eds. James Ackerman and Wolfgang Jung (Harvard: Harvard University, 2000), 11.

Liguria (1982–1988), whose geometric, abstract structure is literally the result of the fusion between the horizontal and vertical projections. As Jacques Herzog mentioned, "if the plan form and the cross-section are expressed as geometric equivalents, the spatial integration of all building parts is strengthened. The building is simultaneously an architectural expression of each single building part as well as of their unified collective form. This specific relationship between the parts and the whole is what we try to find in most of our projects."[101]

4.3 _ "The Reality of Images"

In the introductory commentary to the section "2. Drawings" in the catalogue to the exhibition by HdM at the Schaulager Foundation in 2004, Theodora Vischer made a brief description of the sketches that were on display, the majority made by Jacques Herzog in the context of individual projects. According to the art curator, drawing, which she considers "the medium that is [perhaps] closest to the thought process", was for HdM "an important instrument particularly in the early work, when the architects were still concerned with developing their own language".[102]

In fact, when flipping through the first volume of the HdM monograph by Gerhard Mack, which considers the period between 1978 and 1988, one may acknowledge that besides photographs of the constructed buildings and some models, the projects are mainly documented with technical drawings and a considerable number of sketches. This specific way of presenting the works reflects, in a way, how the architects were addressing the design practice at the time. If, on the one hand, this is symptomatic of the modest scale of the office during the 1980s, with Jacques Herzog and Pierre de Meuron working in small teams and themselves closely following the entire development of the projects, on the other hand, it reveals a methodology that relied mainly on hand-drawn representation.

Nevertheless, the prevalence of drawings, used to explore the design ideas, "approaching the problem; circling around and trying to define it; [...] discovering, reflecting and rediscovering again",[103] as Theodora Vischer described, would tend to decrease over the years as a reflection of both the impact the enlargement of the office had in the organisation of the work within the teams and the immense possibilities the computer opened up in their creative process. From Volume 4 (1997–2001) by Gerhard Mack onwards, this shift is particularly noticeable. In these publications, the presentation of the projects clearly changed; the number of sketches was reduced, and even the role assigned to plans, as the privileged means to communicate the project and provide an insight into the most peculiar architectonic aspects of it, was relativised, being replaced by a great variety of different sources.

In the 1980s, even though the process for thinking and conceiving architecture was primarily based on sketches and plans complemented by model-making, HdM also started experimenting with video. As a reaction to Jacques Herzog's consideration of the traditional means of representation in reducing "the entire world of images, so decisive for [their] architecture, to a stereometric, uniform expression",[104]

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101 Herzog "Hidden Geometry of Nature," 208.

102 Vischer, *No. 250 An Exhibition*.

103 Ibid.

104 Herzog, "Conversation between Jacques," 214.

4.16
Lego House, Paris (1985). Physical model.

4.17
One of the presented video stills showing the interior of the attic room.

HdM introduced in their methodology the work on pictures made from the video recording of models specially done for this purpose.

This technique that, as Jacques Herzog pointed out, "nobody was using in architecture at the time",[105] provided the Swiss architects with an appealing alternative to the typical perspective drawings, which were considered at the time as a discipline on their own and whose artistic effect they have always found questionable. Explored for the first time in the deep blue representation of the entry hall for the early design of the Swimming Pool in Riehen (1979–1982) (***3.19***), this particular way of using video allowed HdM to simulate the ambiance of architecture and provide a more sensual experience of it.

"As in photography, [the] pictorial reality [of the video still] expresses things and acts that look real", Herzog has observed, "so suddenly we found ourselves with a tool that would allow us to express our ideas on architecture in a contemporary form even without a concrete commission—and much more successfully than by using classical means of representation like models, plans and drawings."[106]

These pictures showed the architecture of HdM involved in ordinary life, and their particular cinematic aesthetic, besides simulating the projects as real buildings, as it maintained an atmosphere of imagination, also referred to the world of images from which they had somehow emerged.

Developed for the exhibition "L'Architecture est un jeu magnifique" at the Centre Georges Pompidou in 1985, the Lego House is an example where HdM have more intensely explored the use of the video still image in the representation of architecture.

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105 Jacques Herzog, Philip Ursprung and Jeff Wall, *Pictures of Architecture, Architecture of Pictures, A Conversation between Jacques Herzog and Jeff Wall moderated by Philip Ursprung* (Wien: Springer-Verlag Wien New York, 2004), 13.

106 Ibid.

"Maybe our most interesting and sophisticated example of analysing and exposing representation is the 'Lego House'", Jacques Herzog said about this small project for a conceptual house built with Lego bricks. "In an accompanying text I describe the fragments of real and imagined worlds coming together with this [...] project."[107]

With a clearly divergent approach from the colourful post-modernist contributions by the majority of the participants, Jacques Herzog and Pierre de Meuron surprised the audience by choosing to create an inconspicuous architecture. Inside a house-shaped acrylic glass envelope, the Swiss architects built an ordinary attic room with a dormer window, like the many from their native city of Basel, and focused on showing traces from the life hidden behind the brick walls (***4.16***).

As if they were stolen views from a private interior, HdM presented two black and white blurred video stills that pointed attention to the imaginary dimension of architecture and intensified the communication of the project (***4.17***). These recalled memories from the architects' childhood and illustrated the design idea from a complementary perspective to that of the model and the text imprinted in the end wall of the glass acrylic box. From this point of view, this small work was also a reflection on the different representational forms for architecture and the modes of experience that correspond to each of them. While exploring the relationship between text, model and picture, the architects, as they noted, tried "to achieve coherence on the different levels of reality",[108] creating the idea for an architecture that fully emerged when these all melded together. The construction of scenes from an imagined world allowed HdM to appeal to the five senses and provide an experience of architecture that was as complete as possible. However, when using this technique, HdM also demonstrated, as they described, that "working with images is [in itself] an architectural work; the thinking happens in architectural images which [they] extend to the whole design in other projects."[109]

In the small pavilion for the Eden hotel, Rheinfelden (1986–1987), a singular picture made from the projection of a photograph onto the physical model also reinforces the role of images in revealing the relationship between ideas and reality (***4.18***).

For this pavilion, located amidst the bushes and trees of the hotel garden, Jacques Herzog and Pierre de Meuron decided on a simple open structure consisting of four columns carrying a square concrete grid as the roof. The vertical supports represent the four letters of the hotel—E, D, E, N—having been conceived by the architects as a kind of anagram that becomes legible as a word when seen from a specific location.

The sculptural definition of each letter is imbued in symbolic thinking,[110] so individually they express their own tectonic qualities. Nevertheless, "the pavilion achieves its maximum figurative and semantic self-containment", as described by Gerhard Mack, at the moment the word EDEN appears correctly

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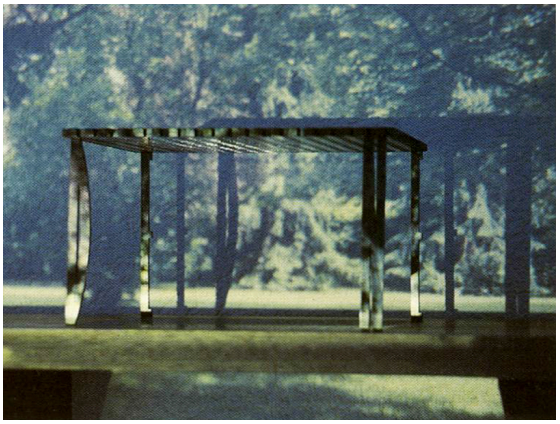
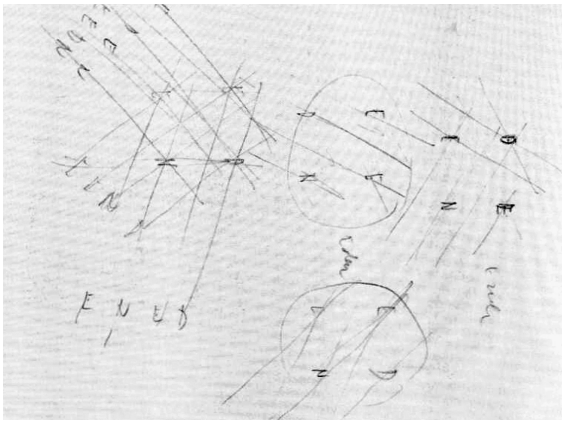
[107] Herzog, "We are surrounded."

[108] "028. Lego House," Herzog & de Meuron, accessed August 19, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/026-050/028-lego-house.html.

[109] Ibid.

[110] "Each support then becomes 'legible' in itself as a figure developing its own sculptural and architectural themes. The 'D', with its stretched shape, projects the principle of load. The architects describe the 'N' as a 'split massive beam'. The 'E' is rather a constructed form whose arches are the same size in order to avoid allusions to the classical column with capital and shaft, similar to the wooden columns of the apartment building in Hebelstrasse, Basel." Mack, *Herzog & de Meuron 1978–1988*, 145.





4.18
E, D, E, N, Pavilion, Hotel Eden, Rheinfelden (1986–1987). Picture of the pavilion model with the projected image of the park.

4.19
Sketch for the four-letter anagrammatic play.

arranged. It is this singular instant that the two-point perspective picture of the small pavilion is trying to capture and communicate. The image shows the airy structure inserted into the park's dense greenery, so, in a way, this is an attempt to contextualise the architectural object and communicate the atmosphere of the whole. However, by restoring the pavilion's peculiar point of view and alluding to its projected shadows, it focuses on the essence of the design; it unveils what was intensely tested in drawings (***4.19***) and that by other representational means would just fall apart.

5.01
Berlin Pulvermühle, Housing Project, Berlin (1992).

5.
Collage and Perspective

5.1 _ "Architektur Denkform"
5.2 _ Repetition and Seriality
5.3 _ Architectural Montage

5.02
"Architektur Denkform", Basel (1988). Exhibition room at the Architektur Museum.

5.03
The translucent picture of the House for a Veterinarian with the medieval roofs of Basel in the background.

5.1 _ "Architektur Denkform"

In the fall of 1988, the first major exhibition of HdM, entitled "Architektur Denkform" (Architecture: a way of thinking), was held at the Architekturmuseum in Basel.

On the four floors of the building dating from the 1960s, the architects exhibited drawings, plans and models of the projects they developed during the first nine years of their professional practice. The physical and graphic documents, shown as remnants of the working process that allowed the single projects to be read and studied up close, were complemented by photographs of the constructed buildings imprinted onto the museum's glass facade (***5.02***).

The floor-high black and white silk-screened pictures that alluded to the reality of the architecture on display transformed the transparent envelope of the exhibition rooms and created an involving environment filtered by a translucent veil where cutouts of the buildings by HdM and urban scenes from old Basel melted together (***5.03***). "The result was a new space, [...] [and] the atmosphere was really quite 'impressive'," [111] Jacques Herzog remarked. The different elements—plans, models, images and the town itself—entered into a relationship and formed a unity that aimed to communicate a specific thinking about architecture.

Rather than a celebration of their work, HdM explored the exhibition process as an opportunity for research. As they continued to demonstrate over the years in subsequent exhibitions, for the Swiss architects these represented an opportunity each time to reflect on their practice and on architecture in general. Therefore, instead of making exhaustive representations of the individual projects, whose didactic value they found questionable, HdM preferred to connect them within a particular standpoint and promote their relationship to the larger context. By doing so, as Gerhard Mack argued, exhibiting

[111] Rémy Zaugg and Herzog & de Meuron, "Five exhibitions on H&deM by H&deM," in *Rémy Zaugg: Herzog & de Meuron. An*

for HdM "became an instrument with which one could step back from one's own discipline and take a look at its methods as well as one's approach."[112]

In the Basel Museum of Architecture, the exhibition, as the title suggests, was about architectural thinking, with HdM working out a strategy to make this tangible and experienceable. So, in the first instance, the floor-to-ceiling pictures imprinted on the glazing were an allusion to the role that images have always played as catalysts for their ideas.

As Jacques Herzog stressed more than once,[113] from the very beginning, pictures, which they have collected from the city and elsewhere, even from movies, have been the stimulus for their designs. As mental projections of one's experienced reality, the immaterial world of thoughts and images, from which invention arises, is where the physical takes up the continuity of its existence. Therefore, as HdM observed in the context of their project for the Virtual House, New York (1996–1997), "it is […] utterly absurd to isolate the virtual and immaterial from the material, physical world of daily life; the two worlds are inextricably, existentially interdependent".[114]

Presumably, for that reason, the silk-screened photographs in the Basel museum were cropped pictures that showed only fragments of the constructed projects. By avoiding descriptive illustrations and providing instead images that worked like brief disparate insights into the buildings, HdM pointed to the concepts and ideas underlying the exhibited architectural realities. In their odd and suggestive character, these representations particularly targeted the imaginative world. They were engaging from a perceptual point of view and appealed to the senses, stimulating the mental construct of the absent architectural forms and contributing to the apprehension of their immaterial quality.

Additionally, the experiments on the translucent envelope were an opportunity for HdM to test out a new procedure they would develop further in their buildings.

Volume 1 of the HdM monograph by Gerhard Mack concludes with the presentation of this exhibition. Indeed, it summarised the work developed by the Swiss architectural office up to that point, between 1978 and 1988, the period addressed in the publication. Nevertheless, more than closing a phase, this exhibition opened up a new research direction in their design practice and, in a way, signalled a turning point in their approach to architecture. "Our exhibition at the Basel Museum of Architecture has served as a model for the way we have gone about things", Jacques Herzog has said. "It was a very important event for us, allowing us to go further [in] our research on the relation between façade and image, on the façade made up of, constituted of images."[115]

In this exhibition, HdM for the first time applied screen prints to facades. In the following years, this technique became a recurrent topic in their architecture and, for a period, they explored it in some projects to enhance the tactile and iconographic qualities of the surfaces.

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[112] Gerhard Mack, "Architecture as a Multiplicity of Observation. The Architecture of Herzog & de Meuron 1989–1991," in *Herzog & de Meuron 1989–1991. The Complete Works*, vol. 2, ed. Gerhard Mack (Basel, Boston, Berlin: Birkhäuser, 1996), 9.

[113] Herzog, "Conversation between Jacques," 212.

[114] "152. The Virtual House," Herzog & de Meuron, accessed September 3, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/151-175/152-the-virtual-house.html.

[115] Zaugg and Herzog & de Meuron, "Five exhibitions on H&deM," 10.

The Swiss architects have always been keen to go beyond the conventional use of materials by exploring them in new ways so that hidden and unexpected qualities might be revealed. Therefore, the photographed pictures and the texts incorporated on the buildings' shells worked as devices that allowed HdM to question the nature of the materials and search for new reinterpretations in the borders between smooth and textured, transparent and translucent, solid and immaterial, plain and decorated. Projects like the Greek Orthodox Church, Zurich (1989), the SUVA House, Basel (1988–1993), the two Libraries for the Université de Jussieu, Paris (1992), the Ricola Europe SA, Mulhouse (1992–1993) and the Eberswalde Technical School Library, Eberswalde (1994–1999), are examples where the imprints applied on marble, glass, plastic and concrete uncovered ordinarily undetected features of the materials and made their traditional character disappear. "Glass isn't glass anymore, it's as solid and stable as stone or concrete. Conversely, by printing on concrete, it suddenly becomes porous or shiny like glass",[116] Jacques Herzog said when questioned about his continuous interest in creating new impressions of things that are familiar.

However, the application of images that made the facades look like tattooed skins also raises the question of ornament, a topic that HdM have embraced so effectively in their practice and addressed during the 1990s by using various printing techniques.

"We find tattoos interesting, in antique as well as contemporary culture", HdM stated. "Therefore, we find what Loos describes […] reactionary and difficult to understand. Ornament has always been interesting when it has a spiritual dimension. Although that sounds so old fashioned, it's important that it has meaning."[117]

On several occasions, Jacques Herzog revealed his fascination for the old farmhouses of the Engadine valley whose facades are decorated with inscriptions and paintings. Like artificial objects clearly differentiated from the natural world, these traditional architectures, tattooed with frescos that create, according to Jacques Herzog, a feeling of astonishment, have been studied by the Swiss architects "in order to discover their secret", as they referred to it; "to appropriate their magic so that [their] projects [could] enchant today's world."[118] Similarly, the discovery of Arab architecture has also impacted HdM's approach to ornament. From the notes Jacques Herzog took in his sketchbook when visiting the Alhambra (Granada) in 1990, which Gerhard Mack described,[119] one realises how much the architect from Basel was impressed by the illusory effect the coloured ceramic tiles produced both on surfaces and in space. In addition to endowing the surfaces with a textile-like appearance that visually

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[116] Jacques Herzog, "Collaboration with Artists. Catherine Hürzeler. Interview with Jacques Herzog," by Catherine Hürzeler, Herzog & de Meuron, accessed August 27, 2021, https://www.herzogdemeuron.com/index/projects/writings/conversations/huerzeler.html.

[117] Herzog & de Meuron, "Minimalism and Ornament. Herzog & de Meuron in conversation with Nikolaus Kuhnert and Angelika Schnell," by Nikolaus Kuhnert and Angelika Schnell, in *Archplus. Herzog & de Meuron. Minimalism and Ornament*, vol. 129/130, eds. Marc Fester, Sabine Kraft, Nikolaus Kuhnert and Günther Uhlig (Aachen: ARCH+ Verlag GmbH. December,1995), 117.

[118] Jacques Herzog, "Firmitas," in *Herzog & de Meuron 1992–1996. The Complete Works.* vol. 3, ed. Gerhard Mack (Basel, Boston, Berlin: Birkhäuser, 2000), 250.

[119] "In June 1990, two years after this sparkling exhibition ["Architektur Denkform"], Jacques Herzog made the following notes in his sketch book when visiting the Alhambra in Granada: 'Space—the illusion of a plane instead of space or lattice work in front of the endless space. Surfaces—stone (earthly, heavy) becomes cloth (textile, immaterial). The doors and windows seem like permeable points in a textile fabric; stone, ceramic surfaces—textile effect.' Of the ceramic cladding on the Moorish facades, Herzog notes, '[they] do not trace structural components, [...] they cover over the structure, the lines of force of load-bearing and supporting elements, space—plane.'" Mack, "Architecture as a Multiplicity", 7.

5.04
Eberswalde Technical School Library, Eberswalde (1994–1999).

5.05
The concrete imprinted panels and the print patterns.

dissolved their solid materiality, tiling altered the perception of endless depth, flattening space into a virtual plane. So when HdM restored the symbolic status of ornament in architecture by covering the facades of their buildings with scripts and figurative motifs, they had in mind the bewildering effect of the surfaces and sequences of rooms in Islamic architecture. Just like the work of Matisse, in which ornament, as Jacques Herzog recognised,[120] enabled the French artist to destroy perspective and shape, so, in architecture, ornament plays with ambiguity; it is about the illusion game where volume and surface overlap each other, leading to the viewer's continually shifting perception of the building.

"We're interested in having the surface change the volume and, conversely, in having the volume affect the surface",[121] Jacques Herzog said, when talking about their treatment of decoration. As the Eberswalde library reveals, the photographs printed on the concrete and glass panels and arranged in horizontal bands running around the facades, resembling a montage,[122] blur the volume and dissolve its three-dimensionality. In its turn, the minimalist volume disturbs the applied images, which are no longer individually perceived as single pictures (***5.04 / 5.05***). “The potential of ornament as a means of destroying ‘valid’ form”,[123] as HdM remarked, is one of the engaging aspects of ornament recognised by the architects, having enabled them to break down and question traditional categories again. "We started embellishing surfaces when we found ourselves faced with the difficulty of declaring, in reference to a

120 Herzog, “Ornament, Structure and Space,” 36.

121 Herzog, “Collaboration with Artists.”

122 When referring to the Eberswalde Technical School Library, Catherine Hürzeler says that the intended content of the pictures on the building's facade, chosen by Thomas Ruff, was subject to a process of alienation through the use of the technique of montage. Hürzeler uses the term "montage" instead of "collage", which is interesting to notice, as, according to Tate's online glossary of Art terms, "a montage is an assembly of images that relate to each other in some way to create a single work" and is therefore "more formal than a collage [as it] is usually based on a theme". See “Art Term. Montage,” Tate, accesed September 18, 2021, https://www.tate.org.uk/art/art-terms/m/montage.

123 Chevrier, *From Basel*, 37.

specific project, 'That's the form I want, no doubt about it.' Ornament has often helped to solve this problem",[124] Jacques Herzog mentioned.

However, this work on images discloses an ulterior aspect, which is specific to their design practice. The architects' emphasis on the facade as the architectural layer where the building takes on its full expressiveness was, in the 1990s, explored to such an extent that it led many to talk about their architecture as being "minimalist" and "ornamented".

Theodora Vischer[125] noted that HdM have subordinated volume to the surface in later works, which she lamented, especially when compared to their initial projects where body and surface seem to be in perfect harmony. Similarly, Rafael Moneo affirmed that the architects' field of action, in some projects, seems merely concerned with the control and definition of the building's skin. According to the Spanish architect, at the end of the 1980s and during the 1990s, some projects reveal "unnecessary external influences that had led [the architects] to understand buildings as communicating machines [...]. Materials seem now only to serve [the appearance of the facades], having been lost [in] that solid structural condition that made one look at their early work with such great respect."[126]

Indeed, after the Basel exhibition, the facade gained special prominence in the architecture of HdM, sometimes even at the expense of volume that, as a kind of a prerequisite to draw attention to the surface, was reduced to great simplicity. Nevertheless, if one follows Philip Ursprung's reasoning, who seems to look at this issue from a slightly different perspective,[127] this attitude might be relativised and, in a way, understood just as one of the variants in the HdM approach to what the Swiss art historian considers to be their goal in architecture—"to create forms that make material speak."[128]

5.2 _ Repetition and Seriality

In the conversation we had with Harry Gugger, he revealed that the computer was used in the office for the first time in the project for the Railway Engine Depot, Basel (1989–1995).

As this project, consisting of five adjacent linear volumes, was big and repetitive, Harry Gugger, who worked on it, considered that it did not make sense to draw by hand, so he decided to buy himself a

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124 Ibid.

125 Herzog, "Interview by Theodora Vischer," 29.

126 "La arquitectura de Herzog & de Meuron no siempre alcanzó al fin de los años ochenta y durante los noventa aquella intensidade que nos admiraba en sus primeras obras. Incluso advertiremos en algumas de ellas innecessarios influjos exteriores que les ha llevado a entender los edifícios como máquinas comunicatorias, perdendo así aquella considión opaca y hermética que tanto nos seducia cuando nos encontrábamos con ella en obras del primer ciclo de su carrera. [...] los materiales ahora parecen sevir tan solo a ello [al control de las fachadas, a la definición de la piel del edificio] y se ha perdido aquella condición estructural del sólido que nos hacía ver con tanta admiración sus primeiros trabajos." Moneo, *Inquietud Teórica*, 370.

127 In "Exposures. Herzog & de Meuron and photography", Philip Ursprung elaborates on HdM's use of images in architecture, and, in particular, on the impact that the fruitful collaboration between the Swiss architects and the German artist Thomas Ruff had in the development of a new concept of spatiality. Taking the Eberswalde Library as an example, Ursprung suggests that "Herzog & de Meuron's attitude to space recalls the theories Henri Lefebvre advanced in his book *The Production of Space*", once they pursue what the French philosopher called a "unitary theory of physical, mental and social space". From this perspective, Philip Ursprung argues, a deeper meaning in applying images onto the facades emerges than the mere collage of figurative motifs. He says that "the facade of library Eberswalde is therefore not a screen, onto [which] images are projected and mediated in abstract space, but rather a kind of sponge, which is impregnated with the flood of images continually produced by the phenomena of the world, our observations, our memories, our imaginations. The facade is not a neutral frame for the images of the past; rather, it is permeated by these images and becomes a part of them." Philip Ursprung, "Exposures. Herzog & de Meuron and photography", in *Materiality and Architecture*, ed. Sandra Karina Löschke (Oxon and New York: Routledge, 2016), 24.

128 Ursprung, "Exhibiting Herzog & de Meuron," 33.

computer. "Jacques and Pierre were rather cautious in their approach to the computer",[129] the former partner said. Therefore, as he noted, "up to around 1990 [in the office] you have hand drawings, and then CAD starts to move in." [130]

In fact, this coincides with what had already been observed about the diagram on the drawing methods elaborated by Kai Strehlke,[131] in which one may also see that 2D CAD was introduced in the working methodology of the Swiss architects in the early 1990s.

Used as a drawing machine to generate plans, first and foremost, and thus digitise a task that was previously done by hand, the computer has progressively become the main representational tool in the office, after a transition period in which both hand and digital drawing were simultaneously adopted. For almost the whole decade, as the Sammlung Goetz, Munich (1989–1992) or the Tate Modern, London (1994–2000), reveal, in the projects it was a mixture of techniques, as Harry Gugger mentioned; the plans were mainly in a digital format, while the details were often still hand drawn. Indeed, this is reflected in the second and third volumes of the HdM monographs by Gerhard Mack, which address the period between 1989 and 1996. Most of the plans, sections and elevations presented in these publications are digitally drawn. However, when it is about scaling-up the projects to focus on the construction details or deal with more complex architectural issues, drawings are often made by hand, as if more analogue thinking had been necessary to solve these aspects. For this reason, among the published technical drawings one may find detailed cross-sections, like the ones of the gabion wall for the Dominus Winery, Napa Valley (1995–1998), most of them expertly executed by Mario Meier,[132] an experienced former collaborator and a crucial figure in the office who had worked closely with the two founding partners since the early 1980s.

However, despite the advantages and disadvantages[133] that computer-aided design inevitably brought into the working methodology, it did not change the architects' way of thinking, conceiving and representing architectural forms. The new tool did rationalise the drawing process; however, the approach to the geometrical understanding and definition of the shapes remained on the same two-dimensional basis. The design practice relied, as before, on the representational principle of orthographic projections and the output was still the plan.

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129 Gugger, “This is too generic.”

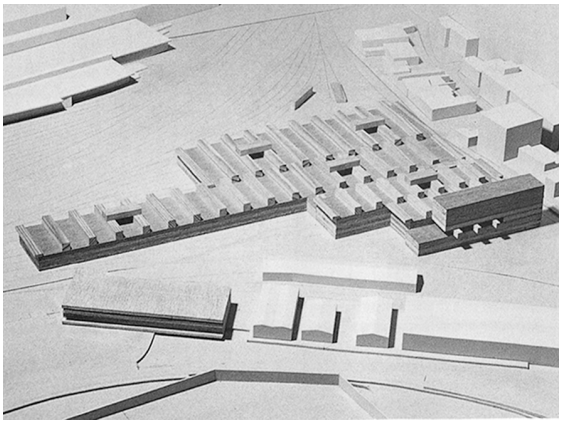
130 Ibid.

131 This topic is addressed in the section “*3.4 _ Hand Drawing / 2D CAD / 2D CAD+3D Data / BIM*”, 75–77.

132 In the above-mentioned conversation with Harry Gugger, he spoke about Mario Meier in the context of the project for the Goetz Sammlung, explaining that "Goetz was, in no small extent, designed by hand. It was drawn mainly by Mario Meier, a crucial figure in the office. He was an experienced collaborator, he knew how to construct things, and he always did beautiful hand drawings. He had his style."

When searching by name on the website of HdM, Mario Meier appears as having collaborated on a total of about 23 projects—the first listed as "013. Apartment Building Conversion, Basel (1981–1982)" and the last one as "300. Artists' Choice: Herzog & de Meuron, Perception Restrained, MoMa, New York (2006)", which means that he began his collaboration in the office in the early 1980s and worked there roughly up to around the first years of the 2000s. It is also interesting to notice that MoMA's online collection of Modern and Contemporary Artworks considers Mario Meier an artist. The museum holds two hand-drawn vertical sections of the Dominus Winery by him, donated by the Jacques Herzog and Pierre de Meuron Kabinett.

133 See Harald Gatermann and Oliver Fritz, “Computer Aided Design (CAD),” in *Atlas of Digital Architecture. Terminology, Concepts, Methods, Tools, Examples*, Phenomena, eds. Ludger Hovestadt, Urs Hirschberg and Oliver Fritz (Basel: Birkhäuser, 2020), 129–143.



5.06
Railway Engine Depot, Basel (1989–1995).

5.07
Physical model for the Railway Engine Depot project.

When referring to the project for the Railway Engine Depot, Harry Gugger talked about it as being repetitive, a word that appears again[134] in our discourse as an attribute used to characterise the architecture of HdM.

Indeed, in this building, the architects took the modular structure of the railway tracks as a reference and designed a system made itself of standardised units. In the description of the project, HdM synthesised the overall structure of the building as constituted by two elements—the cast-in-situ concrete walls that run parallel to the adjoining tracks and divide each of the sheds, and the square section steel girders that rest on the concrete skeleton, solving the monumental roof through a system that allows natural light to get in (***5.06***). The idea of repetition underlying the construction principle of this large-scale complex reflects on its formal structure, impacting the architectural image of the building. The light-boxes placed on the roof at regular intervals counterbalance the raw linear character of the concrete walls, punctuating the facades with their wave-like rhythm. In the same way, they emphasise, together with the glass windows—with which they establish a dialogue based on an alternating metric—the serial nature of the building, as if this could infinitely grow by the continuous addition of the same modular elements (***5.07***).

Regarding this project, Rafael Moneo referred to continuity, repetition and seriality as issues he considers inevitably present in both construction and architecture.[135] In fact, in the work of HdM, as the geometric reduction of forms to simple boxes became more and more apparent, the two latter concepts in particular—repetition and seriality—became prevailing subjects in the design of architecture.

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134 In section "*4.2 _ A Classical Sense of Order*", there is a quote by Eduardo Souto Moura in which he also described HdM's architecture as being usually repetitive.

135 "Serialidad, repetición y continuidad como cuestiones inevitablemente presentes en la construcción y en la arquitectura", Moneo, *Inquietud Teórica*, 384.

In the acceptance speech for the Pritzker Prize in 2001, while explaining the fundamentals of their architecture as originating from an interest in self-evidence and a non-distinguishable figuration within the search for a hint of memory or association, Jacques Herzog and Pierre de Meuron noted that their "designs became increasing minimal, radically minimal." [136]

When characterising the architecture of HdM from this period, Gerhard Mack spoke of a "reductive vocabulary". The German art historian mentioned that, together with the exploration of materials, the Swiss architects launched and experimented "with the "box" concept as a strategic vehicle for a reductive approach that offers a sense of direction in a time of arbitrary, postmodern plurality." [137] Indeed, the simplicity of lines, recognisable in the projects from the end of the 1980s and first half of the 1990s, reveals an architecture marked by formal austerity and geometric regularity. It seems as if, at a certain point, the qualities of Minimalist art,[138] which HdM took as a reference to consolidate their approach to architecture and set themselves in the post-modernist context, had been explored in a more literal sense, endowing the buildings with an object-like appearance and emphasising their impervious character. One may even risk arguing that some of the procedures timidly explored in the first decade to soften the formal rigidity of the buildings—such as the use of the curve or irregular polygons in tracing floorplans or the bending and fracturing of the volumes—have practically disappeared from the compositional repertoire of the architects. Buildings, in general, became very compact and pure from a volumetric point of view, and the rectangle, dominating both plan and section, stood at the basis of the design. As a result, the architectural compositions were, to a great extent, regulated by a set of orthogonal axes. The grid and the modular coordination[139] became recurrent geometrical strategies to organise the layout and ensure the dimensional relationship between the several components of the building.

Constructed in 1993 in France, close to the Swiss and German borders, the second warehouse that the architects from Basel designed for the Ricola company is one of the buildings from this period that embodies the new themes that came into play in their architecture (***5.08***). It is precisely from the confrontation between these two sheds, the one in Laufen and this in Mulhouse, that some of the main differences in HdM's approach to architecture emerge. Both buildings are simple boxes, where the architects' work mainly focused on the definition of the envelope. Nevertheless, while in the storage

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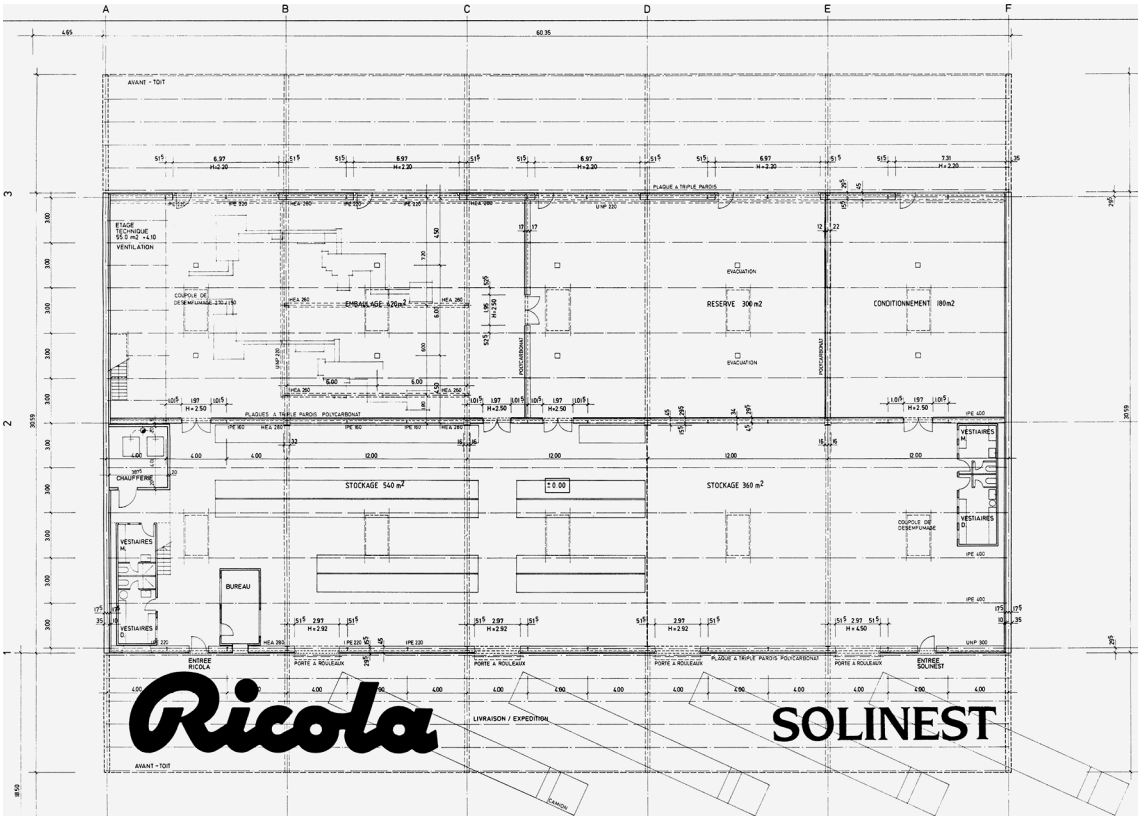
136 Jacques Herzog and Pierre de Meuron. "[acceptance speech] 2001 Pritzker Architecture Prize," in *El Croquis. Herzog & de Meuron 1998–2002. The Nature of Artifice*, vol. 109/110, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2002), 10.

137 Gerhard Mack, "Traits of a Topographical Architecture," in *Herzog & de Meuron 1997–2001. The Complete Works,* vol. 4, ed. Gerhard Mack (Basel: Birkhäuser, 2008), 7.

138 "Minimalism is an extreme form of abstract art [...] typified by artworks composed of simple geometric shapes based on the square and the rectangle. [...] Aesthetically, minimalist art offers a highly purified form of beauty. It can also be seen as representing such qualities as truth [because it does not pretend to be anything other than what it is), order, simplicity and harmony", "Minimalism" entry in Tate's online glossary on Art Terms, "Art Term. Minimalism," Tate, accesed September 17, 2021, https://www.tate.org.uk/art/art-terms/m/minimalism.

139 In the book "The geometry of environment," Lionel March and Philip Steadman consider "Modular coordination" a concept of new mathematics that reflects in buildings' physical and spatial arrangement. Addressed in Chapter 8: "Modules and Numbers", "modular coordination" is described by the authors as being concerned with linear relationships where dimensions conform, in the horizontal plane and even in the vertical, to the modular unit of a grid. See Lionel March and Philip Steadman, *The Geometry of Environment. An Introduction to Spatial Organization in Design*, (London: RIBA Publications Limited, 1971), 199–200.



5.08
Ricola-Europe SA, Production and Storage Building, Mulhouse (1992–1993).

5.09
The imprinted wall from the interior.

5.10
Ricola hall ground plan.

building in Laufen the essence of the architectural image lies in the construction, in the sense of how the several elements were put together in a particular assemblage system, in the hall in Mulhouse HdM concentrated on exploring the materials' surface qualities (***5.09***). Furthermore, when looking at both facades, the first one suggests rhythm and proportion, while the second is the expression of a stricter composition regulated by an underlying orthogonal grid.

With a form that recalls, as the architects mentioned, "a cardboard box lying on the floor with open flaps",[140] the building for Ricola Europe SA, Mulhouse (1992–1993), is a rectangular prism with cantilevered extending roofs on the longitudinal sides. To the extreme simplicity of the shape, the architects contrasted the sensual expressiveness of the materials. Therefore, the end walls are made of darkened in-situ concrete that acquires a shiny appearance as the rain from the roof intentionally starts to run down over it, while the long walls are made of polycarbonate panels, silk-screened with an *Achillea umbellata* photograph by the German artist-craftsman Karl Bloosfeldt (1865–1932), whose translucency oscillates between bright transparency and dark compactness.

The floorplan of the hall is a double square 60 metres long and 30 metres wide.

The internal layout is all very rational, following, as expected from an industrial building, a regular orthogonal subdivision determined by the structural constraints of the steel framework. Therefore, underlying the architectural planning a modular square grid using a basic unit of 1 metre works as a kind of hidden matrix that regulates the geometrical relationships that arose when the shape began to be organised within the building. As the steel construction used different intervals in the two perpendicular directions overlapped with this original subdivision, the result was a rectangular grid in a major module—3 metres wide and 4 metres long—that governed the spacing of the several structural elements. Therefore, while the main load-bearing structure of columns and beams sits on a rectangular grid—15m x 12m—whose dimensions are fixed as multiples of the major module, the secondary roof beams are placed longitudinally along the grid lines at every 3 metres, and the columns that support the polycarbonate facade follow the metric of 4 metres (***5.10***).

However, even though the building form relies on a system of interrelated linear dimensions and each element refers to a basic unit that repeats, the modular coordination, in this specific case, should not be seen as the particularly notable aspect of the design. The industrial condition of the building leads one to consider it instead as a natural prerequisite of the construction, with an impact on the overall composition. From this perspective, other buildings, like the Sammlung Goetz, Munich (1989–1992), the Elsässertor Office and Cargo Building, Basel (1990), the Eberswalde Technical School Library, Eberswalde (1994–1999), the Institute for Hospital Pharmaceuticals, Basel (1995–1998) and the Dominus Winery, Napa Valley (1995–1998), are revealed to be more emblematic. In their overall configuration, these projects clearly express the suitability of the grid associated with a module-based system to assist the arrangement of regular shapes in both the horizontal and vertical planes, endowing each part of the building with an ordered character and a sense of belonging to a regulated comprehensive whole.

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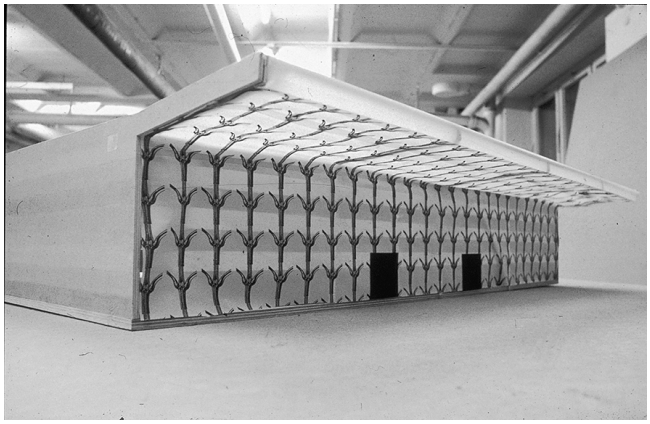
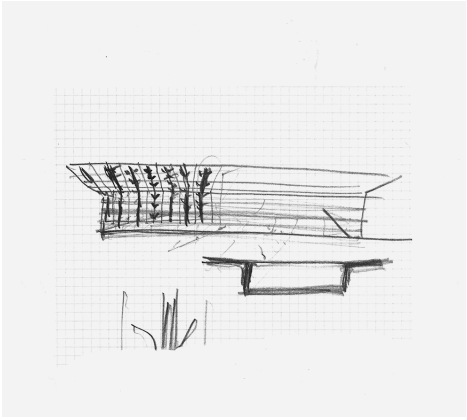
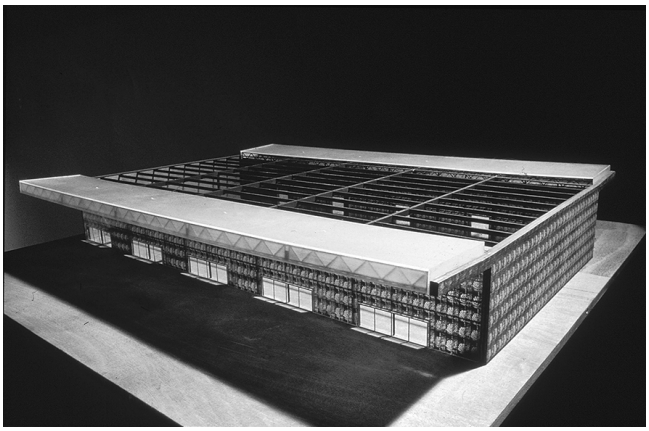
[140] "094. Ricola-Europe SA, Production and Storage Building," Herzog & de Meuron, accessed September 20, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/076-100/094-ricola-europe-production-and-storage-building.html.







5.11
Physical model with early panicle-shaped motif imprinted on the facade.

5.12
Sketch of the Ricola Europe with panicle-shaped motif applied onto the polycarbonate surfaces.

5.13
The chosen *Achillea umbellata* motif by Karl Bloosfeldt.

5.14
Physical model with *Achillea umbellata* motif imprinted on all four facades.

In the Ricola Europe SA, the most peculiar aspect lies in the polycarbonate walls imprinted with a naturalistic motif, not only for the odd character of the option itself but also for how that was addressed from a compositional point of view.

Although the architects argued this was a strategy to relate the building to the surrounding garden or, as Gerhard Mack suggested, "point to the nature that provides the herbs for the bonbons of Ricola AG",[141] to open an industrial building to the outside with translucent walls and adorn it with the image of a leaf is not something expected. In a certain way, this implied looking differently at an industrial building—as HdM had already done in the Storage Building in Laufen—and considering it worthy of architectural treatment.

Composition-wise, this represented a crucial topic in the design process.

The "building was designed in no time", Jacques Herzog has said. "A first sketch defined the profile and the transverse section. [So] most of the design work on the building involved choosing the right image for printing on the glass facade. We tried many different motifs and different scales. [...] If the image is not exactly right, the result is horrible." [142]

When analysing the material that documents the project, available both in publications and the HdM digital archive, this undisclosed process becomes perceptible in the physical models and some sketches. After considering the corporate name "Ricola" as a possible graphic structure for the facade, the architects opted to use one of the Karl Bloosfeldt photographs of greatly enlarged plant details whose degree of abstraction, as Herzog has referred to,[143] they particularly appreciated. The design work focused on choosing the right motif from the inventory of plant forms and deciding, within a repeated structure, how it could be arranged on the facade and what size would be the most appropriate.

Early experiments reveal a proposal in which a panicle-shaped motif, as Gerhard Mack described it,[144] was applied onto the polycarbonate surfaces (***5.11 / 5.12***). However, the strong linearity resulting from the combination of various motifs and the still present figurative component of the image were attributes that the architects probably did not intend to achieve. Indeed, the loss of the representational nature of the original picture and the uniform character of the pattern created on both the longitudinal facades and cantilevered ceilings are distinguishing features of the built solution. For that, the motif itself played a fundamental part (***5.13 / 5.14***). In addition, "the effect of the images in repetition", as Jacques Herzog noted, "was crucial. The [picture] we chose was still recognisable as a plant, but the repetition also turned it into something different, something entirely new."[145]

Repetition as a compositional device, together with the concept of seriality, as it was explored in the field of art and particularly by artists like Gerhard Richter or Andy Warhol, whose influence Jacques Herzog has never denied, were used by HdM as strategies to incorporate iconography in architecture

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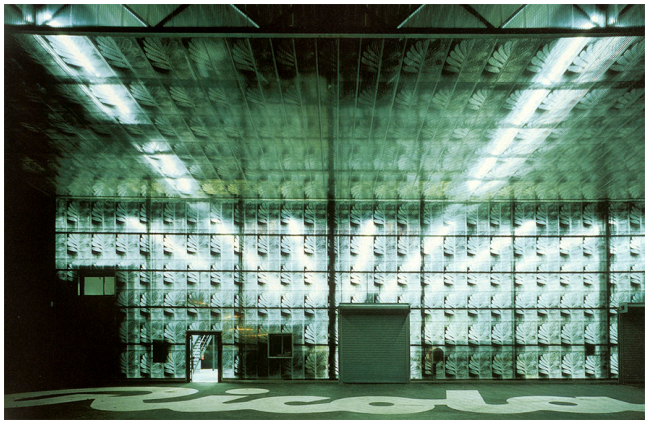
141 Gerhard Mack, "Architecture as Seduction. Reflections on Some Aspects of the Buildings by Herzog & de Meuron," in *Herzog & de Meuron 1992–1996. The Complete Works.* vol. 3, ed. Gerhard Mack (Basel, Boston, Berlin: Birkhäuser, 2000), 29.

142 Herzog, "A Conversation," 30.

143 Ibid., 31.

144 Mack, "Architecture as Seduction," 29.

145 Herzog, "A Conversation," 31.



5.15
The serial application of the *Achillea umbellata* motif following the grid pattern.

again. When elaborating on the idea of "serial imagery" in painting and sculpture, John Coplans affirmed that "with serial imagery, the concept of masterpiece is abandoned." This is directly related, as Coplans mentioned, to the "inherent capacity of serial structures to interact and to reinforce, by juxtaposition, each other's presence and qualities", which means that not only "each work within a series is of equal value", but also that "its qualities are significantly more emphatic when seen in context than when seen in isolation." [146]

In a way, this is what HdM experimented with when they repeated the *Achillea umbellata* motif in a continuum. They were not so interested in the individual image as they were in the global effect produced by the final pictorial arrangement, which they considered to be a texture fully integrated with the wall like a piece of architecture, rather than a decoration or an element introduced to make reference to the media (***5.15***). As Jacques Herzog explained to Theodora Vischer in 1994, for the Swiss architects, "the photographic image acts exactly like a brick or a stone or a concrete wall" and, at the time, these "non-architectural" devices particularly interested them "because they [had] not been exhausted as building materials". In Herzog's opinion, "they have to have a conceptual cogency that makes them seem self-evident; a wall with photographed motifs should seem as natural as a brick wall."[147] Therefore, so that the leaf motif would become part of the architecture, HdM developed intense work on the size of the picture as if this were an ordinary building material. As Herzog described,[148] the dimension of Karl Bloosfeldt's photograph was thoughtfully calibrated to be not too small, like a

[146] John Coplans, "Serial Imagery," *ArtForum*, October, 1968, Vol. 7, Nº2, https://www.artforum.com/print/196808/with-serial-imagery-the-idea-of-the-masterpiece-is-abandoned-36591.

[147] Herzog, "Interview by Theodora Vischer," 31.

[148] Herzog & de Meuron, "Minimalism and Ornament. Herzog & de Meuron in conversation with Nikolaus Kuhnert and Angelika Schnell," by Nikolaus Kuhnert and Angelika Schnell, in *Archplus. Herzog & de Meuron. Minimalism and Ornament*, vol. 129/130, eds. Marc Fester, Sabine Kraft, Nikolaus Kuhnert and Günther Uhlig (Aachen: ARCH+ Verlag GmbH. December,1995).

bathroom tile, nor too big, and to thus establish a one-to-one relationship with the human being. In its condition as a cladding material that imprints the facade with a delicate orthogonal drawing of joints—as happens, for instance, with the matt glass and the birchwood panels of the Sammlung Goetz or the bottle-green glass layer of the Institute for Hospital Pharmaceuticals—the repetition of the *Achillea umbellata* attended to the underlying modular system of the building. The picture's width recovered the primary subdivision of the floorplan, bringing out onto the external skin of the building the traces of the basic 1 metre unit grid that stands at the origin of the whole design.

5.3 _ Architectural Montage

In 1995, in an essay entitled "Between the Face and the Landscape", Alejandro Zaera described the projects of HdM as strongly concerned with the construction of surfaces as preeminent elements of architecture. In the opinion of the Spanish architect, the envelope, "as the face of the building [...] where the public values of the architectural object are registered",[149] had turned into HdM's main research field, beyond the structural and spatial organisation.

While following his reasoning, Zaera argued that this determination to operate from the surface was quite clear from how the Swiss architects addressed the design process. The author noted that their method originated "in the characteristic lead pencil drawings on paper where a two-dimensional organization is asserted as the seed of the project" and underscored "the notable absence of perspectival or three-dimensional representations in the elaboration and presentation of projects"[150] as an evident manifestation of HdM's specific style.

However, from our viewpoint, it is not absolutely valid to suggest that the design method of HdM lacked a representation that pointed to the understanding and communication of the architectural object in its three-dimensional condition. HdM had never dispensed with images that complemented what they considered to be the limitations of the traditional graphic means of representation, such as orthogonal projections, in developing design ideas and translating the conceptual dimension of the projects. Indeed, as we saw in the previous sections,[151] HdM had even worked out their own method to visually capture the projects' spatiality. So, even though one might argue that, in the beginning, the video recording of models used to produce pictures of the conceived spaces was not explored consistently in every project and was, above all, concerned with expressing the ambience of architecture, from the early 1990s geometrically constructed perspectives came into play in their working methodology as a tool for envisioning designs.

Around 1990, the technique that HdM used to create visual representations of the imaged architectural objects changed, and with that, also, the communicating purpose of the pictures was somehow redirected. The cinematic stills that the architects produced during the 1980s were taken over

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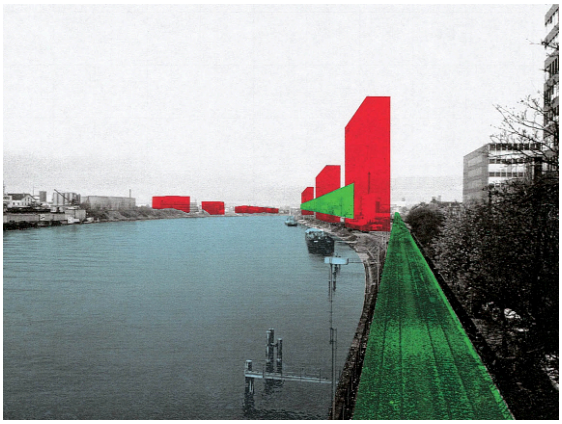
149 Alejandro Zaera, "Between the Face and the Landscape," by Nikolaus Kuhnert and Angelika Schnell, in *Archplus. Herzog & de Meuron. Minimalism and Ornament*, vol. 129/130, eds. Marc Fester, Sabine Kraft, Nikolaus Kuhnert and Günther Uhlig (Aachen: ARCH+ Verlag GmbH. December,1995), 118.

150 Ibid.

151 See section "*4.3 _ 'The Reality of Images'.*"



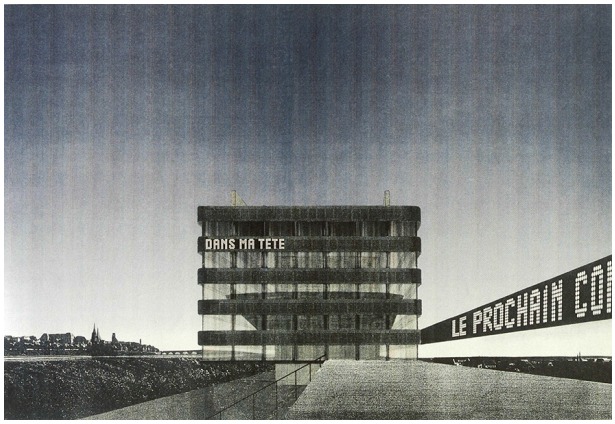
5.16
Contribution to the exhibition Berlin Morgen, Deutsches Architekturmuseum, Frankfurt a. M. (1990).

5.17
"Eine Stadt im Werden?" Urban Study, Basel (1991–1992).

by perspective drawings, often combined with the appealing graphic qualities of the collage, a medium that was common at the time in the architectural context but that HdM began to make use of only from this time onward.

According to the HdM monographs and the material published on the architects' website, the two urban proposals developed in collaboration with Rémy Zaugg for the exhibition "Berlin Morgen", Frankfurt (1991), and the study "Eine Stadt im Werden?", Basel (1991–1992), are among the projects in which collages constructed from photographs were first employed (***5.16 / 5.17***). In both cases, pictures of the city were used to show the cubic mass of the design through the assemblage of volumetric representations of the proposed buildings in the urban context. Within their schematic appearance, these possible future images of the city had a strong conceptual character, maintaining the aura of something envisioned and that pointed, to a certain extent, especially in the case of the four towers for Tiergarten, to a visionary idea of the town.

In these years, architectural competitions multiplied in the list of works by HdM and, particularly associated with these, more elaborate work was developed to present the designs. In addition to the graphic refinement of the elevations through the insertion of vertical projections in a photograph of the context and the detailing of texture, colour, transparency and the shadows of the buildings' surfaces (***5.01***), by exploring the cut-and-paste modernist technique, perspective drawings of the project assembled in a picture of the surrounding landscape became more and more recurrent in their working methodology. The competition entry for the Arts Centre in Blois (1991) clearly expresses this graphic approach. The one-point perspectives of the longitudinal elevations and the entrances to both the music hall and the theatre show the building on the site—along the riverbank and with the historical city in the background—and depicted the outer configuration of the proposed volume (***5.18***). The photomontages of the building by night illustrated the moment in which the arts centre, with a performance happening



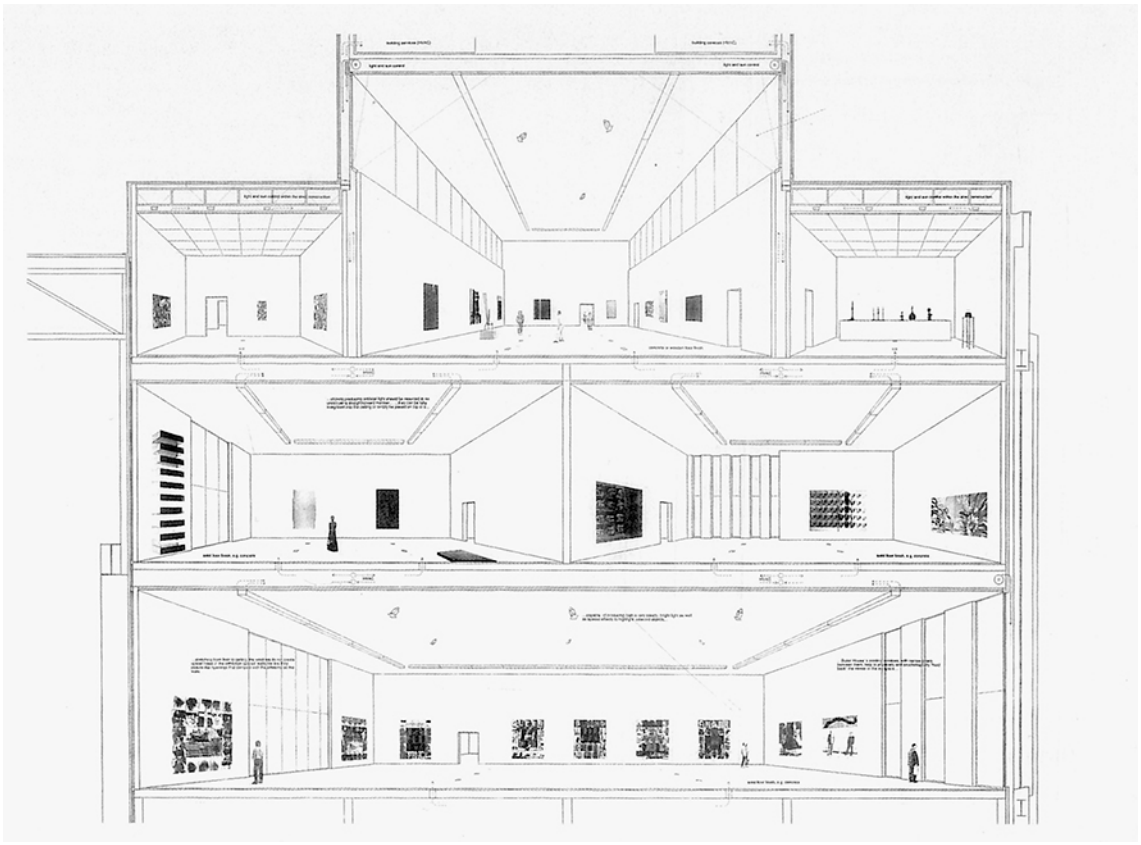
5.18
Arts Centre, Blois (1991).

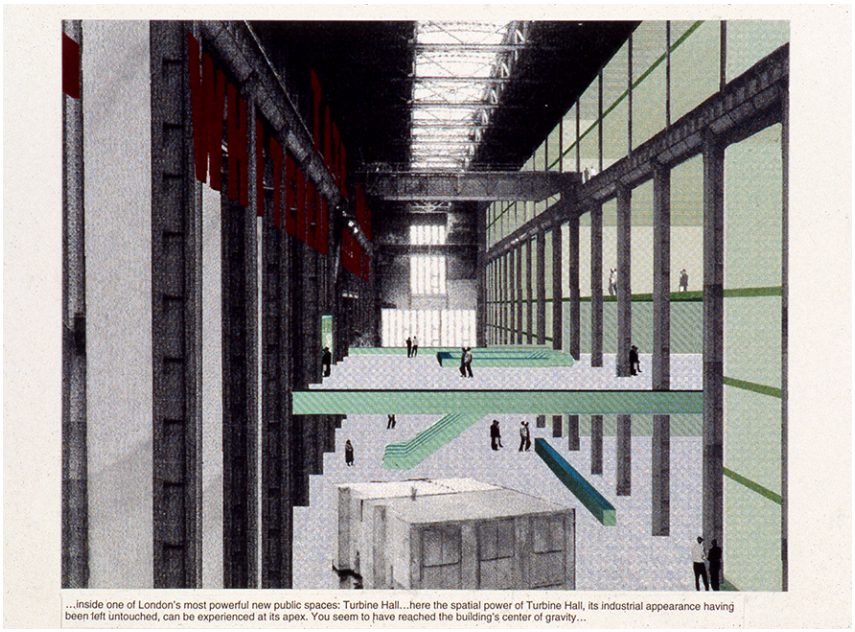
inside, would have its facades enlivened by the colourful interior lights and the fragments of texts shown on the electronic scrolling displays that wrapped around the building. While expressing the ever-changing character of the building's external skin, the pictures emphasised the airy and almost immaterial nature of the arts centre, allowing the viewer to capture one of the major design concepts of the proposal.

However, in what concerns the employment of perspective as a means to understand the architectural work in three dimensions and enrich the insight provided by technical drawings, the project to convert the Bankside power station into the new Tate Modern art gallery, London (1995–2001), is revealed to be a particularly relevant example. The many drawings for the competition entry, published in the Tate Modern monograph,[152] show a varied and widespread use of perspective that proves the ability of this means of representation not just to describe as faithfully as possible an architectural space on the basis of controllable measures, but also to persuade, to appeal to the human imagination and underscore a particular goal of the design.

Essential perspectives, similar from a graphic point of view to contour drawings, complemented the art gallery floorplans, pointing to the spatial configuration and providing a rigorous three-dimensional outline of the architectural volumes. In the same way, perspectives were also combined with cross-sections, counterbalancing the common flat character of these cuts through the walls. Compared to conventional projections, perspective sections work as if a window towards the space has been opened up, and a readable impression of the building's interior is suddenly given. Among the several sections in which perspective endowed some of the drawn spaces with three-dimensionality, one in particular stands out for the intriguing character of the representation itself. It is a transverse section of the Boiler

[152] See Rowan Moore and Raymund Ryan, eds., *Building Tate Modern. Herzog & de Meuron transforming Giles Gilbert Scott* (London, Tate Gallery Publishing, 2000).





5.19
Perspective cross-section from the competition entry showing different gallery types.

5.20
Photomontage of the Turbine Hall with Rachel Whiteread's "House" (1993) installed.

House showing the different gallery types (***5.19***). Each of the six illustrated rooms is represented according to a one-point perspective whose vanishing point is located on the central axis of the space. While observing it, the first impression is disturbing as the viewer's look is directed simultaneously towards the many centres at which the receding parallel lines meet. Therefore, rather than using a single vanishing point, which might have given coherence and credibility to the whole, HdM decided to play with the ambiguities of representation. They went beyond the conventions of drawing to explore an interpretation that fulfilled their communicating purpose, having opted to concentrate on the single rooms and give the right impression of their height, width and depth as well as of their architectural configuration and display conditions.

When HdM submitted their competition proposal for the Tate Modern project, they worked, as Jacques Herzog described, "with collages and other manual techniques to express [their] vision and ideas for refurbishing the colossal industrial building."[153] Indeed, in addition to the above-mentioned more accurate description of the design, HdM also made perspectives in which they explored the rhetoric of drawing. Using the techniques of photomontage and collage, HdM created perspectives of a strong speculative nature that, besides serving the visualisation of a concept, sought to convey an impression of the potential atmosphere of space.

The competition entry photomontage for the Turbine Hall is a clear example of this (***5.20***). This is the key image in which the architects depicted the strategic move in their design proposal. It illustrates the architects' intention to remove the flooring of this great hall and create an even more monumental space crossed by a platform connecting north and south entrances. The conceptualisation of this covered plaza as a new type of exhibition space that would be able to host innovative large-scale installations is signalled by the controversial sculpture "House" by Rachel Whiteread (1993) that HdM included in the image as an artistic object on display. Far from being photorealistic, this image has a strong abstract character that, despite focusing on specific design principles and conveying a particular perception by the architects, keeps the viewer's idea of the architectural object open.

In the HdM digital archive, we had the opportunity to see three more perspective drawings of the exhibition rooms, not yet published, that graphically resembled the inspiring later collages by Mies van der Rohe. As a mixture of drawing and collage, these artistic perspectives, like those of the German modernist architect, were not about showing architecture from a neutral and descriptive standpoint, but they were rather persuasive, visually manipulating the object to create a specific impression of it.

When thinking about some of HdM's architectural interests in these years, it is curious to notice how all of this comes together somehow. In their architectural practice, the Swiss architects were also experimenting with collage. They were applying images to buildings' external skins as a strategy that impacted how one sensed the surfaces and volumes, allowing them, as Catherine Hürzeler mentioned,

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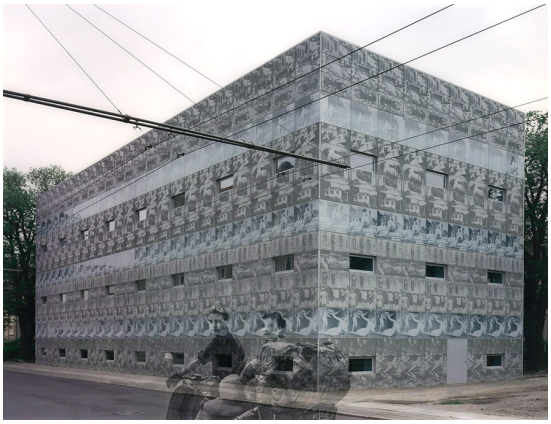
153 Herzog & de Meuron, "No.263 The Tate Modern Project," in *Herzog & de Meuron 2002–2004. The Complete Works*. vol. 5, ed. Gerhard Mack (Basel: Birkhäuser, 2020), 117.



5.21
"Bibliothek Eberswalde", Thomas Ruff (1999). Picture of the Eberswalde library.

to "demonstrate that even architecture, which is meant to last forever, is constantly changing according to the chosen angle of perception."[154]

The collaboration with Thomas Ruff, particularly intense during the 1990s, is also a reflection of HdM's interest in the "subversive capacity [of pictures] to undermine our faith in so-called reality",[155] as Jacques Herzog said when describing Ruff's photographic work. This is evident in their collaboration on the Eberswalde Technical School Library. For this project, the artist chose from his series "Zeitungsbilder" (Newspaper Photographs) the motifs that, in a process similar to that of tattooing, were printed onto the outer skin of the building, turning the library itself into what Ruff, according to Philip Ursprung,[156] considered to be basically a photomontage. Furthermore, when HdM asked Thomas Ruff to photograph some of their buildings—which happened on specific occasions between 1991 and 1999—they wanted to see how the German photographer, whose aim "is not to capture images selected from the fullness of reality but rather to construct them",[157] would apprehend and depict a world so familiar and seemingly self-evident to them (***5.21***). The pictures, all resulting from electronic processing, are manipulations of reality. These are like "genetic operations", Jacques Herzog said, in which one realises "that everything that appears fine is [indeed] all wrong."[158]

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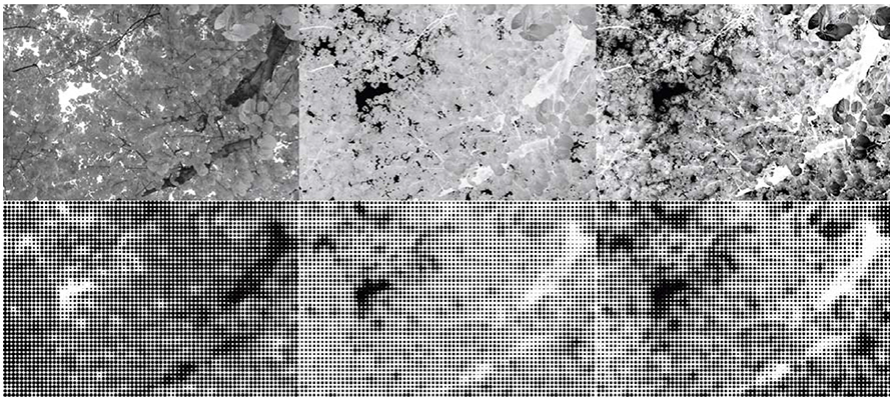
154 Catherine Hürzeler, "Herzog & de Meuron and Gerhard Richter's *Atlas*," in *Herzog & de Meuron: Natural History*, ed. Philip Ursprung, (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002), 207.

155 Herzog & de Meuron and Philipp Ursprung, "Portfolio," in *Herzog & de Meuron: Natural History*, ed. Philip Ursprung, (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002), 244.

156 "The Library, begun in 1994, is closely related to the photomontages he has been making himself since 1996. For Ruff, Eberswalde is itself basically a photomontage," said Philipp Ursprung. Philip Ursprung, "I Make My Picture on the Surface: Visiting Thomas Ruff," in *Herzog & de Meuron: Natural History*, ed. Philip Ursprung, (Montréal, Baden: Canadian Centre for Architecture and Lars Muller Publisher, 2002), 163.

157 Ursprung, "Picture on the Surface," 159.

158 Herzog & de Meuron, "Minimalism and Ornament," 117.



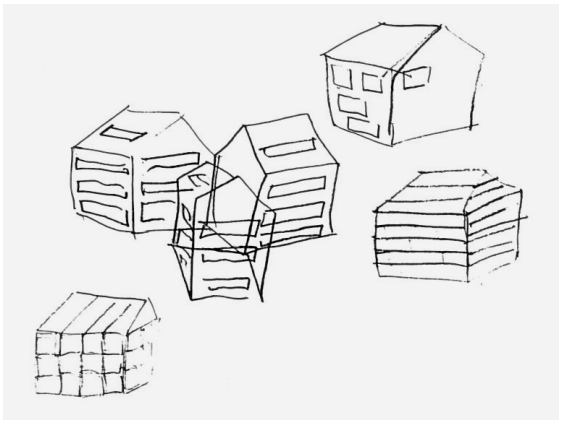
6.01
De Young Museum, San Francisco (2002–2005). Pixellation of photographs of backlit tree crowns.

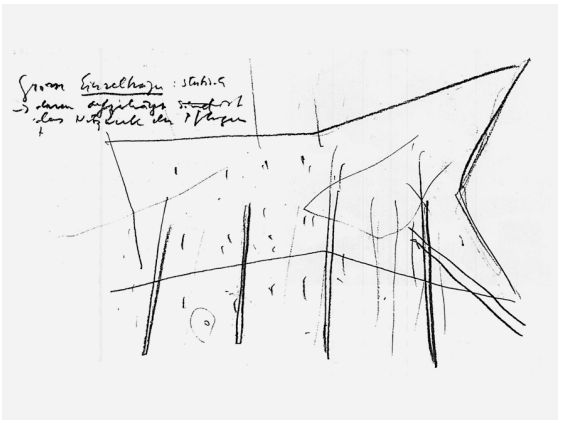
6.
Pixellation and Digital Modelling

6.1 _ Geometric Freedom

6.2 _ Topographical Landscapes

6.3 _ Capturing Three-dimensionality





6.02
Ricola Marketing Building, Laufen (1997–1999). Early sketches of a compact volume with gabled roof.

6.03
Sketch of the star-shaped plan for the Ricola pavilion.

6.1 _ Geometric Freedom

In May 2001, in Monticello (Virginia, USA), in the acceptance speech for the Pritzker Prize, the two founding partners disclosed that the architectural practice of HdM was experiencing a turning point. After having explored formal simplicity as a compositional strategy for some years, which in a way offered them a sense of direction, Jacques Herzog and Pierre de Meuron explained that they "began to have more and more doubts about the dominance of the rectangle in [their] designs". As they described, "it had become too confining. Paradoxically, the box, conceivably the simplest and the most basic architectural shape had acquired the value of its own like a stylistic device",[159] something that HdM always tried to avoid. Therefore, by the end of the 1990s, while their co-authorship opened to other partners, they realised that "individually distinctive gesturally expressive forms and images for [their] projects were feasible", and so "sculptural and even seemingly accidental elements [as well as] the figurative and the chaotic" [160] began to appear in their work.

Luis Fernández-Galiano, who follows the work of HdM closely, considers that it was around 1997 that their projects acquired a new geometric freedom, opening the panorama of the forthcoming century. The Spanish critic places this moment of inflexion at such a precise date chronologically because he believes that it was triggered within the development of the project for the Ricola Marketing Building, Laufen (1997–1999).

Galiano argues[161] that the sudden formal mutation that occurred during the design process for this building brought on a stylistic change in the oeuvre of HdM.

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159 Herzog and de Meuron, "[acceptance speech]," 10–11.

160 Ibid.

161 Luis Fernández-Galiano expressed this idea in some of the essays he has published since the mid-1990s in the newspaper "El País" and the architectural review "Arquitectura Viva". Among the many texts, we should highlight "La belleza súbita. Sudden

Early sketches for this office building show the idea of a compact volume with a pitched roof (***6.02***), very similar to the prototypical house shape that HdM had just used in the unbuilt project for the Wood House, Stuttgart (1995), and the concrete volume raised off the ground for the Leymen House, Leymen (1996–1997). However, in the course of the design maturation, the initial drawings yielded an irregular polygonal ground plan with a glazed envelope (***6.03***). The compactness and the monolithic character of the first attempts generated a less massive shape that, in a sort of reinterpretation of the modernist notion of the pavilion, was bent, dissolving in multiple transparencies and reflections. In a way, the same gesture that HdM had tried some years before in the Plywood House, Bottmingen (1984–1985), of folding the volume inwards to integrate a mature Paulownia tree in the design of the house was applied on three sides of the glazed pavilion, softening the overall shape of the building and promoting its fusion with the surrounding vegetation.

From the same period, the project for the Cottbus University Library, which was developed in two distinct moments, listed by the office with different numbers,[162] is another example that makes clear how the compositional strategies adopted by HdM changed from the perfect prism to more elaborate and diversified volumes (***6.04***).

In the competition phase for the Library and Master Plan of the BTU, Cottbus (1993), the proposed architecture, as HdM described, "was radically simple in organization and construction".[163] The cubic volume of the library with three singular constructions on the top—all clad with a silk-screened translucent envelope—resembled the early projects from the 1990s, in which the Swiss architects, while reducing shapes to elementary figures, gave particular emphasis to the tactile character of the external skin. However, when the project was taken up again five years later in 1998 due to programmatic alterations, together with the architects' intent to affirm the landmark quality of the library in the surrounding context, or simply, as Rafael Moneo suggested,[164] because HdM probably considered that it was the occasion to experiment with new languages, the rectangular volumes gave way to a continuous sweeping shape (***6.05***). Seemingly reminiscent of the conceptual wavy crystalline skyscrapers by Mies van der Rohe in Berlin (1922), this organic form, based on four circles, presented itself differently from every angle of approach, suggesting a strong idea of movement.

As signs of expanding HdM's approach to the shape in the search for a novel complexity, the star-shaped pavilion for Ricola and the amoeba-like tower for Cottbus anticipated the realisation of a series

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Beauty" (El País, 23 September 2000) and "Construir del natural. Building from Nature" (in El País, 26 October 2002). These essays were recently collected in the book: Luis Fernández-Galiano, *Herzog & de Meuron* (Madrid: Arquitectura Viva, 2021).

[162] The project for the Cottbus library is listed as "098. Library and Master Plan of the Brandenburg University of Technology, Cottbus, Germany. (Competition 1993)", and "166- IKMZ BTU Cottbus, Information, Communications and Media Centre, Brandenburg University of Technology, Cottbus, Germany. (Competition 1993, project 1998–1999, 2001, realization 2001–2004)." See "098. Library and Master Plan of the BTU Cottbus," Herzog & de Meuron, accessed November 12, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/076-100/098-library-and-master-plan-of-the-btu-cottbus.html. and "166. Cottbus Library," Herzog & de Meuron, accessed November 12, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/151-175/166-cottbus-library.html.

[163] "098. Library and Master Plan."

[164] "El cambio, por tanto, no solo se débia a razones funcionales. Probablemente los arquitectos consideraron que era la ocasión para experimentar nuevos lenguages." Moneo, *Inquietud Teórica*, 403.

6.04
Design evolution of the Cottbus University Library, Cottbus (1993, 1998–2004). From a cubic volume to an amoeba-like shape.

6.05
The library's continuous, sweeping, crystalline shape.

of singular architectural objects that enriched the language of the Swiss office and opened a phase in which their work, as Galiano noted, "has gone from minimum to maximum."[165]

Indeed, when looking at the projects by HdM from the transition period for the new millennium, they "had become more exciting in formal and plastic terms", [166] as noted by HdM, and reveal an impressive diversity that underscores the specificity of the responses to particular situations. Projects clearly differ from one another, and the compositional strategies also broadened, almost as a reflection of an artistic path reaching full maturity. The geometric simplicity that characterised the previous projects was practically abandoned, and formal approaches such as bending, waving, chiselling, twisting, extrusion and intersection were introduced, supporting the conception of more sculptural shapes. Marked by such an explosion of processes for creating form and modelling the architectural object, this period thus takes us back to the architects' original engagement with a hidden geometry of nature.

While referring to this specific moment in the career of HdM, Rafael Moneo mentioned that "this abandonment of prisms […] seems to lead, as a necessary counterpart, to a formal world in which it is necessary to speak of biology."[167] In fact, their projects show that nature, a particularly intriguing world for Jacques Herzog, became, in this period, a primary inspirational reference for their architecture. Beyond some more overt analogies, which make one speak of the ground plan for Cottbus as an amoeba-like shape, the windows of the Schaulager as geological fissures, the building for Prada Aoyama as a piece of crystal (***6.06 / 6.07 / 6.08***) or the volume for the Astor Place as a compact mass of

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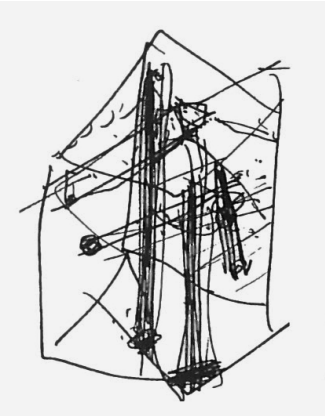
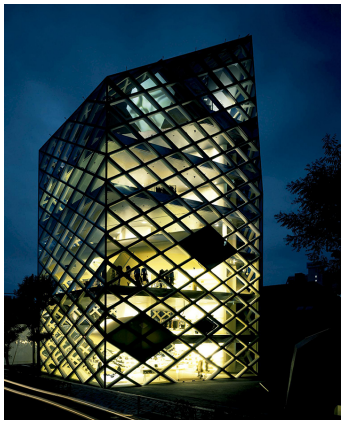
165 Luis Fernández-Galiano, "Construir del natural. Building from Nature," in *AV Monografías 191–192. Herzog & de Meuron 2013–2017*, ed. Luis Fernández-Galiano (Madrid: Aquitectura Viva SL, 2017), 292.

166 Herzog & de Meuron and Ursprung, "Portfolio," 82.

167 "Este abandono de los prismas que parece llevar, como obligada contrapartida, a un mundo formal en el que resulta forzoso hablar de biologia, se pone una vez más de manifiesto en un proyecto como el de la *Biblioteca universitaria de Cottbus*, de 1993." Moneo, *Inquietud Teórica*, 403.





6.06
Prada Aoyama, Tokyo (2000–2003). Sketch of the vertical access cores and horizontal pipes.

6.07
The sculptural glass shell of Prada Aoyama.

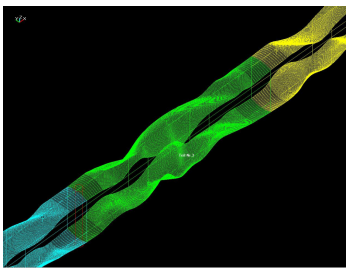
6.08
The Crystal Ring by HdM (1997).

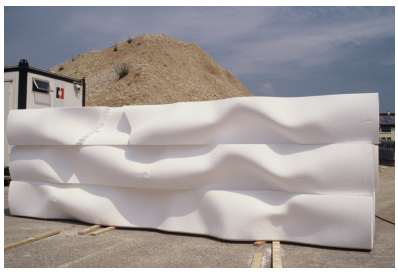
stone, nature was above all taken by HdM as a conceptual model for the creative process. HdM particularly appreciate the great sensuality that natural configurations often radiate. Therefore, with the aim of capturing their organic development and bringing it into architecture, HdM took those as references and searched for compositional strategies that, working as intrinsic geometric structures, guided the creation of form.

The catalogue of their major exhibition, "Herzog & de Meuron: Archaeology of the Mind" at the Canadian Centre for Architecture, Montreal (2002–2003), curated by Philip Ursprung, is an explicit confirmation of this. In its title, "Herzog & de Meuron: Natural History", the book refers to the concept of the exhibition itself, which was modelled on the natural history exhibits, and to the character of the materials on display, directly dug up from the architects' archive and that, in their condition as “waste products”, as the architects said,[168] have something in common with the natural history objects of study. Nevertheless, this catalogue, conceived as an atlas in which the authors sought to collect the many triggers and allusions of HdM's acts of making, also discloses that nature has ever been a central inquiring subject in their practice. Therefore, besides having been taken by the curators as an analogy to present "the natural development of [the work of HdM] over a period of time", natural history, in the sense of the "study of natural objects",[169] also emerges as a relevant source of investigation within their creative process. The many examples assembled in the book prove that nature has always been a

[168] “These archived objects are therefore nothing but waste products. Since the immaterial, mental processes of understanding, learning, and developing always have priority. We have never been interested in producing objects invested with an aura in the nature of an artwork. These objects are not works of art; they are an accumulation of waste.” “183. Archéologie de l’Imaginaire,” Herzog & de Meuron, accessed November 23, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/176-200/183-archeologie-de-l-imaginaire.html.

[169] “Definition of *natural history*: […] 2: the natural development of something (such as an organism or disease) over a period of time; 3: the study of natural objects especially in the field from an amateur or popular point of view”. “Natural history,” Merriam-Webster.com Dictionary, accessed September 23, 2021, https://www.merriam-webster.com/dictionary/natural%20history.





6.09
Schaulager, Laurenz Foundation, Basel (1998–2003). Physical models for the cracked earth shape of the windows apertures.

6.10
The process for achieving the organic shape: from the photogrammetric scanning of the hammered cylinder to the digitally milled polystyrene moulds.

6.11
Detail of the Schaulager facade and window.

common denominator for most projects. However, they also confirm that, as HdM's interest in new shapes grew, their romantic empathy with nature had turned into a more speculative and structural approach that multiplied in an outbreak of geological and biological references for the form-making processes of architecture.

In his introductory essay[170] to volume 4 of the HdM monographs, which addresses the period between 1997 and 2001, Gerhard Mack also reinforced this same idea. In the text where the author gathered the traits of what he defined as topographical architecture, Mack noted that the impact and full scope of the main conceptual principles of HdM's architecture, developed in the early years and of which their affinity with nature is part, began to emerge only in their recent designs. A shift that occurred as their projects became less abstract, looking, as Jacques Herzog said in an interview, "more 'like' things—more like a rock, more like an animal, or more like something organic, which means that the analogical side has been reinforced".[171]

In the same monograph, a few pages ahead, in the "Work Chronology" section, Gerhard Mack observed about the exhibition at the CCA an aspect related to HdM's working methodology that accentuates another dimension of the turning point their practice was experiencing. While commenting on the fact that the exhibition in Canada was focused on the HdM design process—showcasing materials that revealed the intricate design world of accepted and rejected ideas—the German critic mentioned that "the two-dimensional sketches, plans and photographs presented at the Pompidou Centre [in the exhibition "Herzog & de Meuron" conceived by Rémy Zaugg (1995)] gave way, in this exhibition, to all the tactile physicality of the three-dimensional, further emphasized by swinging plexiglass covers."[172]

The contrast perceived in the two displays, between a presentation primarily based on the two-dimensional description of the architectural objects and another strongly assisted by the construction of artefacts that translated the imagined forms three-dimensionally, is itself a reflection of the shift that their own design process was undergoing. By the end of the 1990s, model-making and the production of other physical matter gained particular prominence in HdM's method as the privileged approach for grasping the design idea and developing it through the elaborate back-and-forth design process. It is almost as if the fertility of their formal imagination in this period, expressed in a multitude of researched shapes, demanded a method supported by means that would allow the architects to better control, visually and physically, the inherent complexity of the conceived forms. And even though, in these years, CAD systems—with their increasing ability to support the three-dimensional representation of complex shapes—have been progressively introduced in HdM's working methodology, the process for capturing and developing the design ideas was still very much manually based, with the physical models playing a crucial role in the decision-making process. In this regard, the method undertaken by the architects to decide on the window configuration for the offices and workplaces at the Schaulager Laurenz Foundation, Basel (1998–2003), is an emblematic example (***6.09***).

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170 Mack, "Traits of a Topographical Architecture," 9–21.

171 Herzog, "The Nature of Artifice," 18.

172 Gerhard Mack, ed., *Herzog & de Meuron 1997–2001. The Complete Works,* vol.4, (Basel: Birkhäuser, 2008), 266.

When confronted with the issue of how to make the openings in such a specific wall, the architects, after having tried with standard sections, realised that the conventional right-angled solution would not be suitable for the heavy, earthy look of the facade. So, after some experiments, as Harry Gugger, the partner in charge of the project, revealed, HdM agreed "that the windows should be a homologue of the wall surface",[173] looking as if they were cracks in the earth. Therefore, to achieve this biomorphic effect, the architects worked in a very craft-based way, crushing sheet-metal cylinders and making plaster moulds out of them until they got to the desired undulating form. "I asked a trainee to take a tube, to hammer it and then to roll it out, and that's how the inner surface from the cafeteria appeared. If you now put the deformed tube in a wall, you get to this special form".[174]

Only later, when the architects already knew what they wanted to achieve and had made the physical models that enabled them to capture their design intent, did they do the photogrammetric scanning of the hammered cylinder so that the complex three-dimensional shape could be optimised from a construction and production point of view. The processing of the free-form shape on the computer allowed the architects to solve some of the technical issues raised, such as those related to the water collecting system; it was also crucial to transpose it using digitally controlled tools into negative polystyrene moulds, facilitating the construction process (***6.10 / 6.11***). Once digitally modelled, the data for the windows were also used to generate, by repetition, the undulating surfaces of some interior spaces. "For the first time", HdM said, "we had no qualms about jettisoning the archaic idea—so ingrained in the minds of the architects since the pouring of concrete burst in on modernism—of working with repetitive and reusable formal elements."[175]

6.2 _ Topographical Landscapes

In the essay "Exposures: Herzog & de Meuron and photography" (2016), Philip Ursprung elaborates on the relationship between the work of the Basel-based office and photography, focusing on the encounter between the Swiss architects and the German artist Thomas Ruff, which the author considers to have influenced the conventions of architectural photography. When referring specifically to "image as material", Ursprung highlights the Eberswalde Library as the project that marks the culmination point of HdM's engagement with photography and remarks that the interest of the Swiss architects in images is, however, something that goes back to the early years of their career. The author gives some examples where the projects by HdM can be interpreted as variants on the theme of the camera and photograph, and adds that "one could pursue this line of enquiry even further by identifying a parallel between the buildings of Herzog & de Meuron and the transition from analogue to digital photography".[176] According to Ursprung, this shift is evident at the moment the architects explored the

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173 Gugger, "This is too generic."

174 Ibid.

175 Herzog & de Meuron, "No.169 Schaulager", in *Herzog & de Meuron 1997–2001. The Complete Works,* vol. 4, ed. Gerhard Mack, (Basel: Birkhäuser, 2008), 62.

176 Ursprung, "Exposures", 23.

motif of the pixel in projects such as the Tenerife Espacio de las Artes, Santa Cruz de Tenerife (1999–2008), and CaixaForum Madrid, Madrid (2001–2008), which happened in the early 2000s.

This observation, which occurs very discreetly in the essay's context, is, in fact, an acute detail that points to a particularly relevant topic for HdM's design practice in these years. However, from our viewpoint, the issue is not so much in the pixel itself, but in the way "these discrete elements that together constitute an image"[177] were explored by the architects in their projects.

HdM had always worked with pixellated images. Actually, these were used in the first situation in which the architects proposed to cover the entire surface of a building with pictures. In the Greek Orthodox Church, Zurich (1989), the architects reduced photographic representations of old icons to grainy images that were supposed to be etched by a special process into the translucent marble that clad the whole interior of the church. A similar idea was applied some years later to the external skin of the Eberswalde Library, Eberswalde (1994–1999), with the motifs chosen by Thomas Ruff also transformed into pixellated pictures that were then transferred by a specialised silk-screen technique to both the concrete and glass panels.

So, in early 2000, when the architects explored the composition of the facades and the tactile character of the surfaces by working on images in the projects mentioned by Ursprung for Tenerife and Madrid and others such as the De Young Museum, San Francisco (1999–2005), a fairly fundamental aspect had changed. HdM were no longer interested in constructing a building out of images and taking advantage of their visual and iconographic qualities as they had done before. In these projects, the architects went beyond the figurative nature of the pictures used, extracting out of them a graphic structure from which to expand the compositional approaches, reinvent materials and make the surfaces denser. This, of course, is related, in the first instance, to the change in the architects' own research interests and their will to move in novel directions. Nevertheless, this also finds motivation, or at least it was supported, by the tools themselves, which opened up new ways of working and offered possibilities for looking differently at the world.

This is where the transition from analogue to digital photography that Ursprung spoke about, complemented by the increasing expansion of the raster graphics editors, played an important part. In a way, the computer allowed the architects to make this step forward and explore the abstract side of the images, focusing on their digital condition as a rectangular matrix of square pixels and manipulating their structure in search of a geometry with which to recreate the acts of making.

The work developed by HdM for the copper cladding of the De Young Museum is an example that clearly shows how the architects moved from a direct approach to images, associated with imprinting techniques, to a more researched one in which they sought for inner patterns that were interpreted three-dimensionally. To establish a dialogue with the dense greenery that surrounds the Californian museum, or simply to create something which reflected the natural environment, the architects took photographs of backlit tree crowns and used them as a graphic basis to explore the materiality of the cladding (***6.01***). By enlarging and pixellating the foliage pictures, the architects arrived at a pattern of different sized dots, which they translated into a grid of overlapping holes and embossing that was

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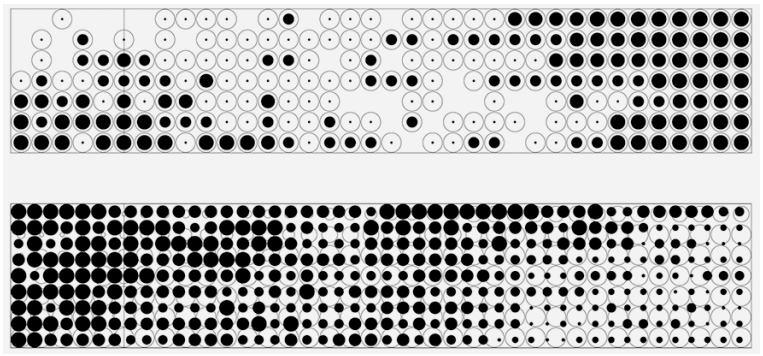
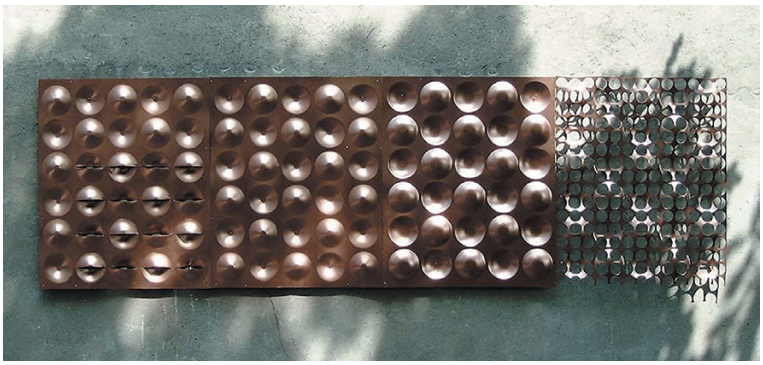
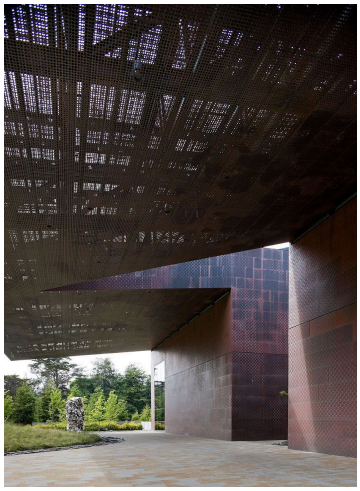
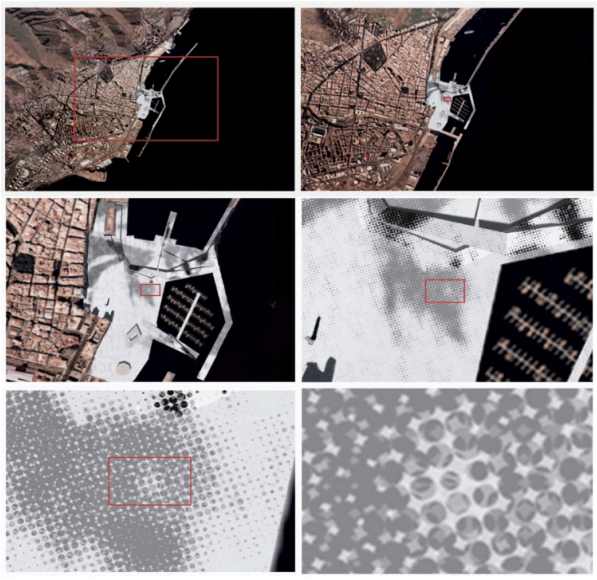
[177] "Pixel," Merriam-Webster.com Dictionary, accessed December 17, 2021, https://www.merriam-webster.com/dictionary/pixel.









6.12
De Young Museum, San Francisco (2002–2005). Experiments for the holes and embossing of the cladding.

6.13
Sample of the copper sheet.

6.14
The Museum with the copper cladding.

6.15
Puerto de Santa Cruz, Santa Cruz de Tenerife (1998–2004). The whole site as if it were a large pixellated image.

6.16
Physical model with the perforations expanded vertically upwards in three dimensions.

applied onto the copper (***6.12 / 6.13***). While transposing this key element of the site into the building, HdM converted the conventional, homogeneous and plain character of the metal sheets into a vibrant, textured surface made of circular hollows and perforations and enriched by the effect of light breaking through (***6.14***).

A similar operation was pursued by HdM in the Tenerife Espacio de las Artes, confirming that the strategy to abstract a geometrical system from pictures had provided the architects with a kind of architectural grammar that they experimented with at several scales in different situations. For the design of the openings in the concrete wall facing the riverbed of the Spanish cultural building, HdM worked with a photograph of the sea that has been digitally enlarged until it became a complex pattern of rectangular pixels (***3.05 / 3.06***). This abstract matrix guided the whole process for the configuration of the apertures and was used to produce the negative forms for the concrete pouring of this screen-like wall, which recalls, when light glows through the perforations, a reflecting undulating water surface.

In the unbuilt project for the Puerto de Santa Cruz, Santa Cruz de Tenerife (1998–2004)—where everything started—HdM had taken this research further. The use of pictures as supporting material for the architectural composition was not limited in this instance to the definition of some details of the building's surface but was rather extended to the structure itself. HdM based the form-making process of this whole new urban landscape on the scaling-up of a picture until this turned into an unrecognisable raster of circular pixels (***6.15***).

The impressive geology and topography of the volcanic island were seen by the architects as a possible inspiration and a model for the construction of the artificial reality from the beginning. HdM had the ambition to recreate in the project for the harbour and jetty the same complex inner structure they found in the volcanic pebbles pocked with small holes, which led them to deal, as Jacques Herzog said, with the "desperate struggle to create something which reflects the natural object yet remains autonomous."[178] Therefore, in this complex process for finding the right degree in which to take nature as a reference, the idea of the pixels came up as an alternative strategy to the mimetic stand that the architects adopted while developing, for the early proposals, a design that literally suggested a flow of lava.

As Gerhard Mack described, HdM "planned to underscore the reference to figuration by basing their design on a photograph of a woman's face that had been transposed into a grainy pixellated structure."[179] However, when the architects focused on the topographical condition, they released themselves from the motif's figurative aspect and adopted only the photograph's harsh black and white contrasts. This provided them with an underlying abstract geometrical system that, beyond regulating and ensuring the coherence of the whole design, resulted, when manipulated through extrusion, in volumes of the spatial richness HdM were searching for.

"That is when the idea came up to underlay a raster of pixels as if the whole site were a large photo", Jacques Herzog mentioned in the conversation we had. "That photo could have been a picture of anything—we were not interested in the subject that was represented but just in the fact that it was

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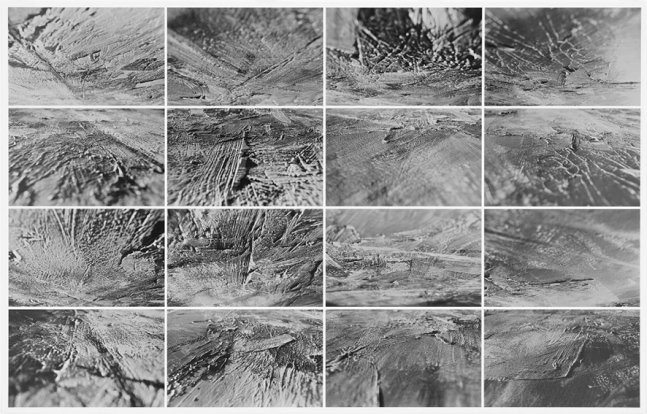
178 Herzog, "The Nature of Artifice," 16.

179 Mack, *Herzog & de Meuron 1997–2001,* 53.



6.17
'Untitled' from 128 Details from a Picture (Halifax 1978) II, Gerhard Richter (1998).

creating a raster image that we could extrude vertically in order to create a three-dimensional landscape (***6.16***). This fictional landscape then could be manipulated, carved out, cut, sliced, etc., according to the programmatic and functional needs for the building it should become. Each building was different—cruise terminal, shopping mall, cinema, hotel, marina club—but all of them related through their underlying pixel raster."[180]

This peculiar way of addressing the form-making process, based on the enlargement of an image that, all of a sudden, provides a starting point for the design process, is something that finds affinities, as Jacques Herzog noted, with the practice of artists, themselves constantly dealing with the issue of having to invent a subject. The fascination Jacques Herzog always had for the work of Gerhard Richter is well known and has been inclusively addressed by Catherine Hürzeler in an essay on the interaction between both practices. In this particular case, this association is of special significance not only for the methodology HdM applied in the design process but also for how they looked into images in search of unusual perspectives.

More than once, Jacques Herzog has expressed his strong interest in the work "128 Details of a Picture" (128 Fotos von einem Bild) by Gerhard Richter, constituted by several detailed photographs of an oil painting, each from a slightly different angle (***6.17***). For Jacques Herzog, it is particularly intriguing how the partial views on the abstract painting in this work have converted it into a series of unexpected topographical landscapes. The Swiss architect described this as the "business of taking a real, existing thing apart and reassembling it to come up with something else",[181] a process that is in fact quite close to what HdM did when they took images and looked at their inner structures with the aim of reinventing their meaning and perception.

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[180] Herzog, "We are surrounded."

[181] Hürzeler, "Herzog & de Meuron," 205.

About the design method applied in the project for the Puerto de Santa Cruz specifically, Jacques Herzog noted that at the time this was "quite new and interesting".[182] Of the fact that they departed from a geometrical system extracted from the graphical structure of a picture, Herzog said that this enabled him to feel not "under the pressure of an author bound to create form but rather like a DJ arranging form",[183] a method he believes to have apprehended from artists and that shares once again analogies with the work of Richter. With his "Atlas", Gerhard Richter has been assembling, since the mid-1960s, a collection of photographs, newspaper cuttings and sketches—an artistic process that stands, as the artist said, "between documentary source and something worth exhibiting",[184] besides offering insights into his way of creating imagery, which is very much based on the photographs as source images for the paintings. Jacques Herzog described this as a "photographic method, which allowed [the artist] to paint without the need to invent motifs and form", [185] just like HdM did in the project for Tenerife. The geometrical system of extruded pixels was taken as a kind of language that has allowed them more freedom of expression and the ability to generate "all these complex forms and spaces without bringing in a personal style or personal handwriting as a sculpture might have done.[186]

6.3 _ Capturing Three-dimensionality

Developed during these years, the Jinhua Structure, Jinhua (2004–2006), despite its specific character and modest scale, is still today considered by the Swiss architects, especially by Jacques Herzog, a significant project, in particular for how the form-making process was addressed (***6.18***).

For the conception of this small pavilion located at the Jinhua Architecture Park (China), the architects experimented for the first time with a method entirely based on an algorithm-driven design, letting themselves be influenced by the virtual shapes that the computer continually generated. Even though this probably stands, as Jacques Herzog mentioned, as “the only project with such a strong degree of dependence on the computer",[187] this was the opportunity for the architects to achieve a highly complex three-dimensional structure, hardly to be imagined and conceived by traditional means, that shared some analogies with the organic formation processes. From a design method point of view, Jinhua also reflects the moment in the practice of HdM in which digital media began to be tested and adopted, playing, from this moment on, an increasingly active part in their working methodology.

This small spatial structure designed by HdM was one of the seventeen pavilions intended to serve a broad range of purposes that, as kinds of follies of widely different forms and sizes, were built in the architecture park planned by the Chinese artist Ai Weiwei. The pavilion by HdM was dedicated to reading and had two further variations that the architects conceived for two exhibitions, applying the same design strategy—a vertical structure developed for the Beyeler Foundation garden in Riehen

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182 Herzog, “We are surrounded.”

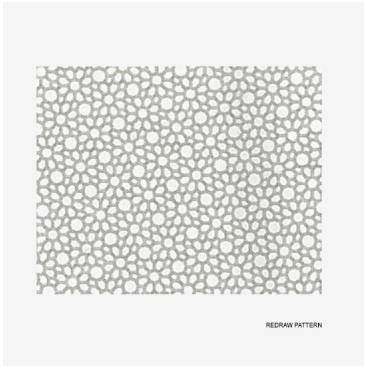
183 Ibid.

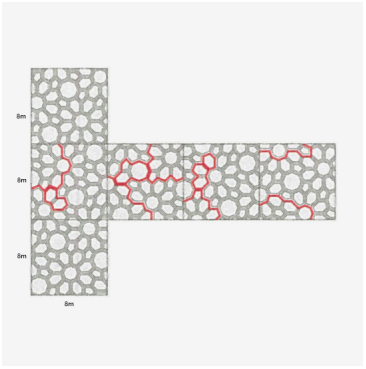
184 Gerhard Richter quoted in Hürzeler, “Herzog & de Meuron,” 201.

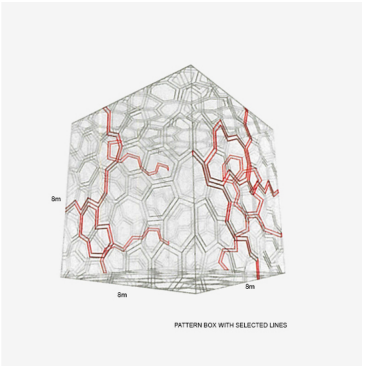
185 Herzog, “We are surrounded.”

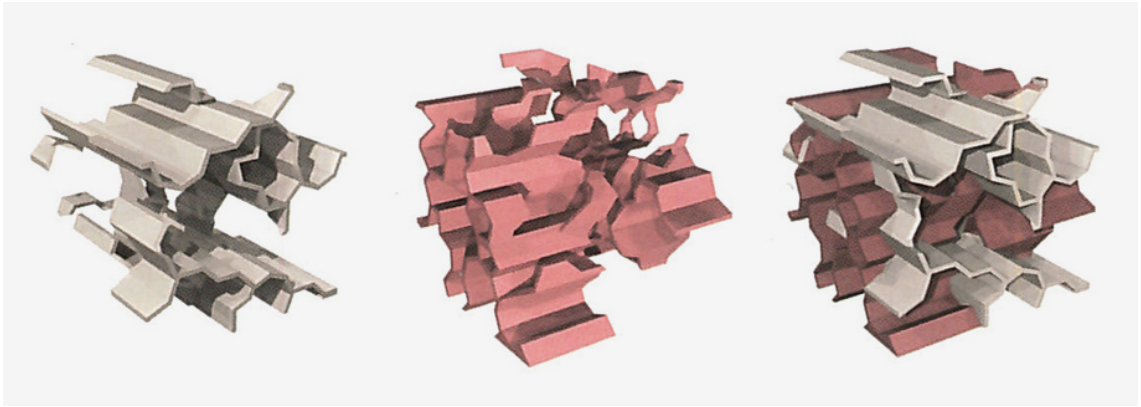
186 Herzog and de Meuron, “[acceptance speech],” 20.

187 Herzog, “We are surrounded.”









6.18
The Jinhua Structure I, Jinhua Park, China (2004–2006).

6.19
Design strategy: from the redrawn traditional Chinese pattern to the virtual pattern box.

6.20
Extrusion and intersection process for the sets of lines on the faces of the cube.

(Jinhua Structure II- Vertical, 2004), and an unbuilt pergola designed for the courtyard of a palazzo in Genoa (Jinhua Structure III- Horizontal, 2004).

As the architects mentioned in the description of the project, the same geometrical pattern that they had just created from a traditional Chinese motif found in floor tiles and wood carvings to apply as an ordering scheme onto the building volumes of the project for the Jindong New District, Jinhua (2003–2004),[188] was used as the starting point for the design of this pavilion. "Everything appeared quite simple and logical", the architects said, "our Jinhua pavilion would merely be a shell consisting of the same geometric pattern we had developed for the building in the Jindong district."[189]

Therefore, departing from a virtual cube eight metres wide, HdM laid over the six faces of the prism a network of intersecting lines that formed a honeycomb pattern, ranging from pentagonal to octagonal cells, from which the whole shape of the pavilion was imagined and conceived (***6.19***). Just as they did with the pixellated pictures in the projects for Tenerife, San Francisco and Madrid, in the Jinhua Structure, HdM relied once again on a graphical structure that was taken as a reference to generate the architectural form—a design strategy in which an ornamental scheme, whether geometrical or organic, underlays the architectural composition, regulating it and setting out its boundaries. Widely explored by HdM in these years under distinct perspectives,[190] this was revealed to be a process, Herzog noted, that besides allowing them "to avoid looking for form as such", also made the architect "disappear as 'creator'".[191]

In the Jinhua Structure, the geometric pattern was not to remain confined to the surface but rather to be given depth and to be projected into space, forming a three-dimensional grid (***6.20***). After a selective process in which the most extreme forms—according to angles of incline and scale—were suppressed from the original pattern, sets of intersecting lines, suggested by the computer, were extruded inwards from all sides of the cube. As the architects mentioned, the result was a "virtual spatial grid consisting of an infinite number of intersected lines and points of intersection inside the geometric body".[192] Therefore, rather than a fixed, predetermined shape, the outcome could be given by an endless number of possible combinations. In the end, within the resulting intricate sets of planes and due to their topographical features, passageways, platforms, niches, and other interior spaces began to be revealed as usable places, endowing the whole structure with an architectural sense (***6.21***).

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188 See Herzog & de Meuron, "No. 236 Jindong New Development Area", in *Herzog & de Meuron 2002–2004. The Complete Works*. vol. 5, ed. Gerhard Mack (Basel: Birkhäuser, 2020), 68–75.

189 "261. Jinhua Structure," Herzog & de Meuron, accessed January 7, 2022, https://www.herzogdemeuron.com/index/projects/complete-works/251-275/261-jinhua-structures.html.

190 In this period, HdM collaborated on some projects with Urs Roth, a Swiss "geometry engineer", as he defined himself, who has provided consultancy, especially in the field of geometric patterns. For the Mosque in Abu Dhabi (2002) and the facades of both the Astor Place Hotel, New York (2000–2001), and Prada Levanella, Arezzo (2000–2002), Roth has created geometrical arrangements based on the principle of a standard element, whose outcome, despite relying on an ordered structure, left the impression of randomness and chaos. See Urs E. Roth, "Wissenschaft und Baukunst," *TEC21 Kunst und Ingenieur*, nº 16, April 14, 2008, https://www.e-periodica.ch/cntmng?pid=sbz-004%3A2008%3A134%3A%3A4095.

191 Jacques Herzog, "Ornament, Structure and Space [A Conversation with Jacques Herzog]," by Jean-François Chevrier, in *El Croquis. Herzog & de Meuron 2002–2006. The Monumental and the Intimate*, vol. 129/130, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2006), 34.

192 "261. Jinhua Structure."

6.21
The topographical character of the intricate intersection of planes.

Jacques Herzog described this process as an exercise purely based on computer modelling. "We developed an algorithm that produced countless different 3D-constellations from which we could pick those we found appealing and appropriate. Just like when you watch cloud formations in the sky. A design strategy quite far from control and authority."[193] In this case, the geometric motif worked as a kind of genetic code, the architects said;[194] as a set of rules with which they played, obtaining a cohesive shape that, like a crystal, grew from an orderly repeating pattern extending in all three spatial directions.

In 1993, a period for HdM quite distinct from this in terms of the architectural research topics and the means supporting their design process, Jacques Herzog, in an interview, anticipated[195] what he considered to be one of the computer's potentials with interest for their practice. While discussing the computer's ability to calculate endless amounts of information, the Swiss architect pointed out the possibility of generating programs that, working like organic structures, could create self-similar details by iteration and thus promote the analogy between natural and built structures.

In a way, this is what HdM accomplished, nearly ten years later, in the Jinhua pavilion. In this elaborate spatial structure of voids and divisions, which recalls, as Gerhard Mack noted, “a piece of artificial nature”[196]—as could be the sculptural form of a scholar’s stone so appreciated by HdM[197]—there is full correspondence between ornament, structure and space, a quality that HdM sought for their

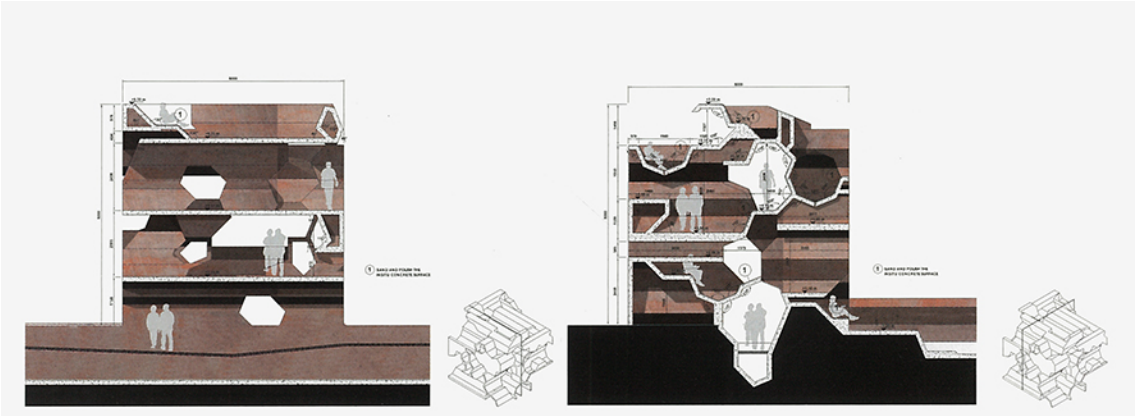
193 Herzog, “We are surrounded.”

194 Herzog, “Ornament, Structure and Space,” 34.

195 Herzog, “Continuities,” 24.

196 Mack, *Herzog & de Meuron 2002–2004*, 115.

197 HdM talks about their fascination with the scholar’s rocks and their influence on some of their projects in a conversation with Philip Ursprung. See Herzog & de Meuron and Ursprung, “Portfolio,” 84.



6.22
Cross-sections of the Jinhua Structure I.

architecture with particular interest during this period. According to Jacques Herzog, the Jinhua pavilion "is the outcome of three-dimensional experimentation with ornament",[198] where the three topics mentioned above merged in a unitary entity, made possible due to the digital medium and its ability to manage such a complex amount of information. Indeed, only "with the help of a powerful computer, [were HdM able to have] developed the inconceivable and unimaginable forms and spaces of the pavilion",[199] crucial support that extended to other projects and that leads one to recognise in their designs from this period a kind of capturing of three-dimensionality.

In the Jinhua Structure, this aspect is expressed in the object, which, as mentioned, resulted in a highly complex geometrical entity expanded in all three spatial directions, and in the design method itself, which inverted, with the 3D modelling of the architectural object preceding its two-dimensional description. Actually, the whole process for conceiving, testing and defining the spatial structure was developed by directly manipulating the digital model. The bi-dimensional representation, in this case, was only carried out later because of the construction process.[200] As the pavilion was built from an artisanal, in-situ hand-poured concrete system, the digitalised structure had to be translated into conventional analogue documentation (***6.22***). The architects had to slice the object at every ten centimetres to produce the plans that the local craftsman who built the pavilion used for the construction. As such, conversely to what happened in previous periods, abstract orthographic projections had somehow lost their primacy as the instruments used to regulate the geometrical

198 Herzog, "Ornament, Structure and Space," 34.

199 "261. Jinhua Structure."

200 Unlike the pavilion for the park in Jinhua, the whole process for the Jinhua Structure II, from design to construction, was entirely digitally controlled. "The Beyeler pavilion", HdM noted, "was factory made, in other words, not only conceived but also milled by computer." Herzog & de Meuron, "No.261 Jinhua Structures", in *Herzog & de Meuron 2002–2004. The Complete Works*. vol. 5, ed. Gerhard Mack, (Basel: Birkhäuser, 2020), 110.

relationships, no longer guiding the process for defining form. Instead, the object's shape was determined from a complex set of extrusion and union operations directly worked out in the virtual space.

Gerhard Mack stressed that "it was in some ways the experience with the Jinhua Structure that elevated the computer to the same status as any other architectural tool." [201]

Indeed, in the Jinhua Structure, the digital medium played a particularly crucial role, strongly contributing to grasping the design idea and making it viable in formal terms. However, this was part of a broader process taking place in these years in the practice of HdM. Due to the growing size of the commissions and the increasingly global scale of their practice, or just simply because it made sense to accept the technological advancements and integrate them in the working methodology, HdM, in early 2000, had progressively begun to adopt digital means and to take advantage of these in the creative process, especially in the development of issues with relevant formal and technical complexity.

Volker Helm, a German architect who worked in the Basel office between 2003 and 2010 and with whom we conducted an interview, was one of the collaborators leading the process for bringing in new design tools that expanded the working possibilities. In particular, Volker Helm introduced the "Rhinoceros 3D" software in the office and developed the first very simple experiments with scripting and parametric modelling. So, in a way, his early years of collaboration translate how this whole process came about and somehow evolved into an increasingly consistent and structured approach to using digital means.

In the office, this period is marked above all by the expansion of manual digital modelling, which enabled the architects to generate and describe the architectural objects accurately in three-dimensions, providing them with a powerful tool for assisting the creative process. As described above, the design method for the Jinhua Structure was an exceptional case and other examples of algorithmic design in the early 2000s were limited to a few scattered instances. Indeed, when Volker Helm came into the office he was mainly responsible for digital modelling as a "virtual constructor",[202] as he defined himself, and worked on several projects with the aim to create three-dimensional representations that served above all to have an overview of the object and to communicate it.

The design of the National Stadium, Beijing (2002–2008) was a significant time for the office.

In 2002, HdM won the competition for the project of the Beijing Olympics Stadium that was conceived as an embracing shell made of a seemingly accidental arrangement of steel members, and which many, as Jacques Herzog mentioned, "have suggested [has] an association to a bird's nest".[203] The project was jointly developed, from the beginning, with Arup Sport,[204] whose team was responsible

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201 Mack, *Herzog & de Meuron 2002–2004*, 115.

202 Volker Helm in conversation with the author, "The computer is just a hand tool for Herzog & de Meuron." Dortmund, January 23, 2020 and Zoom meeting, Porto-Dortmund, June 8, 2020.

203 Herzog, "We are surrounded."

204 The design consortium for the project for the National Stadium had three partners: Herzog & de Meuron, Ove Arup & Partners and China Architectural Design & Research Group. According to J Parrish, "within this integrated team, the architects at ArupSport were responsible in particular for the bowl, the concourses, and the spectator facilities, which together defined the form of the Stadium. They also produced an initial optimised structural proposal for the roof and envelope, which Herzog & de Meuron then developed. CADG provided vital local expertise during the competition and scheme design, and then took the baton for the final stages of the project, liaising with the local authorities, producing construction information and monitoring the works on site." J

for the bowl's design and all engineering disciplines. In its turn, HdM, together with Ai Weiwei, focused on the external form of the stadium, working on the concept for the facade and roof.

The development of such a high profile project, which represented then the "peak of innovative and complex stadium design",[205] benefited from the most advanced design software technology at the time. Indeed, as Stephen Burrows and Martin Simpson from the British firm stressed, "the use of CAD software was critical to the success of the National Stadium".[206] Arup adopted the CATIA platform by Dassault Systèmes—the only software that could then handle the complex surfaces and geometrical requirements of the elements—and based the approach to the design process, from conceiving to construction, in "virtual prototyping". Along with the advantages of being a parametric and associative modelling software—particularly relevant when dealing with a design that is required to be adjustable and continually changing—CATIA allowed all elements of the stadium to be assembled in a single environment and tested, performing several simulations that aimed at optimising the building's design by an iterative process.

We could not gauge precisely how this methodology impacted or interrelated with the architects' own design process, which was, as usual, very much based in the manual model, nor confirm whether these kinds of tools were also in some way mastered by the team in Basel[207] or if, on the contrary, this specialised support was entirely backed up by Arup's engineering team, which likely must have been the case. However, from Volker Helm, who was directly involved in the design team, we learnt that "Rhinoceros 3D" software was used for the first time in the office[208] within the scope of this project. After the competition phase, when the architects needed an accurate three-dimensional representation of the proposal, it was Helm's task to create the digital model for the stadium. "A precise 3D model of the stadium had to be created", Volker Helm explained, and "this was not possible with "Form-Z" by itself. So, we switched to "Rhino" because this software has better functions for the 3D modelling of complex geometries. "Rhino" has some features that lend itself well to architecture that other 3D programs do not have."[209]

The adoption in the office of "Rhinoceros 3D" as a versatile software that produces mathematically precise representations of geometries denotes the increasing importance that virtual modelling had, from this moment, in the creative process of HdM. Used for the possibility it offered to accurately represent architectural objects in three dimensions and therefore provide a better understanding of their

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Parrish, "The architectural design concept," in *The Arup Journal. The Beijing National Stadium Special Issue*, vol. 44, nº1, ed. David J. Brown (London: Corporate Communications Group, 2009), 8.

205 "Pushing the limits in stadium," AECMagazine, AEC, posted on July 1, 2008. https://aecmag.com/features/pushing-the-limits-in-stadium/.

206 Stephen Burrows and Martin Simpson, "The Stadium geometry," in *The Arup Journal. The Beijing National Stadium Special Issue*, vol. 44, nº1, ed. David J. Brown (London: Corporate Communications Group, 2009), 18.

207 For optimising the stadium's roof structure, HdM also cooperated with the former research group "Kaisersrot", based on the CAAD chair of prof. Ludger Hovestadt at the ETHZ. Through a computational approach that relied on evolutionary algorithms, the group contributed to optimising the complex geometrical structure in terms of buildability, whereby the spaces between the beams needed to be minimised. See "National Beijing Olympic Stadium (CN) 2003," Projects, Kaisersrot, accessed January 20, 2022, http://www.kaisersrot.ch/kaisersrot-02/2003_National_Beijing_Olympic_Stadium_%28CN%29.html.

208 According to Volker Helm, around 2000, in the HdM office, "for the 2D planning, mainly "Autocad" and "Archicad" were used. The software "Form-Z" was used for the 3D modelling, and there were a few licenses for "Maya" and "3D Max". Then [Volker Helm] introduced the "Rhino 3D" modelling software […] there were also licenses for the usual image and layout editing programs." Helm, "The computer is."

209 Helm, "The computer is."

physical attributes, digital modelling was adopted as a tool to generate, manipulate, and visualise the shapes and their relationships. In his early collaboration, Volker Helm, under the supervision of Philipp Schaerer,[210] began by creating visualisations of the projects, for many of which simple 3D models served as the basis for the whole image editing process. Only in a second moment was the production of digital models, as the mere representation and communication of an instrument, eclipsed to acquire a more active part in the design process while assisting the architects to easily experiment with complex shapes within a more immediate, interactive and detailed approach.

Among the several examples mentioned by Volker Helm, the project for the staircase of Pierre de Meuron's own house[211] is a representative instance of the ability of this technique to expand the design possibilities. While exploring the same compositional strategy as the one implemented in Jinhua Structure II, the architects generated the staircase form from Boolean operations, conceiving an intricate vertical structure whose primary function was enhanced by additional niches. In this case, as Helm described, the computer offered "the opportunity to generate geometries that a person cannot easily imagine. For example, if you subtract two three-dimensional bodies from each other, the result is not necessarily predictable, but inspiring residual spaces or areas can arise. The computer can carry out such operations in seconds, and the result can be viewed immediately from all sides".[212]

Moreover, the fact that "Rhinoceros 3D" supported scripting languages—which enabled the user to enhance the software features and adapt them to his individual purposes by moving beyond standard tasks and thus handling complex operations in a specific, targeted and personalised way—opened up the possibility for the first experiments with parametric modelling developed in-house.

In the conversation we had, Volker Helm stressed how his innate interest in the connection between architecture and computer science was always encouraged in the office by the partners, who gave him the freedom to experiment with different technologies, given the interest that the results could have for the design. This soon led Helm to become involved with the programming strategies of "Rhinoceros 3D", parameterising complex operations in some projects, which offered fast and comprehensive manipulation of the overall object without the need to recreate the geometry every time. This modelling approach implied looking at the design problems as a system of relationships and mapping them into

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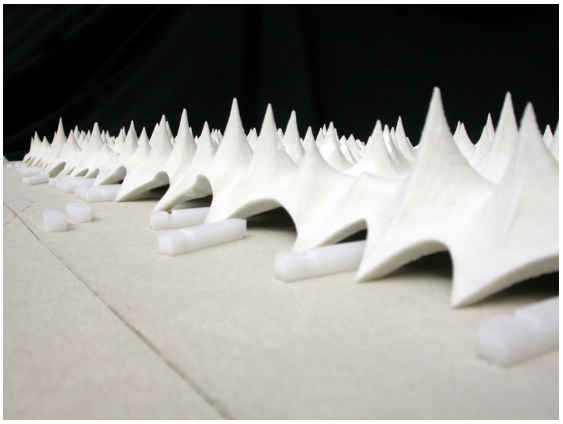
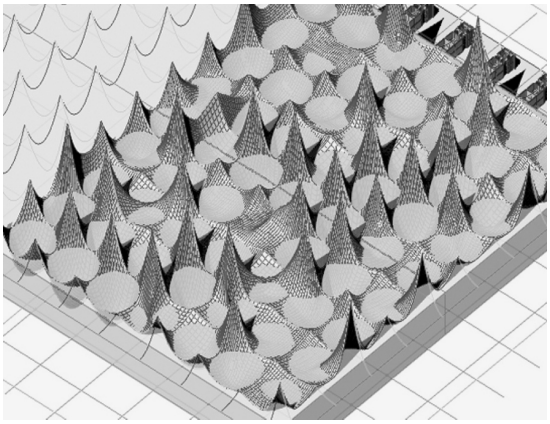
210 Philipp Schaerer is a Swiss architect and a visual artist. From 2000 to 2006, he collaborated with HdM as an architect and a knowledge manager, having played a crucial role in the office in architectural visualisation. In a period marked by the gradual incorporation of the new digital processing technologies into the architecture practice and the increasing predominance of images depicting architecture, Philipp Schaerer produced digital architectural images from a highly manual execution base. Quite laborious and demanding in terms of their graphic editing process, these digital collages had a style that, as he stresses "comes across as considerably more nuanced, multilayered and soft than early 3D visual scenes that were purely calculated". Therefore, in addition to the fact that many of these images, as Schaerer says, have played “a significant role in shaping the visual language of the architectural visualisations that are now commonplace”, in HdM's work methodology, these signalled a turning point as the first digital images to intervene with the design process. See “Introduction,” Commissions, Philipp Schaerer, accessed January 20, 2022, https://philippschaerer.ch/commissioned/introduction/.

We had the opportunity to talk to Philipp Schaerer (Zoom meeting, Porto-Steffisburg, July 8, 2020) about the work he developed at HdM, the methodology he used to construct his visualisations and the impact these had in the design practice of the Basel architects. However, unfortunately, for both parts it was not possible to edit the conversation, so this was not published in the thesis.

211 As this is not an official project by HdM, it is not listed nor published on the website. In this sense, we did not have access to either images or written descriptions. A very brief mention of the project is made in Mack, *Herzog & de Meuron 2002–2004*, 115.

212 Helm, “The computer is.”





6.23
Prada Levanella, Arezzo (2000–2004). 3D printed model of the second design version.

6.24
3D model of the roof study.

certain rules. As such, geometry, instead of being defined by fixed values, was described by a set of parameters and relationships that brought components into dependencies, automating some design procedures and enabling the architect to play with alternatives interactively.

One of the first scripts developed by Volker Helm was for the tensile structure of the second design for Prada Levanella, Arezzo (2000–2004).

When HdM were asked by Prada in 2004 to develop a simplified version of their first project for the goods distribution warehouse located in Italy, the architects proposed a rectangular modular floorplan building covered with a tent-like roofscape (***6.23***). "A regular system of pillars", Gerhard Mack describes, "with simple horizontal reinforcement bracings and a tarpaulin-like suspended roof create tent shapes that can be varied by adjusting the height of the support, depending on the required usage. Vertical incisions lend the facades a vibrantly lively silhouette that varies according to the interaction of wall and roof".[213] Therefore, to assist the design team in calibrating the hall's shape fast and intuitively, Volker Helm created a script with which the architects, by manipulating the attributes of the points defining the tent poles, were able to easily test different variations and visualise the resulting form immediately (***6.24***). "At that time", Volker Helm said, "there was no parametric software like "Grasshopper", so I developed a program with which the free-form roof could be set and changed using an Excel table. This, of course, helped the design team to make their own settings".[214]

Furthermore, once the architects had this precise digital model of the building, they were able to send the data to production and generate what had become one of the first 3D printed models of the office. As Helm noted, “this was the first step towards a digital process chain, so to speak”. [215]

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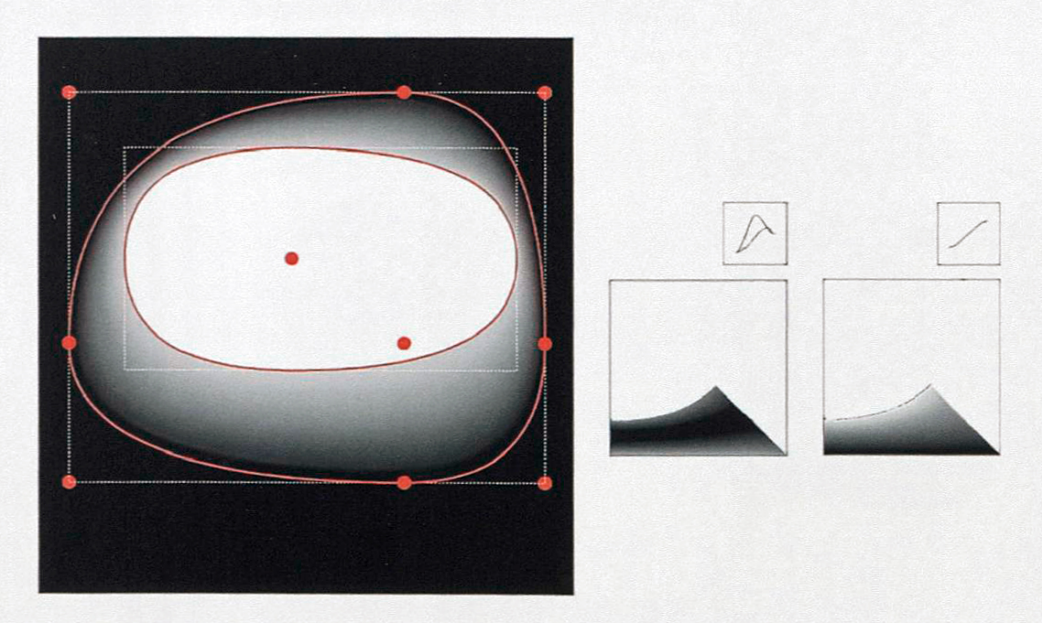
213 Mack, *Herzog & de Meuron 1997–2001,* 141.

214 Helm, “The computer is.”

215 Ibid.



7.01
Elbphilharmonie, Hamburg (2001–2016). Gradient parameters for the screen pattern on the facade's glass panels.

7.
Scripting and Parametric Design

7.1 _ Experimental Explosion
7.2 _ Parametric Ornament
7.3 _ Geometric Rationalisation

7.02
"Herzog & de Meuron. No. 250 An Exhibition", Basel (2004). General view of the tables at the lower level of the Schaulager.

7.03
Installation view with the many physical models displayed on the tables.

7.1 _ Experimental Explosion

Between May and September 2004, the recently opened Schaulager at Munchenstein, Basel, hosted the "Herzog & de Meuron, No.250 An Exhibition" curated by Theodora Vischer and Jacques Herzog (***7.02***). In the following two years, this exhibition toured Europe at three different venues—in Rotterdam, London and Munich—showcasing many of the physical traces produced within the involved design process that has characterised the work of HdM from the outset of their career up to recent times.

Once again, this major exhibition by HdM was not "used to present what [had] already been achieved", the curators said, but instead had worked out as "an autonomous statement that can only be expressed in this form".[216] The fundamental openness with which the Swiss architects address the particular circumstances of a given site was taken in this exhibition as the factor that lends individuality to each of their projects and is the trigger for the great variety of experiments that the architects develop in the work process and that, on this occasion, were brought out of their archive. The many physical models laid out on the thirty-five tables placed at the lower level of the Schaulager, (***7.03***) in their condition as artefacts that express formal intentions, made the intricate design world tangible and presented "architecture […] as a way of mulling over possibilities."[217] The aim was to focus on the process through which architecture is ultimately achieved, allowing one to ascertain in the multitude of these speculative objects the deeply researched approach that supports the creative practice of HdM.

In their comments on the exhibition, Theodora Vischer and Gerhard Mack suggested that this display, for how it was conceived and the material itself, made somehow clear that the work of the Swiss architects had changed in recent years. With an impact on their methodology and the architecture itself, this new reality, however, may be seen as part of the turn that was already taking

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216 Vischer, *No. 250 An Exhibition.*

217 Mack, *Herzog & de Meuron 2002–2004*, 95.

place in their practice by the end of the 1990s and that, throughout the first decade of the 2000s, acquired more overt expression.

Mack compared this presentation to the one in Paris,[218] curated by Rémy Zaugg roughly ten years before, and noted how the ordered arrangement of the room at the Pompidou Center stood in contrast to the seemingly random disposition of the tables at Munchenstein with the works unfolding achronologically. The minimalist response of the first exhibition—itself a reflection of the architecture on display—gave rise in 2004 to an informal layout that privileged affinities between the exposed materials and in which the wide-ranging experimentation attending the formal processes was revealed to be key to the variety and compositional richness that distinguishes HdM's responses to architecture. "The exhibition at the Schaulager takes place just a few years later [than the one in Paris]," Gerhard Mack noted, "yet by then, our world, as we experience and perceive it, has utterly changed. This is true not only for the wider changes in society due to modern media, it is also true of the architects' world of work."[219]

In the introduction to volume 6 of the HdM monograph, Mack characterises the period between 2005 and 2007 by describing it as a moment of particular worldwide wealth that impacted the global architecture scene. Along with the emergent digital technologies, now capable of "calculating structures that would previously have been impossible to envision", as Mack described, the construction boom and "the preferred projects at that time, [which] seemed to be museums, churches and concert halls, […] gave architects more or less free rein to explore their artistic leanings."[220]

In this context, HdM were no exception to the rule. They "were main players in the architecture of these years", Gerhard Mack stressed, and "their buildings and projects shaped the debate more than most."[221] And even though they always showed themselves to be cautious about the pressure in present times to think mainly iconically[222]—believing that their conceptual approach to the process of architectural design could somehow be helpful to counter this contemporary symptom—the Swiss architects were increasingly confronted with situations in which they had to respond to the state of a world where architecture, as Jacques Herzog pointed out, is used as an element with which cities "set themselves apart from other cities."[223]

Around 2005, HdM were already working on the Olympic Stadium in Beijing (2002–2008) and the Elbphilharmonie in Hamburg (2001–2016), their two major projects with perhaps the greatest

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218 "Herzog & de Meuron, une exposition, conceived by Rémy Zaugg", Centre Georges Pompidou, Paris (8 March–22 May 1995).

219 Mack, *Herzog & de Meuron 2002–2004*, 95.

220 Gerhard Mack, ed., *Herzog & de Meuron 2005–2007. The Complete Works*, vol. 6, (Basel: Birkhäuser, 2018), 9.

221 Ibid.

222 When questioned by Hans Ulrich Obrist about the current obsession with icons in architecture, Jacques Herzog replied that "people are quick to accept 'beauty'. But what is that? Architects tend to use 'form' in order to produce beauty: iconic form, in fact, as demonstrated in recent years. We are somewhat hesitant in that respect because we want to avoid being dependent on 'iconic form'. We do not want to be immediately recognized as authors. We need the freedom to approach each project from scratch without being loaded down with the baggage of earlier works." Jacques Herzog, Hans Ulrich Obrist and Ezra Petronio, "On Transcending the Boundaries of Architectural Thinking. Jacques Herzog in conversation with Hans Ulrich Obrist and Ezra Petronio," in *Herzog & de Meuron 2005–2007. The Complete Works*, vol. 6, ed. Gerhard Mack (Basel: Birkhäuser, 2018), 205.

223 Ibid.

7.04
Gazprom-City, St. Petersburg (2006). Composite image.

international recognition[224] and that, according to Mack, "might even be seen as symbolic of the prevailing sense of new beginnings and infinite possibilities in architecture."[225] By this time, the architects from Basel had also received the commission for iconic projects such as the extension to the Tate Modern in London (2004–2016), the new hall for the Messe Basel, Basel (2004–2013), the Triangle, Paris (2006–…), and the well-known "stack projects" later built in Allschwil, Weil-am-Rhein and New York. In the following years, many other works across countries worldwide went on expanding this list of large-scale commissions, confirming, as discussed in a previous section, the office's engagement with the global construction boom and its continuous involvement in projects with relevant urban impact.

From an architectural point of view, this increasing growth of the HdM practice and its expansion in global terms has witnessed the multiplication of their formal proposals. The geometric freedom that HdM had embraced by the end of the 1990s, when they opted to broaden their compositional strategies in the search for a more inspiring architecture in formal and plastic terms, was explored in this period even more intensely. Mack had no hesitation in asserting that the Swiss architects had followed the freedom of that time and experimented with a whole range of new forms, in some cases even largely without self-imposed limitations, as their designs for the Hotel Casino, Las Vegas (2005)—referred to by the author—but also for the Gazprom-City competition, St. Petersburg (2006) (***7.04***), or the first proposal for the Roche Building 1, Basel (2006–2008), clearly reveal.

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224 In an article about the Elbphilharmonie, Charles Jencks elaborates on this "typical megabuilding of today", which he considers to be an architectural piece that shows the virtue of Postmodern complexity, arguing that "this hybrid structure is one of the few iconic buildings since Frank Gehry's Guggenheim to be a masterwork." Charles Jencks, " 'A civic masterpiece': Charles Jencks on Herzog & de Meuron's Elbphilharmonie." *The Architectural Review*, March 2017. https://www.architectural-review.com/buildings/a-civic-masterpiece-charles-jencks-on-herzog-de-meurons-elbphilharmonie.

225 Mack, *Herzog & de Meuron 2005–2007*, 9.

In a similar way, Luis Fernández-Galiano has also suggested that an “experimental explosion” [226] marked the architecture of HdM from these years.

Indeed, when looking at the projects HdM were working on in the second half of the 2000s, the architects' idea of rejecting a personal style in architecture and cultivating an open attitude that constantly led them to develop specific responses for the many different places became, in this period, more crystal clear than ever. “Far from the common practice of repeating successful formulas", Luis Fernández-Galiano noted in 2005, HdM have explored "new grounds [...] reinventing themselves in each new commitment with a seemingly inexhaustible richness of proposals.”[227]

If, until now, it was relatively attainable to identify and follow up, in their oeuvre, a few cohesive lines of inquiry that spread later in the compositional variants developed on the single projects, from this moment on their fields of action seem to have begun to disconnect, with the designs asserting themselves more and more as fragments of research whose permanent structure and conceptual basis must be perceived in the long term of their career. At first sight, each project seems to be part of autonomous investigations. There are clearly no recipes, and even if earlier strategies were to be reapplied, these were always reviewed and adjusted according to specific local and programmatic demands, acquiring an individual expression each time. As Jacques Herzog mentioned in 2007, "we want to probe the possibilities of architecture today and use its potential for a project. Whatever the style, materials, forms, spaces and specifications… But there are, of course, themes that we return to or that we elaborate on. […] You can't reinvent yourself every time you do another project, nor is it necessary."[228]

In the already-mentioned introductory essay to volume 6 of the HdM monograph, Gerhard Mack said that in this period the architecture of the Basel office was marked by a compositional strategy based on the combination of simplicity and complexity. Taking the “stack projects” for the Actelion Business Center, Allschwil (2005–2010), and the VitraHaus, Weil-am-Rhein (2006–2009), as emblematic instances of this design approach, Mack noted that individual modules of an elementary shape had been combined in an additive process from which complex structures of sculptural form and impressive spatiality emerged (***7.05 / 7.06***). For the German critic, simplicity and complexity are thus the two fundamental concepts that allowed the architects to increase the scope of their practice, at the same time as it enabled them to review their relationship to their past projects in a more nuanced way.[229]

However, while in the two mentioned projects—Actelion Business Center and VitraHaus—the idea of complexity refers to something volumetrically complicated and difficult to apprehend, in the majority of their designs this concept alludes to the sense of “something with many parts […] [that] interact with each other in multiple ways, culminating in a higher order of emergence greater than the sum of the

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[226] This term is used by Luis Fernández-Galiano as title for a group of projects by HdM published in Luis Fernández-Galiano, ed, *AV Monografias 114. Herzog & de Meuron 2000–2005*, (Madrid: Arquitectura Viva SL, 2005).

[227] Luis Fernández-Galiano, “Planet Basel,” in *AV Monografias 114. Herzog & de Meuron 2000–2005*. ed. Luis Fernández-Galiano (Madrid: Arquitectura Viva SL, 2005), 2.

[228] Herzog, Obrist and Petronio, "On Transcending the Boundaries," 206.

[229] According to Gerhard Mack, this ambivalence is a quality that has always been present in their oeuvre, lying behind those subtle architectural contradictions responsible for the disturbing sensation their buildings frequently induce in visitors.

7.05
Actelion Business Center, Allschwil. (2005–2010).

7.06
The complex spatiality resulting from the stacking of boxes.

parts."[230] This means that the complexity their projects may express in formal terms has not so much to do with intricacy itself, but instead with a compositional refinement the architects seem to be interested in achieving by combining simple shapes in a process where nature continues to be regarded as an enduring reference.[231] As such, despite frequently departing from pure volumes, the architects addressed the projects based on geometric procedures that they often envisage as ordinary and straightforward gestures, such as piling, stretching, opening, shifting and leaning. Besides endowing the objects' configurations with coherence, these formal processes mark the conceptual approach to the shape and contribute to lessening traces of rigidity, making the whole richer than the individual parts without obscuring its original clarity.

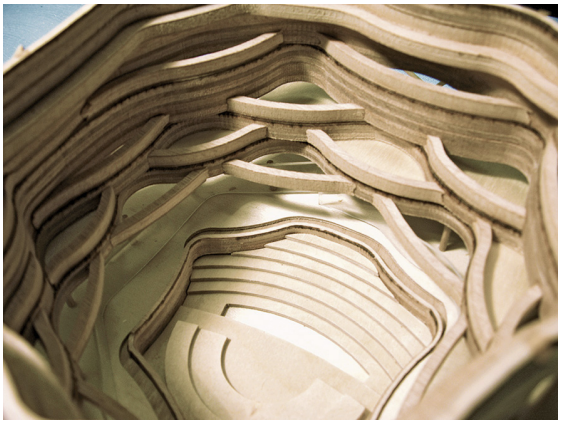
A sharp example of this approach is the design for the Auditorium du Jura, Courgenay (2005–2006).

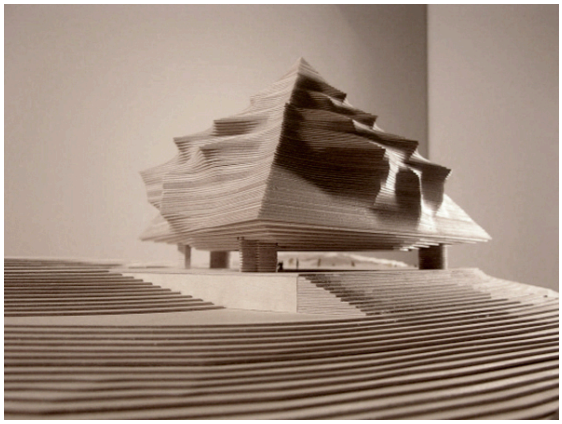
Confronted with the dilemma of what kind of architecture could rise out of the mountains' undulating topography, standing all by itself in the landscape of the small village in the Swiss Jura, HdM opted for the precise geometric shape of a triangle that gradually surfaced, becoming a pyramid raised off the ground. However, "since [HdM] did not want the pyramid to be a pure and dominant element", the architects said, they "placed a dome inside, made up of several superimposed and twisted hexagons"[232] (***7.07***). Arranged concentrically, with the orchestra in the middle, the auditorium was

230 "Complexity," Wikipedia, accessed March 16, 2022, https://en.wikipedia.org/wiki/Complexity.

231 When referring to "Nature as a Model of Complexity" in the work of HdM, Jean-François Chevrier said that "the activity and performance of the firm naturally deals with monumental and urban aspects of architecture, but always within the continuity of previous research. This continuity is based largely on an enduring reference to nature as a model, which certainly doesn't belong to the canon of contemporary architecture." Chevrier, *From Basel*, 39.

232 Herzog & de Meuron, "No.280 Auditorium du Jura", in *Herzog & de Meuron 2005–2007. The Complete Works*, vol. 6, ed. Gerhard Mack (Basel: Birkhäuser, 2018), 50.





7.07
Auditorium du Jura, Courgenay (2005–2006). Physical model showing the auditorium.

7.08
The triangle pyramid with a series of protrusions.

designed as a sequence of stacked rotated rings of hexagons with rounded edges that stretched out the external skin of the pyramid, deforming it with a series of protrusions. By intertwining these two geometrical systems, the Swiss architects achieved a new whole where the original volume, without losing its precise shape, acquired a more gentle and vibrant configuration (***7.08***). The hard, flat surfaces of the pyramid, envisaged as a kind of textile membrane, transformed into a series of minimal surfaces that brought to the outside some of the convoluted internal arrangement. As Jean-François Chevrier noted, "Jacques Herzog and Pierre de Meuron are wary of 'representation' and symbolism. […] [They] cultivate clarity and simplicity of form, devoid of compositional effects but with a complex structure."[233]

7.2 _ Parametric Ornament

In the *vademecum* of "Herzog & de Meuron, No.250 An Exhibition", when referring to "Drawings" in the sense of hand-sketches, Theodora Vischer argued that this instrument had declined enormously in importance in the methodology of HdM as a consequence of the change that recently occurred in their work process. According to the art curator, the internal organisation of the office[234] was one of the causes leading to this shift, together with the possibilities that the computer had opened up in design and building—a factor that she also emphasised as having impacted the architecture of HdM.

The enormous potential Jacques Herzog recognised in 2001[235] for the computer in their very hybrid design process became, in these years, truly effective, which explains why, in the conversation with

233 Chevrier, *From Basel*, 23.

234 "Where once things were developed much more in isolation, today a team is assigned to every project right at the outset. Many drawings are produced directly at the workspace, in conversation with the project team. More often than not they are only just scribbles, suggestions as to the direction in which things could move", in Vischer, *No. 250 An Exhibition.*

235 Herzog, "The Nature of Artifice," 29.

Theodora Vischer for the exhibition in 2004, the founding partner said that "the things we are doing now can't even be captured in a drawing: I can just point in a certain direction."[236]

In the same booklet, a few pages ahead, while resuming the topic of the digital in the methodology of the Swiss architects, Vischer made Herzog's intriguing assertion clearer when she mentioned that "in both the execution and the planning stages of their projects, Herzog & de Meuron exploit the full potential of the computer's digital possibilities with great fascination and pleasure, using the computer as a multifaceted and productive tool that enables them to push their architecture forward."[237] Indeed, from this moment on, digital technologies became an integral part of their work process, assuming a leading role in a practice that was responding to a global scale and seemed to be interested in having no limitations on their creative approach and ability to adopt any formal strategy and manipulate the geometry, whatever that might be.

A crucial figure and a specific project signalled this turning point in the work of HdM.

In 2005, Kai Strehlke[238] entered the Basel office to solve a specific design issue on the facade of the unbuilt project Ciudad del Flamenco, Jerez de la Frontera (2003–2008), with which the teams, as they were working with conventional tools and by manual processes, were facing some difficulties.

In 2003, HdM had won the competition to design, for the heart of the old city of Jerez, a cultural complex[239] that would both celebrate the art of Flamenco and act as a catalyst for the urban regeneration of a decaying historic quarter. The location was Plaza de Belén—a plot left, some years before the competition, as an urban gap following the demolition of an existing school.

Unlike the majority of the other competitors,[240] who proposed to fill the entire site with a significant volume of construction, HdM drew inspiration from the Alcazar of Jerez and conceived a garden of ponds and orange trees enclosed by a perforated perimeter wall that contained the staircases and skylights connecting to the underground spaces (***7.09***). A tower lookout rose above the wall, entering into dialogue with the nearby cathedral (***7.10***).

In this project, as HdM described, "several themes that [they] pursued in the early 2000s overlap […]: architecture as an urban topography, in this case, a walled garden in the center of the city, and ornamentation."[241] In fact, the ornamental character of the poured, perforated concrete envelope

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236 Vischer, *No. 250 An Exhibition.*

237 Ibid.

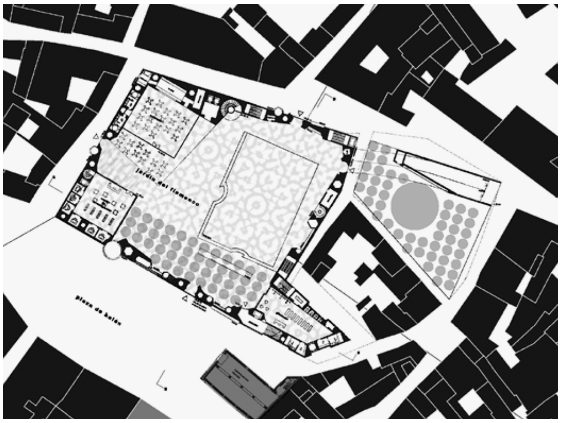
238 Kai Strehlke is an architect who worked between 2005 and 2015 in the office of HdM in Basel as head of the "Digital Technologies Group". Strehlke graduated in architecture at the ETHZ, and after a two-year experience in a German architecture office he returned to Zurich University, where he enrolled in post-graduate studies in digital architecture. He worked at the ETHZ for six years as a researcher and assistant, doing lectures on digital fabrication, and afterwards he went to HdM.

In a way, the office's engagement with digital production has been influenced by the connection to Hovestadt's chair at ETHZ via Philipp Schaerer—one of his assistants also working at the time in HdM. Some of Hovestadt's former students were employed at HdM, and the first outsourced services in parametric programming of the Basel office were assigned to his team of researchers.

239 "This cultural building, entirely dedicated to flamenco, will be made up of four basic pieces: the Flamenco Auditorium; the Museum of Flamenco; the School of Flamenco Art; the Center of Investigation and Documentation of Flamenco Art", *Ciudad del Flamenco. Jerez. International Competition*, (Jerez: Ayuntamiento de Jerez, 2004), 11.

240 "Invited to compete for this commission were two Sevillian teams […] Cruz & Ortiz […] and Vásquez Consuegra […]; the painter and architect Juan Navarro Baldweg […]; the Japanese Sejima & Nishizawa (…); the Portuguese Álvaro Siza, who was in association with Juan Miguel Hernández León […]; and the Swiss Herzog & de Meuron", Luis Fernandéz- Galiano, "Tapia y Tapiz," in *Ciudad del Flamenco. Jerez. International Competition* (Jerez: Ayuntamiento de Jerez, 2004), 5.

241 Mack, *Herzog & de Meuron 2002–2004*, 77.



7.09
Ciudad del Flamenco, Jerez de la Frontera (2003–2008). Ground floor plan.

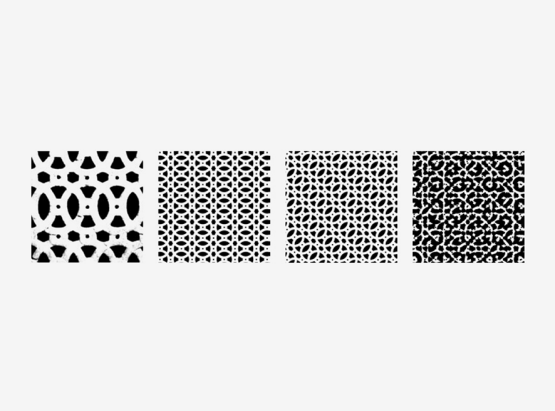
7.10
Night perspective of the tower and the walled perimeter presented in the competition entry.

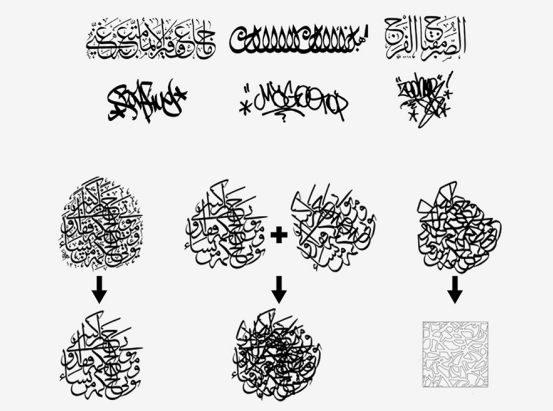
represents a high point in the architects' exploration of this subject in their oeuvre. The iconographical use of ornament in the complex for Ciudad del Flamenco recalls, in a way, that of the Eberswalde library, with the building entirely covered by a pictorial motif. However, in the project for Spain, this subject merged with two other research interests, also recurrent in their architectural practice: texture and three-dimensionality. If, on the one hand, the ornamental motif was envisaged as an abstract textured pattern that, when applied to the facade, affected both the outer surfaces and the internal spaces by enriching them with special light effects—as in the Dominus Winery—then on the other hand, by endowing it with thickness, HdM focused on the architectural qualities that could be discovered from an ornament, as they were exploring in the Jinhua Structures. In this project, the idea of ornament has thus intersected with an important three-dimensionality, becoming, as HdM said, "the expression of a holistic architectural vision: it is not decorative, it is indispensable to the whole; it defines and permeates structure, space and appearance."[242]

The architects wanted the concrete tangled mesh of the facades to allude to Gypsy patterns and Arabic calligraphy combined with contemporary street art, especially that of American graffiti tags.

In the initial studies for the ornamental pattern, done before Kai Strehlke came to the office, the teams worked, above all, on images that they manipulated by copy, rotation and overlap, with the aim of generating a more complex motif (***7.11 / 7.12***). The work was developed purely manually by processing the images on Photoshop and then digitally redrawing them by hand, which, besides being very time-consuming, led to a result that was neither very flexible—in the sense that it did not easily allow for adjustments—nor did it respond to both the internal programming and the structural engineering demands. Therefore, in 2005, Kai Strehlke was asked to join the teams to specifically support, through

[242] Ibid.





7.11
First ornament study based on traditional patterns from Arab cultures.

7.12
Initial studies for the process of transforming Arabic calligraphy into a pattern for the facade.

digital programming, the achievement of a solution that, besides proving to be consistent with the architectural idea, should react to the various internal uses and remain flexible in the design process.

Strehlke decided to approach the problem via digital scripting, converting the overall design of the facade into a parametric ornament.

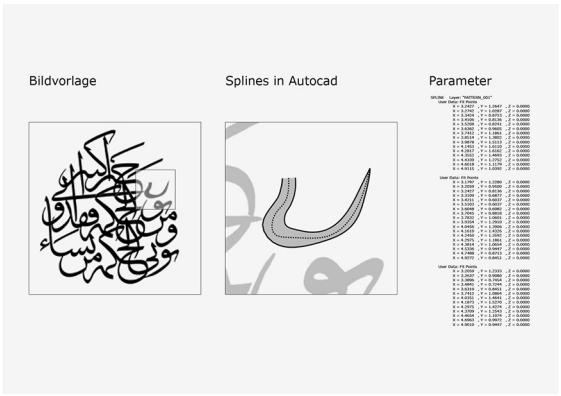
The process was long, and some inflexions on the methodology had to be addressed, namely, to capture the compositional expression that would better correspond to the architectural concept. In particular, this aspect led to an important revision of the parameterisation method developed by Kai Strehlke for the individual tags.[243]

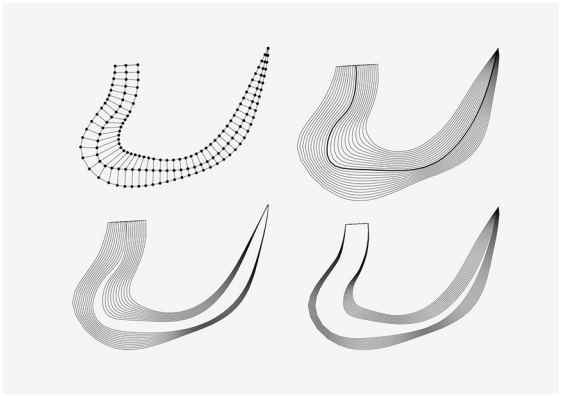
The first step in the digital process was the parametric definition of the tags, which were then distributed on the facade following patterns that the computer automatically generated according to specific rules that translated the different functions[244] of the concrete envelope.

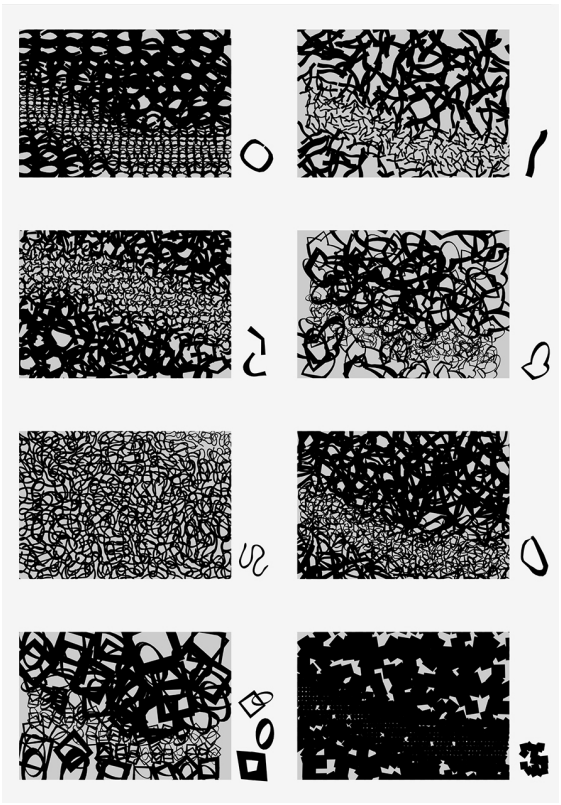
In the initial approach used by Kai Strehlke, the tags were fragments of lettering geometrically defined by splines—which allowed different transformations to be applied through programming—and were afterwards combined by translation, rotation and scaling (***7.13*** */* ***7.14***). Each of the patterns tested for the facade, in this design version, resulted from the overlap of a single tag (***7.15***). However, due to the closed and fragmented character of the tags' shapes, the generated surfaces, as Strehlke mentioned,

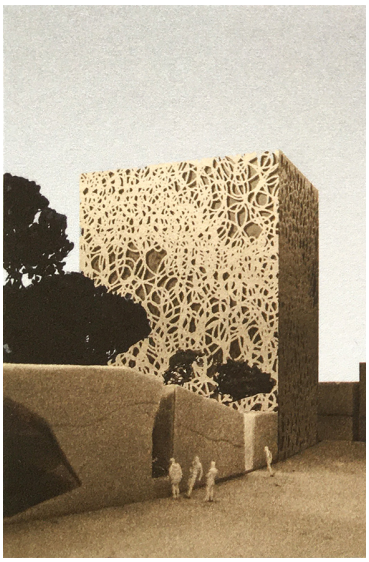
[243] The whole process for the digital approach to the design of this ornamented facade is well documented in the PhD dissertation by Kai Strehlke, in a section dedicated to the project Ciudad del Flamenco. See, Kai Strehlke, "Das Digitale Ornament in der Architektur, seine Generierung, Produktion und Anwendung mit Computer-gesteuerten Technologien" (PhD diss., ETH Zürich, Zürich, 2008), 94–118.

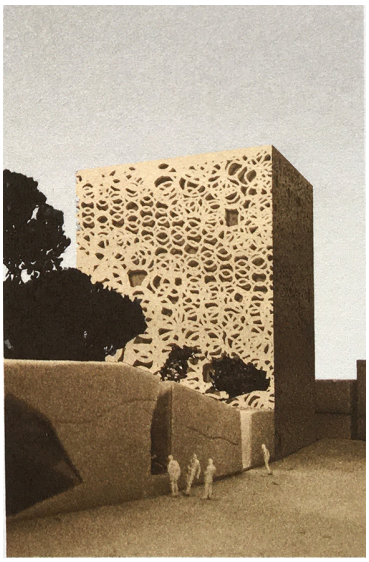
[244] The facade of the tower had, in the first instance, to be designed to be load bearing. Beyond the static requirements, the facade also needed to respond to fire safety regulations—which implied the existence of some apertures for the fire brigade to enter the building—and also work, when necessary, as sun protection for the rooms inside. Moreover, there was also an external escape staircase that was to be reflected in the development of the facade.

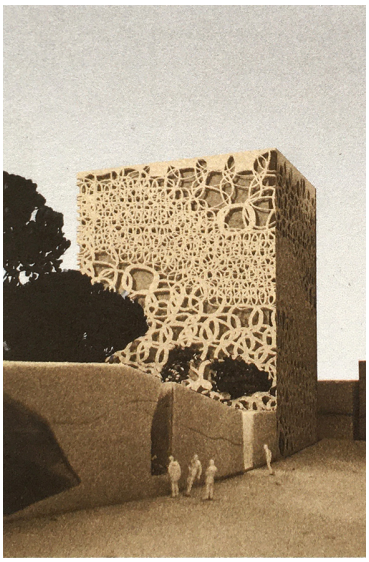










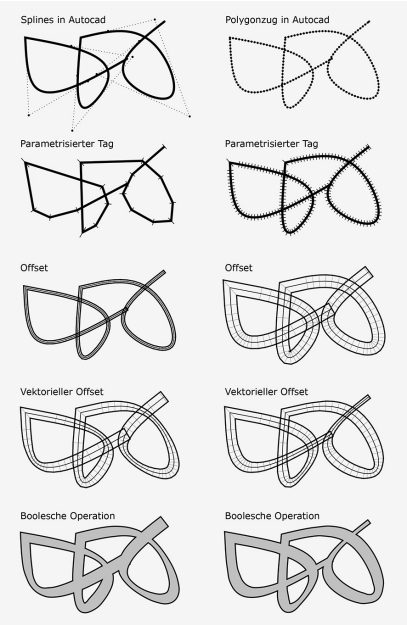


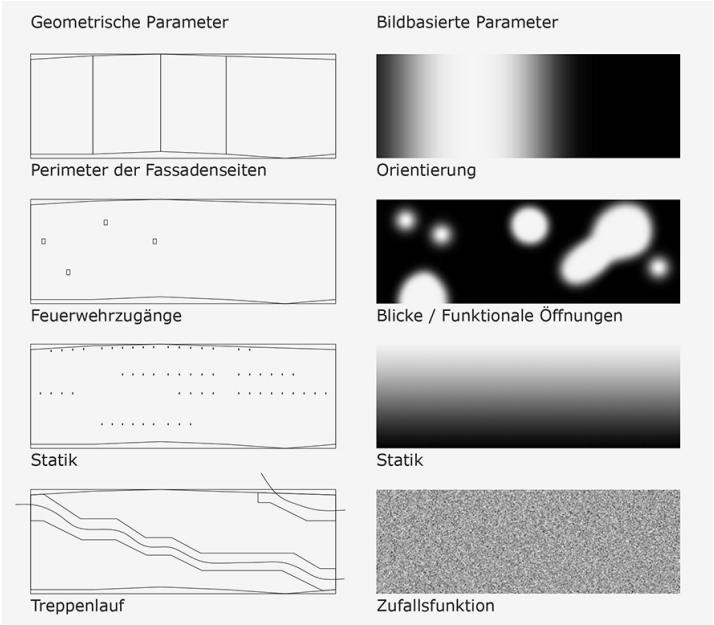
7.13
Parameterisation of a fragment of lettering.

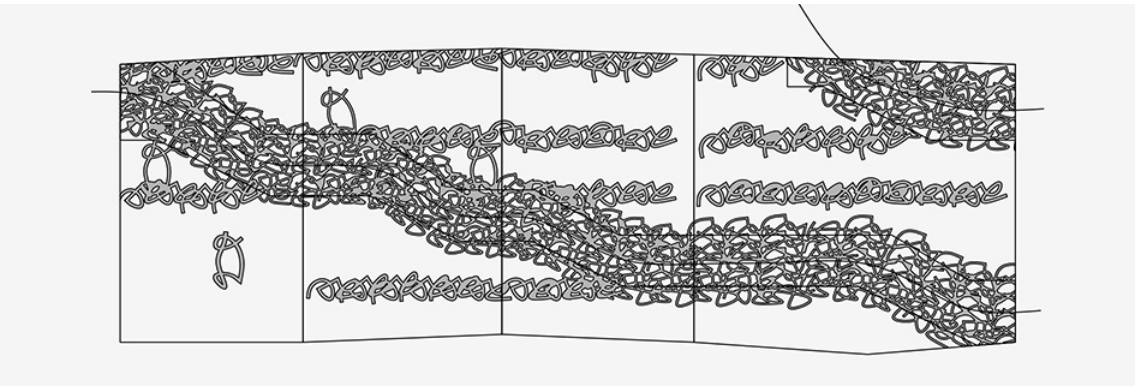
7.14
The parameterised tag with different transformations.

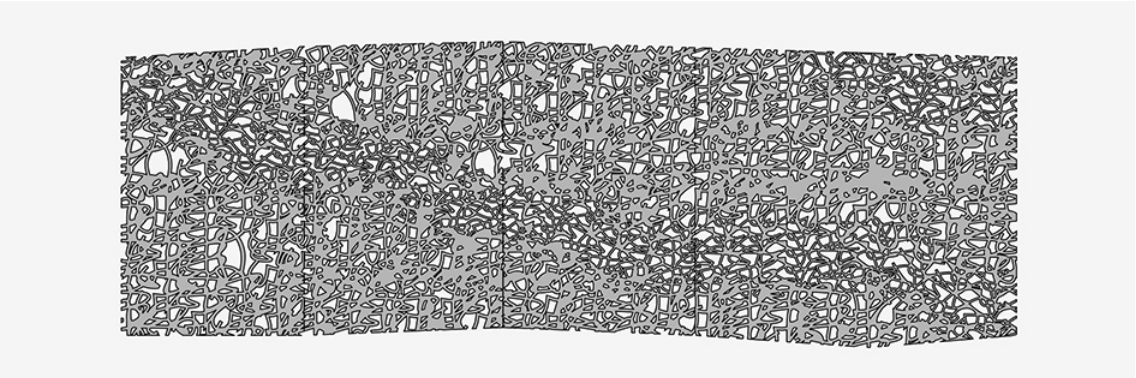
7.15
Patterns of different tags.

7.16
Application of three programmings on the tower.









7.17
Parameterisation of the second tag.

7.18
Geometric parameters (on the left) and image-controlled ones (on the right) for the distribution of the tags.

7.19
Step in the digital generation of the facade with tags placed in the fire brigade openings, floor slabs and stair course.

7.20
Overall view of the tower facade.

"looked more inspired by a macrame than an Arabic calligraphy or modern street tags from the graffiti scene"[245] (***7.16***).

The facade needed a more aggressive expression, so a new digital approach had to be found. Instead of representing the tags as fragments of lettering, these should correspond, as Strehlke noted, to the character of complete lettering; they had to become longer, have edges and corners and, as in calligraphy, open beginnings and endings. Geometrically, Kai Strehlke defined the new tags differently. These were described only along the axis—instead of the three splines as previously—which, via an algorithmic process and using a vector, has allowed some important geometric issues to be solved, like the non-uniform offset of the motifs' edges. In this way, the tags were given a variable width that changed with the curve's direction, like calligraphy (***7.17***).

In this second approach, Kai Strehlke developed various tags that were used according to aesthetic and functional criteria to form together the intricate ornamental pattern of both the tower's facade and the perimeter wall.

When generating the concrete envelope for the tower by overlapping the tags, several rules had to be followed. Some of these rules had to be observed with geometric precision—such as the position of the floor slabs, the fire services access and the area of the staircases—and others, instead, allowed some flexibility—like the facade's orientation, the views and the functional openings. Therefore, to control the distribution of the tags, Kai Strehlke applied two different methods. The parameters that required the exact placement of the tags were controlled in the scripting via geometric values, and the others via greyscale images of the facade (***7.18***). Both methods could combine, simultaneously affecting the position of the tags, their rotation and thickness. In this process, special attention was given to the static requirements of the envelope and the openings for the fire brigades, with tags especially designed for these two topics and accurately positioned on the pattern (***7.19 / 7.20***).

According to Kai Strehlke, "a major challenge in the project was to develop a fully automated digital chain and to program the facade without manual intermediate steps".[246] By proceeding in this way, this methodology made it possible to quickly try out different parameters and combine different tags, allowing multiple variants to be easily generated. Nevertheless, the whole process for the design and the decision-making was continuously assisted by drawings and the production of physical models made out of grey cardboard and hard PVC panels with a CNC milling machine (***7.21***). Only with the models was it possible to assess the relationship between the openings in the pattern and the thickness of the wall and understand the logic with which the pattern, for instance, should turn the corners. This was an intense back-and-forth process. Kai Strehlke had to respond to the continuous requests of the teams and provide them with design alternatives in an intensely interactive relationship where the partners themselves took an active part by directly reacting to the several experiments.

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245 "Die Fassade wirkte eher wie von einem Macramee inspiriert anstatt von arabischer Kalligrafie oder modernen Strassentags aus der Graffitiszene." Strehlke, "Das Digitale Ornament," 104.

246 "Eine grosse Herausforderung im Projekt war es, eine komplett automatisierte digitale Kette zu entwickeln und ohne manuelle Zwischenschritte die Fassade zu programmieren." Strehlke, "Das Digitale Ornament," 110.

7.21
Various facade models in grey cardboard and PVC.

7.22
1:1 scale, four-metre high expanded polystyrene mockup.

As often happened in the practice of HdM, the refinement of this unique ornamental facade and the testing of its effect in relation to the human scale, as well as of its buildability, were taken up to the 1:1 scale with the construction of two four-metre tall mockups of a building's corner—one in expanded polystyrene (***7.22***) and the other in poured concrete with the formwork elements also in polystyrene. In both situations, the developed digital chain played a fundamental role, with the data for the cutting of several components in a CNC hot-wire machine coming directly from the parametric model.

After having collaborated on the project for Jerez, Kai Strehlke was put on teams every time they faced difficulties solving design problems with standard drawing techniques. He then became a kind of "ping pong" player, as he described himself,[247] who was from the scripting side and had the role of creating tools to help the teams realise what they wanted to do. Around that time, HdM had also asked Kai Strehlke to set up and conduct an in-house department responsible for implementing the many possibilities of digital technologies in the office's methodology, from the design development and the building of models and mockups to the fabrication process. The "Digital Technologies Group" was established in the following years.

Creating this specialised department in the office has contributed to strengthening the role of the digital instruments and techniques in the projects' development. It has fostered the dialogue between the two parts—design and digital expertise—which, instead of remaining as two separate domains,[248]

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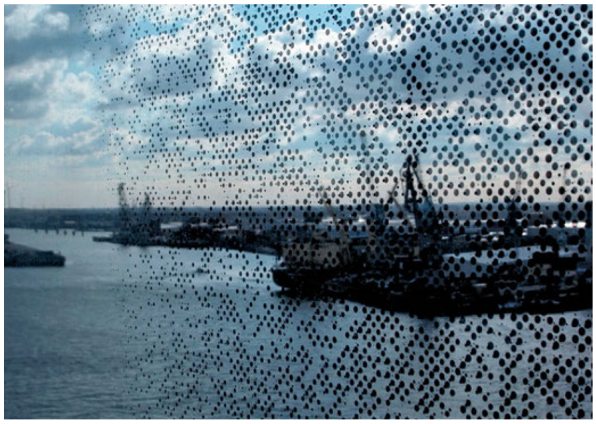
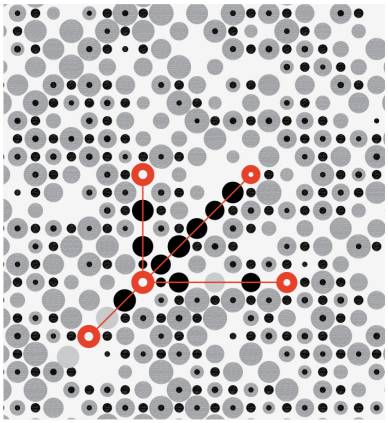
247 Strehlke, "Like an orchestra."

248 Before Kai Strehlke entered the office, HdM had outsourced services for parametric programming in the context of some projects. This happened, for instance, with the optimisation of the roof structure for the National Stadium, Beijing (2003)—as already mentioned; the reverse-engineering of the problematics of shadow-casting for the MAAG Tower, Zurich (2004); and the initial approach to the aperture arrangement on the facade for the Südpark Basel, Basel (2005). In these situations, external support was given by researchers working at the CAAD chair of professor Ludger Hovestadt from ETH in Zurich. However, as Kai Strehlke mentioned, this relationship was somehow "difficult because [the office] had to specify [exactly] what they wanted." On the contrary, having the DTG in the office was a "proactive situation". "The architects", Strehlke said, "can just go to my table, and a dialogue starts. [...] And if this is a good dialogue, then I am in the team doing one of these tasks." Kai Strehlke, "The Digital Toolbox of





7.23
Elbphilharmonie, Hamburg (2001–2016). Glazing close-up.

7.24
Screen detail with code.

have merged into a daily and constructive work relationship, triggering the conception of those special and usually more involved architectonic details that often lend the buildings their distinctive character. Several projects from this period are explicit instances of this tight collaboration. These are frequently marked by elaborate compositional strategies and architectural components of a particular geometric complexity for which the use of digital means, namely scripting and parametric design, had been revealed as indispensable for grasping the design idea in formal terms and describing it accurately, from the planning stage to construction.

Beyond the impressive Elbphilharmonie, Hamburg (2001–2016), in which the work by the DTG was particularly expressive—especially in the design of the 10,000 unique Voronoi acoustic panels[249] that line the ceiling, walls and balustrades of the main concert hall and the frit pattern for each of the nearly 400 panels of the undulating glass skin (***7.01 / 7.23 / 7.24***)—other projects that have relied on the expertise and support of the DTG include the SüdPark, Basel (2002–2012), and its seemingly random arrangement of unevenly sized windows on the facade; the Roche Building 1, Basel (2006–2008), when it was still a double-helix vertical structure closed by minimal surfaces; the new hall for the Messe Basel, Basel (2004–2013), with the hyperbolic paraboloid facades made out of 15,000 individually shaped aluminium sheets; and the Beirut Terraces, Beirut (2009–2016), with its high-rise structure of stratified horizontal slabs of varying sizes and configurations.

Herzog & de Meuron," Zurich, Institute of Technology in Architecture, Faculty of Architecture, January 28, 2013, vídeo, accessed April 17, 2016, https://vimeo.com/72031563, 6:46.

249 The work on the acoustic interior of the Grand Hall and Chamber Music Hall of the Elbphilharmonie was assigned to Benjamin Koren, at the time a DTG collaborator. Later on, in 2009, Koren founded ONETOONE, a computational design and digital fabrication firm specialised "in bespoke geometric computation, precision 3D-CAD construction, integrative CAM fabrication and innovative R&D at all scales." "About. OneToOne," OneToOne, accessed 17 November, 2022. http://onetoone.net/about/?lang=en.

However, it is interesting to go back to Kai Strehlke's initial work in the office and the partners' reactions to the earliest experiments with scripting. In a lecture held at the ETH Zurich in 2013 about "The Digital Toolbox of Herzog & de Meuron", Strehlke recalled that "when [he] came into the office, there was no hype [in these tools]. […] It was a very critical approach about parametric scripting, and it was for [him] also a quite tough time to make it acceptable." [250]

In our conversations, Kai Strehlke has often insisted on this topic. When he joined the office, as he explained, HdM had only asked him to solve a design problem that they could not resolve with the resources they had until then, and he could have done it with whatever approach he thought would have been more appropriate, as long as he solved it. Therefore, the introduction of digital means in the office was not received with particular amazement nor with the conviction that these instruments and techniques could somehow supplant a wholly well-established way of approaching architecture. Quite the contrary, in HdM, as Strehlke noted, "scripting was never pushing architecture. […] [Jacques Herzog and Pierre de Meuron] would never hype any kind of technology for the sake of the technology. […] They always try to take all the advantages they can from all the different people, from the team, the technology, or whatever, and they try, from all of these, to get the maximum." [251]

According to Kai Strehlke, in the office of HdM "scripting [was] only pushed by architecture, […] [and] it [depended] on the projects if it makes sense to do scripting and what to script." [252] It was considered just one of the many possible tools [253] for the design practice—like the many musical instruments that together form an orchestra—and, in this particular case, a very potent one, as it takes advantage of the computer's calculation capacity, revealing itself to be particularly helpful for understanding the design idea and translating it into a concrete architectural form. Nevertheless, these digital design methods had appeared in the practice of HdM at the right time, when the architects were trying to break boundaries to push their architecture forward and were dealing with complex design aspects. So, at this precise point in their career, these tools made sense and proved to be particularly instrumental for them to delve into specific architectural research.

7.3 _ Geometric Rationalisation

Between 2005 and 2015, when Kai Strehlke was in the office, the DTG was working on five main branches: computer-aided design (CAD) management, scripting and parametric design, digital workshop and digital fabrication, building information modelling (BIM), and visualisation and video.

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250 Strehlke, "Digital Toolbox," 4:16.

251 Strehlke, "Like an orchestra."

252 Ibid.

253 In the introduction to volume 5 of the HdM monograph, Gerhard Mack also reinforced this same idea. When referring to the 40 Bond apartment building in New York as a project where HdM had used the computer software for the abstraction and parameterization of lettering, the author said, "it soon became clear that Herzog & de Meuron would never let themselves become besotted with [the potential of computer-aided-design]. The newfound freedom and economic potential of its use was tempting. Yet, unlike other firms producing so-called blob architecture, they did not succumb to letting their designs be determined by these new technologies. They did not participate in the CAAD boom that was celebrated at the 9th Venice Architecture Biennale in 2004 [...]. Their absence was not on moral grounds. After all, they cherish freedom and diversity in architecture as essential to the attractiveness of our cities. Instead, it was a purely pragmatic and conceptual choice based on their belief that a design should be the right one for the place and the task, rather than being formalistically developed using new tools." Mack, "For the City," 16.

As head of the department, Strehlke had a clear conviction about the fields that were instrumental for the design practice of HdM and were revealed to be more significant as strategic tools for the development of the architectural ideas.

Even though, in this period, BIM had begun to be implemented in the office on specific projects that were ideally represented by a consistent database,[254] Kai Strehlke had always been somehow critical about this digital approach, having doubts especially about its suitability for an architectural practice that usually responds in a very individual way to each design commission. According to Kai Strehlke, in the DTG they had always made an effort to decide when to use BIM and how deep to go with it in the projects. One criterion, he explained,[255] was wondering whether the model of a project could be done using LEGO; if that would have been a good system, then BIM could be a good way to start quite early. However, even then, in the initial design stages, Strehlke had a preference for other instruments that, unlike BIM—which is a methodology that goes far beyond traditional CAD software by representing the project in the form of a database—describe the objects in purely geometric terms.[256] BIM is about putting the design information together from a technical point of view and solving complexity within a collaborative approach, having more to do, in Strehlke's opinion, with digital management tools rather than with digital design tools.

At the outset of a project, the effort must be directed towards understanding the architectural concept, understanding the geometry, and trying to translate it into a consistent system of relationships that manages to get the full sense of the design idea and make it sharp. Therefore, in an office such as that of HdM, marked by a highly research-based practice, and where each building conceptually stands by itself, it is particularly relevant not to restrict creativity but rather to keep the design process open, enabling it to flow in different directions. This explains why, for Kai Strehlke, the most relevant branches of the DTG were those related to the processes that have geometry at their core and contribute to clarifying the architectural intent by attending to the definition of the rule sets that could drive the design. Along with the digital workshop equipped with generic CNC machines that had significantly expanded the production of physical models, scripting and parametric design were considered by the head of the DTG as the topics with the most significant added value for the practice of the Basel office.

Besides their unique character, the projects by HdM from this period were frequently marked by components with a high level of complexity, which, to be apprehended composition-wise and later on taken to production, required the programming of customised computational tools that enabled their accurate representation and provided the teams with the instruments to delve deeper into the

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254 According to Kai Strehlke, the Roche Building 97, Basel (2006–2011), and 56 Leonard Street, New York (2006–2017), were among the projects in which Revit was used for the first time in the office of HdM. During this period of about ten years, roughly sixteen projects were developed with Revit, all having some particularities.

255 This subject was addressed by Kai Strehlke in Strehlke, “Like an orchestra.”

256 “For example, you have a project where you have a very small footpath, and from this footpath you create a smooth transition to a wall out of it, and then the wall starts to turn into a roof until eventually you get a very big covered space. If you would do this in a "normal” way you would take a piece of paper and you would glue it and lift it. It doesn't look pleasant, but it is a sketch, and it totally translates the idea. If you do this in Rhino 3D, you could work with a single surface which is lofted.
If you were to do it with BIM, what is your building element? Where is your floor, where is the transition? How does it work? You don't want to decide all these things at the beginning of the design. You only want to grasp the idea first, do your findings inside the idea and then make this idea sharp. If you start too early with this kind of definition, you do not support the idea. You kill the creativeness. This is why I'm quite sceptical about BIM.” Strehlke, “Like an orchestra.”

architectural issues, addressing them rigorously. Therefore, just as each building design by HdM was specific, so the strategies adopted by the DTG had, in the same way, to be flexible and adaptable. Instead of assuming themselves to be experts in generic free-form surfaces or trying to create frameworks to approach the scripts, the group had to stay dynamic to capture the designers' ideas and write a specific tool for them in a very dedicated way. There were no predefined formulas, so the group had to respond fast enough each time—at the same speed as those working by hand, otherwise they were simply left out of the process—and in a way that meant they could handle all the different conceptual design approaches to turn them into a workable architectural plan.

"With parametrics, you get the geometrical sense of what the design should be", Kai Strehlke said. "When you do a script, you try to use the idea which is in the architecture, and you translate it into a code, [so] the driving motto is always architecture, is what you want to realise in the end."[257]

Addressing the design from a parametric perspective leads one to think about the representation of the objects in a procedural way. It implies a mindset that looks at the forms from a mathematical point of view and is focused on the several dependencies that can be set up between the variables carried through the modelling operations. It requires an in-depth knowledge of geometry and a particular ability to rationalise the shapes, always in the search for the simplest rules with which these can be described.

For Kai Strehlke, the issue of reducing the forms and their compositional relationships to a straightforward and logical condition was one of his major concerns and a factor he continuously aimed for in the work he developed. Strehlke called this "geometric support", which meant to make the teams aware of the kinds of geometric rules that could be applied to create something easier, simpler and, at the same time, more consistent from both design and construction points of view.

One example that Kai Strehlke pointed out in our conversations was the design process for the round shapes of the shifting disks of the Blavatnik School of Government, Oxford (2011–2015).

In response to Jacques Herzog's consideration, who had singled out four points as crucial for one of the shapes, the design team drew a NURBS curve with them and asked the DTG to develop a script. Strehlke realised that the four points and the resulting shape were nearly a circle, so he insisted that the architects should take only three of these points and opt to design a perfect circle. The team showed a certain reluctance to accept his suggestion. However, design-wise the difference between the two geometric figures was imperceptible, and the circle, unlike the NURBS curve, in terms of construction, allowed a more rational solution, as the glass panels for the windows, instead of becoming unique, would all be the same size (***7.25 / 7.26***).

The scripting process by the DTG for the street facade of the Südpark, Basel (2002–2012), is another relevant instance of the effort to set up the project on simple geometric principles that combine the design intent with construction and fabrication requirements. To promptly work out the architectural expression of the building, HdM had initially counted on the support of the CAAD chair at the ETH in Zürich, which, via parametric programming, assisted in the development of the concept for a facade made of unevenly sized and shaped windows arranged in a seemingly random disposition.

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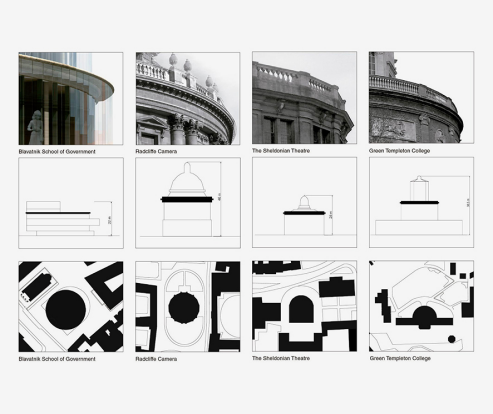
257 Strehlke, “Like an orchestra.”



7.25
Blavatnik School of Government, Oxford (2011–2015).
The geometry of pure discs shows analogies to the immediate historic setting.

7.26
The exterior appearance of the school marked by a series of shifted discs.

As the architects described it, the idea for the project was "to render the historical character of the differently shaped windows in the Gundeldinger Quarter in a contemporary architectural idiom."[258] The facade thus consists of twelve window shapes that were freely combined, following a pattern that changes from a more orderly composition along Güterstrasse to a more open one where the building faces the railway tracks. In correspondence with the four floors occupied by offices, the windows are of simple rectangular shapes, while in the seniors' residence housed in the ten-storey highrise, the openings have a more complex configuration that results from the merging of the individual modules (***7.27***).

HdM started drawing by hand, as Harry Gugger, the partner in charge of the project, revealed. "But this was a lot of drawing, and the human being always gets annoyed", he said. "As such, [they] never had the final result, because collaborators started to get annoyed, having new ideas and forgetting about the set parameters, or introducing new ones."[259] That is how the researchers from the CAAD department got involved.[260] They assisted on the design in the initial stage of the project, and when HdM got the planning permission, the DTG took over the task. According to Kai Strehlke, the work developed by the ETHZ stayed at a graphical level. They did not take into consideration the internal planning of the building nor the technical requirements of how a window is made, so that, by just clicking on a button, several variations to the facade—some of them even nonsense, construction-wise—were easily generated.

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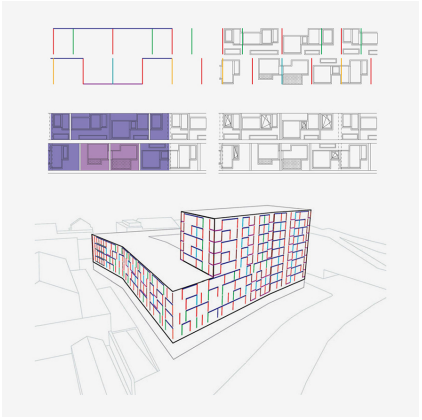
[258] "214. Südpark Basel," Herzog & de Meuron, acessed November 17, 2022, https://www.herzogdemeuron.com/index/projects/complete-works/201-225/214-suedpark-basel.html.

[259] Gugger, "This is too generic."

[260] By this time, Kai Strehlke was already working at HdM. However, as he was fully involved in the project for Ciudad del Flamenco, HdM had to outsource this task to the CAAD department at the ETH in Zürich.



7.27
Südpark, Basel (2002–2012). The facade facing the railway tracks.

7.28
Diagrams of parametric programming for the facade by means of colour coding.

HdM wanted to have this randomness, but they also wanted to have control and ensure that the outer visual appearance of the building was driven, as well, by what happened inside. So, when the DTG went ahead with the work, they selected some of the modules developed by the CAAD department and tried to understand how these could work constructively on a detailed scale. This allowed the group to define a set of a few modules that made sense by themselves as windows and were used to recreate the play of openings on the facade. Conversations with the manufacturers had also clarified that if some elements were repeated, then the solution could be optimised.

The next step was to find a system for placing the modules in the facade.

From this, a dialogue emerged between the DTG and the design team to decide on the planning elements that could impact the windows' configuration. By means of colour coding, the junction between elements (red), the party walls (cyan), the space-dividing walls (green), the columns (yellow), the loggias (magenta) and the openable windows (blue) were taken as the parameters that informed the scripting process and according to which the modules were chosen and associated with each other to form the openings (***7.28***). This system expressed the logic of the arrangement of the windows in relation to what happened inside and was revealed to be very flexible, allowing the architects to play with it until very late in the design process and almost up to the production phase.

Similar intense work to find the most reasonable geometric structure was carried out by the DTG in other projects, and in a particularly dedicated way in those like the Elbphilharmonie and Messe Basel, where a fully digital chain was involved with the design directly taken to fabrication.

However, among all these architectural examples, which are inevitably associated with long and complex processes, the design by HdM for a simple table stands as one that notably enhances the relevance of geometry in rationalising the forms and endowing them with a consistent graphic structure, able to be manipulated.

7.29
Tenerife table (2009).

Together with Mario Meier, Jacques Herzog sketched by hand the idea for what would become later the Tenerife table (2009) (***7.29***). The drawing they created had thousands of lines and suggested an asymmetrical round form that looked, in the words of Kai Strehlke, "a little bit like an egg".[261]

The drawing was given to the DTG so they could understand what kind of shape this could be. Kai Strehlke and Volker Helm were both involved in the design of the table. Initially, the shape was interpreted as a NURBS curve that perfectly outlined the hand-sketch. This served the purpose. However, further in-depth analysis of the geometrical principles of this NURBS proved that the oval could be described as four ellipses fitted together, sharing common axes and being tangent to each other. This reasoning on the shape allowed them to recognise an underlying geometric structure that reduced the description of this particular figure to four quarters of elliptical curves, each defined by only three control points. This geometric definition of the shape was later translated by digital scripting into a set of parameters and relationships that automated the representation of the curve and allowed the generation of an endless number of variants. However, the striking point of this example relies on the ability of geometry to turn something that resulted from a spontaneous human gesture and had an organic outline into a measurable and mathematically comprehensible sign.

"It is beautiful to see that someone is sketching a weird form, then you rationalise it, and you see that there's something very clear about it", Kai Strehlke noted when speaking about the design of the table. "There's a rule behind this form, and you can translate it into something with three control points; it's very simple. And this is something which I find absolutely fascinating about geometry."[262]

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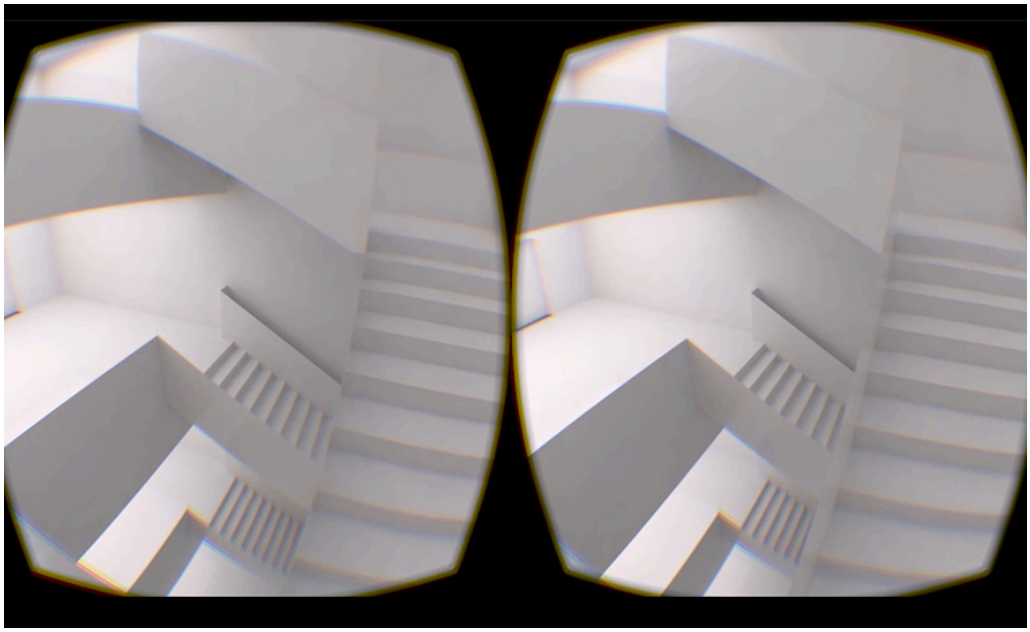
261 Strehlke, “Like an orchestra.”

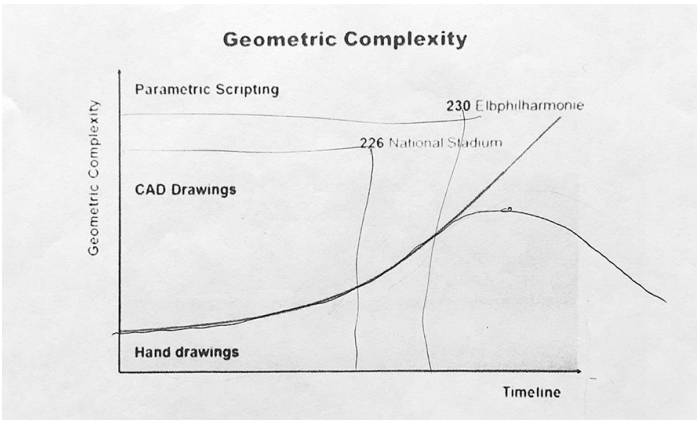
262 Ibid.



8.01
Stereoscopic cubemaps for the virtual reality of a staircase.

8.
Data and Interaction

8.1 _ New Simplicity
8.2 _ Information-Rich Models
8.3 _ Digitally Generated Reality



8.02
Print of Kai Strehlke's diagram on "Geometric Complexity" in HdM architecture sketched by Steffen Riegas.

8.1 _ New Simplicity

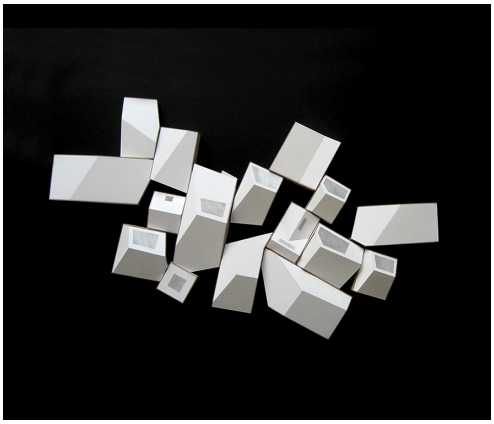
In August 2019, in a meeting with Steffen Riegas, we discussed a diagram that Kai Strehlke had shown six years before in a lecture at the ETH in Zürich.

Used to present the evolution of the design tools at HdM—from hand-drawings to parametric scripting—and demonstrate when and why computational methods had been introduced into their work methodology, the diagram relates the timeline of the office to geometric complexity, revealing that the practice of the Basel architects has been marked by increasing complexity over the years. When Steffen Riegas observed the chart, he immediately sketched a downward counter curve on it, explaining that, in his opinion, the complexity of the projects by the office has decreased in recent years (***8.02***). According to the current head of the DT department, the National Stadium and the Elbphilharmonie, both represented in the diagram, signal the peak of a geometric complexity that recent projects, such as the Vancouver Art Gallery, Vancouver (2014–…), or the two high-rises, Building 1 (2009–2015) and Building 2 (2015–…) for Roche, in Basel, no longer feature.

When reflecting on the causes that may have led to this inflexion in the architectural practice of HdM, Riegas pointed to the financial crisis of 2008[263] as perhaps one of the likely factors for this return to formal restraint.

In their writings about the recent work by HdM, Gerhard Mack and Jean-François Chevrier also refer to the collapse of Lehman Brothers in New York as an event that must be taken into account for the general understanding of this period and that somehow had an impact on the global architecture scene. Mack, in particular, noticed that, as a consequence of it, investments in new buildings dried up

[263] Steffen Riegas addressed this topic in our meeting in August 2019 in Basel. However, his comment was not included in the edited version of the conversation published in this dissertation (see appendix).



8.03
Physical model of the first proposal for the Parrish Art Museum (2005–2008).

8.04
Aerial view of the two elongated volumes of the Parrish Art Museum (2009–2012).

dramatically,[264] and the free experimentation, specific to the architectural context of the time, was in a way stigmatised.

In turn, Jean-François Chevrier, focusing on the work of the Basel architects, highlighted the Parrish Art Museum, New York (2005–2008 / 2009–2012),[265] as one of the HdM designs directly affected by the need to reduce costs in the wake of the financial crisis. In 2008, the client asked the architects to think about a new proposal that would be many times less expensive than the original, so the "fairly spectacular" first project (***8.03***), as Pierre de Meuron described it,[266] turned into a more straightforward and modest exhibition building (***8.04***). The initially developed idea of a small-scale pavilion complex that emulated the artist studio spaces of the region in terms of proportion, dimensions and specific natural light conditions ended up giving rise to a single building of a pure shape that resembles the vernacular architecture of a barn. Refined from a spatial and construction point of view, the museum consists of two elongated parallel volumes with gabled roofs that, in a very expressive gesture, were laid diagonally in the landscape of the extensive meadow to take advantage of natural light coming from the north. [267]

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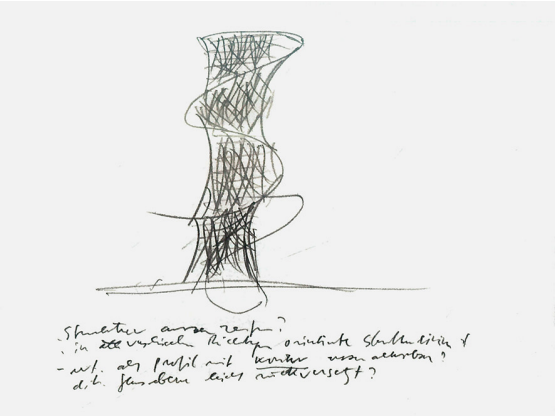
[264] "Investments in new buildings dried up so dramatically that in places such as Dubai even demolition projects were halted in their tracks, leaving broken pieces of reinforced concrete hanging in midair." Gerhard Mack, "Complexity and Simplicity. On the Return of Classical Elements in the Architecture of Herzog & de Meuron," in *Herzog & de Meuron 2005-2007. The Complete Works*, vol. 6, ed. Gerhard Mack (Basel: Birkhäuser, 2018), 10.

[265] This project is listed with two entries—277 Parrish Art Museum, New York (2005–2008) and 349 Parrish Art Museum, New York (2009–2012)—corresponding to the two proposals HdM developed for the museum in Long Island.

[266] Chevrier, *From Basel*, 15.

[267] In an article about the Parrish Art Museum, Srdjan Jovanovic Weiss also highlights this project as an important contribution to a debate about how to design in the age of abrupt changes in the global economy following the crisis of 2008.
In the author's opinion, the process of designing this museum "stands as a lesson to the discipline and to the practice of architecture. This lesson is not only that architecture has tools with which to overcome the global economic crisis, but also that it might instruct the future of that economy through design solutions that are at hand."
Further on, the author adds that "the shift that took place between the two Parrish Art Museum schemes seems to encapsulate a greater, office-wide shift in design practice and ideology at Herzog & de Meuron." A "turn [that] has been referred to [namely by some of the firm's partners] as the New Simplicity, which specifically refers to an intentional downsizing from the extravagant spatial



8.05
The two intertwined spirals high-rise for the Roche New Office Building. Sketch by Jacques Herzog.

8.06
Visualisation of the Roche Basel Site, with Building 1 and Building 2 on the right, together with Building 52 by Roland Rohn (1952-1961), and the pRED Center on the left.

However, in this period, other factors also led to the approach to design being overturned in the work of HdM. The project for the new Roche Office Building, Basel (2006–2008), whose revised version was listed as Roche Building 1, Basel (2009–2015), is a good example of that. In this case, the reasons were instead related to the character of the building and its inadequacy, in the client's perspective, to reflect the company's image.

Between 2006 and 2008, the architects developed the proposal for a crystal high-rise with two intertwined helices to be erected at the heart of the Roche headquarters in Basel (***8.05***). The tower was complex in shape and had an iconic and rather striking appearance. So when the project was already set for construction, the client, as Pierre de Meuron explained, "felt that the conspicuous shape of the building did not […] reflect the Roche image. [He] did not want his firm represented by a building that he considered too spectacular [...] [and] wanted something 'more modest', 'more reserved', [and] 'more classical'."[268]

HdM thus revised the project,[269] which became simpler in its formal expression. The tower took the form of a straightforward truncated prism whose overall appearance, marked by horizontal bands, is reminiscent of the company's architectural identity, forged in the 1930s by Otto Salvisberg and later his

propositions of the pre-2008 era. This shift to simple was extreme—and perhaps we can read in the Parrish Art Museum and other similar works a departure to extreme realism." in Srdjan Jovanovic Weiss, "Architecture of Abrupt Change: The Parrish Art Museum," *The Avery Review*, no. 12, December, 2015, http://averyreview.com/issues/12/parrish-art-museum.

[268] Jacques Herzog and Pierre de Meuron, "Conversation," by Jean-François Chevrier, in Jean-François Chevrier, *From Basel. Herzog & de Meuron* (Basel: Birkhauser, 2016), 230.

[269] "We asked for a meeting with the Chairman at which he suggested we develop three new projects. It was a sort of internal competition giving the client an opportunity to choose from three architectural proposals which, although different, were of equal functional quality. We worked with a diverse range of structural types (one tower, two towers, a unitary block, etc…) and, following a joint evaluation process during 2009 the final project was selected." Pierre de Meuron in Jacques Herzog, Pierre de Meuron, "A Conversation with Jacques Herzog and Pierre de Meuron," by Jean-François Chevrier, in *El Croquis. Herzog & de Meuron 2005-2010. Programme, Monument, Landscape*, vol. 152/153, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2010), 31.

assistant Roland Rohn. The option for "this conventional form, at once simple and iconic,"[270] Jacques Herzog remarked, allowed for continuity with the modernist tradition of the original Roche buildings and ensured, at the same time, that the future growth of the campus—also designed by HdM and which comprises the construction of another tower next to the first one—would emerge with an appropriate character to the Basel landscape (***8.06***). "If [the tower] had been built like [the first proposal]", Jacques Herzog said, "we would have had to invent a new spiral for the second tower […]. With the first project, we would have created a spectacular sculptural effect in the style of Shanghai, Abu Dhabi, or Dubai, but Basel, with its Protestant background, has a different history. [...] [And it would have contradicted] the spirit of the city."[271]

In a conversation between the founding partners and Jean-François Chevrier in 2010,[272] in which these two projects were addressed as signs of both the flexibility the office must undertake within the course of the design development and the renewed attraction Jacques Herzog claimed to have again to the notion of geometric clarity, Pierre de Meuron added that, in some cases, changes in direction do not come from the relationship with the client alone. As he mentioned, there is also the internal functioning of the office and the work within the teams, whose approach to design and method of working and intervening they deliberately want to keep flexible and open-ended. Wide-ranging experimentation is encouraged within the office, as Chevrier remarked, and for the architects, "the response [always] varies according to the project; there are neither rules or recipes", [273] which suggests that HdM are moved by their own inspiring architectural interests rather than simply letting themselves be subjugated by the circumstances of a given social or economic context.

This same idea is shared by Gerhard Mack, who asserted that, despite the euphoria versus depression that coursed through architecture before and after the crisis of 2008, "Herzog & de Meuron are the masters of their own fate and respond in their own way to unfolding events."[274] By saying this, the author places the work of HdM on the sidelines of these global contingencies, where it emerges as an autonomous artistic practice with internal cycles motivated, above all, by their own investigations and interests.

Mack notes that HdM's engagement with reduced designs is indeed something that came long before 2008. From an early point in their career, the architects already had a preference for simple shapes and clear geometries, which their history unequivocally demonstrates. So in the years leading up to the financial crisis, at the moment of great expressive freedom and new technical possibilities, HdM, according to the author, re-evaluated their interest in classical modernism and their own initial work. In fact, while working on intricate projects, like the Elbphilharmonie, Hamburg (2001–2016), and the Actelion Business Centre, Allschwil (2005–2010), they also developed more straightforward designs such as those for 1111 Lincoln Road, Florida (2005–2010), and the Helsinki Dreispitz, Basel (2007–

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270 Herzog and de Meuron, "Conversation," 231.

271 Ibid., 235.

272 We refer to the interview by Jean-François Chevrier with Jacques Herzog and Pierre de Meuron published in El Croquis. Herzog and de Meuron, "A Conversation with," 22–41.

273 Chevrier, *From Basel*, 16.

274 Mack, "Complexity and Simplicity," 10.

8.07
Ricola Kraüterzentrum, Laufen (2010—2014).

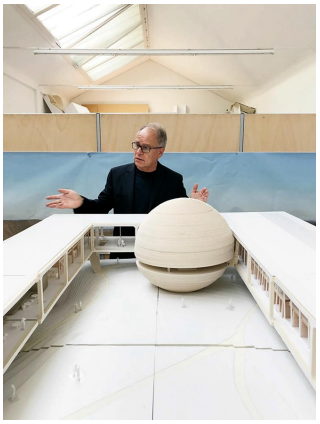
8.08
Vitra Schaudepot, Weil am Rhein (2013—2016).

2014)—two brutalist concrete buildings that are a glaring expression of what Mack describes as the "architects' intuitive handlings of the language of modernism combined with a determination to achieve a new simplicity and directness."[275] In the end, the author means that there has always been an interest in simple geometries underlying the architectural practice of HdM. However, it is as if the architects "were just not able to trust the calm and sense of security that these exude", which may explain—as their oeuvre shows—"that from time to time, they go for the greatest possible simplicity precisely in order to discover where that elusive quality known as 'clarity' can be found."[276]

A similar opinion came from Jean-François Chevrier, who considers the architectural practice of HdM as “a push and pull between an initial assumption of what could be qualified as a "minimalist" simplicity, and a search for complexity.”[277] According to the French art historian, since 1978, HdM have regularly seen turning points and changes of orientation in their work, in such a way that the new simplicity emerging from their designs around the 2010s has appeared, he said, "as a spiralling movement rather than a simple return to the firm's origins."[278]

In the conversation with Chevrier in 2010 that has already been mentioned, while giving as examples the three high-rises for the Triangle, Paris (2006–…), the tower of the New Headquarters for BBVA, Madrid (2007–2015) and the previously discussed Roche Building 1, Basel (2009–2015), Jacques Herzog himself asserted that the recent projects by the office were becoming more geometric and had greater clarity–an approach that has continued into their most recent work. Although in specific situations this may present as the most reasonable architectural option to adopt, their attraction, as

275 Ibid.,12.
276 Ibid.,11.
277 Chevrier, *From Basel*, 13.
278 Ibid.,15.



8.09
Berggruen Institute, Los Angeles (2015–…). Visualisation of the Institute building located at the southern end of the ridge.

8.10
The larger sphere for the lecture hall, leaning against the frame in one corner of the courtyard.

Herzog disclosed, was to "platonic volumes, as well as by straightforward, rugged materials producing no illusion that they are anything other than what they are."[279]

This renewed interest in a stripped-down radicality reminiscent of their beginnings is especially illustrated in small-scale projects where an aesthetic essentiality merges with material refinement. This is the case with the Ricola Kraüterzentrum, Laufen (2010–2014), a "geometrical segment of landscape"[280] built out of locally sourced earth (***8.07***); the prototypical house-shaped volume for the Vitra Schaudepot, Weil am Rhein (2013–2016), modelled in a singular masonry of fractured bricks (***8.08***); or even the luxury store for Prada, Miu Miu Aoyama, Tokyo (2012–2015), in which the architects, with an understated language, have re-used the concept of the box with the cover slightly open.

However, even though the architects, as Jacques Herzog mentioned, know that the line is very thin between clarity and purity and heroic monumentality, this compositional bareness also extends to some large-scale projects. Beyond the upright, symmetrical figure for the tall building of the Vancouver Art Gallery, Vancouver (2014–…); the self-contained and self-evident shape for the Neue Nationalgalerie-Museum des 20 Jahrhunderts, Berlin (2016–…); and the sharp triangular volume for the recently inaugurated Songeun Art Space, Seoul (2016–2021); the Berggruen Institute, Los Angeles (2015–…) emerges in this context perhaps as one of the most radical examples.

In the project for California, HdM have complemented the rectangular frame that they proposed for the Institute with two spheres (***8.09***)—the purest and most perfect geometric figure, in the words of Jacques Herzog,[281] that has always attracted him, but the use of which it is not easy to find a reason for

[279] Herzog and de Meuron, "A Conversation with," 32.

[280] "369. Ricola Kräuterzentrum," Herzog & de Meuron, accessed September 20, 2021, https://www.herzogdemeuron.com/index/projects/complete-works/351-375/369-ricola-kraeuterzentrum.html.

[281] Jacques Herzog, "Re-Use," Madrid, Máster Habilitante de la ETSAM, November 14, 2017, video, accessed February 15, 2018, https://www.youtube.com/watch?v=-llcaLd-LjE, 1:17:17.

in architecture. Strategically placed in the building as iconic elements with a functional background—the smaller sphere is for the water reservoir and the larger one for the lecture hall—they are to be left as if untouched, to stand out from the architecture that hovers over the ridge with all their volumetric purity (***8.10***).

In Herzog's opinion, this approach towards a new simplicity does not imply "a change of language; [but] rather, it is something one comes back to after having explored other avenues." [282] And when, in our conversation, we questioned him directly about this issue—as probably expected from someone who always rejected personal style and never bothered to find a single way to approach architecture—he agreed that "maybe [their] recent architecture is again more rigid and based on symmetry and pure geometries", but immediately added that "it could change again at any moment." [283]

In the end, what really fascinates him is exploring "how [they] can produce form",[284] he asserted.

8.2 _ Information-Rich Models

In 2014, a few months before Kai Strehlke left the office, Steffen Riegas, who had worked for two years—between 2010 and 2012—as a collaborator in the DTG, took over his position as head of this specialised in-house department. From that moment, the focus of the group was slightly redirected.

In recent years, the name of the department has changed from "Digital Technologies" to "Design Technologies", which, according to Riegas, allowed them to sharpen the term and be more specific—"because [nowadays] everything is digital",[285] he said—but also to recentre the scope of the group, since they support all of the architecture projects' technological needs.

In the same way, the fields of action were revised and readjusted. Whereas before, with Kai Strehlke, the DTG acted in five main areas,[286] now the DT department is organised in three branches: CAD and BIM management; visualisation and virtual reality; and digital fabrication. If, on the one hand, these adjustments denote that the strategy set out for the group has been redefined, with new advancements in digital methodologies, tools and approaches being incorporated into the practice of the office; on the other hand, these reveal that there is a different interaction happening between design practice and digital means, which suggests that the recent architecture by HdM probably requires a different type of support. This is particularly noticeable in the fact that "scripting and parametric design" is no longer considered a branch itself. In their role as tools that offer a lot of freedom and rapid success with a considerable degree of complexity, scripting and parametric design had somehow lost the primacy they had before as crucial instruments that often assisted the teams to grasp the design idea and take it to production.

In the first instance, this is likely to be a consequence of HdM's architecture.

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282 Herzog and de Meuron, "A Conversation with," 32.

283 Herzog, "We are surrounded."

284 Ibid.

285 This issue is addressed in Steffen Riegas in conversation with the author, "Digital tools are not the driver of anything. They are just tools.", Basel, August 6 and 7, 2019.

286 As mentioned in Section 7.3, the five branches of the DTG were: CAD management; scripting and parametric design; digital workshop and digital fabrication; BIM; visualisation and video.

The greater geometric simplicity of the projects—from a formal and construction point of view—has in a way lessened the need for these kinds of tailored digital tools and relativised their impact on the achievement of the design concept. Projects of such a high level of complexity and need for mass customisation, like the one for the Messe Basel—with all cladding elements of the facade and their substructure being unique in form and angle—have not been so frequent in recent years. However, this does not imply that geometric complexity has completely disappeared from the designs. Although that may no longer be at the heart of the architectural idea, as in previous projects, it still underlies specific design details. As Steffen Riegas remarked, the ornament, for instance, which is often associated with the idea of randomness, has not lost its relevance in the architecture of HdM. This means that in this specific case, as the nature of the problem is partially geometrical, programming methods still make sense in their approach. The quite ornamental facade for the National Library of Israel, Jerusalem (2013–...) (***8.11 / 8.12***)—with the cast surface made of openings and carvings that follow an abstract pattern inspired by erosion found on ancient stone walls—and the external pavement around the unbuilt project for the Stamford Bridge stadium, London (2013–...) (***8.13 / 8.14***)—whose organic and diverse design was drawn from the natural forms and geology of the old creek that ran along the eastern along the eastern boundary of the grounds—are two good examples of that.

"I still think [scripting] is relevant", Riegas said. "I just don't like to overexpress this term. For me, it is a tool, and it solves a problem. [...] Scripting [...] is when we sit down and write our own libraries of code to make our life easier." [287]

With a very pragmatic vision on this matter, which differs from that of Kai Strehlke, the current head of the DT department regards scripting above all for geometric accuracy and the shortening of the drafting process it enables. For him, situations like the design of stadium bowls—in which “you don't want to put tens of thousands of seats into the stadium by hand "[288]—or the typical HdM intricate spiral staircases—like those for the Musée Unterlinden, Colmar (2009–2015), where the team "had to model them very precisely in Rhino and then give that information to the manufacturers who would cast them in concrete"[289]—are moments in which writing some functions proves to be particularly useful.

Furthermore, in the last few years, visual programming languages, like Grasshopper, launched by the end of the 2000s, made coding more accessible and intuitive.[290] Scripting has thus become endemic in the architectural world, entering into everyday use and reinforcing Riegas' belief that this is

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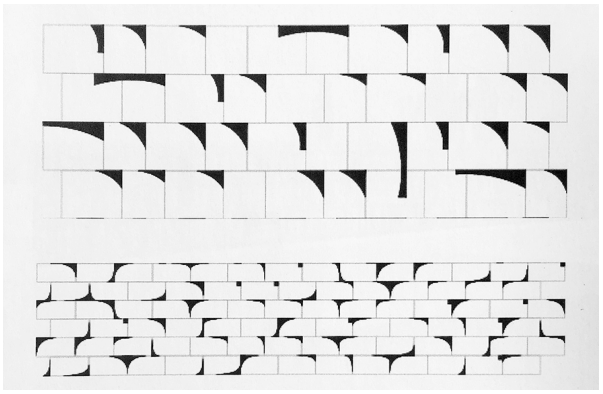
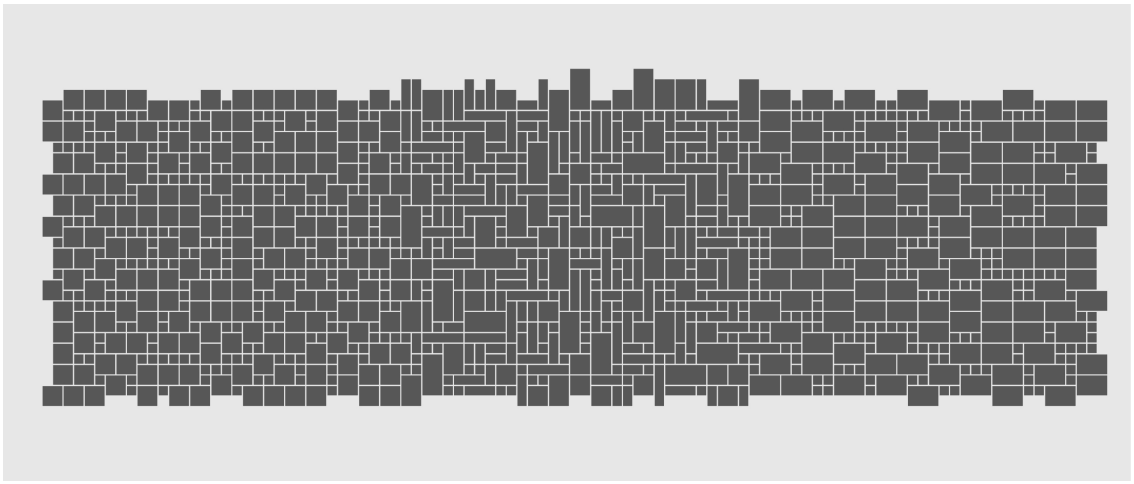
[287] Steffen Riegas in conversation with the author, “Digital tools are not the driver of anything. They are just tools.", Basel, August 6 and 7, 2019.

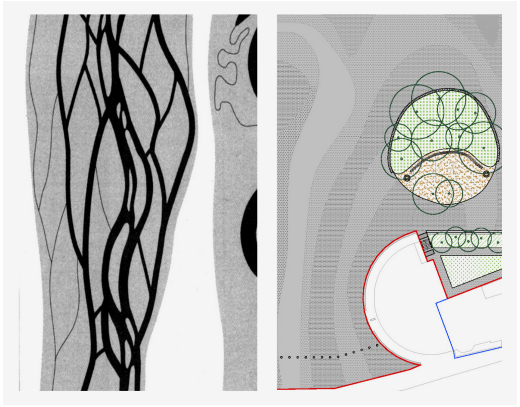
[288] Ibid.

[289] Ibid.

[290] Urs Hirschberg addresses the impact of Visual Programming Languages [VPLs] in design practice in his chapter about “Scripting”. Hirschberg says, “there is a conceptual line that leads from this playful, user-friendly methodology of teaching children coding right through to Grasshopper for Rhino, which—though not designed for children but for professional designers—similarly tries to, and fairly succeeds in, making things easy and intuitive for the user. The key to this is the Graphical Interface, or GI. […] The popularity of VPLs in architecture is no accident. Many people prefer them to the more 'bare bones' scripting languages such as, for example, Python, which is written in leaner code but more difficult to learn in terms of syntax. And this again will not come as a surprise: graphical interfaces imitate the process of modelling and allow the user to 'just get on with it' and design. And they're powerful tools in their own right. They make it comparatively easy to create shapes and alter them, to render versions and visualise objects ranging from the simple and compact to the complex and vast.” In Urs Hirschberg, “Scripting,” in *Atlas of Digital Architecture. Terminology, Concepts, Methods, Tools, Examples*, Phenomena, eds. Ludger Hovestadt, Urs Hirschberg and Oliver Fritz (Basel: Birkhäuser, 2020), 358.



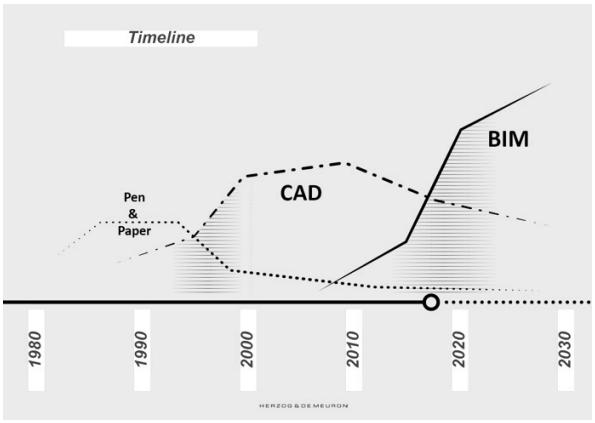




8.11
National Library of Israel, Jerusalem (2013—...). Israel Wailing Wall, slide from a conference by Jacques Herzog (2016).

8.12
Stone facade patterns inspired by eroded walls.

8.13 / 8.14
Stamford Bridge stadium, London (2013—...). Flowing river typologies concept image for the natural stone pavement around the stadium and detail of its parametric pattern.



8.15
Diagram on the drawing methods at HdM by Steffen Riegas.

just one of the many available tools for the design process that one may use or not, and which is part of a more comprehensive methodology.[291]

The diagram of the HdM drawing methods developed by Steffen Riegas reflects this standpoint and emphasises what is currently one of the department's priorities. Unlike Kai Strehlke, who structured the first version of this diagram using four topics,[292] with the digital parametric means playing an important part in one of them, Riegas classified the drawing methods into three categories—Pen & Paper, CAD and BIM—that he sees as distinct ways of handling the representation of the architectural object (***8.15***). For him, scripting is inside the BIM since it has to do, as he argues, with how the digital model is generated and put together. Therefore, while Strehlke regarded the drawing methods from the perspective of the mindsets implied in each of them and was concerned with the impact these may have on the architectural practice, even influencing how the design is driven, Riegas looks at the subject from a more procedural standpoint, focusing on the way of doing things and on how the processes of addressing the design are methodologically implemented.

“Hand Drawing, CAD and BIM are seen as a process", he explained. "This is about how you produce your final product. It also means that your final product is also different. Here you are producing a piece of paper, here a file that has 2D information in it and here you are producing a file that has 3D information and data."[293]

The majority of the projects by the office are currently documented in 3D, which means, as the diagram shows, that from the mid-2010s, BIM has acquired increasing relevance in the practice of

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[291] In the office, these kinds of tools are available to all collaborators who may use them when needed in the projects. The specialised support from the DT department is only required by the teams when issues achieve relevant complexity.

[292] Kai Strehlke's diagram is presented in Section 3.4, 36. As mentioned, the former head of the DTG structured the diagram using the following topics: Hand Drawing, 2D CAD, 2D CAD+3D Data and BIM.

[293] Riegas, “Digital Tools.”

HdM. Indeed, when we questioned Riegas about what has changed in the group over the last few years, he replied that in addition to growing, BIM and Revit had become a huge part of the work, with the competencies of the group members[294] becoming highly specialised in the management and coordination of this complex collaborative approach to design.

While in the beginning at HdM the experiments with BIM were pushed by specific scenarios,[295] in recent years, the creation of these information-rich digital models that can be shared collaboratively has turned into the natural approach to the design development of a building. And although Steffen Riegas is aware that this way of working is not something they deliberately decided to implement, having emerged as a sort of requirement from how the construction industry works nowadays, he recognises that this methodology, not yet perfect, makes sense and contributes to having a better product in architecture. "Maybe for the architects at first glance, it is more work, it takes longer, it's more effort you are investing," Riegas asserted, "but you get a better result. The quality of the model is better. The quality of your delivery is better."[296]

According to Steffen Riegas, one of BIM's misconceptions is that people often see it as only 3D documentation where drawings are simply no longer made. However, as the head of the DT department explained, within this data-supported collaboration they still do a lot of 2D work in the office. "Modelling is one-third of the work, the creation of the 2D documentation is another third, and then the last third is enriching all this with attributes and data",[297] he said.

Indeed, one of the particularities of this methodology, which distinguishes it from CAD systems, as also implied in Riegas' diagram, is that a 3D model or referenced set of models is at the heart of the whole process. Plans, elevations and sections are deduced from this single central source—the digital model—it being no longer necessary to update them. Any change made to any core models automatically gets translated into every other iteration or rendition of the building. This represents a leap in reliability and accuracy and avoids, as Riegas remarked, any conflicting information that was previously dependent on the expertise and interpretation of the person who executed the drawings.

In addition, when compared to CAD systems, BIM systems take a clearly different approach to planning methods once they are object-based rather than plan-based or model-based.[298] From this

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294 "As we speak we have 8 BIM managers full-time, and every project has a BIM lead. The BIM competencies in the office are still growing. Last time [we] met with all BIM Managers and BIM Leads, [we] realized that we can call 5% of the staff in projects Revit experts." Ibid.

295 When reflecting on the office's BIM strategy and specifically on the reasons that have led them to adopt this approach in the design development, Steffen Riegas realised that three different situations have pushed this: because it was legally mandatory, the client required it, or they realised it made sense to use it.

296 Riegas, "Digital Tools."

297 Ibid.

298 "The CAD programs of the first generation were really drawing tools: they generated […] two dimensional geometries which therefore consisted of their basic elements: lines and planes. Consequently, what you were able to create with these programs were essentially discrete plans or elevations, meaning they were flat drawings that contained no or little additional 'intelligence' or semantic information, that were unrelated to each other, and that therefore had to be amended manually every time any single aspect of the project changed.

A second generation of now 3D CAD systems was already capable of making complex 3D models. These were, by definition, no longer plan-based but model-based, which made it possible to automatically deduce from the core 3D model perspective drawings and plans, elevations, and sections, which would therefore correspond to the model. It was now no longer necessary to manually update individual drawings: these outputs were connected and related to each other. This, obviously, made for a leap in reliability and accuracy: both vital in any design and engineering project.

BIM systems take a principally different approach to design. No longer is either plan-base or model-based, but object-based, 'object' here referring to construction elements or objects, rther than to the overall architectural object. The model now is generated

specific feature derives what Riegas considers to be some of the advantages of this methodology but also its greatest weakness in design terms.

To generate a 3D model from either predefined or user-customised construction elements as building blocks endowed with detailed information about themselves is the crucial premise for the idea of collaboration that stands at the basis of this approach. The enrichment of the model with meaningful information stored in each object promotes a cross-discipline data integration that, besides facilitating the coming together of different fields of expertise, provides a basis for timely validations and simulations to test the design from many different parameters. Therefore, unlike conventional planning, these simulations can be implemented in the initial stages of the project, which means that different design options can be examined and compared to each other early on, which in turn may well improve the overall quality of the design.

"The questions are more demanding now in terms of what we want to answer, [for instance, as in the case of the] sustainability of a building", Steffen Riegas argues. "Ten or fifteen years ago, we were talking about some standards or certificates that you could quickly check if you had them. Now we are really looking at every little component of the building [...]. And in the model, you can immediately check because all items are connected, there's a database that has all these values, and then you can quickly see what works better, what makes more sense",[299] or even what is more convenient in terms of cost.

An example that the head of the DT department highlighted as emblematic of a quite successful implementation of BIM in the office is the project for Roche Building 2, Basel (2015–…) (***8.16 / 8.17***).[300]

In this instance, Riegas particularly stressed the consistent, but not always easy, collaboration between the team, the client and the engineers. All agreed on the BIM approach, as he explained, and worked together on this.

Besides Building 2, Riegas also mentioned the Roche Building 1, Basel (2009–2015), as a very similar building developed in previous years and where the experience gained from its realisation guided the planning and construction of the second tower, especially in what concerns the use of BIM. Despite not having been developed with a software like Revit, in Riegas' opinion, the project for the first high-rise was quite strategic. Building 2, as he argued, "is a logical development from what we learned from the [first] one."[301] Therefore, even though this was still a 2D documented work CAD project, according to Riegas, its planning already followed a BIM logic. In the project for the first high-rise, "all these modules are element-based", he said. "It is all coordinated, and we can join them in a 3D model. A door is not a line but an object AEC. It is as far as you can go with a product like Autocad. But technically, you can

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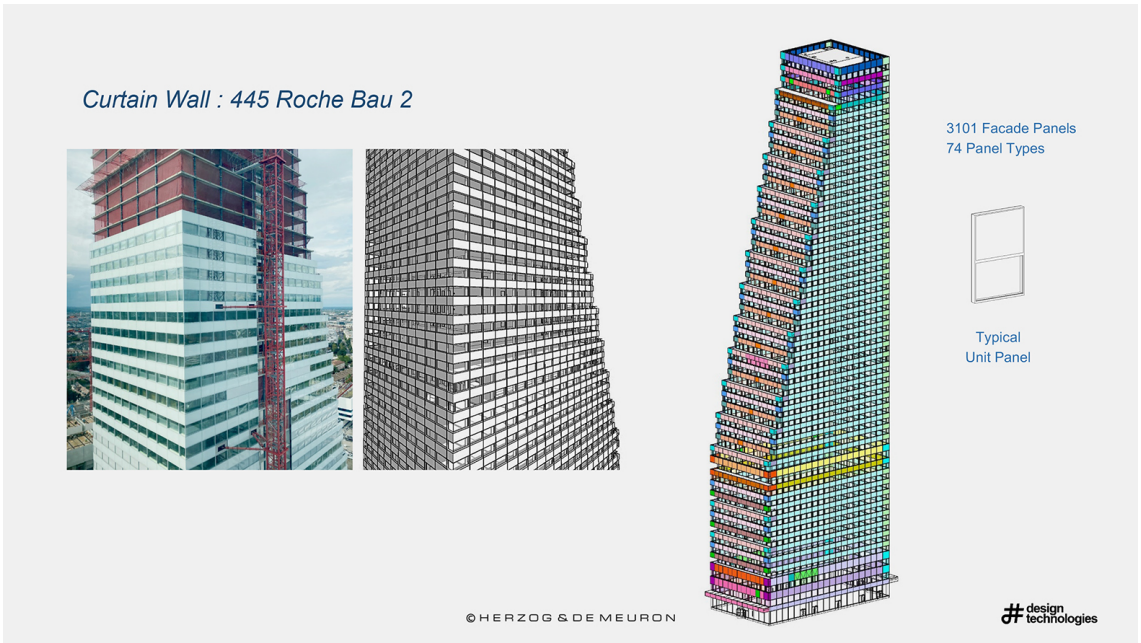
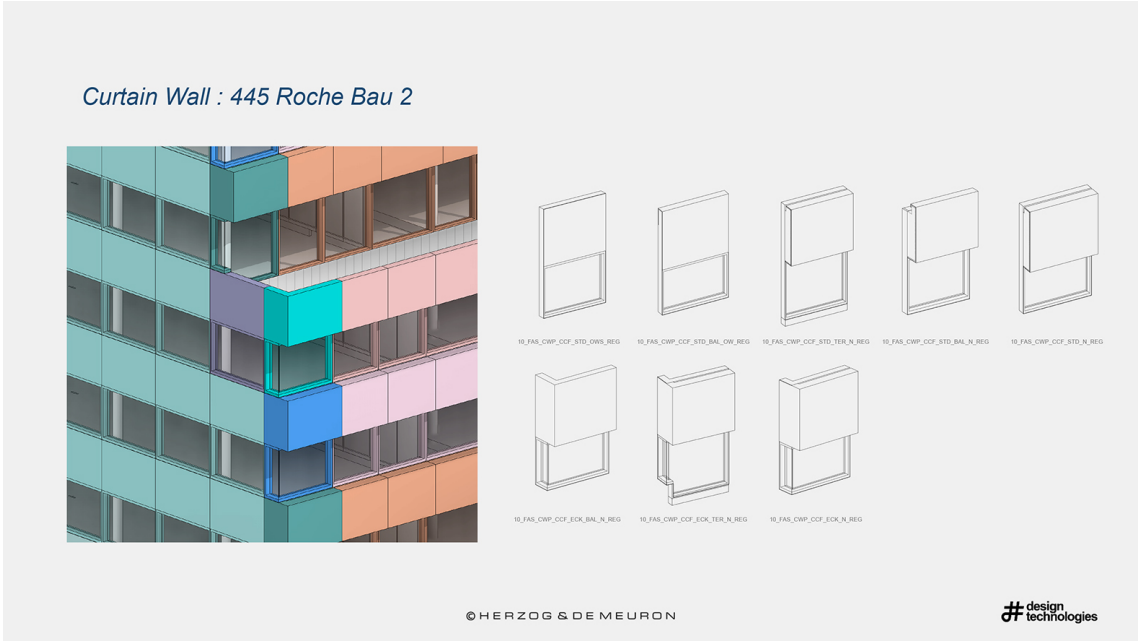
with either predefined or user customised construction elements as the building blocks for the design […]. As we've emphasised, these elements are not just geometries though, they are endowed with information about themselves, much of which is not merely useful, but in fact essential for the building to be able to stand up and fulfil its purpose." Jakob Beetz, André Borrmann, Petra von Both, Krank Petzold and Odilo Schoch, "Building Information Modelling (BIM)," in *Atlas of Digital Architecture. Terminology, Concepts, Methods, Tools, Examples*, Phenomena, eds. Ludger Hovestadt, Urs Hirschberg and Oliver Fritz (Basel: Birkhäuser, 2020), 513.

299 Steffen Riegas, in conversation with the author, Basel, May 6, 2022.

300 A short article has further developed this subject. Patrick Pick, "Neue Bauten auf dem Roche-Areal". *Espazium*, October 29, 2020. https://www.espazium.ch/de/aktuelles/neue-bauten-auf-dem-roche-areal.

301 Steffen Riegas, in conversation with the author, Basel, May 6, 2022.





8.16 / 8.17
Variations on the module of the window component element for the Building 2 curtain wall facade. Slides from a presentation for an in-house BIM workshop.

put all these drawings together and have a 3D full build model. […] So in this sense, Building 1 was already a BIM project, just done with the Autodesk AEC, and Building 2 is a full Revit model."[302]

To achieve the primary goal of BIM—an interdisciplinary collaboration based on the planning and coordination of data and information flows from the management of the digital 3D object—implies that the model is rich in precise and detailed information about each component. This means that the construction of the virtual model goes beyond the purely geometrical aspects. The model represents the object in physical terms, but it also contains a wealth of data that is useful for developers to have to hand and share. Therefore, the modelling process is about geometry and data, which somehow ends up compromising BIM software as the ideal instrument to use to address the design early on.

In fact, even though Steffen Riegas thinks that BIM "makes sense in the later stages of design,"[303] he agrees that perhaps this is not the tool one uses to develop the initial ideas for a building.

As he argued, "we constantly change tools for different tasks or phases. In an early concept phase, a pencil and a napkin that's fine [...]. But of course, if you are on a construction site, you should maybe replace the pencil with something a bit more precise that can handle more information. That's when BIM as a method and Revit as software become interesting. It is very precise, and it's easy to coordinate with a lot of different people."[304]

So, to avoid losing the crucial freedom and intuitiveness in exploring the shape of objects—which, in a way, is limited by BIM software, since the architectural elements must always refer to constructive components—the DT continually works on strategies that allow architects to keep the best of both worlds. For example, "BIM Light", as Riegas named it, is an initiative they have in the office in which the teams mostly use a digital tool like Rhino to be able to already apply BIM ideas in very early concept stages, at the same time as they benefit from all the flexibility it gives in manipulating geometry. "What we are trying to do", Riegas disclosed, "is that we still want to model with Rhino easily, like intuitively, but we want to be able to attach a lot of extra information to what we model."[305]

8.3 _ Digitally Generated Reality

As we write, in our last visit to the HdM office in Basel, in May 2022, the DT team was particularly excited about a short video they had just finished at that time. When we met them, two collaborators responsible for its production were enthusiastically reviewing it with Steffen Riegas. They wanted to hear his opinion about it and know whether they had to make any adjustments to improve it. The video presents, in a quite playful and creative way, some of the most recent research the department is carrying out in the visualisation and virtual reality field (***8.18***).

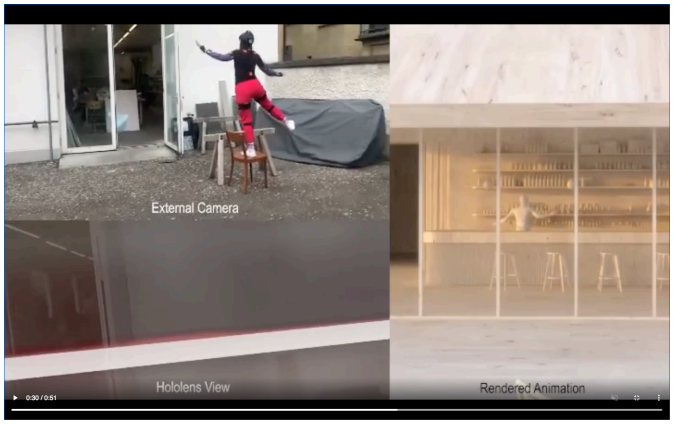
An Italian female architect working at the DT is the video's protagonist. She was filmed with some colleagues in the Campus courtyard in Reihnschanze. She wears a motion capture suit, has a HoloLens device on, and interacts with a stool, the only physical object that makes up the real scenario. The rest

302 Ibid.

303 Riegas, "Digital Tools.".

304 Ibid.

305 Ibid.



8.18
Animation produced by the DT on reconstructing full-body locomotion sequences for virtual characters (2022).

of the environment—a bar counter with some drinks shelves behind it, some more stools and the space delineation—she sees as holograms displayed by the smart glasses.

In the video, the Italian girl plays the character of a bartender who uses the stool to pick up some bottles from the shelves to prepare a drink. Afterwards, she returns to the room and dances excitedly for a moment.

The team is testing the reconstruction process of full-body locomotion sequences. They are digitally recording her custom movements for a virtual character to use in architectural animations. The video documents the making process. It shows, in a three frame window, the real situation filmed in the courtyard by an external camera, together with the mixed reality view that one can experience when wearing the headset and the rendered animation of the digital model with the reconstructed virtual character, all having as background the odd bar scene.[306]

The video is revealing of the work the department is currently developing to explore recent technologies for visualising and dynamically representing architecture in the search for use cases that can improve their application in the design process and the projects' communication. Indeed, in the last few years, techniques to visually bring an architectural object to life—statically by renderings, dynamically with animations or interactively through virtual and augmented reality—have become ubiquitous in the office and with greater relevance for the design practice.

In HdM, every project is currently documented in 3D. A virtual 3D model of the architectural object lies at the core of the design process, making it simple to produce renderings that depict the object, even only in geometric terms, to assist the decision-making early on. In the conversation we had with Wim Walschap, partner of HdM, he disclosed that rendered images had, in fact, acquired a crucial role

[306] A revised version of the video we saw in Basel was posted on the HdM Instagram page on June 14, 2022. https://www.instagram.com/p/Ceyc_qhKfnu/.

8.19
Hortus, Allschwil (2020–…). Still of the project 3D animation.

in the office's practice, asserting themselves in some cases even as an alternative to the construction of physical models. While some years ago, renderings were mainly used at the very end to present the project, nowadays, at HdM, architects apply them on a daily basis.

"At that time, we were working more with physical models and refining things in these models", Wim Walschap mentioned. "I've seen that in the span of the last ten years, very often we don't work with physical models anymore, because it takes too long. [...] In one of my projects, I really saw the shift. [...] The design time is so limited that you have to go much faster, and by the time the physical model is done it is already too late. So it was not following the design process anymore. There, I clearly saw that we switched to 3D modelling and rendering, but rendering for daily use, to make steps in the design work."[307]

Along with renderings, animations have also turned into an everyday tool, not only to present the project to the client but also to support the design discussion within the teams. Thus, the DT has recently begun experimenting with visual languages that maintain the architectural object at a certain degree of abstraction so that these videos can be used early in the initial design stages. As a result, these animations do not depict the vision for the project in captivating detail, with features, materials and decorative elements all beautifully rendered. Instead, the character of the generated model is that of a real physical model done in cardboard or any other plain and homogeneous material that lacks photorealistic detail. This makes it particularly suitable for communicating the design in intermediate phases, as it avoids, in its bareness, the creation of overly ambitious images in the minds of the decision-makers.

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[307] Wim Walschap in conversation with the author, “It makes it more interesting by not being perfect,” Teams meeting, Porto-Basel, July 16, 2020.

8.20
Physical model for the project of the Puerto de Santa Cruz, Santa Cruz de Tenerife (1998–2004).

The animations are also enriched with 3D animated characters that, in addition to giving scale to the model, introduce the time component and reveal how people might move, behave and interact with the architectural object (***8.19***). Thus, when looking at these short videos, one might be reminded of those typical HdM physical working models done in the late 90s and early 2000s that also had some white human figures and whose photographs, taken from carefully defined points of view, were often used as the basis for creating digital collages (***8.20***). The style is quite similar, which reinforces the feeling that we were looking at these static cardboard models that suddenly seem to have come to life, revealing an enhanced dynamic vision of the project.

To amplify the perception of the non-yet-built architectural objects and to have the ability to test design solutions interactively, architects at HdM also experience the projects immersively through virtual and augmented reality.

Steffen Riegas considered this a strategic priority when he took over the DT group in 2014. Back then, for him, it made sense to introduce virtual reality in the office and provide the teams with a medium in which they could immerse themselves in a digitally generated simulacrum of their designs. As professionals who conceive objects that one may have an entire perception of only when they are built, architects constantly seek ways to experience the imagined objects as fully and precisely as possible.

And for a practice as experimental as HdM, this issue has always been critical, having even sometimes become a research interest that was part of the form-making processes of their architecture.

“You can draw a sketch, you can build a model, but the furthest you can go is to probably build a mock-up in 1:1, and then the real experience, you have it when it is finally built,” Steffen Riegas said.

"However, it takes time, and you only have one shot. So that was the promise of virtual reality, that you can experience the architectural object in the scale 1:1." [308]

The extension to the MKM Museum Küppersmühle, Duisburg (2013–2021), was the case study in which the department, around 2016, tested for the first time the potential of virtual reality for simulating and communicating architecture. The design of the intricate spiral staircase for the new building, spatially inspired by that of the 1999 project,[309] was the trigger for the whole experimental process.

The stairs are interior, narrow and geometrically complex, which raised the question of how one could have a full perception of their configuration and how it would feel to walk on them (***8.21***). Traditional means of representation were particularly limited to conveying the elaborate form of the stairs and their atmosphere. Therefore, according to Riegas, virtual reality proved to be the best tool to complement the insight provided by drawings, renderings and physical models (***8.22 / 8.23***). That allowed the design team to really get into the staircase. For the first time in the office, architects were no longer outside the computer, looking at its display, but they effectively stepped into the digital world and interacted with it by physical means.

Besides allowing the teams to experience the space from within, virtual reality also enabled them to develop and work on the stairs, refining the design in an interactive process of continually looking at the object and then returning to the model to make adjustments as necessary until they got what they wanted to achieve. In addition to the staircase, in Küppersmühle, the work in the virtual world also extended to the adjacent gallery spaces—simple white boxes with paintings hung on the walls (***8.24***). For both the client and the design team, this became a very useful tool, which they played with to move paintings and to try out different exhibition frameworks and also to change the rooms' configurations by moving walls and ceilings directly in the virtual environment or simply flipping through different design options.

Following this experiment, virtual reality became a topic in the office.

Over the last few years, hand in hand with the technological developments, the DT has continually searched to minimise its pitfalls and to create additional tools that improve it as a design instrument, making it accessible to everyone in the office and enlarging the toolbox for HdM. "Virtual Reality is not anymore a DT thing. This is already around in the office", Steffen Riegas asserted. "The teams don't need any kind of specific technology. The architects themselves model the objects in Rhino, and the technology they need to see these in the VR glasses, the Enscape, they have. […] so they are totally autonomous in this issue. They don't need us anymore."[310]

By the end of 2019, in one of our visits to the office in Basel, we occasionally met Jacques Herzog in the room where the DT sits. Herzog was quite enthusiastic about the potential of virtual reality for the architectural practice, something he later confirmed in our conversation in June 2021.

When we questioned him about the interplay between the tools architects use to represent architectural objects and design practice, Herzog asserted that virtual reality is a powerful tool that

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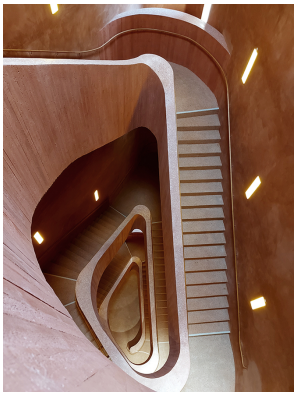
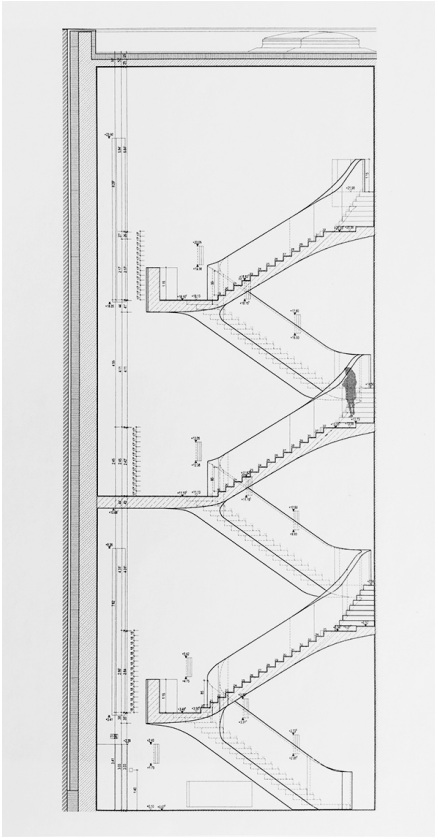
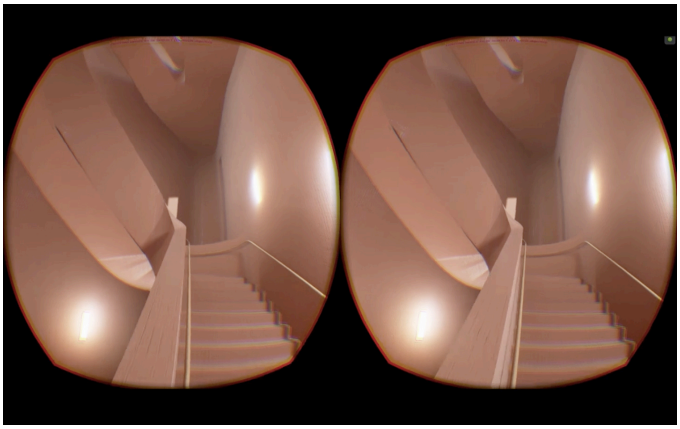
308 Steffen Riegas, in conversation with the author, Basel, May 6, 2022.

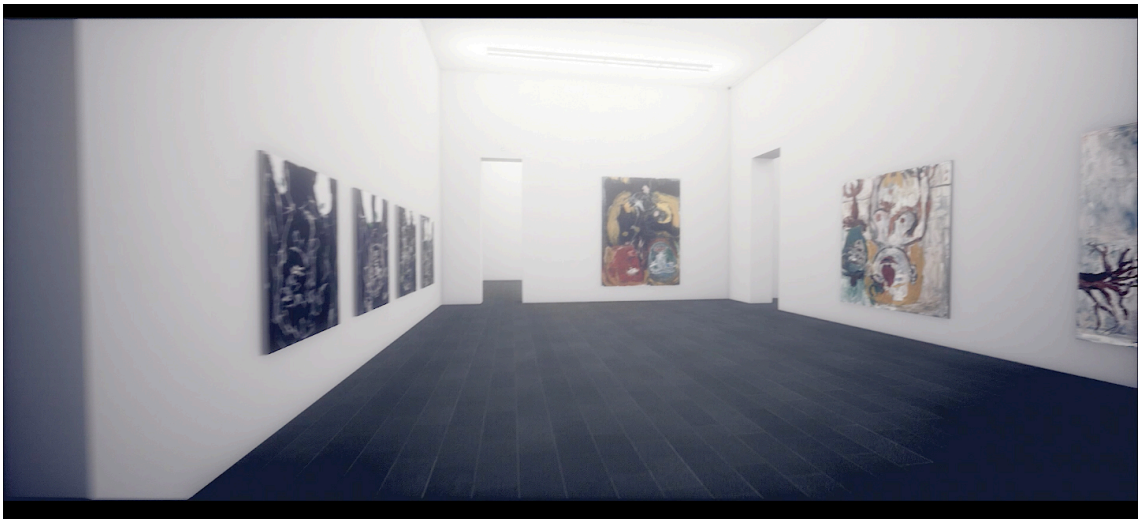
309 We refer to the conversion of the existing industrial building into a museum for the Grothe collection, which the office listed as project 151, Küppersmühle Museum, Grothe Collection, Duisburg (1997–1999).

310 Steffen Riegas, in conversation with the author, Basel, May 6, 2022.









8.21
MKM Museum Küppersmühle, Duisburg (2013–2021). Photo of the intricate spiral staircase.

8.22
Stereoscopic cubemaps for the virtual reality of the stair.

8.23
Staircase cross-section.

8.24
Frame of the exhibition rooms virtual reality video.

amplifies the perception one can have about projects nowadays. "We can now use VR and walk around in our buildings before they are built", he said. "As you walk around there with your headset you discover more things than ever before. That clearly helps you to discover things that you normally wouldn't have seen. It is a new tool and a very efficient one."[311]

For him, it is clear that, like other tools, virtual reality is merely an instrument that helps architects to understand what they want to achieve in a specific project without ever replacing "what one might call the inspiration that is often still needed to get the project started."[312] However, he also suggested that virtual and augmented reality, as new tools, "are again opening up new paths that [HdM] are about to explore quite a bit."[313]

Indeed, in recent years the idea of planning a new major HdM exhibition to take place in London with the topic of virtual reality as the trigger and background theme for its conception has been in the air.

The last major exhibition by HdM was held almost 20 years ago at the Schaulager, Basel. Before that, exhibitions used to be frequent, standing out from their work as high moments in which one could have an insight into their rich, inventive imaginary and, at the same time, intuit possible future paths for their research. Therefore, if this exhibition were to take place, it would undoubtedly be an inspiring occasion to ascertain how HdM continue to appropriate and reinvent architectural tools to improve their design methods and expand their creative possibilities. At the same time, it would make us return to their beginnings, where, using the then-innovative video still, they were already exploring the "reality of images".

311 Herzog, “We are surrounded.”

312 Ibid.

313 Ibid.

M.1
HdM Chronology Map

Sketches and Plans
(1978–1988)

Collage and Perspective
(1989–1997)

Pixellation and Digital Modelling
(1998–2004)

Scripting and Parametric Design
(2005–2014)

Data and Interaction
(2015–2020)

HAND-DRAWING

2D CAD

2D CAD + 3D DATA

BIM

007 | Swimming Pool Am Mühlebach
Wohlen, Switzerland
C:79, 81 P:80

005 | Blue House
Oberwil, Switzerland
P:79 R:79-80

003 | Redesign of the Markthalle
Basel, Switzerland
C:79 P:80,83,85,87

002 | House for a Veterinary Surgeon
Dagmersellen/Lucerne, Switzerland
P:83 R:84

017 | Stone House
Tavole, Italy
P:82 R:85-88

014 | Fiat Photographic Studio
Wall am Rhein, Germany
P:81 R:81-82

025 | Schützenmattstrasse 8,
Basel, Switzerland
C:84-85 P:91 R:92-93

034 | House Art Collector
Therwil, Switzerland
P:85 R:86

027 | Outdoor Swimming Pool
Rehen, Switzerland
P:86-87

043 | Housing Pilotengasse
Vienna, Austria
P:87-88 R:89-92

033 | Vlop Theatre
Vaja, Switzerland
C:84

031 | Schretter Building
Basel, Switzerland
C:85 P:85 R:87-88

035 | E, G, K, N, Pavilion
Rheinfelden, Switzerland
C:86 R:87

044 | Schwarz Park
Basel, Switzerland
C:87-88

032 | SUVA House
Basel, Switzerland
P:88-90 R:91-93

049 | Signal Box
Basel, Switzerland
P:89 R:91-94

048 | Railway Engine Depot
Basel, Switzerland
P:89 R:91-95

065 | Stadswerkt
Basel, Switzerland
C:90

064 | Antipodes I
Gizzo, France
P:90 R:91-92

072 | Arts Centre
Bilzio, France
C:91

071 | Berlin Zentrum
Frankfurt, Germany
E:26.01-24.03.91

084 | Roots-Europe SA
Muhlhose, France
P:92 R:93

090 | Two Libraries
Paris, France
C:92

100 | Roche Building 92
Basel, Switzerland
P:93-95 R:96-00

098 | Library of the RUT
Cottbus, Germany
C:93

119 | Central Signal Box
Basel, Switzerland
C:94 P:95 R:98-99

106 | Dalvesselle Library
Dalvesselle, Germany
P:94-96 R:97-99

133 | Studio Remy Zaugg
Mulhouse, France
P:95 R:95-96

132 | Inst. fr. Pharmaceuticals
Basel, Switzerland
P:95 R:97-98

141 | Schauspielhaus Zürich
Zurich, Switzerland
C:96

128 | House in Leymen
Leymen, France
P:96 R:97

154 | Novartis Marketing Build
Leuben, Switzerland
P:97 R:98-99

151 | Kopppermmühle Museum
Duisburg, Germany
P:97 R:97-99

163 | REHAB Basel
Basel, Switzerland
C:98 P:98-99 R:99-02

163 | Puerto de Santa Cruz
Tenerife, Spain
C:98 P:99-04 R:07-

173 | De Young Museum
S. Francisco, California, USA
C:99 P:00-02 R:02-05

164 | TDA
Tenerife, Spain
P:99-07 R:02-08

179 | Prada Aoyama
Tokyo, Japan
P:00-02 R:01-03

177 | Adur Plaza Hotel
New York, New York, USA
P:00-01

201 | Caixaforum Madrid
Madrid, Spain
P:01-03 R:03-08

189 | Hisarna Winery
Pomarol, France
P:01-03

208 | National Stadium
Beijing, China
C:02 R:04-08

214 | Sinibaldi Bäuferli10
Basel, Switzerland
C:02 P:04-11 R:06-12

227 | Rotterdoy
Dennis, Switzerland
P:03,05

225 | Roche Building 65
Basel, Switzerland
P:03-05 R:04-06

263 | 40 Bond, Apt. Building
New York, USA
P:04-05 R:06-07

213 | Messe Basel - New Hall
Basel, Switzerland
P:04-12 R:13-13

269 | Beijing Film Academy
Qingdao, China
P:05

283 | Tate Modern Project
London, UK
C:05 P:05-12 R:10-16

290 | Roche Building 57
Basel, Switzerland
P:06-08 R:08-11

286 | Roche Building 97
Basel, Switzerland
P:06-08 R:08-11

312 | Helsinki Deepcity
Basel, Switzerland
P:07-13 R:12-14

311 | Waterfront Hotel
Helsinki, Finland
P:07-08

337 | Fehmarn Parla Volta
Milan, Italy
P:08-13 R:13-16

349 | Parrish Art Museum
Water Mill, New York, USA
P:08-10 R:10-12

343 | Cultural Complex Luz
São Paulo, Brazil
P:08-

370 | Pavilion at a Lakeside
P:10 R:11

362 | Aabeppa II
Basel, Switzerland
P:10-13 R:13-15

377 | Hinterphalt Zürich
Zurich, Switzerland
C:11-12 P:14-

354 | 1 Arena do Morro -
Vila Luca, Natal, Brazil
P:11-12 R:12-14

400 | Fitzroy Street Station
Melbourne, Australia
C:12-13

398 | Jade Signature
Florida, USA
P:12-14 R:14-18

418 | Mond Oppenheim
Basel, Switzerland
P:13-15 R:15-16

417 | Vina Schaudepot
Weil am Rhein, Germany
P:13 R:14-16

416 | Roche Development Plan
Basel, Switzerland
P:14

416 | New North Zealand Hosp.
Hillerød, Denmark
C:13-14 P:14-

448 | Bangarwan Institute
Los Angeles, California, USA
P:15-

445 | Roche Building 2
Basel, Switzerland
P:15-22

469 | Museum der Moderne
Berlin, Germany
C:16 P:16-

478 | Bastiekwicky Brewery
Moscow, Russia
P:17-

472 | Royal College of Art
London, UK
C:16 P:16-18 R:18-21

515 | Autodesknicho
Andeer, Switzerland
P:19-

543 | Hafnia
Allschwil, Switzerland
P:20-

570 | Bridge Porto
Porto, Portugal
C:21

HdM. Exploring SongEun Art Space
Seoul, Korea
E:06.09-20.11.21

029 | Lego House
Paris, France
E:10.07-29.08.95

047 | Architektur Denkform
Basel, Switzerland
E:01.10-20.11.98

074 | Architektur von Herzog & de Meuron
Kunstverein München, Munich, Germany
E:01.03-07.04.91

076 | La Biennale di Venezia
Swiss Pavilion, Venice, Italy
E:08.09-06.10.91

Portraits by Thomas Ruff
Pete Blum Gallery, NY, USA
E:08.06-05.09.94

130 | HdM, by Rémy Zaugg
C.Pompidou, Paris, France
E:08.03-22.05.95

127 | Portraits by Thomas Ruff
TK-Probe, Tokyo, Japan
E:22.11.96-09.01.97

The Un-private House
MOMA, New York, USA
E:01.07-03.12.98

183 | HdM, Archäologie de l'Imaginaire
CCA, Montréal, Canada
E:23.10.02-06.04.03

250 | HdM, No. 250. An Exhibition
Schaulager Basel, Switzerland
E:06.09-09.09.04

EXHIBITIONS

PROJECTS

1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

120 employees

360 employees

Part II

The Tate Modern Extension, between Analogue and Digital

9.01
The Tate Modern, London. View of the west elevation.

9.
Tate Modern Extension

9.1 _ The Conversion of the Bankside Power Station
9.2 _ The Extension of Tate Modern 1
9.3 _ The Project for Tate Modern 2
9.4 _ The Office of HdM around 2005

Four years after the opening of the Tate Modern in 2000, Herzog & de Meuron started working on the design of its second phase. For the architects, this was an opportunity to return to a highly esteemed project that had meant so much for their careers.

Tate Modern 1 (TM1) was the first, and the largest, project developed by the office to have a significant international impact, not only in the architectural context but also in the world of art. The conversion of Gilbert Scott's building into the first modern art gallery in London was the project that brought HdM, at the beginning of 2000, into the realm of internationally acclaimed architects. "It is the project that made the company world-renowned. It is as simple as that", Harry Gugger explained. "The company was already well-renowned in the world of architecture, but not publicly recognised, [...] [and] the Tate project made the office popular. It was an important stepping stone in the evolution of the office."[1]

For HdM, the project for the Tate Modern extension (TM2) implied, in the first instance, a dialogue with their own work. Much of the architectural research HdM developed in the 1990s is synthesised here. Therefore, while dealing with the completion of the existing building, HdM chose to take the logic and the fundamentals established in TM1 as the premise for the design of the new extension.

"The second phase should feel like part of one and the same building complex, with its robust industrial architecture",[2] Jacques Herzog said. Therefore, an architectural approach based on the acceptance of the character of the existing building, and an interest in enhancing it, guided the whole intervention again. In TM2, old and new would stand side by side in a dialogue balanced between continuity and innovation ***(9.01***).

9.1 _ The Conversion of the Bankside Power Station

In May 2000, an inaugural exhibition of works by Louise Bourgeois was held at the Tate Modern's Turbine Hall, marking the opening of the modern art gallery to the public.

The installation by Louise Bourgeois consisted of a sequence of three steel towers placed in the eastern part of the Turbine Hall. All of the sculptures, made of spiral staircases surrounding a central column, were designed for people to climb up. Arriving at the top platform they would find, in two of them, large circular mirrors. As the artist described them, these sculptures "were about looking and being looked at",[3] promoting, with their intricate crossing of reflections, an interaction between the public, the work of art and the architecture itself.

Besides these three towers, Louise Bourgeois revealed her monumental steel spider "Maman" on the bridge of the Turbine Hall—the largest spider sculpture ever made by her, and shown for the first time on this occasion ***(9.02***). For the French American artist this was a remarkable exhibition that,

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1 Harry Gugger, in conversation with the author, "This is too generic; this is not the Tate!", Basel, February 20, 2020.

2 Jacques Herzog, Pierre de Meuron, "Jacques Herzog and Pierre de Meuron in conversation with Chris Dercon," by Chris Dercon, in Chris Dercon and Nicholas Serota, eds., *Tate Modern, building a museum for the 21st century* (London: Tate Publishing, 2016), 98.

3 Louise Bourgeois quoted in Adrian Searle, Jonathan Jones, Charlotte Higgins and Skye Sherwin, "The Tate Modern at 10," *The Guardian*, May 4, 2010, https://www.theguardian.com/artanddesign/2010/may/04/tate-modern-10th-anniversary.

9.02
The big spider “Maman” by Louise Bourgeois exhibited at the bridge of the Turbine Hall in 2000–2001.

9.03
The Turbine Hall seen from the west entrance.

besides making her a “household name”,[4] represented an undeniable opportunity to pursue her artistic research on a large scale.

Louise Bourgeois was the first contemporary artist invited by the Tate to create an installation especially designed for the distinct and challenging Turbine Hall. This was the first in the Tate’s series of annual commissions for the space. Since then, this vast exhibition hall has been filled with a succession of works of art that stand as "some of the most innovative and significant sculptures of recent years".[5] Large-scale installations, like "Marsyas" by Anish Kapoor (2002–2003) or "The Weather Project" by Olafur Eliasson (2003–2004), are explicit expressions of how the unique spatiality of the Turbine Hall may be reinterpreted by artists, and play an active part in their artistic approaches.

Referring to Tate Modern's annual commissions, Adrian Searle remarked on the innovative character of this initiative within the museum context of the early 21st century, implying that the Turbine Hall itself played an essential role in this accomplishment. "The Turbine Hall presents an enormous opportunity, but also a huge career risk. [...] [It] is the most public museum space anywhere and is spectacular in itself. [...] To show here is a test of an artist's capacity and ingenuity. No one accepts the commission lightly, and no one can get away with going through the motions. [...] In an age of spectacle, it continues to put art itself to the test."[6]

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4 "The twisted steel legs of her giant spider Maman, alongside a sequence of fabulous, hellish towers, gave the brand-new Tate Modern an instant visual signature, and made the then 89-year-old French-born New York artist a household name. Until then, Bourgeois had been revered by a small world of contemporary art fans", in Searle, Jones, Higgins and Sherwin, "The Tate Modern at 10."

5 “The Unilever Series,” Exhibitions & Events, Tate, accessed February 25, 2020, https://www.tate.org.uk/whats-on/tate-modern/exhibition/unilever-series.

6 Searle, Jones, Higgins and Sherwin, "The Tate Modern at 10."

In 1995, when HdM won the competition for the conversion of the Bankside Power Station,[7] they were far from knowing how significant their design strategy would be for the success of the modern art gallery in London. A few years later, after Tate Modern proved to be one of the most visited modern art museums in the world, Jacques Herzog was completely aware of this, saying that the Turbine Hall "is the key design piece on the way to creating Tate Modern".[8] It became not only a new type of exhibition space, envisaged as a public forum opened up to the city and attracting a lot of people, but also turned out to be a challenge for artists and led to the development of a new kind of artistic work (***9.03***). The hall, as mentioned by Pierre de Meuron in an interview, was "not in the brief, there was no requirement to have it, but it was given by the building. It created a wholly new way of showing art."[9]

Among the several design proposals presented in the architectural competition for the new museum, by the end of 1994, the project by HdM stood out for its simplicity and the almost invisible but powerful few interventions proposed, which revealed, as mentioned by Nicholas Serota, "their ability to recognise what the fundamental elements were that should be retained and what could be dispensed with".[10] As requested by Tate, HdM avoided a signature building, and instead of working in opposition to Gilbert Scott's power station, they accepted its industrial character and monumentality and even worked to reinforce them. The whole intervention was moved by an understanding of the nature of the building and a search for solutions that would seek to heighten it rather than deny it. The architects treated Scott's construction as part of their structure, aiming to give it continuity through a natural growth process in which old and new coexist side by side in a gentle relationship.

The Turbine Hall was without doubt a significant move.

Rather than using the underground level of the central nave of this industrial building as a black box or an auditorium, HdM decided to dig it out, to remove the floor at ground level, revealing the space beneath it and making the hall feel even more monumental (***9.04***). Thus, a great covered plaza was created in the core of the new museum, leading people from the city to its interior in a very natural way through a slow descent. The Turbine Hall's design strategy also took into consideration Tate's intention to open the museum to the south side and use the oil tanks as exhibition spaces, even if, for budgetary reasons, this had to be postponed until a second phase. For HdM, it was clear that the Turbine Hall, standing in the central axis of the old power station, should be seen as akin to a street that runs through the building, having a north facade and a south facade in which the "commercial areas", on both sides, animate the space and give sense to its configuration.

In Jacques Herzog's opinion, the success of this space is also due to the fact that they opted to leave its architecture raw and industrial, and didn't add many signs of their design. "There is little evidence of an architect's handwriting", said Jacques Herzog, "which can often be a bit awkward and

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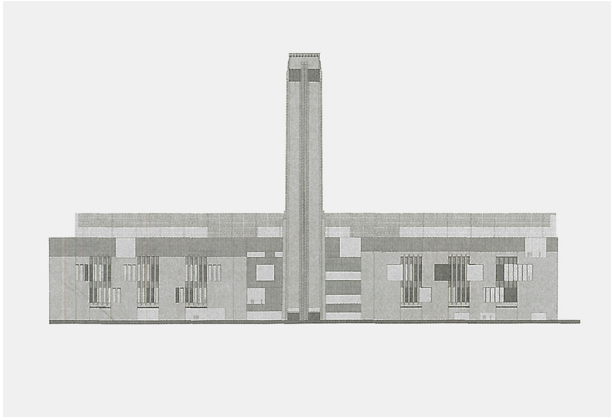
7 This project is listed by the office of HdM as "126 | Tate Modern. London, UK. Competition 1994–1995, project 1995–1997, realization 1998–2000".

8 Herzog, de Meuron, "In conversation with Chris Dercon," 94.

9 Rowan Moore, "Herzog & de Meuron: Tate Modern's architects on their radical new extension," *The Guardian*, May 15, 2016, https://www.theguardian.com/artanddesign/2016/may/15/herzog-de-meuron-interview-tate-modern-switch-house-extension.

10 Nicholas Serota, in conversation with the author, "Tate Modern 2 is a post-digital building," Zoom meeting, Porto-Helston, June 25, 2020.



9.04
The removal of the flooring in the Turbine Hall during conversion works.

9.05
Proposal for the river elevation.

invasive. Our main contribution was to make the space even more like what it was already or like what it wanted to be when it was first built, namely, an industrial cathedral."[11]

This same approach is also evident in the external appearance of the building.

Although the interior of the power station was demolished, with only the steel frame structure encircled by the brick walls remaining, and an entirely new set of gallery floors has been installed in the Boiler House, from the outside, the signs of the architects' intervention are quite hushed. The brick masonry walls were preserved, and the new design for the north facade was established with an accurate sense of fusion and integrity that makes it difficult, at first sight, to distinguish between what is old and what is new. However, the several studies that were developed for the river elevation (***9.05***) reveal that more expressive approaches were also taken into consideration, such as the radical cut out of the brick facade for the introduction of new openings, similar to what the architects would do later in the project for the Küppersmühle Museum in Duisburg, Germany (1997–1999) or the Caixa Forum in Madrid, Spain (2001–2008). However, as mentioned before, the intention of the Swiss architects was never to obliterate or overwhelm Gilbert Scott's architecture. Therefore, HdM removed some additions made to the existing building. They reconstructed some elements that had been destroyed, and even redesigned other parts of the fabric in a contemporary language, such as the recessed part of the facade to the left and right of the chimney, while always having in the background the intention of not disturbing the original composition. "Initially we altered the existing building radically, but, more and more, we became restrained, accepting the building as it is", said Harry Gugger. "The interventions were reduced to the ground floor because of the restaurant. So the specific functions made the exceptions, and the rest stayed as it was."[12]

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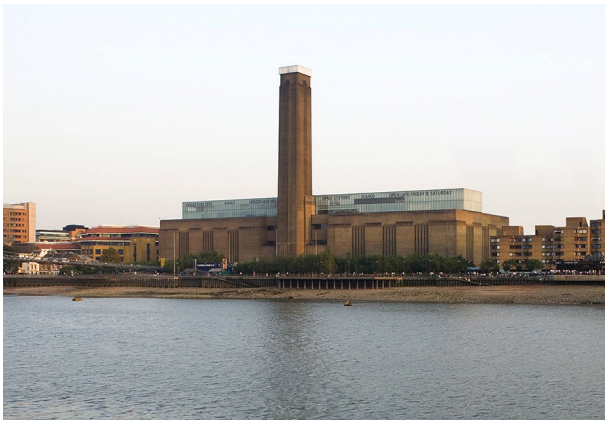
11 Herzog, de Meuron, “In conversation with Chris Dercon,” 97.

12 Gugger, “This is too generic.”



9.06
TM1 seen from the north bank of the Thames.

The "light beam" is the new architectonic element that fully announces the transformation of the power station (***9.06***). Placed asymmetrically on the roof of the Boiler House to provide natural light to the interior of the exhibition galleries, the "light beam" signals the contemporary intervention straight away. With a discrete presence during the day, this glass box, with its simple geometric composition, glows intensely by night, emphasising the verticality of the chimney and pointing out, as mentioned by Harry Gugger, that now "it's about light and not electricity any more."[13]

9.2 _ The Extension of Tate Modern 1

When Nicholas Serota, director of Tate from 1988 to 2017 and client for both TM1 and TM2, together with the trustees, chose the Bankside power station as the location for the first modern art gallery in London, they were aware of the potential this building had to respond to the spatial demands of the new kinds of artistic works that started to be developed around the 1960s. The use of a former power station, a distinguished building designed by Giles Gilbert Scott at the end of 1940, was also in line with the new museum typology that emerged in the 1980s with the reuse of warehouses and derelict industrial factories as exhibition spaces in which contemporary art was shown and experienced in a completely new way. "Herzog & de Meuron had the ambition to make a museum that offered many different kinds of gallery space", Nicholas Serota pointed out, "because artists sometimes want space which is refined and pure, but they also want to respond to raw industrial space [and] we had the opportunity to give them both."[14]

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13 Ibid.

14 Serota, “Tate Modern 2.”

However, the impact that the conversion of this industrial building could have in the Southwark area, which, since the 1950s, had been peripheral to the development of London, was also important for the trustees. The creation of the new museum could trigger urban development and contribute to new vigour in this part of the city, located as it was in a prominent position right in front of St. Paul's Cathedral and the City of London.

For Nicholas Serota, Bankside had great promise "not just for Tate but for London as a whole".[15] And, in fact, the enormous public success of Tate Modern[16] in the years after its opening had an immediate impact on the surrounding context. Bankside started to attract property developers and suddenly became, as Oliver Wainwright described, "a hotspot of supercharged property speculation".[17] Office blocks with commercial areas, and luxury apartment towers, were constructed right next to the modern art gallery, threatening its possible future development. What started as an instant side effect of Tate's own success became one of the main reasons leading the institution to anticipate the already planned second phase of development.

The intention to expand the modern art gallery using other parts of the old power station, like the oil tanks, and the idea of opening the museum to the south to improve the urban connection between the riverside and Southwark through the bridge of the Turbine Hall, had always been in consideration since the earliest proposals for TM1 (***9.07***). However, in the first phase, due to necessary budget cuts as well as to the fact that the Switch House was still being used by EDF Energy to house the transformers for the substation, these intentions were put on hold.

Nevertheless, by the early 2000s the gallery was already overcrowded, so there was a need to create more space for art. "There was a recognition by the Tate in 2002 and 2003", explained Nicholas Serota, "that we should try and do the second phase, and therefore that we needed a master plan. [...] We saw the possibility of developing new kinds of space, and because Tate Modern was being visited by such a large number of visitors, we wanted to spread the visitors and to give them a better experience."[18] However, it was the concern that they might lose the rights of construction, following the continuous rise of new buildings around the museum, which dictated the trustees' decision to initiate, around 2003, the project for transforming Tate Modern. There was a "development beginning to take place immediately in the vicinity of the Tate", said Nicholas Serota. "I could see that if we were not careful, these developments would be realised and the owners of those new sites would then object to us constructing a large building on the south side of Tate Modern. So, I felt a certain urgency to get a scheme into the public domain and to show the planners that we had intentions that could be frustrated if they gave planning permission to other buildings."[19]

That's when HdM initiated the studies for the extension of the new Tate Modern.

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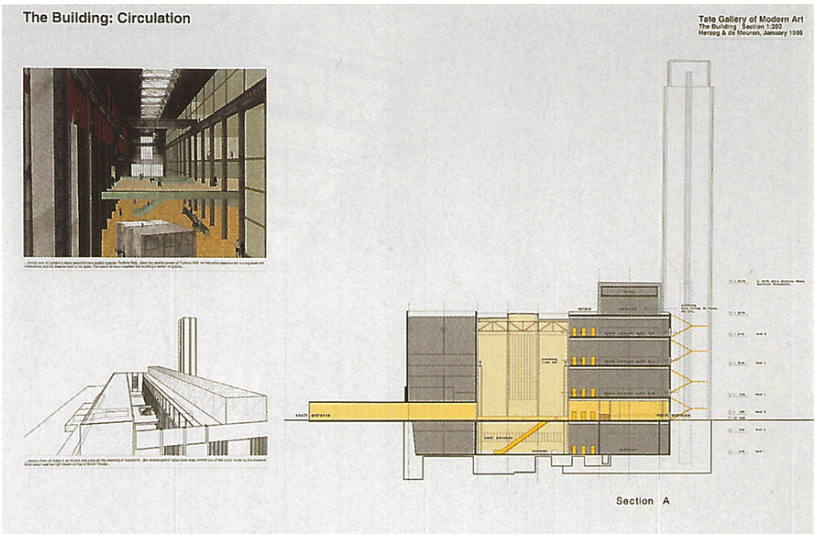
15 Nicholas Serota, "Foreword," in *A museum for the 21st century*, eds. Dercon and Serota, 19.

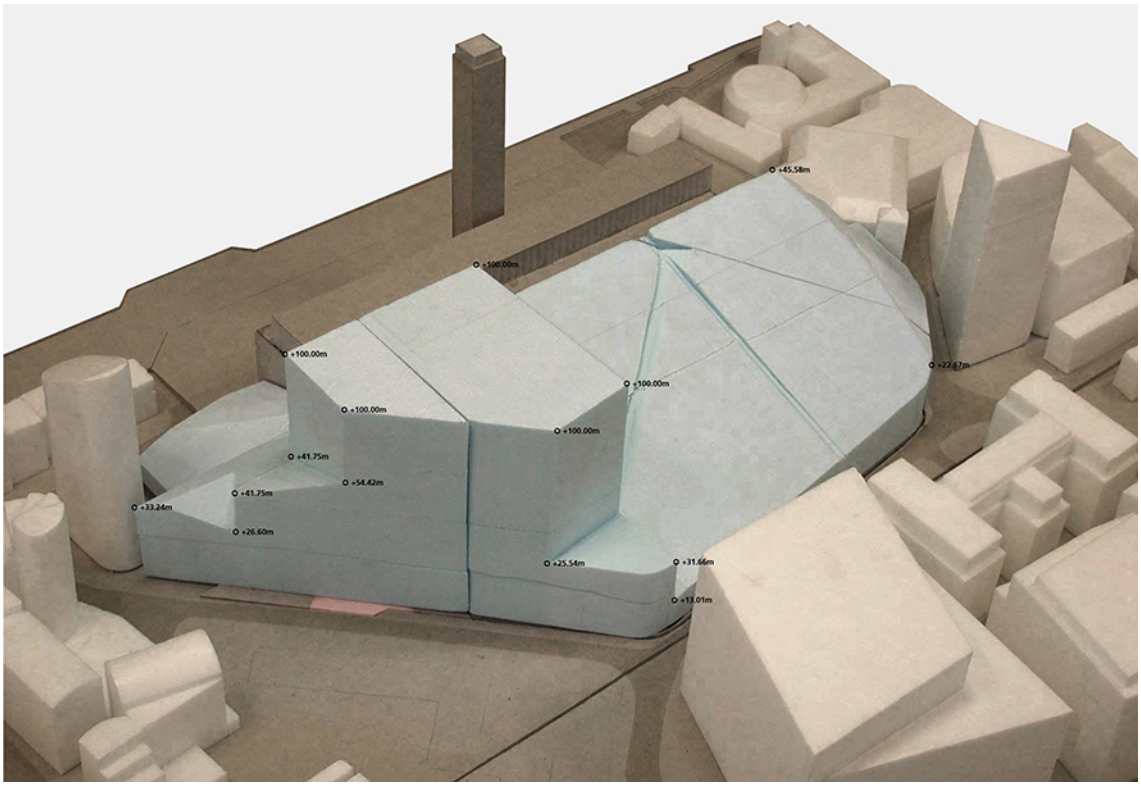
16 "By 2005 Tate Modern was receiving steady 4 million visitors every year – compared to the 2.6 million of MoMA in New York and 2.5 million of the Pompidou Centre in Paris. [...] the £135 million refurbishment of an old power station soon became one of the most popular visitor attractions in the country." Oliver Wainwright, "Lofts and Caves," in *A museum for the 21st century*, eds. Dercon and Serota, 32.

17 Wainwright, "Lofts and Caves," 27.

18 Serota, "Tate Modern 2."

19 Ibid.





9.07
HdM competition entry for the Tate Modern (1995). The north-south urban route throught the bridge of the Turbine Hall.

9.08
Physical model of the “Rights to light” development envelope (2004).

Between 2003 and 2004, the office developed a masterplan[20] that established the new building's volumetric constraints, outlining the general envelope within which the full extension would have to fit.

Done in an open dialogue with the property developers of the plot fronting the southwest site area of the Tate, the definition of this envelope was based on zoning laws for light and views of St. Paul's Cathedral. "The people who developed the tower were first interested in buying a plot from Tate, so we were in contact with them", said Harry Gugger. "They would show us what they wanted to do, but they would only do what we agreed upon, and that's how the pyramidal form comes about." [21]

From the physical model that summarises the "rights of light" envelope, (***9.08***) it becomes clear that the further development of Tate should take place on the southwest part of the plot and that the new building, concentrated in one single volume, should have a vertical configuration. As Harry Gugger said, "this was a given",[22] and, in fact, this was the definite premise that determined, from the very beginning, the volumetric features that would be common to all the design proposals. A pyramidal tower should rise adjacent to the Switch House's southwest corner, containing, in its strained envelope, all the program of the extension and becoming visible from the north bank of the Thames as a signal of the new intervention.

9.3 _ The Project for Tate Modern 2

The project for the Tate Modern extension[23] had officially started in 2005, when HdM won the competition for the second phase,[24] and it was concluded in May 2016 when the construction of the building and the external works and landscaping were completed.

According to Nicholas Serota, "this time, the brief was more straightforward."[25]

The already mentioned connection of the museum to the south and the requalification of its outer public space were vital in this second phase. Besides an increase in the number of exhibition spaces, which now needed to be varied in size and character to respond to the needs of contemporary artists more engaged with installation and performative forms of art, the extension to the museum also had to incorporate learning and social areas. Tate was interested in reinforcing the involvement of the public with the art gallery, embracing the idea of the museum as a place for social and educational exchange. As referred to in a publication by Tate, "the ambition is to redefine the museum for the twenty-first

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20 This project is listed by the office of HdM as "246 | Tate Modern Master Plan. London, UK. Project 2003–2004."

21 Gugger, "This is too generic."

22 Ibid.

23 This project is listed by the office as "263 | Tate Modern Project. London, UK. Competition 2005, project 2005–2012, realization 2010–2016."

24 "When we came to choose an architect, we ran a competition for the second phase. [...] and we had four or five in the final shortlist. We had independent advisors who had not been involved in the first competition and we tried to treat it as a new competition [...]. And it was very, very difficult for HdM. [...] The other competitors presented grand visions, which were extremely attractive to some of the trustees. Herzog & de Meuron knew too much and were very restrained, and the form of their building hadn't yet crystalised. So they were talking more about potential than they were about design. In the end they were selected because the potential that they described seemed to offer more than the others." Serota, "Tate Modern 2."

25 Serota, "Foreword", 20.

century, [...] fully integrating the display, learning and social functions of the museum, and strengthening links between the museum, its community and the city."[26]

In addition to the display spaces, the architectural brief specified areas for learning, office space and retail. The new building needed exhibition rooms, education spaces, cafés, restaurants, shops and offices, beyond the necessary circulation area, back of house facilities and plant rooms.

In what concerns the spaces for the exhibition of art, Tate Modern decided to almost double its area, enabling it to bring out of storage and show its growing collection on a more permanent basis. The reuse of the oil tanks' subterranean space, with its raw industrial character, would be complemented by a new set of refined galleries located within the volume of the old Switch House. Understanding the great diversity that the exhibition rooms should now offer was key to responding to the full range of contemporary artistic practices, which embrace, besides painting and sculpture, the new areas of visual culture such as photography, film, sound, dance and performance. Simultaneously, as mentioned by Nicholas Serota, there was also the intention in TM2 to break out of some of the Boiler House limitations that "were to do with the enfilade system of circulation. To do with the fact that the ceiling heights were uniform. To do with the fact that the light came from the windows on the north side, etc."[27]

Therefore, when referring to the extension of Tate Modern, Pierre de Meuron said that "in the new building there is less of what you might call the 'classic gallery' and more of a 'museum experience'."[28]

Due to the great emphasis that Tate decided to place on the learning and social strands of the museum, a considerable number of facilities, corresponding to about 60% of the total area, were dedicated to increasing the public knowledge and enjoyment of art, as well as to promoting social encounters and relaxation. In a vertically ascending movement, shops, cafés, restaurants and a members' room, together with the spaces for the education programme, were spread over the eleven floors of the pyramidal tower crowned by a panoramic public terrace which allowed a 360º view across the city of London.

In the opinion of Nicholas Serota, "in the brief much was obvious", and the challenge of the new project lay "in the configuration of the spaces within a tight envelope, in the size and heights of the gallery spaces that would contrast with the existing rooms in the Boiler House and in the treatment of the facade." [29] In fact, the architects in the Tate Modern extension had to deal with two major questions that ended up becoming the two most specific architectural features of this project.

The first was about the spatial organisation and internal connection between all the parts. It was about how to fit everything into a restricted, given, tent-like shape and, even more complex than this, how to distribute the whole program in a vertical arrangement over ten floors. As Harry Gugger pointed out, "the essence of Tate Modern 2 is the vertical circulation, because you should never build a museum on ten floors if you are not forced to."[30]

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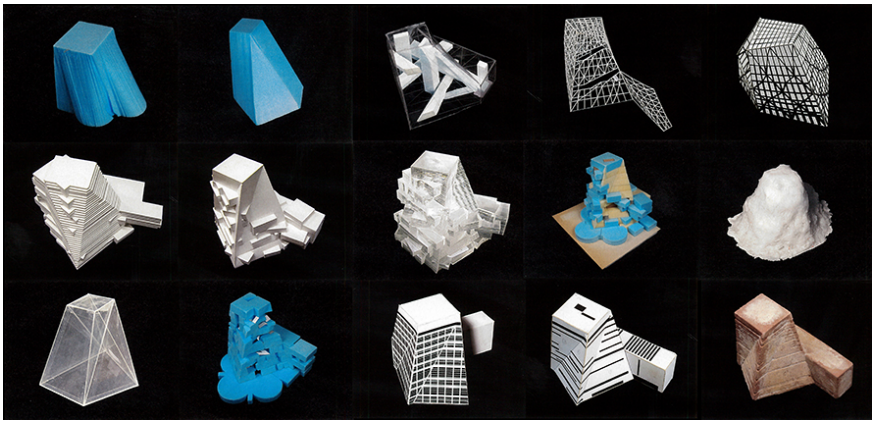
26 Tate, *Tate Modern. The Building* (London: Tate Publishing, 2012), 8.

27 Serota, "Tate Modern 2."

28 Herzog, de Meuron, "In conversation with Chris Dercon," 110.

29 Serota, "Foreword," 20.

30 Gugger, "This is too generic."



9.09
Study models for the three projects developed within the schematic design (2005–2008).

The second issue had to do with the outer appearance of the building. HdM "wanted the combined elements of Tate Modern, old and new, to be expressed as a whole; [they] wanted to have them come together and function as a single organism",[31] and this led them through an intricate design process in which different proposals about what could be the appropriate solution for the shape and the external material of the new building were considered and developed almost as complete projects.

"It took them quite a long time to arrive at the final shape of what should be done on the Tate Modern site", Nicholas Serota pointed out. "As you know, we got planning permission for a building which was very different from the brick building that we see today. When you look back now, it all looks inevitable, but it felt actually much more uncertain at that time."[32]

One of the exceptional aspects of the TM2 design process was a willingness to explore in depth very different configurations for the building until it achieved its final shape. Within the schematic design stage, three different projects, corresponding to three different design approaches, concerning the spatial organisation and, above all, the external appearance of the building, were fully developed until the idea of a pyramidal tower covered by a perforated brick veil emerged as the most reasonable proposal to be adopted (***9.09***).

9.4 _ The Office of HdM around 2005

Referring to the big challenge that the TM2 project represented, concerning how to relate the two parts and how to have them function as a unitary whole, Jacques Herzog said that “this was a major

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31 “263. The Tate Modern Project, London, UK”, Projects, Herzog & de Meuron, accessed April 4, 2020, https://www.herzogdemeuron.com/index/projects/complete-works/251-275/263-the-tate-modern-project.html.

32 Serota, “Tate Modern 2.”

challenge and one of the most interesting points of exchange between Nick and us, namely, how these things get connected. [And] I don't think we would have been able to do that back in 1995."[33]

In 2005, HdM were in a different situation compared to when they won the competition for the conversion of the Bankside power station. In ten years, the office grew significantly in size and structure, and they also acquired experience. There is no doubt that TM1 and the Pritzker Prize afterwards (2001)—in which the jury described the conversion of the "giant power plant of the Thames" as "the largest and most dramatic in size and scale"[34] example of their built work over the previous twenty years—were serious contributors to the enlargement of the office. TM1 allowed HdM to open up their practice to international-scale works, as well as bringing them more museum commissions.

HdM are known for cultivating, ever since then, a special connection with the world of art, having a particular fascination with artistic practice and the way in which artists approach their work. This keen interest in contemporary art has shaped their specific design methodology and influenced what they pursue in architecture, leading them, over the years, into frequent collaborations with artists as well as a natural engagement in the design of art museums.

If, before the competition for the new Tate Modern, the building for the Goetz Collection in Munich (1989–1992) was the only acclaimed art gallery designed by the Swiss architects, in the years during and right after the development of the project for the conversion of the industrial building, the office was given a large number of commissions for exhibition spaces and museums.

The Küppersmühle Museum (1997–1999) in Germany, the Walker Art Center (1999–2005) and the De Young Museum (1999–2005) in the United States, and the Tenerife Espacio de las Artes (1999–2008) and Caixa Forum (2001–2003), both in Spain, are all projects for art galleries that started at the same time, around the year 2000. Referring specifically to Caixa Forum, Harry Gugger asserted that, in this case, the project for Tate Modern was quite decisive. The partner in charge of TM1 explained that in the first meeting they had with the Spanish clients, HdM suddenly understood that they "were simply thinking: "London power station turned into museum; Madrid power station turned into museum".[35]

Besides these more "conventional" art exhibition buildings, we should also highlight two other projects that challenged the architects by the end of the 1990s with their unique and, in a certain sense, innovative programs. The first one is the Kramlich Residence, Napa Valley (1997–2015), which focused on how to unite life and art in a single building ***(9.10)***. This project was about how to integrate the exhibition of a non-traditional art collection which belonged to the clients into a residential space, combining the domesticity of the house with the requirements of an intangible contemporary art based in the new media.

The other project is the Schaulager Laurenz Foundation, Dreispitz/Basel (1998–2003), which presented itself as a "new building type"[36] for art. Thought of as a warehouse for contemporary art, this building stores the private collection of the Emmanuel Hoffmann family according to a new storage

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33 Herzog, de Meuron, "In conversation with Chris Dercon," 98.

34 "Jury Citation", Jacques Herzog and Pierre de Meuron. Laureates 2001, The Pritzer Architecture Prize, accessed March 27, 2020, https://www.pritzkerprize.com/laureates/2001.

35 Gugger, "This is too generic."

36 "169. Schaulager, Laurenz Foundation, Münchenstein/Basel, Switzerland", Projects, Herzog & de Meuron, accessed March 28, 2020, https://www.herzogdemeuron.com/index/projects/complete-works/151-175/169-schaulager.html.

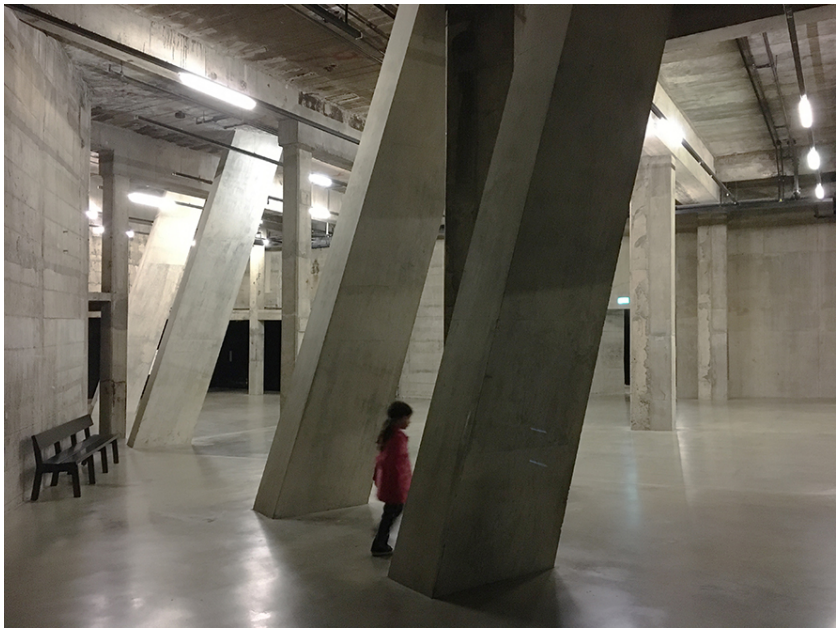
9.10
The Kramlich Residence, Napa Valley (1997–2015). Installation view of Cut Pipe by Gary Hill (1992).

9.11
The Schaulager, Dreispitz/Basel (1998–2003). View of a storage room.

concept, in which the artworks, unpacked and installed according to conservation standards and the artists' intentions, should remain accessible to the public for study purposes (***9.11***).

All of these projects were undertaken in a short period of about ten years and represented an important learning process for HdM that has informed the office approach to designing display spaces for art. Along with this particular connection to the world of art, the beginning of 2000, as mentioned in a previous section,[37] was also a relevant moment for the office, as HdM saw their architectural practice being recognised at a global scale. In this period, the National Stadium of Beijing (2002–2008) was under construction in China, and, in the meantime, HdM received commissions for several large-scale projects with high levels of complexity which were spread all over the world, some of them having a significant international impact. While the project for the extension of Tate Modern was being developed, the Swiss architects were also working on the initial stage of the Elbphihlarmonie (2001–2016) in Hamburg, the Beijing Film Academy Qingdao (2005) and the Jindong New Development Area (2003–2006), both in China, as well as the Actelion Business Center (2005–2010) in Allschwil, the Triangle (2006–...) in Paris and the Kolkata Modern Art Museum (2005) in India, just some of the commissions that influenced, or were influenced by, the design of the new Tate gallery in London.

37 See section "3.3 _ Local / International / Global."



10.01
The Tanks concourse.

10.
Rational vs Organic

10.1 _ Out of Tate Modern 2
10.2 _ Inside Tate Modern 2

"Everybody may ask himself or herself 'why this form?'" says Jacques Herzog, "which is something between a very rational form and a very irrational form or a pyramidal shape. It's to do with the geometries given there of the land parcel, but also angles that would lead people into the building; opening up, reclining or bending over. So, very archaic and almost sculptural impulses, which have a very clear and irrational basis."[38]

In a short video about the extension to the Tate Modern, Jacques Herzog gives an overview of the main architectural ideas that lay behind the project. Referring specifically to the envelope of the pyramidal tower, the architect remarks on the strangeness of its shape, explaining that it resulted from a series of combined geometries that model the volume in a close inter-relationship with the site and the existing building. The result is a shape ruled by a regular matrix blended with some disconcerting elements that endow the new extension's overall form with a subtle sense of movement.

This duality between something which has a rational basis, crucial to stabilise and give order to the architectural composition, and something more organic that disrupts and frees the design, is a key feature of the project that is evident in the outer configuration of the building, but also in the internal arrangement of the spaces. Rational and organic are thus the two concepts that guide our architectonic reading of the Tate Modern extension. While outside the intersection between regular and irregular alignments determines the overall shape of the pyramid, inside the overlap between the grid and the spiral rules the outline of the floor plans, providing the circulation in the building with a general sense of fluidity.

10.1 _ Out of Tate Modern 2

When approaching Tate Modern from the south, the first image we have is of a massive brownish brick construction standing right at the centre of our perspective through Great Suffolk Street (***10.02***).

Our attention is suddenly caught by the singular presence of the original chimney, rising vertically with solemnity above the roofline of the old power station. To the left of this respectful sentinel, an entire corner of the new art gallery sticks out from the alignment defined by the buildings along the street, exposing one of the sloping surfaces of the volume perforated by narrow horizontal openings. Standing side by side, these two elements create a unitary whole, unveiling in its singular appearance that something of an exceptional character is expecting us at the end of the street.

Up closer, the signs of the power station tend progressively to decrease while the scale of the new building becomes more and more impressive, and its particular shape is fully announced when we get near the recent glazed blocks located on Sumner Street (***10.03***).

A truncated pyramidal tower covered by a singular brick skin rises on the southwest corner of the Tate plot confronting Holland Street, linked to the original museum through the west part of the old Switch House. This massive brick tower rises to a height of 65 m, folding in a twisting movement of vertical and inclined planes that materialise the four sides of the volume. From bottom to top, the building is punctured by long, narrow, transparent windows that animate the facade in an apparently

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[38] Jacques Herzog, "Transforming Tate Modern: The Architect's Vision," Bloomerang TateShots, video, accessed July 17, 2019, https://www.youtube.com/watch?v=Hypdk-EW2zo, 01:30.

10.02
Tate Modern from Great Suffolk Street.

10.03
The southeast corner of the Tate Modern pyramid.

random composition, counterbalancing the monolithic appearance of the construction. At its highest level, a colonnade wraps the building, concluding the TM2 tower in a classical manner.

Seen from the recently enhanced public space located to the south of the old industrial fabric, the volume of the Tate Modern extension has a dominant presence, detaching itself from the original construction and acquiring its own autonomy (***10.04***).

One of the most intriguing aspects of the new building lies in the uniqueness of its shape, whose sloping faces and massive character recall, as suggested by some authors, the monumental structures of ancient times, such as the Mesopotamian ziggurat, "built in diminishing stages, each level being reached by ramps",[39] or a Medieval fortified siege tower "poised to wage war across the Thames".[40]

The well-pronounced kinks that underline the dramatic ascending movement of the tower have a significant impact on the surrounding public space; they model the faceted volume of the brick pyramid and ensure a transition between its irregular footprint at the ground floor and the simple rectangular figure outlining the rooftop. In the strangeness of its shape, it seems as if the building—its planes in different directions intersecting each other along oblique lines—is searching to absorb all the geometric inputs given on the site.

In fact, it happened exactly like this. The position, the mass and the height of the volume of TM2 sit directly within the "rights of light" envelope defined on the masterplan, and the building's considerable scale, necessary to accommodate all the required areas of the architectural brief, was intended to reinstate Tate Modern as the most significant building in an urban zone under continuous growth and

39 Wainwright, "Lofts and Caves," 28.

40 Wouter Davidts, "A Ziggurat of Brick and Concrete," in *Tate Modern, building a museum for the 21st century*, eds. Chris Dercon and Nicholas Serota (London: Tate Publishing, 2016), 60.

10.04
The Tate Modern extension building, east and south facades.

10.05
Holland street on the south side of the building.

intensive development. However, as Pierre de Meuron said, "in the case of Tate Modern 2, we wanted to find a new form—a prism. We took the various parameters into account, breaking them down and studying them meticulously until the final form practically found itself."[41] From the beginning, the architects intended to compose the new building as a response to the several demands of the place, taking into account in its configuration not only the more organic alignments coming from the site but also the rational layout that structures the original industrial fabric.

Therefore, the pyramidal form is the result of the combined geometries found both on the site and in the existing building, having, in its twisting movement, the strategic device that allows this complex, suggestive overlap.

Since its arrival into this north part of Southwark in the mid-1990s, Tate Modern had always played an essential role as a catalyst for improving the surrounding area. The modern art gallery is one of the most relevant institutional players in the Bankside Urban Park, and it had never neglected the impact that it could have on the urban design of this area.[42] Quite the opposite—Tate was always aware that creating a great museum in this particular area of London would make a significant difference to its development, and this influenced how the entire complex was envisaged and, later on, how the architecture embodied these aspirations.

Referring to the choice of Bankside as an ingenious strategy, in terms of urbanism, that only Nicholas Serota was able to perceive, Jacques Herzog in 1999, explained that "the only thing [HdM, as architects] could then contribute was [to try] to understand what the location is and to try to develop it

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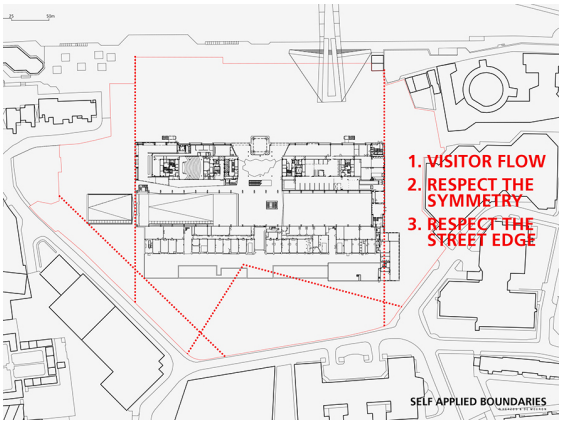
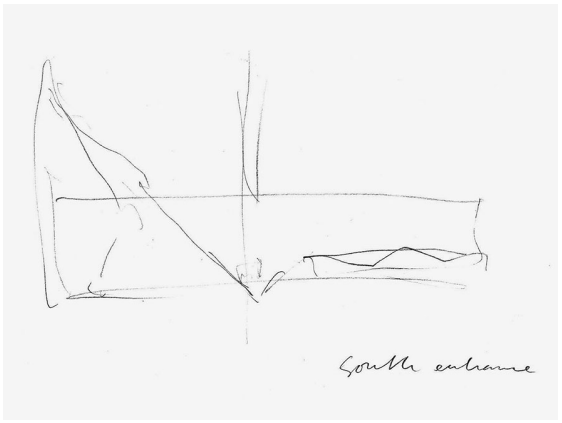
41 Herzog, de Meuron, "In conversation with Chris Dercon," 109.

42 "Keen to pre-empt what might happen immediately behind it, Tate commissioned an urban study from Richard Rogers Partnership in 2001 to examine what a potential extension, combined with a mixed-use public-private development, might look like. The results didn't bode particularly well. [...] Yet it was admirable that Tate should have had the foresight to take an interest in ts wider neighbourhood, and indeed unusual that a museum should think to take on role of urban planner at all." Wainwright, "Lofts and Caves," 34.





10.06
Diagram of the self applied boundaries (2005).

10.07
South entrance, sketch by Jacques Herzog (2005).

very logically according to connecting paths and lines, the river, the bridge, the situation with St. Paul's."[43]

TM2 is the accomplishment of a strategy delineated ten years before, revealing in the configuration of the extension volume a concern for the urban dynamics of an area that exceeds the nearby surrounding context and encompasses the district of Bankside. In its bending movement, the new building outlines the immediate outer public space by following some of the existing urban alignments and introduces new directions to influence the development of a wider area. Respect for the street pattern and tracing of the desired visitor flow are thus two of the principles that rule the contours of the pyramid base on both the south and east sides.

While to the south the building, on the ground-floor, keeps the general alignment with Holland Street, (***10.05***) opening the angle just a little bit towards the north to promote access from the southwest corner of the building to the Plaza above the oil tanks, to the east, the tower at its base takes an inclined direction that links the south entrance of the museum with the central urban route through Sumner and Great Suffolk Streets (***10.06***). The torsion of this facade was thought to guide visitors approaching from the south towards the new entry to the gallery, and to promote pedestrian movement along a north-south route through the museum's interior (***10.07***). By doing so, the extension to the art gallery materialises one of the major ideas of Tate Modern, expressed from the beginning on the bridge of the Turbine Hall, which is to lead people from the north part of London to the heartland of the Bankside Urban Area.

For the rest of its outer configuration, the new building references the rational composition of the old industrial fabric.

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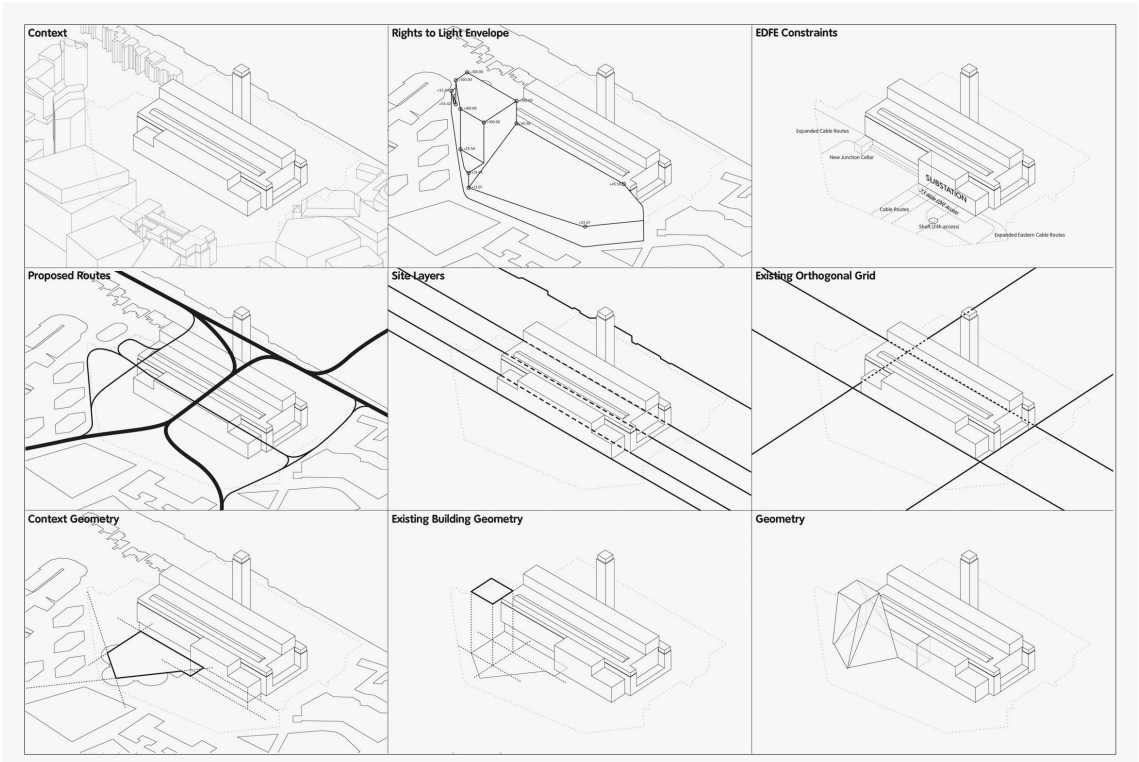
43 Rowan Moore, "Conversation. Jacques Herzog, Nicholas Serota and Rowan Moore", in *Building Tate Modern. Herzog & de Meuron transforming Giles Gilbert Scott*, eds. Rowan Moore and Raymund Ryan (London, Tate Gallery Publishing, 2000), 37.



10.08
The chimney of the old Bankside power station in dialogue with Christopher Wren's dome.

10.09
Architectural concept diagrams (2009).

Longitudinally, the Bankside power station is divided into three parts, "the 85 ft [26 m] high main Turbine Hall in the centre, [...] the Boiler House to the north and the electricity transformers and Switch House to the south".[44] Perpendicular to this direction, the layout of the existing building is ruled by symmetry, defined on the central axis by the elegant brick chimney positioned on the north elevation that, similar to a campanile, faces the river in a dialogue at a distance with Christopher Wren's dome (***10.08***).

Compliance with the symmetry and the "site layers"[45] of the existing complex is thus the other principle that guides the geometric set out of the new construction, this having particular relevance on the west and north facades. On these two sides of the volume, the vertical surfaces align with the original walls of the Switch House, which was incorporated into the volume of the Tate Modern extension. At the point where TM1 and TM2 meet, the west facade of the tower is set back 5 m, reinstating the former volumetric relationship between the Switch House and the Turbine Hall edge. However, starting at this recessed point, the sloping surface on the west side of the volume takes an oblique direction, reestablishing on the southwest corner of the pyramid base the alignment with the west facade of the old industrial shed.

The regular matrix underlying the compositional structure of the new volume is fully announced at the rooftop, whose rectangular figure is settled according to the orthogonal grid of the existing building (***10.09***). While on the ground floor the irregular perimeter of the tower is searching for relationships with the context, at the top of the brick pyramid the regular shape resulting from the intersection of the four vertical surfaces anchors the new building in the old original structure.

On the east side of the brick pyramid, an open plaza was created in front of the new entrance to the art gallery. Higher than the street level, this public space is bordered on its south and east limits by weird circular walls that literally break out from the underground, apparently disconnected from any local reference (***10.10*** / ***10.11)***. Almost as if it was the result of archaeological work, HdM decided to excavate, leaving exposed at the street level the hidden traces of the massive oil tanks that stand at the foundation of the new building. "The contours and the critical mass of the Oil Tanks were to be made visible", explains Gunther Vogt, the landscape architect who worked on Tate Modern. "The Tanks were originally sticking out 1.5 m above ground, so the height of the walls corresponds to this. We also wanted to give it a robust form, a form of otherness. The morphological character and the height of the Tank walls express a critical difference between the human body and the scale of the building. They are constructing a local horizon and not a metropolitan horizon."[46]

By doing so, HdM emphasised these elements that, while alluding to the original industrial nature of the building, take an active part in the design of the surrounding urban space. At the same time, by making visible these buried objects that are witness to the history and character of the site, HdM reinforced their architectural approach based, from the very beginning, on the acceptance of preexisting

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44 "Bankside Power Station", Wikipedia, accessed July 21, 2021, https://en.wikipedia.org/wiki/Bankside_Power_Station.

45 In the design reports, the office considered as "site layers" the longitudinal tripartition of the Bankside power station, together with the north and south landscape of the parcel.

46 Chris Dercon, "Gunther Vogt in conversation with Chris Dercon", in *Tate Modern, building a museum for the 21st century*, eds. Chris Dercon and Nicholas Serota (London: Tate Publishing, 2016), 127.

10.10
The circular walls that reinstate the mass of the oil tanks.

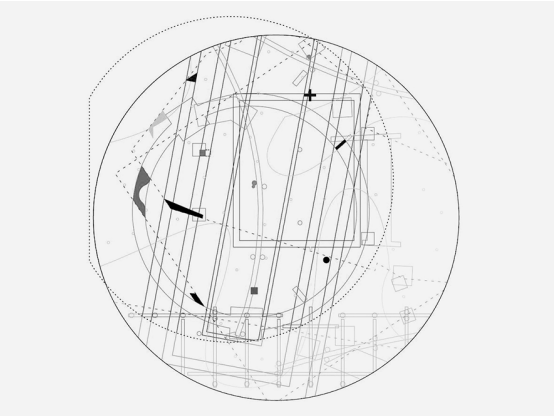
10.11
The Plaza created in front of the south entrance.

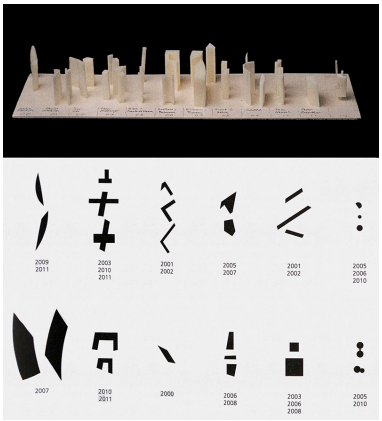
local traces. Referring specifically to the TM1 project in a statement that can be extended to the case of TM2, Jacques Herzog explains this particular way of considering the "givens" of the site and using them as active elements in the definition of the new architectural object: "We wanted to do what we try to do in most of our projects, which is to look at the givens as carefully as possible in order to identify the potentials before taking action and possibly destroying something that we might regret later. We try to reinforce what the site offers before introducing new things."[47]

The intention of working with the site and its most particular elements is recurrent in the design practice of HdM and one of the distinctive features of their approach to architecture. Whenever it makes sense, HdM take, as strategic starting points for the development of the project, specific signs from the context, using their reinterpretation as a rich source of experimentation within the design process. Besides strengthening the site qualities, whose positive features are reinforced by the project, this way of proceeding endows the new building with a sense of belonging to the place.

In London, the Serpentine Gallery Pavilion (2011–2012), designed by HdM in collaboration with the Chinese artist Ai Weiwei, is a particular project, in the sense that it is a temporary structure with no special programmatic requirement and in which the experimental character of architecture was encouraged. From this point of view, this small structure displayed at Kensington Gardens is distinct from the Tate Modern project. Therefore, any analogy between them should be made with regard to this distinction. Nevertheless, in its conceptual approach, this pavilion arose from the idea that a form free of any constraints should be avoided, being emblematic of HdM's interest in bonding their architecture to the existing traces of the building's context.

47 Herzog, de Meuron, "In conversation with Chris Dercon," 94.





10.12
Serpentine Gallery Pavilion, Kensington Gardens, London (2011–2012). Floor plan, foundation intersections.

10.13
Columns from each of the previous pavilions, 2000–2011.

"We came to a very quick agreement on what we didn't want to do", said Pierre de Meuron. "From the first moment, we knew, all three of us, that we didn't want to fall into the trap of doing another fancy object [...]; we then became interested in finding geometries or forms of something that was already there but was, on the other hand, no longer there, since it had been demolished. So things [that] are virtually there but no longer physically there."[48]

In the absence of any real contextual references on which to base their design, HdM and Ai Weiwei decided to recover and make visible the set-outs for the foundations and footprints of the former pavilions that had been built between 2000 and 2011, taking them as virtual remnants from an excavation that provided a pattern of overlapping shapes in which to settle the logics of the new architecture (***10.12 / 10.13***). "Instead of creating a new fantasy, we wanted to generate something different and playful, but in a straightforward way",[49] said HdM about the project. Accepting this singular landscape of hidden marks as a given and playing with it, HdM used the found traces as the generating forces for the design, achieving a result that, as they pointed out, they could not have invented on their own. Built upon the concept of memory, the round amphitheatre, excavated below ground and covered by a circular floating roof with reflecting water on it, brought to the surface old signs from the site and put an accent on the foundations as a key element of the architectonic method. "How a building touches the ground", says Jacques Herzog, "is a fundamental question in architecture, [is] something that goes back to the very first human structures", being also a "key element [...] in classical architecture".[50]

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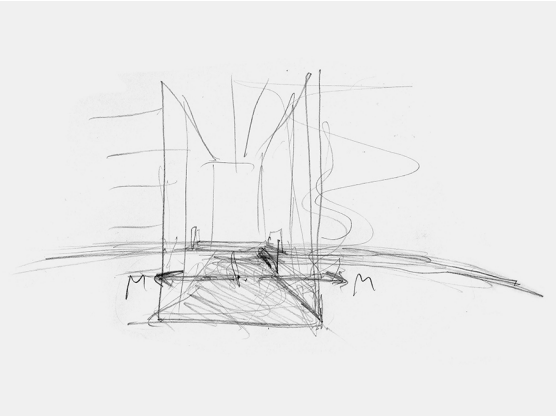
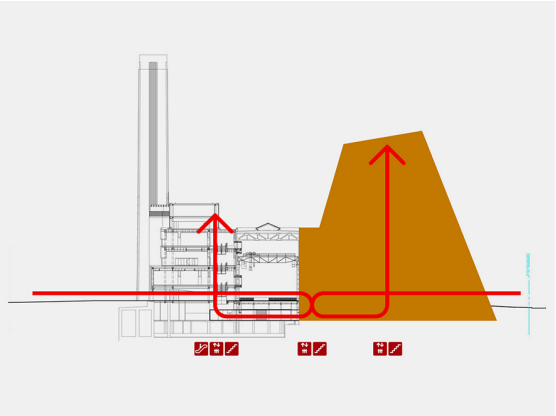
48 Ibid., 95–96.

49 Herzog & de Meuron and Ai Weiwei, "Thinking and Becoming", in *Herzog & de Meuron + Ai Weiwei. The Serpentine Gallery Pavilion 2012*, eds. Sophie O'Brien, Melissa Larner and Claire Feeley (London: Koening Books and Serpentine Gallery, 2012), 73.

50 Julia Peyton-Jones and Hans Ulrich Obrist, "A conversation. Jacques Herzog, Pierre de Meuron, Ai Weiwei with Julia Peyton-Jones and Hans Ulrich Obrist", in *The Serpentine Gallery Pavilion*, eds. O'Brien, Larner and Feeley, 97.





10.14
The Turbine Hall at the heart of the new complex. Sketch by Pierre de Meuron (2004).

10.15
Proposed circulation diagram (2005).

10.2 _ Inside Tate Modern 2

One can access Tate Modern from one of the three entrances on the north, south or west facade. Nevertheless, entering the building from the wide cut on the west elevation directly into the Turbine Hall remains one of the most impressive spatial experiences available in the Tate Modern gallery.

A large ramp, placed in the central east-west axis of the building, sticks out from the west facade, gathering visitors into the external landscape and leading them in a downward sloping movement to the interior of this cathedral-like space. Once we get into the building, the immense proportions of the unique Turbine Hall are fully revealed in an extraordinary view of the entire space. As Pierre de Meuron described, "accessing an interior space on an inclined plane generates a singular three-dimensional experience—you first walk down, you don't have to watch your step, you decelerate; you get a first overview of the building from the inside, you get your bearings. In addition to all that, when you reach the bottom of the ramp you will soon have the choice of turning north to the Boiler House or south to the newly converted oil tanks and the new extension, the Switch House."[51]

With the development of the art gallery to the south, the Turbine Hall, a crucial " 'unnecessary' place to hang out",[52] as described by Jacques Herzog, has seen its core position reinforced as the primary element of the spatial orientation within the transformed Tate Modern (***10.14***). Even if one enters the building at the street level from the north or south entrances at the ground floor, the natural circulation flow runs down to the level of the Turbine Hall, where all the facilities for a programmed visit to the museum are concentrated (***10.15***). From the lower level of this covered plaza, visitors can then proceed continuously through the entire building, in either TM1 or TM2, from the bottom up to the top floor.

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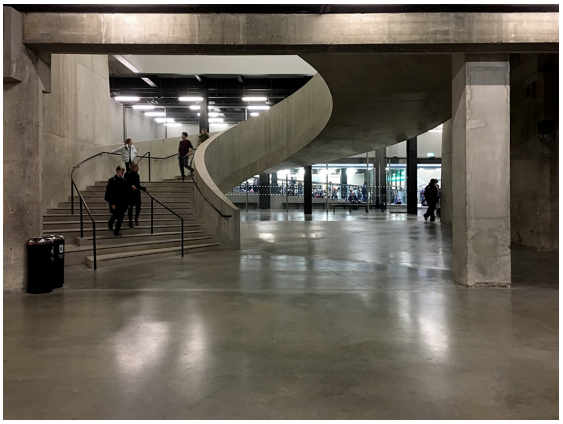
51 Herzog, de Meuron, "In conversation with Chris Dercon," 99–100.

52 Ibid., 100.



10.16
Exhibition room at the Tanks.

10.17
The spiral staircase from level 0–1.

The spaces that originally contained the ancillary plant and equipment of the old power station, together with the former oil tanks—"a clover-leaf of three buried concrete cylinders, big enough [and fortified enough] to hold the fuel that once powered a substantial chunk of London",[53] as described by Oliver Wainwright—are now the point of departure for walking through the building. Left as found, with a raw industrial character, this subterranean floor was converted into a set of unique spaces for the display of large-scale artists' installations, performances and films (***10.16***).

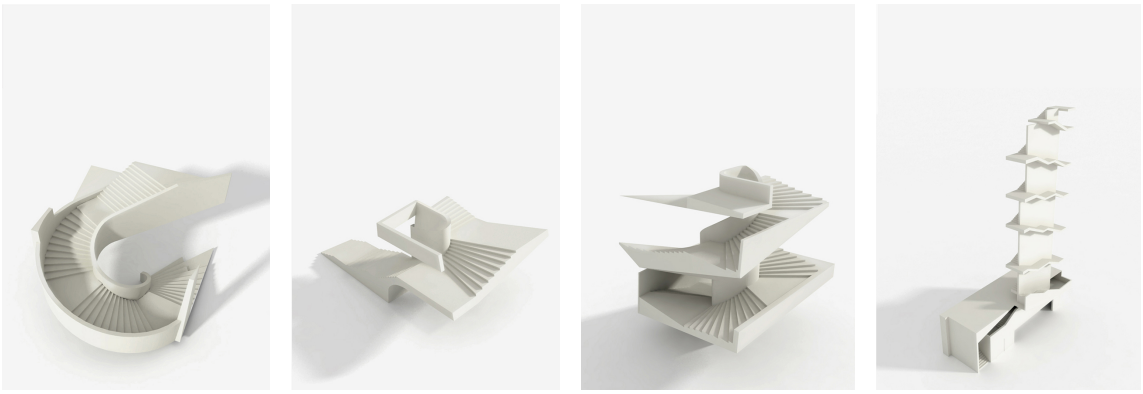
Arriving at the Tanks concourse, six impressive slanted concrete columns aligned in a disruptive direction immediately draw our attention, bringing into this underground level the traces of the geometry that rises above (***10.01***). We are, in fact, at the foundation of the pyramidal tower. From here, the load-bearing structure of the new building literally erupts, acquiring from this rough-edged architecture the unrefined character that extends, on the upper floors, into the art gallery.

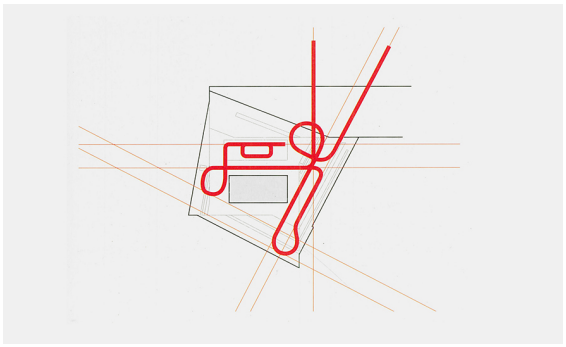
To our right, a freestanding spiral stair takes us up to level 1(***10.17***).

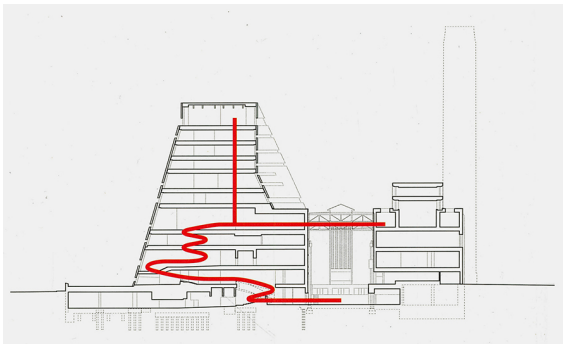
This contorted concrete element is the first part of an elaborate "ceremonial route", as it is called by HdM, that runs throughout the building, from the dramatic oil tanks to the public terrace on level 10, in a continuous sweeping movement. Consisting of four different stairs designed in a particular response to its location, this generous and spacious circulation system follows the main directions of the ever-changing perimeter of the tower, contrasting in its fluid development with the regular layout of the internal spaces (***10.18 / 10.19 / 10.20***).

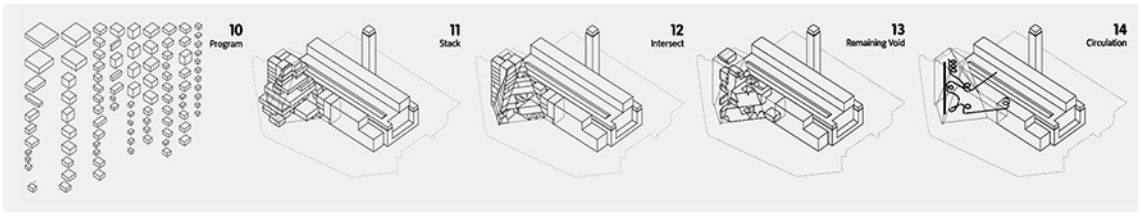
As happens in the outer shape of the pyramid, the internal arrangement of the building is the result of a rational order combined with an organic element that counterbalances the strictness of the grid and endows the architectural composition with a dynamic sense.

53 Wainwright, "Lofts and Caves", 31.









10.18
Sequence of composite images for the circulation system: level 0–1 Tanks stairs; level 1–2 stairs; level 2–4 art stairs; level 4–10 tower stairs (2009).

10.19 / 10.20
Floor plan and cross-section diagrams showing the “ceremonial route”.

10.21
Architectural concept diagrams for the building: Program, Stack, Intersect, Remaining void, Circulation.

The disposition of the spaces inside TM2 follows the orthogonal matrix of the former industrial fabric. This is seen in the setting out of the art display rooms, arranged within the linear volume of the old Switch House, whose steel frame structure, rebuilt only above level 3, has the same metric as the adjacent Turbine Hall. The regular layout of the existing building is also reflected in the positioning of other important structural elements: the two large reinforced concrete cores, carefully located in coordination with architecture and services strategies, and the very limited number of internal columns strategically placed by the engineers "to maximize the internal spans and emphasise the internal spaces".[54] Inside the building, the rooms follow this regular grid, acquiring a formless configuration only when they meet the irregular, star-shaped contour of the pyramid.

The concept behind the building's spatial organisation is explained in some of the diagrams presented in the design report of July 2008 (***10.21***). In a sequence of five schematic axonometric views of the building, it becomes clear that the program was first translated into a set of regular boxes, which were then, over the eleven floors, stacked on each other according to the orthogonal directions of the old power station. Afterwards, this pile of boxes intersected with the external envelope of the truncated pyramid, which provided an irregular configuration to the spaces that directly met the facade. In the remaining void, consisting of several concourses where visitors can frequently find places to pause, linger and meet, the "ceremonial route" finds its way up to the top.

Seen as a complement to the gallery spaces, this sequence of generous circulation areas was envisaged by the architects as analogous with the great Turbine Hall. Pierre de Meuron observed that "the Turbine Hall was a non-programmatic part of the first building which really did exploit its potential as a place to have new art experiences. The same will happen along the *parcours* we laid out in the new Tate Modern. Visitors will find a lot of unexpected places and unexpected art experiences. That is what we are striving for."[55]

In line with Tate Modern's interest in reinforcing the public's role in the art gallery and therefore enhancing the idea of the museum as a space for encounter and socialising, this vertical arrangement of places to "stick around" strengthens "Tate Modern's ability to absorb the urban realm",[56] as it amplifies and tests the limits of what Beatriz Colomina considers to be one of the major accomplishments of the 20th-century museum, the idea of internalising the street (***10.22 / 10.23***).

At Tate Modern, in the opinion of the Spanish architecture historian and theorist, the entire scenario of the 20th-century museum's architectonic culture was digested and amplified. This is evident in the domestic refinement of the galleries—which recall the very first examples of the modern museum that literally emerged from the house and its domestic spatiality with Le Corbusier's La Roche and Mies van der Rohe's Barcelona Pavillion—but above all in embracing public space through "the huge internal volume extended by a massive vertical circulation system including public landings".[57] Describing Tate

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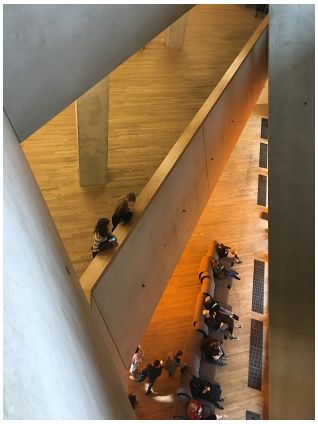
54 Ramboll, *The remarkable and unique Tate Modern Extension*, 18, https://uk.ramboll.com/-/media/files/ruk/3_projects-supporting-docs/tate-booklet.pdf.

55 Herzog, de Meuron, "In conversation with Chris Dercon," 99–113.

56 Beatriz Colomina, "The Museum after Art", in *A museum for the 21st century*, eds. Dercon and Serota, 76–79.

57 Colomina, "The Museum after Art", 77.



10.22
Void connecting the concourses from level 2–4.

10.23
Concourse area at level 2.

Modern through an analogy to one of the most iconic museums of the last century, the Guggenheim in New York by Frank Lloyd Wright, Beatriz Colomina explains, that "once again, the ziggurat with an internal movement returns to intensify the spectacle of encounter between social space and gallery, expanding the range of things that can be exhibited, the ways of exhibiting them, and the spaces of social interaction".[58]

Combined with a sequence of public landings at each floor, the vertical circulation inside TM2 crosses these hangouts, animating them and taking visitors on a spiralling walk through the building.

From the very beginning, when the architects had to deal with the constraint of developing the new museum and organising the several spaces in a vertical arrangement, the circulation system was approached as a central theme. "There was a fairly fundamental discussion", explained Nicholas Serota, "about how to bring visitors through and vertically up the building in a way that did not rely either on escalators or on elevators."[59] Therefore, the whole circulation system soon became a project in itself, at the same time as the idea of developing it as "a fluid and free promenade for visitors throughout the new building, as a complement to the more linear setup in the first building",[60] Jacques Herzog mentioned, ended up being one of the most fundamental principles of the project.

"Jacques described this movement up the building as a 'promenade'", said Nicholas Serota, "because it was intended to give a sense of ease, the sense of being out. To walk slowly up the building; not to see a great flight of stairs ahead of you but to have a perambulation, to move from one

58 Ibid., 79.

59 Serota, "Tate Modern 2."

60 Herzog, de Meuron, "In conversation with Chris Dercon," 108.

side of the building to the other, to look at one point towards Waterloo, at others towards Tower Bridge, or Westminster Bridge and the Houses of Parliament."[61]

In early documents produced by HdM in 2004, in which the first ideas for the new building started to be tested, the museum appears as a flatter volume with the same height as the Switch House, occupying the whole parcel on the south. Composite images and physical concept models of these first "sketches" show an empty, transparent volume with only a contorted curved line inside that moves continuously up and down in many directions, representing the path that would take visitors throughout the several levels (***10.24***).

This major intention was also expressed in a sequence of schematic floorplans where different proposals for the configuration of the circulation system were outlined and placed side by side (***10.25***). In these diagrams, the organic nature of the red curves, representing the public route inside the building, condenses in its abstract approach this idea of fluidity that the architects wanted for the circulation system, resembling, in a way, the artistic research of Olafur Eliasson based on the mathematical concept of Clelia curves.[62] All of these drawings, with their three-dimensional purpose, recall the strong sense of movement implicit in the many variations on the 18th-century spherical curve developed by the Danish-Icelandic artist, of which the three black-and-white stainless-steel sculptures[63] displayed in the Serralves museum in 2019 are a concrete example (***10.26 / 10.27***).

These 3D curves, generated by the movement of a point produced by two simultaneous rotations along the surface of a sphere, contorting on themselves and creating spatial structures of an impressive organic sense, have similarities with how the route inside TM2 moves continuously in space, involving visitors and driving them around the building on a spiral journey.

Even though, in the initial versions of the project, the circulation system was designed as a set of "vectors" that connected the floors by straight inclined tracks, the desired fluidity of the vertical route was fully achieved only in the final version of the project, when the stairs from one level to another acquired a spiral or half-circle configuration.[64]

The idea, according to Jacques Herzog, "is that walking or moving through the building itself is an interesting experience. Every connection from one floor to the other is a different one. And we have made many models, many different stairs, which are not just stairs, but almost like little stadia or hang out places, or bench areas. These stairs or these ways to turn or to reach the next floor are places where you could say 'let's meet there', or 'let's meet there'. So it is really, in terms of topography, like a

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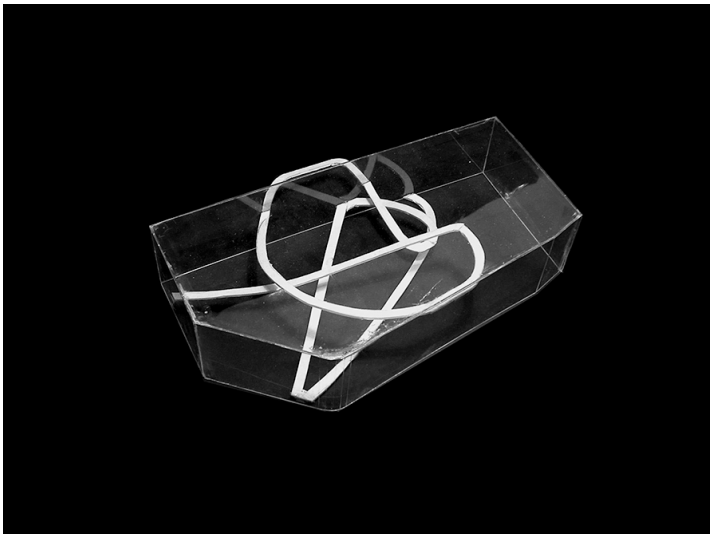
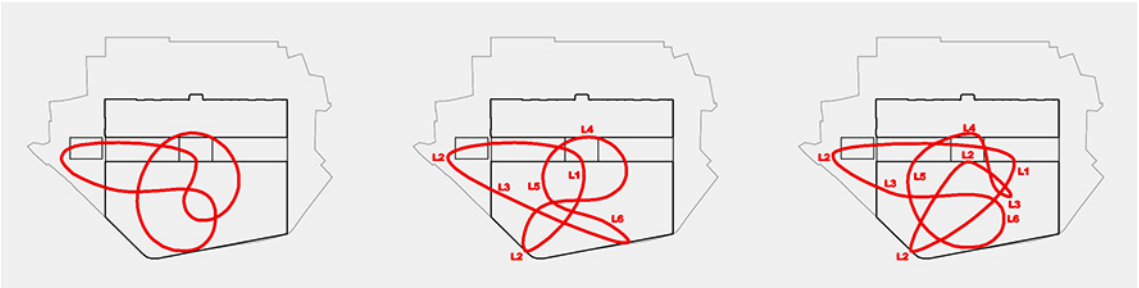
61 Serota, "Tate Modern 2."

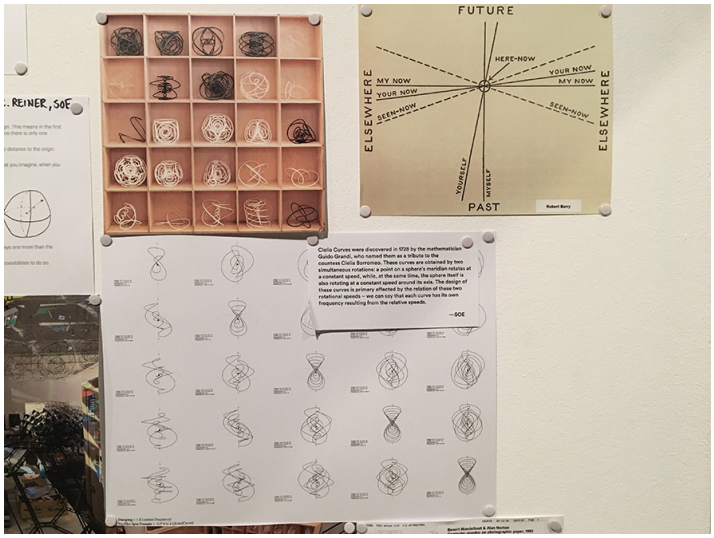
62 "The clelias are the loci of a point M on a meridian of a sphere rotating at constant speed w around the polar axis, the point M also moving at constant speed nw along this meridian. Therefore, physically, we obtain a clelia when peeling an orange or when rewinding regularly a spherical wool ball." "Clelia", Encyclopédie des Formes Mathématiques Remarquables, MathCurve, accessed February 20, 2022, https://mathcurve.com/courbes3d.gb/clelie/clelie.shtml.

63 Olafur Eliasson, Human time is movement (winter), 2019. Artwork exhibited in "O v/nosso futuro é agora", Serralves Museum, Porto, from July 31, 2019, to June 14, 2020.

64 By the end of the design development stage in September 2009, a revision of the design of the stairs was made. The configuration of the stairs from level 5–10 was modified from circular to rectangular, wrapping around and cantilivering from a central-line wall supported by the core below. As noted in the design report, this change created "a more standard format of construction, increasing the circulation space in front of the lobby and lessening the impact of the stair on the surrounding spaces." Herzog & de Meuron, "TTM/TM2. Design Development 100% Stage E Report", September 14, 2009, 9.





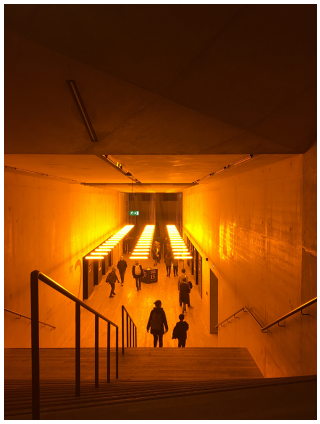


10.24
Concept model for the Tate Modern extension (2004).

10.25
Floorplan diagrams for the circulation system, early studies (2004).

10.26
Studies on Clelia curves by Olafur Eliasson. “In real life” exhibition at the Tate Modern, London (2019).

10.27
“The human time is movement” by Olafur Eliasson. “Y/our futur is now”, exhibition at the Serralves Museum, Porto (2019).



10.28
Staircase from level 2–3. "Room for one colour" by Olafur Eliasson (1997), exhibited at Tate in 2019.

10.29
The spiral stairs at TM2 from level 2–4.

little city."[65] The staircase, ever a preoccupation of HdM, frequently acquires in their architecture a curved shape, becoming a distinct sign of their own way of approaching the vertical circulation inside the buildings. Since the late 1990s, in projects such as the Cottbus Library, Cottbus (1993–2004), the extension of the Aargauer Kunsthaus, Aarau (1996–2003), or the Laban Dance Centre, London (1997–2003), the stairs have often been designed as perfect spirals, strategically placed inside the building in relation to the circulation flows. With an autonomous character due to their pure geometric shapes, these stairs were often designed as free-standing elements, almost like sculptural objects, that provided orientation within the building, having been laid out generously enough to become places for encounter.

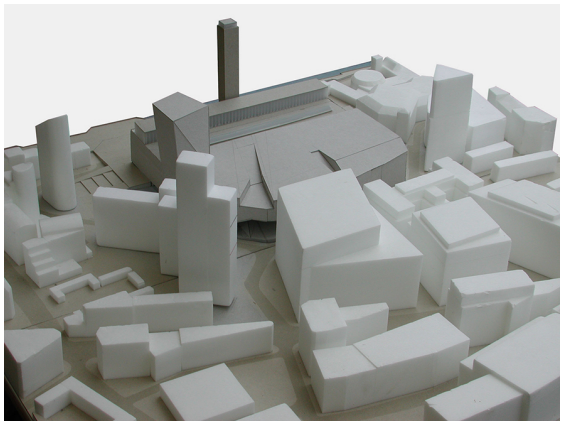
However, in the extension to Tate Modern, the circulation system became more elaborate and developed greater spatial complexity, similar, in a way, to how it was explored in later projects, such as the VitraHaus, Wel-am-Rhein (2006–2009), the Blavatnik School of Government, London (2011–2015), or even the Roche Building 1, Basel (2009–2015), where the public circulation inside the building lay at the core of the design concept. In TM2, the stairs are no longer an autonomous element, detached from the internal arrangement of the floorplans and with straight development from the bottom up to the top along a unique vertical axis. The stairs, fragmented into distinct elements between the floors, are placed in different locations inside the building, strongly interconnected with the desired public access flows. Like a *promenade architecturale*, the stairs are devices that induce visitors to walk inside the building along an intentional route comprised of a well-defined sequence of spaces and movements. Specifically designed according to its location, each stair takes an active part in the experience of architecture, contributing to the enrichment of the spatial sequence with surprising transitions (***10.28 / 10.29***).

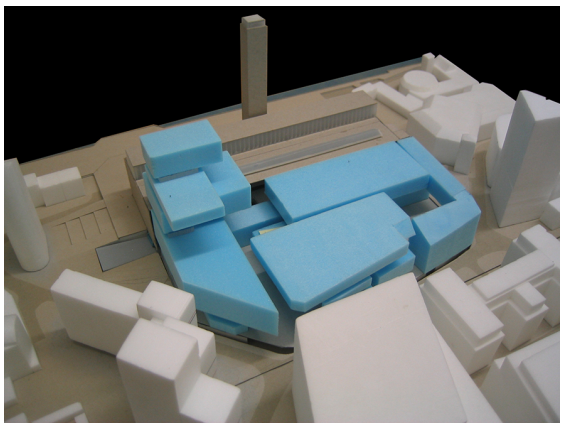
65 Herzog, "Transforming Tate Modern", 02:10.

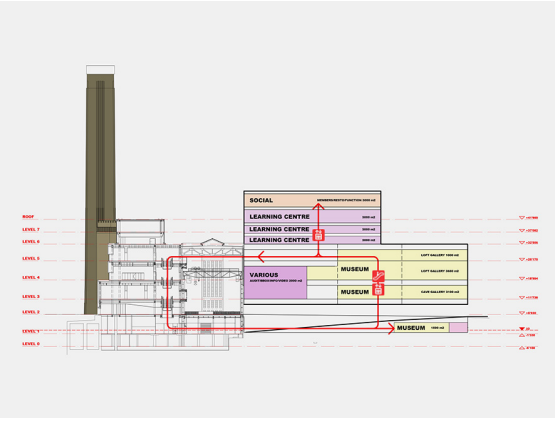
11.01
The twisted pyramid. Physical model (2008).

11.
Morphing, Stacking and Twisting

11.1 _ Previous Concepts
11.2 _ "Extrusion & Morph"
11.3 _ "Primary Form & Boxes"
11.4 _ "Not too tech!"







11.02 / 11.03 / 11.04
Physical models for the initial studies (2004).

11.05
Transverse cutting section showing the internal circulation (2004).

When looking at the design process for TM2, the "schematic design" stage, which took about three years, emerges as one of the most significant moments in the development of the project. This was a prolonged phase with many detours in which strategic issues, like the spatial organisation and, above all, the outer appearance of the building, were intensely discussed and explored.

"The thinking was always the same", said Harry Gugger. "It was about how to accommodate the necessary program within the given restrictions, and, as such, the idea of the pyramid was always there."[66]

Even though the basic principles of the intervention had been set up in the studies and had always been clear, their translation into an architectural form was far from straightforward and led to distinct configurations. The decision, as Pierre de Meuron explained, to "use the same cladding for the old building and the new extension, namely the bricks, [...] [to unify] the entire complex so it can stand out to its neighbours"[67]—which now seems to be obvious and fitting for the site—was not the first proposal by the architects. The significant number of study models and the series of variations tried out on them clearly illustrate the intensive, experimental and non-linear creative process that was developed in search of the ideal architectonic solution for TM2.

Three specific compositional procedures—morphing, stacking and twisting—stand at the core of the three different versions of the project. Understood as devices that guided the many decisions to be taken, these geometric operations and this way of proceeding in the design are a clear expression of the open-minded methodology of HdM, being paradigmatic of how they achieve an architecture that is, as Jacques Herzog points out, "free from a personal style: a style-less conception or a concept-based approach."[68]

11.1 _ Previous Concepts

In August 2004, the architects began the "concept design" stage for TM2, where they tested the first architectural ideas that went beyond the anonymous mass volume of the masterplan. Despite being an early phase, some of the central ideas that became distinctive features of the new building were decided in this period.

Physical models of the first experiments show the idea for a building with the same height as the former power station and occupying the whole parcel, from which emerged, on the west part, a vertical chiselled volume (***11.02 / 11.03 / 11.04***). A schematic section, cutting across the Boiler House, the Turbine Hall and the new extension, reveals the disposition of the brief areas over several of the floors, confirming the architects' intention to establish from the very beginning a programmatic continuity between TM1 and TM2 (***11.05***). While the display areas were accommodated on the lower floors of the new building, corresponding with the exhibition levels of the Boiler House, the learning and social spaces were concentrated in the highest part of the volume, above the roofline of the old industrial fabric.

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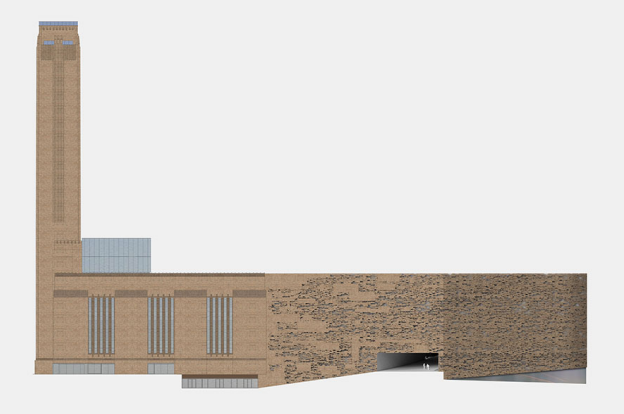
66 Gugger, "This is too generic."

67 Herzog, de Meuron, "In conversation with Chris Dercon," 105.

68 Jones and Obrist, "A conversation," 97.



11.06
Tate Modern, west elevation with the proposed extension volume clad in brick. Composite image (2004).

In the same section, a red line indicates the internal public circulation, revealing the architects' aim to implement a continuous route inside the building linking the exhibition floors of TM1 and TM2 through the vast space of the Turbine Hall. As a complement to the existing connection between both parts of the museum at the ground floor and the first level of this covered plaza, the outlined circulation strategy was already considering the construction of a new bridge amidst the existing roof trusses.

Another issue that stands out from these early documents is the idea of a free-flowing internal circulation system. Concept models, composite images and floorplan diagrams express the intent of HdM to envisage a possible configuration for this fluid route inside the building, confirming, as mentioned by Harry Gugger, that "the real project, the essence of Tate Modern 2, is the vertical circulation".[69]

Among the several documents analysed, one particularly caught our attention because of the direction the project would take in the following two years. It is a west elevation of the Tate Modern in which the materiality of the building was tested (***11.06***). In this composite image, the extension volume, aligned with the west facade of the Turbine Hall and having the same height as the former power station, was clad with the same material as the old building. Brick was applied to the new extension, ensuring a continuity between the two parts of the art gallery.

With no windows, except a large cutout for the entrance located at the ground floor, the external surface of the proposed volume had a perforated appearance that became more impressive as the distance from TM1 increased. This idea of a progressive dematerialization of the building was related to architectural research on pixellation as a compositional device conducted by HdM in this period. Similar to the strategy applied to the concrete walls of Tenerife Espacio de las Artes, Santa Cruz de Tenerife (1999–2008), and in the weathering steel sculptural rooftop of Caixa Forum, Madrid (2001–2008), both

69 Gugger, "This is too generic."

in Spain, this ornamental texture endowed the volume of TM2 with the appearance of a “corroded facade [...] deteriorated by the passage of time”,[70] as Luis Fernandez-Galiano described the Spanish projects, and which, in this specific case, was achieved by the gradual “decomposition” of the brick veil.

The composite image, which tested the possibility of applying the same cladding as TM1 to the new building, is an unlikely proposal given the reluctance for a long time by both the client and the architects to consider using brick. As explained by Nicholas Serota, in the beginning, "there was a feeling that if you used brick, there would just be too much brick. There was an idea that we needed to make a statement on the south side that was different from the north and that the new building should have its own integrity, somewhat separate from the power station. I remember being very insistent on the idea that when you crossed the bridge from St. Paul's, you should see the new building rising above the horizontal 'light beam'."[71]

The new building had to have its own character and autonomy, and in discussions about using brick, as Nicholas Serota mentioned, the architects didn't know "whether it would just to be too much brick; the whole building is brick, and [they didn't] want to look as though [they] were copying what is there."[72]

11.2 _ “Extrusion & Morph”

After this incipient phase, in May 2005 the “schematic design” officially began, and seven months later, in December, the architects prepared a report in which they presented the outline design of the first project for the Tate Modern extension (***11.07***).

The idea of an isolated volume with a pyramidal shape located adjacent to the southwest corner of the Switch House and constrained within the “rights of light” envelope was already established at this stage. Compliance with the urban alignments and the desired visitor flow, together with respect for the symmetry of the existing building were considered the self-applied boundaries that guided the several experiments on the building’s shape. In these initial attempts to capture the form of the pyramid, a series of blue styrofoam models illustrate the intention to generate the shape of the tower by the extrusion of a figure that morphed as the volume rose, becoming smaller and acquiring a different configuration when it reached the rooftop (***11.08***). In the following experiments, this generative process was combined with the torsion of the volume, which increased the organicity of the shape and endowed it with a dynamic sense of movement (***11.09***). As explained in the design report, the resulting four faces of the tower were ruled sufaces, which, due to their doubly ruled nature, allowed the vertical columns and the edges of the horizontal floor slabs, both located in the facade, to be defined by a set of straight

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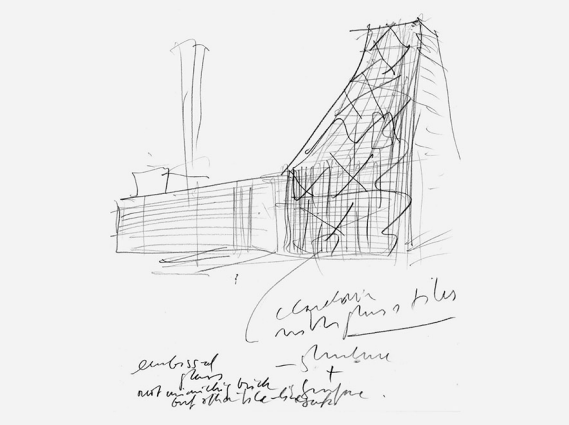
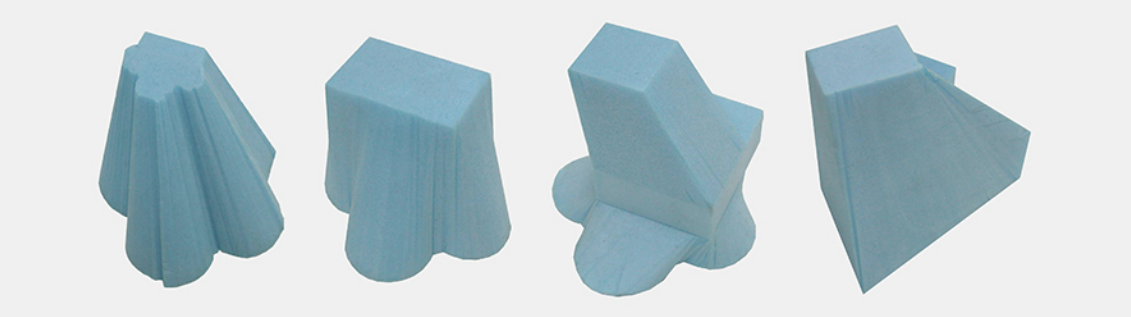
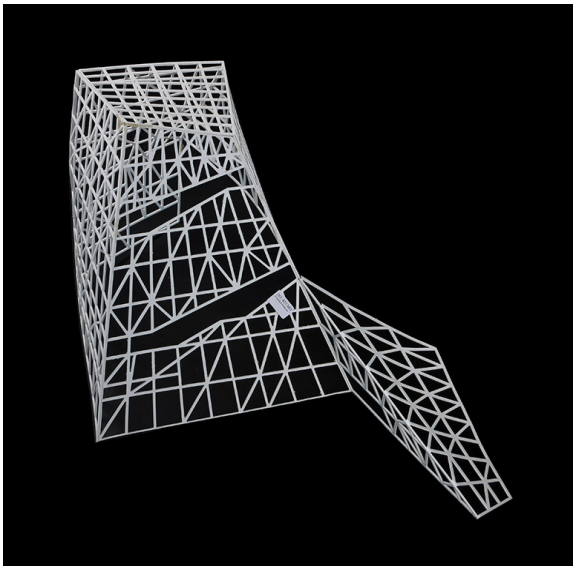
70 “Aquí en Tenerife exploran las fachadas carcomidas. Es como hablar de la imagen que el tiempo habia pasado por ellas, que habian ocorrido cosas y que estaban ya, degamos, degradadas por el paso del tiempo.” Luis Fernandéz-Galiano, “Jacques Herzog y Pierre de Meuron,” *Protagonistas de la Arquitectura del Siglo XXI*, Madrid, Fundacíon Juan March, Madrid, October 25, 2011, audio, accessed May 24, 2017, https://www.march.es/conferencias/anteriores/voz.aspx?l=2&id=2787, 39:00.

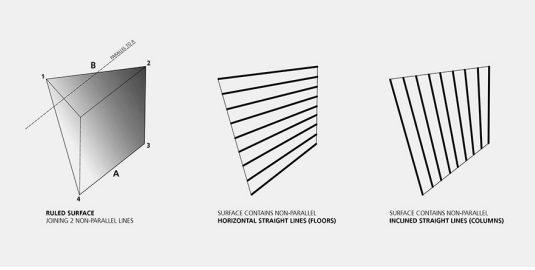
71 Serota, “Foreword,” 20.

72 Ibid.









11.07
The structural expression of the first project for TM2 (2005).

11.08 / 11.09
Form studies for a non-orthogonal volume. Study models (2005).

11.10
Ruled surface diagrams (2005).

11.11
Facade structure. Study model (2005).

lines (***11.10 / 11.11***). This particular way of tackling the definition of the form, based on specific geometric operations that set limits on the creative act and confine its field of action, is representative of the concept-based methodology of HdM. Besides driving the design process, this strategy contributes to the clearness of the architectural composition, promoting the unity of the project as a whole.

Therefore, in the work of HdM, we may find affinities between projects where the same compositional procedures were undertaken to address similar architectonic issues. In this specific version of the project for TM2, a comparable methodology may be seen in the De Young Museum in California (1999–2005), developed in the years prior to the start of the project for London.

This art gallery, which, together with the Walker Art Center in Minnesota (1999–2005), increased the visibility of HdM's work in the United States, is made of three linear, interconnected buildings with in-between open areas where the Golden Gate Park penetrates. Above the impressive roof that unifies the entire complex, a vertical structure rises on the northeast corner, becoming an identifiable landmark that puts the museum and the city into a relationship. For this sculptural tower, HdM developed several experiments until they achieved the final shape.

Seeing the physical models for the Education Tower of the De Young Museum and those for the first project of TM2 side by side, the similarities are evident. The compositional concepts involved, like extrusion, morphing or twisting, and the logic behind the configuration of the volume, are quite similar (***11.12***). The iconic tower of the American museum was, in the beginning, a chiselled volume modelled by clear slicing cuts, becoming, in a second moment, a morphed shape defined by the contortion of the volume on itself. In the end, the geometric process was simplified, and this vertical building acquired a more direct configuration. The rotation of the two horizontal faces of a prism along its central axis generated a twisted shape with two vertical hyperbolic paraboloid faces. By doing so, the rooftop of the tower introduced a new direction into the original orthogonal composition of the museum that came from the Concourse located in front of the park and allowed this vertical architectural object, as described by HdM, to take "a geometrical stand in relation to the strict rectangular grid of the city."[73]

In its turn, the compositional procedures for the De Young Museum tower, together with the use of copper as the cladding material, recall the project for the Central Signal Box in Switzerland (1994–1999). With its curved facade, this small object placed along the railroad tracks of central Basel seems to be the origin from which this specific organicity arose in the work of HdM. "Pressed between the bridge and the street", Gerhard Mack describes, "the ground plan is stipulated by a trapezoid-shaped area cut out by the railroad tracks. This shape is completed, in a gradation throughout the floor levels, into a rectangle. The diagonally countering curve thus created in the copper wrapping provides the north facade facing the bridge with a special expressiveness that seems to become a new theme in the work of the practice."[74]

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[73] "173. De Young Museum, Golden Gate Park, San Francisco, California, USA", Projects, Herzog & de Meuron, accessed May 30, 2020, https://www.herzogdemeuron.com/index/projects/complete-works/151–175/173-de-young-museum.html.

[74] Gerhard Mack and Herzog & de Meuron, *Herzog & de Meuron 1992–1996. The Complete Works*. vol.3, ed. Gerhard Mack (Basel, Boston, Berlin: Birkhäuser, 2000), 89.

11.12
De Young Museum, San Francisco (1999–2005). Models of several tower variations.

The Schatzalp in Davos (2003–2009) is another project concurrent with the initial phase for TM2 in which similar compositional strategies were tested. The architectural concept for this tower, located in the Swiss mountains, is particular and very contextual, as it is based on formal analogies with local natural elements like the snowflake or the pine cone. However, in the initial experiments to capture the overall shape of this vertical structure, it is possible to find some points in common with the form-finding process for the first project of TM2. A set of study models reveals similar geometric strategies, like extrusion, morph and twisting. In some of these experiments, the bending movement of the tower was combined with the introduction of kinks. The curved surfaces were replaced with two flat faces intersecting along a straight crease, as would later be tested and implemented in the pyramid for the Tate Modern.

"On the first itineration", Harry Gugger said about the first tower for TM2, "the pyramid was clad in Corten with big, flash windows."[75] The facade's steel structure and the glazing of the openings in the voids of the framework defined the outer appearance of the building (***11.13***). The architectonic image of the tower came directly from the facade's load-bearing structure, made of a rhombus mesh, to which was overlapped a crack-like series of oblique lines. Getting thinner as it went up, the steel framework was envisaged as a transition layer between the outside and inside of the building. A thickness factor was applied to the openings, allowing the facade to react to what was inside and to house inhabitable spaces in its depth according to the program of each floor.

As mentioned in the design report, the building had a structural expression.

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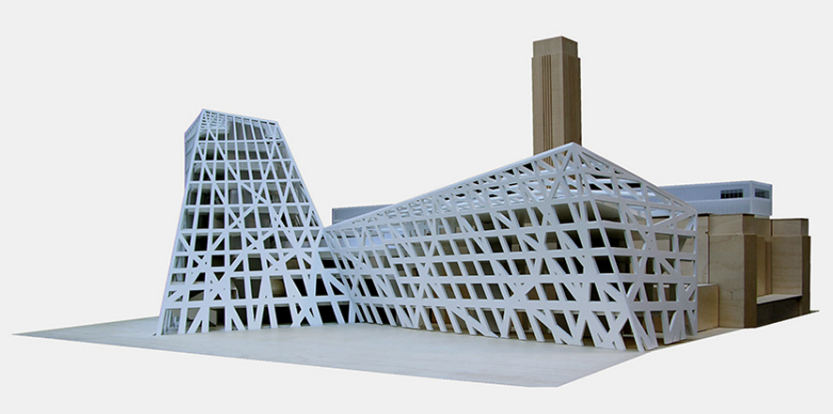
75 Gugger, "This is too generic."



11.13
Physical model of the first project for TM2 (2005).

The idea that the main structure coincided with the external shell of the volume and was directly linked to the architectonic image of the building and its aesthetic dimension was a topic in which HdM were particularly interested in this period and implemented in some projects, like the National Stadium, Beijing (2002–2008), the Ciudad del Flamenco, Jerez de la Frontera (2003–2005), and the Prada Aoyama, Tokyo (2000–2003).

Even though these projects are clearly different from one another in several aspects, explored in all of them is, as Jacques Herzog explained, "the idea that the skin creates unity and that it has depth."[76] This topic is related to the intention to merge the various components of the project into a unified whole and to achieve a strong continuity between the structure, space and ornament. "When ornament and structure become a single thing", Jacques Herzog noted, "strangely enough the result is a new feeling of freedom. Suddenly, you no longer need to explain or apologise for this or other decorative detail: it is a structure, a space. [...] Things start to get interesting when you bring all these elements together in a single thing, and if you can experience it by moving through the building, by using it."[77]

The same idea stood at the core of the facade system for TM2. The outer shell of the volume was envisaged as a structural device that reacted to the internal space at the same time as it determined the outer appearance of the building. In this first project, facade and structure were identical.

The architectural image of the building was determined by the glass of the openings and the weathering steel that the architects decided to apply as cladding material on the external face of the load-bearing structure. According to diagrams presented in the design report, the choice of the weathering steel was related to the brick of the masonry walls of the old industrial fabric and the

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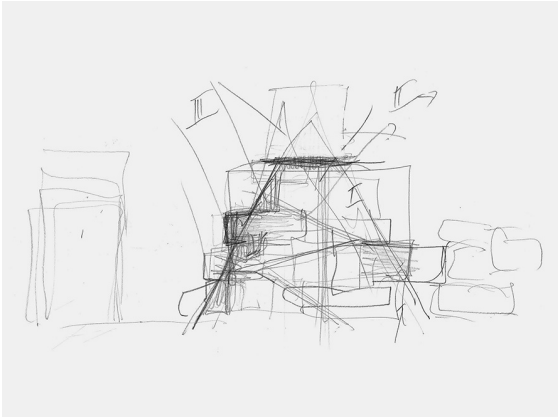
76 Jacques Herzog, "Ornament, Structure and Space [A Conversation with Jacques Herzog]," by Jean-François Chevrier, in *El Croquis. Herzog & de Meuron 2002–2006. The Monumental and the Intimate*, vol. 129/130, eds. Fernando Márquez Cecilia and Richard Levene (Madrid: El Croquis, 2006), 33.

77 Ibid.



11.14
"*Primary Form & Boxes", the concept for the second project. S*ketch by Jacques Herzog (2006).

intention of giving continuity to some of its physical features. Sympathetic to the existing brickwork, as explained in the report, in its roughness, patina and the variation in the surface treatment, the use of this material was understood by the architects as a strategy to endow the new building with some of the old power station character.

However, the resulting project was a long way from establishing a continuity with TM1 and, therefore, from contributing to the achievement of the desired "coherent whole". On the contrary, the first project for the completion of Tate Modern was an extraneous object added to Gilbert Scott's brick mass volume. It was an impressive, glowing work of architecture that would become even more striking in its second itineration.

11.3 _ "Primary Form & Boxes"

A design report from February 2006 makes it clear that the first version of the project for TM2 was revised in two short months. Therefore, for about one year, roughly until the end of 2006, the office worked on a new proposal for the Tate Modern pyramid (***11.14***). The revision process introduced adjustments in the internal planning, and it overturned the approach to the overall configuration of the building's form. This new proposal was submitted to the London Borough of Southwark in October 2006 in the first planning application for the erection of a 12-level extension to Tate Modern, and the consent was granted in March 2007.

Nicholas Serota has mentioned that at this time "there was a certain amount of self-imposed pressure to answer some of the criticisms that had been made a decade earlier when we took on the power station, principally that we didn't have the conviction to do a totally new building."[78]

[78] Wainwright, "Lofts and Caves," 42.

The ambition of Tate to prove itself had induced the architects to take, from the beginning, a startling approach to the completion of Tate Modern. In a way, Harry Gugger confirmed this when he described the trustees' reaction to the first project, which was to request an even more astonishing proposal.

"We showed this to the trustees", Harry Gugger notes, "and they said, 'It's all very rational and reasonable, but it has no "wow" effect. What you design has to have a huge "wow" effect. Why? Because we need to raise money, and we don't believe that, with this project, we can raise the money.' And that's how the glass pyramid appeared. That's when we started to overdo the pyramidal shape, with the blocks all out of glass."[79]

Two distinct operations guided the revisions to the overall form of the building. One is concerned with the refinement of the envelope's geometry, while the other has to do with the conception of the internal program as "boxes" (***11.15***).

On a diagram presented in the design report of December 2006, axonometric views of the tower, together with its corresponding floorplan, were used to compare different options to simplify and rationalise the general shape of the building (***11.16***). The envelope's curved surfaces, which distinguished the previous version of the project, had disappeared. The transition between the irregular footprint of the volume and the rooftop was accomplished only by flat faces. However, to provide autonomy to both contours, in terms of orientation, in most of the possibilities that were compared, each side of the volume was defined by two flat faces—vertical and inclined—that allowed the transformation of the form and ensured the bending movement specific to the first project.

When looking at the three variations of option 4, shown in the diagram, one may notice that in contrast to the irregular quadrilateral standing at the base of the tower, the pyramidal form was concluded at the top by a regular figure oriented according to the orthogonal layout of the former power station. Therefore, the new proposal's envelope was defined by a "primary form", as it was called in the design reports, straightforward from a geometric point of view, that was taking into consideration the alignments of the land parcel and the surrounding context and was anchoring the new building to the existing structure. However, the reference to the regular matrix of the old industrial fabric was only taken into account in the external shape of the volume. Inside, in addition to the different orientations of the rooms, the spatial arrangement mainly followed the east facade's oblique direction.

Along with the refinement of the building's overall shape, in this new version of the project the internal spaces were considered as "boxes". To address the complexity of the architectural brief and to provide the variety of exhibition spaces requested, HdM decided to translate the internal program into a series of rectangular rooms of different sizes and proportions. Taken as pure prisms, these rooms were freely disposed over the floors, creating a massive pile of boxes placed on top of each other according to distinct orientations (***11.17***). Inside the building, a ceremonial route went through the in-between spaces, connecting the several rooms.

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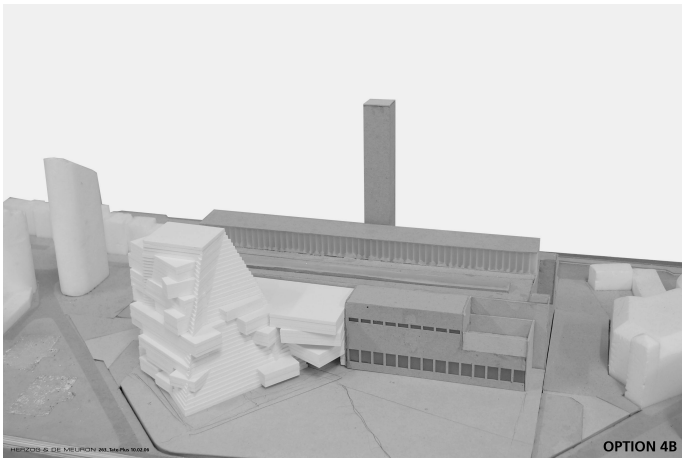
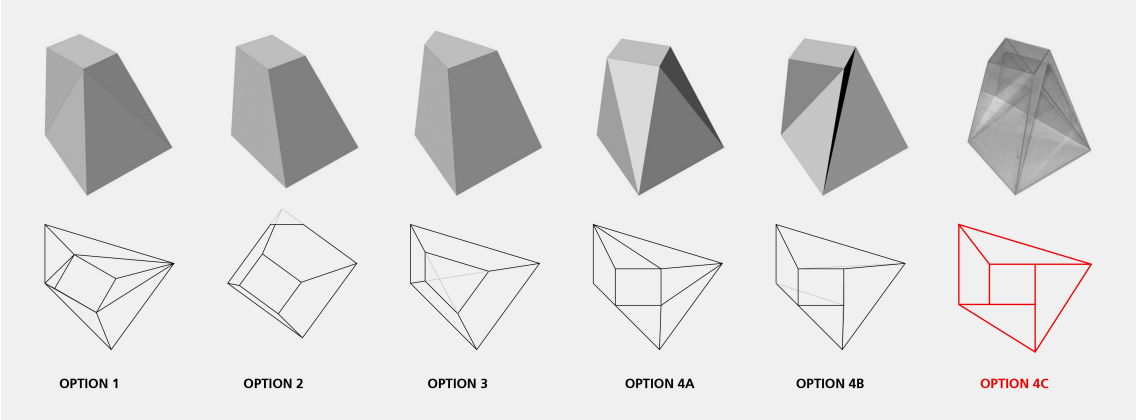
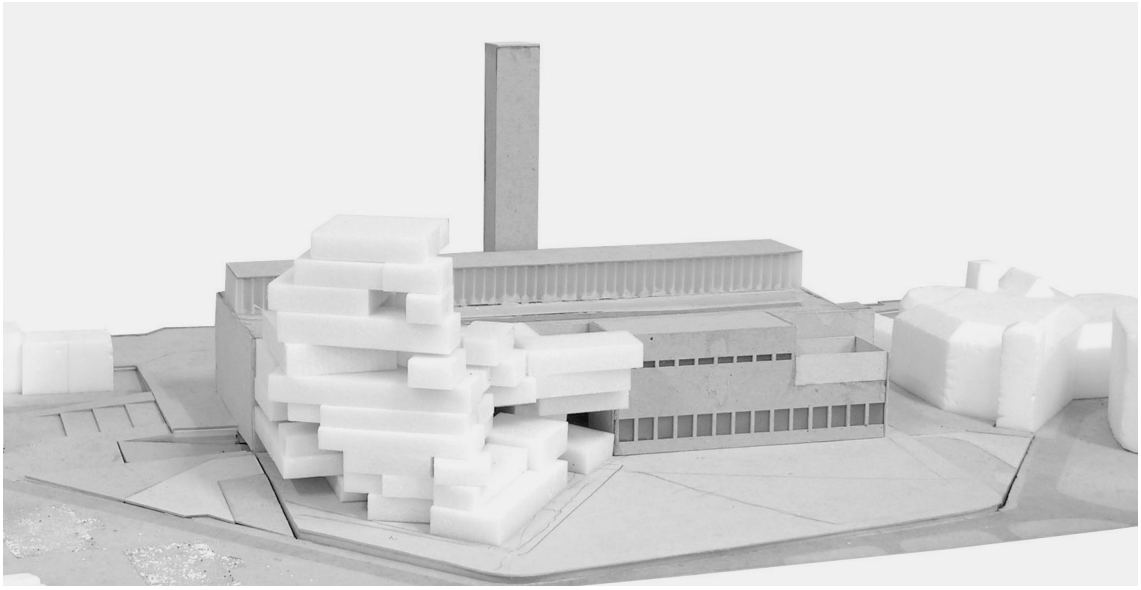
79 Gugger, "This is too generic."







11.15
The overall form of the second project for TM2. Physical model (2006).

11.16
Envelope geometry diagrams (2006).

11.17
Internal program: boxes. Study model (2006).

Referring to this version of the project, Nicholas Serota said that “initially there was a strong desire to create separate galleries, each with its own individual character”, in a certain way influenced by “the strategy used very successfully by SANAA at the 21st Century Museum of Contemporary Art in Kanazawa, Japan, 2004.”[80]

However, this idea of piled boxes in an apparently random arrangement is also directly related to the concept of stacking layers that HdM implemented in other projects in this period. "For quite a while", said Jacques Herzog, referring to TM2, "we believed a pile of stacked galleries in combination with other spaces was the right building typology. We had been working on "stacks" for another project in our office. We liked them; stacking boxes of different sizes and proportions seemed a good way to accommodate the complex brief for Tate 2."[81]

The revision that led to the second project for the completion of Tate Modern happened roughly at the beginning of 2006. The year before, in 2005, HdM had been working on the project for the Beijing Film Academy of Qingdao, China (2005), which, despite not having been built, became pivotal in the sense that it settled a specific approach to form-making that was later carried out in other iconic buildings. The Qingdao project, as HdM remarked, "has given fruitful impulses, substantially influencing subsequent projects of our own, especially Actelion, VitraHaus and the residential tower on Leonard Street in New York",[82] all of them based on stacking as a compositional principle.

Even though the idea of layering has long been a recurrent theme in the architecture of HdM—with the Ricola Storage Building, Laufen (1986–1987), as perhaps one of the most relevant examples—this topic was addressed from a three-dimensional standpoint when it was developed as a means of spatial organisation in the unusual project for the cinematographic campus in China.

In Qingdao, HdM decided to use a "crude but extremely efficient method",[83] as the architects described it, that helped them to deal with the colossal size of the film academy and its highly ambitious program. Working with a considerable number of rectangular foam blocks of diverse sizes and colours, representing the program's elements, and after having tried, with no success, regular and apparently more rational arrangements, HdM decided to play with the blocks, experimenting with random and almost chaotic compositions of stacked elements (***11.18***). The resulting, quite expressive, architecture was suited to the seaside location and the exceptional program, as it revealed a rich set of complex spatial and functional relationships, marking the beginning of a series of designs based on the same additive process of layering.

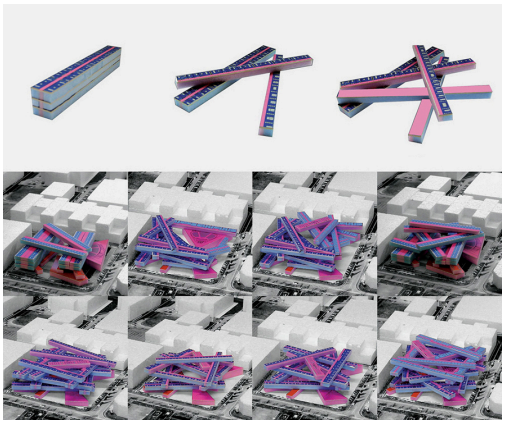
In the following years, HdM applied this sculptural and structural stacking strategy to projects with different needs, from the point of view of the program and the local parameters, but where the creation of an iconic landmark building was a common request. Together with the already mentioned Actelion Business Center, Basel (2005–2010) (***11.19***), the VitraHaus, Weil am Rhein (2006–2009), and the high-

80 Serota, “Foreword,” 21.

81 Herzog, de Meuron, “In conversation with Chris Dercon,” 108.

82 Gerhard Mack and Herzog & de Meuron, *Herzog & de Meuron 2005–2007. The Complete Works*, vol. 6, ed. Gerhard Mack (Basel: Birkhäuser, 2018), 21.

83 Ibid.



11.18
Beijing Film Academy Qingdao, Qingdao (2005). The random stacking of rectangular blocks.

11.19
Actelion Business Center, Allschwil (2005–2010). Study models for the disposal of the beam shaped elements.

-rise building, 56 Leonard Street, New York (2006–2017), the extension to Tate Modern is also part of the "astonishing variety of projects, almost contrary in architectural expression",[84] as HdM described them, that were all generated from the same building typology.

However, in the Tate Modern, the proposed building resulted from the overlap between two distinct formal strategies: the “primary form” enclosing the volume, and the irregular pile of “boxes” that broke the encasing facade by projecting outwards.

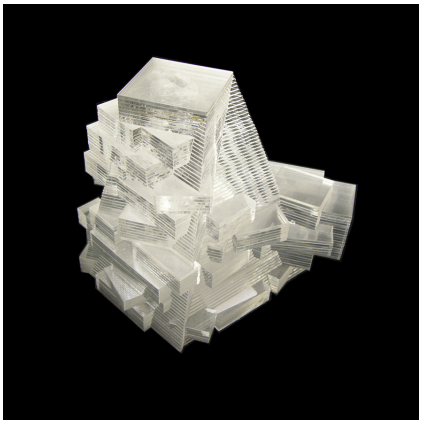
This strategy of deforming the external skin of the volume, making visible on the outside something that is part of the internal arrangement of the building, recalls other works by HdM, namely the pyramid with protrusions for the Auditorium du Jura (2005–2006) in Switzerland.

A similar compositional principle may also be seen in the first project for the Roche Building 1, Basel (2009–2015). Before becoming the regular stepped form marked by horizontal white parapet bands typical of the pharmaceutical company’s architectural identity since the 1930s, this tower was very feminine, as Kai Strehlke described.[85] The first design for the Roche tower was very organic; it was defined by two intertwined helices that jutted through the external surface of the volume, stretching its outer skin and deforming the overall cylindrical shape.

In its second design version, the architectural image of the Tate Modern extension was marked by the appearance of its glazing (***11.20 / 11.21***). Clad all over with laminated textured glass panels, the new

84 Mack and Herzog & de Meuron, *Herzog & de Meuron 2005–2007*, 110.

85 “I worked on the Roche Tower a lot before it became this triangle. On an earlier stage the design was driven by a double spiral. I really liked it. Towers are very often phallic symbols. The first design for the Roche tower was very feminine. It looked more like an Italian Madonna than a phallic symbol. I found this tower extremely unique in the line of skyscrapers and highrises all over the world.” Kai Strehlke, in conversation with the author, “I see it as a little bit like an orchestra,” Zurich, April 16, 2019.



11.20
The glazed tower for TM2. Study model (2006).

11.21
The new Tate Modern behind the former power station. Composite image (2006).

Tate Modern took the form, as Oliver Wainwright described, "of a glacial mountain of cast glass blocks, stacked up behind the former station like a teetering pile of ice cubes."[86]

Again, the relationship with the existing building was based on contrast, on the clear distinction between the new building and the old industrial fabric in terms of shape, materials and character. One might wonder if this didn't share similarities with the "light beam" placed on the rooftop of the Boiler House, which is also marked by a contrasting materiality to the brick industrial building. However, while this rectangular glass prism, added in the nineties, had a discreet presence, establishing a subtle dialogue with the former power station in small compositional details, the new building was quite excessive; it called attention to itself and did not aim to create a unitary whole.

"It would have been a nightmare", Jacques Herzog said recently in an interview. "It was just too alien, too far away from the existing building."[87] As the architects recalled, they felt less and less comfortable with this design because of the glass, with which the new extension "would have become an undesirable ally of the development around it"[88] as Pierre de Meuron pointed out, and because of the building typology of stacked cubes, which didn't match the desired free-flowing circulation inside the tower. "We felt we could really create an unexpected new form", Jacques Herzog observed about the stacked boxes version of the project. "It expressed total freedom—that's what we thought. But that impression proved to be wrong. What seemed to allow such freedom of movement inside turned out to be rather rigid and inflexible."[89]

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86 Wainwright, “Lofts and Caves,” 42.

87 Ibid., 43.

88 Herzog, de Meuron, “In conversation with Chris Dercon,” 106.

89 Ibid.

11.22
"Not too tech!" the third project for TM2. Sketch by Jacques Herzog (2008).

11.4 _ "Not too tech!"

Even though the trustees were satisfied with the glass stacked boxes project, the architects began to feel uncomfortable with it and were no longer convinced that this would be the right direction for the project. According to Harry Gugger, the partner in charge of the project until 2009, they realised that the glass gave the building a generic character, and that overdoing the pyramidal shape with the boxes resulted in a too-glamorous approach, the total opposite of what Tate Modern was meant to be.

"This is generic, and it could be anywhere," Harry Gugger said, remembering a conversation he had with Jacques Herzog. "This is not the Tate! [...] I think we should be much more restrained; we should create a more coherent project. We should not have Tate 1 and then something new."[90]

From this moment, it seems as if the mindset of the architects changed, and the last revision was undertaken, leading to the final version (***11.22***).

"There was a pause", Nicholas Serota notes, "partly because we couldn't raise enough money in the recession, and we found ourselves thinking more and more about the glass and feeling less and less comfortable with it. Jacques became concerned that a glass building would look 'commercial' in a landscape of surrounding glass office facades. As a result, we started to contemplate the idea of the brick."[91]

For about one and a half years, from December 2006, when the design report about the glass stacked boxes was concluded, until July 2008, when the public presentation of the revised plans for the new development of Tate Modern occurred, the office worked on the schematic design for the project's final version. Two main operations led this revision process, both having an impact on the new building's external appearance and on the dialogue that from this moment was established with Gilbert

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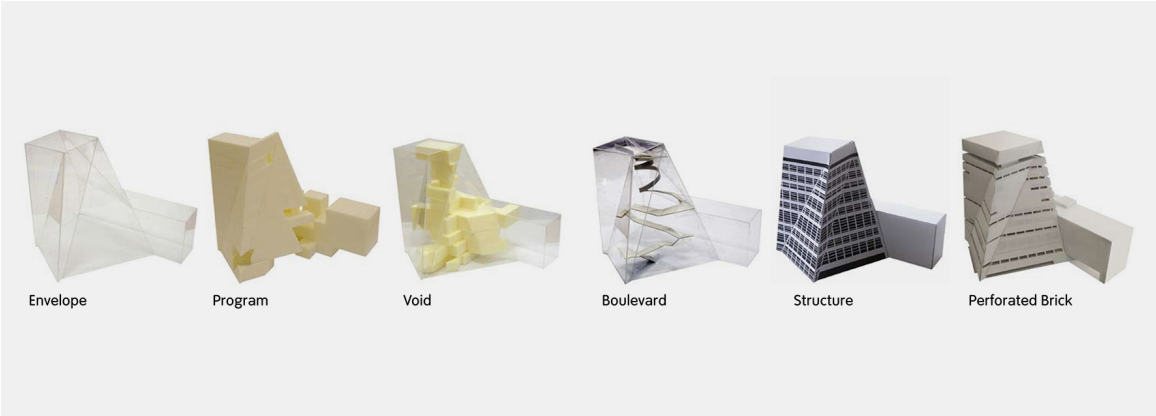
90 Gugger, "This is too generic."

91 Serota, "Tate Modern 2."



11.23
Envelope, Program, Void, Boulevard, Structure and Perforated Brick. Study models (2008).

Scott's power station building. Together with the decision to simplify the outer shape, brick was chosen as the cladding material for TM2.

Six study models, published in the design report of July 2008, illustrate the main concepts informing the architecture of the final project (***11.23***). The first physical model, labelled "Envelope", evidences the fact that the architects "'dissolved' the stacked sugar cubes",[92] as the process was described by Jacques Herzog, and decided to return to the primary form outlined in the previous design. The general shape of the extension became a very clear and precise truncated twisting pyramid, resulting, as already mentioned, from the combined geometries given both on the site and in the existing building. The internal arrangement no longer interfered with the external surface of the building. On the contrary, in this final version, several rooms, still seen as a series of boxes stacked on each other, were intersected by the flat faces of the envelope and acquired an irregular configuration.

The three physical models entitled "Program", "Void" and "Boulevard" are concerned with the internal arrangement, highlighting the role of the ceremonial route as the central element of the vertical circulation that went up through the remaining free public areas, connecting the main parts of the building with one another (***11.01)***.

As opposed to the previous version, the program was now arranged according to the orthogonal layout of the old power station with the gallery rooms fitted into the area of the original Switch House over three levels, like the exhibition spaces at the Boiler House. The diversity required of the display conditions was no longer ensured by separate volumes organised in different directions, but instead by the possibility of adapting the configuration of the column-free floorplans of the Switch House each time, creating a wide range of spaces of varying scales and character in which the different floorplan heights and sources of lighting on each level were distinguishing elements.

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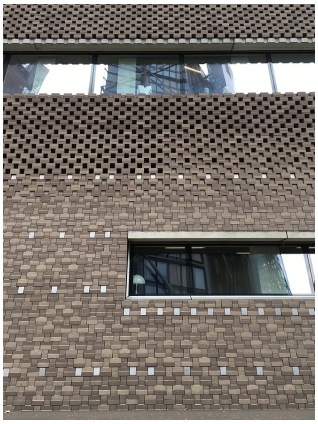
92 Herzog, de Meuron, "In conversation with Chris Dercon," 108.



11.24
The new Tate Modern amid the surrounding glazed blocks.

11.25
Detail of the perforated brick skin. South facade.

The last two physical models, called "Structure" and "Perforated brick", are related to the facade system, illustrating the architects' decision to cover the extension volume with the same brick as the former power station. According to Harry Gugger,[93] it was clear that it was all a question of materiality. If HdM wanted Tate Modern to be one thing and have the two parts, old and new, together in a coherent whole, then the same brick of TM1 should be applied to the extension volume.

By doing so, TM2 has become, as Pierre de Meuron referred to it, "an erratic mineral block in the midst of the surrounding commercial environment",[94] and the link with its primary element, the Bankside power station, has been strengthened (***11.24***).

Understood as a natural growth process, the completion of Gilbert Scott's building was guided by a strategy more like that adopted in the first phase, where the industrial fabric was converted into an art gallery. As HdM said in 2000, referring to TM1, "our strategy was to accept the physical power of Bankside's massive mountain-like brick building and even to enhance it, rather than breaking it up or trying to diminish it."[95] Therefore, an accurate dialogue with TM1 was triggered. It was no longer about making the building stand out through its conspicuous presence, but, on the contrary, it was about working with the given features of the site, enhancing the qualities of the original complex, and seeking to innovate while ensuring a crucial continuity.

A specially designed brick was developed to complement the rough variegated masonry walls of the former power station, tying both buildings into one. By using the same constructive principle as the old building, a steel frame clad with a non-load-bearing wall, the facade of the pyramid became a

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93 Gugger, “This is too generic.”

94 Herzog, de Meuron, “In conversation with Chris Dercon,” 106.

95 “126. Tate Modern, London, UK,” Projects, Herzog & de Meuron, accessed July 16, 2020, https://www.herzogdemeuron.com/index/projects/complete-works/126-150/126-tate-modern.html.

mighty concrete skeleton growing from the underground world of the oil tanks, over which is literally hung a perforated brick skin (***11.25***).

In addition to being the specific material of the former industrial building, brick was also applied in TM2 because of its archaic nature. Being opposite in its materiality and constructive logic to a highly advanced technological building, the traditional material of London, which "nobody uses [today] [...] especially for these new buildings around the Tate", as Jacques Herzog notes, would lead the volume of the new extension to stand "much more alone, [and] be different from the office blocks around [it]",[96] acquiring the desired, distinctive classic appearance.

Laid according to an innovative system, the bricks created a continuous shroud that conferred solidity and massive presence to the building, at the same time introducing, in the refinement of its perforation, a contrasting transparency through which light filters in during the day and the building glows at night. In its changing look, the outer skin of the new Tate Modern is both as robust and powerful as it is light and delicate, almost like a textile. This textured veil, which, like a garment, dresses the building, captures HdM's skilful use of materials, which has distinguished their architecture within the contemporary context since the beginning.

The Signal Box Auf dem Wolf, Basel (1989–1994), is one of the first buildings by HdM in which this peculiar and novel approach to architecture was fully announced. Sited among the railway tracks, this small box, wrapped with copper bands that dissimulate any reference to the conventional concrete construction behind it, embodies a compositional strategy in which the formal restraint of the architectonic object is counterbalanced by the in-depth investigation of the material's nature. In its formal abstraction, the Signal Box is, in the first instance, an exaltation of copper, which has acquired its own identity, becoming the element that determines the architectonic expression of the building. Therefore, in addition to being paradigmatic of a minimalist aesthetic, this compact object marked a practice that put the accent, as Luis Fernandéz-Galiano observed, on "the relevance of the coating material as such and how this can change the virtuality of the architecture."[97]

The Dominus Winery, Napa Valley (1995–1998), developed in the years after the Signal Box, is another of the significant works by HdM that added a new dimension to the research they were conducting on the formal potential of materials. In the project for Napa Valley, the use of stone was reinvented, revealing unexpected qualities of this cladding material and endowing the building with an enriching, ambiguous character (***11.26 / 11.27***). As Gerhard Mack observed, "above all, Herzog & de Meuron solve the monolithic appearance of the building. The stone block made of greenish-grey basalt preserves the heaviness of the material, but it also proves to be rather porous and fragile. [...] What from a distance looks like a massive volume, or at least a thick-walled building, takes on a textile-like quality as one approaches, as though the wall were a sun sail or a veil of stone."[98]

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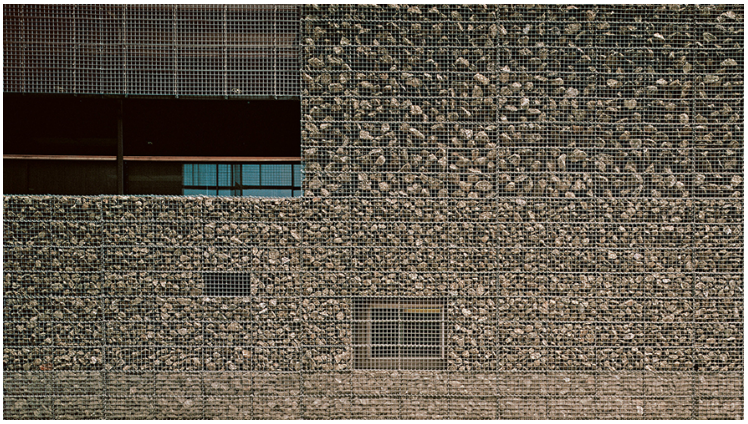
96 Herzog, "Transforming Tate Modern", 03:17.

97 "Quería hablar justamente del revestimiento y del por qué es importante el que revestimiento de repiente altiera virtualidad arquitectónica." Galiano, "Jacques Herzog y Pierre de Meuron," 21:56.

98 Mack and Herzog & de Meuron, *Herzog & de Meuron 1992–1996,* 169.



11.26
Dominus Winery, Napa Valley (1995–1998). The massive look of the stone gabion wall.

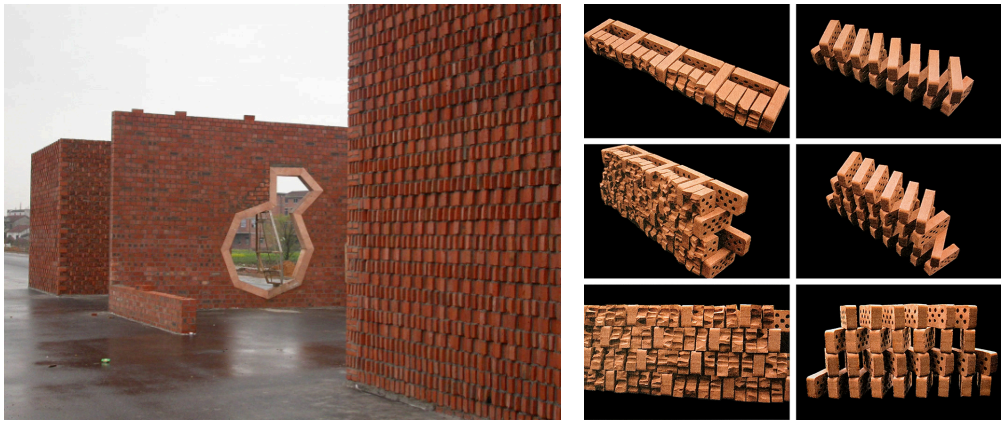
11.27
Transparency and the play of light inside the building.

In the Dominus Winery, the work with the external material was not only about placing it at the core of the architectonic expression, it was also about playing with it, questioning its nature and subverting its constructive logic in the search for unconventional ways of using it that would enhance its most subtle and unpredictable features.

In TM2, the approach undertaken to define the outer skin shares similarities with both examples, particularly with the two-storey block situated among the rows of vines in California. Far from being a normal mortared wall, the external surface of the art gallery extension is an original, innovative constructive system that results from a deep investigation of the qualities of the brick. Besides embodying the image of the building, the brick was exalted in its role as cladding material; what at first instance seems to be ordinary massive masonry is in reality an elaborate textured veil whose appearance changes according to the observer's point of view.

From this perspective, along with the experiments developed some years before for the unbuilt project for the Jindong New Development Area, Jinhua (2003–2006), in China, where brick was intensely explored for its pattern and textural qualities, it may be seen that TM2 developed within the practice of HdM a novel way of looking at brick and considering it in the construction of architecture.

Before these two projects, HdM had used brick in the conversion of industrial buildings, such as TM1, London (1995–2000), the Küppersmühle Museum, Duisburg (1997–1999), and the Caixa Forum, Madrid (2001–2008). In these examples, the mark of the contemporary intervention was not revealed in the brickwork, which was accepted and retained within its traditional construction system, but rather in the overall design of the facades, where the position, scale and proportion of the cutouts for the windows clearly stood out from the original composition.



11.28
Jindong New Development Area, Jinhua (2003–2006). Mockup for the brickwork.

11.29
Different combinations for the use of locally made bricks.

Around 2005, the in-depth investigations of brick carried out within the project for Jindong (***11.28 / 11.29***) and the subsequent development of the innovative brickwork for TM2[99] put the traditional clay block into the material palette of HdM, revealing its great potential from a tactile point of view. Appreciated by HdM for its archaic character and for the fact that it "can [also] be interpreted as a digital field",[100] brick has been used and explored ever since by the Swiss architects in several buildings. Applied in projects where the relationship with the local environment is usually a fundamental aspect, and in which the balance between old and new must be taken into consideration, the brick in projects like the Musée Unterlinden, Colmar (2009–2015), the Stamford Bridge Stadium, London (2013), the Royal College of Arts, London (2016–...), and the Neue Nationalgalerie – Museum des 20. Jahrhunderts, Berlin (2016–...), acquired novel and unexpected expressions. By playing with its physical features, like shape, bond, texture and colour, HdM explored the brick from different perspectives, creating surfaces of unforeseen material qualities.

In TM2, the continuous perforated brickwork wrapping the building was broken by the introduction of long, narrow horizontal windows that appear in the facade according to an apparently random composition.

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99 When questioned about the influence that the Jindong project and the construction of the brickwork system of TM2 may have had in the subsequent brick projects, Wim Walschap explained that, "It was not intentional, and it was more a natural influence from the projects we did some years before in China. We designed multiple projects in which we experimented on how to work with bricks in a more contemporary way. These projects in China were not realised—the majority didn't happen—so I think it's more from there, from this kind of exploration, that something stayed, and then, in the right project, it came back again. [...] I think that the influence comes more from the explorations developed in China, working and playing with the bricks to find new textures and expressions." Wim Walschap, in conversation with the author, "It makes it more interesting by not being perfect," Teams meeting, Porto-Basel, July 16, 2020.

100 "469. Neue Nationalgalerie – Museum des 20. Jahrhunderts, Berlin, Germany," Projects, Herzog & de Meuron, accessed July 28, 2020, https://www.herzogdemeuron.com/index/projects/complete-works/451-475/469-museum-des-20-jahrhunderts.html.

"Ideally, we would have liked no windows", Jacques Herzog said. "Windows are difficult. A simple form always looks best without."[101] However, several demands related to the need for views out and specific requirements for daylight and ventilation determined the cutouts in the external brick veil. In addition to this, the dimension and position of the slots, which follow the brickwork grid, are in direct relationship with the building's internal planning. The main windows, called bottom slots in the design reports, "run from column to column for the extent of the internal program behind. Windows within the slot are in general 1050 mm high and 1050 mm off the floor level to allow for views from both seated or standing positions."[102] Wherever the daylight requirements demanded, additional top slots were introduced in the facade so natural light could penetrate deeper into the floorplan. These secondary cutouts, located at ceiling level, are 750 mm high, and their length is dependant on achieving the required daylight factor.[103]

Furthermore, the provision of natural light through these clear slots in the facade is combined with a diffuse system, with daylight filtered by the perforated brick skin, that allows, as referred to in the reports, "the spaces within TM2 [to have] a range of subtly different day lit characteristics depending on the orientation and the time of the day."[104] Even though, from the inside, the overall effect of these glazing areas with the brick wall behind is not always convincing, from the outside, this device is what allows the brickwork system to emerge in a fully expressive way. From the internal spaces, this ever-present "checkerboard", in addition to obscuring some views out, does not have always a pleasant appearance when seen in backlight leaning against the window frame (***11.30***). Conversely, at night, when the interior light glows through the small holes of the brickwork headers, the hidden facade of TM2 becomes visible, reavealing the refined lightness of the external veil (***11.31***). Contradicting, in a certain sense, what Jacques Herzog said about the windows, the cutouts on the facade are fundamental in reducing the monolithic appearance of the building. They provide further means to moderate the scale and massing of the volume, as they allow the building to avoid expressing too abstract an image.

Despite the apparently unruled disposition of the windows, looking carefully, one may notice that the facade is subtly structured into three horizontal sections, recalling, as Harry Gugger pointed out, "the Renaissance principle of topping a building."[105] Special conditions arising from the internal planning of the building, along with the greater height of the windows in some of the internal public spaces, allowed the architects to visually organise the facade by dividing it up into a base, shaft and cap.

While on the lower floors the generous cutout of the southeast entrance and the special window of the concourse on level 2 mark the base on which the massive brick building stands, in the upper part of the volume, corresponding with the panoramic restaurant on level 9 and the viewing terrace on level 10,

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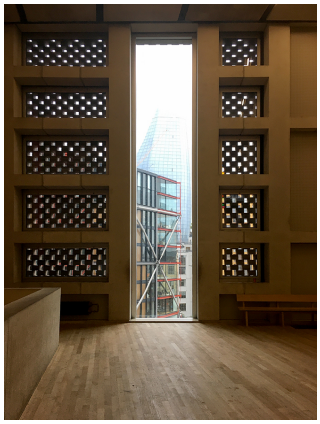
101 Wainwright, "Lofts and Caves," 44.

102 Herzog & de Meuron, *TTM/TM2 Design Development. 100% Stage E Report*, September 14, 2009, 23.

103 "Ventilation/thermal comfort: Natural ventilation is pursued as a solution wherever possible. This is achieved in the concourse spaces, catering spaces and utilised in mixed mode form to the office and educational spaces. The requirement for opening windows and their respective operation is captured in the HdeM window and glazing schedule. Primarily, the high level windows open to help cool down the internal spaces whenever they are above 20 degrees Celsius and the inside temperature is hotter than the outside. [...] At night the high level windows open automatically to purge the hot air out of the occupied spaces and to pre-treat the concrete slabs so they offer a source of cooling during the following day." Herzog & de Meuron, *Stage E Report,* 13.

104 Herzog & de Meuron, *Stage E Report,* 14.

105 Gugger, "This is too generic."

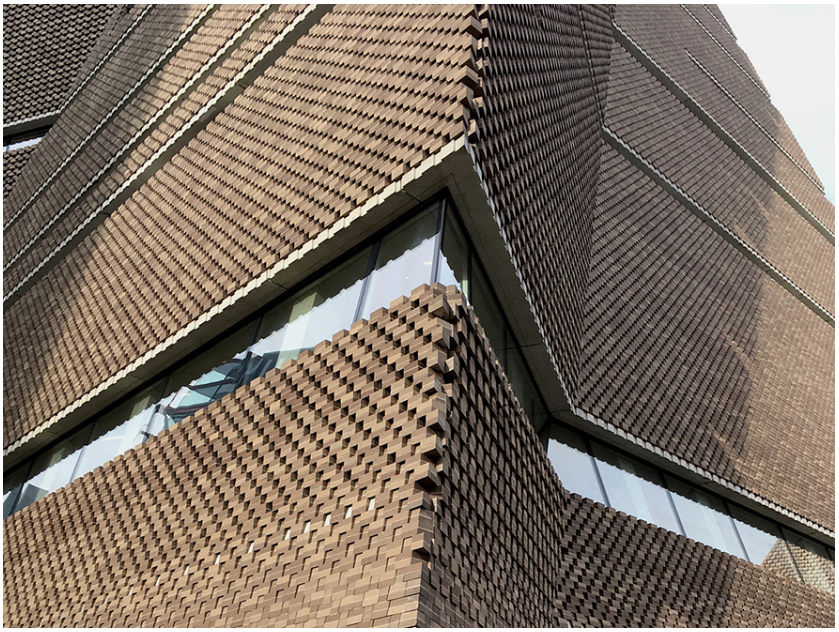


11.30
The diffuse lighting system from inside.

11.31
Opacity and transparency of the brick veil. West elevation.

a cut across the facade and around the building concludes the pyramid in its vertical upward movement.

Another horizontal cut, the window of the office rooms and learning spaces on level 5, introduces an ulterior hierarchy on the facade. Positioned in correspondence to the Switch House rooftop, this 1800 mm height window runs for almost the entire perimeter of the tower and reveals the internal programmatic subdivision of the building between the art display and the social areas, underscoring the part of the pyramid that rises freely above the roofline of the power station.



12.01
The corner of TM2.

12.
Classic vs Vanguard

12.1 _ The Brick as Cladding Material
12.2 _ The Brickwork Special Conditions
12.3 _ The Descriptive versus Parametric Design Approach
12.4 _ The Digital Parametric Tool
12.5 _ The Geometry of the Corner
12.6 _ The Colouring of the Facade

One of the most significant steps in the whole design process was the decision to clad the building with a brick veil. The option of using this local material in the outer shell of the volume, instead of the textured glass panels of the previous design version, changed the appearance of the building and affected several technical aspects of the architectural detailing. From this moment, the will to have the two parts of the building functioning as a single organism was fully achieved, and a significant part of the design process was focused on accurately defining the details that shaped the dialogue between TM1 and TM2.

The brick stands out as one of the key elements of this project, and embodies the hybrid nature of the building. The distinctive twisting shape of the volume, which defies gravity and the logical rules of construction, revealing the architects' aspiration to innovate, is counterbalanced by the use of brick, a traditional material capable of endowing the building with a sense of solidity. The double character of the new extension, which oscillates between classic and vanguard, is particularly demonstrated on the facade, revealing itself in the structural logic of the envelope and some of its construction details. In this context, brick plays a fundamental role. It is the brick that regulates the composition of the facade and exposes, in the geometric complexity of its arrangement, the conflicts that arise from this intricate duality. Therefore, an intensive design process, based on the close interaction between a descriptive process and a digital parametric approach, was carried out to ensure control of the massive amount of data coming from the 336,000 bricks that formed the outer shell of the building, and to support the resolution of the classic architectonic issues that the use of brick as the cladding material brought out in the design of the facade.

12.1 _ The Brick as Cladding Material

When the brick was chosen as the cladding material for TM2, the masonry walls of the Bankside power station were the main reference in the design process for the new facade's construction system. From this moment, HdM explored the tectonic qualities of this local material, searching for a new interpretation of it. In the Tate extension, the Swiss architects worked on "the idea that the construction materials contribute to inscribing a building into its environment",[106] something that Jean-François Chevrier outlines as being recurrent in their practice, and they conceived an unexpected brickwork system that emphasises their distinctive ability in "vernacular invention". As the French art historian remarks, "Herzog and de Meuron appreciate the vernacular, the local, and its potential for technological research. But instead of clinging to traditional values, they profit from this understanding as a valuable source of experimentation."[107]

This is exactly what the facade of the new Tate is about.

The brickwork of the twisting pyramid is a rousing development of the brick walls of TM1, as it is, in the words of Harry Gugger, "a revolution in the use of the brick, and actually a bit crazy."[108]

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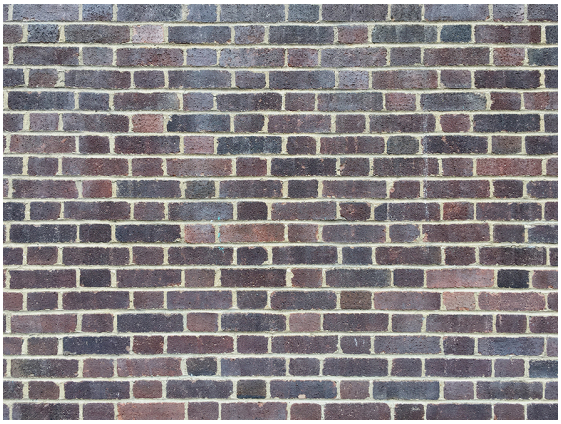
106 Jean-François Chevrier, *From Basel. Herzog & de Meuron* (Basel: Birkhauser, 2016), 20.

107 Chevrier, *From Basel,* 19.

108 Gugger, "This is too generic."



12.02
The ornamented brick skin of the former Bankside power station.

12.03
The Flemish brick bond from the plinth of TM1.

Constructed between 1947 and 1963, the Bankside power station was intended to be built of brick. However, due to the difficulty of obtaining, in the context of post-war reconstruction,[109] the number of bricks required, it was built as a structural steel frame encircled by a fine, ornamented brick skin (***12.02***). Made of standard-size bricks arranged in a bond of alternating headers and stretchers (***12.03)***, the external walls of the industrial fabric are, as Gavin Stamp describes, "a controlled, subtly detailed composition of dramatic planes of beautiful pinky-grey brickwork laid on a subtle batter and enhanced by careful touches of abstract detailing—what [Gilbert Scott] called 'decoration'."[110]

By considering these physical and perceptive qualities in the design of the new building, HdM conceived the outer skin of TM2 as an acute elaboration of the brickwork of the former power station in size, bond, and colour.

The new brick, the primary element of the intricate outer veil, results from the standard-size brick whose dimensions were adjusted according to the architectonic and construction demands of the extension building. With the same stretcher dimension as the traditional brick, the new clay block was doubled in depth, acquiring a square shape measuring 215 mm per side and 69 mm high. Assembled afterwards with a nominal 7 mm joint of polymerised mortar, pairs of bricks were put together in the factory, forming a single block measuring 215 x 215 x 145 mm (***12.04)***.

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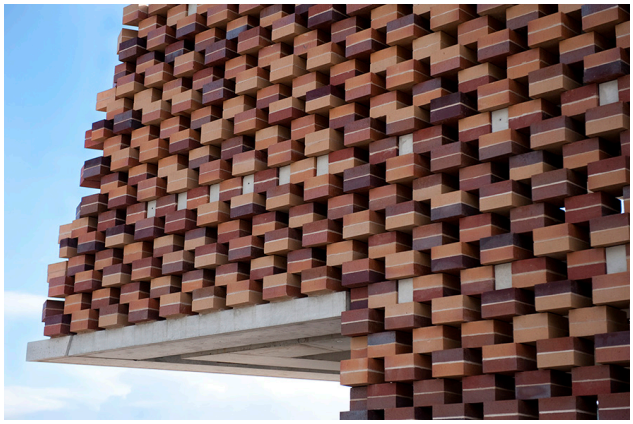
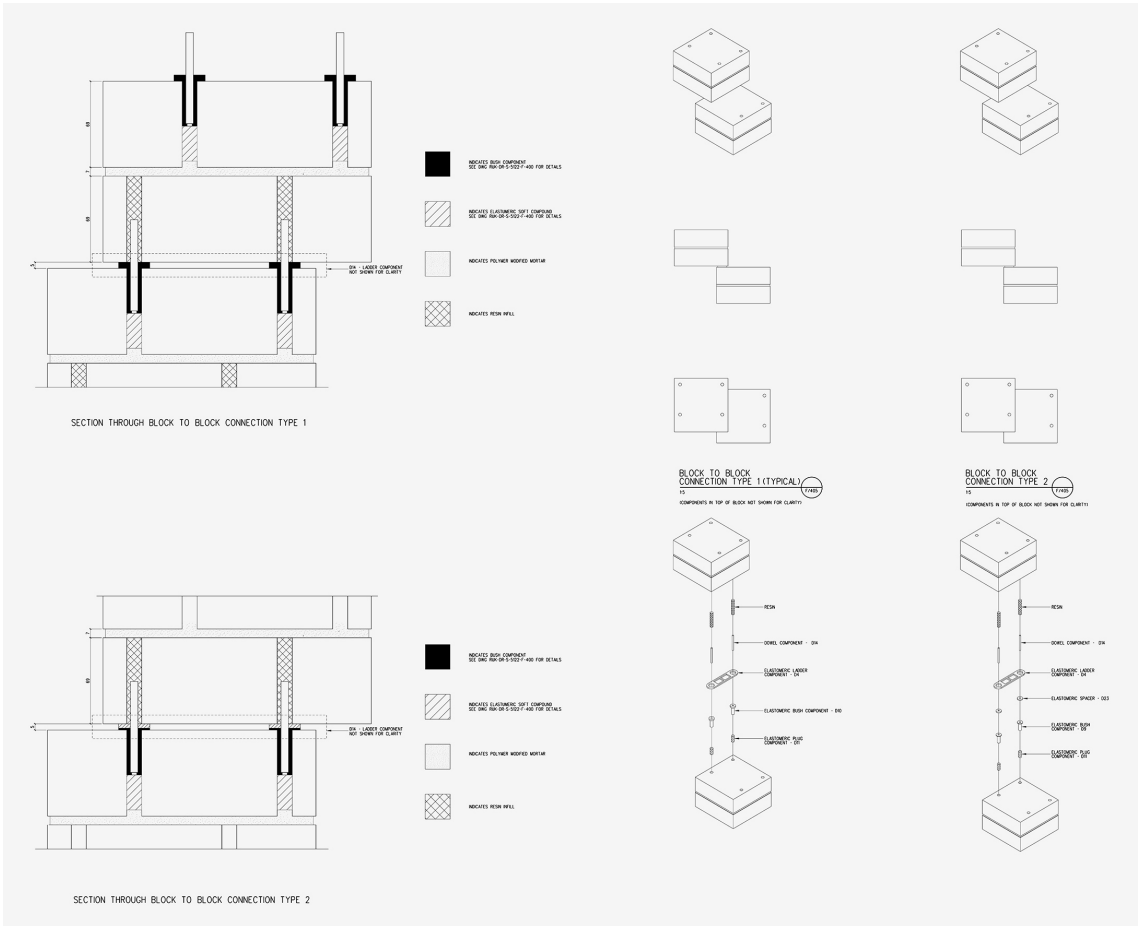
109 "The fabric of the new power station was always intended to be of brick which was London's staple building material. The public inquiry had identified that there would be some difficulty in obtaining the quantity of bricks required—over 4.2 million in the finished building—particularly in the context of post-war reconstruction. The inquiry had therefore recommended a temporary structure made from 'heavy structural steel and 'cladding' of various kinds [which] would be more easily obtainable'. However the power station was built as intended, as a steel frame building with a brick 'skin' and a reinforced concrete roof." Stephen Murray, "The rise, fall and transformation of Bankside Power Station, 1890-2010." *GLIAS London's Industrial Archaeology* nº10, 2012, http://www.glias.org.uk/gliasepapers/bankside.html.

110 Gavin Stamp, "Giles Gilbert Scott and Bankside power station", in *Building Tate Modern. Herzog & de Meuron transforming Giles Gilbert Scott*, eds. Rowan Moore and Raymund Ryan (London, Tate Gallery Publishing, 2000), 183.





12.04
The standard square-shaped block. View of the mock-up (2010).

12.05
The perforated brickwork. View of the mock-up (2010).

12.06
Typical block-to-block connections for the facade cladding.

While in depth the doubling of the dimension was made by the extrusion of the original brick, in height the double course was achieved by the addition of two pieces with a mortar joint in-between, which avoided the creation of a block that was too massive and kept the regular height of the brick legible on the outer surface of the volume.

The brickwork of TM2 follows the same Flemish bond as TM1, with the blocks being offset horizontally by a nominal header dimension of 122.5 mm. In this bond pattern, the headers were removed to create the desired perforation (***12.05)***.

The brick wall then responds to the shape of the twisting pyramid of vertical and inclined planes. On the sloping faces, the blocks are offset at each course, adapting their arrangement to the specific angle of the inclined surface. On the vertical walls, as a response to the brick rows that step up the inclined facades, the courses are also offset 44 mm in and out of the wall plane, ensuring the continuity of the brickwork texture in all eight surfaces of the building.

Placed on top of each other with an overlap of just a few centimetres, the blocks, with four holes inside, on the top and the bottom, are connected by a precise system that uses elastomeric joints and stainless-steel pins. They are linked to each other by a dowel that rests on an elastomeric plug inserted in the bottom brick and is fixed to the top brick with resin to allow for some movement (***12.06)***.

“What we proposed was far from traditional brick construction”, Harry Gugger said. “The bonding was not done with mortar, but with metal bolts. This is very difficult, very delicate and very elaborate. The brickwork looks like masonry, but this is not the masons' work.”[111]

The scaling-up of the brick element and the adjustments made to the bond resulted from a thoughtful calibration that took into consideration the structural and geometric constraints coming from the shape of the pyramid and the effect of transparency that HdM wanted to achieve in the outer skin of the building. While, on the one hand, the increase in brick depth was mainly concerned with the stability of the external walls, which rise 65 m above the ground floor level, with the blocks laid on each other and overlapping on just a small part of the bed surface, on the other hand, the definition of the course height was directly linked to the amount of daylight that filters through the holes of the omitted headers.

“We wanted to work with daylight, but we didn’t want to have big openings”, Harry Gugger explained. “But if you take the standard-size brick, and then you start to lay it down, there’s little opportunity to bring light through. If you go for a double-size brick, you can create bigger openings for more light. The system becomes more efficient in terms of light.”[112]

Therefore, the investigation into the right scale for the pieces and how they were put together, in addition to ensuring that the brickwork would be buildable and stable enough, was aimed at producing a transparent veil instead of an opaque solid wall. The openings created in the header position could not be too small, otherwise light would not come in, but they “could also not be too big, because that would complicate the buildability”, as Wim Walschap, the associate in charge of the facade design, pointed out. “Openings that were too large would also allow pigeons to land, turn around and live within the

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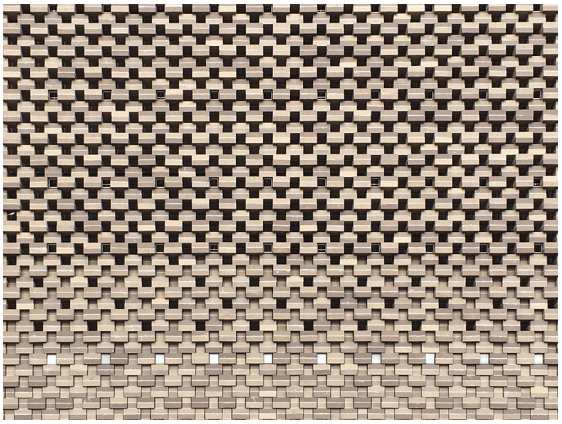
111 Gugger, “This is too generic.”

112 Ibid.



12.07
The fine textile-like appearance of the brickwork surface. TM2 south entrance.

12.08
The perforated brickwork. Detail of the Switch House facade.

brickwork. So, there were several parameters that influenced the development of the perforated facade screen."[113]

In addition to the work on the size of the blocks and how these were put together to form a perforated pattern that would respond to the complex geometry of the volume, the colouring of the bricks was another relevant subject that also came into play. Based on the original intention to establish a dialogue with the former power station, HdM decided to bring into the outer skin of the new extension the crafted character of the existing brick walls and explored ways to reinterpret its variegated appearance. Developed in further detail in the following sections, the work on the brick colours, with the definition of the different ranges and their distribution on the facade, added a degree of refinement to the textile-like quality of the external surface, enriching, even more, its decorative character.

In fact, from a tactile point of view, TM2 is a sharp example of the ever-present interest of the Swiss architects in the perceptual experience of the architectonic object, trigged in most cases by the special treatment given to the facade.

In the Tate Modern extension, the emphasis put on the "surface", something HdM have been exploring since their first projects, was developed in combination with another of their conspicuous design themes, "ornament". HdM do not neglect ornamentation in the condemned sense presented by Adolf Loos, but quite the opposite. As Jean-François Chevrier outlines, Jacques Herzog even "challenges [Loos's] twofold division [between ornamentation and decoration]. He does not despise decoration, and he rejects setting the nobility of the sacred against the vulgarity of the profane."[114]

However, in the project for London, the decorative aspect of the envelope does not come from the embellishment of the surface, as happens in the project for the Ricola-Europe SA, Mulhouse

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113 Walschap, "It makes it more interesting."

114 Chevrier, *From Basel,* 38.

(1992–1993) and the Eberswalde Library, Eberswalde (1994–1999), where the facades with an applied ornamental motif acquire, as Luis Fernández-Galiano argues, the appearance of a "tattooed skin".[115]

In TM2, the decoration is intrinsic to the physical constitution of the external surface and results from the logic of its construction as a brickwork system. Therefore, one may talk about a "necessary decoration" or an "analogical decoration", as Quatremère de Quincy defined it.[116] The decorative character of the outer skin of the extension volume results from the ambition of HdM to get the maximum architectonic expression from the brick, playing with it according to the rules of construction and addressing its technical constraints with shape, texture and perforation. It is about the geometry of the pieces combined in a complex arrangement and the light that falls on them, creating an enriching effect of shadows complemented by a contrasting animated screen-like appearance (***12.07 / 12.08)***.

12.2 _ The Brickwork Special Conditions

Referring to the outer skin of TM2, Nicholas Serota implied that the realisation of such a unique idea for the building's materiality was a challenge in itself. HdM "are highly sensitive to the notion of surface in terms of the skin of a building", he said,

> and I think they had an idea about what they wanted to achieve. I would say they have a remarkable sensitivity to material and very good judgment about scale. They are able to go beyond the mechanics of what the computer, the digital image, can generate. One of the strengths of their work is an ability to move beyond conventional use of materials to achieve a physical form, which cannot be quite defined or predicted. At Tate Modern they wanted to achieve certain effects on the facade that they had no idea how to realise in practical terms. All the fixing mechanisms, all the structural concrete framework had to be developed.[117]

The facade system for TM2 is the result of a complex assemblage of several components where precision was key and in which the "accommodation of the relevant tolerances [...], manufacture and installation", according to the engineers, Ramboll, "were critical to achieving a successful building envelope."[118] The precast concrete frame of the tower is the internal layer of the facade that, together with the two concrete cores, supports the floor slabs. This precast encapsulated steel construction is made of a series of columns that crank to form the creases in the envelope of the building. With a

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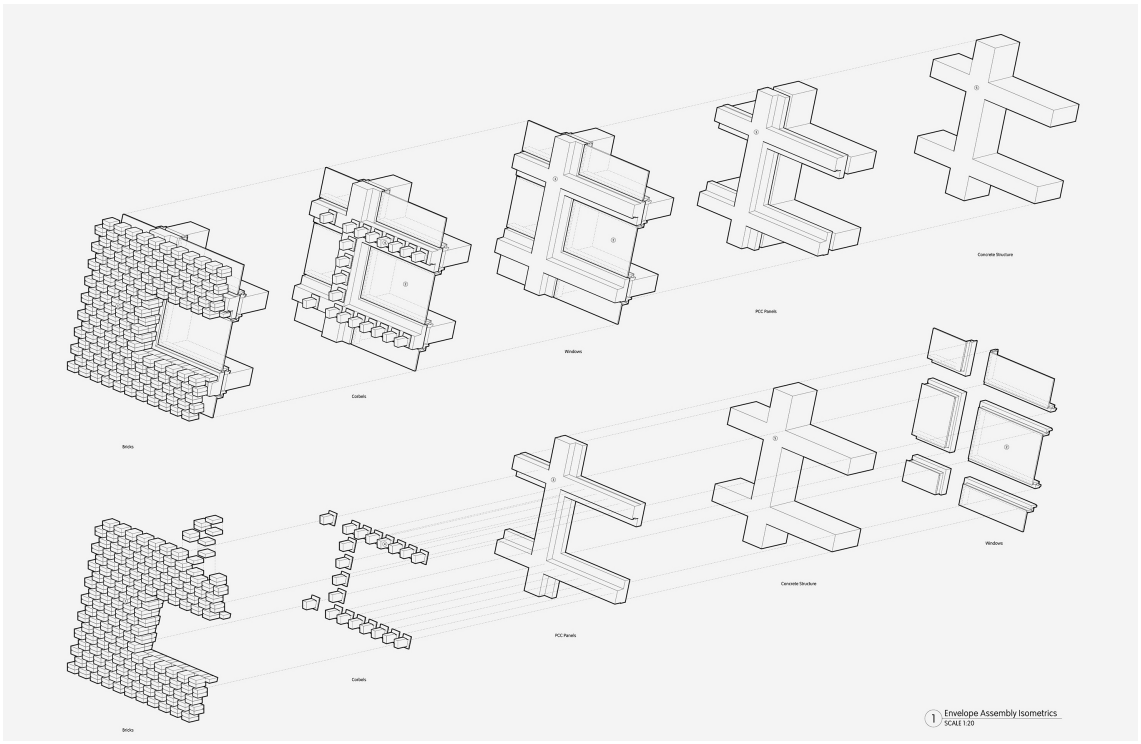
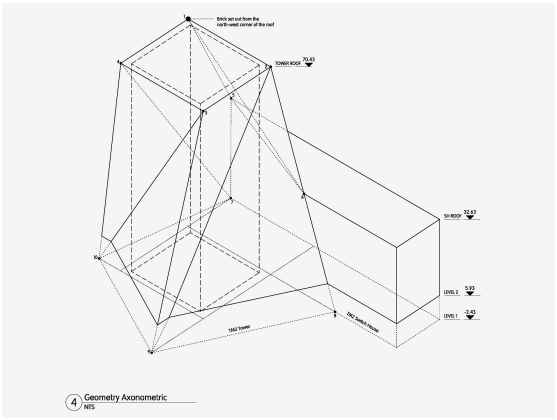
115 Galiano, "Jacques Herzog y Pierre de Meuron," 24:44.

116 "Nella voce Decorazione del Dizionario storico di Architettura, Antoine-Chrysostome Quatremère de Quincy distingue chiaramente l'aspetto positivo e necessario del principio da quello negativo e superfluo. Possiamo riconoscere in questa divisione la distinzione fra decorazione e ornamento.
Dice Quatremère de Quincy: "Noi chiamiamo decorazione necessaria quella la cui mancanza produrrebbe all'occhio e allo spirito un difetto di senso—oppure—quella la cui presenza è propria a spiegare allo spettatore l'oggetto a cui si aplica. Quell'infine che rinforza le impressioni che deve produrre l'oggetto stesso e ne sviluppa il carattere" [...] La decorazione per Quatremère de Quincy può essere di tre tipi: ornamentale, analogica e allegorica. [...] Il secondo tipo di decorazione si può definire analogica [...] e si aplica in analogia alla costruzione. Il sistema costruttivo si fa descrivere attraverso la decorazione che diviene didascalia della costruzione e, in questo modo, conferisce senso e carattere ai suoi elmenti", Antonio Monestiroli, *La metopa e il tríglifo* (Roma-Bari: Editori Laterza, 2002), 85-86.

117 Serota, "Tate Modern 2."

118 Ramboll, *The remarkable and unique*, 21.





12.09
Isometrics of the envelope assembly (Concrete Structure / PCC Panels / Windows / Corbels / Bricks).

12.10
The precast concrete structure from inside. Tate Studio at level 6.

12.11
Axonometric of the envelope geometry. Brick set out from the north-west corner of the roof (1).

cruciform shape in profile, the perimeter columns are linked by secondary horizontal beams, creating a framework of vertical and horizontal elements that support the precast cladding panels, the glazing and the brickwork ***(12.09)***.

Fixed to the internal perimeter structure and the floor slabs, the second layer of the facade consists of the precast concrete cladding panels that, in addition to providing a thermal and moisture barrier to the building, support the corbels, transferring the loads from the brick veil to the main frame at the rear. Where the concrete structure and the precast concrete cladding panels meet, the voids in the envelope are filled by the glazing system ***(12.10)***.

As the external layer of the facade, the brickwork is supported and restrained with the aid of stainless steel corbels located along the horizontal beams of the concrete structure at approximately 665 mm horizontal and 1500 mm vertical centres. At the openings, these are positioned along the sills. Sitting in the holes of the omitted headers of the brickwork, the corbels, as the engineers explain, "offer a mechanism for reducing general frame tolerances as an interface to the more refined brickwork."[119]

Despite being just one of the several layers of the facade, the brick veil, due to the modular nature of the blocks and their arrangement on a regular grid, impacted many aspects of the building.

For the overall shape of the pyramid, the regularity of the brick was particularly relevant in the roof outline, whose dimension is the result of a whole number of stretchers and headers. With a square block at each of the four corners, the rectangular figure on the top of the building is the reference for the setout of the bricks and the corbels over the facade ***(12.11)***. Aligned with the outer face of the inner stepped bricks, the roofline is the starting point for the brick courses, whose numbering, starting from the top of the building at row Y000, increases as it gets closer to the bottom, reaching row Y440 in the lower part of the volume.

Marking the elevations with a sequence of horizontal lines offset at a regular distance, the brick course became the unit of measurement ruling the facade's composition (***12.12 / 12.13)***. With a height of 150 mm, resulting from the block size plus a 5 mm joint, the brick course is the reference measure for the position and dimension of elements such as the floor slabs, the concrete structural frame of the facade and the windows, which were defined by a precise number of rows. Over the ten levels of the building, the floor slabs are all ten brick rows high. Similarly, despite being different from one another, the storeys are also multiples of the brick course. Likewise, the vertical subdivision of the floors for the placement of the facade's concrete horizontal beams also follows the measure of 150 mm. In its irregular spacing, the arrangement of these secondary beams, which are two brick courses high, is related to the position and dimension of the windows and the maximum span allowed for the brickwork. As the placement of the corbels and lintels corresponds with these concrete horizontal elements, their position is limited to a vertical centre length of 1500 mm, which means that the distance between them, even though variable, does not exceed ten brick courses.

As mentioned in the previous section, the configuration of the cutouts for the windows is related to the internal planning of the building and the daylight and ventilation requirements. Nevertheless, it also

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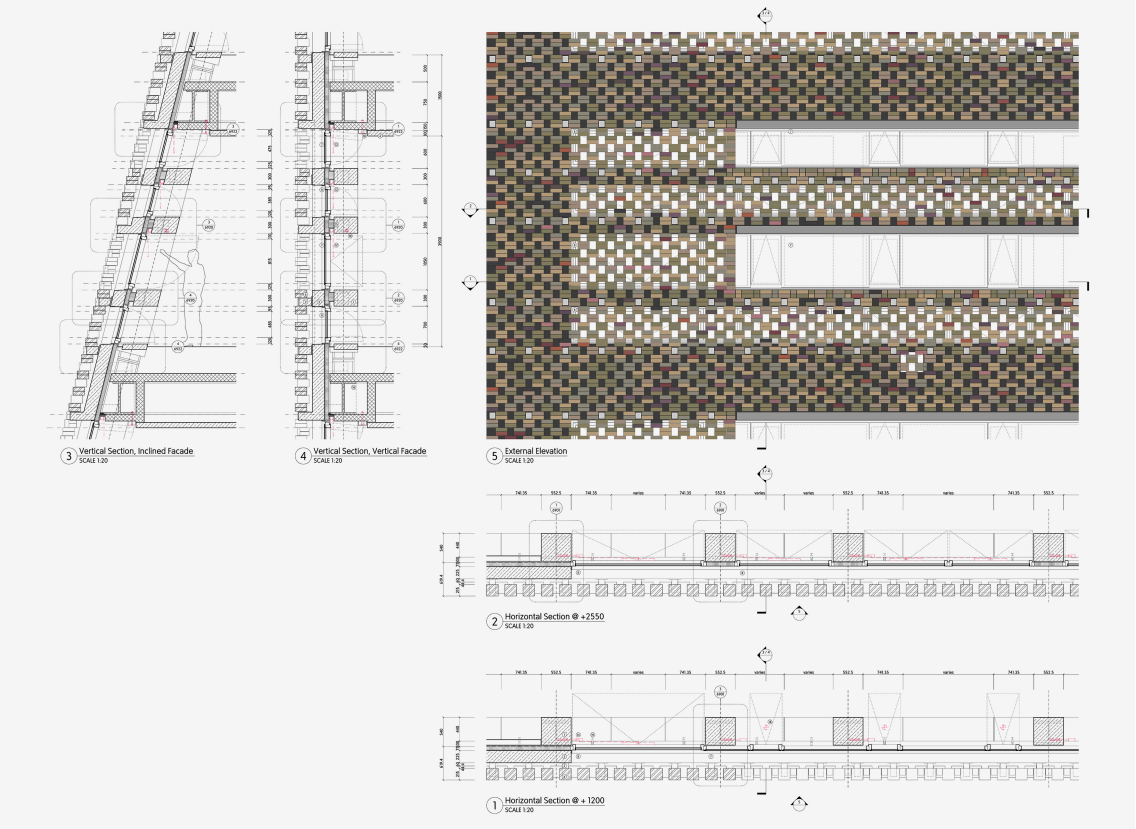
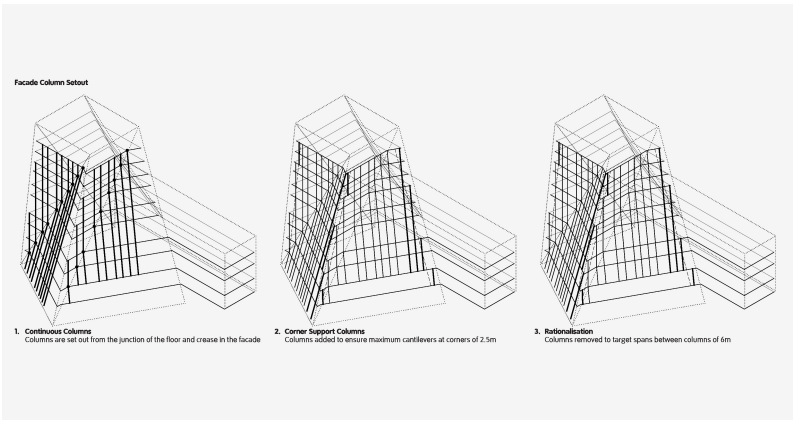
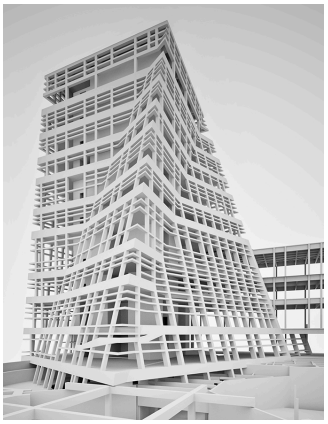
119 Ramboll, *The remarkable and unique*, 24.



12.12
Typical facade assembly. External elevation, horizontal sections and vertical sections.

12.13
The facade from the terrace level.





12.14
Diagrams for the facade column set out (2008).

12.15
Concrete facede structure. Rendering (2009).

responds to the brick grid. The height of the windows is always a multiple of the brick course, and their length is fixed on both sides by the edge of a whole block.

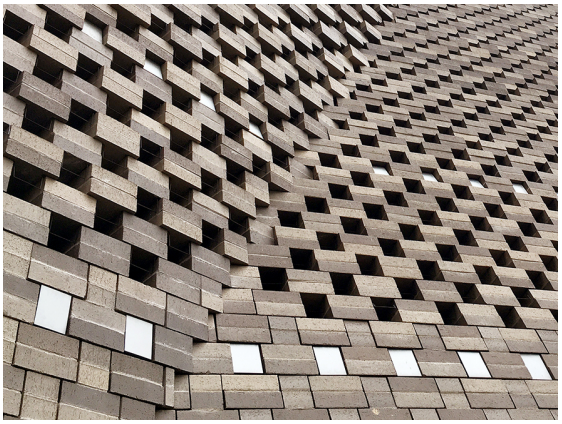
The vertical axis of the brick grid, aligned with the centre of the header faces, also impacted the position of the precast concrete columns. Continuous over the facade, these columns are located, as described in the reports, "at the intersection of the crease line and floor plates [...]. As a result, due to the variation in floor-to-floor heights, the columns are set out at irregular centres". At the corners of the pyramid, "columns are omitted, [and are] set back from the corner to achieve a continuous 'wrapping' of the structural framework around the building. In these locations, columns are located to limit the cantilever to a maximum 2.5 m span."[120] The positions of these structural elements, which are two stretchers plus one header wide, were then adjusted to match the brick set-out, so the columns are perfectly centred, on both vertical and inclined facades, at the vertical axis of the headers ***(12.14 / 12.15)***.

If, on the one hand, the perforated brickwork provided this regular grid of vertical and horizontal axes that ruled the facade's composition, on the other hand, from its intersection with the pyramidal twisting shape, several exceptions to the arrangement of the bricks emerged.

Three situations in the building envelope, each with a particular geometric and constructive complexity, had to be solved in the design of the facade. The cutouts in the brick veil for the openings, the anticlimbing system at the bottom of the volume and the resolution of how the inclined and vertical faces come together at the corners and creases led to the detailing of special conditions.

The topic of the openings, which are regular and fit into the modulation of the brickwork, was mainly concerned with the finishing of the brick bond in correspondence with the sills, reveals and heads of the windows. It had mainly to do with the expression of this architectonic element; about whether it should have a more classic appearance, in line with the character of the brick as a traditional material, or, on

120 Herzog & de Meuron, *Stage E Report,* 12.



12.16
The anti-climbing system at the base of the building. South facade.

12.17
The crease along the intersection between the vertical and inclined surfaces on the south facade.

the contrary, use a more disruptive language that, in a certain sense, would reveal the unconventional system lying behind the brick veil.

At the bottom of the pyramid, to avoid the possibility of people climbing up the building, the perforated stepped brickwork was changed to a solid and flush surface. Between the courses Y409 and Y440, there is a plinth in which the brick wall is full, contrasting with the texture and transparency of the upper part of the pyramid ***(12.16)***. Therefore, at the lowest levels of the tower, the question was about how to make a smooth transition between these two systems; how to implement a gradation within a horizontal band, between the courses Y393 and Y409, where the perforation of the brick bond and the stepping of the blocks were progressively introduced.

At the creases and especially at the corners, the building exposes its fragility. Along these inclined folds, the apparent incompatibility of the regular brickwork system and the contorted shape of the tower becomes evident, with the most challenging detail in the design of the brick facade emerging from this situation ***(12.17)***.

Each of these conditions required accuracy in the detailing of the brick veil, because the architectonic intention, in what concerns the final appearance and the consistency of the principles that support the idea, had to be carefully combined with the feasibility of the solution and its optimisation from a construction point of view. As exceptions to the regular bond, these three situations required special pieces, different from the standard block, which in itself had to be considered with particular regard since this is not a mortared wall where bricks can be easily cut on-site or slightly adjusted when being laid. Due to the interlocking system of the blocks, their internal structure with the holes inside had to be taken into account, alongside the outer shape of the pieces, which not only added technical complexity to the solutions but also multiplied the array of brick types.

For instance, in the vertical faces of the building, where the stepped perforated bond is regular, the blocks placed in correspondence with the corbel position have a different internal structure. To ensure a perfect connection to the stainless-steel supporting element, the blocks sitting above and below must have additional holes inside. The same happens in the sloping faces.

Besides this, in the four inclined facades, once their angles differ from one another and the courses are offset at distinct distances, the holes inside the bricks are also differently positioned, which means that the regular block must be specific for each of these surfaces. Therefore, if there are already ten variations to the standard block in the continuous surfaces—two in the vertical facades and two in each of the four inclined ones—then when considering the special conditions, where the exceptional pieces are unavoidable, the number of block types tends to grow significantly. And if one should add the architects' intention of working with a colour gradation, where bricks would not all be of the same tones, this introduces further variations within the brick types and increases the complexity of the information to be managed from both a design and production point of view.

12.3 _ The Descriptive versus Parametric Design Approach

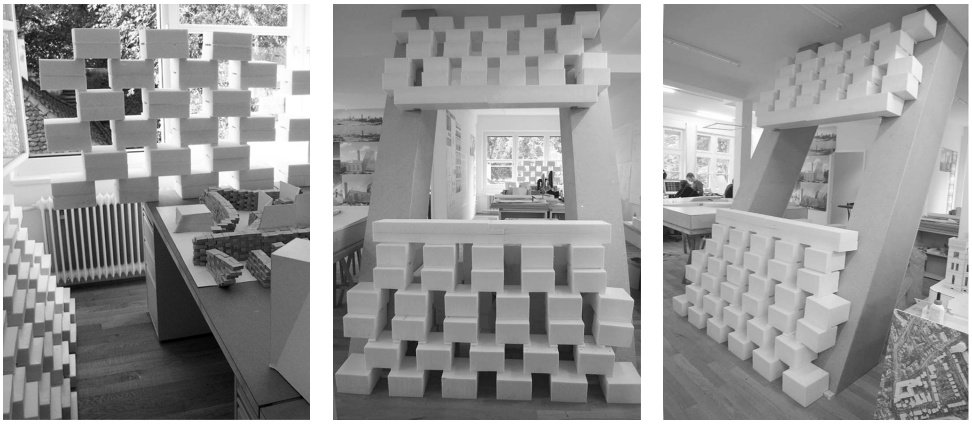
In January 2009, when RIBA Stage D was completed, HdM submitted to the London Borough of Southwark the planning application for the revised plans for the new Tate Modern building. From the report's analysis, by this time, it was evident that some of the most relevant issues in the design of the brick facade, such as the corner condition and the idea for the brick colouring, had already begun to be addressed. However, their full detailing, together with the resolution of the other special conditions, would be developed intensely from this moment onwards.

As explained earlier, this unconventional brickwork system quickly generated many different types of brick, which needed to be restrained for several reasons. Therefore, the rationalisation of the design issues emerged as a necessity to be undertaken within the detailing phase.

As mentioned by Andreas Reeg, the architect who was directly involved in the detailing of the brickwork, "at the beginning, [at the corner], [...] there was a different type of brick on every row, and the bricks had to be extruded from a machine. A metal element had to be built to make these shapes, and for the corner of the building, there were, like, 3,500 different shapes. The cost consultant said it was nonsense, so we had to work on and find out options to get the same appearance but with standardised geometries."[121]

For each particular situation in the brickwork, precise rules had to be defined that, besides translating the architectonic idea, would aim to optimise both construction and production systems. By establishing a clear and simple logic for the arrangement of the blocks and reducing, at the same time, the number of brick types, the construction process would become more controlled, and the costs, in general, would decrease. To achieve the desired effect within an optimised system was thus the

[121] Andreas Reeg, in conversation with the author, "It can't be so hard to solve this corner," Berlin, January 24, 2020.



12.18
Physical models in foam for the brickwork arrangement at 1:1 scale (2008).

principle that stood throughout the whole back-and-forth design process, guiding the many decisions to be taken and leading to the final detailing solutions.

According to their nature, the several design issues fitted into two distinct types. The first was concerned with the previously mentioned special conditions; this had to do with the shape of the brick pieces and their arrangement in the facade, so it was about geometry. The second came from the intention to explore the variegated character of the old masonry walls in the new building and was thus related to the colouring of the bricks.

Even though these two subjects, geometry and colouring, required specific methodological approaches, their resolution soon revealed the limited ability of the non-computational tools to handle the complexity of the problems that had arisen and to solve them efficiently.

The method used by the design team to study, test and find the right solution for the special brickwork conditions, with the corners being the most challenging, was primarily assisted by physical and digital modelling. The construction of foam models with the single blocks at 1:1 scale ***(12.18)*** and the reproduction of the details in the digital environment were fundamental for simulating the brickwork three-dimensionally and developing a clear perception of how the pieces were combined. By dealing directly with the shape of the objects, physical and digital models were revealed to be ideal for manipulating the bricks and easily testing different options. Used together, these methods provided full insight into the final result and immediately allowed the architects to recognise the possible geometric incompatibilities.

As Wim Walschap explained, the architects started by making physical models at 1:1 scale.

“We built, at a particular scale, the blocks in foam”, Wim Walschap said.

> We had two or three of these regular surfaces with the bricks meeting at the corner or the crease, and we explored in the model the options to resolve these edges and how we could introduce a system. After this, the most promising solutions were further tested in Rhino, in very basic 3D modelling. This was a back-and-forth process until we found satisfying pragmatic rules which would allow for an easy production and construction process.[122]

However, this modelling work focused only on specific sections of the brickwork. Even though it allowed the team to develop single details and to test the rules themselves on their absolute conditions, it did not provide control of the whole facade. "We made the decisions based on [physical models]," Andreas Reeg said, "and Jacques and Pierre were overviewing and deciding how we should do it. But then there was the moment in which we needed to visualise it as an entirety. We looked at the four corners, but we didn't have the perception of what everything was looking like."[123]

It was impossible to build a complete physical model of the volume with all the bricks, in the same way that it would be difficult, due to the amount of information, to have and manipulate a full digital model of the brick veil. And even if these had been made, they would have become rigid models that would have barely supported the fundamental trial and error method of the design process. So this methodology, which was ideal for analysing and deciding on the individual parts, did not show how the rules would work when applied to the whole facade, and did not give the architects the full precision that could only be achieved by the integration of the details into the overall set-out of the brickwork.

In what concerns the colouring of the facade, once it was related to the attributes of every block, involving a significant amount of information to be tested and controlled, the limitations of the non-computational tools to address it were soon revealed.

"This was a crucial design issue for the building—how it appears and how it relates to Tate 1", Andreas Reeg argued. "It would have been a nightmare to do it manually. Whether it would have been with Photoshop, picking some bricks and putting them with another colour, or manually selecting bricks on the 3D model to be of a specific colour. […] It would have been a fight for ten people, working day and night, just to get to the right gradient effect."[124]

To explore this subject by manipulating an image in a raster graphics editor or drafting directly in CAD software would have been an uphill task. It would have created a medium that was not flexible enough to be readily adjusted or to allow the testing of variations on it. It would have certainly provided the final appearance of a particular idea; however, this would have remained on a representational basis only. Moreover, the crucial feedback of analytic data, such as the quantity of each colour per brick type, would have been almost impossible to obtain by these means.

Therefore, when the brickwork issues began to be approached, the design team collaborated with the in-house DTG, and their programming methods supported the design process ***(12.19 / 12.20)***. Scripting assisted the investigation of solutions, helping to simplify certain tasks and give faster results,

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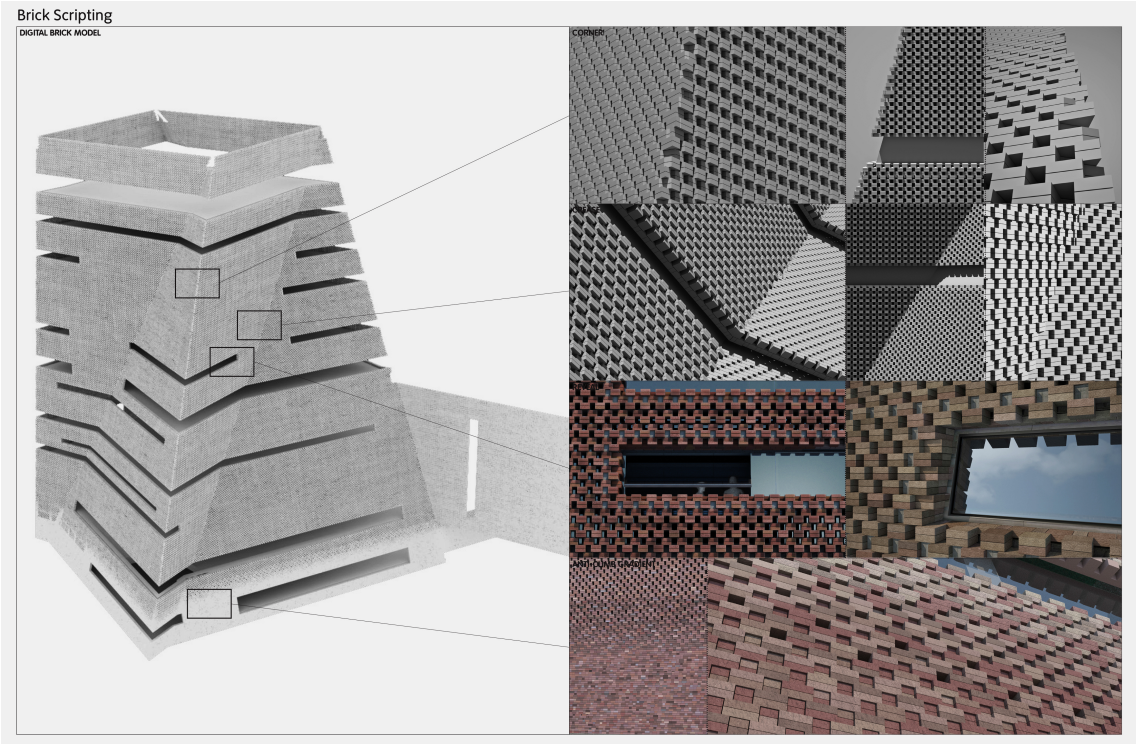
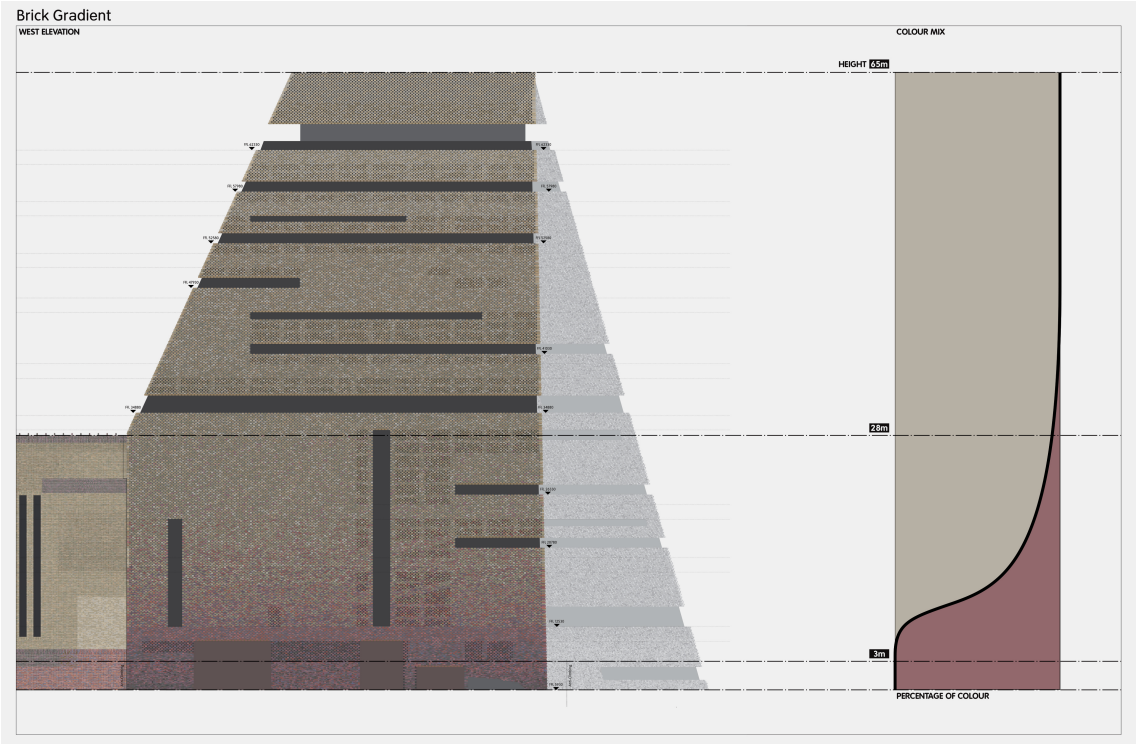
122 Walschap, "It makes it more interesting."

123 Reeg, "It can't be so hard."

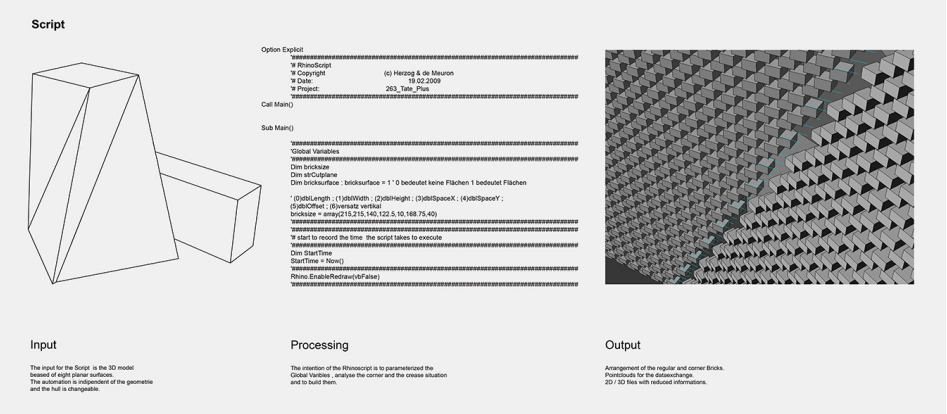
124 Ibid.





12.19
The support of parametric scripting on the brickwork geometry (2009).

12.20
The testing of the facade colour gradient via digital scripting (2009).



12.21
The first developed scripts: Input, Processing and Output (2008).

but most importantly, helping to overcome the gaps in the conventional analogue and digital tools, allowing the architects to push the design forward.

The very first scripts were developed in the initial stage of the design. However, as explained by Andreas Reeg, the team "could not adapt them in the right way, [...] they weren't generating the overall facade. [They] were just creating the whole standard brick grid and weren't taking care of all of the special conditions, like corners, creases, sills, reveals, and so on."[125] ***(12.21)***

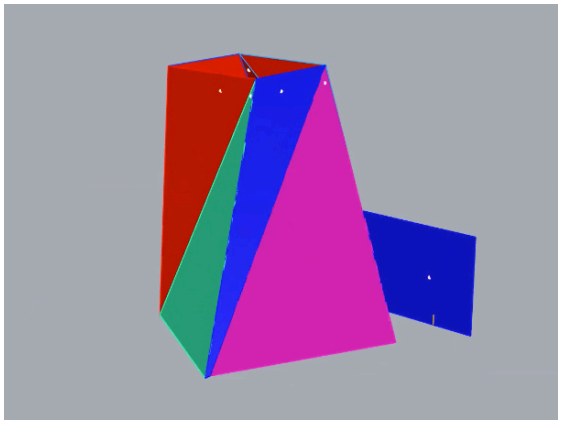
As a result, in 2009, during RIBA Stage E, when the detailing of the solutions was undertaken with more accuracy, the need for a customised digital tool to gather all the information and support the resolution of the complex design issues became apparent. “The previous scripts failed because it was so complicated to write them and to test them”, Andreas Reeg observed. “[And] there was also more time pressure. We had to produce the information, and it was taking ages until something happened. The corner was still not correct, and we had to do it all over again.”[126]

This was when Kai Strehlke, head of the DTG at the time, joined the team to guide the digital process himself, having been involved in the design development from the intensive creative phase to the submission of tender drawings. From this moment, the architects and the DTG collaborated intensely, emerging from this interactive relationship with a strategic methodology based on a descriptive versus parametric approach.

On the descriptive side, the team of architects addressed the design development with tools that relied on the construction and representation of 3D forms. Either by graphical, physical or digital means, they focused directly on the architectural object through the construction of models, complemented by hand sketches, orthogonal projections and very simple renderings. While the design team dealt with the

125 Ibid.

126 Ibid.



12.22
Input geometry: envelope surfaces and reference points. Screen capture of the Rhino viewport.

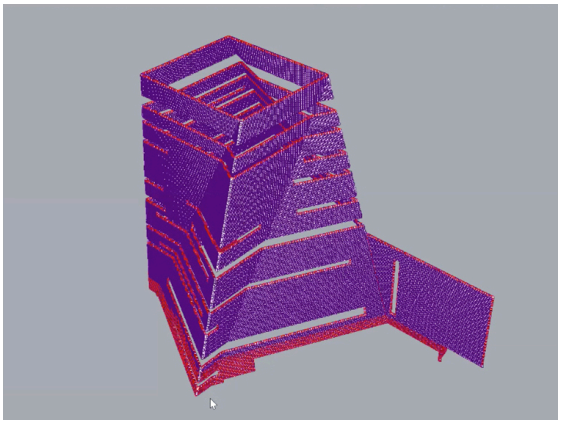
geometric description of shapes, the DTG worked on the explicit rules for the geometry underlying the resulting forms. Addressing the architectonic idea from a parametric perspective, they attended to the compositional relationships and the design components with their associated variable input values. Taking advantage of the computer's proficiency at executing a complex set of instructions, and through the use of scripting, the DTG automated the brickwork design procedures, enabling the generation of a flexible 3D model that allowed the existing shortcomings to be addressed.

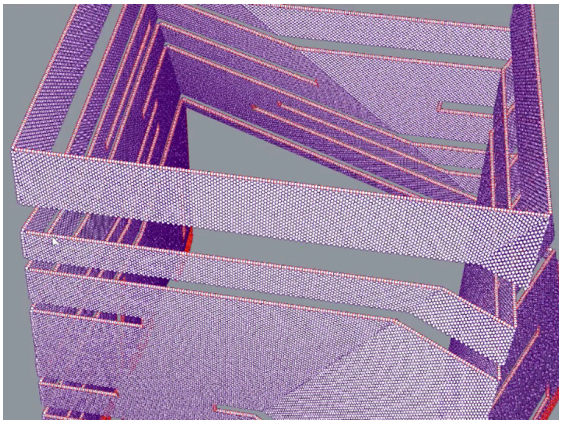
12.4 _ The Digital Parametric Tool

When the DTG, coordinated by Kai Strehlke, took over the task of assisting the design by developing a digital tool, they decided to start the scripting from scratch, mapping the design idea into a data structure that, as Kai Strehlke mentioned, they had not used before.[127]

The scripting was intended to bring together the information about all the existing bricks in the facade, as well as take into consideration the many design issues that were being investigated. Nevertheless, despite this huge quantity of information, the resulting parametric tool needed to be easy to manipulate and be adaptable enough to respond to the design team's continuous demands. For these reasons, Kai Strehlke realised that the scripting should not depend on the geometric representation of the blocks, so he decided to set out the whole data structure on a point cloud. Each brick on the facade would be represented by a single point whose name would collect all the information about that specific piece. "If I was doing the scripting and then anything changed", Kai

[127] Kai Strehlke, in conversation with the author, "The important thing is to understand why they do not do it by hand and why I should script it," Zurich, November 6, 2019.





12.23
Virtual model of the point cloud for the entire building.

12.24
Detail of the point cloud.

Strehlke remarked, “I could not work with the geometry. So I had to have one moment in which I was relying only on the script, and this was possible with the points.”[128]

Developed between 2009 and 2012, the scripting was written in VBScript and was meant to be executed in Rhino 4. It worked on a very simple input geometry, a strategy that Kai Strehlke considers fundamental for a successful working relationship between the tool developer and the design team, and also for the scripting itself, whose structure stands on clear geometrical information.

Therefore, from the architects, the DTG got the envelope of the building, consisting of the eight vertical and inclined external surfaces plus the building ground line and the polylines defining the frame around the windows and the louvres ***(12.22)***. By minimising the input geometry, the information exchange between the architects and the DTG was clear and straightforward. "The communication I had with the architect", Kai Strehlke explained, "was very simple because he had a very easy drawing. If they changed anything in the building, they would just give me these eight surfaces, and I could generate the entire point cloud on it again."[129]

Once there was not a right angle or a zero point in the model, the scripting specified one point on each of the eight surfaces that became the reference for the coordinates on each facade. Even though the position of these points could be flexible, it was conditional on the fact that there should always be one whole brick on the roofline at each of the four corners.

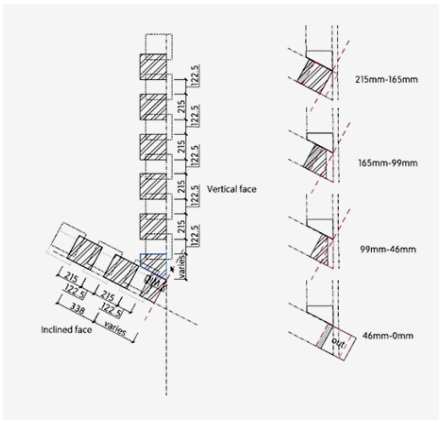
By asking the software to “GeneratePointCloud”, the first function to be executed, the scripts analysed the input geometry and created a continuous grid of points positioned according to the specific coordinates on each surface. The point cloud was generated across the entire facade, one point being placed on every stretcher and header position ***(12.23)***. However, only the points

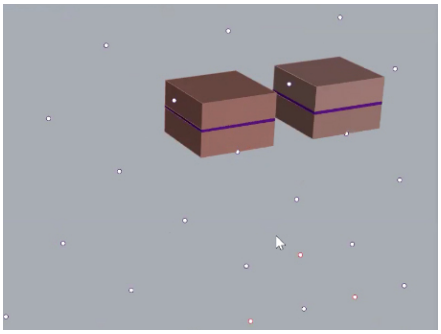
128 Kai Strehlke, in conversation with the author, Zoom meeting, Porto-Gossau, July 30, 2020.

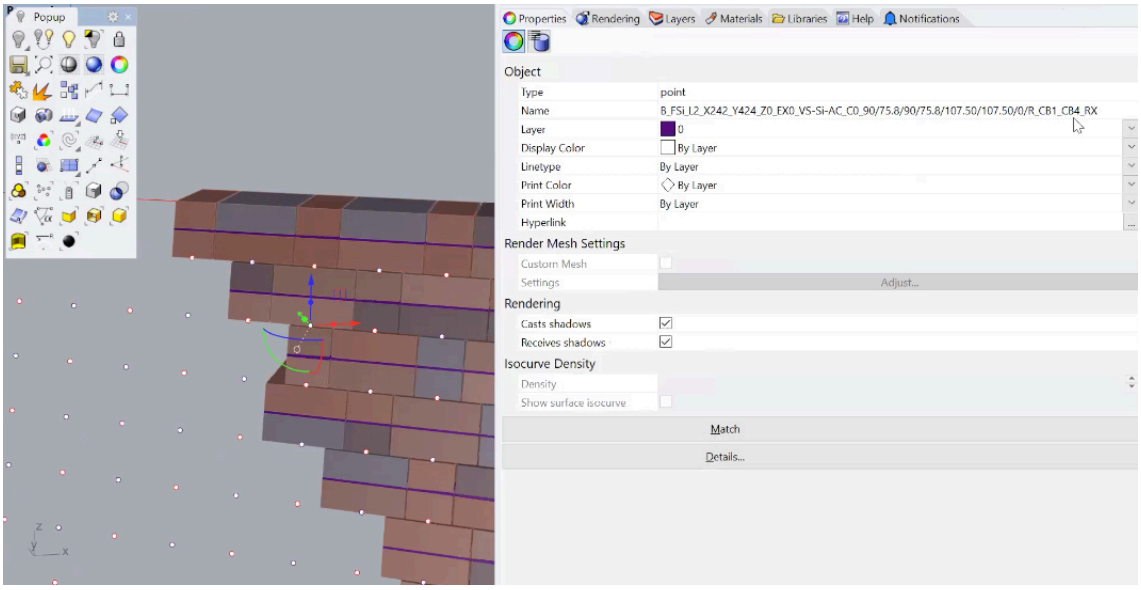
129 Strehlke, “The important thing.”

```
' select all corner brick points of the inclined facades
arrPoints = Rhino.ObjectsByName("B*i_*_EE*")
If IsArray(arrPoints)    Then
    For i = 0 To UBound(arrPoints)
        arrData = GetPointData(Rhino.ObjectName(arrPoints(i)))
        arrName = Split(Rhino.ObjectName(arrPoints(i)), "_")

        ' only consider coerners above the ACF
        If arrData(4) < 394 Then
            ' check which block has to be placed
            If arrData(6) > 165 + dicValues.Item(arrData(1)) Then
                ' nothing has to be done
            ElseIf arrData(4) >= 252 And  arrData(1)= "Ei" Then
                ' do nothing because the facade connects to SwitchHouse
            ElseIf arrData(6) > 99 + dicValues.Item(arrData(1)) Then
                ReplaceBrick arrName, dicBrickTypes.Item("VS-CO1-" & arrData(1))
                arrName(7)  = "VS-CO1-" & arrData(1)
            ElseIf arrData(6) > 46 + dicValues.Item(arrData(1)) Then
                ReplaceBrick arrName, dicBrickTypes.Item("VS-CO2-" & arrData(1))
                arrName(7)  = "VS-CO2-" & arrData(1)
            Else
                RemoveBrick arrName
            End If
            Rhino.ObjectName(arrPoints(i)), Join(arrName, "_")
        End If
    Next
End If
```







12.25
Extract of the scripting file with the code for the corner rule.

12.26
Drawing for the corner rule (2014).

12.27
The points in the virtual model and the corresponding bricks generated as polysurfaces.

12.28
One point name: B_FSi_L2_X242_Y424_Z0_EX0_VS-Si-AC_C0_90/75.8/90/75.8/107.50/107.50/0/R_CB1_CB4_RX.

corresponding to the existing blocks were made visible. As there were no bricks below the building ground line or inside the window frames, these points were automatically hidden in the virtual model, and the parameters regarding the geometrical information assembled in their name were null. The same thing happened in the louvres area and the perforated brickwork surfaces above the anticlimbing, where the bricks were omitted at the header position ***(12.24)***.

Besides the input geometry, the special conditions for the brickwork were also scripted. As the team worked on the details, the DTG wrote small scripts for the geometric rules tested for the corners and creases, the anticlimbing system and the sills, reveals and lintels of the windows ***(12.25 / 12.26)***. With the input geometry and the special conditions encoded, the scripting considered all the exceptions to the standard brick pattern. Therefore, once the point cloud was generated, by asking it to "SpecifyPoints", each point, according to its position on the facade, was informed by all the data concerning the geometric features of the corresponding block. The name of the points, ***(12.28)*** which also took into consideration the specification data that the manufacturer needed for production, was the result of a list of parameters that considered:

. the facade and the level of the building where the point was located

. the point position on the X-direction

. the point position on the Y-direction—the brick course

. the point position on the Z-direction—the distance, in centimetres, from the brick to the envelope surface, which indicated how much the brick was stepping back

. the Rhino block name, which was related to the shape of the brick

. the brick's geometrical information—the inclination angles of the brick's four vertical faces, their length to the left and right of the reference point, and a code specifying whether the brick was a regular or a special piece

. the colour code of each of the bricks that were part of the block

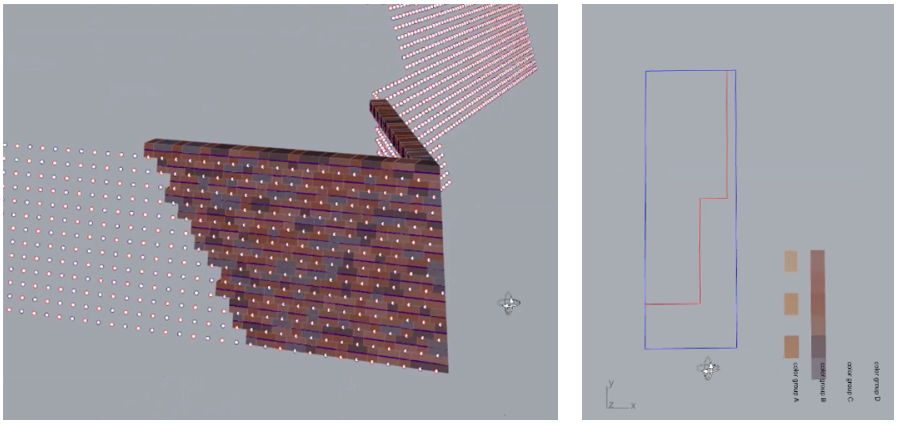
. the Ramboll reference.

Because all of this information was condensed into a set of codes inside the names of the points, when a specific script was rewritten or added to the main structure, the parameters associated with this function would automatically be renamed and, consequently, the properties of the bricks would change. This allowed the team to shorten as well as simplify the update process for the parametric tool. If the architects changed any details, the geometric relationships and the associated input values had only to be updated in the script and the digital model would show the new version of the design.

"If Andreas Reeg, for example", Kai Strehlke explained, "told me that they would like to work with a different rule on the anticlimbing, changing the stepping of the bricks and the number of courses in which this gradation happens, I would just write a small script which would take these points and rename the associated parameter on their name, which would be the Z value in this case."[130]

Scripting was also developed to generate the bricks as polysurfaces in the virtual model ***(12.27)***. Therefore, by asking it to "InsertBricks", it was possible to select the desired number of points and

[130] Kai Strehlke, in conversation with the author, Zoom meeting, Porto-Gossau, July 30, 2020.



12.29
"InsertBricks" function. A desired number of points generated as polysurfaces.

12.30
The input diagram for the "ColourBricks" function.

visualise them three-dimensionally without having to render the whole model ***(12.29)***. This became one of the most useful functions for the design process. It gave the team the ability to easily visualise the experiments that were being developed by hand with great accuracy and apply them to the whole facade.

While being generated three-dimensionally, the bricks could also have a specific colour applied to their surfaces. As the colour of the facade became a relevant topic in the design, a script was also developed to assist the colour-testing process, which was running on a very simple input diagram in the model ***(12.30)***. This task was about finding the right range of colours and the right mix between them to get the desired colouring effect in the facade. Therefore, by manipulating the input diagram, the architects could easily explore all kinds of colouring variations, regulate their distribution over the facade with accuracy and immediately visualise the results of the tests in the virtual model.

On the right side of the input diagram, it was possible to specify the colours to be tested in the model. The colour system was based on the definition of groups—in the image, group A and B—each containing several colours that were supposed to be randomly placed in the facade to enrich the overall colour range with a subtle chromatic variation.

On the left side of the diagram, a vertical blue rectangle represented the facades of the tower. Its length corresponded to the height of the building in the brick courses—from Y000 to Y450—and the width expressed the quantity of each colour group—from 0 to 100%. Inside this rectangle, the red line, which one could freely draw, defined how the different groups should be combined in the facade by relating the quantity of colours with the single rows. Therefore, from the bottom to the top of the building, the red line established, in percentage, the exact amount of each colour group to be applied on every brick course.

Afterwards, by running the function "ColorBricks", the script, according to this diagram, set the colour information for all the blocks, updating the two parameters concerned with the colour code in each point's name. The bricks could then be generated again, and the experiments on the facade colouring would automatically be visualised.

From a design point of view, this function was a significant contribution to the creative process. It enabled the architects to test in a very intuitive way the colours of the thousands of bricks, but most importantly, it made this design idea viable, which, by traditional means, could hardly have been accomplished. As Andreas Reeg remarked, with the script "we were able to change the colours and control how they were supposed to be distributed across the facade. [...] [And] to be honest, none of that would have been possible without the script."[131]

Besides generating the shape of the blocks according to the encoded geometric rules and allowing the development of experiments on the colour pattern, the scripting had a set of other small functions that enhanced its role as a supporting tool for the design process. Once the general structure of the scripting was defined and proved to be working efficiently, which was possible due to the strategy of setting out the point cloud, the DTG was able to continue adding scripts to the main structure in response to the needs of the design team.

The main goal of the script was to provide a digital model of the brick facade in which the design issues could be tested, visualised and, if necessary, revised so that it was possible to make informed design decisions. The architects could opt to keep the model in the digital environment as an accurate 3D object to be carefully observed and manipulated or use it to make renderings of specific parts of the brickwork ***(12.31 / 12.32)***.

In addition to the functions that enhanced the use of the digital model to inform the design process, such as "InsertBricks_depth", "GenerateBlocks", "CopyPoints", "RenamePoints", and those that took into consideration the structural engineers' special conditions, like "RambollRename" and "RambollSelect", the scripting also provided commands that assisted the graphic description of the complex brick facade by allowing the generation of 2D drawings. "You could take the point cloud", Andreas Reeg pointed out, "and, instead of asking to place polysurface blocks onto it, you could ask for 2D surface polylines filled with the colour X to generate the plan view, so then we had the elevations drawn by the script as well."[132]

By asking it to "InsertOutline", which would create the brick countour from a predefined section of the building, and to "GenerateElevation", which would produce the orthogonal projection of a certain number of bricks on the facade, the script generated a LISP file containing the requested information to be run afterwards in an Autocad file. By doing so, a detailed 2D representation of the brick wall was automatically produced, saving all the effort of having to draw this complex arrangement of bricks manually ***(12.33)***. Similarly, the script also made it possible to export points to an Excel file to create lists of all the blocks used in the building. This automatic calculation of the number, and the several geometric configurations and colours, of the bricks, which would have been difficult to obtain without

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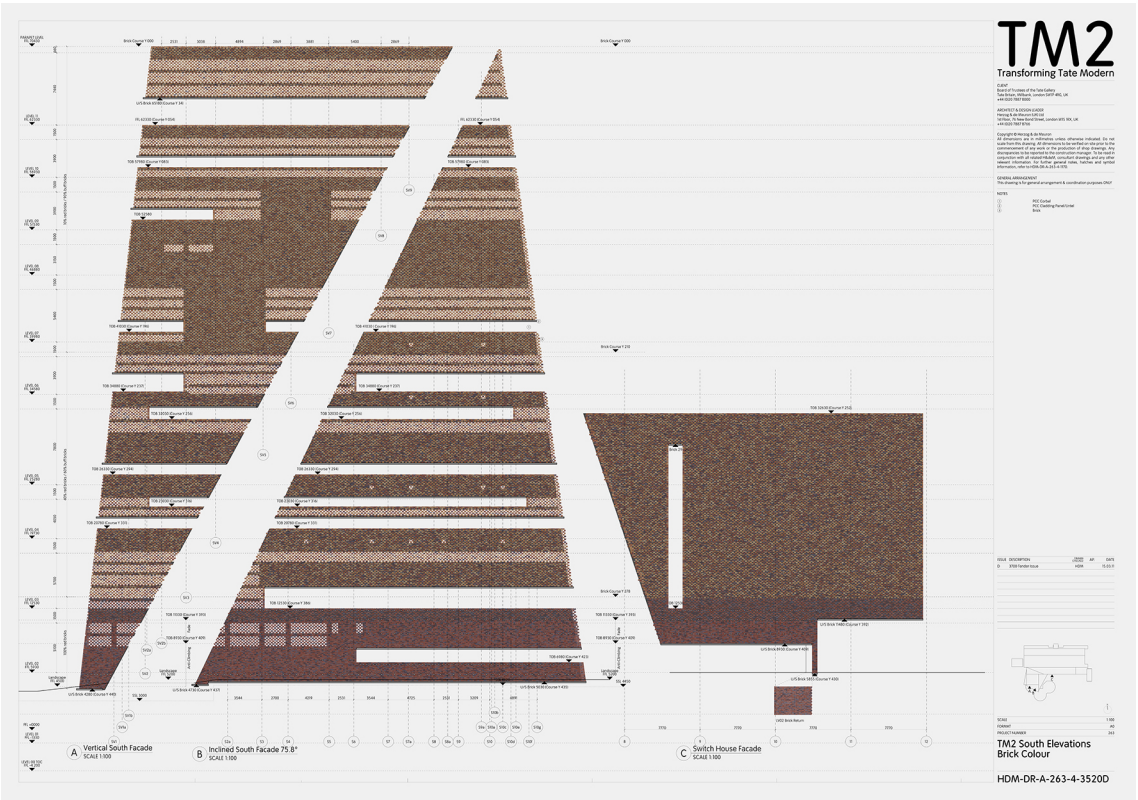
131 Reeg, "It can't be so hard."

132 Ibid.



12.31 / 12.32
Composite images of the brick facade using a render from the parametric model (2010).

12.33
Elevation drawing produced with the support of the scripting (2011).

the computer's information processing capability, was instrumental not only from a design point of view but also in terms of production. Having exact control of the brick quantities per type during the design process allowed the architects to optimise the solutions, and, at the same time, it made it possible during the construction phase to make lists and schedules for the brick manufacturer of exactly what to produce. "In the specific case of Tate Modern", Andreas Reeg said, "the 3D was crucial to handle the project, to make it buildable and to generate all the information that the manufacturers needed."[133]

In the end, the scripting turned out to be a versatile tool, fully integrated into the working methodology, that supported the design process in all of the aspects for which the more conventional means are revealed to have some limitations.

However, in the opinion of Kai Strehlke, it was only possible to achieve this through the close dialogue established between the DTG, guiding the parametric approach, and the team of architects, who were from the decision-making side and conducted the process by descriptive means. "Andreas did not come to me having already everything", Kai Strehlke said. "So, it was not that he did all the design and then afterwards I just scripted it. He came to me with requests, I understood what he wanted, and then I rationalised the things and developed them in a way that he could visualise. [...] And I never told him that we could not change or that we should forget that because it was over."[134]

The two design approaches merged into a well-balanced exchange process, mutually reinforcing and leading to the establishment of a complementary toolset that allowed HdM to grasp the architectonic idea and make it buildable. "If I hadn't been there", Kai Strehlke noted, "I think Andreas would have drawn by hand, but maybe he wouldn't have been able to make so many experiments or changes."[135]

12.5 _ The Geometry of the Corner

Of the many special conditions in the brickwork, the corner was the most challenging and the hardest to rule from a geometric point of view. The bold decision to use a modular material to clad a contorted shape ended up expressing its apparent fragility at the corners of the building, where two differently oriented brick grids somehow had to meet ***(12.01)***.

"The biggest challenge was to develop a design solution for the inclined corners and creases", Wim Walschap said. "The overall geometry of the building is regular, but with inclined facades with stepping brickwork. So, we needed to find solutions for how these inclined surfaces would connect to each other at all the edge conditions."[136]

The regular brickwork pattern and the twisting shape of the pyramid collided along the inclined folds of the volume, raising the issue of how to turn the corner, how the single surfaces should intersect, and what the formal expression of the edges should be. However, what emerged as a demanding design

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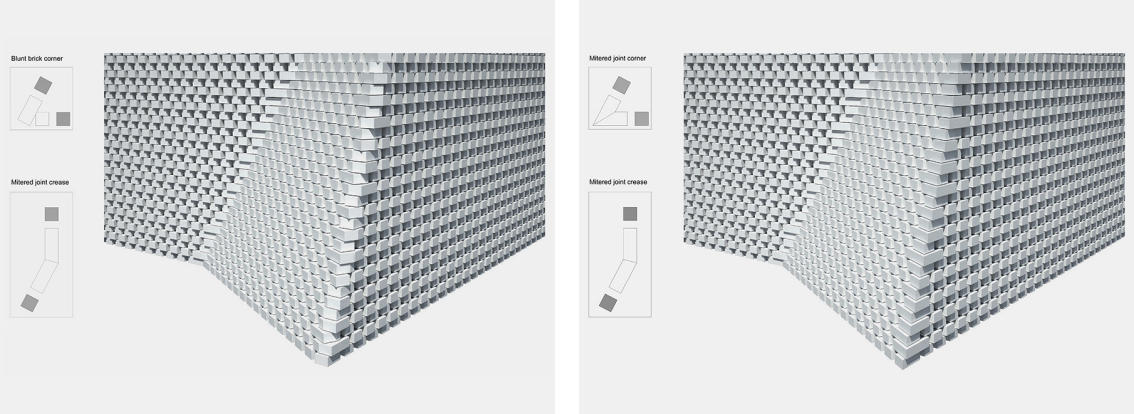
133 Ibid.

134 Kai Strehlke, in conversation with the author, Zoom meeting, Porto-Gossau, July 30, 2020.

135 Ibid.

136 Walschap, "It makes it more interesting."



12.34 / 12.35
Some of the developed options for the brick creasestone and cornerstone (2008).

issue was converted into a strategic detail that enriched the material appearance of the brick facade. The unconventional way in which HdM solved the corner became one of the most intriguing architectonic aspects of the building, one that unveils much of its constructive nature. "How we used the edge", Jacques Herzog explained, "where the two sides come together, to create this kind of porosity which defines or also reveals the construction behind it; it is a simple but important detail for how we used construction as part of the idea of the whole building."[137]

By the end of 2008, when HdM began to outline the corner solution, as presented in the Stage D report, they were thinking about a detail in which "larger brick units [were] proposed to the corners and creases to ensure consistency of the overall texture of the facade."[138] However, this strategy was pointing in a different direction from the one HdM ultimately adopted as the most coherent and engaging from a construction and architectonic point of view. In addition to generating many special pieces, this first approach to the corner, which proposed using larger blocks to achieve a sharp configuration, cancelled the perforated appearance of the outer skin along the edges ***(12.34 / 12.35)***. The effect of a continuous transparency in the brickwork surfaces would be framed by a kind of a solid contour at the corners and creases.

HdM accepted the geometric conflict that existed at the edges of the volume and chose to play with it, preferring a solution that fully expressed the construction condition of the brick facade. HdM did not opt for the perfect pointy edge; instead, they chose to leave it undefined, with the irregular arrangement of the pieces revealing that this is not a load-bearing wall for which the corners must be stiff and solid. On the contrary, the architects realised that these hanging brickwork surfaces, anchored

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137 Jacques Herzog, "Re-Use," Madrid, Máster Habilitante de la ETSAM, November 14, 2017, video, accessed February 15, 2018, https://www.youtube.com/watch?v=-llcaLd-LjE, 24:32.

138 Herzog & de Meuron, *Stage D Report*, 120.

to the main concrete structure behind by a system of corbels, could simply intersect, producing a variable outcome at the corners. “It should not be this perfect, engineered solution that would also be expressed as such”, Wim Walschap explained. “I remember the design review during which we rediscussed this. We agreed on the approach, looking at different foam models in which we could see all the different bricks. I remember that we said that it should be a folded or wrapped solution, which would come with irregularity, and we decided to test it and see how it would look.”[139]

From this moment, the design team directed the detailing of the corner to achieve the desired organic appearance within a clear geometric rule. Due to the connecting system used in the brickwork, the solution needed to contemplate the standardisation of the blocks. The number of special pieces needed to be reduced, and at the same time cutting the bricks on-site had to be avoided as much as possible. Therefore, as Wim Walschap mentioned, "it was to rationalise [...] but also to manage the irregularity of it."[140]

The intricate combination of the pieces that resulted from the overlapping surfaces led to the investigation of many different variations. In addition to the intersection between a vertical and an inclined face, the perforation and the stepping of the brickwork increased the complexity of the design issues that had to be solved. On every course, the bricks met differently, and even if the architects were searching for a random expression, they needed to find a common pattern from which to set out the logic for the arrangement of the blocks. "We spent, like, half a year testing different solutions", Andreas Reeg pointed out. "You can't imagine how many different corner conditions we visualised. That was definitely the most complicated situation. [...] You try to calculate it, and you can't. You try to model it, and it isn't easy."[141]

The many experiments that the design process went through always produced a high number of special pieces and blocks that had to be cut on-site. In addition to this, as both Wim Walschap and Andreas Reeg remarked, physically and aesthetically, the outcome was not controlled. There were always parts of the facade too eroded or too rough. The blocks frequently stood out and dominated the corner or even fell because they were no longer structurally bonded. So, according to Andreas Reeg, from this intensive research process, and to regulate this intricate system, at a certain point two principles emerged that became fundamental to the definition of the final rule. First, the pieces should never cantilever from the outer alignment of the intersecting rows, and, second, one of the walls should always take primacy over the other one —which the architects decided would be the inclined facade.

By making these principles clear, the design team finally managed to set out the rule for the edges, which considered the use of a standardised corner piece for the sloping walls whose shape, cut at an angle, would be manufactured in the factory. For each of the inclined walls, there were two special pieces that could be laid at the end of the brick course. Depending on the leftover dimension to the theoretical corner, the rule considered that either a full block, a 2/3 block or a 1/3 block could be used. When the distance to the edge was too small—between 0 and 46 mm—the brick was left out ***(12.36)***.

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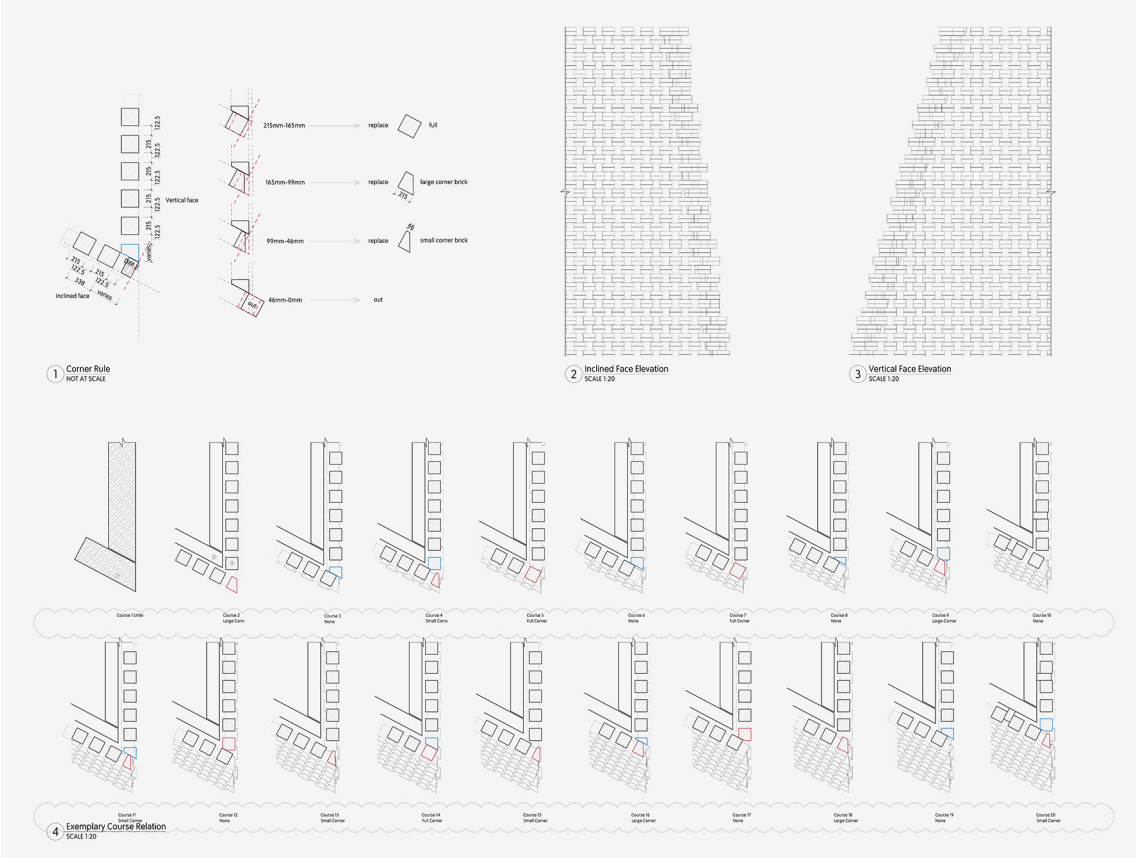
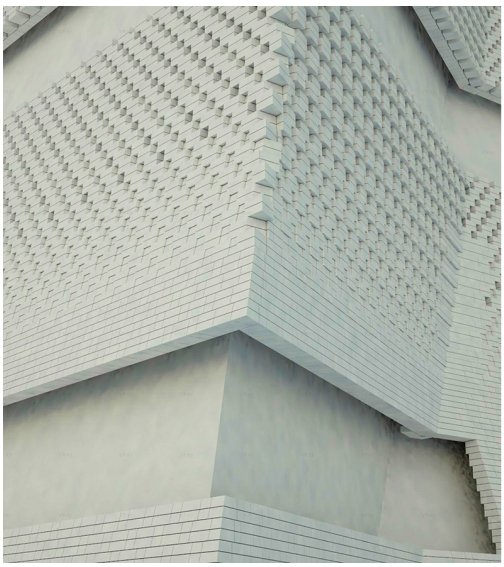
139 Walschap, “It makes it more interesting.”

140 Ibid.

141 Reeg, “It can’t be so hard.”





12.36
Drawings for the corner rule, considering 2 sharp corner pieces and 1 full brick for the inclined faces.

12.37
Corner view close-up. Rendering (2009).

12.38
Mock-up of the corner of one storey of the building built in London (2010).

12.39
The construction of the corner.

In turn, on the vertical facades, the bricks were all regular. The exception was the last block of the course, when hitting the rear of the corner piece, which should be cut on-site.

The process for finding the corner rule was long. Despite all the experiments done and the many means explored to visualise and anticipate the design solution as precisely as possible, the architects—and especially Jacques Herzog and Pierre de Meuron—were only fully convinced when they saw it constructed in a 1:1 scale mock-up. Built in the second half of 2010, the mock-up of the corner of one storey of the building to test the construction system of the facade was revealed to be fundamental for the resolution of the brickwork, having shown the real effect of the elaborate play of the brick geometries ***(12.37 / 12.38)***. "We discussed all the different rules that we had, and then Jacques and Pierre agreed that it should work", said Andreas Reeg. "Afterwards, we tested it on the 1:1 scale mock-up. Up to that point, they were still not really convinced. I did these millions of renderings of the corner, but it was only when they saw it in the mock-up that they agreed that it was actually working"[142]

The corner condition was finally producing the desired architectonic effect. In addition to the visual appearance, the rule came with a simple logic for the disposition of the pieces, which was important production-wise and for the construction process itself ***(12.39)***. The rule for the arrangement of the blocks was the information the bricklayers followed to construct the corners of the building, so, as this system was based on a limited kit of just two special pieces, their work became very straightforward and intuitive. "We developed a system that came with some clear rules", Wim Walschap explained. "The bricks were regular and produced as such, they didn't need to be cut, and you simply saw on site which one would work the best. And this gave the irregularity on the corner."[143]

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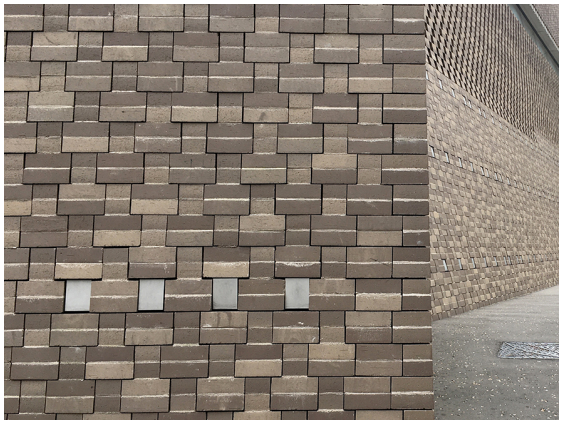
142 Ibid.

143 Walschap, “It makes it more interesting.”



12.40
The building corner between west and south facades.

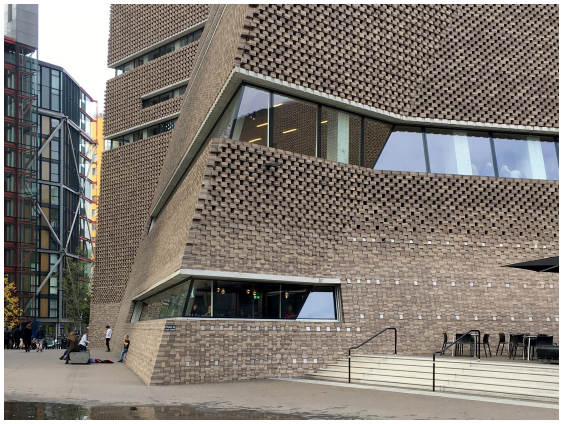
12.41
The sharp corner at the anticlinbing. Inclined west facade.

At the anticlimbing, where the surfaces are flush and the brickwork is not perforated, the corners of the building are perfectly defined, having a sharp and more traditional configuration ***(12.40)***. However, even though the building edge has a distinct appearance, the corner condition at the base of the pyramid followed similar principles to those for the upper part of the building, above row Y409.

Therefore, at the anticlimbing, the inclined walls also stood in front of the vertical. The corner block was a special piece manufactured in the factory, whose length corresponded to the irregular distance from the last standard brick of the row to the edge of the building. However, the variable length of this special piece should never be shorter than the header dimension nor longer than the stretcher. If this should ever happen, then the last header of the standard grid would be replaced by a stretcher to reduce or increase the length of the corner piece, depending on the case ***(12.41)***. On the vertical facade, the last brick of the course would be cut on-site to fit into the leftover dimension to the corner piece.

The overall appearance of the corner in this lower part of the building proved to be continuous and quite harmonious. The necessary adjustments made to the brick pattern and the dimensions of the pieces were perfectly integrated into the general arrangement of the brickwork, being nearly imperceptible at first sight.

However, despite all the efforts made to rationalise the corner, to reduce the number of special pieces and to have as many blocks as possible made in the factory, the system still required the use of blocks cut on-site. The need for these “custom-made” pieces to fill the remaining irregular voids of the brickwork was inherent to the nature of this constructive system and was inevitable, as it was related to the primary decision to clad a twisting pyramid with a modular material. Therefore, the weakest point of the corner geometry lay precisely in these one-off pieces. Slight imperfections in the brickwork, especially evident at the anticlimbing, are associated with these blocks that remain somehow out of the design’s control. The irregular shape of these pieces is determined by the bricklayers who must cut



12.42
The geometry of the corner, from a sharp to an irregular configuration. Southeast corner.

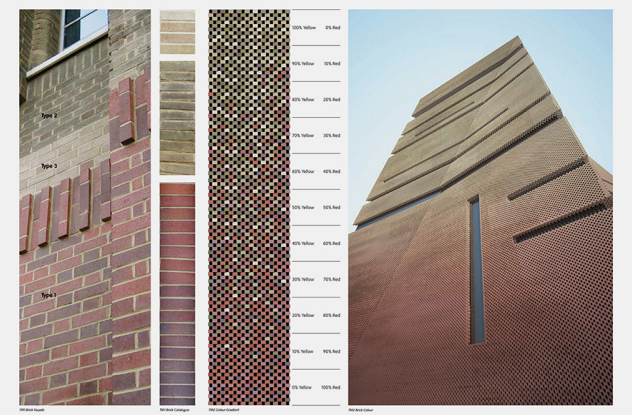
them, and their inner holes must be drilled directly on-site, which inevitably leads to subtle construction inconsistencies.

However, as Nicholas Serota pointed out, "I think that Jacques would say that, in the end, it's the overall impact of the building which needs to register".[144]

From this perspective, the corner is indeed a peculiar detail that speaks to the idea lying behind the building and embodies the particular approach that HdM takes towards architecture and geometry. At the bottom of the building, the corner emerges with a perfectly defined shape that progressively loses its original configuration, transforming into something that seems to have deteriorated ***(12.42)***. As soon as the brickwork pattern becomes perforated and more vibrant in terms of texture, the corner reflects the condition of the surface, acquiring an irregular and undefined appearance. While, on the one hand, this roughness, as mentioned by Nicholas Serota, "leaves the building feeling as if it was built by the hand of a craftsman",[145] making it more sympathetic to the archaic character of the old power station, on the other hand it is a weird imperfection in such a controlled and precise system that catches one's attention and creates a disturbing sensation. "It makes it more interesting by not being perfect", Wim Walschap said. "Depending on the angle you look at the corner from and the light that falls on it, shadows are always different. [...] You wonder what it is about, how it came together, what the logic is behind it. It makes people think about it because it is not obvious all at once."[146]

Referring to the corner of TM2, Harry Gugger observed that the skin of the pyramidal tower shares an affinity with the Signal Box, Basel (1989–1994), particularly in the effect that the twisting movement of

144 Serota, “Tate Modern 2.”
145 Ibid.
146 Walschap, “It makes it more interesting.”



12.43
Visual review of the TM1 brickwork and initial proposal for the TM2 colour gradient (2008).

the copper bands produced in the facades. According to the former senior partner of HdM, the small project for Basel, which was drawn by hand, seems to be the result of the facade-erasing process that ended up creating, in correspondence with the openings, what he called an "interesting impreciseness". "I truly believe that if something is too perfect, it revolts you", Harry Gugger remarked. "It is like a sign of aggression, and the architecture that works with impreciseness is more acceptable, is more human."[147]

12.6 _ The Colouring of the Facade

The colouring of the brickwork is another design strategy that is related to the architects' intention to strengthen the link between TM2 and the Bankside power station.

Triggered by the idea of reflecting the variegated character of the old masonry walls on the facade of the new building, this strategy went through a long process of rationalisation. The initial, almost poetic, idea of creating a smooth colour gradient that made the building fade into the sky was progressively informed and simplified by the increasing knowledge of the brick production process and the need to optimise the building from a construction point of view.

"The colour mix was another topic that needed different rounds of design development", Wim Walschap said. "If you look at the brickwork of the existing building, there is a wide colour range that goes from brown to purple. We had the intention to work with these colours again in the TM2 facades and explored different ideas for the distribution of the colour."[148]

During the Stage D design, HdM carried out a visual review and captured the TM1 brickwork photographically to identify the colour variation of the bricks that have been used. Even though the old

147 Gugger, “This is too generic.”

148 Walschap, “It makes it more interesting.”

industrial fabric was built with bricks from several sources and had undergone numerous repairs and alterations that had increased the diversity of the bricks, the design team was able to "isolate the general brickwork for matching purposes, [...] [having recognised] three types of brick, each with a significant colour range."[149] The former power station has a plinth of a red-purple colour in which highly resistant and less porous Engineer bricks—type 1—were employed. By contrast, above the plinth and crenellations, the walls of the old industrial fabric are of a yellowish tone that comes from the London stock bricks used there. In this part of the building, within the general buff colour, the design team identified two different types of brick, one of a lighter yellow—type 2—and the other of a more yellow-brownish tone—type 3 ***(12.43)***.

For the colouring of the facade, in an initial design stage, the architects had the idea of using this wide range of colours, mixing them in the brickwork to create a smooth, blended gradient that would range from the darker red of TM1 type 1 at the pyramid base to the yellow of type 2 at the rooftop. By doing so, it would be possible to match the Bankside power station's double-colour effect in the brickwork of TM2 and have the same varicoloured expression as the original walls. However, this idea had some inconsistencies that became evident as soon as the architects approached the issues of production and construction.

The first aspect to be considered was related to the high number of colours that the architects considered using to achieve the desired gradient effect. This had an impact on the production process, as the many colours multiplied by the existing brick types significantly increased the number of special pieces to be produced. "We were working in parallel with the manufacturers in Germany, who were delivering the costs, and the number of different bricks [had] exponentially increased", Andreas Reeg explained. "Within all the special geometry types, we also had a lot of colours. So, it could happen that one special brick that appeared, for instance, 30 times in the building, would have to be in 18 different colours, so each of these bricks [would] have to be made specially and manually. That is why we started to reduce and check for alternative solutions where we would have the same effect."[150]

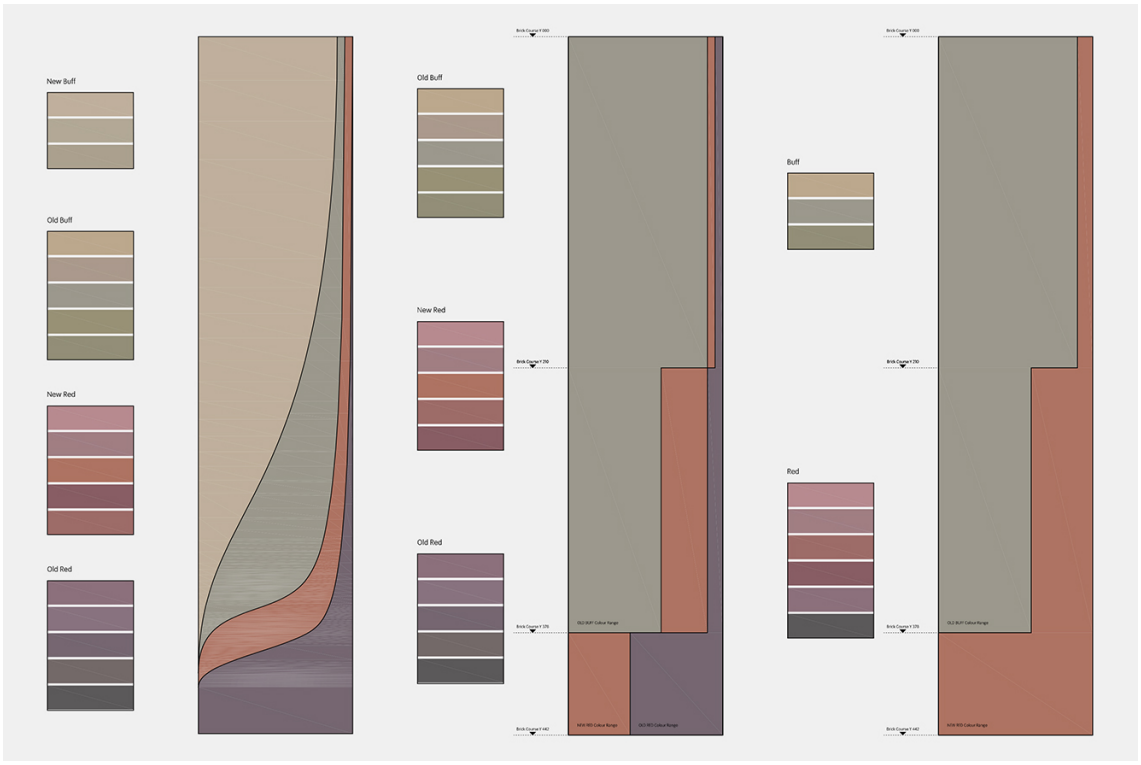
In addition to this, and with a deeper understanding of the production process, the design team realised that due to the composition of the raw materials in the clay mass and small differences in firing conditions, the bricks already presented some slight colour variations between batches. HdM thus recognised that even if they simplified the system by reducing the number of colours, they would still get a variation within each of them as a result of the production process, and this would allow them to have the same desired vibrant effect. "That is why we decided to reduce the standard colour range into something more limited and then play with the variations we would have anyway due to the production process",[151] Andreas Reeg remarked.

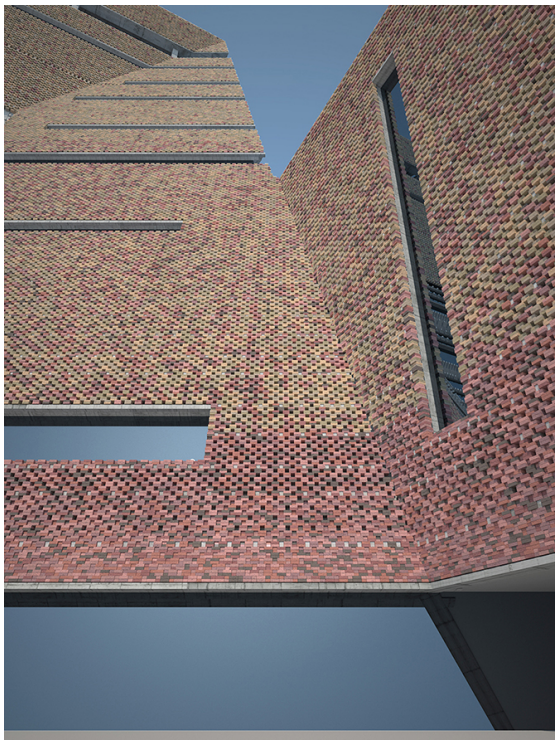
The second aspect of the design of the facade colouring, which came later in the design process, had to do with the distribution of the colours across the facade ***(12.44)***. As the first diagram shows, in the initial approach, which corresponded to the idea of a smooth uniform gradation, the arrangement of the brick colours was defined by flowing curves. This means that the percentage of each colour group was

149 Herzog & de Meuron, *TTM/TM2 Design Development. 100% Stage D Report*, December 15, 2008, 120.

150 Reeg, "It can't be so hard."

151 Ibid.





12.44
Diagrams for the bricks' colour distribution across the facades (2010).

12.45
Colour gradient from a red to a more yellowish tone (2010).

12.46
Brick colour samples corresponding to the proposal developed in the third diagram (2010).

always different and changed at every brick course. Construction-wise, this strategy raised some issues. When HdM planned the 1:1 scale mock-up and were confronted with how to deliver the construction information to the bricklayers, they realised that the workers would need one drawing per row to know exactly what pieces should be laid, which was too complex to be managed.

Therefore, in addition to reducing the number of colours, HdM also decided to rationalise the logic for mixing them. Instead of varying the parameters at each row, the architects chose to relate even more to TM1, and the idea of the plinth, and created at the pyramid base a zone of reddish bricks that then slowly changed to buff tones. As the second and third diagrams show, HdM opted to make the gradation by "steps", dividing the facade into three sections in which the percentage of the colour groups remained constant. In this way, the bricklaying process was simplified, while a visual gradation was still achieved.

"We have discussed with the manufacturers that we wanted the colours to be placed at random on each group", Andreas Reeg explained. "So they would deliver the bricks on-site randomly assorted, and the bricklayer could take out of a certain bunch of the bricks to be laid, automatically having in them some variation. Then the worker had only to introduce the percentage corresponding to the other colour group from another bunch. This was something the workers could do on-site without having a drawing for each brick row."[152]

Even though this gradation system was based on the definition of clear steps in the brickwork, the renderings showed that the final effect was of a continuous transition from a red to a more yellowish colour ***(12.45)***. The well-delimited horizontal bands visible in the diagrams tended, in reality, to disappear once the colours from the different groups were mixed between them, recapturing the original idea of a colour gradient that progressively dissolved into the sky.

The mock-up and some colour samples played a fundamental role in the decision-making process, along with the scripting. Constructed following the solution developed in the third diagram, which considered only nine colours divided into two groups, ***(12.46)*** the mock-up was the privileged means used to perceive the real effect of the brick colours and the actual result of the mix previously tested on the 3D model and visualisations.

However, despite all the efforts and the many tests developed to optimise the system and make the idea of a colour gradient feasible, in the end HdM opted to make the facade all the same buff tone. "There was the moment in which everybody said that probably it was going to work, but in the end, it only used some of these brownish tones", Andreas Reeg said. "I remember that we did one more mock-up on the Tate facade where we decided on these six brownish colours. Everybody agreed that it was looking good, and the decision was taken."[153] The TM2 brick facade was thus built as a continuous mix of only six colours, similar in their brownish tones to the colour of the London stock bricks used in the old industrial fabric, and whose combination enhanced the raw character of the new building's walls.

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152 Andreas Reeg, in conversation with the author, Zoom meeting, Porto-Berlin, September 21, 2020.

153 Reeg, "It can't be so hard."

12.47
The brickwork gradation from a solid to a perforated pattern. East facade.

Even though this whole route to determine the facade colouring has vanished in the end and remains only as the trace of an intricate thought process, it was necessary and served, as Jacques Herzog observed about the remnants of the design process, “to take another step [and] make the board in front of your face a bit less impervious.”[154]

One could wonder whether the colouring effect, as the architects initially thought, would have enriched the textile-like quality of the brick veil or not. "It certainly had some attractive qualities to it," Nicholas Serota pointed out. In addition, it also reflected the particular stance of HdM to be open to the context and react to it, searching for a dialogue that they continually expand in unexpected ways.

Nevertheless, a subtle gradation still happens when looking at the building, not in the colour but in the brickwork pattern itself when it changes from solid to perforated ***(12.47)***. So, in a certain sense, the simplification of the colouring came to enhance the classic character of the building and emphasise the arrangement of the bricks, the latter being mainly responsible, with their intricate play of geometries, for the attractive, tactile quality of the twisting pyramid of TM2.

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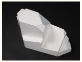
154 Theodora Vischer, *Herzog & de Meuron: No. 250 An Exhibition* (Münchenstein/Basel: Schaulager, 2004).

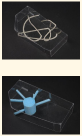
M.2
TM2 Chronology Map

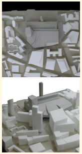
CO- Concept Design
2004.08.01–2005.04.30

DESIGN
and
CONSTRUCTION



246 | Tate Modern Master Plan
2003–2004





Log Book
2005.02

11 12 01 02 03 04 05 06 07 08 09 10 11 12 01 02 03 04 05

2004 2005

FACTS

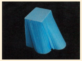
PRESS RELEASE

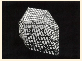
05.01_Herzog & de Meuron
appointed to complete Tate
Modern

ARCHITECTURE

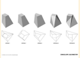
CONSTRUCTION

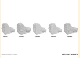
SD- Schematic Design
2005.05.01–2008.06.30



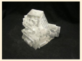


"Extrusion & Morph"
2005.12.16
Outline Design Report





Envelope & Internal Program
2006.02.11
Client Review



Primary Form & Boxes
2006.12
Log Book

06 07 08 09 10 11 12 01 02 03 04 05 06 07 08 09 10 11 12 01 02 03 04 05

2006

2007

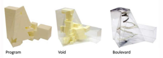
06.07_Tate's Trustees unveiled bold plans to transform Tate Modern into a new museum for 21st Century Britain

06.02_Work on the main brief starts

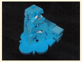
06.10_Brief completed

DD- Design Development

2008.07.01–2009.09.30



Perforated Brick



"Not to Tech!"
2008.07.18
TM2 Book

2008.10.31
REP-3_TM2 Book

2008.12.15
REP-3_Stage D Report

2009.01.14
REP-3_TM2 Book

06 07 08 09 10 11 12 01 02 03 04 05 06 07 08 09 10 11 12 01 02 03 04 05 06

2008 2009

07.07_Expressions of Interest for the Design Team placed in the Official Journal of the European Unioun (OJEU). Four practices shortlisted: Richard Rogers, Herzog & de Meuron, Dominique Perrault and Wilkinson Eyre

07.08_Planning Consent for original glass scheme granted.

08.01_Herzog & de Meuron appointed as architects for the detailed design and construction phase of the scheme.

08.02_Tate has announced the design and construction team for the new development of Tate Modern

08.07_Tate Director, Nicholas Serota, and Jacques Herzog revealed the revised plans for the new development of Tate Modern

08.07_RIBA Design Stage C for present design completed

09.01_Revised plans for new Tate Modern building submitted for planning

09.01_Planning application for present scheme submitted to London Borough of Southwark

09.01_RIBA Design Stage D completed

09.03_Revised plans for new Tate Modern building receive planning permission

09.05_Planning consent for present scheme granted by London Borough of Southwark

CD/S- Construction Documents/Services
2009.09.01–2010.09.31/2016.05.30

(01-02)

(03)

(08-09-12)

2009.09.14
REP-3_Stage E Report & Drawings

2010.01.07
REP-4_TM2 Book

07 08 09 10 11 12 01 02 03 04 05 06 07 08 09 10 11 12 01 02 03 04 05 06 07 08 09 10

2010

2011

10.01_Mayor of London, Boris Johnson, started the enabling works on the new development of Tate Modern

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09.09_RIBA Stage E completed

10.03_Jasper Morrison is appointed as furniture designer

10.07_The construction of a full-scale mock-up of the facade begins at Tate Stores

10.07_Uxus area appointed as retail consultants to work with Herzog & de Meuron on the shops within the new building

10.08_Sevil Peach works with Herzog & de meuron on the design of the offices

10.12_The design of the project as a whole is complete

11.02_Tate and Herzog & de Meuron sign off repair works for the inside of the Tanks performance space, galleries and lobby areas

---

10.01_Full construction site is established. The main works site is established with the Turbine Hall strengthening works and demolition work of the oil tank lids continuing

10.01_Construction work on the Tate Modern Project begins inside the existing Tate Modern building with the works required to strengthen the southern wall of the Turbine Hall in preparation for the extension

10.02_Enabling works begin

10.01_The opening up and demolition of the oil tanks begin

10.01_The beginning of construction is celebrated by the Mayor Boris Johnson

10.07_Major works on site begins with the formation of the foundations for the oil tanks and the new structure which will rise above.

10.08_The demolition work is completed, the foundation works are progressing well and further below ground substructure works commence

10.10_The Turbine Hall wall strengthening works are completed

10.11_The initial foundations works are complete and the sub-structure works continue, enabling the oil tank spaces and new "as found" galleries to form the basement level of the Tate Modern extension

10.11_The full site accommodation is placed on the South Lawn in preparation for the next stage of the project which will include the demolition of the western side of the Switch House, the continuation of the sub-structure and the repair of the oil tanks

10.11_The initial works of the Tate Modern Project within the existing Tate Modern start.

11.01_The piling work in the ground beneath the oil tanks is complete and the sub-structure work has started. This includes the capping of the piles with concrete and creating the huge service trench which will be situated below the floor of the oil tanks

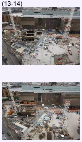
11.02_The capping of the piles is completed and the construction of the core walls within the tanks has started. The salvage steel columns are being prepared for the re-installation in the east oil tank

11.03_The demolition of the western end of the Switch House has begun and the site is being prepared for the reinstatement of the Tanks lid

11.09_The main structures for the Tanks and Transformer galeries are complete. Work continues on the core of the building and steelwork has started on the existing and new buildings. The services are currently being installed within the service tunnel beneath the Tanks

Construction
2009.12–2016.06

(13-14)



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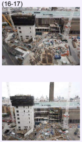

(18-20)

(22)

(22B-22C)

11 12 01 02 03 04 05 06 07 08 09 10 11 12 01 02 03 04 05 06 07 08 09 10 11

2012 2013

12.01_The main activity on site is near completition of the sub-structure works, and preconstructuion activitty on the superstructure has begun

12.01_Preparations are progressing for installing cranes on the site. Finishes and Builders works within the Tanks areas are progressing

12.01_Construction activity starts on the tower superstructure

12.05_Completition of the Tanks

12.07_The superstructure work continues on site above the tanks. The North Core is complete to level 4 and the South Core to level 3

12.07_83% of the works have been procured

12.12_Construction works on the pre-cast concrete perimeter structure above ground continue and the north and South core external walls are completed

12.12_The steelwork to the Switch House reconstruction, which will house the new galleries, has now reached level 5 and the installation of the mechanical and electrical plant has begun within these spaces

12.12_The next major visible part of the construction will be the erection of the concrete components which make up the 35 perimeter sloping columns. External walls of both cores of the new building complete.

13.03_Preparations are underway for the closure of the Turbine Hall and western entrance within the existing Tate Modern to create the new level 4 bridge across the Turbine Hall connecting the existing building with the new extension

13.05_Construction activity remains focused on the superstructure above ground. Level 3 slab is complete as are the columns and beams up to Level 2 and the installation of the level 3 atrium balaustrade is complete

13.05_Work on the Switch House area is progressing well and steelwork is very nearly complete

13.07_Construction works are progressing on the perimeter structure of the new building. All perimeter concrete columns are in place up to level 4 of the tower. Crease columns are being installed on the eastern side of the tower, showing the complex geometry of the building. The void space that links level 2, level 3 and level 4 concourse is now visible. The concrete balustrade to the void on level 3 is in place and the concrete floor slab on level 3 has been poured

13.07_82% of the facade bricks has been manufactured. The project is 87% procured

13.07_Steelwork to the Switch house is complete

(25-27)

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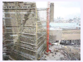

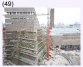
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2014 2015 2016

14.10_The furniture for the public areas has now been presented to Tate non-executive committees for their comments

14.01_The complex pre-cast concrete perimeter structure continues to rise up to 8 levels with the panels being placed on the lower levels

14.01_The new bridge on level 4 spanning the Turbine Hall has been completes and the Turbine Hall is re-opened to the public

14.02_The grand public staircase which is being poured on site is progressing up the building from levels 1-4

14.03_The perimeter structure has now reached level 9 and work has started on the final level 10 at the top of the Switch House. The pre-cast concrete panels continue to be installed, creating the envelope

14.03_Art lift installed and in use

14.04_The glazing manufacture is 87% complete

14.04_94% of the construction works have been procured

14.05_The roof-top glazing for the level 4 Gallery West is complete

14.05_Perimeter structure is complete

14.08_The grand public staircase leading from levels 0-4 is complete

14.10_Work on the brickwork installation has started

14.12_The external envelope made up of pre-cast concrete panels is complete

15.01_The concrete perimeter structure, the pre-cast concrete panels and the roof of the Switch House are complete

15.01_The installation of the windows in the facade of the tower is underway

15.01_Works start in the Existing Tate Modern to create a new service route connecting the Switch House to the Boiler House

15.04_The window installation is complete to level 8 with the exception of level 2 to atrium 4 windows

15.05_Work has started on the inside of the building to install the windows overlooking the atrium

15.05_Floor screed is being laid in the nwe galleries, ready for the timber flooring to be laid.

15.05_The perimeter art walls are being built

15.06_The external brickwork on the Switch House is nearing completition and the scaffolding on this facade starts to come down

15.07_The atrium glazing within the Switch House is complete

15.08_The brickwork installation has reached level 5 on all elevations and is 53% complete

15.08_The installation of the windows is complete

15.08_The timber floor in the new level 2 gallery is complete and the coffered ceiling in the level 3 galleries has been finished

15.10_Permanent floor installation is rogressing on all other areas

15.10_Work to pedestrianise Sumner Street on the edge of the new southern landscape starts

15.10_Tate starts the installation of the information Technology Systems

15.10_Over 300 photovoltaic solar panels are installed on the roof of the Turbine Hall

15.10_The timber flooring is complete in all the galleries and the stretch fabric ceiling in level 4 galleries is installed

15.11_The rehang of the Tate collection starts in the existing Tate modern galleries

15.12_90% of the brickwork is now complete

16.01_The internal glazed screens throughout the Switch House are complete

16.01_The new galleries are complete

16.01_The permanent floors are complete in all areas of the Switch House

16.02_Integrated systems testing is complete

16.03_The installation of the works from the collection starts in the Switch House level 3 galleries

16.03_The fitting out of the new staff offices begins

16.04_The new service route and kitchens in the existing Tate Modern are complete. The fitting out of the new Terrace shop begins

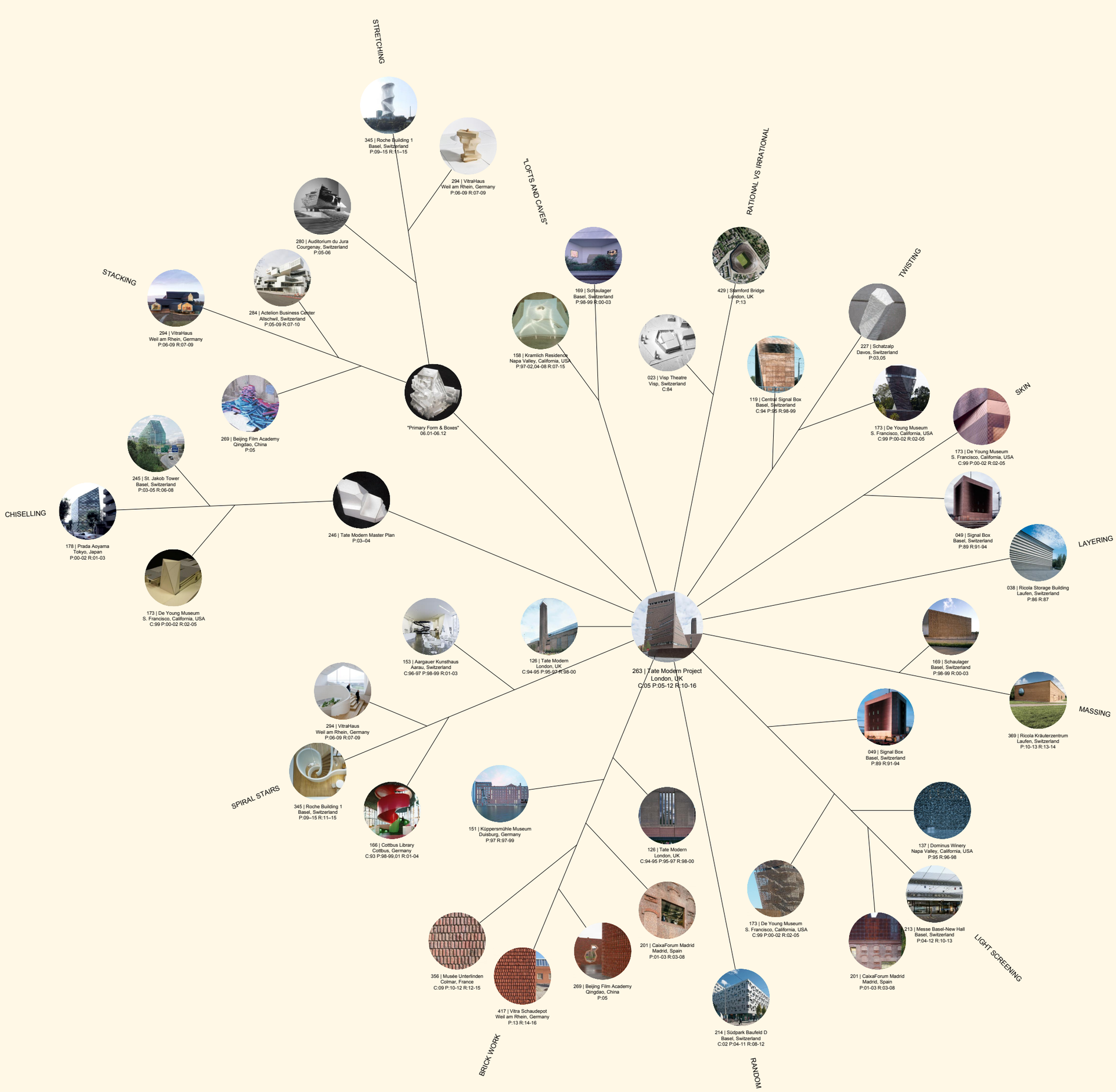
16.05_The external works and landscaping are complete

16.05_Pratical completion of the whole project

16.05_The public furniture designed by Jasper Morrison arrives from storage and is installed floor by floor

16.06_The new Tate Modern opens to the public

M.3
TM2 Architectural Reference Map



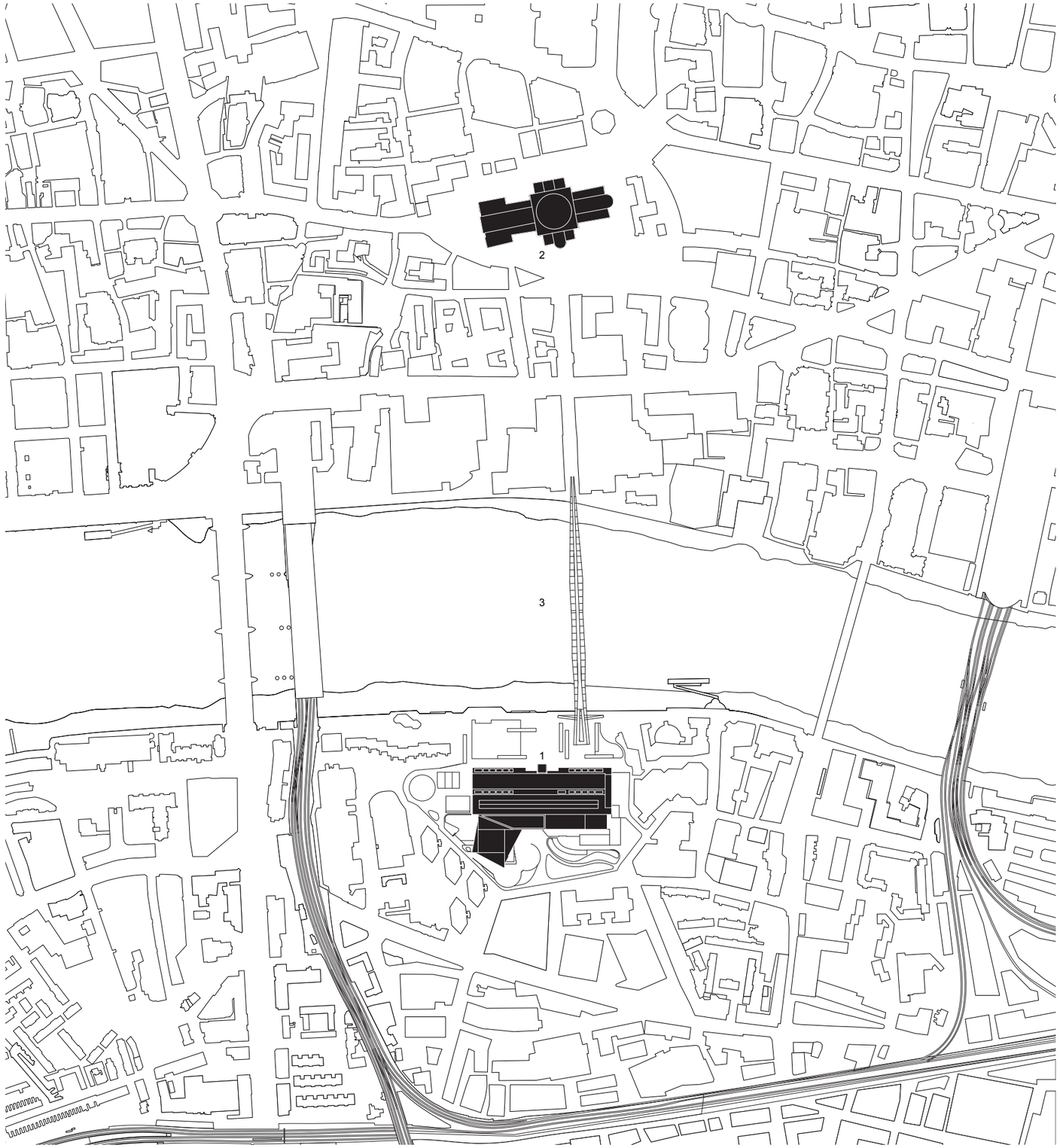
"Their projects can be read as a continuous redrawing of earlier ideas and buildings. Their view of architectural history is less concerned with radical innovation than with the uninterrupted, gradual transformation of existing structures."

Canadian Centre for Architecture, "Herzog & de Meuron: Archaeology of the Mind", CCA Press Release, accessed October 29, 2019, https://www.cca.qc.ca/en/events/2644/herzog-de-meuron-archaeology-of-the-mind.

M.4
TM2 Plans

The Tate Modern Project

1 Tate Modern
2 St Paul's Cathedral
3 River Thames



SITE PLAN

scale 1:7000

0 25 50 100

The Tate Modern Project

3 River Thames
4 The Tanks
5 Turbine Hall
6 Boiler House
7 Switch House
8 North Landscape
9 South Landscape

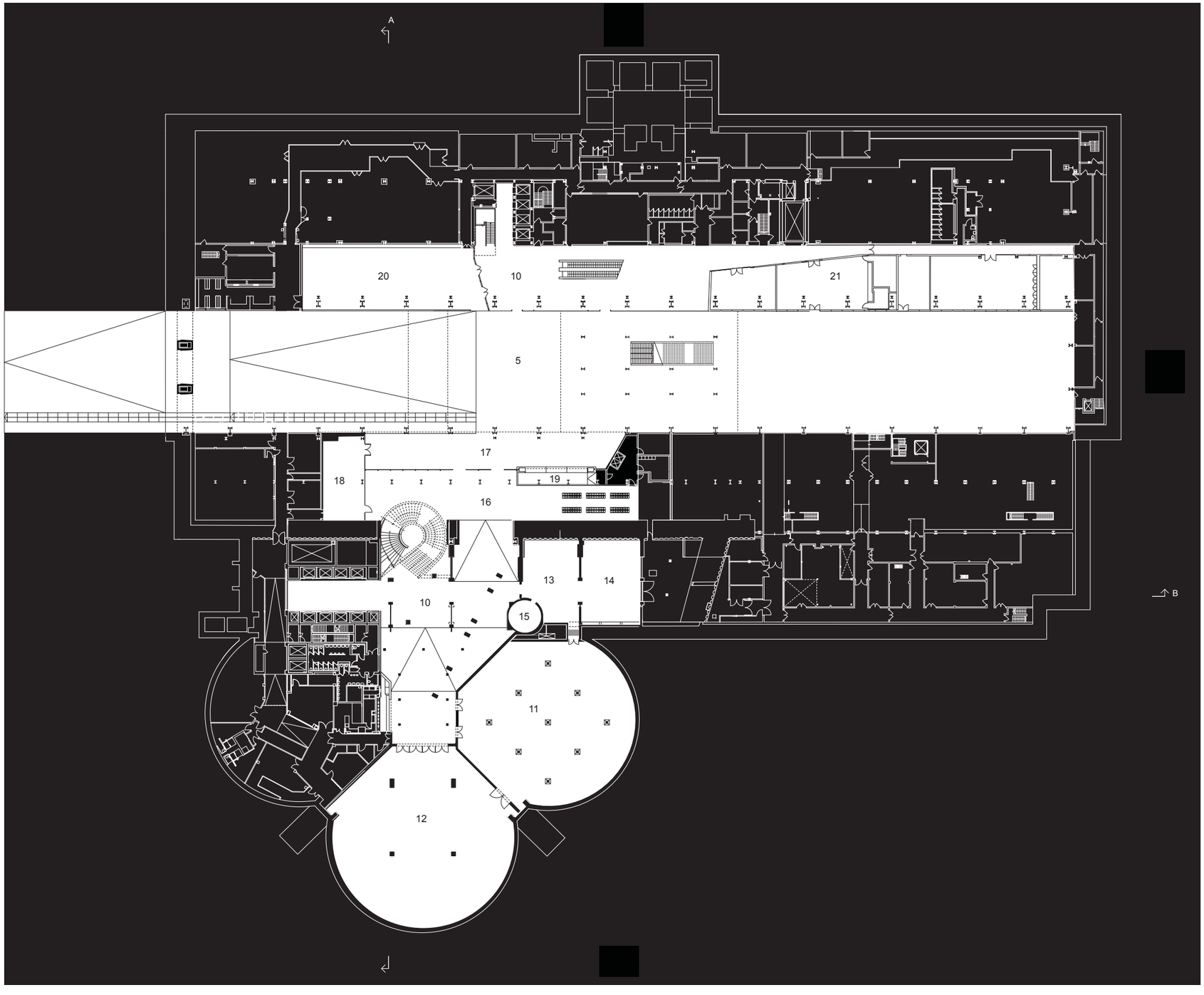
SITE PLAN

scale 1:4000

0 25 50 100

The Tate Modern Project

5 Turbine Hall
10 Concourse
11 East Tank
12 South Tank
13 The Transformer I
14 The Transformer II
15 Drum Gallery
16 Lobby
17 Orientation
18 Multiuse Space
19 Info / Ticketing
20 Main Shop
21 Clore Learning Centre



LEVEL 0

scale 1:1000

0 5 10 20

The Tate Modern Project

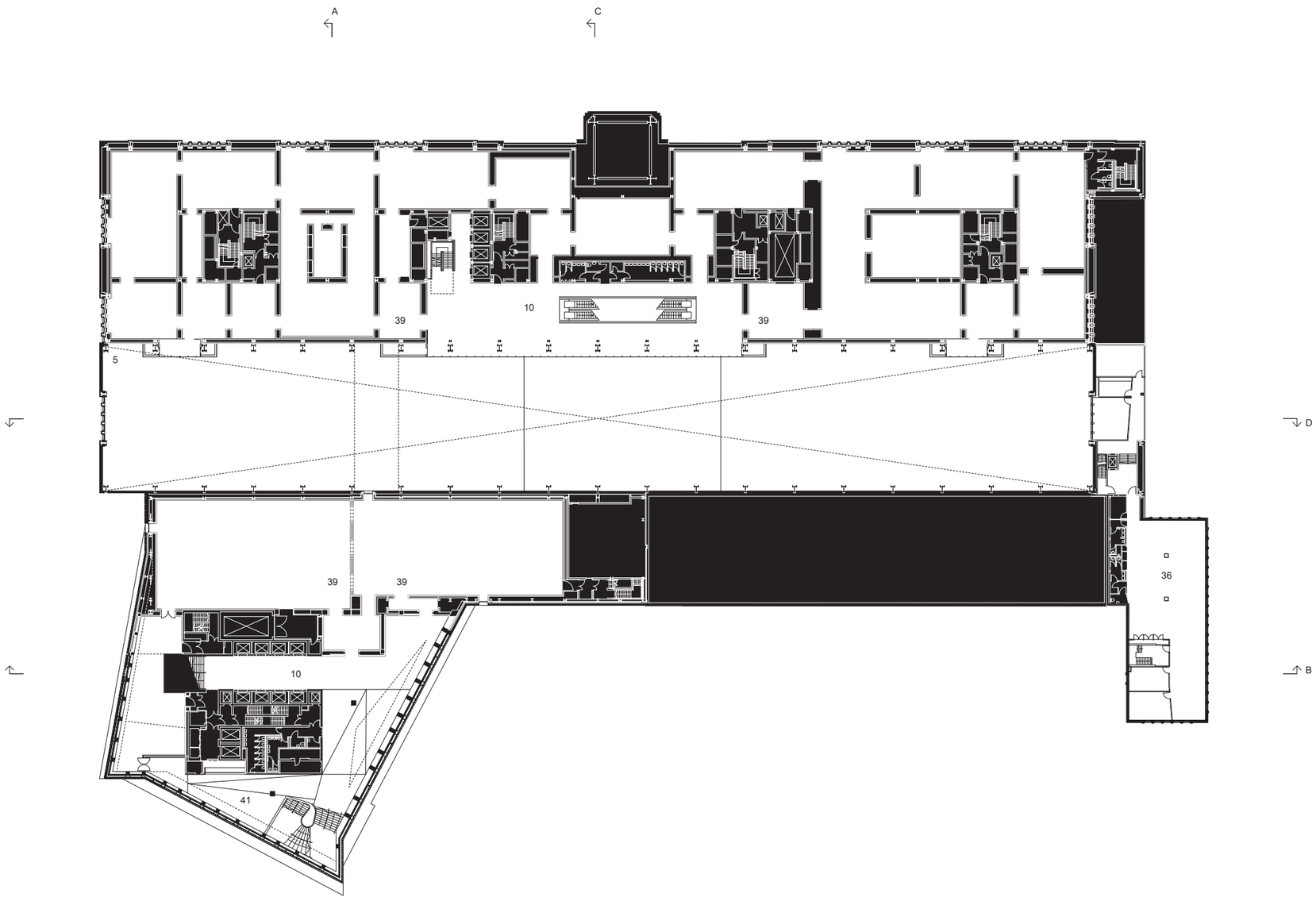
5 Turbine Hall
8 North Landscape
9 South Landscape
10 Concourse
19 Info / Ticketing
23 Turbine Hall Entrance
24 River Entrance
25 South Entrance
26 Terrace Entrance
27 West Entrance
28 River Shop
29 Café
30 Starr Cinema
31 Tate Addition Shop
32 Terrace Shop
33 Bar
34 Community Room
35 Bridge Level 1
36 Office
37 East Goods Handling Zone
38 West Goods Handling Zone
59 Lawn

LEVEL 1
scale 1:1000

0 5 10 20

The Tate Modern Project

5 Turbine Hall
10 Concourse
36 Office
39 Collection
41 Expresso Bar



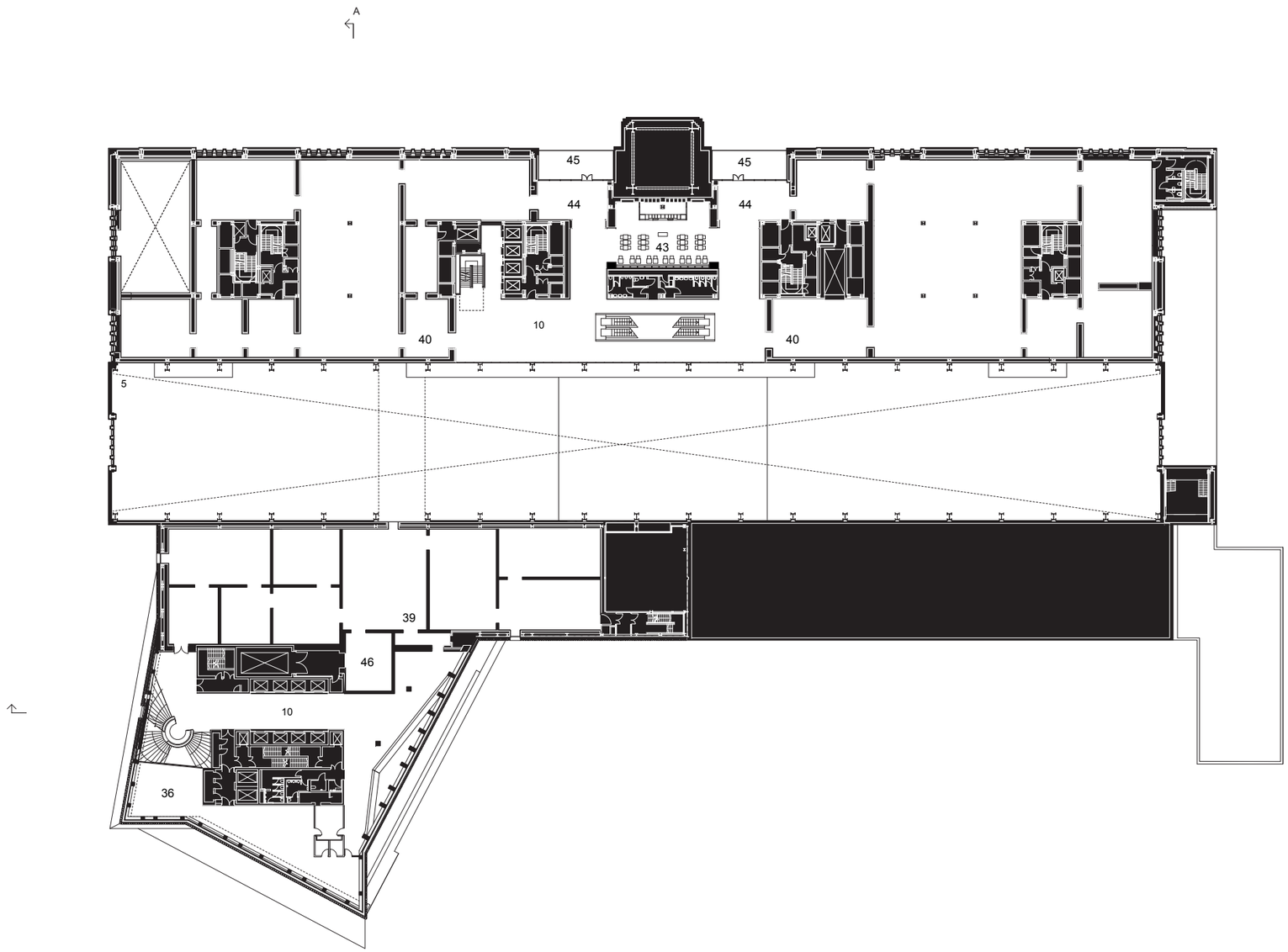
LEVEL 2

scale 1:1000

0 5 10 20

The Tate Modern Project

5 Turbine Hall
10 Concourse
36 Office
39 Collection
40 Exhibition
43 Expresso Bar
44 Exhibition Shop
45 Terrace
46 Interpretation Space



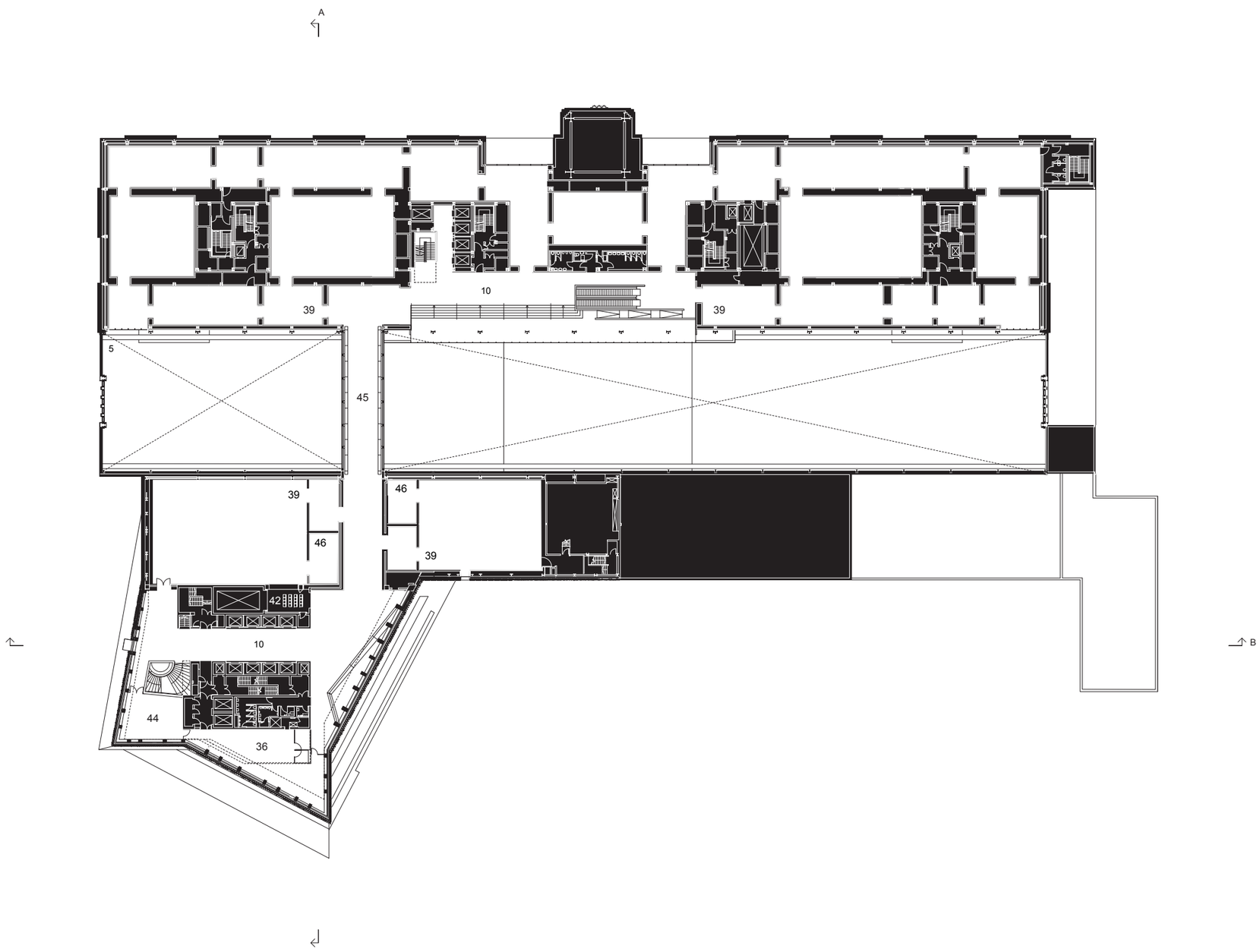
LEVEL 3

scale 1:1000

0 5 10 20

The Tate Modern Project

5 Turbine Hall
10 Concourse
36 Office
39 Collection
42 Screening Room
44 Conservation Studio
45 Bridge Level 04
46 Interpretation Space



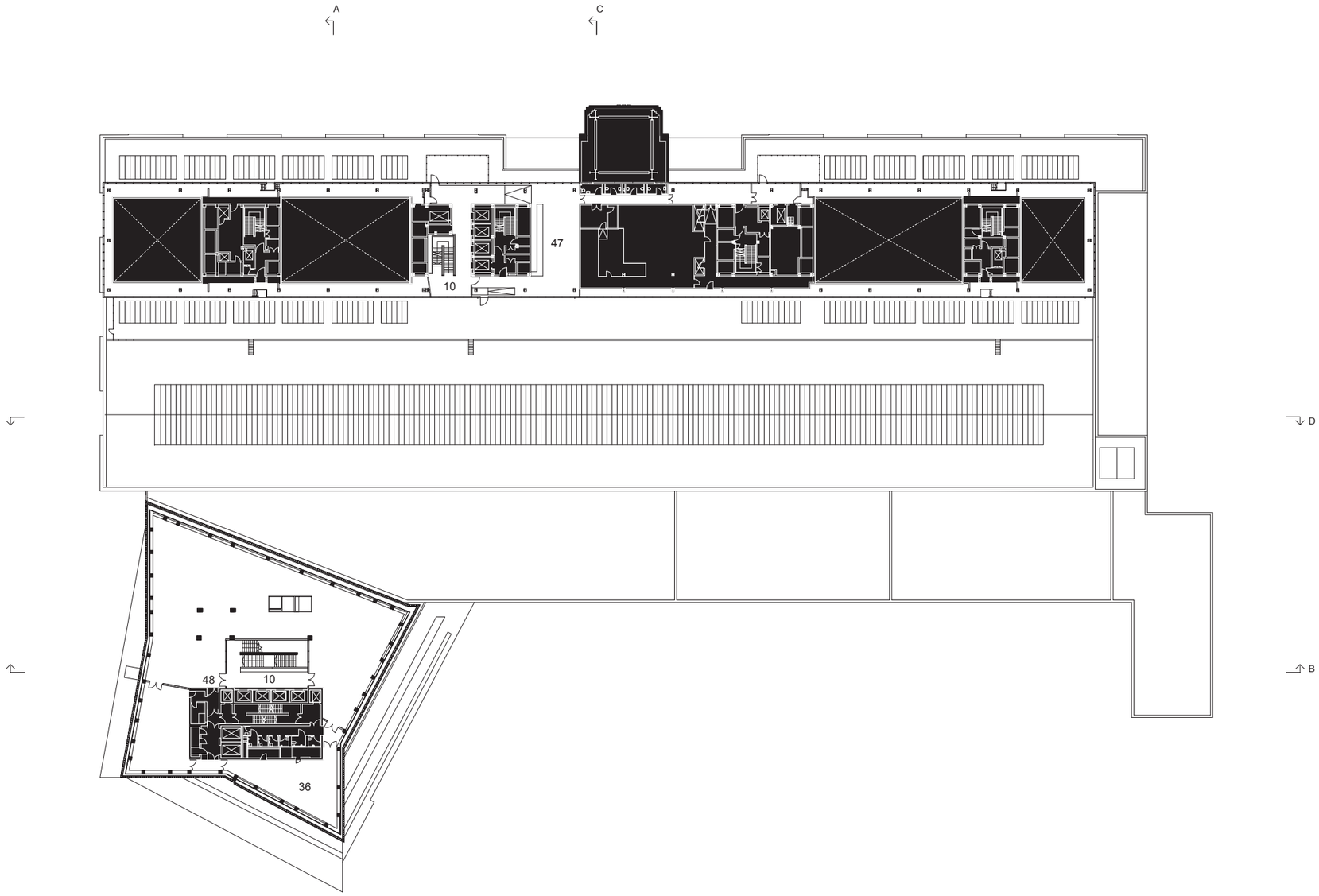
LEVEL 4

scale 1:1000

0 5 10 20

The Tate Modern Project

10 Concourse
36 Office
47 Members Room
48 Tate Exchange



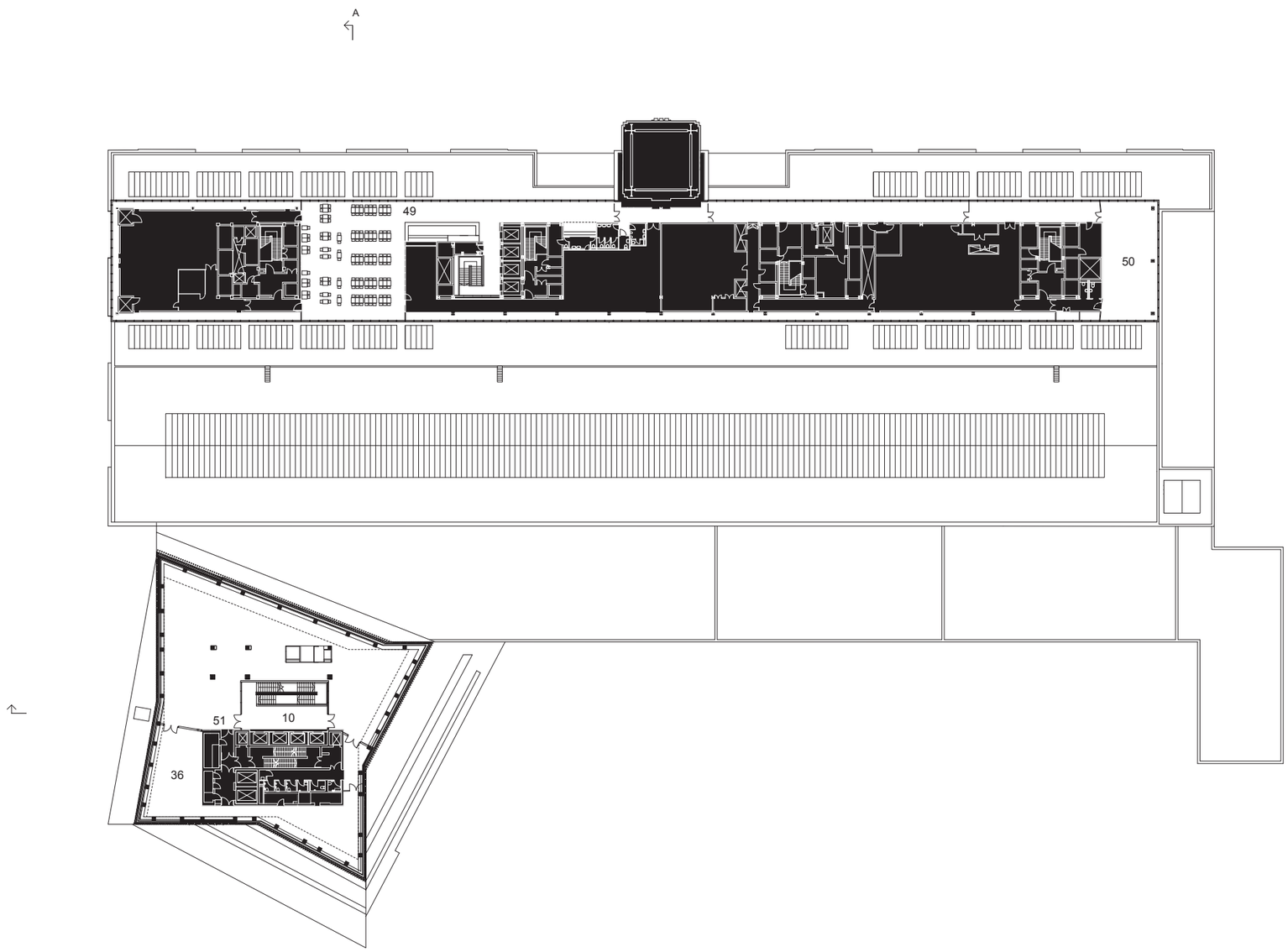
LEVEL 5

scale 1:1000

0 5 10 20

The Tate Modern Project

10 Concourse
36 Office
49 Restaurant
50 East Function Room
51 Tate Studio



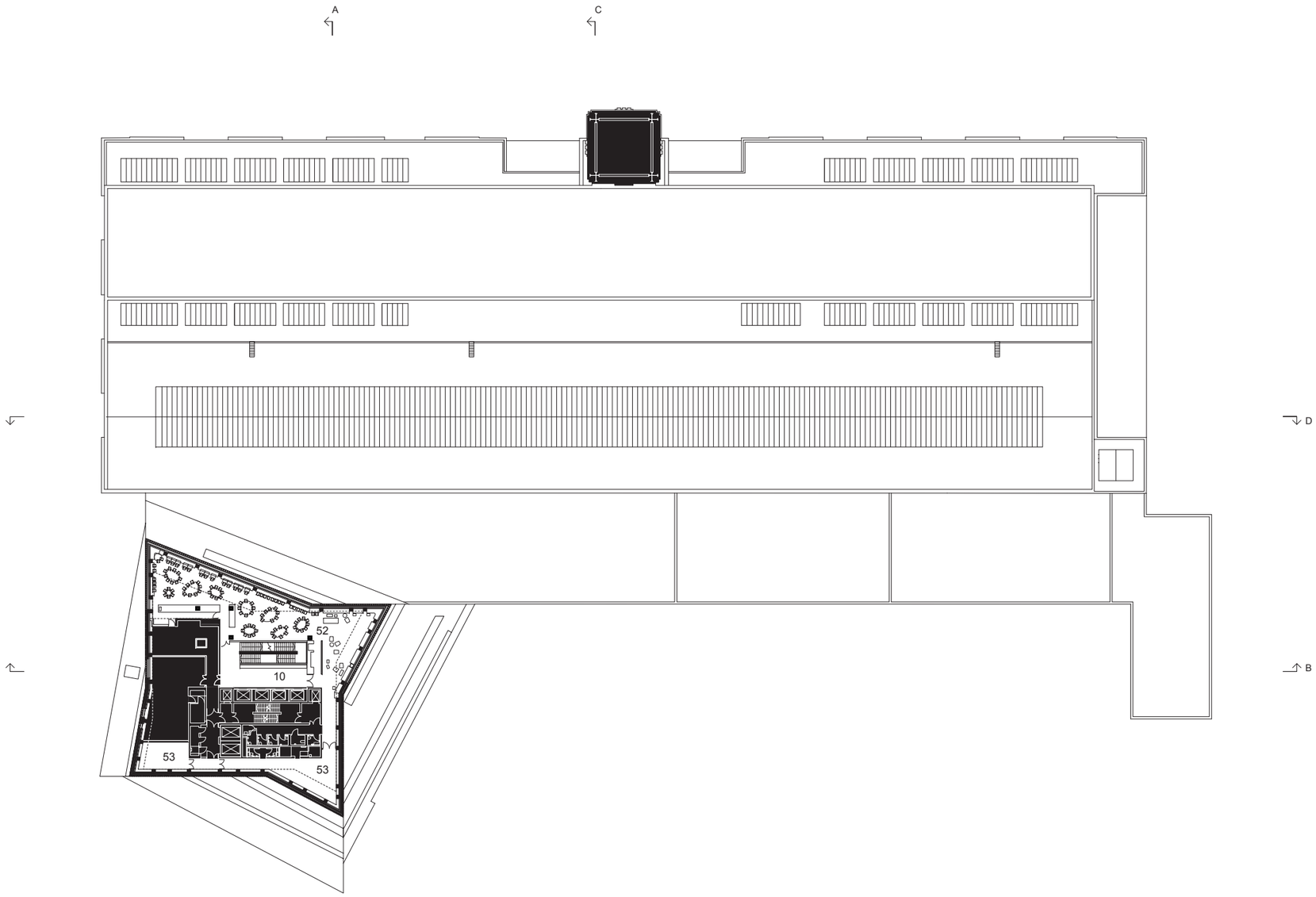
LEVEL 6

scale 1:1000

0 5 10 20

The Tate Modern Project

10 Concourse
52 Staff Restaurant
53 Storage



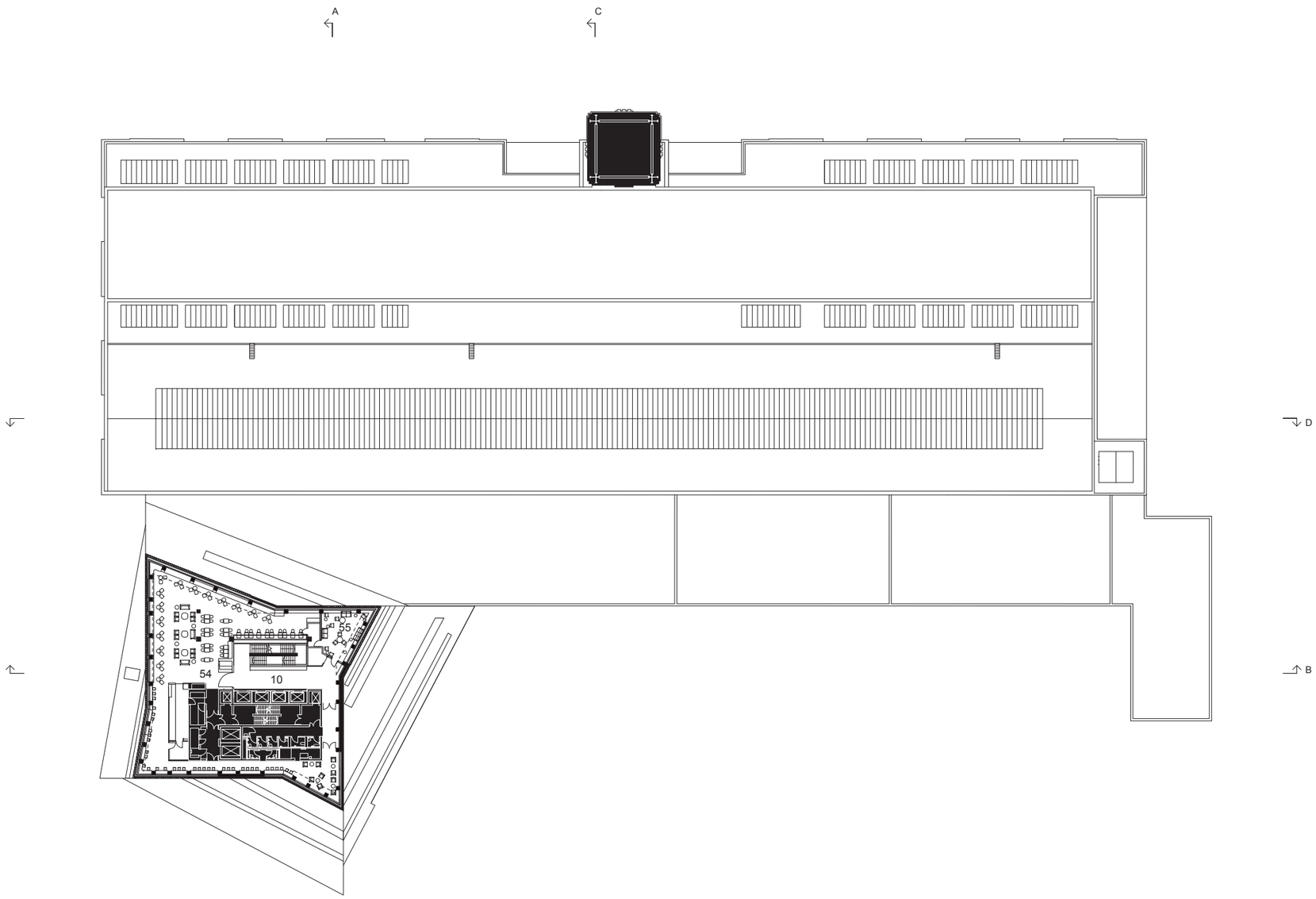
LEVEL 7

scale 1:1000

0 5 10 20

The Tate Modern Project

10 Concourse
54 Members Room
55 Patrons Room



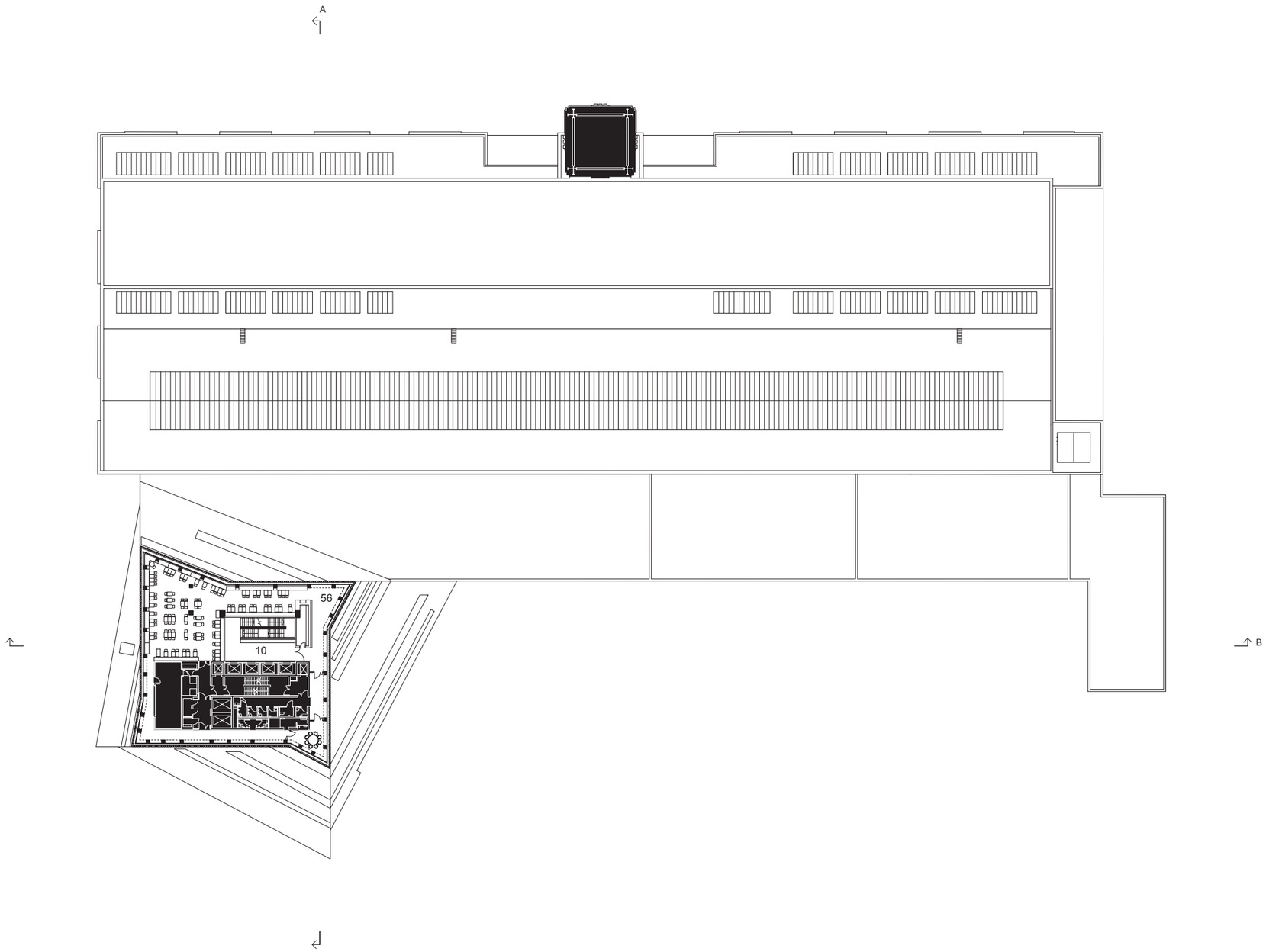
LEVEL 8

scale 1:1000

0 5 10 20

The Tate Modern Project

10 Concourse
56 Restaurant



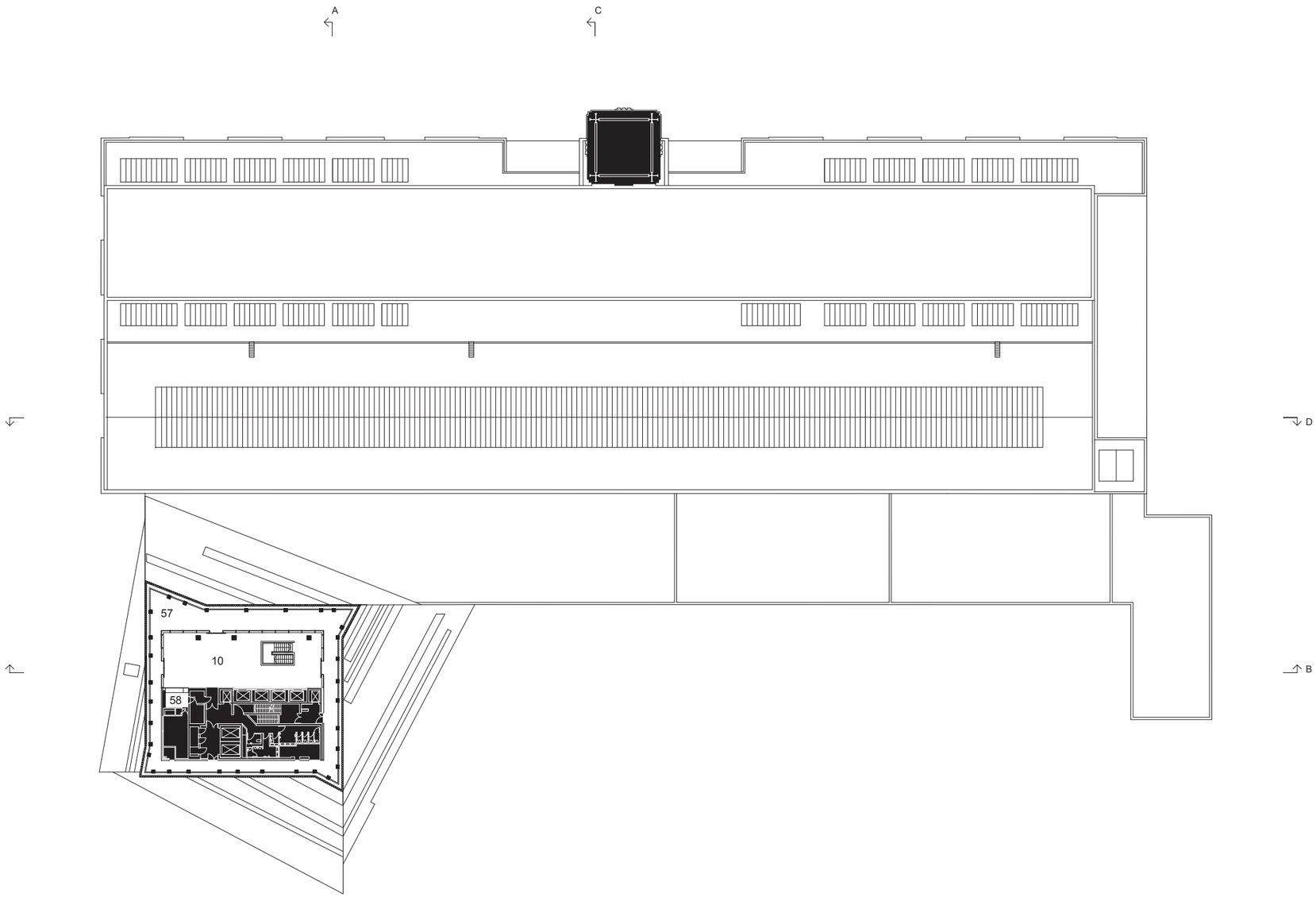
LEVEL 9

scale 1:1000

0 5 10 20

The Tate Modern Project

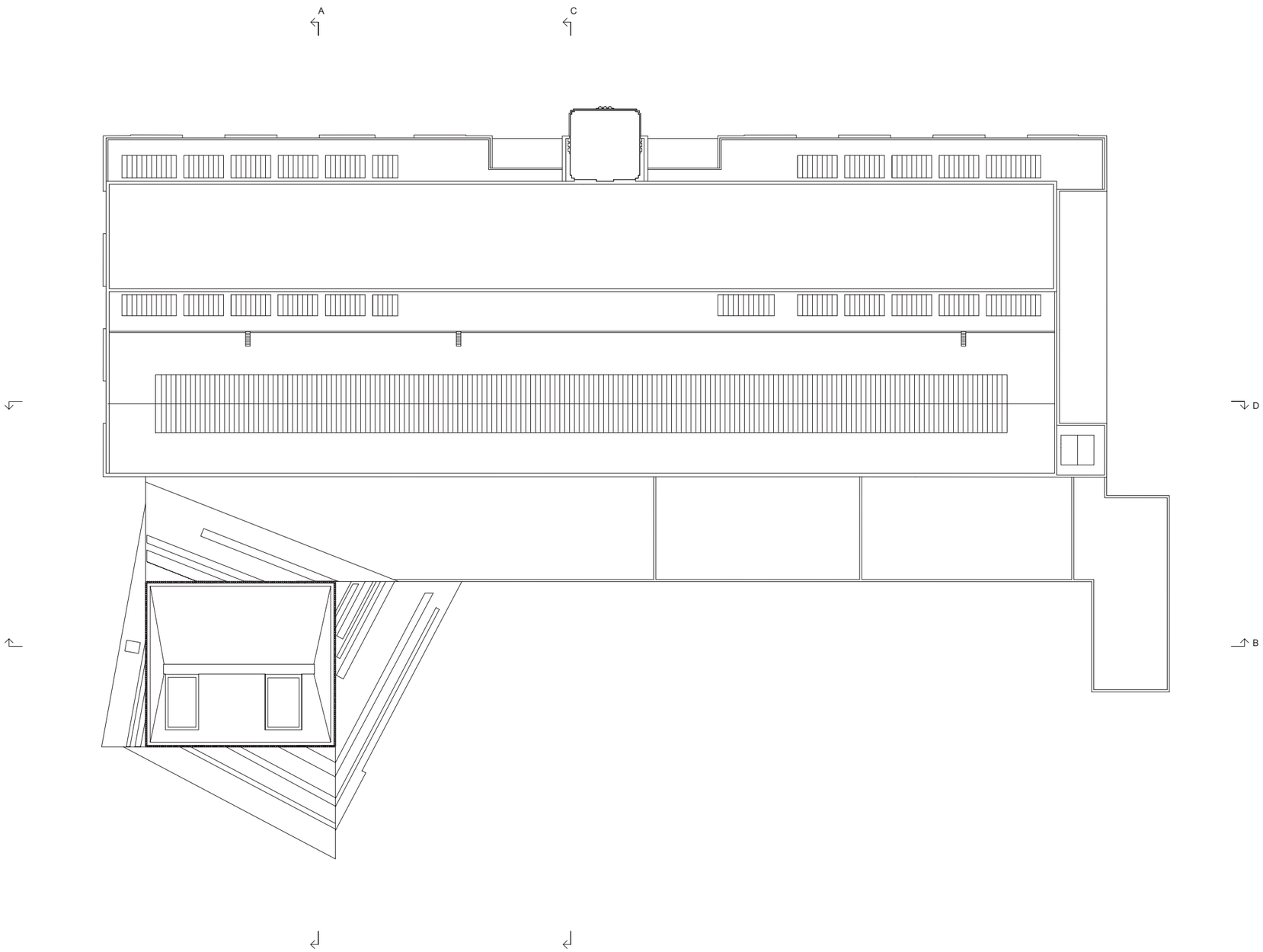
10 Concourse
57 Viewing Terrace
58 Espresso Bar



LEVEL 10

scale 1:1000

0 5 10 20



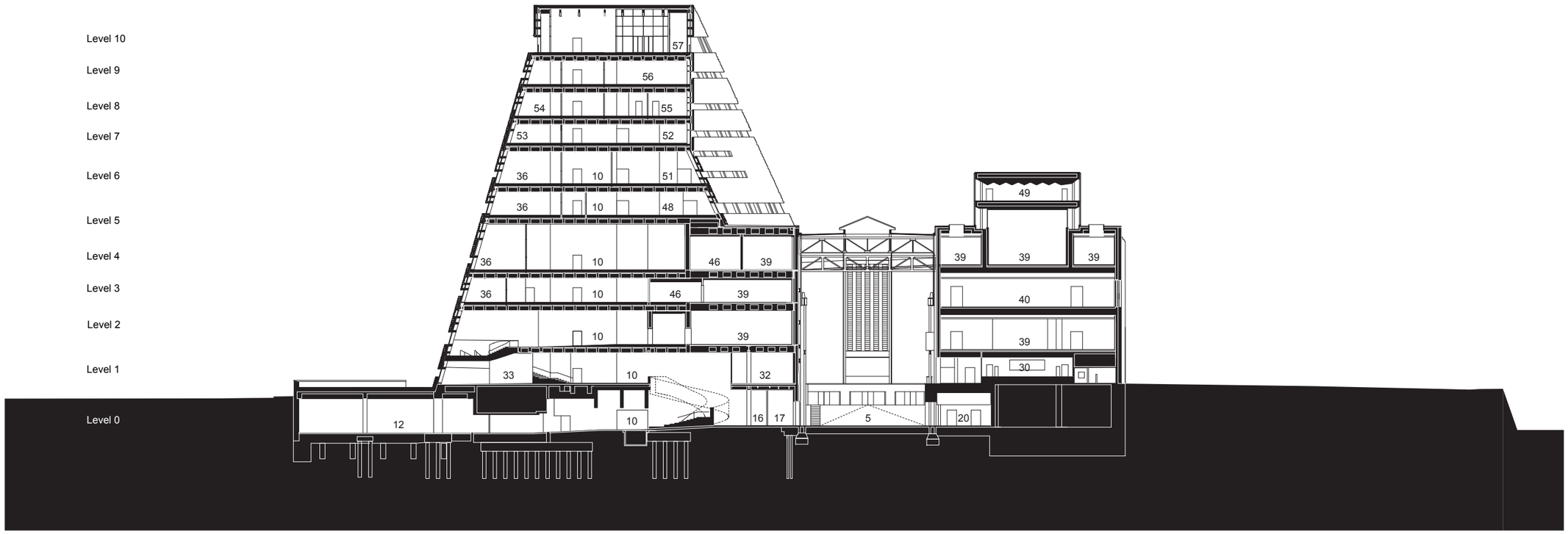
ROOF

scale 1:1000

0 5 10 20

The Tate Modern Project

5 Turbine Hall
10 Concourse
12 South Tank
13 The Transfomrer I
14 The Transformer II
16 Lobby
17 Orientation
20 Main Shop
30 Starr Cinema
32 Terrace Shop
33 Bar
36 Office
39 Collection
40 Exhibition
46 Interpretation Space
48 Tate Exchange
49 Restaurant
51 Tate Studio
52 Staff Restaurant
53 Storage
54 Members Room
55 Patrons Room
56 Restaurant
57 Viewing Terrace



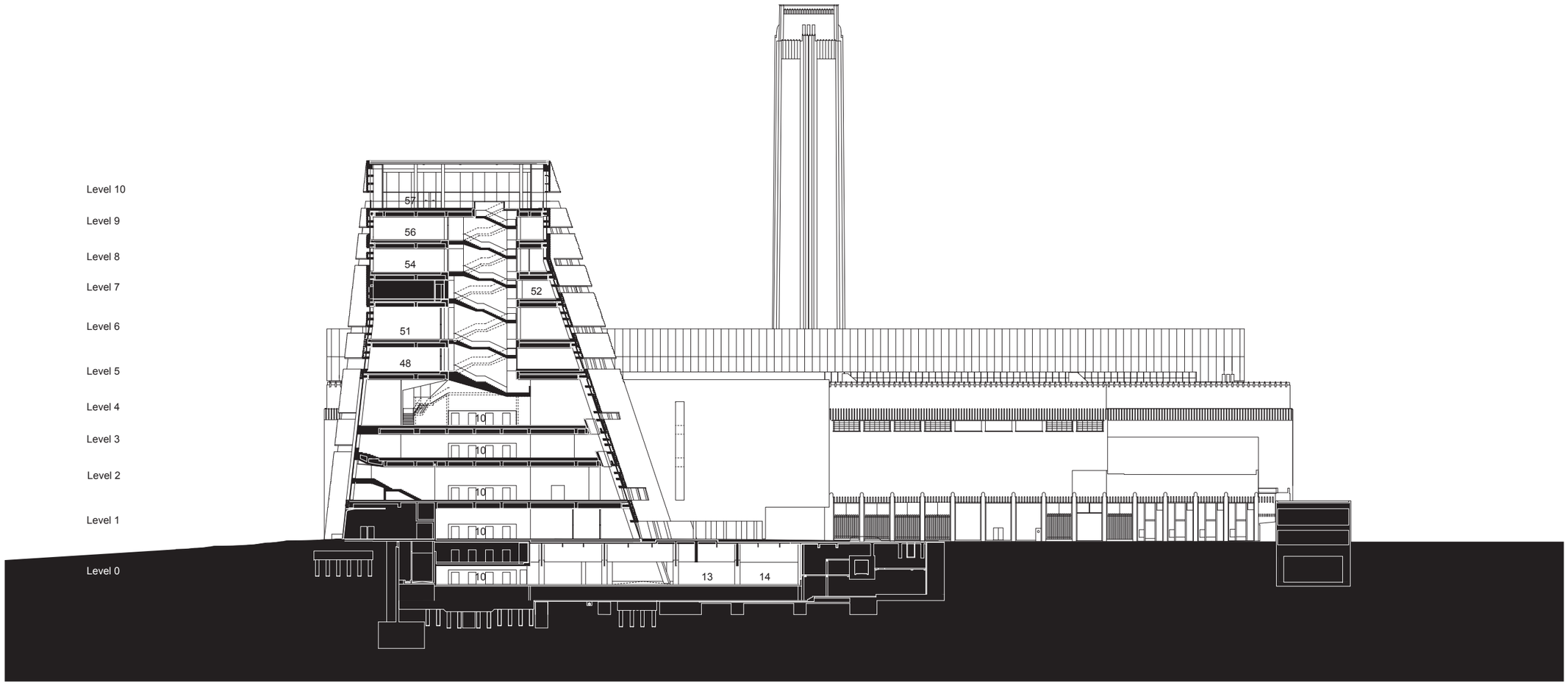
SECTION AA

scale 1:1000

0 5 10 20

The Tate Modern Project

10 Concourse
13 The Transformer I
14 The Transformer II
48 Tate Exchange
51 Tate Studio
52 Staff Restaruant
54 Members Room
56 Restaurant
57 Viewing Terrace



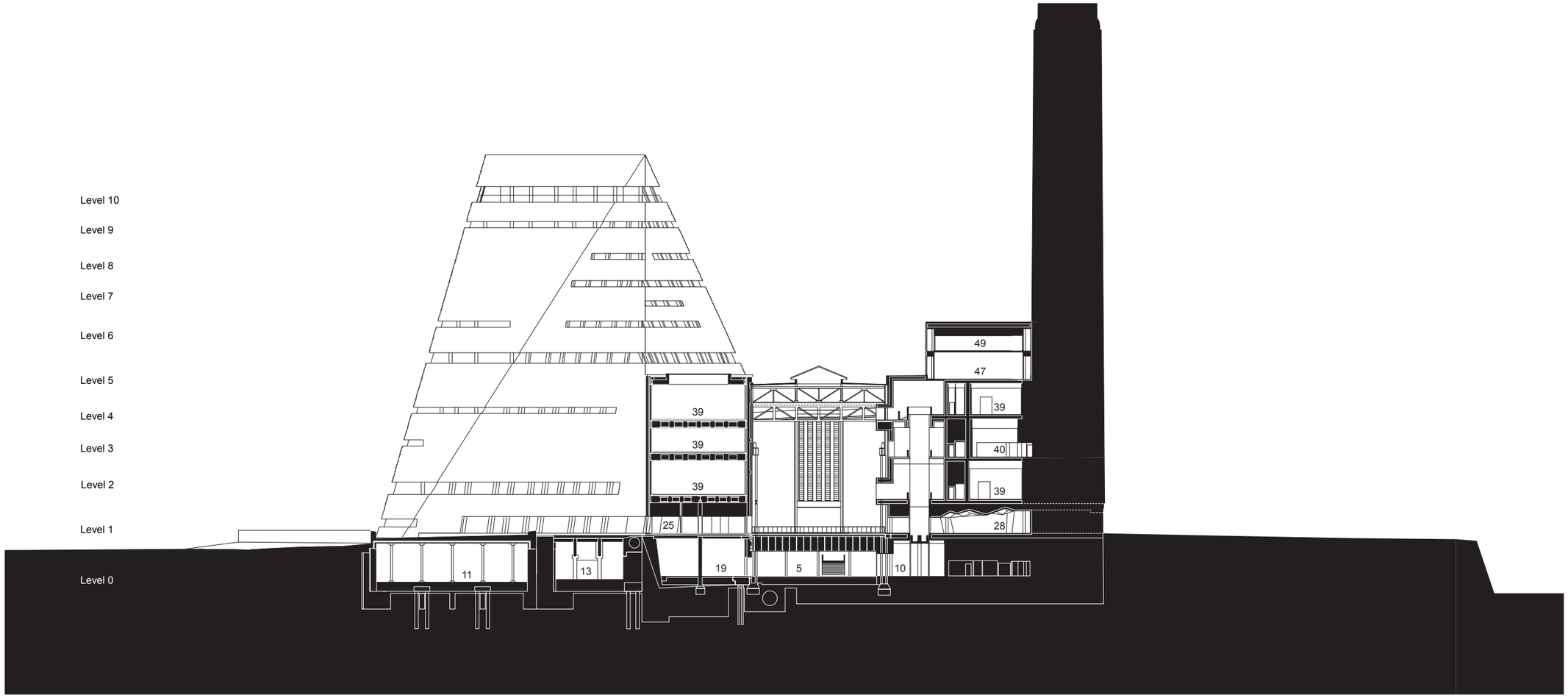
SECTION BB

scale 1:1000

0 5 10 20

The Tate Modern Project

5 Turbine Hall
10 Concourse
11 East Tank
13 The Transformer I
19 Info and Ticketing
25 Terrace Entrance
28 River Shop
36 Office
39 Collection
40 Exhibition
47 Members Room
49 Restaurant



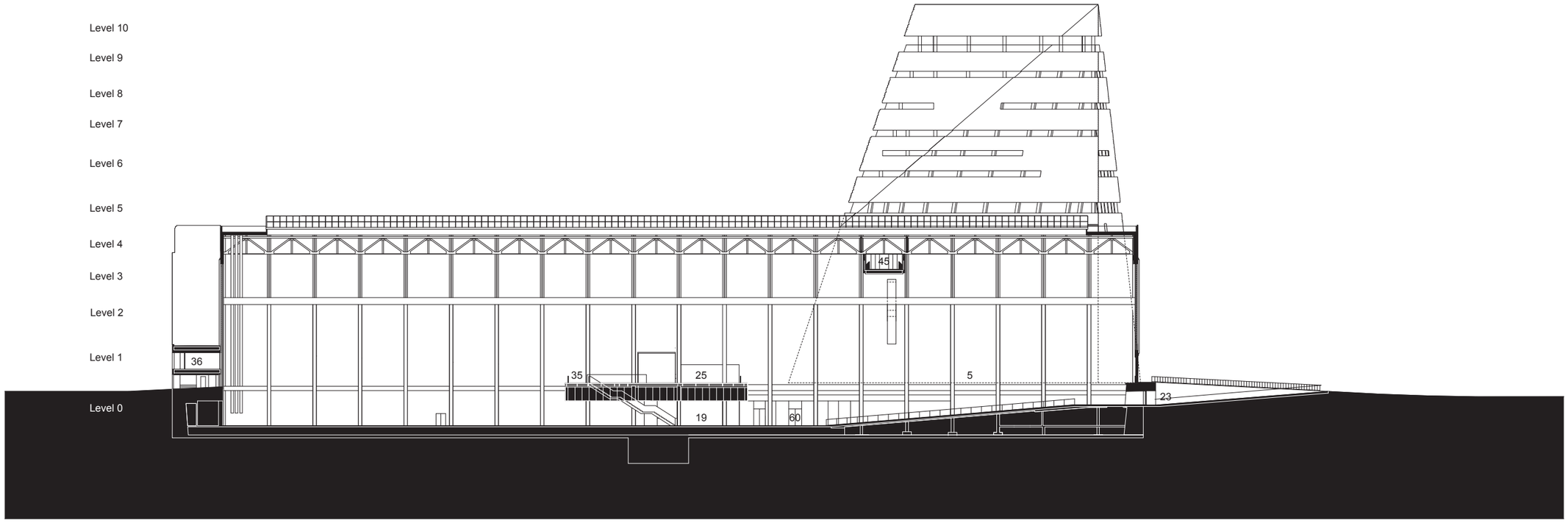
SECTION CC

scale 1:1000

0 5 10 20

The Tate Modern Project

5 Turbine Hall
19 Info / Ticketing
23 Turbine Hall Entrance
25 Terrace Entrance
35 Bridge Level 1
36 Office
45 Bridge Level 4
60 Entrance to Tanks



SECTION DD

scale 1:1000

0 5 10 20

13.
The Hidden Geometry of Architecture

From Where We Started · Final Notes

From Where We Started

In the Introduction to the dissertation, it was made clear that the present investigation focuses on the relationship between geometry and architecture in the work of HdM.

As evidenced throughout the sections of the thesis, the approach to the practice of the Swiss office aimed particularly at recognising how the Basel architects have dealt with geometry over the years, and how they consider it in both their design theory and practice, to ultimately infer what in their architecture changed from the moment they introduced digital design methods and tools into their work process.

The contemporary debate about how information technologies—now ubiquitous in architecture—have impacted architectural practice over the last thirty years, reshaping working methods and reconfiguring the traditional role of geometry in the design process, opening it up to conspicuous possibilities, was necessarily at the outset of our questioning. The digital has become the basis for architectural processes and the means through which design ideas are conceived, flow and proliferate. So, in this sense, geometry, as the language of the architect—as a structured system of communication that enables architects to express themselves rationally throughout the conception, representation and construction process of the imagined objects—has inevitably been affected by this technical and methodological shift. The increase in potency of the notation tools architects have now at their disposal for design practice and the logic underlying the digital systems, which necessarily differs from the traditional compass and ruler method, have offered a more ambitious approach to geometry and opened the door for a higher level of complexity.

However, as demonstrated in Section 2, the discussion on the contemporary phenomenon has been mainly addressed, both in practical and theoretical terms, from the often self-referential precincts of the so-called "digitally intelligent architects." In particular, the first and second digital turns that Mario Carpo theorises as having been particularly significant geometry-wise have been consolidated in the work by the group comprising those designers who rapidly adopted digital tools and embraced digital change in their practice, contributing to the emergence of a formal expression—a visuality or a style, as some authors call—that directly stems from the challenges and opportunities technology continually brings about.

HdM are not part of this digital avant-garde, nor are they featured as protagonists in the histories of those who write on the digital in architecture. The Basel architects work the other way around, and this is what, in a certain sense, makes them particularly non-consensual in the realm of digital culture. So, if, on the one hand, our decision to use them as the case study for the investigation can be said to have been somewhat risky—as we flee from what would be most expected for an approach to the topic, having instead opted to delve into a supposedly marginal instance about which very little on the subject has been published and, above all, systematised—on the other hand, this apparently odd but deliberate and conscious choice is in itself revealing of our own standpoint. This is why Section 2, after a brief state of the art appraisal on the digital in architecture—in which we circumscribed the phenomenon methodologically and gathered the names of some of the architects whose work marks the debate in the contemporary context—concludes with the question we believe to be one of the most intriguing points for those interested in the subject, “Why did we decide to focus on the work of HdM?”

The answer, which acknowledges our interest in the hidden side of the phenomenon, is endorsed by the investigation developed, as this is progressively presented in the several chapters of the dissertation.

At the outset of our research, the text by Jacques Herzog from 1988, "The Hidden Geometry of Nature", whose enigmatic title we proposed to recover both in the title of the dissertation and of this concluding section, emerged as the first, critical argument that persuaded us to take the Basel office as the case study. This seminal essay, which contains many of the premises, still valid today, for what we can consider to be HdM's design theory, was the crucial clue suggesting that a very genuine and peculiar interest in geometry was at the origin of their idea about architecture.

Along with this written evidence, which also points to the relevance that representational means play in their design process as tools that should collaborate with the architectural idea and contribute to expanding creative possibilities, the architecture by HdM, since the early years, has been marked by an experimental character arising from their fascination with the tactile quality of surfaces and the consequent interest in reinventing materials in the search for unexpected perceptual attributes. This fundamental factor, which lends their architecture an identity of its own, has led HdM to continuously work at the forefront of technology. So, before questions of computation spread into the contemporary context, HdM, because of their highly research-oriented practice, already worked in an intensely creative and constructive dialogue with the building industry, always considering geometry as the device that provided them with the compositional strategies from which forms can be produced and settled rationally.

Moreover, when we undertook the investigation, another topic came into play. The same openness with which the Swiss architects explore matter and form in design is also revealed to be present in their work methodology, within the particular wide-ranging experimentation the architects cultivate in the creative process and the inventive approach they take towards the means of representation. In addition to using all the available tools to imagine their architecture and exploring a great diversity of means and techniques to develop design ideas, HdM have always worked hand-in-hand with technological advancements, having adhered to digital design and manufacturing processes as if in a natural adaptation to the media evolution.

With the growing size and complexity of the projects, together with the transition of the office from a local to a global-scale practice, HdM, around 2005, created an internal specialised department to support all the technological needs of the design process. From that moment, information technologies were structurally introduced into the office, and digital methods and tools became instrumental, opening up the designs to increasing geometric complexity and allowing the practice to move forward in new directions. Therefore, from this perspective, the work of HdM over the years is also revealing of the steady evolution of the design tools in architecture. Founded in 1978, HdM began as a traditional office—with hand drawing as the tool par excellence of architectural practice and forms that settled on classical geometric constructions—and evolved by gradually incorporating the design and productive capabilities of the digital medium, taking advantage of these to reformulate ways of doing, explore unforeseen strategies and push forward the design. However, unlike the digital avant-garde, HdM do not regard technology as a central point of their agenda. They do not see it as an end in itself, but rather

as an inevitability of our times, as a very versatile set of tools and methods whose potential it makes sense to explore, not as a search for something else but to enhance and expand the possibilities of their form-making processes while staying true to their convictions.

These several findings—HdM's original interest in geometry, their research-oriented practice and inventive approach to the means of representation and the creation of a specialised internal department in digital technologies—were the premises we began with. These were our certainties and the convictions with which we set out the investigation. Together, they suggested that HdM could become a promising subject to study, with many relevant topics to discuss. Afterwards, the research and the writing of the various sections were conducted in order to bring to light some of the issues proposed in the following questions.

When did HdM introduce digital technologies into their work methodology, and how have they combined these advanced methods and tools with their personal way of approaching the creative process? Have the computational means affected their practice and altered their ideas about architecture? And what about geometry? How crucial is that within the work of these Swiss architects? How have they used it over the years, and how has its role been reconfigured in relation to the evolution of the working tools and the architects' ever-changing compositional strategies?

We found answers to these questions throughout the investigation and clarified them through the two complementary approaches developed in the dissertation on the work of the Basel office. In Part I, the critical analysis of HdM's oeuvre provides a chronological narrative of what happened in their design practice from 1978 until recently, focusing on the interaction between geometry, architecture and design tools. By cross-referencing very different sources and looking deeply into some specific projects, we built up a structured view of the work of HdM that subdivides into five moments that, despite having their own specificity, affirm the strong continuity of the principles that have characterised the architecture of the Swiss office over the years. By contrast, Part II delves into the design process of a single project—the extension to the Tate Modern in London (2005–2016)—disclosing how the same interrelationships take place at the scale of the architectural object within the creative process, from the formulation of the first design ideas to the construction phase.

Final Notes

Now that we are closing the dissertation and a final reflection on what the outcomes of the investigation are, or what the practice of HdM has shown us, is required, we cannot think of a better synthesis than the project for the extension to the Tate Modern itself, and in particular, one architectonic detail we see as embodying the essence of the building. In our viewpoint, the geometrically deconstructed corner of TM2 is the highest point of our research and the metaphor for much of what we got from the study of the Basel office. The unstable play of brick stones along the inclined folds of the pyramidal tower summarises the architectural lesson from HdM.

To briefly elaborate on this subject and clarify our reasoning, it is pertinent to go back to two crucial conversations[1] we had during the investigation, the first with Kai Strehlke, right at the beginning of the work, and the second with Jacques Herzog, which took place two years later, in 2021, when we had already consolidated most of the thesis considerations.

In August 2019, in one of our meetings with Kai Strehlke at the Zurich train station, we discussed projects by HdM that we could study in the dissertation in more detail. We explained to him the several characteristics we would like this building to have and stressed that, deep down, it should be itself the response to the big question posed by our work, "What changed in the architecture of HdM from the moment they introduced digital tools into their design process?"

After thinking for a brief while, Strehlke, with no doubts, immediately asserted that he knew what he would take. "I would choose Tate Modern",[2] he said.

At the time, our knowledge about this building was limited, as the in-depth investigation into the project was still to occur in the months that followed. We weren't fully aware of the innermost reasons for the project, its several overturns, nor its real meaning and pertinence within the oeuvre of HdM. However, it is precisely this fact that makes it interesting to return to this conversation. When rereading it, we now realise that the comments and reflections made then on the building already pointed to some of the most distinctive aspects of the project, informing and revealing HdM's approach to architecture and the incorporation of digital tools into their design practice. In a certain sense, this conversation comes up as a lucid look at the project that recaps its highest points.

The first of these issues is related to the choice itself, not at all obvious, of TM2.

One of the prerequisites we set for the choice of building to study in detail was that it should have resulted from a design process in which digital tools played a fundamental part in solving important geometric aspects of the construction. Against the odds, Kai Strehlke suggested a museum whose architectural character couldn't be farther from the image one would expect of a digital building. Indeed, by looking at the outer appearance of TM2, with its archaic quality deriving from the use of brick and the classical approach to the facade composition, the answer to the question formulated above should simply be, "Nothing changed!"

In the conversation with Kai Strehlke, the project for the Elbphilharmonie, Hamburg (2001–2016), was also considered. From the same years as the extension to the Tate Modern, the Philharmonic on the Kaispeicher is one of the most emblematic and eye-catching buildings by HdM, certainly more relevant than TM2 in what concerns the use of digital tools, as it is characterised by very complex geometric issues whose accomplishment greatly benefited from the support provided by advanced technological design and fabrication systems. Moreover, the project for Hamburg was also well known to Kai Strehlke, who directly guided and worked on the digital processes for the roof cladding, the facade frit-pattern and the main hall acoustic panels himself.

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1 We refer to two conversations the reader may find in the Appendix of this dissertation: Kai Strehlke in conversation with the author, "I would choose Tate Modern," Zurich, August 7, 2019, and Jacques Herzog in conversation with the author, "We are surrounded by things that exist, but we don't see them, we don't hear them, we cannot smell them...", FaceTime, Porto-Basel, May 6 and 12, Porto-Tenerife, June 3, 2021.

2 Strehlke, "I would choose."

However, according to Strehlke, Elbphilharmonie, in its exceptionality, is unique. By contrast, TM2 is a project that overtly stands in continuity with the architectural research HdM have developed over the years. As Kai Strehlke asserted, it "is a building that gives much more food to relate to, to investigate. [...] when you consider some parts of it, you can connect it to other buildings."[3]

In this regard, the former head of the DTG mentioned, as an example, the Ricola Storage Building in Laufen (1986–1987), arguing that the idea of layering that marks the composition of the facade made of fibre cement boards is also present in the London building in the horizontal rows of bricks and in how the transition from the bottom to the top of the volume was architecturally worked out. In the same way, we can also underscore the ornamental character of the facade of TM2, referring to it as a recurrent feature that one can find in some of HdM's most iconic buildings, such as the two Signal Boxes, Basel (1989–1994, 1994–1999) or the Dominus Winery, Napa Valley (1995–1998). The perforated outer skin of TM2 works as a visual facade in which the architects explored the materiality of the brick in the search for qualities capable of endowing the building with an enriching textured aspect. This is something that is specific to HdM and has distinguished their work in the context of contemporary architecture.

However, beyond these affinities, some of which we have systematised in the TM2 Architectural Reference Map, the key to reading this project in our view lies in the architects' decision—after one and a half years working on startling proposals—to clad the pyramid with brick.

This is the factor that embodied the architects' positioning towards the project, towards what they, in the end, considered to be the proper solution for the Tate Modern site, and that simultaneously posed the critical construction challenge that ended up determining the image of the building.

In addition to concealing in itself the building's intricate design process and witnessing the wide-open character of the Basel architects in the search for the right approach to the project, the option for brick is also revealing of the architects' readiness to renounce formal expressiveness and consolidate the project in an enriching dialogue with the surrounding context. Actually, the building in many of its aspects—such as the site plan alignments, the bending movement of the volume, the internal organisation of the floor plans, the composition of the facade openings, the specially designed brick, the construction system and the textured character of the outer skin—can only be fully understood within the delicate balance the architects sought to create between old and new, between what already existed in the place and had to be enhanced and the building itself, which should acquire a consistent but discrete autonomy.

Nevertheless, the architects' option of cladding a volume made of vertical and inclined planes meeting along oblique lines with a modular material raised important geometric issues. The intersection of the brickwork pattern with the twisted shape of the pyramid created several exceptions to the regular bond—the corner being the most challenging—that made the detailing of the brick skin particularly demanding.

This is when programmed methods were brought into the working process.

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3 Ibid.

Combined with a more traditional approach to design based on analogue methods, digital scripting was fundamental to the ability to control the massive amount of data coming from the existing 336,000 bricks that form the outer skin of the building. It allowed the generation of a flexible 3D model that supported the visualisation of the design experiments and facilitated the testing of solutions, informing, in this way, the decision-making process. The close dialogue that from this moment on was established between the DTG, guiding the digital parametric approach, and the architects' team, conducting the process by descriptive means, was crucial for HdM to grasp the architectural idea and make it buildable, always within a sense of optimisation and constructional rationality.

In fact, in the conversation with Kai Strehlke, this was the argument he immediately put forward for choosing TM2. "There's a relationship in [this] work between something [HdM] have purely done by hand and something they have done with the computer's support," he said. "Tate Modern 2 is very much scripted, and from a geometrical point of view it is something where they really played with the geometry. When you look at the bricks, there's a lot of investigation of how to use them."[4]

The well-balanced exchange process into which the two design methods—analogue and digital—merged is one of the most remarkable points of the project, which reveals how HdM have added digital means to their toolbox and incorporated them into their design methodology. From this perspective, the project for London is emblematic of the architects' hybrid and eclectic creative process, which combines all the techniques from primitive to technologically advanced with no preferences, and which, in the same way, clearly demonstrates how, for HdM, digital means are just tools that help them to be faster, to interact with a design team, to support the design process, and, as this instance makes particularly evident, to understand geometrical issues.

In his reflection on the singular aspects of the project for TM2, Kai Strehlke further observed that in the facade, there are "points in which the bricks intersect that look very strange." Referring to the corner, he remarked that this is not a consensual detail, "some people find it interesting, some people find it amazing, some people ugly, but it has a position".[5]

Indeed, when looking at the building, one cannot help noticing the intriguing corner and wondering why the architects laid the brick stones along the folds of the volume as if geometrically undefined.

Knowing that HdM spent more than half a year intensely testing solutions for the special brickwork conditions, moved by a great sense of geometric control, why didn't they opt for a sharp corner? Why did HdM prefer to express the opposite of perfection, which was so clearly achieved in the whole facade system, going instead for a solution that reveals formal blurring and an apparent absence of rules? Why did HdM need computational tools to define a detail that, in the end, looks like a mistake? Given that they had at their disposal the most advanced digital means capable of overcoming any limitation arising from more conventional means and that a highly specialised team was specifically supporting the design of this topic, could it be that they simply weren't able to solve this geometry problem?

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4 Ibid.

5 Kai Strehlke in conversation with the author, "The important thing is to understand why they do not do it by hand and why I should script it," Zurich, November 6, 2019.

That was not indeed the case. As shown in the dissertation, HdM intensely tested many configurations for the corner, including consideration of the sharp solution and even applying it at the anticlimbing. Thus, expressing this roughness at the folds of the volume was entirely deliberate.

Harry Gugger and Wim Walschap explained that this impreciseness, consciously decided, makes the architectural object more interesting. And Jacques Herzog, in a conference, when referring to how the two sides of the volume come together, forming a kind of porosity that reveals the construction behind it, asserted that this is a simple but important detail for how they used construction as part of the idea of the whole building.

In addition to architecturally express the incompatibility that emerged from the choice of cladding a twisted shape with brick stones, we should not forget that, construction-wise, the undefined corner was revealed to be the most reasonable solution, allowing a certain repetition and preventing each piece, at the edges of the volume, from being unique. Therefore, this detail that reverberates strangely and leaves one questioning its deepest reasons is profoundly ingrained in the logic of the discipline of architecture itself. It is something that finds its reason in the rules relating to the architectural-constructive language and to perceptive modalities, underlining the primacy of the design intent as the driver of the creative act, with design instruments that support its implementation and not the opposite.

In this detail, HdM's idea about geometry is fully synthesised. This is the expression of how the Basel architects consider the geometry and have explored it in architecture, always looking for ordering systems that, in addition to triggering the generative processes and rationalising the composition, allow them to address forms with an idea of playfulness and randomness.

In the conversation with Jacques Herzog, in which the example of TM2 came up more than once as a kind of confirmation of the reflections made, he couldn't have been clearer on this point. For Jacques Herzog, the idea of geometry in architecture is firmly embedded in the concept of nature and those inherent geometric structures—which sometimes become visible but very often remain invisible—from which natural forms emerge and come into being. This explains why, over the years, HdM sought to explore in other directions, away from too rigid, monumental and imposing forms. The form-making processes of their architecture are usually prompted by compositional strategies that aim for a certain naturalness and rule-based organicity.

And this is exactly what the corner of TM2 is about.

As Jacques Herzog remarked, the "geometry there is very complex; [and] we do not express perfection like architects in historical periods would have done, but quite the opposite: randomness, even failure! This is not because we are romantic and adore decay as an inevitable human fate, but simply because it adds something fragile, less monumental, to the whole building. Something more approachable for people."[6]

Concerning the topic of design tools and working methods, Jacques Herzog, in our conversation, has somewhat disregarded their impact in architecture. He explained that in the long process for achieving the final architectural result, these are just a crutch for him "in order to find a path which eventually leads to a piece of architecture." And even if, as he himself agreeded, in some moments of

6 Herzog, "We are surrounded."

their career these had certainly influenced the design, not least because they offered novel ways to capture the objects' architectural dimension and opened up new possibilities that allowed the Basel architects to move forward in new directions, Jacques Herzog reiterated that he has no preferences for tools, doubting whether these have ever changed "what one might call the inspiration that is often still needed to get a project started." [7]

It is, therefore, with this unpretentious sense regarding the design instruments and methods that Jacques Herzog once again referred to the extension of the Tate Modern, remarking that he "never understood the need for a computer for that facade. But the amazing thing is that every brick on the construction site was put in place as if a computer put it there, like a video game. Yet, in fact, we didn't want to achieve anything else other than a super archaic, simple and straightforward brick facade for that building." [8]

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7 Ibid.

8 Ibid.

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Acronyms and Abbreviations

AD _ Architectural Design
CCA _ Canadian Centre for Architecture
DT _ Design Technologies
DTG _ Digital Technologies Group
FAUP _ Faculty of Architecture of the University of Porto
HdM _ Herzog & de Meuron
TM1 _ “126, Tate Modern”
TM2 _ “263, The Tate Modern Project”

Appendix
Conversations with ...

C.1
Jacques Herzog

A.01
Jacques Herzog.
Founding Partner of HdM together with Pierre de Meuron.

“We are surrounded by things that exist, but we don’t see them, we don’t hear them, we cannot smell them...”

Conversation with Jacques Herzog

FaceTime video call, Porto-Basel, May 6, 2021.

FaceTime video call, Porto-Basel, May 12, 2021.

FaceTime video call, Porto-Tenerife, June 3, 2021.

Alexandra Castro (AC): In the text you wrote in 1988, "The Hidden Geometry of Nature", you opened it by explaining that: "'The Hidden Geometry of Nature' [...] is the expression of an approach, a search for perception and meaning, a search of something hidden, something that is integral to nature, that occurs in nature. A search that must fail at the moment I believe I have found my geometry."

Is this statement still valid for you today?

Jacques Herzog (JH): Well, coincidentally, I have been reading some early texts again. They are a mixture of romantic and poetic and, of course, they reflect a moment of research when a young architect tries to find a way into the world of architecture.

I was always fascinated by the natural sciences. I started studying biology and chemistry before architecture and at ETH Zürich I also took classes in crystallography. I was interested in understanding how crystals come to exist as a result of ideal conditions where they can literally express their inherent geometries. Each matter, each chemical element, has its own geometrical structure that sometimes becomes visible but very often remains invisible. Nevertheless, it exists. We are surrounded by things that exist but we don't see them, we don't hear them, we don't smell them.

We humans live in a world of which we understand just a small part. This is also a subject that painters deal with when trying to paint landscapes. The deeper they go into painting a landscape, the more they understand that they can hardly paint a stone or an apple. Think of Cézanne, for instance. Painters become desperate because the closer they come, the more naturalistic they try to be, the less they are successful and they always understand that they just scratch the surface.

Under the influence of artists, especially Joseph Beuys, we also tried to explore the potential of invisible forces on materials, such as copper, wood or stone; materials that have a long tradition in the world of architecture but were always used in a conventional way. Normally, architects use materials for aesthetic reasons or because the practice dictates how to use them. We tried to change this—to

expose the “hidden nature” of materials. There are also hidden qualities within the built world, in traces of human behaviour. In the built form, you can read social behaviours. Once it is built, architecture expresses something psychological physically: social and psychological patterns. You cannot visualise psychology, you cannot visualise people's character, but these are expressed by people's own way of living, by how they decorate themselves and how they build cities.

AC: I remember that, once, talking about the experience associated with architecture, you mentioned that it leaves a mark on us and reminds us of our own story. In a way, this reinforces the fact that architecture has a kind of an aura or spiritual quality, let’s say, from which all these elusive emotions emerge.

JH: Yes. To put it simply, many things exist, though we don't see them, we don't hear them, we don't even smell them, but they exist nevertheless. They are real and affect us all. We cannot make successful architecture if we do not try to understand such phenomena, even if they are not visible. To smell, hear, taste and touch are basic human senses—they offer a great potential for architectural design. “Time” is also invisible, but it affects us all and transforms everything.

AC: Resuming the topic of geometry, what role does geometry have for you in architecture?

JH: For architects in all centuries, geometry has been an important tool to construct something and introduce a sense of proportion and relationship between the different construction elements. We still use this tool very actively. Sometimes, you make a circle to inscribe a space so you can understand that this circle also defines the edges of another wall that is adjacent, you work with a symmetrical axis or you try to establish a grid pattern. These are simple geometrical tools that help you to orient a space, to provide a certain stability or instability. We still use geometry to draw a plan, as it is necessary with analogue tools, such as a real pencil, a pen and all those elements that are very physical.

The use of the computer today reduces the importance and significance of geometry as a tool to create order. The digital computing system can do anything. A circle? A triangle? All quite easy for the computer. Geometry has lost its importance versus algebra, versus the digit, as the history of mathematics tells us. Geometry led in the beginning, but in the course of time algebra has taken over and became more dominant. The digital era has underscored this dominance of algebra over geometry in a pronounced way.

AC: From a theoretical perspective, we may speak about geometry as a kind of device that enables architects to materialise in the architectural object a specific conceptual idea or a relationship with something in particular. Suppose we consider the Ricola warehouse in Laufen and the National Stadium in Beijing. Even though they are very different, do you think it is possible to make an analogy about how you worked with geometry in both projects?

JH: As an architect, when we were building the Ricola warehouse in Laufen, we would not have been able to imagine the complexity of the stadium in Beijing. It would have been impossible because we did not have the technical tools to visualise and construct it, but also, in our minds, we were not able to imagine such a thing. On the other hand, today, we would no longer be able to go back to create

something so modest and simple but, somehow, magic and powerful as the Ricola warehouse. I think that the time that has passed between the two architectures is more decisive than the evolution of the technical tools. Time transformed—and is constantly transforming—our minds and how we perceive things.

AC: The Ricola warehouse is a classical building that comes from hand drawing. It has a very Cartesian composition, it is symmetrical, and it recalls, somehow, an order. On the other hand, the Beijing stadium is a post-digital building with a highly complex structure, apparently with no rules. However, you departed from a clear, conceptual idea that somehow guided the design process in both. In the warehouse, you tried to accomplish the idea of the stacking shelves and you also searched for a relationship with the quarry based on the concept of layering. In the stadium, you decided to take the Chinese cord as a reference for the overall shape of the building, so a significant part of the design process was to translate it into a buildable form, trying to find a very rational and controlled system within a seemingly accidental arrangement of elements.

Hasn't geometry played an essential part in the concrete accomplishment of both conceptual ideas?

JH: I don't think that geometry was ever at their basis, but to take geometry as a tool to compare both designs is not uninteresting. I think the Ricola warehouse is conceptually so interesting because, at the time, it was totally new to do something which, as you say, has a kind of classical aspect. From a certain distance it looks almost like a Florentine palazzo of the 16th century but, when you come close, it falls apart in bits and pieces. Every piece is given the same importance: the consoles in wood, the vertical and the horizontal boards. It is just a pile of boards, actually.

The building in Beijing is more an expansion of a large form. It is more like a crystal that grows out from inside, based on a precise plan. The Beijing stadium may have suggested an association to a bird's nest for many people, but, actually, it is open to other associations as well.

AC: Frequently in your projects you explore a kind of compositional freedom that seems to aim to preserve, in a certain sense, the spontaneity of the creative gesture. This is visible in the New North Zealand Hospital, where you have this kind of flower, in the first Roche tower with the two intertwined helices or, going a little further back, in the undulating Cottbus library. But you also explore systems in which you search for an accidental or unruled appearance, such as the many stacking projects where you wanted something random or undefined.

What do you think about the relationship between geometry and compositional freedom?

JH: In classical periods, like the Renaissance or Baroque, architects not only used geometry for construction but as a kind of demonstration in praise of geometry itself—geometry as a way to demonstrate the achievement of human genius to transcend nature—even if, as I said earlier, there is a purity of inherent geometry in natural crystals that the architects never achieved at that time. However, geometry was a reason for architects to express it. Think, for instance, of "Revolution architecture" and its appraisal of the sphere.

In the project for Berggruen, we use the pure sphere that may be seen as a leftover of this thinking. I am interested in the sphere for different reasons. I think it is one of the most beautiful forms; perfect and pure. But also one of the most stupid forms; not, really, ideal to turn into architecture. It is so difficult to hold in place and to create access into it. It always needs a socle or something equivalent. For Berggruen, we propose a new interpretation; not a socle, but a large frame that holds back the sphere from rolling down the hill. It therefore involves, also, some randomness and playfulness. Like the stacked cubes balancing above each other in the Leonard Street tower in New York.

AC: I think that a very interesting example is the corner of the Tate Modern extension, which was one of the most challenging geometric details of the whole design process. You had the regular grid coming from the brickwork that, when combined with the twisting shape of the pyramid, made it difficult to have a sharp and perfect corner. So, you opted to express this incompatibility in the facade, and, as Wim Walschap mentioned, you searched for a bent solution where the corners would be irregular. And it is particularly interesting to notice that the detail in which you wanted an imperfect or undefined appearance was where you spent more time working on geometry. You had to define the rule, and I know that you spent more than half a year searching for the right solution.

JH: Exactly. That is a good point. Geometry there is very complex; we do not express perfection like architects in historical periods would have done, but quite the opposite: randomness, even failure! This is not because we are romantic and adore decay as an inevitable human fate, but simply because it adds something fragile, less monumental, to the whole building. Something more approachable for people.

AC: In "The Hidden Geometry of Nature", you mentioned that: "the relationship to preexisting architecture and building form is unavoidable and important [because] architecture has never arisen out of nothing." And you added that architecture should be built in pictorial analogies, having as reference the preexisting reality made of all the images that one carries of the city, building forms and building materials.

Does this mean that, for you, architecture is the result of an appropriation process?

JH: There is so much architecture around us, so much world and knowledge around us, that we cannot say we are totally innocent and nor is our mind ever a blank sheet of paper. So, obviously, we are somehow influenced by something.

If you, for instance, are now designing the project for a house and you build it within a year, the project will be different to if you had been asked exactly the same thing five or ten years earlier. You have changed, the world around you has changed, and the information available around you has changed. Architecture is strongly linked to the existing world, and it is good to be aware of that; [an] awareness of all the images that we carry with us. I like architecture that reflects the origins of that artistic consciousness. Architecture is the creation of something new, but consciously based on preexisting architectures, preexisting stories and images.

When I wrote the text you mention, I was very much inspired by images. Almost obsessed, I would say. That was like an interior film. I was a young architect and had not built much yet, so I was very interested in pushing forward that inner film as something different from what the previous generation had in mind. Architecture is a generational discipline, in the sense that a new generation carries different images from the previous one. So, in the early years of my career, this also worked as a kind of a fight against what had been done before. I wanted to get rid of the images that were confirming the existing design world. My text is the expression of a kind of iconoclastic or anti-iconic impulse that I tried to send out into the world of architecture of that time.

AC: I mentioned this quote because, when looking at your buildings, we may find many references to other things that come from the surrounding context or that you somehow found on the site. Once you stated that "you do not have the desire to set up new establishments, but on the contrary, you want to pursue existing perceptions in order to complete the city". Is it this wish to search for relationships with the context or, at least, trying to find the right architecture for each place, that explains the constant heterogeneity of your buildings?

JH: Obviously, every place is different, and time changes, so our architecture shows this whole latitude of differences. In our latest project in Basel, the Stadtcasino, we decided to use the preexisting architectural language, which was the more classical language of the 19th century. The preexisting building has a strong identity, and we wanted to enhance that. That is why we conceived the addition (large foyer spaces which double the total volume) in the same language. A perfect simulation but carved in wood and not in stone. It would have been stupid to apply a modernistic language in that historical city context.

AC: Even though this relationship with the context in your architecture is hardly very direct and is sometimes even established by opposition, there is always the desire to find the right architecture for each place, an architecture that sits well on the site.

For instance, in Tate Modern 2, after trying out some versions of the building that were kind of forced for the place, you realised that you had to dialogue with Gilbert Scott. So, in the end, you opted for a building that fitted the site and made sense for Tate Modern as a whole.

JH: Yes, it was the right decision to conceive Tate Modern 1 and 2 as one whole museum complex. One architectural whole that could also express its materiality: brick. The brickwork is different from the former power station but actually in a dialogue with the architecture of Gilbert Scott, which also makes it look very different from the buildings in glass and steel surrounding the Tate like an ocean of ubiquitous towers.

AC: Is it important for you, when you have a commission, to visit the site, go around, get to know the city, the people, the culture, and the architecture?

JH: Yes, everybody knows that this is important. But I am not a fanatic who would pretend that I need to sleep on the site or be there half a year in order to find inspiration and familiarity with a site. Genius Loci is nonsense, I think. But it is good to visit the site for real: to be exposed to the climate, to

understand how the sun moves, to walk around and to watch people on the street. Especially for public projects, it is key to understand how people use public space.

AC: In an interview once you referred to Andy Warhol, describing him as an artist who transcended categories and used his work to say something new. And you explained that this is exactly what you are interested in: to use well-known forms and well-known materials in a new way so that they become alive again. You added that you "would love to do [...] architecture which looks familiar, which does not urge you to look at it, which is quite normal, but at the same time, it has another dimension, a dimension of the new, of something unexpected, something questioning, even disturbing." Can we say that this particular way of looking at form and matter and exploring both in architecture is one of the constant interests of your design practice?

JH: Probably, yes. Things tend to become invisible and uninteresting over time. A door handle, a material surface, the shape of a window. This all seems so evident, the same appearance, over and over again. Kind of a bore. But sometimes it just needs a small shift in shape or colour, or how a material is presented, to inspire some fresh aura, a new look at things. This can also happen with people you live close to—your wife, your husband or even the friends you have known forever. You don't see them any more. So, sometimes, you have to reinvent how to look at a person so you become aware of how much you like or dislike her. All that is rather based on your own perception than on factual truth. In other words, we can change our point of view, our perspective. This can be very inspiring and healthy!

AC: In what concerns the geometric complexity of the projects, we may see a general overview of your work as like a steep curve that grew over time, having had its apex around 2008, with the Elbphilharmonie as the most emblematic project. In recent years, it seems that geometric complexity is decreasing, and compositional strategies are being directed towards a new simplicity, visible in projects such as the Triangle, Vancouver Art Gallery, or the Berggruen Institute. What is driving this return to a new simplicity?

JH: Maybe our most recent architecture is again more rigid and based on symmetry and pure geometries, but it could change again at any moment. We have had moments like the Jinhua architecture park, where we developed an algorithm that produced countless different 3D constellations, from which we could pick those we found appealing and appropriate. Just like when you watch cloud formations in the sky. A design strategy quite far from control and authority. I am always interested in how we can produce form. But I have no preferences for this or that method, approach, style or taste.

AC: In "The Hidden Geometry of Nature" you also wrote about "Presentation", where you criticised neutral white models and naturalistic perspective drawings, explaining that "thinking about the presentation of an architecture is identical to thinking about the architecture itself." Is this idea about the representation of architecture still valid for you today?

JH: Representing, describing, simulating architecture outside its built reality remains a challenge but also an intense topic I constantly learn from. Each time we plan an exhibition, we are somehow in a deep crisis because it is such a challenge. Architecture is what is out there. Exhibiting it is mostly boring. Of course, in the last 20–30 years things have changed. You can now do simulations with the computer that you could not do when I wrote this text. At the time, the tools you had as an architect were the white models that were very deceiving because they provided just a very neutral idea of the project, and then you had these perspective drawings which were like a discipline on their own. So, from very early on, we have developed many different ideas using, for instance, video. Maybe our most interesting and sophisticated example of analysing and exposing representation is the "Lego House", where we used existing Lego bricks from our childhood. In an accompanying text I describe the fragments of real and imagined worlds coming together with this Lego project.

AC: What about your E, D, E, N pavilion?

JH: The physical model on the table looked just like a conventional model of an architectural project but its projection on the wall revealed the word E, D, E, N, produced by the shadows of the four columns.

AC: What about your first Venice Biennale exhibition at the Swiss Pavilion in 1991?

JH: Architecture is so complex. It is physical, three-dimensional and so large that you cannot actually exhibit it. You can only exhibit aspects of it or become aware of that fragmented reality with which you also deal. That remains, I think, a very important moment of our thinking. When we were asked to present our work at the Venice Biennale in the Swiss Pavilion we did not want to present our own viewpoint of the work, but, rather, we wanted to exhibit the viewpoint of other people. We invited photographers to look, in their own specific way, at our work. A building photographed by different authors produces totally different ideas and viewpoints of the same building.

AC: From your comments in this text, but also in two more conversations you had with Theodora Vischer in 1988 and 1993 about this same subject, the idea emerges that, for you, the means of representation are technical instruments that serve to translate an abstract idea into the rational world of shapes, but they should also be explored as tools of expression to investigate the individual character of a project and communicate a particular insight into it.

In my opinion, this is what explains one of the most particular features of your working methodology: the fact that you are always searching for—or including in your design process—alternative modes of representation and exploring them in accordance with your very personal way of looking at architecture. Do you agree with this?

JH: Yes, I can see that. New tools, such as VR and AR, are again opening up new paths that we are about to explore quite a bit. These are, again, just tools, instruments, but they help us understand what we want to achieve with a specific project, what we actually want to achieve with a piece of architecture.

AC: In what concerns this very personal way of using the design tools, two examples come to my mind. The first one has to do with physical models and how you intensely explore them, almost as if you were trying to exhaust all the formal possibilities of a project. Once, you mentioned that you often try out stupid things because you never know where it will go, and sometimes it leads to unexpected results.

JH: That's true. I think that sometimes you discover something perchance; coincidence can be a strong actor. That's why I do not like the teams to always come up with finished models. They should make them more unimportant and just do a few volumetric studies that we can tear apart and reassemble. When you are developing a project, it is important to keep it open; you should not restrict it. It should be free to evolve so that it can grow and it can navigate your own thinking in different directions.

In this we can also learn from children. It's better to not always teach a child to do exactly what you already know and what you believe should be done. Otherwise, you don't give it a chance to evolve in an unexpected way. Isn't that the goal: revealing unexpected truths?

AC: The other aspect that intrigues me has to do with the pixellation process that you explored with particular focus in the late 1990s in projects such as the De Young Museum, TEA or Puerto de Santa Cruz. Can we say that this technique has suggested to you a specific compositional strategy in architecture?

Once, you talked about this as a "language [that allowed you] to speak with great freedom." And you added that "Just as a painter discovers a language, and then the work explodes on the basis of a vocabulary, so this is what happened to us with this geometrical system of extruded pixel structures."

JH: For Tenerife we wanted to create a whole new urban landscape, not just a collection of individual buildings. That is when the idea came up to underlay a raster of pixels as if the whole site were a large photo. That photo could have been a picture of anything—we were not interested in the subject that was represented but just in the fact that it was creating a raster image that we could extrude vertically in order to create a three-dimensional landscape. This fictional landscape then could be manipulated, carved out, cut, sliced, etc., according to the programmatic and functional needs for the building it should become. Each building was different—cruise terminal, shopping mall, cinema, hotel, marina club—but all of them related through their underlying pixel raster.

The design process was quite new and interesting. I did not feel under the pressure of an author bound to create form but rather like a DJ arranging form. I think artists like Gerhard Richter chose similar photographic methods which allowed them to paint without the need to invent motifs and form.

AC: Over the years, you have always combined, in your working methodology, a great variety of tools and means to support the development of the design.

What is the value in not limiting the design process to a couple of tools but, rather, to develop it using an eclectic method that combines many different techniques?

JH: The variation and multiplication of working methods is just a crutch for me in order to find a path which eventually leads to a piece of architecture. I always rejected “style” and tried to minimise personal traces. This seems like a good way to find specific solutions for the many different places and programs architects have to work on. But I am quite aware that it is not the only way an architect can choose. Often architects are known for their personal style—think of Mies or Gehry or Zaha Hadid—who have realised great works of architecture in places very different from each other. Obviously, there is not just one recipe for good work, but quite a few.

AC: But I suppose that working with so many different design tools at the same time, like plans, physical models, virtual models, images, sketches, renders, or composite images, is what allows you to have different insights into the project. Each tool shows you a different perspective on the architectural object.

What is, for you, the advantage of working simultaneously with analogue and digital processes?

JH: I like speedy design processes. I often take whatever is around—paper, pencil, mobile phone, leftover magazines or newspapers, wood, matches, collages—so I can get an impression of how good first ideas are when being assembled. Once I get the feeling it is right, the team can take it further and develop more sophisticated forms of representation.

AC: Once you said in an interview that the models are testimony to an archaic understanding of body and reality, to which you opposed virtual images, explaining that as soon as the architecture is restricted to visual experience it is dead.

Is the analogue what provides you with a sensual and tactile approach to architecture?

JH: I don’t care what the tools are. The tools don’t have to be sensual and tactile, but eventually the resulting piece of architecture does. As I said, I like to go forward very fast. With impatience. If the sketches and models which are being produced go that way in the design process, well then, this is much better!

AC: We mentioned before the fact that, over the years, we may find in your architecture clear moments in which you were investigating different compositional strategies. At the same time, from 1978 to recent years, technologies dramatically changed and the office, in a way, has followed this evolution by gradually integrating them in the design practice.

Do you think that, at some given moment in your career, means of representation may have influenced your architecture by making you look at it in a particular way, or simply by opening up new possibilities and therefore allowing you to move forward in new directions?

JH: For sure. We can now use VR and walk around in our buildings before they are built. As you walk around there with your headset you discover more things than ever before. That clearly helps you to discover things that you normally wouldn't have seen. It is a new tool and a very efficient one. But I doubt whether it has changed what one might call the inspiration that is often still needed to get a project started.

AC: Maybe it interferes with how we address the design process and manage to master, through representation, the architectonic object as a whole. I think that the shift between 2D and 3D is a clear example of this.

In the eighties, when talking about the relationship between the parts and the whole as a quality you consider fundamental to architecture, you gave the example of the Stone House in Tavole and mentioned that this unity could be achieved if the plan form and the cross-section were expressed as geometrically equivalent. This particular way of talking about architecture, in my opinion, is deeply bonded to hand drawing and the period in which the means of representation, mainly based on 2D projections, somehow limited the design process to a bi-dimensional approach. In contrast, around 2004, when thinking about the Jinhua structure and other projects of this same period, such as the Vitra Haus and Actelion, I think that these could hardly have been imagined without the three-dimensional approach to the shape provided by the computer and, in particular, virtual modelling.

Do you think that this shift from 2D to 3D has somehow changed how you addressed form-making?

JH: You mentioned the right projects. Jinhua was an exercise purely based on computer modelling. There, we again created a geometrical pattern, an algorithm, actually, and we let it walk; we let it fly like clouds, as I told you. Then we said: "Stop! I like this image." Or "Stop! I like this one." It was a somewhat random way of form-making, and it goes back to what we have been discussing before. But I think it is the only project with such a strong degree of dependence on the computer.

In the Tavole House, the very strong similarities between the section and plan come from a fascination I had. It solved, literally, something I admire in archaic architecture, for instance in cathedrals, where you see that one material dominates everything and the outside reflects the inside, and vice versa. Many of our projects have this strong relationship between structure, space and facade, where all these three fundamental architectural categories blur into one single whole. This concept is not bound to a specific methodological approach.

AC: When looking at the evolution of the office, we may talk of a stage when the "Digital Technology Group" was established, around 2005, and the computer started to be used as a computational tool. In this period, scripting and parametric design allowed you to handle the high level of geometric complexity that characterised, at the time, many of your projects, such as Ciudad del Flamenco, Elbphilharmonie, or the first Roche Tower.

Were these digital technologies fundamental for you to move forward with your research interests? Would it have been possible to develop the ornamental pattern of Ciudad del Flamenco, as you had in mind, or even to build the Tate Modern brick facade, without the scripting?

JH: For all these projects we definitively needed the DT tools established in our firm. It is obvious for Ciudad del Flamenco, though Tate Modern is special. I never understood the need for a computer for that facade. But the amazing thing is that every brick on the construction site was put in place as if a

computer put it there, like a video game. Yet, in fact, we didn't want to achieve anything else other than a super archaic, simple and straightforward brick facade for that building.

AC: This is exactly what I find so fascinating about this building. It has a very traditional appearance, it is made of bricks, and, still, it has a lot of technology behind it that was crucial for making it buildable.

JH: I think that's a very good way to end the conversation: with a paradox. We still like straightforward architecture, which appeals to all our human senses.

END

C.2
Kai Strehlke

A.02
Kai Strehlke.
Head of the Digital Technologies Group at HdM from 2005 to 2015.

"I see it as a little bit like an orchestra."

Conversation with Kai Strehlke

Zurich HB train station, Zurich, April 16, 2019.

Alexandra Castro (AC): Maybe we should start from the beginning.

You joined the office of Herzog & de Meuron in 2005. What did you do before? What is your background?

Kai Strehlke (KS): *I studied architecture, and when I finished I worked for an architect in southern Germany for two years, but I got very fed up with the quality of the architects' work in Germany.*

In Switzerland, you always work in a team. Everybody—the client, the architect, the constructor—all these people work together. In Germany, it is more like a war zone. When you do the bidding, the companies present very low prices because they know, as things have not been really decided, that later on they will get the money back. So it's not about working together, it's more about working against each other.

AC: Even between architects and engineers?

KS: *Very much between architects and engineers. You always have the bidding phase, in which you have several companies giving a price, and if you are doing public commissions you have to give it, very often, to the lowest price. Later on, there are mistakes, changes, adaptations, and the companies, with this, make a lot of money. This situation also creates a lot of distrust between the architect, the companies, and the client who got the price and has to pay more. All this makes life very uncomfortable.*

So, then I decided to go back to the ETH in Zurich. I did post-graduate studies in digital architecture, which, at that time, was very CAD-based. It was based on virtual architecture, on creating platforms and exchanging design ideas. It was not so much based on tools to create digital architecture, as we think about it today.

Afterwards, when I finished these post-graduate studies, I worked for six years at the ETH as an assistant, where I got to know CNC fabrication, the Prefix, which was a milling machine bought by Greg Lynn. When he left for Austria, he left the machine at the ETH, and, together with a colleague, I was

setting courses for the machine and doing lectures on digital fabrication. This was when I got fascinated by the connection between scripting, doing parametric design and realising it on the machine. During these six years at ETH I did a lot of different kinds of projects, and afterwards I went to HdM.

At HdM, my first task was to create an ornamental pattern which was also a functional pattern for the building Ciudad del Flamenco, in Jerez de la Frontera. I started with this project, and afterwards I was always put into groups which could not solve their problems with the standard technics of drawing. So I started to become a kind of "ping pong" player. There was the office, who were working on architecture, thinking architecture, and me, coming from the scripting side, trying to create a tool to enhance, to push the teams to realise what they wanted to do.

AC: How did you start working in the office? Were they looking for someone with specific skills to work in the project for Ciudad del Flamenco?

KS: Yes. HdM had won the competition for the project Ciudad del Flamenco in which they wanted to use an ornamental pattern. Jacques Herzog had two ideas. He is always using these kinds of artifacts he finds in the place, in the region, in the culture, whatever. At that time Jacques was interested in Arabic calligraphy, on the one hand, and on street tags. For him, street tags were a kind of modern way of using calligraphy. He thought that it would be a good starting point to search for a formalism which could result in spaces, the facade, or a shading system between the inside and the outside. In that period, the team was working by hand. They were working with Photoshop and drawing everything by hand.

AC: Before you came in, were they working only manually?

KS: Yes. But HdM wanted this pattern for the facade to be much more adaptive, much more related to the architecture they had. They were not happy with the results coming from the teams, so they asked me to do a script for this facade, and this was the very first job I did there.

AC: So they asked you to come to the office to develop a script.

KS: No, they asked me to solve this problem. They didn't care about scripting, and they didn't care about whatever. They could not resolve it with the manpower they had until then, and they asked me to solve it with whatever approach I would use. They would have also been happy if I had done it with another tool.

AC: As long as the problem was solved.

KS: Yes. Have you seen my PhD?

AC: Yes, I've translated the part about Ciudad del Flamenco into Portuguese.

KS: This project was the very first one. What happened then was that I did not get the idea. I did the script for it and started to play a kind of "ping pong" game. I began to understand what a tag is. Then I created the very first tag, and afterwards I showed them what came out. Christine Binswanger was the partner in charge, and she reacted to it. She liked some of the stuff I did, disliked some other

stuff, and then it was a kind of "ping pong" game, between me doing something and she reacting to it. Also, Jacques Herzog and Pierre de Meuron were interacting in this process. It turned out that, in the end, they were quite happy with the result at that time! I think that now they would look at it differently.

You have to understand that an office has its own path. There's always a moment in which they open to new directions, and that was really a direction. HdM were very interested in using these digital tools and finding forms with them, and they were also very interested in patterns and ornamentation, which they abandoned later on.

AC: I have a diagram with some of the projects from the office and, around 2005, we can see this interest they had for the use of patterns in other projects also.

KS: Yes, exactly. You have the Walker Art Centre Museum.

AC: The De Young Museum also. But before you came in, they already had some projects with a kind of complexity, like Elbphilharmonie or Beijing Stadium.

KS: Yes, of course, but Elbphilharmonie was different, because in 2005 it was in a very early stage. I worked on the frit pattern of the facade, and my team—not me, but Benjamin Koren—he worked on the acoustic system on the inside, but much later, maybe in 2006 to 2007, when we built the 1:10 scale model of the concert hall.

All of these patterns that we had on the surface of the hall, I think they still did not exist at that moment. HdM knew that they would work with Yasuhisa Toyota. They had to break the surfaces to improve the acoustic situation, so they thought about this pattern. The scripted pattern and the Voronoi system used inside were basically taken up by the team, which was guided later by Benjamin Koren.

So, I would say that around 2005, 2006 and 2007 they were very much interested in this kind of ornament. And they were searching for what happens inside an ornament, like the Jinhua structures. This is a project where they were exploring what kind of architectural qualities can be discovered from an ornament, how spaces can be created from an ornament. There's also another wooden structure built for the Beyeler Foundation in Basel. I think all these projects are pointing to a particular moment in the whole path of HdM.

AC: So is this all connected with scripting?

KS: No. For example, in Tate Modern, it is not connected with scripting. The scripting came later. I scripted on the facade of Tate Plus, and I translated what they wanted for the facade with the script.

I worked in quite a lot of different projects at different stages, but as you said at the beginning, the script was never pushing the architecture, it was always the architecture. I consider Jacques and Pierre to be like eagles, having a kind of meta view on the project. They know what they want, and, with them, the partners. Afterwards, it's all about how they do it, what kind of teams they play, what kind of manpower they put onto this idea, and then it starts a sort of "ping pong".

They would never hype any kind of technology for the sake of the technology. Jacques and Pierre are extremely wise and intelligent, they always try to take all the advantages they can from all of the

different people, from the team, the technology or whatever, and they try, from all of these, to get the maximum.

AC: I've got these two diagrams which I suppose were made by you.

KS: Yes, both of them are mine. This is a more difficult subject. There is a big, big push nowadays on BIM, and I'm extremely critical about BIM. There's always this argumentation that you have hand drawings, and then you jump into the CAD drawings which are only a translation of what used to be done by hand. Everybody is saying that the same thing is happening now. CAD is over, and now it's BIM. For me, this is too short-sighted, and it is not the reality. I see things as much more complicated. When you look at this diagram, we even have hand drawings much later in the office.

We have done a building in wood, and an architect drew a plan by hand at the scale of 1:1. At 1:1, you have the thickness of the wood, and while you draw it, you understand the forces, you understand if this piece of wood is too thin or too thick, if it becomes clumsy or if it becomes elegant. Before, with hand drawing, we worked in scales, and with time you got used to what a scale is. As an architect, you could jump between scales. It was a mindset which allowed you to do a certain kind of architecture.

When you do the CAD drawing, you can erase everything, and you can copy things, work with blocks. You have the technology to be much faster on the drawing, but, at the same time, you have lost something. You lost the sense of scale, because you are always zooming in and zooming out. You see it when you ask people to make a drawing at the scale 1:500. Nowadays, very often, students don't understand that at 1:500 it's a different abstraction, a different logic in what you want to say about the urban situation or the building. They just take the same drawing and scale it down, and this is not why you have different drawing scales in architecture. So, with this kind of CAD drawing we gain a lot, but we also lose something, which I think we should not forget. When we teach, we should be aware of these things.

BIM is extremely pushed by industry nowadays. With parametrics, I see that you get the geometrical sense of what the design should be. When you do a script, you try to use the idea which is in the architecture, and you translate it into a code, however, the driving motto is always architecture, is what you want to realise in the end.

AC: And you think in architecture using a geometric approach.

KS: Yes, yes, and BIM is different. The mindset we have is like a legal system. With BIM, you don't think very freely in an architectural way. You think very early in building elements and how they plug into each other. When I was working at HdM and we had to decide if we should do a building with BIM, I always wondered whether the model could be done using LEGO. If LEGO would have been a good system, like it would have been in some of these buildings, then BIM could be a good way to start quite early. But even then, I always preferred to have a very free approach in the beginning. We had projects which were squares, circles, triangles. You have huge changes inside the projects, and I think you are much faster with a hand sketch, a small poem you write, a clay model, or whatever. You have an idea, and you just try to catch the idea; this is what you try at the beginning of the design. I find it very confusing if you start with a very big model where you already have a database. So there are certainly

reasons to use BIM, whatever you call BIM, because BIM is just Building Information Model, and there are millions of definitions behind, or understandings of what BIM is afterwards. But for me, I see hand drawings, then CAD drawings, parametric design and BIM, and for me, they are different kinds of mindsets. I don't think this is only an evolution in one direction, but sometimes a particular technology is absolutely valid, even nowadays.

AC: So, you're saying that some things from hand drawing, for instance, can also reappear nowadays because they are needed and still make sense.

KS: This diagram was an internal presentation I did when I was in charge of the CAD drawings in the office. For example, I think that for the CAD drawings to build Prada Tokyo there were less than 100 plans. I guess that for Elbphilharmonie there were 5000 to 10,000. Each toilet, each door, each element was one plan, and we had thousands and thousands of them. So it became extremely difficult to organise the plans and to be sure that we hadn't made any mistakes in any of these thousands of plans. So I started arguing about whether this is what we really need. Do we need so many drawings to define architecture? When we look back at hand drawings, we could not draw 1000 plans. We had plans which were capturing the main idea, and more details were drawn on the plan with annotations.

AC: But we are also talking about a different size of project and with a higher complexity.

KS: Not always, Prada Tokyo is quite a complex project. These projects are bigger, but you have others which are also complex but with a small number of plans, and nowadays all the projects are going into thousands of plans.

AC: So you are saying that when we worked by hand, we were more synthetic.

KS: Yes!

AC: Because we knew that it takes time to make a drawing, and with CAD it is just copy-paste.

KS: Copy-paste, change a little bit. If you have a bathroom, and another one which is exactly the same, but in one of them there's the window which is a little wider, you copy the whole bathroom, and you have two floorplans and two interior elevations of the plan. You have an attitude to drawings, and this is something I was very much criticising.

I did an exhibition inside the office where I wanted to show how we had changed our way of drawing in the office from very old projects to very new projects, and how the scripting and all these things also changed the quality of drawings. In a big shed, we had this exhibition where you had the drawings of different periods and different phases of the work—initial designs, sketches, but also drawings for construction. You had a kind of metrics in which you had an evolution within the time and the project. I just hung these things, and I did a few of these graphs to say how many drawings, how many projects we had, what kind of types, and there were a few of these diagrams.

This was one of them. This diagram was also to show that the transition from hand drawings to CAD went quite fast. From a method point of view, first, it was only replacing the hand drawing with the CAD drawing. With scripting and BIM, we took much more time.

AC: Scripting and BIM appear and disappear, maybe because they are not always required.

KS: Scripting, yes, but BIM not quite.

The architecture pushes the scripting, so it depends on the projects if it makes sense to do scripting and what to script. Scripting is only pushed by architecture. BIM is pushed much more by the technology which is behind it, by the market and by the client. So why we choose different kinds of technologies depends also on who the driving force is that is behind it.

I am much more critical with BIM. For example, you have a project where you have a very small footpath, and from this footpath you create a smooth transition to a wall out of it, and then the wall starts to turn into a roof until eventually you get a very big covered space. If you would do this in a "normal" way you would take a piece of paper and you would glue it and lift it. It doesn't look pleasant, but it is a sketch, and it totally translates the idea. If you do this in Rhino 3D, you could work with a single surface which is lofted.

If you were to do it with BIM, what is your building element? Where is your floor, where is the transition? How does it work? You don't want to decide all these things at the beginning of the design. You only want to grasp the idea first, do your findings inside the idea and then make this idea sharp. If you start too early with this kind of definition, you do not support the idea. You kill the creativeness. This is why I'm quite sceptical about BIM.

My biggest luck was that I worked in an office which is driven by architecture and is doing this "ping-pong". That was my biggest luck—of having people who did not neglect the scripting but who were clearly interested in the architecture, and only in the architecture. Many other offices in the world are hyping technology and only thinking in one kind of way, and for them there's nothing else but this technology. Some of these offices were like star offices in 2000, and they do not exist any more. It was like a bubble that exploded.

AC: You joined the office in 2005, and then you set up the "Digital Technologies" group, right?

KS: They pushed me to set up the DT group. My greatest pleasure was to script, to be in the teams and to play this "ping-pong". This was one great pleasure that I had. Another one was working together with the workshop guys, and bringing these two worlds together, the analogue models, analogue design and digital models with the CNC machines.

So my greatest pleasure in the office was when I could work on the scripting on one side and the workshop on the other side.

I was asked to guide this DT group, and this implied having to conduct all the CAD management, to oversee the image-makers and to guide the scripting team, the digital workshop and the BIM team. I was trying to script myself and, at the same time, guiding the digital workshop. I was milling and creating models, but also conducting the people to work with this workshop. For CAD, we had

someone working on it, and I tried to put some logic inside, and some quietness. Also, with this kind of exhibition, it was a subtle way to ask people to create less unobligated data.

The image-makers were a very, very strong group. I was not doing any images myself, but it was more human resources. I was getting people and placing them, and trying to support them in a way so that the quality of their work was always at a top level. In an office like this, you have the tendency that every working model, every working sketch, becomes like a final submission sketch. Every team inside the office wishes to make, already, on the first sketch, a fantastic rendering. And this is something you have to fight against. I was trying to have the teams working only on important images. I was also trying to work with external companies that did professional images, to have these renderings always on a very high level, but, in a way, so that not everything became a super important image.

The BIM department was the team with which I had more problems. I had to decide when we should take BIM, how deep we should go. Some people knew how to use it and always wanted to solve everything in BIM. I tried to understand when it worked, but I didn't touch it myself; I never worked with REVIT, I never worked with these tools, it was more about managing these tools from the outside.

So, image-makers, CAD and BIM was more about managing, while scripting and the digital workshop, I did work on them.

AC: The main fields of the DT group were parametric design and scripting.

KS: My favourite.

AC: Digital fabrication and digital workshop.

KS: My second favourite.

AC: CAD management and geometric support, then visualisation and video and finally BIM.

KS: Here, we should make two differences. One is CAD management, which was AutoCad. We had one guy who was inside and outside Autocad.

Geometric support for me was different. For example, we had one project, which I think was the Blavatnik School, where Jacques Herzog came in with four points, saying that these were very important for one of the shapes. So the team took these four points, did a NURBS curve with them, and asked me for scripting. I said these four points were nearly a circle, and it didn't make sense to do this NURBS curve. So I suggested they just take three of these points to have a perfect circle, and then we would see how much we were out of the four points. It was like 30 cm. It was nothing! So I said, "We make a circle, and we just push the four points into the circle." At that time, the team said, "No, no. Jacques said the four points could not be touched! We have to make a shape out of it." And I said, "This is nonsense because if we make this, every single window will become unique, but the difference between them will be nothing. Nobody will understand this. By just using these four points, you will make the building a few million more expensive, and this does not make sense." This is what I considered “geometric support”— to make people aware of what kinds of simple geometric rules could be applied, in what situations, to create something easier, simpler.

AC: Now, when people use Rhino they get in contact with complex geometries, and most of the time they don't understand them, they do not control them, and they are not aware of what they are doing.

KS: Yes, exactly. This is what I said very often when we had these design problems. I always tried to understand what the kind of ruleset is which could drive the design, which I could use in scripting and which could also be used in construction.

Another situation happened with the Sud Park building, which is not very esteemed in the office, but I like it a lot. I worked on the scripting of this project. This was first done and scripted by the ETH. They did a script where you pushed on a button and then the whole facade was generated. You pushed again, and the entire facade was generated again, again, and again, and everything changed. HdM wanted to have this randomness, but, at the same time, they wanted to have control. So, when HdM stopped working with ETH, I took over the script, and I said, "Let's take out what has been scripted by ETH, interesting shapes. Let's try to build one and to understand what it means as a window. What is the frame, how much glass do we have?" Because we had some of these windows in which the glass became like one millimetre, and the frame around was complete nonsense!

AC: They did a script without thinking about the architectural result.

KS: Yes. So I suggested, "Okay, let's take one of these openings. Let's understand it as a module, as something we could use." The constructor also explained that if we started to repeat some elements it would become cheaper, so HdM decided to work with a set of so many modules. At the same time, the design team came and said, "We don't want this to be just driven by a facade study. We want this to react on each floor, on each room that is inside." And this makes sense because it is not an artificial facade, but a facade driven by what happens behind. There was a difficult communication happening between the ETH, who saw this more like a purely geometric problem, and the team that could not work with what they got from them.

In the beginning, they asked me to work on this, but I was working on the project Ciudad del Flamenco. As I did not want to take everything on me, I suggested we collaborate with the ETH. Hdm started to work on that project together with ETH, then they stopped and I took it over.

AC: So this is what you call geometric support.

KS: Yes—clarify the geometric structure, the logic, and why you do it.

For example, on the roof of Elbphilharmonie, these are very simple NURBS. They are driven out of the NURBS logic, and it works. It works for the roof, it works for the appearance, and things like these are understandable there.

Another beautiful thing is the furniture designed by the office. Herzog & de Meuron often focus on the details and also design chairs and tables. There was a table in which Jacques worked with an older person in the office, Mario. They were drawing by hand, and they did not want to have a round table, they wanted a table which looked a little bit like an egg. The drawing they created had millions of lines, so they came to us with this drawing, and we had to understand what kind of shape they wanted. We drew a NURBS shape on it, and they were happy. But then Steffen Riegas tried to understand how this

NURBS shape functioned, and he found out that it was four ellipses fitted together, in which you have the tangencies. So we build these four ellipses on top of this hand drawing, and it was exactly—exactly—what they were drawing before.

I believe this happens with the axes, it happens with the arm, with the way of movement, of how our human being is drawing something that is not a perfect circle. It is beautiful to see that someone is sketching a weird form, then you rationalise it, and you see that there's something very clear about it. There's a rule behind this form, and you can translate it into something with three control points, it's very simple. And this is something which I find absolutely fascinating about geometry.

AC: Does this have something to do with the courtyard of BBVA? Did you work on it?

KS: I've worked on the shading system of the BBVA. On the main egg; I had someone working on it, but I don't know exactly how it was defined.

AC: I have the idea that the work developed by the DT group on parametrics and scripting is concerned only with specific parts of the building, for example, the facade, the spiral staircases, the random patterns. It's never applied to the entire project.

KS: Sometimes you have situations, like in the Elbphilharmonie, where you have particular things on specific scales, like the frit pattern of the facade, the roof, the pattern on the roof, or inside the auditorium. Different moments where you use different tools to create the architecture. You create a specific tool for a particular architectural element, which later becomes important for the building.

I worked in Austria as a professor, and I always had students who wanted to work only with one technology or one material. They wanted to make a wood building, without using any piece of steel, and very often it resulted in a kind of poor architecture. It's a radical movement, but it's a movement which is too intellectual. This office is also very radical in what they do. Still, scripting is not the solution for everything. It is the solution for the facade or the spiral staircases, which then become a very important element inside the overall design, in contrast to something else.

AC: Digital fabrication is quite connected to parametric design and scripting, which, besides solving specific design problems, facilitates their translation into fabrication, allowing, therefore, the building to be customised.

KS: Yes, but this also came much later in the way I worked in the office. The first thing I did in Ciudad del Flamenco was an ornamental pattern. I scripted it, but I was not considering how to build it and what the advantages could be.

When we developed the Messe Basel, in which Steffen Riegas and Volker Helm worked a lot, here it was about how much torsion and pressure you can put into a flat panel to deform it. You can distort the panel only by forcing it onto the surface below, which makes it much cheaper than creating a formwork to bend the panels. So, understanding the production process and using its advantages in the scripting to also make the production easier—this came a little later in the office.

AC: So the Messe Basel was one of the first projects in which the topic of digital fabrication was taken into consideration in the design.

KS: It is one of them. The Elbphilharmonie, where we used the frit pattern, is another one. In the beginning, somebody else was working on the frit pattern. They created tremendous, big Autocad files, where the construction company took an extremely long time to transfer the design data onto the machine. We went to the company and asked them what kind of data their machine was getting. In the end, we did not submit a drawing, but the pure data for the machine included additional information, like logistical information. Everything was in this dataset. They didn't have to do anything. In the beginning, they took, like, eight hours for the workflow to get the design produced by the machine. We reduced this to five minutes. At that time this was quite difficult, because, as an architect, you design something and afterwards the constructors do their own construction drawings. In this case, there were no construction drawings, and my data fed the machine directly. I was extremely afraid about what could happen if I made a mistake. To control my work I designed a reverse engineer process where I converted the production data back into a two-dimensional design. This was a time-consuming process, but it gave me the confidence that my production data was correct. An error in the production data would have caused enormous costs.

AC: But it makes sense to establish a connection with the production phase and to work in a digital chain in which design and fabrication are connected.

KS: I'm now working in Blumer Lehmann, and there we try to get in contact with the architect very early to make one prototype to solve technical, production and material issues. In this way, before defining everything, before the bidding phase, you can take this knowledge and use it to understand your design.

This is something we tried in the office. We tried to work with mock-ups a lot. But if we had a public building, like the Elbphilharmonie, we were not allowed to do it. We were allowed to get in contact with the constructor only after the bidding phase. This is a big mistake. When you do standard buildings, you can work with standard building elements, and you can define them in a standard way. Then you can ask for prices and compare prices. But when you do something where everything is unique, it's very difficult to make a definition of what you want. Even as an architect, you still don't really know how you are describing it, in a perfect way.

AC: If you work closely with companies, you can inform your design process and make the building more economical because its design is connected with the construction system.

KS: Exactly, and this is the main difference between private and public buildings. In a private building, the investors understand it and can say, “Okay, we’ll make a mock-up”. Public clients are bound to follow official rules.

AC: In your opinion, what was the great added value that parametric design and scripting brought to the design process of HdM?

KS: I think you can push the design and you can realise things with scripting which would have been much more difficult to do without it. But I also think that it's because of the way we scripted it. In the Auditorium du Jura, the team wanted me to script something. I went into my small room and started scripting it. After ten days, I came and said, "I have a result!" and they said, "No, we don't want this any more, we are in a completely new design direction now". And they gave me another exercise. I went back into my room and started scripting again. When I finished, I came, and I said, "Look! It works" and they said, "Yeah, but it's over, we already changed the design". So, when I was in the office, I understood that you have to play "ping pong". There's the speed of the design team, and when you play "ping pong", you just get a certain amount of time to bounce the ball back on the other side. If you don't do it, the ball falls out, and you are out of the game.

This was something I understood very much here in this project. If I want to play with the design teams, I have to react within one or two days, and sometimes within hours. Then the scripting was also very often not perfect, but enough for the design crit to grasp the idea, to still be in this game. So the added value was that, from the moment I understood this, I was able to play this "ping pong" and work together with the design teams.

I learned another important aspect when scripting for a design team with the project Ciudad del Flamenco. In this project, they asked me if I could do some variations. I did ten variations. They looked at them and asked me again for variations of the variations. This process repeated to the point where I had scripted more than 400 to 500 different kinds of facades. There was a moment where it became difficult for the design team to react. This was when I understood that scripting is not pushing on a button to create 100 different shapes, but it was to understand how many shapes you can create for the other side to grasp it, to understand it, to work with it and to react to it, and I became much more subtle and efficient with the time.

For the Elbphilharmonie, I worked on the frit pattern, and I only provided them with ten different design possibilities of how these dots, triangles and small different other shapes could be. Very little information. I worked a lot, I decided by myself, I reflected by myself, and I only let—after a very strong self-filter—little things into the design team. I understood that a lot of people were in this design. Even my scripting group, who was so proud because there was a design team which was doing one version, and they had scripted fifty versions. This is not what you want. If you want to have “ping pong”, you play with one version against another one. If you start submerging the office with a lot of variations, it becomes more difficult to choose what you really want, and to develop something which is there and is good.

In the image-making, the marketing department, which is called the "kitchen", worked with photographers a lot and sometimes I got some subsets of photos to analyse. Sometimes you've got photographers that, when they go to a newly built project, they make 800 images, and they submit these 800 images. Then the partner in charge—Jacques, Pierre, the marketing, the project manager, some architects—everybody is going through 800 images, analysing the subset, and it becomes difficult. As a photographer, you have the power of choice. First of all, when you make an image, when you shoot your camera, but also after, when you have 800 images, you have to choose what the four or five images are you should really give to your client. For me, it was the same in scripting. I could click on

a button and create 800 versions, but in the end, for me, the important thing is how many versions, how many variations I have to submit to be in this "ping pong" game, and not make things too difficult.

AC: I suppose that one added value of parametrics and scripting is to open up the design possibilities and allow their control from a geometric and numeric point of view.

KS: Not always, because you have the parametric design, but then you have agent-based design and optimisation design.

Parametric design is very simple to translate to the team because you have parameters which are driving your design idea, and this is quite simple to decide. For example, in the Elbphilharmonie you had rooms with one to five windows. You had to achieve 30% of G-value for every room. Big rooms with five windows could have some windows with a higher light transmission and some with a lower light transmission, as long as the complete G factor for the room was achieved. In this case the parameters where very clear.

But, for example, if you have an agent-based system it becomes much more difficult to control the design. It also becomes more difficult for the design team to understand how much you are still driving the design, and how much it is a random process completely out of control and you just click when you like it. So for me, I work much more with parametric tools. I also work with optimisations and agent-based, but I found out that for this office, for the spirit of the office, a parametric design approach was the best.

AC: I read that you implemented in the office a digital workshop with CNC machines, which had a relevant impact in the model-making process.

KS: When I started in the office, they were thinking about having a 3D printer. They asked me to support the 3D printer, and I declined. I said I didn't want the 3D printer, and they didn't understand. They said, "You are a digital guy, and you don't want a 3D printer?!" I replied that, for me, a 3D printer is very often quite easy. The easiness of using Rhino to create complex forms is very cheap to translate on a 3D printer. But if you take a cardboard cutter or a milling machine, you have to understand the form, you have to understand the tool, and you have to understand how to assemble it. All this kind of understanding—how you make the model, how you assemble the model, how you subdivide the model into elements—is part of the construction process. If you just 3D print, you are not so critical about the construction process. This is why I was, in the beginning of my career in the office, very critical of 3D printing.

First, I asked for a laser cutter, then I got a 3D mill, and after, a cardboard cutter. With the laser, they started to make every model with plexiglass, which looks very shiny, very beautiful, but with this materiel every working model looks like a final model. People didn't understand that a model is only an abstraction in the process of the design development. With the laser, you don't change the model. If you have a cardboard model you can tear things off, you can glue things on, and you can change things. The model becomes ugly, but there's a process in which you work with the model, and you work on the architecture. You understand what happens, and there's a transformation process

occurring in the architecture, in the design process, but also in the making of the model. This is why I tried to work more with the cardboard and the milling than with the 3D printer.

I also later bought 3D printers. The office became bigger, the 3D printers became cheaper, and you want to play with all the possibilities you have, so we also bought a 3D printer. When I left, there were three 3D printers in the office. The decision-making process in acquiring the digital tools was very well-considered.

AC: About visualisation and video. I suppose that, in the office, renders are considered important design tools that contribute to having a more clear perception of the project.

KS: Steffen and I, we have different views on this. Maybe I'm older, maybe I'm more ancient with technologies, but, for me, an image is something which is grasping the idea of the architecture. When you make a building, you tell a story. When you have a client, you tell a story, and you tell him that your architecture is fantastic and that he has to build it because it is going to be a key piece in the city or whatever. You are telling a story with your building, and to create an image is to put everything into one single frame. When a client looks at a picture, you can follow his view and also control it. You have the possibility to explain to him what he sees. With a VR environment you are in a different world; I have no control of you any more. This is what I am criticising with VR. It is fascinating, but you lose control of what you show.

For example, when I lived in an old watermill near Geneva, we had three different entrances. We had entrances that we took every day, but when we had visitors, we took another entrance. There was also a window where we had a beautiful view of Mont Blanc, and it was always the same; we went up, and when we were at this window, it was very beautiful because we could see the top of Mont Blanc from there. And when we showed the building to someone, we started walking in the building and had a very precise idea of what to show. It was like a promenade architecturale inside the building. It wasn't about not letting people go into some areas, but it was because we wanted to orchestrate how they perceived the building.

For me, images are the highest point of the orchestration because you define the perspective, you put together the information, the detailing, an atmosphere, and people have to concentrate on this image. When you work with a movie, it becomes a little blurrier, and when you work with the virtual environment, it becomes even blurrier still. This is where Steffen has a completely different approach than I have. But this is amazing, because it shows how important it is to have different people with different approaches in a design studio.

AC: But as a design tool to be used in the office, I think VR is a powerful tool. It gives you a more realistic sense of space. It is like entering into a model, and I understand that HdM appreciate physical models very much. They do big models to have exactly this possibility, to experience the space.

KS: There was one image maker in the office who was amazing, and he did a lot of images for the Beijing Stadium. It was Philipp Schaerer. He didn't know how to render, and was doing everything with Photoshop. He had a very small and cheap digital camera, wich he used in the workshop to photograph

the cardboard models to find the right perspective. Then he used the photos as a basis to make fantastic images of the project with Photoshop. These images have an artistic quality, and they have such a strong atmosphere. So all the image makers I called into the office, I didn't look at whether they knew how to render, but I was looking much more at whether they knew how to tell a story with an image using Photoshop or other tools. It's not about them being professionals, but it's about them being strong in understanding the sensibility of an image language.

AC: Which projects of HdM do you highlight as being paradigmatic of a strong connection with digital tools?

KS: With digital imaging, I think in all of them. This was a very, very important step in all the designs we have done.

The scripting, for me, I have to say that the buildings which I've worked on most of my time I consider as highlights; the Elbphilharmonie, SudPark, Ciudad del Flamenco, Messe Basel, Tate Plus.

With the BBVA I had a very strange relationship. I was asked to do the scripting for the shading system, I submitted it, and then I didn't hear anything any more. Once, when I took a taxi in Madrid, I saw that they had built my proposal without any changes. For me, this was too fast; the "ping pong" game was not over. That didn't feel as strong as the Tate Plus, for example, in which I worked intensively with one architect from the office.

I worked on the Roche Tower a lot before it became this triangle. On an earlier stage the design was driven by a double spiral. I really liked it. Towers are very often phallic symbols. The first design for the Roche tower was very feminine. It looked more like an Italian Madonna than a phallic symbol. I found this tower extremely unique in the line of skyscrapers and highrises all over the world. But it was not a Roche tower, it was too far away from the mindset of the company, and I totally understand that they killed the project.

AC: Roche is now constructing a new tower, right next to the first one. So it would not have worked if both buildings had such an expressive shape.

KS: The second didn't exist at this time. Everybody thought that there would be only one big tower. At that time I liked working on the elliptical tower a lot.

If you want, these are more or less the highlights on which I worked.

In Beirut Terraces, there was also a very interesting script done by one of my colleagues. There they did a floor plan, they did a second-floor plan, and after that they created a rule for how one floor could then go on to the next one. There were not so many floor plans, but we had, I don't know, like 80 million different kinds of towers. Then we looked at one tower and said "this is not beautiful." It is not beautiful when three or four floorplans are copied one on top of each other. So we created a rule in which it was not possible to have three or four equal plans on top of each other. So, from these 80 million, we had 30% less. Then there was a very ugly column through which one floor was connected to others, and there was an edge that people didn't like, and so on. In the end, there was a pure randomness of floor plans stacked together but controlled by very specific aesthetic rules, based on the criteria that this is beautiful, this is not beautiful. In the end, only this set of rules reduced these millions of possibilities to

five. The team developed these five possibilities, and for me this was one of the most amazing moments. Jacques came, looked at them and said, "Wow, this is nice!" and we asked "Which one do you want?" and he said, "I don't care, you choose!" It was not about him saying “This is what I want”, but it was about him being the eagle, driving all the processes, and the scripting team getting, in the end, to something which fitted the idea.

AC: In your opinion, what criteria could guide the choice of the case studies in my PhD?

KS: I think one criterion could be ornament. Some buildings, like Jinhua, Ciudad del Flamenco, The Walker Art Centre, the sculpture in the Beyeler Museum, and also the Caixa Forum, are strongly connected to the theme of ornament.

Then there are projects which are much more functional. For example the Messe in Basel. There's a purely functional aspect which is driving the ornamental aspect and appearance of the facade. I would also put the Elbphilharmonie in this category. The driver of the frit pattern of the facade is functional, the appearance is ornamental.

Another kind of criteria are buildings where digital tools, like BIM, are used to solve complexity, to put the design together from a technical point of view. Here, we can no longer speak of digital design tools but of digital management tools. The projects in the office became bigger, more complex and faster.

There are three types of criteria to look at: ornamental, functional, and complexity, which is also related to the size of the projects.

One further aspect is the construction process. In the Messe Basel, the parametric system of the facade panels is connected with the material and the fabrication process. The same happens in the Elbphilharmonie, where we worked together with the glass imprinting companies. This also happened in the early years of the office, like the Eberswalde Library. There, you already had a direct connection between the design, the material and the production process. However, in recent projects, you have the fabrication process, which includes digital tools. That could be a fourth criteria to investigate in your PhD.

AC: Do you think that it could also make sense to look at an issue and make a comparison between how it was solved with the digital technologies and the traditional tools?

KS: You could. For example, when you work with brick as a material, you could look at Tate Plus and Caixa Forum. In Tate 2, there is a very clear relationship with the old Tate Modern and its brick tradition. In Caixa Forum you also had the existing brick facade, and the question about how they were dealing with it. In these older projects, the design was driven in a much more graphical and radical way. In Tate, we worked with different colours, with different grains; we worked with the logics of how to have a pattern that is evolving from the bottom to the top. So there could be situations where you compare an older building with no digital tools and a newer one.

AC: For now, I have to identify what the most paradigmatic projects are that could be more interesting to speak about, and, also, to understand if it would make sense to go back to the

beginning and interrelate things from the initial period with others from the digital one. I think that it would be interesting to talk about the design tools, without neglecting the hand drawing. We could try to see what the differences are, and probably, in the end, we will recognise that digital tools improve some aspects; however, we still should use hand drawing because you can also have some benefits from it. It is not about saying that we should only work with digital tools, but it is trying to understand what they can improve in architecture and what their role is.

KS: I see it as a little bit like an orchestra. We have a lot of different instruments. We have violins, trumpets, synthesisers, flutes. It is not about the violin being the only instrument in the world. It is about all these instruments playing their part in the music and bringing this fantastic music together. This is what we do very often. A lot of people say I am a trumpet player, I am a scripter, I am a Grasshopper guru, I am a BIM guru, and they only focus on and see the world from their perspective. If you are a good violin player, you should play the violin, but this is only one of the instruments that make an orchestra, that make the overall music. My role was that of a scripter; with this clear standpoint I was able to give my input to the projects in the office.

AC: And they liked that, right?

KS: They liked that because they got a clear standpoint from me. They could take it or reject it. In Lyon Confluence, I worked on a masterplan. Pierre came and said that he wanted a tool to decide which of the variations was better. I created a tool, and Pierre was very happy. However, Christine Binswanger thought it was complete nonsense. It was her project, so the tool was rejected.

AC: You developed a tool to decide which master plan would be better. What kind of parameters did you use?

KS: I created a tool that was taking a screenshot out of every window. I got 20,000 images, and with a histogram of every image I could analyse all the images. I could analyse how many other buildings could be seen from a window, or if the street, a river or the mountains were visible from a window.

AC: So it was a question of views.

KS: Yes, and a lot of people found it really interesting. I found it an interesting way of translating what Pierre wanted.

AC: Did he tell you first what the criteria could be?

KS: No, no. I came up with this, but he liked it, and Christine didn't like it. She was the partner in charge. It's okay! I still think it was a good tool. This is how things happen. Very often, I was taken out of teams, and then I came back later and helped them again.

END

"I would choose Tate Modern."

Conversation with Kai Strehlke
Zurich HB train station, Zurich, August 7, 2019.

Alexandra Castro (AC): I showed Steffen Riegas the diagram in which you related the drawing methods used in the office and the projects' geometric complexity.

In the opinion of Steffen, this curve is going down. He thinks that there was a time when the geometric complexity of the buildings was higher, but around 2012–2013 it started decreasing, maybe due to the crisis.

Kai Strehlke (KS): I think there's a difference between the office and the world.

You have a different kind of architect who is looking for their own style, and I think that HdM never really wanted to have their own style. However, in some moments they investigated ornamentation more, and in others they went away from it. I have the idea that in this later period ornamentation is not so present in their architecture any more.

AC: I agree with you. I also think it has more to do with HdM's research interest in ornament, which is very clear between 2000 and 2010. However, it began much earlier. In the first years of their career this is visible, for instance, in the imprints on the glass, concrete or polycarbonate.

When you joined the office in 2005, HdM were investigating this topic from a three-dimensional approach. Digital tools allowed them to go further.

KS: Yes, Ciudad del Flamenco is a good example for this. Their research interest was the study of Arabic calligraphy as well as tags from street art and their implementation in architecture.

AC: Afterwards, I think that there's a turning point in their research, because from 2010 the buildings' overall shape became simpler and more essential.

KS: I agree with you. Maybe it also has to do with the kind of projects they have. Like Roche, for example, when they worked on the double helix. The double helix project was very beautiful because you had, in one direction, a very steep helix, and in the other a very shallow one. The intersection

between the two helices always occured at 90 degrees in different positions. This allowed there to be a meeting point, like a cafeteria, that was looking at the landscape at different heights. There was a lot of thinking in this building, and I suppose they were also quite happy with it, but in this case, it did not fit the client. The client, Roche, has a completely different mind. They are very structured.

AC: Swiss!

KS: Yes, it's also that! When you look at Roche and compare it to Novartis, Novartis filled the campus with many different architectures. They have Gehry doing this egg inside the campus. The mentality of Novartis is completely different from Roche.

AC: Roche has had its architectural style since the fifties, with these black and white stripes.

KS: This particular architecture is very much driven by the client.

AC: Do you think that HdM would have been happy if the first Roche building had been built?

KS: Yes. At that moment, it was a surprise that the client rejected the project. We had to stop, and start with a completely new project.

AC: The "Digital Technology" group is now called "Design Technologies". HdM consider that nowadays everything is digital, so they wanted to focus on the design issues rather than the digital. They have three main areas of expertise: 1- Project delivery, which includes CAD and BIM management, scripting and geometric support; 2- Digital workshop and fabrication; and 3- Visualisation and VR.

KS: A little bit different from my time. We had five departments, and for me, geometric support, scripting and parametric design were quite important, because, at that time, the projects had some relevant geometrical issues. It was important to understand the geometry, the design and how you can do things more simply.

In Messe Basel, for example, this wall is a hyperbolic paraboloid. You have a ruled surface, but when you offset it you get to a double-curved surface. It's strange, but it's like this. So, for a long time, the construction behind was a double-curved surface. Then I came and said, “Listen, this does not make sense at all. We should make this as simple as possible. We’ll make a ruled surface on one side, and then a second ruled surface on the other one.” The geometric consequence is that the horizontal distance between the two surfaces varies. This distance is bridged with steel elements which are laser cut. So we put the geometric complexity into these elements and scripted them. In all these projects, there were always issues related to geometry in which it was essential to understand what is important for the design and what are the simplest rules you can follow to produce them. For me, this was the most important task in the department.

AC: Steffen told me that Revit was used for the first time in the office in around 2004, in the Roche Building 97.

KS: Revit was used a lot of times while I was there. We did sixteen projects with Revit, but they all had some particularities. Leonard Street, for example, was a project done in Revit. There they worked mainly on the outer facade with Revit. There were buildings where it was very successful, but I think it was because of the team and how they were using it.

It was different in Roche Building 97. In this project, there was a young architect who had never worked with Revit. He didn't come from the scripting side, and the office asked him to do this building with Revit. In the end, he was the only one who was working, and, for him, it wasn't easy.

AC: I suppose that now, in the office, the majority of the projects are done with Revit. Steffen showed me this diagram which also shows the relationship between hand-drawing, CAD and BIM, but scripting is not mentioned. I believe that for Steffen, scripting does not have the same importance as for you. It is a tool used as a complement to Rhino, to draw in a faster way. On the contrary, for him, BIM is quite important.

KS: I was always very sceptical about BIM. Nowadays I'm working in a timber construction company, so I'm happy when we have good models. We work with CadWork, a software for wooden structures, in which we have everything. It's a kind of BIM model. You have all the parts, with the additional information about the materials, numbering, textures associated to every part of the building; how these are assembled, the groups, the sub-groups, the order of construction. Everything is in this model. What we have is exactly a BIM model. We use this a lot, but when we work with Revit models, we still get extremely creepy information. So, my point is that people often believe that a BIM model is precise per se, and that you get all the data by just clicking a button. In my time, there were many projects, for example, where you had a very complicated staircase that you just implemented as a 3D model. After, when you tried to take the data out of it, like how much concrete you need, the weights, you didn't have it because the staircase was not modelled with the BIM software.

For the Kinderspital and these buildings, we had BIM teams. However, I didn't have this impression that BIM was the most efficient way of doing things. Models became extremely big, extremely heavy, and I wonder if all this complexity needs always to be there all the time.

At the New North Zealand Hospital, in the very first stage, they had to deliver a Revit plan, but there was also a lot of scripting to find and foster the main design idea. The beautiful thing about this building is the spirit that is inside. You have a first level which is super complex, with all the surgery rooms, and then you have one roof on top of it, which is a beautiful garden. All the patients who are at the border of the building, they can look out on one side into the landscape and on the other side into a park. People don't have the impression of being in a hospital. These are beautiful design ideas. For this, you don't need a Revit model. It's not the Revit model that helps you with this. We were supporting that design process with small scripting tools.

AC: I would like to talk with you about the case study for my PhD. I would like to take only one building as the main case study, even if, when I analyse it, I will certainly relate it to other buildings. However, I should choose just one building.

In my opinion, it should be from 2005 onwards. It should be a building that stands out as an exceptional architectural example in which digital tools were fundamental in solving geometric problems, but also in which we may find those most trivial questions of architecture. For example, a building that is iconic but also contextual, and at the same time, paradigmatic of the possibilities opened up by technology. I also think that it should be built.

Do you want to suggest any? Looking at this map, I can tell you which buildings I find more interesting: the Elbphilharmonie, Jinhua Structure, Tate Modern 2, Actelion, Blavatnik School, Stadium of Bordeaux, Stamford Bridge.

KS: What is going to be the title of your PhD? You should know. I was in a conference with John Fraser, and he said that when someone is doing a PhD, he should have the title in mind and be able to describe it in two sentences.

AC: I have my question, "What changed in the architecture of Herzog & de Meuron from the moment they introduced digital tools into their design process?" My keywords are geometry, architecture and digital tools.

KS: I know what I would take! I would choose Tate Modern.

I would take this one for several reasons. It's a building in which they became very famous. There's a relationship in their work between something they have purely done by hand and something they have done with the computer's support. Tate Modern 2 is very much scripted, and from a geometrical point of view it is something where they really played with the geometry. When you look at the bricks, there's a lot of investigation of how to use them. There's always this relation between the old and the new, and from a material point of view, it is interesting how they used brick. It's also very decorative because there's a concrete building behind, so it's a very visual facade. You have points in which the bricks intersect that look very strange. Some people find it interesting, some people find it amazing, some people ugly, but it has a position, and, at the same time, you have a very architectural material. You also have other similar situations where they used brick, cutting out the windows directly in the traditional brick wall. I think this is an amazing building.

Elbphilharmonie is an exceptional building, but it's unique. Tate, instead, is a building that is giving much more food to relate to, to investigate. And it is an interesting case for the use of digital technology—not BIM, not other stuff, but the use of scripting and geometry tools. For example, Stamford Bridge is a building where they also tried to use this kind of brick appearance, but it's so far away. For me, this is a very strange building. When I was in the office, I complained a lot, saying the columns look like laminate. They are so thin.

AC: Something, I suppose, that is complex in this building is the stairs.

KS: Yes, the complete circulation system.

Tate Modern 2 is also a contextual building. It sits in an area where another building is located made of the same material but with a completely different system. I think it will give you a lot of food.

AC: Okay, it's done! I accept your suggestion. With my supervisors, for a while, we thought it could be interesting to choose a building with the two phases, analogue and digital, and Tate Modern came to my mind. Tate Modern 1 comes from hand drawing and 2D CAD, and its architectonic language is clearly related to their initial projects. In the same complex, on the south, there's Tate Modern 2, which has been developed with digital tools.

KS: I didn't look at it before, but when you explained the kind of building that interested you, I immediately thought about this one. You can also relate it to Ricola because of how things appear on the facade, this kind of layering. I think that when you consider some parts of it, you can connect it to other buildings.

AC: If I asked you, "would it have been possible to design and construct this building if you didn't have the digital technologies?" what would you answer?

KS: I was in Mannheim seeing the Multihalle by Frei Otto. If you constructed this building today, you would say that you can only do it digitally. I think everything is possible in different ways. For me, the digital tools we have are just tools. They help you to be faster, to interact with a design team and to support a design process, to test things, and understand geometrical issues. Yes, you could have also done it without, but these tools existed, they were used, and they were part of the design and part of the story. But I believe a lot of things are possible, even with no digital tools.

AC: And what about the Elbphilharmonie?

KS: Maybe there are some parts of the building, like the frit pattern, that you could not do without them. For that, you definitely needed digital tools. When you look at the roof cladding which has been used, you need to script it. This is too complex. But if you don't script them, what would you do then? You would do bigger circles and smaller circles. Then you would randomly place the bigger circles, and the smaller ones, you would have placed them in-between. So there's always a manual answer to achieve similar results. It might not look exactly like this, but I'm sure you would be able to find easier ways to think about things differently.

In Tate 2, we worked on geometry, but we also worked on the colour of the bricks, which was a very interesting task. When you burn a brick, you can add air or take the air away during the cooling process. When you put more air into the fire, you burn the brick, and it becomes darker. You have the possibility with the same clay to get a variety of shades and colours. In the beginning, when I scripted it, they wanted to have a smooth gradient of colours on the facade. Each stone had its own colour. But then we realised that we could not construct a building and say the stone there should be a little lighter than the other one. We went to the company that produced the bricks and looked at the different colours they could provide. When they burn bricks, they take them out of the oven and burn another bunch of bricks. They take them again out of the oven, and

they don't have exactly the same colour, so they mix them. From a production point of view, we did not change anything. We took a horizontal band of the building in which we decided to have the bricks burnt very high in five bunches, two not so dark, and we mixed them. I mixed them also in the script, and you saw how it would look afterwards. It was not important to define the exact colour of each brick. We just wanted to define the mix. Then, higher on the building, we changed the colour of it again. So it was understanding the production system, understanding the construction, understanding the design possibilities of it, and then using scripts to test it, design it, define it, and so on. For me, that was a beautiful task. In total we have fifty-four different kinds of bricks. We have straight bricks, inclined bricks. We have the anti-climbing system, which is a kind of gradient where the bricks start to be placed a little bit inside and then they are taken off. There are a lot of geometrical issues happening in the facade, which were included in the script. I was super happy working on this, and when you stand in front of the building, you see everything. You see all these kinds of geometrical solutions. Because of the twisting it became quite complicated.

There's also another interesting aspect. The building is very ornamental. The facade's texture is something you can compare to other buildings from the office.

In the Schaulager, for example, you have a windowsill, which looks very strange. It is very ornamental, and they designed it using a can. They squeezed a can, took clay, and rolled the can into the clay. This was the design method for the windowsill. At the Schaulager it was a very manual design method producing an ornament. In contradiction to the Schaulager, the ornamentation of the Tate results from the application of digital computer scripts.

AC: In a monograph of HdM, the detail of these windows is described as "digital landscape, calculated forms produced with digitally controlled tools", and there's a picture of this surface designed by the computer.

KS: But this was drawn manually, and the original idea behind it is the can. I think the can is also in the archive. The initial idea came from manual work.

It's the same for the Elbphilharmonie. In the beginning, for the sala, they made a lot of foam models, some of which you can see in the archive. When you look at these models, they are not sophisticated. They are just catching the idea. It's not about making a beautiful model, it's about capturing the design idea and finding a translation in the world using models, drawings, sketches to understand it, and this is extremely manual.

AC: Before you joined the office, were they working with digital modelling?

KS: Yes. I had a student when I was at the ETHZ, Volker Helm. He went to HdM, and I think he was the one who was doing a lot of 3D modelling at the beginning. With him, Rhino was introduced into the office.

AC: When did this happen? Do you remember?

KS: I would say 2003–2004.

AC: I found out that around 2000, in these projects for Prada, HdM worked with Urs Roth, a geometric engineer from Zurich. They asked him to develop an aperiodic pattern for the facade of one of these buildings. Maybe their idea was to have a random composition that was geometrically controlled. If, at that time, they already had the scripting, they would probably have used it instead.

KS: Yes! I think an interesting point about Jacques and Pierre is that they never neglect anything. There are architects, like Peter Zumthor, who often neglects technology and doesn't want to have anything to do with it. And I think this is a fascinating point about Herzog & de Meuron. They are always interested in good architecture, and they don't care how, why and who. They are incredibly open to working with artists, biologists, scientists. They are not chasing the hype, and they are not trying to jump behind important things that other people are doing. They try to do their signature and their architecture. Still, they are incredibly willing to create connections with other people in different fields of knowledge, like in the Kunsthaus at Aarau, where they worked with biologists. They were working on the stone, and tried to generate the green colour of the building only with moss. They did a lot of tests in the office where they had stones with water. They tried to understand how the stone should be in order to grow the moss, but in the end, the building was too much in the sun, and it didn't work.

AC: In the archive, do you suggest that I look at anything in particular about Tate Modern 2?

KS: I don't know exactly what is in the archive about this building. We did many brick models, very big brick models, but I'm sure that they did not archive all of them because they were too big. You know that you archive what you can archive!

The best thing to do is to follow the buildings along the path. If possible, you don't stop and walk once in the whole archive. One thing that strikes me is when you look at the first years, where you see that there are like two, three, four, five models. Then, when you come to these buildings after 2005, there are massive amounts of models. When you continue, you see fewer models again. This happens because we had the digital machines, the CNC technology, which pushed the models incredibly. Around 2006–2007 there's a lot of models. So, when you walk along these shelves, in the beginning, you can see one year, two years, per shelf, then you continue, and you see, oh, it's not a year, it's like one week, another week, another week. This is an interesting point.

Then, I think it is interesting to look at how they catch architectural ideas with these models. These models are not beautiful, but they are about catching the design idea.

If you work on Tate 2, I would try to look at the models of this building and then, of course, at all the brick buildings, especially the Tate Modern 1, to compare how many models they have done. The Tate Modern extension is interesting because of the context, and it is interesting because of the material, because of how the brick is used. And I think there are lots of different levels of analysing it and looking at it.

END

"The important thing is to understand why they do not do it by hand and why I should script it."

Conversation with Kai Strehlke

Zurich HB train station, Zurich, November 6, 2019.

Alexandra Castro (AC): Which were the biggest geometric challenges you had in the Tate Modern extension?

Kai Strehlke (KS): One challenge was the massive amount of data coming from the brickwork. For this, we had to define a kind of data structure that we hadn't used before. In the case of the Tate, we didn't draw geometrically, but we set a point cloud and, after, we informed each point with information about the brick, such as the colour, the geometry, the type.

In this project, we worked with the structural engineers, Ramboll, who wanted to do all the work in Catia. However, as we worked a lot with Rhino in the office we said no, because, from a geometrical point of view, we could have the same precision in Rhino as in Catia. But when we tried to generate the geometry, it was too complex for the computers we had, and it was taking too much data. We decided to define a point for each brick, which would have the information about the geometry. In the end, this allowed us to generate parts of 3D models that we needed for rendering and also 2D drawings. When we had a section or a plan, we could generate a specific drawing from the scripting with only the facade's external layer. I think this was an important step for the team in handling the design of the brick facade.

AC: So, each double brick was defined by a point.

KS: Yes, by a single point. And, for certain kinds of information, we just took some of these points and generated a 3D drawing out of them. So, I think, the biggest challenge was really to define this kind of structure.

AC: In a small description about the Tate Modern 2 project, Ramboll mentioned that, "in total 336,000 bricks in 212 different types were installed (...) The architectural intention was for the

wall to be "movement joint" free and this was a key consideration in developing the most suitable brickwork system. (...) 3D setting-out tools were invented for the project, to ensure that tolerances of +/- 2mm were maintained over the 65m high facade".

KS: It's a long time ago. I had in mind around 400,000 bricks. So, this is more or less okay. But I remember many fewer types of bricks.

AC: I remember you spoke about fifty.

KS: Yes, I think it was about fifty-four. Then we had the concrete structure below, and the corbels were placed on it. So, we didn't have to maintain 2mm over 65m. What we had to achieve was, within the bricks, to reach the next corbel.

AC: The tolerance is between the corbels.

KS: It is between these corbels, from one corbel you have to reach the next one. We would not have achieved a tolerance of 2mm in 65m in the brickwork. This doesn't work. These corbels, I think they were every two metres, and this is something you can reach. I'm not sure how they did it in the end, but I suppose they had the double bricks, and in-between a kind of elastomeric joint.

AC: What kinds of other complex geometric issues did you have?

KS: We worked a lot on the colouring of the bricks. When you look at the buildings in London, you see many bricks, and they all have different colours. When HdM looked at the colour they wanted from the bricks, they decided to have a smooth gradient. For me, that was a very interesting step because it started as very design-wise, not looking at the material but looking at the design. Then afterwards, when they started thinking about the construction, they realised that they could not define each brick's exact colour. So, they tried to understand how bricks are produced, and, coming out of the way they are constructed, HdM came back into the design and said they would like to use this effect with different kinds of colours. Usually, when you burn bricks, you never get exactly the same colour. You burn them in one bunch, and another one, and a third one, and then you mix the bricks for the construction. HdM decided to use that production strategy for the design. They would control the kind of burning, and therefore the type of colour, and decided to do this gradient on levels. The bricks had different colours on different levels. It was not a smooth gradient any more from bottom to top.

AC: But in the end they opted for a continuous mix of different colours.

KS: Yes. However, there was a moment when they had a gradation, from dark to light, and afterwards they decided to have it on different levels. These things were design issues, and they asked me to script them and make small variations of the script. In an early version, the double brick had the same colour.

AC: I think this gradation is now achieved by the pattern variation, when the bricks, above the anticlimbing, start to gradually step back.

KS: Do you also have a photo of the corner in the anticlimbing? This is something I find quite interesting. There, you always see one, one, one, and when you get closer to the corner, at this point, it looks like a mistake. This is something I'm quite proud of because it is scripted.

If you placed a standard brick here, the corner's brick would become too thin. So, you have this kind of "mistake" two bricks before. A little before the last one is where you usually do it because it seems regular when you look at the corner. This is a typical way of dealing with this kind of problem in traditional brickwork. I find this interesting. You see a geometrical problem, you see how it was done in history, and then you use exactly the same kind of logic. And everything is inside of the script.

AC: It's a geometric and construction problem. This happens a lot in the architecture of Siza. He works with stone, and he draws every stone. So he has to solve a lot of these kinds of problems. Could you have solved the corners and creases in the upper part of the building as in the anticlimbing? I know that it is much more complicated because it is not only an intersection of planes. You have a vertical and an inclined facade, and you also have the bricks going in and out.

KS: There was a huge discussion about how to make these corners. I'm still not convinced about the final solution, but that was a design decision.

AC: Who wanted it, Jacques Herzog?

KS: Herzog and de Meuron, because they said they had a pattern.

They are sometimes quite radical in architecture, like in Caixa Forum, in Madrid. There, they worked with bricks, and they just cut the facade and made a big window inside. They sometimes have a very brutal and direct way of making architecture.

The corner of Tate Modern 2 was, for them, something where they went very brutal on it. I was not happy, but they wanted it like this. I scripted it, and I drew it, because, with these points, I could make a three-dimensional visualisation of it, with everything, perfectly. I showed them the corner, but they said, "Yes, it's okay, that's how we want this."

Do you like it? It looks like a mistake.

AC: I didn't know the criteria or what was behind this, but I always thought the corner could be well defined. Maybe they could have started from the corner piece, as in the lower part of the building. The corner piece would be regular and the adjustments made before the corner.

KS: I totally agree.

AC: In a conference in 2017, Jacques said that the corner is crucial in this project. It reveals the concept that is behind the construction. You see these two planes that don't match, and they really wanted to be like this.

KS: I know! You work there, and you have your own opinion. Sometimes you are amazed at what they think, and sometimes you have a slightly different idea.

AC: When you look at the corner, it seems like everything will fall.

KS: Yes, a little bit. It feels like you go to a corner, and you break it a little bit. It feels like it is not perfect. In my opinion, all the building looks perfect but then when you look at these corners...

AC: The corners and also the creases.

KS: But the creases are less visible.

AC: They are less visible, but still, you don't have a perfect line.

KS: Yes, but I find the creases all right.

Another important issue is that I always worked with input geometry working on the script itself. So, in this facade, I only had eight plane faces and the windows as polylines, which was everything I got from the team, and I think this was wise.

The architect gave me a drawing with no other information and, afterwards, I generated the point cloud on the surfaces of the building. Then I calculated the colour, the type of brick, or whatever. So, I had one drawing with, I think it was 440,000 points. Later on, we could select just some of these points and decide to make a 3D model to analyse how it looked. This 3D model was quite heavy, but it was not so heavy as it would have been had I taken all the facade. So, the communication I had with the architect was very simple because he had a very easy drawing. If they changed anything in the building, they would just give me these eight surfaces, and I could generate the entire point cloud on it again.

At the same time, when they had done any plans, I could generate the 2D drawing for them with exactly what they needed, with only the information regarding the bricks. I think this was a good working procedure for this project. If you had to design the bricks, I think it would have been impossible.

I'm not the only one who worked on the scripting. Volker Helm and Dominik Nussen worked on the scripting first. But then Dominik went back to study, Volker left for ETHZ, and I took it over. When I took it over, I went to London, and the architects had changed the facade slightly. I had to recalculate the bricks. They were drawing all the sills by hand, so it was not perfectly scripted. The parts not scripted were drawn by hand, which made it nearly impossible for me to work. So I took everything away, started from scratch and created something in which the changes on the bricks were completely scripted inside.

AC: Did the DT group give support only on the brickwork?

KS: Yes. Very little on the inner staircase, but not a lot.

AC: On the 3D models?

KS: We did 3D models, we used our model-making machines, and we also worked a little bit on the scripts for how these steps should go up. When you have a staircase that is turning around, and it's not perfectly round, but it's opening or doing something like this, you always need to have one line, which you consider to be the main line, along which people are walking. On this line, you have to be careful that the steps have the same proportion. You cannot just define the steps geometrically because it would not be comfortable walking on them. Here, we did a little bit of thinking and helped the team to make a staircase that works, but I don't know if they used it in the end.

As the DT group, we always entered into teams until they said, "Okay, we can go along without you." Then we went out. Only in the brick facade were we involved until the end; not the construction, but the end-of-submission drawings.

AC: I know that the decision to use brick as a cladding material is related to establishing a relationship with Tate Modern 1.

KS: I think that's it! They decided to use the brick.

AC: But they also took into consideration the brick bond. Tate 1 has a Flemish bond, and I suppose that the brickwork pattern on Tate 2 has something to do with this.

KS: Yes, and they just took out the headers.

AC: The Bankside power station was an industrial building, and it still had some decorative details on the brickwork. I wonder if HdM had decided to use the brick in an ornamental way because of this particular aspect.

KS: This is very typical in the work of HdM, to look at what they have on site and reuse it in the project. In Tate 2, they looked at the industrial fabric, but they didn't try to copy or make any mimicry of it. I think they were interested in using this kind of brick more from a design point of view, in a very digital and straightforward manner. Of course, the big relation is that you have one building, Tate 1, in brick, and you make another one where you want to play with this material. This is very typical of HdM. They take something, but then they transform it.

You see this kind of brickwork that belongs to London. You look at it, you analyse it, you play with it, you make a new reinterpretation of it, and, in the end, you have something which fits into the site. It fits into London, and you don't make this in Basel, for example. But it's not from London. It's something you have done with the same material.

So Tate1 and Tate 2, of course, talk to each other, but it is not mimicry.

For example, in Elbphilarmonie, HdM worked with waves and water, and you also have this in the auditorium. Simultaneously, the roof itself is also doing a sort of wave, and you still find the same kind of geometric language in small details. HdM scale them up, they play with them, and I think this is what they are doing in the Tate with the bricks.

AC: How was the brickwork information transmitted to the construction site?

KS: It was simple for the construction. The bricks that were not next to the windows were just standard bricks, and we didn't even control their colour. We didn't tell the bricklayers to put this brick or this one. We had the rules in the special conditions, so we controlled just the kind of variations we wanted.

AC: How did it work for the corners?

KS: We had the logic for finishing the corners. I have to remember, but in the end, I suppose that, depending on the geometry, the workers placed a specific piece or just left it out. That is why we have this porosity.

AC: Do you know anything about the windows? At first sight, it seems that they are all different in height and length and that their position in the facade has something random about it. But you can perceive that there are some rules in it. Most of the time, windows are placed at the corners and creases. I think that only one or two are cut on a single face, contributing to the continuity of the volume. You can also see that at level 5 there's a window that wraps the building, in correspondence with the Switch House roofline. The same happens at level 9 and at the terrace, which helps to conclude the volume.

KS: The architects designed this. They just gave me a drawing in which they put a line for the window. I got one layer with the eight surfaces and another one with these windows.

Once I was involved in many different projects, I always tried to work with one person in the team—only one—and I never chose an important person. Andreas Reeg is a brilliant architect who worked on this building. However, I also worked very often with trainees and didn't care who my partner was in the project. I would rather work with somebody who was totally in the subject than with an associate or partner who was in many different projects and maybe not so much concentrated on the subject. So, I searched for someone who was dedicated entirely to the facade and was controlling the design. Then I decided about what kind of geometry was interfacing between him and me.

When this person gave me the windows, I had no clue where the floor slabs behind them were, and I didn't even care about it. I was concentrated on my work.

AC: Do you know how the design process for Tate Modern 2 started and evolved?

KS: There was this significant moment in which they worked on a glass building, and, afterwards, they went to the brick. This was later in the project, but when you look now, it seems evident that they should have started with the brick, which did not happen.

You have a few buildings in the office which are quite straightforward. For example, the Vitra Museum is a building where HdM worked on the stacking, but they worked quietly, in a small team. They went forward really fast, and they built it. Then you have other buildings which are not like this. When I was in the office, I felt they were having a hard time developing Tate 2. You have some projects which are very easy going and other projects which are difficult in their way.

AC: I think they insisted on the idea of the stacking because, at the time, they were developing other projects which were also about this topic, like Quingdao, Actelion or VitraHaus. These are all stacking projects. Jacques Herzog mentioned that this was a compositional strategy on which they were very keen. So I suppose they tried to test it here on the Tate also. But at the same time, they wanted free movement for the vertical circulation inside the building. The two things were not compatible. So they gave up on it and simplified the external volume.

KS: Yes.

AC: At a certain point, they also realised that it didn't make sense to build a glass building. If they had done it, they would have created a stronger relationship with the surrounding context, with all these commercial buildings, rather than Tate Modern 1.

KS: Yes, this looks very obvious, but I was not involved in the way they were working.

AC: Can you categorise the design tools used in the office?

KS: I would make one very big item. The mock-ups are, for me, a new topic. I have shown you in the presentation about Ciudad del Flamenco that we did a big styrofoam mock-up. To scale-up models to the scale of 1:1, I have never seen this in other big offices, which instead work pretty much in a digital way.

I asked the students in Bern to design small chairs and stools and told them to make a 1:1 scale model in styrofoam. Students who did not construct a 1:1 scale model designed stools entirely out of proportion. Interestingly, when you work with these models, you feel precisely the thickness of the material. At this scale, one or two centimetres make a real difference, which you don't see in a plan or a section. It is something you feel very much at the real scale.

AC: It's like a prototype.

KS: Yes, it's like a prototype. This, we did a lot, in the office, and I think scaling up things to 1:1 is something very particular to HdM.

From the design tools point of view, I always had a big fight with people who wanted to work with a kind of framework to script. They wanted to generate the HdM framework, and I was very much against it. I copy some code from other projects when I have to do intersections because it's a copy-paste thing, but, for me, the important thing was to understand the design, understand what they really want and why they do not do it by hand, and why I should script it. I always created a geometrical interface so that I could work on the script, the team on the project, and then I produced for them whatever they needed for the design.

For me, it's difficult to say that we have one kind of script. What I would say is that I'm always working on the interface between the architect and the group, with very simple geometrical elements, so I could to customise it for exactly the kind of design they wanted.

For example, when you look at the Roche Tower, I think the interface was only these two lines that were generating everything. The minimal surfaces and all these things were done afterwards

on the script. But the architect's input, in the end, was only this spiral in one direction and the other one in the other direction.

So I always worked with minimal geometric information, a kind of DNA for the design.

AC: Steffen Riegas suggested that I speak with Andreas Reeg, the architect who was directly involved in the brick facade design.

KS: My world was eight surfaces, some points, some lines and the script behind. Whatever happened in the whole design, I just heard a little bit of it, but I was quite distant because I was involved in many different projects at the same time. Andreas Reeg was controlling the design.

AC: So you think it would be interesting to have a conversation with him.

KS: It would be super interesting!

Maybe it is not a design tool, but it is undoubtedly a design strategy to work with only one person on the team. I'm doing the same now at Blumer Lehmann.

My biggest problem in HdM was when BIM came, and we lost the "guerrilla" approach. This "guerrilla" terminology came to me from HdM. They say that when they have a problem, they want to have a solution and always try to find an interesting way of getting it. This is how I work. Each project is about a particular design aspect, and, therefore, I must develop a specific script. For me, this was amazing, and when BIM came, it turned.

AC: Do you think that in some way this has changed their way of working? I know that you believe that HdM put architecture first and go forward with their research interest independently from the tools. But it is also true that when you know that a tool can solve a problem in a specific way, maybe you tend to go that way.

KS: Yes, but I think a design tool is like a musical instrument. I may have a guitar, a violin, or a drum; however, having a musical instrument is not the same as making music. I don't know how to play the violin, and if you give me a violin, it's only noise. I'm not making music. I think it is the same for these kinds of tools, like scripting. By scripting, you may destroy a project or make it too complex.

AC: When you joined the office, they had a problem, and they wanted to go in one direction. You came, and you gave HdM the tool to solve that problem. If you hadn't given them the tool, they would have gone in a slightly different direction. So, if people in the office work in a certain way, in the end, this will influence the process.

KS: I think so, but they would never agree on saying this. If you have a hammer, you always see a problem that you can solve with a hammer. BIM has some kinds of complexity that you can perfectly solve with BIM, and I think this is a little bit directing. But this is only one aspect. The other is the hidden complexity you have on this kind of project.

When you start Revit, for example, it tells you the internal conflicts. There was a time in which we had a project with 500 conflicts. When you have 500 conflicts, you don't solve them any more.

You don't see which conflict is becoming harmful and difficult. Once, in one BIM project, suddenly the file didn't open, in a team of twenty-three people. It was so corrupt that you could not open the plans any more, and they had to send twenty-three people home because the model was not working. This was because of this complexity. The file was too big, and, nowadays, this happens a lot in our digital world. We have big buildings which are so complex that they never finish, like the airport in Germany. Look at what is happening to Boeing. They have software problems, they are not in control of the complexity any more, and they have enough money, enough engineers, enough knowledge. Still, they got ruled over by the complexity of this digital world.

I think that this, in BIM, is a danger we have in architecture.

When working on Roche, I got a book with 200 questions that I had to answer, but I said I was not doing that. If we start answering 200 questions when we should make the sketch, you don't do any sketches. Of course we have to solve these things, but we have to neglect them at a certain moment. First, we have to find a big idea, and, later on, we will think about all these things, not first.

I know that in BIM, you have these L1, L2, L3, L4, etc. However, the idea is that you have your brick with all the information. I always criticise BIM, saying that if you have BIM, you work as a legal model. You have the floor, and you have a wall, a door, a window, things like that. But in HdM, sometimes you don't know if it is a wall. You have something flattened that maybe turns, becoming a wall, then a roof. When HdM have an idea, they just come with a folded piece of paper, they give it to you and say, "Now, do something!". And then you start scripting. I'm much more in favour of this "guerrilla" technology where I can say, "Okay, what do they want?"

AC: And in which you have to customise the tools to solve a specific problem.

KS: Yes, exactly.

END

C.3
Steffen Riegas

A.03
Steffen Riegas.
Head of the Design Technologies department (2014) and Associate Partner of HdM (2020).

“Digital tools are not the driver of anything. They are just tools."

A conversation with Steffen Riegas
Herzog & de Meuron, Basel, August 6 and 7, 2019

Alexandra Castro (AC): Can you give me a quick introduction to where we currently are?

Steffen Riegas (SR): Yes, of course. Over the years, we have grown into these premises and moved into more and more buildings. It’s what we call the Campus, and it’s where the majority of our project teams work. There are a few additional facilities elsewhere across town, like the Atelier, which is our large-scale prototyping workshop equipped with a five-axes milling machine, or The Kabinett, which houses a collection of our architectural models.

But of course, we have our main model-making workshop here, in the heart of the Campus. It’s a combination of both a traditional architectural model-making workshop plus a CNC workshop. The DT team sits close by, so we can support the teams with technology like 3D scanning or modelling to allow for ideas to quickly move between digital and physical, and vice versa. The idea is to give the design teams direct access to tools like laser and cutting and milling machines or small desktop 3D printers.

AC: I read, and I also spoke to Kai Strehlke about this. From what I've understood, in your opinion, 3D printers don't add much to the understanding of an object's construction process. It's too easy to model a complex shape and then print it.

SR: If you want to develop a specific detail, the assembly of components or just investigate some complex shapes it can be an excellent tool. But yes, it’s true, sometimes technology makes it a bit too easy, and you may easily overlook some important issues. It’s an interesting part of model making, that you encounter many of the difficulties of building already, only at smaller scales.

I think that’s why we never invested into a professional-grade stereolithography printer. If we need those kinds of models, we work with external companies.

AC: Do you also outsource other services, which are typically part of the Design Technologies domain?

SR: Sure we do. It wouldn't be feasible to do and develop everything in-house. But many times, it adds fundamentally to our design processes. It makes a huge difference if you apply technology as part of the design team or bring it in through external providers.

Take architectural visualisation as another example, another field where the DT group supports the project teams. The entire process of rendering images becomes a tool itself, which we can use to question and develop our designs. The process is much different than working with an external studio.

AC: What is your background? When did you join the office, and when did you become responsible for the DT group?

SR: My background is architecture, as it is for almost all of us working in the group. I was lucky that when I joined architecture school, I already had a bit of computer and code experience from my childhood and high school years. So when I discovered the APIs of Rhino or other CAD applications, I realised that I could automate things by writing down the rules, and the program would work for me. That was something quite fascinating as it had a highly creative side and enormous productive potential. Already, before I finished my Master's degree in Architecture, I was lucky enough to work with a firm like UNStudio in Amsterdam, where I could still focus on my personal interests in technology while working on different projects.

Parametric modelling was in high demand with tools such as Bentley's Generative Components and various scripting and programming languages. Information-enriched 3D models and BIM began to become a bigger subject that would soon change the entire architectural profession.

To handle the complexity of some of the designs, we developed what we called the "poor man's BIM" toolkit, which allowed us to attach more data to 3D objects instead of just having pure geometry. When I joined Herzog & de Meuron, we applied similar methods to stadium design or the facade of the Messe project.

I then moved to Copenhagen to work with 3XN in their innovation unit.

Back in 2014, I took over the leadership of the Design Technologies Group from Kai.

AC: How do you compare the practice of UNStudio to Herzog & de Meuron? Do you find any differences?

SR: Of course! Every organisation has its own culture where people with very unique skills and interests work together in such studios. Even today, I am amazed at the openness and the level of technical skills I have met in Amsterdam.

AC: What about architecture and the way of thinking in architecture?

SR: One of the special things about HdM is that there is a lack of a strong aesthetic framework. The studio has the feel of that great openness which you experience at a design studio at university in many parts. In Amsterdam, we worked with "design models". Essentially, these were high-level geometric approaches used to articulate and organise programme into architecture and buildings.

AC: But then you have these shapes that are autonomous and seem not to establish any kind of relationship with the context, for instance.

SR: Well, that depends on the rationale or justification for the expression of such architectures. I agree that it is sometimes hard to follow the narratives and logic of why something has come to a given shape.

AC: When I look at this kind of architecture, in my opinion, this is mainly about being at the forefront of technology. This architecture is always linked to keywords such as movement, flexibility, innovation or sustainability, and you always have these eye-catching buildings whose shapes result from a very free creative act.

When you look at the practice of HdM, you talk about other concepts. I suppose they appreciate the vernacular, the local and its potential for technological research. The prerequisite for every project is the context analysis, and they always try to take something from the context, even if sometimes it is only at a concept-based level. They often refer to important figures or buildings of the architectonic culture. I remember, for example, Elbphilharmonie and the relationship with Scharoun and the Berlin Philharmonie; how HdM have read that building and tried to use some elements of it, reinterpreting them in the new building.

In HdM, I find these kinds of topics, whereas, in other big important offices, the architects are very much for experimentation, technology, movement and new things.

SR: In concept design everything should be possible. Why is it only three stories and not five stories, why is it long and square and not round, why is it curvy and not a box. You always must find a reason for why and how those decisions were made. I guess it many times helps to develop ideas along a narrative.

What we can bring to the table, as the ones in this organisation who implement technology, is that here, technology is never the driver. You can surely use a tool to explore new possibilities and come up with new ideas. Rhino, for example, is at the same time an intuitive and precise modelling tool that we use a lot to explore geometries. Here we also apply scripting, parametric design or even generative approaches. However, when you give away control to a system, then you better make sure you understand and manage the system.

I mean, we use 3D modelling as a tool to solve a problem, not to create new ones.

AC: "Digital Technologies" group, is this the correct name?

SR: It was at some point. Recently we tried to sharpen the term and be more specific because it's 2019 and everything is digital. Our group is now called "Design Technologies", so still shortens to "DT". We are supporting the architecture projects with all their technological needs. Everything that we as architects produce to deliver our works. It stretches the entire project delivery pipeline, with the classical CAD and BIM management at its core. And then extends to visualisation and the workshop teams.

AC: So, digital workshop and digital fabrication.

SR: Exactly. In-house, we maintain the digital workshops with CNC machines, 3D printers and laser scanners, but we can also get involved when coordinating with contractors and manufacturers for projects under construction.

AC: What is the relationship between the "Design Technologies" department and the design teams? For example, when a project starts, are you suddenly called in, or do you wait until the design team has some issue to solve?

SR: Unfortunately, the latter is often the case. We do a lot of support, when teams call us too late, when they've already run into problems. It has something to do with the ability of architects to suffer. They try to solve everything by their own means until they come to a point where they realise this needs to be done differently.

AC: What kinds of problems are you usually asked to solve?

SR: Tasks like studying complex geometry facades, facades with thousands of different members which are hard to model, and it takes a lot of time if you'd do this with a manual approach.

Stadium design is the same. You don't want to put tens of thousands of seats into the stadium by hand, because you know you are going to change those again the next day, so our own tools help us a lot to control our models. Sometimes it makes it obvious that we should be joining a team from the very first day on.

When talking about visualisation, where a team typically needs some high-quality images for press releases or public presentations—in competitions this is a standard—we join them very early on and try to develop a visual narrative.

BIM and CAD, of course, especially if we have big teams working together. I would say Revit is still a big beast. If you have a project with 20 people having to work together, collaborating on the same model, you need people who really understand how these models are put together, how to drive them, and to set the boundaries for these people. That's why CAD managers and BIM managers join these projects from the first day on. You can't expect a normal architect to manage this. It's a complex task, and you need a lot of experience in software, but also in leadership.

AC: In these almost 15 years, since 2005, what has changed in the DT group?

SR: Mostly, we have grown. BIM and Revit, which have become a huge part. As we speak, we have eight BIM managers full-time, and every project has a BIM lead. The BIM competencies in the office are still growing. Last time we met with all BIM Managers and BIM Leads, we realised that we can call 5% of the staff in projects Revit experts.

AC: Has BIM in the office become more relevant in developing the projects?

SR: Yes, of course! This is always the question: what is the driver behind this change process? Now we are doing things that we were not doing five years ago, so why are we doing this, did we

choose to do this or not, was it our decision to document everything in 3D or is this coming from somewhere else?

It comes from different sides. In the UK, for example, since 2016, for every public building of a certain size, you have to deliver the project at a certain BIM level. We don't have this in Switzerland, we don't have this in Germany yet; it's not a government mandate, but still, we do it. So, the question, why are we doing it? One reason is that it is a great tool, and it makes sense to work like this. Maybe for the architects, at first glance, it is more work, it takes longer, it's more effort you are investing, but you get a better result. The quality of the model is better. The quality of your delivery is better.

AC: But this is not about architecture.

SR: No, it's about collaboration.

AC: It's not a tool you use to develop your initial sketches.

SR: No, but it makes sense in the later stages of design. We constantly change tools for different tasks or phases. In an early concept phase, a pencil and a napkin, that's fine, we should still do it, why not? But of course, if you are on a construction site, you should maybe replace the pencil with something a bit more precise that can handle more information. That's when BIM as a method and Revit as software become interesting. It is very precise, and it's easy to coordinate with a lot of different people and then we have to quickly talk about collaboration, and how do we share all this information centrally.

AC: Otherwise, if you change something, you must inform others and send them another drawing. Then they have to change it and re-send it to you again.

SR: Yes. I always have this feeling that when you talk about this to non-architects who don't know the history of these tools and have no idea how architects work, they are sometimes surprised for how we work with drawings and how we exchange information. Working collaboratively in 3D models seems so obvious. The way architects work can seem pretty old school, and not the best use of technology that is around.

AC: It is very laborious.

SR: Yes.

AC: I have this diagram which Kai made, and, for me, this was very useful because it helped me to understand that when we talk about the design tools of the office, we have to consider these three phases: Hand-drawing, 2D CAD, 3D Data and BIM.

SR: I should show you the latest version of this diagram. We tried to simplify this a bit but still you can see these different phases. The first transition is somewhere here in the nineties. Then we have another transition phase around which peaked 2015 that is still going on. But also, the “pen and paper” projects that you see here at the beginning of the timeline still exist nowadays.

AC: Kai told me about a recent project for a wooden building in which someone had drawn a 1:1 scale detail by hand.

SR: Yes, “pen and paper” drawings still exist, and might as well also continue to do so. It still has its right to exist. Same with CAD, for sure; we’ll use it less, but we’ll still use drawings in the future.

AC: When you refer to BIM, is this the “3D data” from the first diagram?

SR: Yes.

AC: And where do you put the scripting?

SR: If you take 2005, and this could be, for example, the Olympic Stadium in Beijing, of course, we did have 3D models for that. Otherwise, we could not build this. But it was not a BIM model, like a full-on BIM model that had every building element with attributes and so on. There was a three-dimensional model from which we could derive a lot of information and also the 2D drawings from it. But, usually, a model exists at the centre of the project.

AC: Do you see any difference between a 3D model, manually done, and one based on the scripting?

SR: Yes, but that just means how this model was made, how the pieces came together. You can do this by hand and click a lot of buttons, or you can automate the process, and the result is generated from your scripts. It does make a huge difference. It's a different way of making these models. For stadiums, it requires programming and scripting because otherwise you wouldn't be able to control these models.

AC: If you look at this first transition from hand-drawing to 2D CAD, this is an easy shift because you think about the project in the same terms. You changed the tool from analogue to digital but still work mainly with projections. Scripting and 3D modelling imply another mindset. It is a different way of thinking about the project and defining it. BIM, in my opinion, is yet another thing. Do you agree with this?

SR: Yes, it depends on how you work. I don't see scripting as a concept. Scripting is a tool. In a way, it is like model making. Here in this diagram, CAD, BIM and hand-drawing are seen as a process. This is about how you produce your final product. It also means that your final product is also different. Here you are producing a piece of paper, here a file that has 2D information in it and here you are producing a file that has 3D information and data.

Within this BIM data, we still do a lot of 2D work. I would say that maybe thirty per cent of the work is put into the 3D model. Then you take the model, you generate projections from that, and you work on those, putting dimensions or tags. This is 2D work, it is like drawing on plans, and that is sometimes more work than actually producing the geometry. So, modelling is one-third of the work, the creation of the 2D documentation is another third, and then the last third is enriching all this with attributes and data.

I think this is one of the misconceptions of BIM. People always think that Building Information Modelling is all about 3D documentation and that we will be working without drawings. People will still be working with plans. Just not on paper, hopefully.

AC: So this is a process of working. And what about Rhino? Is it in BIM?

SR: Rhino should be part of the BIM process. Somehow, we must put this Revit model together. Some things are much easier to do with Rhino. For example, a spiral staircase, we would today not do in Revit.

The problem was always that these two programs describe geometry in quite a different way. We have some tools that bridge the gap. With Rhino7 comes a new feature called Rhino-Inside which lets you run Rhino with all its parts from within other applications. So you can move sliders in Grasshopper, and create native Revit objects. So, modelling in BIM, Rhino is already part of it.

AC: When Kai was in the office, you did not use BIM so much. Is it a recent thing?

SR: Yes, BIM hadn't hit the industry as hard back then. The first project we did as a pilot with an early version of Revit was Roche Building 97.

AC: I think the computer started to have a more relevant impact in the design process some years before Kai came into the office, roughly around 2000. From this period, we have, for example, the free form of the window frames for the Schaulager, which HdM describes as "Digital Landscape: calculated forms produced with digitally controlled tools".

Then, there is also the project for Prada Levanella, with its very particular roof, the two stadiums—Allianz Arena and the National Stadium in Beijing—and Jinhua, which I suppose is a particularly relevant project for the office. About the latter, Jacques mentioned that this was the first time HdM conceived a building directly in the computer's virtual environment.

SR: It's not computer generated, like in a generative process that runs on its own.

Actelion and VitraHaus are similar projects, in which you take simple extrusions and shapes and merge them, ending up with very complex intersections. They are beautiful, but sometimes they would be hard to conceive if you didn't have the computer and the 3D model to control them.

In Jinhua, it is the same. You are using even more simple extrusions, you arrange them in 3D and what you get as a result are very complex artifacts and spaces. In a way, you can say the computer generates them because you generate them on the computer.

AC: I have the idea that when Kai was in the office between 2005 and 2015, scripting was a very relevant tool.

SR: I still think it is relevant; I just don't like to overexpress this term. For me, it is a tool, and it solves a problem. Parametricism. Of course, you can use it to create a certain aesthetic, or it might even be a prerequisite. But scripting does not generate an architectural style. Scripting, for me, is when we sit down and write our own libraries of code to make our life easier.

You would be surprised which projects have had a significant contribution of programming and scripting exercises, while others didn't. It doesn't always manifest in the appearance of the projects.

For example, Beirut Terraces was done with a lot of scripting to generate the arrangement of slabs. Messe was a long term job too. In Südpark, we used scripting at a point where it was about data transferred to manufacturers, but not so much for the design studies. All these different types of windows, we could do them by hand and most of them were also done by hand. However, later on, once you have these thousands of different windows and you are dealing with this complexity, how do you make sure that the manufacturer doesn't show up with the wrong pieces? So scripting was used late in the process to support digital fabrication. The same happened with Messe.

AC: Kai told me that the ETHZ assisted early on in the development of the project for the Südpark Basel. They created a script for the facade. However, I suppose there were some issues in the relationship between the random composition of the windows and the internal program planning. So, later on, when he took over the scripting, he made some adjustments to rationalise all the logic behind it. In this case, I think the scripting was also used to support the facade composition.

SR: Randomness is an interesting function because you cannot mimic this by hand. The same happened with Beirut Terraces. However, the scripting was not generating the architecture, it was just assisting you in finding the best working configurations.

You need to understand first what works and what not. Then, based on your observations, you can write the rules. So, for Beirut Terraces, we simply excluded many sequences so that, in the end, the script could generate only working configurations. There were only a few configurations you could choose from.

AC: It helped to give some design possibilities.

SR: It actually helped to narrow the possibilities down.

Unterlinden, for example, there are two free-form spiral stairs. We had to model them very precisely in Rhino and then give that information to the manufacturers who would cast them in concrete. Everything had to be precise, but to shorten the drafting process I wrote a lot of short functions for automatically rounding all of the corners off.

This is what I mean scripting is to me. It's a tool you may use or not. It can be part of your repertoire, but ideally it doesn't drive the entire design or even leave a visual trace.

AC: At the beginning of our conversation, you told me that the projects' geometric complexity had decreased in these last years. Why do you think this happened?

The geometric complexity we may particularly recognise in the projects between 2000 and 2010 came above all from HdM's interest in exploring ornament. Do you think that this interest has changed towards another thing?

SR: I wouldn't say the texture or ornament lost its relevance. And scripting is, in fact, a great way to approach ornamentation problems since the nature of this problem is partially geometrical. The more

recent National Library of Israel is quite ornamental, where we play with a certain degree of randomness in the facade.

AC: Which projects by HdM do you highlight as being paradigmatic of a strong relationship with digital tools?

SR: From all the projects happening in parallel at the office, there are some we heavily support and some we hardly communicate with at all as the DT group. For the Chelsea Stadium, for example, we had almost the entire team working on it at some point.

I think there was a phase in which it was a little bit like "anything is possible", and from a design or formal standpoint, the office was exploring the limits of geometric complexity. The Beijing Stadium, Actelion, VitraHaus, and Leonhard Street, the initial design for a Tower for Roche, fell into this era. You look at this curvilinear geometry, which is very challenging to design and build.

AC: But once a specific technology has solved a problem, you know that you can count on it, that you can use it again to solve other similar design issues and even go further in exploring them. However, I agree with you. In this office, architecture comes first, and technology serves to solve a specific problem you already have in the design.

SR: Exactly. In Elbphilharmonie we used digital tools extensively. It simply is a huge and ambitious project with a high degree of complexity. Why did we bring in technology? I think we did because it promised to solve a couple of problems. It's not the other way around where we bring in technology, and now we can go all crazy. If you look at other design studios, I get the impression it is sometimes the other way around. So, digital tools and scripting make some things possible, but they are not the driver of anything. They are just tools.

But back again to your question about which projects I would highlight. I would say Messe and Tate Modern 2, in the sense that we never went this far in terms of producing manufacturing data. Then about BIM, data and 3D documentation, "M+ Museum" as an experiment where we had to learn many things about a BIM process the hard way. This was the first big project under construction for us using data from the model.

AC: Do you think that any of these projects could have been built if you didn't have digital technologies?

SR: Sure. We can build all of these without them. It would have just taken a long time, or the process would have been different.

We discussed if whether we should buy an industrial robot for manufacturing. We looked at what universities were doing with these robots. I liked the ornamental exercises with bricklaying patterns where you work with a material, which is very analogue, archaic. For us, this was interesting. So, we prepared a presentation for Jacques and Pierre to show them what we could do with these robots, and I remember Jacques looked at it and said: "Yes, it's interesting, but what do we need the robot for?" And he is right. You could make this wall without the robot. It's an interesting fact that it was done with

the robot, but it's not what enabled us to do an ornamented curved brick wall. We could already make curved walls thousands of years ago.

So, what is the goal here? Using a robot or making the curved wall? So we have to see what tools do we need to do a curved wall, and if we need a robot, we'll get a robot. It's never the other way around.

AC: But if you think, for instance, in the Elbphilharmonie, there are a lot of things that would have been hard to accomplish without the support of digital technologies, or maybe that if you knew that you wouldn't have had the help of those tools, perhaps you wouldn't have gone for them.

SR: I think that you would just find a different tool. Look at these two projects, Signal Box and Messe Basel that are, in a way, very similar; both have metal stripes that open and close. They look different, but they follow a very similar idea. You have horizontal bands, and you bend the metal strips to create openings. The differences are in terms of scale and material, but it doesn't matter. I think that Messe in terms of pattern is a bit richer, indeed.

AC: Yes, a little bit more complex. And it is also integrated with the manufacturing process, right?

SR: Yes, they are both fully integrated with their manufacturing processes. But again, and this is quite interesting, when we designed this we didn't limit ourselves by how this could be made. At the beginning you design and then you have to find ways of doing it. So, in the case of Messe, we went to talk to different manufacturers to say, "this is what we want to get, can you make this?" And there was only one company that could do it.

When you make these waves, they consist of three parts, one is the wave itself, the sheet metal; another one is the profile that is curved in the back, and they are joined together; then there's the substructure. To connect these pieces you have to drill holes and put a screw through it, but we didn't want that. We wanted to have threaded pins welded on the back so you wouldn't see them from the outside

The machines that existed on the market could punch or cut out shapes, but they couldn't weld pins at the same time. This machine did not exist. So this company said that they could alter their machine and add this extra functionality. In a way, it was not that we designed this so it could be producible with the machines that existed. We had to design and built a machine that can do this. That company was the only one that could do it, so they got the commission to do it.

This is a good example. You don't limit yourself by what is possible, or what the technology allows you to do, but instead you define what you want to achieve and you find a solution for it. Sometimes it means that you have to write some software, sometimes it means that you have to build a different machine, sometimes it means you have to invent a new building material.

END

C.4
Volker Helm

A.04
Volker Helm.
Architect at HdM from 2003 to 2010.

"The computer is just a hand tool for Herzog & de Meuron."

Conversation with Volker Helm

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Alexandra Castro (AC): When did you start working at Herzog & de Meuron?

Volker Helm (VH): After studying architecture in Germany and completing a postgraduate study in Zurich, I started working for Herzog & de Meuron in 2003.

AC: I suppose that also Kai Strehlke did this postgraduate course.

VH: Kai was a supervisor at the chair of Ludger Hovestadt. I'm not sure if he graduated as well.

AC: How long have you worked in the office?

VH: I started in 2003 and left in 2010.

AC: I know that you began by making visualisations. In which projects were you involved?

VH: I was mainly responsible for the 3D modelling as a "virtual constructor". For example, I was involved in projects like the Beijing Stadium, Prada Levanella or the Tate Modern project "The Tanks".

Then, under the supervision of Philipp Schaerer, I also created a lot of visualisations and/or the associated 3D models. The form of expression and the quality of the visualisations by Philipp Schaerer are absolutely unique to me.

AC: Was there anyone else doing visualisations in the office?

VH: Christian Zöllner from Hamburg, who after this founded BloomImages, came afterwards.

AC: Can you tell me a little bit more about the period before Kai joined the office? What were the digital tools that you were using at the beginning of 2000?

VH: For the 2D planning, mainly "Autocad" and "Archicad" were used.

The software “Form-Z” was used for the 3D modelling, and there were a few licenses for “Maya” and “3D Max”. Then I introduced the “Rhino 3D” modelling software into the office.

Of course, there were also licenses for the usual image and layout editing programs.

AC: In which projects did they need digital modelling?

VH: The National Stadium in Beijing for the 2008 Olympic Games.

After the competition phase, a precise 3D model of the stadium had to be created. This was not possible with “Form-Z” by itself. So we switched to "Rhino" because this software has better functions for the 3D modelling of complex geometries. "Rhino" has some features that lend itself well to architecture that other 3D programs do not have.

AC: In which projects did you use Rhino for the first time?

VH: Difficult question. I have provided digital support for many different projects.

The good thing about Herzog & de Meuron was that they gave me the freedom to experiment with different technologies.

I've always been very interested in the connection between architecture and computer science, so I quickly got involved with the programming interfaces of Rhino. It is possible to program and parameterise complex operations instead of drawing them. At this time, this approach was absolutely unusual for architecture offices.

AC: So you showed them Rhino.

VH: Yes, in addition to Rhino, I also introduced scripting into the office.

At that time, I started with Visual Basic and used examples to demonstrate how you could program and change complex geometries without having to redraw them over and over again.

This is nothing new these days, and many offices are familiar with this approach.

AC: So you convinced them that Rhino could be a helpful tool to go further in the design process, experimenting on the objects' shape.

VH: At the beginning of my job, I supported the teams with 3D modelling.

The interest was enormous, and I was then more and more often involved in design changes and design adjustments. I enjoyed that, of course, and showed that digital tools could also play a role in the design process.

AC: I have the idea that they are curious and very open to any kind of technological tool. If they recognise some interest in a particular tool, they try to integrate it in their approach to architecture, exploring the possibilities that this can open in the design process.

What impact did 3D modelling have in the office? Do you think they felt it somehow as an improvement?

VH: The computer offers the opportunity to generate geometries that a person cannot easily imagine.

For example, if you subtract two three-dimensional bodies from each other, the result is not necessarily predictable, but inspiring residual spaces or areas can arise.

The computer can carry out such operations in seconds, and the result can be viewed immediately from all sides.

AC: What you are describing is an operation similar to that of the Jinhua structure, right?

VH: Exactly.

AC: I know that for Jacques Herzog, Jinhua is a significant project. He speaks about Jinhua as the first project that they designed entirely in the virtual environment, using 3D modelling to conceive and visualise the form, which would have been difficult by other means.

Looking at the work of HdM, we notice that around 2000–2005 there's a shift from 2D to 3D. For example, before that, ornament was mainly explored bidimensionally. The ornamental motifs were applied directly to the materials' surface. I wonder if it is connected to this, that when HdM introduced 3D modelling in the design process, the projects gained a three-dimensionality.

VH: The “gain in three-dimensionality” is perhaps the wrong formulation here. At least some projects have become more digital.

New tools open up the possibility of experimentation, and they also took advantage of it.

This means that the computer was not only used for the process of generating the shape. In addition to providing the basis for visualisations, the computer also allowed us to create sections and floorplans directly from the 3D model. Even production data for CNC machines could be generated from precisely constructed 3D models.

AC: HdM work a lot with physical models, which are an excellent means to visualise the shapes you conceive in your head. So I suppose that working with 3D modelling allowed them to improve the complexity of the projects.

VH: I'm not really sure if a 3D model can completely replace the physical model. I could often see that in a meeting, the built model always got more attention.

Despite new technologies such as VR, I can well imagine that this has not changed until today.

AC: In one of the HdM monographs by Gerhard Mack, the author mentioned that in Actelion, a stacking project that comes from the original idea developed in Qingdao, China, the computer played a fundamental role. It helped the architects to control the complexity of the form.

VH: In your statement, I like the word “help”.

The computer helps but is not at the same time the source of ideas. However, the computing potential of the computer can also be used for architectural purposes. For example — as you say — for controlling complex geometries.

AC: HdM are always and only thinking about architecture. I agree with you.

However, there is always an influence between the means and the research you have in mind. For example, if you have a collaborator in the office who can develop specific architectural topics with the tools that he masters, this, of course, allows the architects to go further with their interests, otherwise they perhaps have to change direction.

VH: During my work, I became aware that the computer is just a hand tool for Herzog & de Meuron, but that with the increasing digitisation, you can dive into specific areas and research them. For example, parametric design, in which one can use algorithms to bring components into certain dependencies.

However, I can also well imagine that, for example, algorithmically generated shapes are no longer of interest for the office and that new technologies and approaches have been researched there for some time.

AC: Currently, they are exploring more BIM and virtual reality.

VH: It could be. Or maybe a mix of several technologies. That's a good question for the current digital technology group.

AC: I think that they are very wise in catching the possibilities of a design tool. Just think about the passage from the 2D to the 3D of which we spoke before. HdM like to experiment with new things. And when they feel that some specific tool, that, for instance, one of their collaborators has mastered, can improve their research interests, they explore it.

VH: I absolutely agree with you.

Fortunately, at the time, I was in a position where I had the opportunity to try out many different technologies. Some of the results were of interest to the office, were followed up and partially incorporated into the projects.

AC: Do you think that the work you developed in digital modelling has somehow led to a new way of approaching architecture in the office?

VH: I do believe that new technological possibilities have influenced some projects.

At the time, I was fascinated by the fact that projects never repeated themselves and that HdM always sought new approaches. Therefore, digital processes certainly also played a role for a certain period.

AC: Kai Strehlke joined the office in 2005 to work on the Ciudad del Flamenco project, and from this moment, scripting became relevant in the office as a supporting tool in the design process. However, first, you said that before 2005 you were already working with small scriptings.

VH: I started by creating some "helping" scripts, like those for the National Stadium in Beijing. When developing the stands for a stadium, there are some important rules to keep in mind. This can be easily

inserted in a computer script, and the algorithm behind it is relatively simple — for example, the quality of the view from a grandstand to the field.

By changing individual values, it can have a significant impact on the shape but also the capacity of the stadium. With this script, you could try out quickly and automatically different situations and settings.

At that time, I was working with Steffen Marbach, one of the partners. He was very interested in these processes and realised that they saved us time and enabled us to react more quickly to changing things. I assume that he talked to Jacques and Pierre about it and then gave me the chance to delve deeper into the subject.

I was also involved in the Prada Levanella project. At that time, there was no parametric software like Grasshopper, so I developed a program with which the free-form roof could be set and changed using an Excel table. This, of course, helped the design team to make their own settings. The data for a 3D print was then created directly from this generated 3D model. This was the first step towards a digital process chain, so to speak.

AC: You told me that this was the first 3D printed model of the office.

VH: In fact, I'm not sure if it was the first 3D print. However, it was certainly the biggest and most noticeable print in the office at the time. In contrast to the 3D prints made of plastic, the plaster model was convincing. After an internal evaluation, the decision taken was to outsource the 3D printing.

Regarding scripting, I forgot one more interesting project. I worked as well on an oval table based on a small computer script.

AC: Kai spoke to me about this table.

VH: There were four control points that outlined an oval. The script was able to automatically move the x and y coordinates of the points according to a certain rule so that each time a change was made, a different oval-like drawing was created. After this procedure, I generated a PDF with many slightly different shapes, and from this, the shape for the table was selected.

AC: I saw this table in the archive.

VH: Yes, the project was fun, and I think this parametric approach helped me to make decisions.

AC: That's why HdM interest me. They are open to technology and have integrated it into their design practice. However, this is somehow hidden. When you look at their buildings, you don't see that kind of architecture in which you suddenly feel that there's a digital tool behind it.

VH: I agree with you. In some projects, however, conclusions can be drawn about the tools. At least with the people who know a little about it. For example, I would mention the facade of the Basel Exhibition Centre or the glass printing of the Elbphilharmonie.

AC: I know that you also worked on the competition for the Gazprom highrise.

VH: The Gazprom City project was very interesting for me. It led me to learn how to include the topic of parametric design in a competition. In this project, it could be shown that scripting is helpful for the generation of form but also for the analysis of design statuses.

In this case, the area calculation was output directly when a proposal for the tower was generated.

It was similar to the Messe Basel project in which I worked with Steffen Riegas. For the facade, for example, the maximum bending of each individual aluminium sheet could be displayed.

AC: All of these functions allow you to optimise your design in specific topics.

VH: Exactly. By iterating with different design parameters, shapes can be optimised.

AC: When I spoke to Harry Gugger, he told me that one of the first times they used scripting in the office was in the competition for the high-rise in Zurich, to calculate the "two hours shadow".

VH: Yes, this is a very good example of how a computer can take over repetitive processes that follow a clear rule. For example, in this case, the script was able to calculate the shading of a building at any time, both as a percentage and as a line drawing. Nowadays, such tools are probably already implemented as a standard in the CAD software.

AC: Harry Gugger also described Südpark as a paradigmatic project in terms scripting. So, there was the table, Prada Levanella, and the competition for both Gazprom and the Zurich high-rise.

VH: Yes, and many more smaller projects.

In any case, I would also include the facade of Messe Basel.

AC: I know that you were also involved in the project for the Tate Modern extension. I suppose you developed the first scripting for the facade.

VH: The challenge in this project was the geometry of the building. The project team had difficulties creating a 3D model for the building because the surfaces are inclined. Geometrically, this is not that easy — especially when sloping surfaces intersect. Together with Dominik Nüssen, we helped the team to translate the 2D drawing into a 3D drawing.

AC: There was a big issue with the bricks and their geometry, especially at the creases and corners.

VH: The formulation of the crease and corners was solved by the project team. We supported the automatic distribution of the stones in 3D.

AC: Why did they ask you for the scripting? Was it because of the amount of data?

VH: Yes that's right. With every change in the building envelope—such as the inclination of the surfaces—the position of the stones also changed. If you had to draw each one individually, it would be quite time-consuming.

AC: What do you remember about this process?

VH: At this point in time, it became increasingly clear to me that the digital processes described can provide enormous support in the development of architectural projects. Today this topic has found more acceptance in offices — especially for large projects. It was already clear to me at the time that generative approaches in architecture were not just a fad.

AC: In your opinion, what are the most relevant design tools in the practice of HdM?

VH: You'd best ask Jacques Herzog and Pierre de Meuron. I would also be very interested in the answer. I would imagine that part of the answer is creativity and good ideas. The computer will likely have a minor role.

END

C.5
Harry Gugger

A.05
Harry Gugger.
Architect at HdM (1990) and a Senior Partner from 1991 to 2009. Partner in Charge of the projects for TM1 and TM2.

"This is too generic; this is not the Tate!"

Conversation with Harry Gugger
Harry Gugger Studio, Basel, February 20, 2020.

Alexandra Castro (AC): In my PhD, I'm studying the relationship between geometry and digital tools, and I decided to take Herzog & de Meuron as the main case study. I'm interested in understanding what has changed in their architecture from the moment they introduced digital tools in their design practice.

Harry Gugger (HG): Jacques and Pierre were rather cautious in their approach to the computer. I was working on the Signal Box and the Engine Depot, and because this last one was such a big and repetitive project it didn't make sense to draw it by hand, so I bought my own computer. The Engine Depot was thus the first project which was drawn by computer. I used "Top CAD", a software with which you had to do a lot of scripting yourself because it was not very developed.

AC: Was the Goetz Gallery designed by hand?

HG: Goetz was, in no small extent, designed by hand. It was drawn mainly by Mario Meier, a crucial figure in the office. He was an experienced collaborator, he knew how to construct things, and he always did beautiful hand drawings. He had his style.

In the Goetz Gallery, it was a mixture, like in Tate Modern 1. Of course, in TM1 it was all CAD drawings, but the details were often still hand drawn.

So, up to around 1990 you have hand drawings, and then CAD starts to move in.

AC: This diagram is from Kai Strehlke. He did it when he was in the office and it shows that in this initial phase in the office there were only hand drawings, and at a certain point, around 1990, as you said, CAD was introduced. Afterwards, more or less around 2005, digital tools, like scripting, and a digital workshop, were introduced in the office, roughly at the same time that the DTG was created.

HG: I employed Kai at the time. I had a former PhD student, Russel Loveridge, whose thesis was about digital production, and Kai was his friend. They knew each other from the CAAD chair of Prof. Ludger Hovestadt at the ETHZ. Ludger is also a significant figure in this whole digitalisation process.

AC: In my PhD, I decided to study, in particular, Tate Modern 2 because it is a project in which scripting was used to support the design of the brick facade. However, the design process for TM2 was the result of a close interaction between analogue and digital, in which physical models played an essential role in the definition of the solutions. Tate Modern 2 interests me also in a particular way because when you look at it, you don't see a "digital building", but rather a classical architecture that is searching for relationships with the surrounding context.

I spoke with Kai, who was directly involved in the scripting of the facade. I also had a conversation with Andreas Reeg, the architect responsible for the detailing of the brickwork, even though he joined the office in London only at the end of 2008, when you were concluding the planning application that was submitted in January 2009.

HG: If you want to talk with someone who was really instrumental in the facade development, it is Wim Walschap. He is now a partner at HdM. He was sort of Mario Meier for the Tate Modern 2 project.

He came from Belgium, where he was a collaborator of Robbrecht en Daem, which is an office with very high sensitivity in construction, and he brought that with him. Wim was developing the facade. If there was a key figure in terms of the regular tools, that was Wim. The design was then translated to be more efficient and to allow for better construction with the help of digital technologies. From my point of view, for as long as I was in the office, the design was hardly ever driven by the digital. The digital was always a tool.

A more extreme project is, maybe, Südpark. It was the very first time where we really used scripting. This building is located in a plot between the open field of the railway tracks and a rather ordinary road, defined by traditional buildings with small windows. The idea was to change the scale from an orderly facade to a more open facade. We started drawing by hand, but this was a lot of drawing, and the human being always gets annoyed. As such, I never had the final result, because collaborators started to get annoyed, having new ideas and forgetting about the set parameters, or introducing new ones. So, I never had a complete result, and I was getting upset. So, we started to work with Steffen Lemmerzahl, an assistant at the chair of Ludger Hovestadt at the ETHZ.

Do you have our design for the Prime Tower in Zürich in your map?

AC: The competition for the highrise in Zurich? I don't have it here.

HG: As I mentioned, the engagement with digital production started with Russel's employment at my chair at the EPFL and our close connections to Ludger's chair at the ETHZ. Kai, Russell and Steffen are all pupils from Hovestadt, from his early period at the ETHZ. It had a huge impact when he came to the ETHZ, and there's a whole generation which is still around, like Kai, working for Blumer Lehman now, and Russel, who is now the director of Switzerland's National Research Competence Centre for digital production [the NCCR Digital Fabrication].

So, we brought Steffen in because of the special highrise regulation we have in Switzerland, the "two-hour shadow". We wanted to have a digital tool to calculate this "two-hour shadow" for different forms of highrises. Consequently, we also collaborated with him on the Südpark. This project is all about parametric design, because, as I said, we never got to a full result with manual tools. I think this was a key project concerning the application of digital planning and production, and it also helped, of course, to build it economically because it has so many different windows.

AC: Kai told me that the ETH first developed it. However, I suppose that the result was not "good"—this is not the right word—but it did not relate the external appearance to the interior planning, so at a certain point Kai took over the script and worked on it.

HG: That's true, but I don't think it is about good or not good, because first we needed to develop it promptly. This project has a history. In the beginning, it was very different in its appearance, but it failed. In Basel, we have what is called the "Stadtdbild Kommission", a design panel which I think is unique in Switzerland, since it is based on an aesthetic law in Basel in which you have to comply with its "Paragraph 58". This is not only advice, but you can also fail or not, and if you don't comply with it, you don't get the planning application—and we failed in this project. That's why we needed to develop a new architectural expression, and that's how the CAAD department got involved. They worked with us for as long as we had to come up with the conceptual idea to be presented to the design panel. Then, when we got the planning permit, and we got to tender drawings, that was when Kai came in. But it was not because they were not good enough. They simply had fulfilled their job, and so it was passed on to our internal development team.

AC: I also spoke with Volker Helm, because of these projects around 2000 in which we may perceive that there's already something of the digital. He also came from the ETHZ.

HG: Well, he came from the ETHZ to work with us, and then he went back.

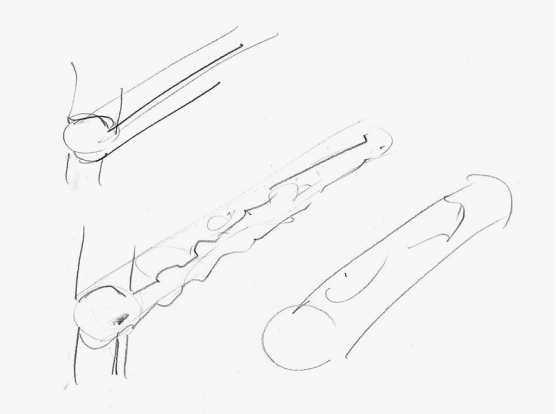
AC: I suppose Volker was a student of Kai at the CAAD chair.

HG: I think you might be right; Volker was a student of Ludger Hovestadt. Then he joined us, and afterwards he wanted to do a PhD, so he left again.

AC: He worked on Prada Levanella. For this project, he developed one of the first scripts for the office, a very simple one. Volker told me as well that it was made into a large 3D printed model of this project, which was produced by outsourcing.

I know that you were the partner in charge of the Schaulager, so I would like to ask you one thing about it. Is there anything digital in the design and construction process of the windows?

HG: Yes! The problem here was simple: how to do an opening into such a specific wall. Of course, we had tried standard windows. However, we were never happy. When I worked on the Tate, Jacques would often join me, and so we discussed the matter on a flight to London; that's when the idea that the window should be a homologue of the wall surface came up. The window should actually be like the surface.



A.06
The deformed tube. Sketch by Harry Gugger (2020).

So, we started to think about how that could be done, and we began to think about frottage. Do you know what frottage is?

AC: Yes, it is the same technique that you used on the doors.

HG: The window is the same but blown up. Can I draw? If you take a cylinder and you start to deform it, and then you start to roll it, you get to the surface of the wall. This surface appears in the cafeteria and the shop. It's always the same shape but in different scales.

So, on that flight, we discussed the window, and Jacques said, "It's like if one would drill through the wall."

When I came back to the office, I asked a trainee to take a tube, to hammer it and then to roll it out, and that's how the inner surface for the cafeteria appeared. If you now put the deformed tube in a wall, you get to this special form, but, at the same time, this leads to tons of problems, like water collecting at the deep points. So, we took this deformed tube and made a photogrammetric reading. This gave us a digital set, and then we started to push and pull the points, which now were all controlled. Wherever it is the lowest, the water flows into and that's where we put the drainage tubs. So, this is all highly technical, and it was only possible to solve the problems with digital tools.

The imprinting of the metal doors did also rely on a digital file, which allowed us to mill the pressing tool. Everything is digital.

AC: But you started with a physical model.

HG: Very often; also in Tate Modern. Here it was the brick. It was all about the brick.

Do you know all the itinerations of Tate 2? There are three, all based on the pyramidal form that derived from the "rights of light".

AC: Ok. So, it comes from the master plan that was done between 2003 and 2004?

HG: Yes, it does. The owner of the adjacent plot wanted to develop his property. In England you don't have a zoning law, so you can build, for example a tower, wherever you want. If you get all the stakeholders behind you, no one can stop you. But once a tower is built, you might not be able to build next to it anymore because of the "rights of light". So, the Tate knew that at some point this would lead to a problem, and they needed, not knowing what was going to happen, to defend their own development property. The people who developed the tower were first interested in buying a plot from Tate, so we were in contact with them. They would show us what they wanted to do but they would only do what we agreed upon, and that's how the pyramidal form came about. So, this was a given.

On the first itineration, the pyramid was clad in Corten with big, flash windows. This was already a fully developed project, ready to go for planning application, and we presented it to the trustees.

AC: When did this happen? After the master plan?

HG: Yes.

AC: Was this the first study?

HG: Study?! It was already a commission to design Tate 2.

We showed this to the trustees and they said, "It's all very rational and reasonable, but it has no "wow" effect. What you design has to have a huge "wow" effect. Why? Because we need to raise money, and we don't believe that, with this project, we can raise the money." And that's how the glass pyramid appeared. That's when we started to overdo the pyramidal shape, with the blocks all out of glass.

AC: Is this the Corten version that you are talking about?

HG: Yes, exactly.

Then we presented the glass version to the trustees, and they said, "Wow, this is good! We like this. This is exactly what we were looking for."

After the meeting I flew back with Jacques, and I told him that, in my opinion, we should not proceed with the glass cube design. I said, "This is too generic, and it could be anywhere. This is not the Tate!" Jacques asked, "What do you mean by this?" I replied, "I think we should be much more restrained; we should create a more coherent project. We should not have Tate 1 and then something new." Jacques actually shared this opinion and that's how we moved on to the third itineration.

AC: I understand, because from the beginning you were saying that Tate Modern should be one coherent whole, and in the glass versions it is not like this.

HG: Yes, and this is when the brick came in.

Of course, we first tried the stacked box version with brick, but it was too clumsy. So, it was clear that we should go back to the pyramidal form clad with brick, and that's how the final version started to evolve. We didn't want to have the ordinary size brick, and so the double brick came into play. We also wanted to have a quite archaic form and, at the same time, we wanted daylight penetrating the facade.

AC: Maybe to speak about Tate 2 we should return to Tate 1, which is where everything began. Why was Tate Modern 1 so special for HdM?

HG: It's the project that made the company world-renowned. It is as simple as that.

The company was already well-renowned in the world of architecture, but was not publicly recognised, like, e.g. Richard Meier or Mario Botta. The Tate project made the office popular. It was an important stepping stone in the evolution of the office.

If you ever write about Tate, you should have an interview with Nick Serota. He is the figure you have to talk to, because he is the Tate! Of course, many people have made important contributions. Still, the nucleus of it all is Nicholas Serota. He is a very special man, highly intelligent. Intelligent in two ways, very rational, but he is as much a humanist as he is a technical scientist. He unifies these two worlds, like you often see happen in architects. Nick Serota was a very good client. Not just from top down; in a way he became a partner. Generally, as an architect, you educate the client, but, for once, there was a client educating us. He has an incredible aesthetic sensitivity, he would comment on each drawing, and all his questions were pertinent, so there was a lot to learn from him. Also, for this reason, the Tate was a crucial project.

Also because of the political situation. The project happened when England started to open up and to change from conservative and technocratic-oriented to a progressive, culturally minded country.

AC: And now they are closing again.

HG: Now they are closing again, they always open up and then they close in again. But that is another story.

Tate Modern played an important role in the transformation. It merely brought contemporary art and, anyway, the art world, to the UK; it also had an impact on architects like Caruso St. John or Sergison Bates. This whole generation was brought to the surface in this climate.

Tate Modern was a turning point for the office, but at the same time for London.

AC: Before choosing the winning team, I know that the jury visited some of the buildings designed by the architects who were on the competition because, I suppose, they were searching for someone who they could work with.

HG: Absolutely, and in this, we have to be very clear, Jacques played the key role.

Jacques was able to create a close relationship with Nick, like no one else in this process. For Nick, it was important to find a design competence, but also an intellectual competence in the broader sense. He liked the fact that the office was, relatively speaking, compared to the others, a young and an upcoming practice. Nick Serota didn't go for fame, but he could have fallen for it.

And of course, the office proposed an intelligent and respectful project, respectful to the existing structure. Others made mistakes, like David Chipperfield, who cut off the chimney.

AC: Among all the proposals, yours was the most simple, and, from the external appearance of the building, it seemed even like you didn't do anything.

HG: Not anything, but very little.

AC: And in a very careful way, because it was very respectful to the existing building. In your opinion, what are the aspects that best synthesise the intervention on Tate 1?

HG: Very simple. The Light Beam. The Turbine Hall and gallery spaces that foreground the art. That's it!

AC: On the monography of Tate 1, there are some studies for the north elevation in which we see that different design options for the facade were taken into consideration. As usual on HdM, before accepting one solution, you try unexpected things that may open up other possibilities. I notice that in some of these studies, the facade was much more transformed. I remember a drawing in which there was a continuous opening on the ground level, or another one in which the windows were cut out on the facade in a very radical way, which reminded me of the Küppersmühle Museum.

HG: But Küppersmühle was later.

AC: Yes, it was later, but some things that were studied here reappeared later in Küppersmühle, and then also in Caixa Forum, like the cut-out at the ground level.

HG: That's again a different story.

For the Tate, it is the "light beam" which signals the transformation, because it is emitting light; it's about light and not electricity anymore. And then to open up the Turbine hall...

AC: "It's about light and not electricity anymore"?

HG: Yes, a power station is about electricity and a museum about light. The bay windows in the Turbine Hall kind of reflect the light beam from the top and bring the light topic into the Turbine Hall.

But to come back to your question about the facade, yes, initially we altered the existing building radically, but, more and more, we became restrained, accepting the building as it is. The interventions were reduced to the ground floor because of the restaurant. So, the specific functions made the exceptions and the rest stayed as it was.

Caixa Forum, in turn, is all about public space, actually the lack of public space. There was the Paseo del Prado, the building, and in-between, a gas station.

The client came to us because of our work on the Tate. This is a funny story.

At HdM we had an old bell. Not an electric bell; one that you pull with a string. At lunchtime, Pierre and I were the only ones sitting in the villa, and someone rang the bell. We were sitting on the top floor, and we didn't react. Then someone rang the bell again, and I said, "Pierre, do you expect someone?" and he said, "No!" To which I responded, "I also do not expect someone, so we don't go down."

"No, we don't go down!"

The bell rang again, and then I said, "Ok, I will go to see who is insisting." I went down, and there were two distinct men, very well dressed.

They asked, "Is this Herzog & de Meuron?"

And I said, "Yes. Do you have an appointment?"

"No, no appointment, we want to talk to HdM."

"You come here and you don't have an appointment, so who do you want to speak to?"

"We want to speak to HdM."

I said, "Well, there are many people working here."

And they said, "We have a commission; we want to build a museum with you."

To which I said, "What!?"

They kind of came across as madmen, but at the same time, they looked very proper. So, I said, "This is Switzerland, it is lunchtime, and nobody works."

"Well, we happen to be here. Can we come in?"

I said, "Ok, come in." I went up to Pierre, and said, "Pierre, listen, there are these two guys, and they want to build a museum with us." So we sat down at the cafeteria, and after a while we understood that they had this power station in Madrid and they were simply thinking, "London power station turned into museum; Madrid power station turned into museum". A week later, I was in Madrid.

But nothing worked out! They had a huge program, so I told them, "You can work with this power station, but you won't get the program you want, or you can build your program, but you need to go somewhere else."

They said, "We want both. Our program in this power station."

And I said, "Ok. But you also know that we are in a second row. There's Paseo del Prado, there's a gas station here, and there's no public space. So how should all that work?"

And they said, "You are the architect; you make it work".

I replied, "Ok, but you know what, this gas station has to go."

And they said, "No problem, we will buy it!"

But there was still not enough public space, so that's why we took out the socle. The plinth of the building was in granite blocks, and if the client would have listened to us, these granite blocks would still be there, because we wanted them to be dispersed on the ground as seating opportunities. They didn't like the idea, but it would have been beautiful. At the end, we of course needed more area; that's why the building extends below ground and on top of the existing building.

AC: When did Tate Modern 2 start? I suppose that on Tate 1 there was already the idea of making an extension. When you designed the Turbine Hall, I think the decision of going underground was also related to the use of the oil tanks as exhibition spaces.

HG: The oil tanks were originally part of Tate 1. But many things were not done in Tate 1 due to budget cuts, because there was only a restricted amount of money available. There would have been an art storage, and the exhibition spaces were extending into the oil tanks. This is again inherent to the concept if you have the Turbine Hall as a covered street; a street has two facades, and you have shops on both sides. It was always clear that the Turbine Hall has not only one face but two.

So, there were the oil tanks on the other side, but this wasn't affordable. There was also the idea to have access from the south, but this didn't work because of the transformer station. The old transformers occupied the whole Switch House, and only when the transformer station was reconfigured, the opportunity to transgress it came up. So, in a way, Tate 2 was always there. If you ask me 'when did it start?' It started with Tate 1, but we hit the wall.

AC: In some composite images, I saw that there was also the TM3.

HG: Only on the master plan level. The idea was to create a facade in front of the remaining Transformer Station.

AC: So, everything began with the master plan. Knowing that, afterwards, it would not be easy to build, Nicholas Serota decided to develop a master plan to ensure, based on the "rights of light", the general envelope of a building that would be designed later. When we look at this picture, we see many of the concept models that were done during the "schematic design" stage. Can you please explain to me what happened in these three years, between 2005 and 2008?

HG: As we discussed before, this was the period when we designed the three iterations of the TM2 pyramid—the Corten, the glass cube and the brick version. The thinking was always the same. It was about how to accommodate the necessary program within the given restrictions, and, as such, the idea of the pyramid was always there.

AC: In 2007, HdM concluded the report on the glass version. During 2007, I have the idea that the process was kind of suspended, maybe because Tate needed to get more money to continue, and I noticed that it was during this period that the direction of the project changed from the glass to the brick version.

HG: If I remember well, we changed the design pretty immediately. We were forced to do so because otherwise the trustees would have gone with the glass version. We had to tell them that we didn't want that to happen, and this was not so easy. We had to tell them that we would like to redesign again for the third time.

AC: The report of the glass version is from December 2006 and the report after, the one regarding the brick version, is from August 2008.

HG: Don't ask me about dates, but believe me, we immediately continued to work; there might have been, at some point, for some other reason, a stop, but this was a continuous work process until the complete schematic design report for the brick version was delivered in August 2008.

AC: What did the trustees say about the brick version? How did you explain it to them?

HG: We criticised our own work, and we told them that we had been overreacting on their wish for a "wow" factor, that the project became too glamorous. We told them that we should go back to a more restrained, more coherent project, emphasising the ensemble, and that this was not least a question of materiality.

The trustees are very intelligent and cultivated people and there are always artists on the trustee board, so they understood what you were talking about. And we never got to the trustees directly, we always spoke to Nick first, and Nick knew how to handle the Board. These were all very carefully designed processes, and Nick is a political animal; he could act as Prime Minister of England. His mother was the first woman in parliament, so he must have inherited that political talent.

AC: So, you decided to simplify the volume, to work with the brick, and you chose to use the same brick.

HG: Yes, you are right. The new brick comes from the same quarry as the original ones.

AC: Then a lot of work was developed on the size, bond and colour of the brick, always trying, in a certain way, to innovate.

HG: What we proposed was far from traditional brick construction, and rather expensive. The bonding was not done with mortar, but with metal bolts. This is very difficult, very delicate and very elaborate. The brickwork looks like masonry, but this is not the masons' work, this is a revolution in the use of brick and actually a bit crazy.

AC: And everything was developed taking into account the whole system of the facade.

HG: We wanted to work with daylight, but we didn't want to have big openings. But if you take the standard size brick, and then you start to lay it down, there's little opportunity to bring light through. If you go for a double size brick, you can create bigger openings for more light. The system becomes more efficient in terms of light. The question was very simple: how to create a uniform architecture allowing for daylight to penetrate, allowing for the easy integration of windows, and working also with the pyramidal form. It is as simple as that. These are the parameters with which you have to solve the problem.

AC: You also worked on the colour of the brick. The colour was also an important issue, right? I saw some composite images of the facade where we see a kind of gradation that goes from darker on the bottom to lighter on the top.

HG: The idea was to use the same kind of brick and, actually, we went back to the quarry to source the brick from the same place as the original one.

AC: I saw that you identified, in the masonry of the Bankside power station, three types of brick: the red one, which is in the plinth, and then the yellow and the yellow-brown that are on the upper part of the building, and you tried to develop a gradation with the same range of colours.

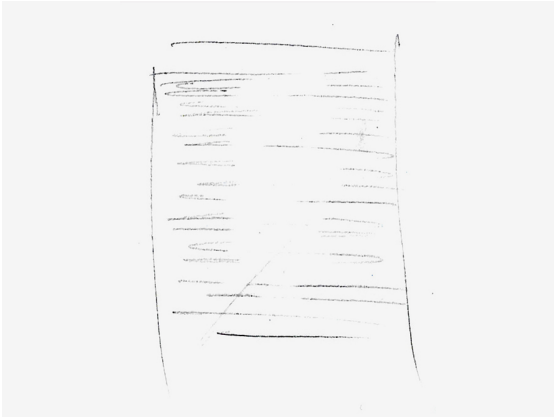
HG: Yes, this was the original intention, to replicate the graduation of colours as in the existing facade.

AC: But in the end you decided on the same colour range from the bottom to the top.

HG: Well, don't we have the red brick in the bottom?

AC: I think it is the same kind of bricks from bottom to top.

HG: On the northwest corner? I don't remember, but I think there is a strip in the connection point between the old and the new building, only for the plinth.



A.07
The concept of the Signal Box facade. Sketch by Harry Gugger (2020).

AC: The geometric shape of the building is not simple, because it is a twisting shape made of vertical and inclined faces that intersect each other along oblique lines. This shape, together with the perforated brick wall, brought out some very complex geometric problems which are particularly visible, for instance, in the corner.

HG: Yes, we liked that complication.

AC: Were you aware from the beginning that this would be an important and complex issue to solve?

HG: Of course. This was very interesting, because you could see a ziggurat in this volume. You could see an ancient building or a ruin in it, and this is all very conscientiously decided. This is all part of the architecture, and it allows for many different perceptions. It is open, and it offers food for the eyes; it is tactile, it makes the eye engaged.

AC: I remember that in the report in which the brick version was presented, it was mentioned that, for the corners, a special brick would be used, a larger brick that would give stability to the edge. But then, in the following reports, this solution was changed, and in the corners we have a kind of porosity; it seems like everything is going to fall down. Jacques, at a conference, said, "How we use the edge, where the two sides come together, to create this kind of porosity which defines, or also reveals, the construction behind it, it is a simple but important detail for how we use construction as part of the idea of the whole building."

HG: The skin of Tate 2 has a lot to do with the facade of the Signal Box. This was drawn by hand, and this is what this is about. It was almost like erasing the precisely drawn lines. It is an interesting impreciseness.

The antique Greek architecture is all about that. The building collapses, the columns are shaped, the plinth is curved. The Greeks did this because you make the building appear more monumental.

I think this should be a celebrated quality of architecture. If I take your face and I mirror it, you look pretty boring. You are more beautiful because your face has two sides; this makes you more interesting. I truly believe that if something is too perfect, it revolts you. It is like a sign of aggression, and the architecture that works with impreciseness is more acceptable, is more human.

AC: I spoke with Andreas Reeg, who worked on the detailing of the brickwork, and it was clear from his comments that, from a construction point of view, the ideal solution was not the one with the perfect corner. On the contrary, it would be more reasonable and even cheaper if the corner was imperfect. In this way, bricks would be regular, the holes inside the blocks would be all controlled, and the pieces could be standardised.

HG: Yes, that's how we wanted it to be!

AC: I would like to ask you one thing regarding the openings.

The brick veil is the element of the new building responsible for the relationship with Tate 1. This outer skin is a device that, being autonomous from the structure, allows it to control, through the openings, the scale and the composition of the facade.

I know that some technical issues, such as daylight and ventilation requirements, interfered in the design of the openings. However, I think that there is also something of the architectonic about it.

I noticed that all the windows are positioned at the corners or creases, which accentuates the volume continuity. Then, in correspondence with the Switch House rooftop, the window at level 5 runs all around the perimeter of the building. The same happens on the top of the volume, at level 9 and 10, so when you look at the building, you may notice a horizontal tripartition. It is as if the building had a base or a plinth, then the main body, and on the top, a cap that concludes the volume.

HG: Absolutely! You could call it the Renaissance principle of topping a building. These are all important measures to define the top of the building, and, of course, it has a function, because it is the viewing terrace.

AC: How do the partners interact in the design process The few sketches I found in the archive are all from Jacques and Pierre, and they always focus on the main concepts of the project, like these. What is the importance of the sketches in the design process?

HG: The project is controlled in dialogue. For Siza, the sketches are essential; for Herzog & de Meuron I believe that the dialogue is important. This is inherent to the fact that Jacques and Pierre have started the practice together, which allowed them to open up to other partners. Very often, it is a review process, like in school. I don't know how it is right now, but Jacques and Pierre used to play an important role because they were the only ones connected to every single project.

There are projects in which I was not involved. I, of course, knew about those projects, but would only be part of the discussion at my discretion. But in projects like the Tate, I was the one working with the team, and, for example, an essential part of this project, the vertical circulation, I developed with two very young architects. The whole circulation is a project in itself. They formed an almost independent team, they were really young, worked in their own little room, and it was my role to connect their work with the other parts of the design, to coordinate it with the rest of the project. We had the outer form and then we had the inner circulation. Tate Modern extension was a complex project and I believe that the circulation was more important than the outer appearance. The facade is one thing, and of course complex and interesting, but the real project, the essence of Tate Modern 2, is the vertical circulation because you should never build a museum on ten floors if you are not forced to.

AC: On a text about Tate Modern 2, Beatriz Colomina speaks exactly about the topic of the museum made of ramps, which has its origins in some models of Le Corbusier and Frank Lloyd Wright. Even Ibere Camargo Museum in Brazil, by Álvaro Siza, is made of ramps. On a recent conference in Porto, Siza mentioned that when an architect has to design a museum, he cannot help thinking of such important buildings from the history of architecture, like the Guggenheim in New York. And I think that Tate 2 is also one of these examples.

HG: Tate 2 might have become another reference for how to organise a vertical museum. But, as I said, this was not intentional; we were forced to organise the extension vertically because of the forces of the real estate market.

AC: What is the role of these study models in the design process? I suppose that in the initial phases they are highly significant.

HG: Not only in the initial phases are the models important. We built all kind of models throughout the process. Models are essential for the practice, and everything is decided and discussed based on models.

AC: At a certain point in the design process, you realised that the scripting could be useful as a supporting tool, and Kai developed a very well-organised script that became operative in the design process of the brick facade. However, Andreas Reeg explained that the solutions and decisions about how to do this were first defined on the physical models. Only after, when they were already established, were the rules transmitted to Kai, who would include them in the script. So, the script was not used as a designing tool but a production tool.

HG: Yes, you are absolutely right!

AC: In your opinion, what had changed in the design process of HdM, more or less around 2005, when the digital tools were introduced?

HG: What had changed? Well, I think nothing.

This is my conviction, but I'll try to be as objective as possible. The digital tools, as the name says, are simply tools that certainly allowed for processes to be feasible and economical which otherwise

A.08
Stadiums. Sketch by Harry Gugger (2020).

would not have been, and of course, they had a huge impact on the evolution of the office. You can describe this in dichotomies: small–big, simple–complex, and of course, local–international, in that the digital plays a key role, it allows an office to control projects in the full range these dichotomies present.

When the office worked on "Pilotengasse", the housing project in Vienna—and that is not so long ago—everything was drawn by hand; the only technical tool was a fax machine. This fax machine worked with this coated paper, and every evening at six o'clock our collaborator in Vienna, Gerold Wiederin, sent the latest drawings by fax. It was metres and metres and metres in one thing. Then the team in Basel would prepare it, show it to Jacques and Pierre, and then, with annotations, send it back again. Nowadays, it is much easier, you can control processes anywhere in the world, and that has to do with the current communication and information technologies. That's an important fact, and that, of course, is part of the digital world. So, I think that the digital was merely a tool which allowed the office to grow in size and work with higher complexity.

This project for the National Stadium of Beijing, you could think this is a result of digital processes, but it is based on a Chinese cord which Ai Wei Wei brought along.

I was leading the competition team, and we had to work on the competition over Christmas and deliver it in a very short time. We had our Christmas dinner, and Pierre told me that he wanted me to be responsible for the competition, and I believe, I remember, that by the end of January we already had to submit the project. So, at the office Christmas party, which was a terrible evening for me, I had to select the team and we suddenly started to work. The first thing we did was analyse the last two Olympic stadiums, in Sydney and Athens. They are, of course, both round stadiums because it serves the track and field competitions, but the main structure in both cases was two large overarching beams. The Athens stadium is by Calatrava, and the one in Sydney by HOK. So, there is a radial figure clashing with

a linear main structure; there can't be a pleasant result. You might solve the problem, but you can make this a great piece of engineering. So, we wanted to have a pure radial structure.

The other thing is that if you design a track and field stadium you get to an oval, but the viewing distance should be the same everywhere. So, if you start with an oval and you start to add the seats for the spectators, you get to a circle at about 80,000 seats, because you want to have fewer ranks on the short sides of the field and more on the long ones. This is a geometric condition.
So, we approached this step by step, track and field oval, adding spectators, good view lines, and we ended up with a circle. Now why should the circle be interfered with by a linear structure, like in the two other stadiums? This was the story we told Ai Wei Wei, who immediately thought of a ball of string, and he brought one along from China as a piece of reference.

The digital wasn't powerful enough at the time, this is why we ended up with a rather traditional structural design, which is not sustainable. But if each element of the structure could be loadbearing, this would result in a very intelligent design, and we could have spared a lot of metal. But at the time the engineers told us that the digital tools were not yet able to do that. They still had to rely on primary elements, which you can easily detect if you study the structure carefully, and secondary elements which were not loadbearing, because the finite method of the calculation didn't allow them to include every single member. This was right at the beginning of this century. Maybe today you could make this structure more intelligent and efficient.

AC: In your opinion, what is the most important design tool in the office?

HG: The models! It is now a while ago that I left the office, but until then, the models definitely. Also the drawing, of course, but what kind of drawings? Sketch, hand drawing, technical drawing, it doesn't matter!

END

C.6
Nicholas Serota

A.09
Nicholas Serota.
Director of Tate from 1988 to 2017 and client of both TM1 and TM2.

"Tate Modern 2 is a post-digital building."

Conversation with Nicholas Serota

Zoom meeting, Porto–Helston (Cornwall), June 25, 2020.

Alexandra Castro (AC): I am currently developing my PhD, which is concerned with the relationship between digital tools and design practice in the work of HdM. For several reasons, I decided to take the extension of Tate Modern as the main case study of my research. In particular, this project interests me for the role that scripting had as a fundamental supporting tool in the design of the brick facade.

So, I asked you to have this conversation because I know that you were a very special client, and I would like to have your insight into the project. I also met Harry Gugger, who suggested that I should speak to you, saying that if ever I should wish to write about the Tate, I would have to speak with Nicholas Serota, because he is the Tate.

Nicholas Serota (NS): That's not true, but anyway, I would like to thank Harry for saying this.

Obviously, we will talk about it in detail, but I should say, in general, I was only distantly aware of the degree to which they were using scripting in the development of the facade. We can certainly talk about that development, and about the way in which it appeared to us as the client.

AC: I would like to speak with you above all about Tate Modern 2. However, I think we should start with Tate Modern 1. So my first question is, why did you choose HdM to convert the Bankside power station?

NS: When we began the process of choosing an architect for Bankside, I was looking for an architect who would have a respect for what was there, but also an ability to think in a very fresh way about the relationship between the past and the present. This was a moment when there was a very strong inclination, particularly in England, to have too high a regard for heritage. And it is certainly true that some of the architects who came forward in the competition preserved almost every aspect of the building. There were also one or two who took away too much.

AC: There was Chipperfield, and also Koolhaas.

NS: In the final phase of the competition, David made a gesture to take away the chimney. Rem kept the form of the whole chimney, but only with its steel framework. That was an interesting idea in itself, because he was exposing the nature of the building and the way it was constructed on a steel frame with brick cladding. He took away the cladding.

We chose Herzog & de Meuron, partly for their ability to recognise what were the fundamental elements that should be retained and what could be dispensed with. We were also deeply impressed by the invention and singular quality of the small buildings that we saw in Switzerland and elsewhere. We were equally impressed by their engagement with artists. Jacques, in particular, had a close association with Joseph Beuys when Beuys made the "Feuerstätte" sculpture, which is now in the Kunstmuseum in Basel. There was a curator in Basel called Dieter Koepplin, who had worked with Beuys on drawing shows, so there was already an association between Beuys and Basel. In 1978, Jacques invited Beuys to be part of the Basel Carnival and to do a performance, which resulted in the sculpture.

If you look at the final shortlist of six, at the end there was a choice between three: Renzo Piano, Rem Koolhaas and Herzog & de Meuron. Some of the jury were very keen that we should take Piano. For me, the choice was between Rem Koolhaas and Herzog & de Meuron. I leaned, in the end, to Jacques and Pierre because I thought that they had greater respect for making spaces in which artists would want to show their work. I think Rem, especially at that time—maybe I would take a slightly different view now—was very much interested in the passage of visitors through space. So, his proposal was as much about the circulation as it was about the gallery spaces. The second factor was probably Jacques and Pierre's realisation that you could make the Turbine Hall even more powerful if you took out the deck at ground floor level to create a single volume. So, there would be no basement in this building. We would not have the conventional auditorium below ground level, dark galleries below ground level, and everything else in the light. It was this way of looking at space and volume that was so compelling.

AC: You also said in an interview that "one of the reasons we choose HdM is that they respond to the particular circumstances of an individual commission (...). You have this sense that the architects have looked at the building and tried to interpret, in a contemporary manner, a solution that might have been conceived fifty years ago. Not in a retro sense, but in some way, they create a bridge between the old and the new." You mentioned also some details that we may find in the Tate, like the grilles or the handrails. In your opinion, it seems that these elements belong to the original building, but when we look carefully, they are not "old" but rather a contemporary interpretation of the character of the building.

NS: Many architects develop a signature language quite early in their career. Of course, their vocabulary develops, but broadly speaking, one building is quite similar to the next. A remarkable thing about Herzog & de Meuron is that they always approach the project with a fresh view. Of course, you can see elements that carry forward from one project to another. So, the wooden floors that you see at Tate Modern were first tried out somewhere else on a smaller scale, but then they became the accepted

way in which Jacques and Pierre make wooden floors for museums, as seen later in the Schaulager. There is some continuity, but the freshness with which they approach each commission is very unusual.

AC: Answering this same question, Jacques said that you were pretty convinced that they would be able to come up with a kind of antidote to what was considered, at that time, an appropriate museum design. He said that you were looking for a radical departure—industrial, rough and basic galleries in an existing building—and that you were convinced that they would be able to make a different museum.

NS: I think it was one of the reasons why we chose them rather than, for instance, Renzo Piano, whose approach at that moment to making space and volumes was much more conventional. Very beautiful, very pure and very refined spaces, as you see in the Beyeler in Basel or de Menil in Houston, but with no relation to the raw industrial character of the power station.

Herzog & de Meuron had the ambition to make a museum that offered many different kinds of gallery space, because artists sometimes want space which is refined and pure, but they also want to respond to raw industrial space. We had the opportunity to give them both.

I also think that, although their architecture is quite refined, it is also quite muscular. There have been criticisms that the architecture of Jacques and Pierre is too 'masculine'. That's also probably a reaction to the way in which Jacques sometimes presents the work in lectures.

AC: Is it because sometimes he presents in a provocative way?

NS: Yes. He makes a proposition, but he often does it in a way in which it is deliberately provocative.

AC: I remember, last November, when Jacques was in Porto, he did a conference in Serralves, and he concluded his presentation with the Badaevskiy project, which is not consensual at all. I don't know if you heard already about this project. It is a residential building in Moscow made of a huge block raised up in the air on a "forest" of very tall columns. The conference had been very calm and quiet, but ending with a building like this was very...

NS: Controversial?

AC: Yes.

Tate, in the end, resulted in a very successful building. Even if, at the beginning, HdM were an unpredictable choice as a young and an upcoming practice, in the end everything went well. For the Tate itself, which was a huge success, becoming the most visited contemporary art museum in the world. For the museums and art galleries context in the UK. For the world of architecture, since it influenced the work of many architects. And about this, I remember that Harry Gugger mentioned that the generation of young English practices, like Caruso St. John or Sergison Bates, gained attention because this project indicated that there were other approaches to architecture than those which had dominated critical discourse in England. And

also for HdM, because Tate Modern 1 was an important stepping stone in their career, marking the passage from local to international recognition.

On TM2, I have the impression that the idea was always there. The intention of using the oil tanks as gallery spaces, or opening the museum to the south, was already planned in the first phase, but for some reasons, I suppose for budget cuts or even because EDF Energy was still using the Switch House, the idea wasn't implemented.

However, we can also say that the second phase was inevitable, because of the exponential growth of the surrounding buildings and your concern that you might lose rights of construction. So, at a certain point you decided to start developing a master plan, and, once again, you chose to work with Herzog & de Meuron. Was this a natural decision for you, to have the same architects designing the second phase?

NS: No! As you say, we always had the ambition to use the oil tanks and, as you can see from some of the drawings, there was a moment when it seemed as though we might incorporate the oil tanks in the first phase of the Tate Modern. I'm really pleased that we were unable to do it, because eventually we were able to do something much more significant.

We were unable to do it largely because we didn't raise enough money. However, we were also determined to get the building opened in 2000, and it became clear that there wasn't going to be time to do the Tanks, so we stood back.

We took the decision to try to move forward again in 2003. However, I'm absolutely certain that if we had known how difficult it was going to be, we would not have started on the second phase, but, fortunately, we didn't. We didn't know there was going to be a recession in 2008 and I completely underestimated the reluctance of people to support a second project. Because the first had been so successful, I made the mistake of believing that the people would naturally want to support the second.

AC: So, it was difficult to find supporters.

NS: It was difficult because many people said, "But you have already done enough, why do you need to do more?" When we came to choose an architect, we ran a competition for the second phase. It was a competition that was limited, because only a small number of architects put themselves forward. Most people thought that we would naturally choose Herzog & de Meuron. But we ran a competition, and we had four or five in the final shortlist. We had independent advisors who had not been involved in the first competition, and we tried to treat it as a new competition. And it was very, very difficult for HdM. They came forward with some ideas, knowing exactly what the limitations of the building were and the constraints in planning on the site. Some of the others came forward with grand visions of what could be done with the building.

AC: But when was this competition done? Was it before or after the master plan?

NS: The master plan was done first.

AC: So, you were saying that HdM knew a lot of the site constraints.

NS: The other competitors presented grand visions, which were extremely attractive to some of the trustees. Herzog & de Meuron knew too much and were very restrained, and the form of their building hadn't yet crystallised. So, they were talking more about potential than they were about design. In the end they were selected because the potential that they described seemed to offer more than the others. But it was quite difficult in terms of the relationship with Jacques and Pierre, because they were our friends and collaborators and suddenly they were back in a competition. They felt they should have just been given the job.

You mentioned the Tate Modern had brought them success and had advanced their reputation. It didn't happen immediately, but once the success of the building was evident, by 2002, 2003, 2004, they had begun to receive invitations, and they were working on many other projects between 2002 and 2006. It took them quite a long time to arrive at the final shape of what should be done on the Tate Modern site. As you know, we got planning permission for a building which was very different from the brick building that we see today. When you look back now, it all looks inevitable, but it felt actually much more uncertain at the time.

AC: I saw the mention of that competition in 2005. However, when I prepared the chronology of the project, it was hard for me to understand when and how that competition fitted into the sequence, as there was already a lot of work done before. For me, it always seemed like a continuous sequence in which they did the master plan and then started developing the project.

NS: There was a recognition by the Tate in 2002 and 2003 that we should try and do the second phase, and therefore that we needed a master plan. Some of the reasons were positive. We saw the possibility of developing new kinds of space, and because Tate Modern was being visited by such a large number of visitors, we wanted to spread the visitors and to give them a better experience. There were also negative reasons. As you mentioned, development beginning to take place immediately in the vicinity of the Tate. I could see that if we were not careful, these developments would be realised and the owners of those new sites would then object to us constructing a large building on the south side of Tate Modern. So, I felt a certain urgency to get a scheme into the public domain and to show the planners that we had intentions that could be frustrated if they gave planning permission to other buildings.

The best people to develop a master plan that would explore the potential of the site seemed to be Herzog & de Meuron, rather than bringing in someone completely different. When you look at the 1994 competition entries, their first sketches showed how the building would appear from the south side. They were always thinking about the building in the context, or the urban situation. So, they seemed like the right people. The master plan was also intended to ensure that we were really thinking about the potential of the site in the long term. There are still some elements of the master plan that have not been yet realised.

AC: Like the TM3?

NS: TM3, yes. There was a brief moment when there was talk about the possibility of the Design Museum, which was then near Tower Bridge and has now moved to High Street, Kensington, occupying the building that is shown as TM3 on the master plan. In the end, that didn't happen, for a number of reasons. However, we were determined to explore the full potential of the site and not to make a mistake of building something that then precluded doing something else.

AC: Harry Gugger placed a lot of importance on the master plan, saying that it was the first given of the project. The master plan determined the volumetric features that would be common to all the design proposals; a pyramid rising adjacent to the southwest corner of the Switch House.

NS: That's correct!

AC: When we look at the design process of TM2, we notice that the "Schematic Design" stage was spread over about three years. It was a prolonged phase, with a lot of detours, in which strategic issues, like the spatial organisation and, above all, the outer appearance of the building, were intensely discussed. One of the most unusual aspects of this three year period is that HdM developed three different projects for the same client, with the same program and in the same location.

In the beginning, around 2004-2005, what did you, as client, ask of HdM? What were your intentions regarding the building?

NS: There was a fairly fundamental discussion about how to bring visitors through and vertically up the building in a way that did not rely either on escalators or on elevators. Coupled with that, there was an ambition to create different kinds of gallery space, different kinds of volumes, with different sizes and heights that would provide galleries with very different characters.

The limitations of TM1, the Boiler House, were to do with the enfilade system of circulation. To do with the fact that the ceiling heights were uniform. To do with the fact that the light came from the windows on the north side, etc. So, there were three or four givens in TM1 that gave the museum its character, and in TM2 we wanted to break out of those. A great deal of the discussion was about how to arrange a circulation system within the pyramid. Jacques described this movement up the building as a "promenade", because it was intended to give a sense of ease, the sense of being out. To walk slowly up the building; not to see a great flight of stairs ahead of you but to have a perambulation, to move from one side of the building to the other, to look at one point towards Waterloo, at others towards Tower Bridge, or Westminster Bridge and the Houses of Parliament. At the same time, they wanted to explore the potential for having these different kinds and shapes of galleries and boxes. They were working with model makers, using styrofoam boxes that they would put together in many different ways. It was a very visceral and a very tactile way of approaching design and thinking about design.

AC: You are referring to the version of the project that they called "Primary Form & Boxes". But previously there was another version of the project, a glazed volume with a steel frame on the facade. It was also a twisting pyramid but with weathering steel panels on the facade.

NS: Yes, and then there was the version also with glass boxes.

AC: That was the second one.

NS: The first one, it didn't survive for very long. I have a feeling that it disappeared because, although the client was interested, Jacques lost confidence in it.

There was, for a long time, a reluctance to consider using brick.

AC: In the beginning?

NS: In the beginning, yes. There was a feeling that if you used brick, there would just be too much brick. There was an idea that we needed to make a statement on the south side that was different from the north, and that the new building should have its own integrity, somewhat separate from the power station. I remember being very insistent on the idea that when you crossed the bridge from St. Paul's you should see the new building rising above the horizontal 'light beam'.

The new building had to have its own personality, and in discussions about using brick the architects kept saying, "We don't know whether it would just to be too much brick; the whole building is brick, and we don't want to look as though we were copying what is there."

So, there was, as you say, this weathering steel and glass combination. Then there was the glass building, for which we did get planning permission. However, there was a pause, partly because we couldn't raise enough money in the recession, and we found ourselves thinking more and more about the glass and feeling less and less comfortable with it. Jacques became concerned that a glass building would look 'commercial' in a landscape of surrounding glass office facades. As a result, we started to contemplate the idea of the brick. I think Harry was still working with us at that time.

AC: Yes, I really think so. He left in 2009, and the brick was already there.

NS: We thought that maybe we should think about a different way of using brick. Then came the idea of a 'double' brick, and it all started to open up in a very interesting way.

AC: I read that you said that "There was a certain amount of self-imposed pressure to answer some of the criticisms that had been made a decade earlier when we took on the power station, principally that we didn't have the conviction to do a totally new building." Did this feeling influence, somehow, the way in which HdM approached the design? From your statement, it seems that maybe you were reluctant to use brick because it could be too conservative, so you decided to go for a distinct building with a clear contemporary appearance.

NS: I think it did, and it probably delayed us. We went through stages, and we spent money that probably we didn't need to have spent, but we wouldn't have come to the result that we finally achieved if we had not been on that path.

I think that what you are identifying is correct. There was definitely a feeling that we had made a very successful museum, with some very beautiful spaces for art, that we had recovered a historic building and brought it back into the city, that we had changed the urban fabric. However, there was also a feeling that maybe we had not managed to do what is often the most difficult thing, which is to conceive something totally new, which feels very much of the present, but which will have an enduring quality for the future. So, there was a certain unfulfilled ambition. That was probably the reason why we were not satisfied with the first version and became unsatisfied with the second version. The second version, with the glass, was designed and developed very quickly, partly in order to try and make sure that we secured the planning permission before applications were made for the neighbouring development that was eventually designed by Richard Rogers. But I remember, when we went back to get planning permission for the brick building, the first question the committee asked me was, "Well, you came to us eighteen months ago, and told us about the importance of light, and the importance of glass. Now you want to use brick. Why should we believe you?" It was a difficult question to answer, and I was not fully prepared, but I did manage to persuade them. The whole route to the brick was slow and tortuous.

AC: About the two first versions of the project, Harry told me that when HdM developed the first project, the one with the weathering steel and glass, and showed it to the trustees, the trustees said, "Ok it is all very rational, but with this project we cannot raise money. We have to have a 'wow' effect! You have to do something which has a 'wow' effect!" According to Harry, this was the reason to reconsider the form and work with the stacked glass boxes, which was a theme that they were exploring in other projects, like Actelion, or the Vitrahaus, which had originated in the Qingdao project in China.

NS: He is probably right. This would have been about 2006–2007, and if we were going to raise the money the building had to be rather striking, and strikingly different. And he is also correct in saying that the boxes were to do with taking those elements of the building that were galleries and putting a skin around those elements. That coincided with work in China, and also Vitra, where they had houses that were stacked one on another. It all somehow came together.

AC: Harry said that when they delivered the glass boxes project, he was not convinced about the solution, because it didn't create a unitary whole. In his opinion, Tate should be one thing, and for this, it should have used the same material as the first Tate.

NS: Yes. The principal reason why we abandoned glass was Jacques' feeling that a number of buildings being built close to Tate Modern were commercial buildings with glass facades. Adding another glass building, or a building that was largely glass, would mean that there was no real distinction between commercial and public buildings. Harry's observation about connecting the building back to the original brick building is perceptive. I used the word enduring a few minutes ago. Maybe there was a sense that a glass building was almost too much '2005', rather than a building that would really last.

AC: I found a composite image from 2004 of the west facade, where you can see the volume of the new Tate, which has the same height as the Turbine Hall and is covered with the same material. Everything is in brick and you have this perforated skin based on a pixelation effect, similar to the one they developed in TEA, in Tenerife, or Caixa Forum, in Madrid. In this initial drawing, they were thinking about the brick as a possibility. I didn't show this drawing to Harry, so I don't know who did it or why it was done. I don't even know if it was a significant drawing in the process, or if it was just done by a collaborator experimenting with some ideas.

But the question was, do you know if they ever considered, in the beginning, using brick as the cladding material?

NS: Well, I said a moment ago that I think that in 2003, 2004 we all thought that to continue with brick would be too solid, too heavy, too much. I also think that, as you describe that drawing, it feels as though the building is not sufficiently differentiated from the original building, it doesn't have its own character, it doesn't have some of the desirable qualities that I was describing, of being independent but connected, having its own identity, having its own presence. Therefore, whenever that drawing was done, it may have been just put aside for those reasons.

AC: And it was not a high building as you mentioned before.

What do you think about the way in which they used the brick? They decided to use the brick, to return to the brick, to establish a dialogue with the masonry walls of the Bankside power station; however, they decided to use it in an unexpecetd and innovative system.

NS: Well, I think it is a characteristic of their architecture that they have a sense, or they have an ambition, of how a surface should both read, look and feel. They are highly sensitive to the notion of surface in terms of the skin of a building, and I think they had an idea about what they wanted to achieve. I would say they have a remarkable sensitivity to material and very good judgment about scale. They are able to go beyond the mechanics of what the computer, the digital image, can generate. One of the strengths of their work, is an ability to move beyond conventional use of materials to achieve a physical form which cannot be quite defined or predicted. At Tate Modern they wanted to achieve certain effects on the facade that they had no idea how to realise in practical terms. All the fixing mechanisms, all the structural concrete framework, had to be developed. And I believe that we suffered at that point from the departure of Harry. Frankly, and this isn't a criticism of others, if Harry had stayed with the project, I think the building would have been finished earlier and would have cost less. Harry is such a good engineer. He is very practical, I mean, he is driven by an ambition that includes vision, but he is very, very good at realising a way of doing something in a very practical fashion.

I think that we missed him in the next phase of the design development because we ended up with a building that was extremely difficult to build. Just to give one example: we ended up with fifty-seven different types of windows. Maybe if Harry had been there, it would have been thirty. There would have been a compromise. The windows might not have fitted within the envelope in such a beautiful way, but somehow the building would have got built, and we would have accepted it.

AC: I know that, at some point, there was also the idea of the colour gradation of the brick, and someone told me that this came from Harry. I know that this topic had many, many versions, and it went through an optimisation process, but in the end it didn't happen. From bottom to top the bricks are all the same colour. You said that some things were lost because he left. I don't know, but maybe this was one of them.

NS: I can't quite remember why that happened. It's difficult to tell now whether it would have been better in that form or not. It's a speculation. It certainly had some attractive qualities to it. I don't think it was taken out for cost reasons. It would have cost more, but I don't think it was taken out for that reason.

AC: The geometric shape of the building is not simple, because it is a twisting shape made of vertical and inclined faces that intersect each other along oblique lines. This shape, together with the perforated brickwork system, brought out some very complex geometric problems which are, for instance, particularly visible in the corner.

What do you think about how the corner was solved? In my opinion, this is not a consensual detail, and I see it almost like those architectonic 'mistakes' that you sometimes find in buildings and that are crucial for the understanding of the whole project.

NS: Well, if you look carefully, you can see imperfections. But I think then it comes back to what I was saying earlier about Jacques and Pierre's understanding of how a whole building reads, as well as the details. So, I think you could argue the detail is not one hundred percent consistent. You, with your interest in geometry, would probably see more than most people, but I think that Jacques would say that, in the end, it's the overall impact of the building which needs to register.

AC: In a conference, he said that "how we use the edge, where the two sides come together, to create this kind of porosity which defines or also reveals the construction behind, it is a simple but important detail for how we use construction as part of the idea of the whole building."

NS: Yes, I think that one of the biggest transformations in their approach to architecture—which occured after Tate Modern 1 and before they got to the second phase of the building—has to do with the way that the structure of their buildings became visible, rather than relying entirely on a skin or a surface. These changes in their architectural language were taking place during the period when TM2 was being designed. In my mind, at least, it began with those buildings, where they started to elevate off the ground, as in the Caixa Forum in Madrid or in the Barcelona building, where somehow the structural skeleton of the building becomes more visible. The nature of the building changes and, rather than being a block, it becomes a block that you can cut into. These changes were quite fundamental to the way in which we read their buildings. They had not lost their interest in surface, but they were beginning to create an edge where planes come together in different ways, rather than simply at right angles, as they do at the corner of a conventional rectilinear building. It feels like the moment when they broke away from Aldo Rossi, who had been so fundamental to the way in which they had conceived form.

AC: At the beginning, when I explained to you that I was interested in the brick facade of the Tate Modern 2 because of the 'scripting' process, you told me that you don't know too much about that, but that you could explain some things.

NS: I think what I was trying to suggest was that, obviously, the development of the detailed specifications of the brickwork and the calculation of the number of bricks that had to be made in each different configuration was something that they could never have managed if they had not been able to use scripting. This a post-digital building. It couldn't have been done by arithmetic calculation.

AC: The scripting was essential because there was a huge amount of data, a lot of bricks and a lot of different types of bricks. It was very helpful because it allowed them, in a relatively easy way, to generate 3D models, 2D drawings, such as plans or elevations, and prepare lists and schedules for the production and construction process. However, the design and the geometric issues were mainly solved with physical models, sketches and small 3D models done manually. So, the script was not a tool that guided the creative process in itself, because this was pretty much done manually, but it was a controlling tool. And I know that it was a big fight, it was very complex, to solve the corner; it was not simple. When you look at the four inclined facades, the bricks look all the same; however, they have holes inside, and these holes are positioned differently because of the angle of each facade. So, I'm pretty sure that it was really complicated, and I find it interesting how they decided to solve the corner. In the beginning, not knowing all these issues, it seemed a strange detail. But when you start to understand all these geometrical constraints, you understand the corner—which is the result of the combination of a specific architectonic appearance and the need to rationalise the construction—to have fewer different types of bricks, and in this sense to optimise the system.

NS: And it almost leaves the building feeling as if it was built by the hand of a traditional craftsman.

AC: When I questioned Harry about the corner, he made a sketch of the Signal Box. He used a pencil to draw the copper bands, and then he erased them with rubber and explained that the corner of Tate Modern 2 is the same as the windows of the Signal Box. It is something which is not defined, and it is imprecise.

NS: I think that if the building was perfect, it would feel very different because it would feel mechanical. That sounds negative, but it would feel smooth and mechanical in a way that would probably not be right next to the brickwork of the original power station. So, I think that the fact they couldn't achieve absolute precision was maybe helpful in the end. I think that they understood that there's a limit to perfection. There were challenges arising from the loading of the building and the calculation of how much distortion there would be on the frame. You could design the perfect brick, but if the frame slightly distorts then the brick doesn't fit.

AC: How was your working relationship with Jacques and Pierre? I read that they see you almost like a collaborator. They said that you became a partner and that they learned a lot from you. So, from what I've understood, you had an important role also in the design process.

NS: Well, I think I was a critical friend. I had a huge admiration for their work as architects. I also had an ambition that Tate would achieve a really magnificent building, so I was quite insistent on understanding what they were doing and why they were doing it. I would ask a lot of questions and sometimes I would make suggestions. That's probably what being a collaborator means. Sometimes there were real difficulties, but we overcame those. It has been a long relationship, and you can't live with someone for fifteen years and not occasionally have an argument. But then, if you survive those arguments, the bonds are very deep.

AC: After all these years working with them, what do you see as one of their biggest qualities as architects?

NS: I think it's an ability to rethink a problem from first principles, and to come up with unexpected solutions, exploring both volume and surface, coupled with their very strong commitment to finding new ways of using familiar materials. So, in Tate Modern 2 we have the example of the brick, or in Tate Modern 1 the floors, or the handrail. They are always finding material and using it in new ways. It's why each building has its own character, but there is nevertheless a development one from the other and you can see the line. Every now or then I see a new building or a new project, and I am astonished by how far they have moved forward, and I think to myself that if I was building now I would want to use them as architects.

AC: When I started studying the Tate I made a diagram with references that were coming from other of their works. So, even if the buildings are very different from each other, you can retrieve this line that comes even from as far back as the eighties, when they founded the basis of their architecture. Some of their initial research interests are still present in the way they develop their work nowadays, even if they are a big office with a lot of partners.

NS: Yes, I think that's another point I would make, which is they have managed to grow the practice to a size which is as large as many big commercial offices without losing their principles and ability to innovate. Obviously, Christine is still there, but they have other new partners, and they managed to continue to develop their language. They are never frightened of engaging someone who is very strong and has her or his own ideas. Their skill in taking those ideas and using them to develop the language of the practice is deeply impressive.

END

C.7
Wim Walschap

A.10
Wim Walschap.
Architect at HdM (2007) and Partner since 2014.

"It makes it more interesting by not being perfect."

Conversation with Wim Walschap

Teams meeting, Porto-Basel, July 16, 2020

Alexandra Castro (AC): When did you join the design team of TM2?

Wim Walschap (WW): This must have been in 2008. For the extension of Tate Modern, we actually designed two different concepts. The first one was a stack of shifted glass volumes. When I joined, this first concept had already been finished, and afterwards the design process stopped for a while. When the project restarted I joined, but with a limited involvement. I was only assisting in the development of the new facade ideas, by preparing a set of buildable details for the facade concept that we had in mind.

AC: By the end of 2006, the first planning application for the project was submitted. Then it took about a year and a half for the Schemetic Design of the brick version to be concluded, which happened around July 2008.

WW: There was a pause, during which the project was on hold. When it restarted, the project was totally redesigned, especially on the outside. I joined when the project had already been running again for a while.

AC: So when you joined, the idea of the brick was already established.

WW: Yes. For the second concept, it was more the idea of starting from the existing material of TM1 and to build further on it. So the idea of the brick facade was already there when I joined the team.

AC: Besides the glass boxes project, there was a first version with glass and a weathering steel frame structure on the facade. This first project survived only for a short period. Then there was the glass version with the stacked boxes and, in the end, the brick version, which was the final one. Why did you take so long to choose the brick?

WW: It was a process, but one of the key reasons to move away from the glass and to explore brickwork was because we wanted Tate Modern, in its whole, to be expressed as a single and unitary organism. Secondly, the brickwork would avoid the new volume becoming part of the existing glass and steel architecture in the immediate urban context around the Tate Modern.

AC: When you decided to establish a relationhip with TM1, the masonry walls of the Bankside power station became the main reference. However, as usual in the practice of HdM, you worked within this continuity while seeking to innovate.

How did you get to this specific brickwork system? How did you define the size of the brick, the doubled block or even the perforated system?

WW: It was to make this outer skin more transparent, through which light would filter in and out, rather than a traditional solid brick wall. The use of bricks and brickwork were inspired by the existing Tate Modern, but developed in an unconventional way, the bricks stepping almost as though in reaction to the sloping faces of the volume. By exploring texture and perforation we were able to transform the brickwork from a massive material to a veil that is covering the building. To find the right grain for the screen, the idea was to double the footprint of the bricks and to combine two of these enlarged bricks on top of each other and, as such, create what we called “blocks”. The depth of the blocks allowed for the stepping in the inclined faces, and the height gave the right size for the perforated veil.

These openings could also not be too big, because that would complicate the buildability. Openings that were too large would also allow pigeons to land, turn around and live within the brickwork. So, there were several parameters that influenced the development of the perforated facade screen.

AC: Previously, you were speaking about the structural aspects, and I suppose that when you decided on a square brick, which is double a standard-size brick in depth, this was something that also allowed the stepping of the courses over the inclined facades.

WW: Yes. If you were to apply standard sized bricks, with a typical depth of nine to ten centimetres, and if you were to lay them in a stepping manner, these bricks would hardly rest on top of each other. So, this was another criteria that we took into consideration when we defined the size of the blocks In plan; the brick was doubled, like two bricks one behind the other, which gave it a square footprint. Then it was also doubled in height. However, by stacking two bricks with a mortar joint in-between we don't have massive blocks, because the original brick height is still legible in elevation.

AC: What were the main challenges you had to face in the design of the brickwork system?

WW: The biggest challenge was to develop a design solution for the inclined corners and creases. The overall geometry of the building is regular, but with inclined facades with stepping brickwork. So, we needed to find solutions for how these inclined surfaces would connect to each other at all the edge conditions. Of course, there were many solutions, but it had to be a solution that would have a certain repetition, and which would be buildable, avoiding too many unique pieces and too much cutting work on site. This may sound rather easy, but, in reality, it was not, and that's where the scripting was helpful.

AC: You have the windows.

WW: But the windows are regular cut-outs within the block grid.

AC: And they are positioned on the facade according to the block grid.

WW: Yes, they fit into the modulation of the brickwork, and that was not so difficult. The challenge was in the irregular corners; how to solve them, to avoid having many different special corner pieces. At the same time, we didn't want the corner to be regular and sharp. That would have been another possible solution, in which the blocks would have been cut on site under an angle. We were interested in a different solution that would give the impression that the brickwork veil appears as though wrapped around the inclined corners, and that the irregular outcome of this action could give an unexpected result. And indeed that is how it looks in the end.

AC: Andreas Reeg told me that even the production process of the bricks was not easy; that you consulted many companies to understand how these bricks, which have four holes inside, could be produced. It's not a standard brick, so you had to find the company with the right technology able to produce them.

WW: Yes, with strict tolerances. That was quite important and challenging, because the blocks were first compiled out of two bricks that were connected with a mortar joint and then, afterwards, the blocks were interconnected with steel dowels. Every block, which consisted of two bricks, had four of these stainless steel dowels to make the connection stable, and the holes for these dowels had to be positioned in a precise manner. Therefore, we had to find the right company, which was, in the end, Gima, based near Munich in Germany.

AC: I suppose that this was also another issue that complicated, even more, the resolution of the corner, because we are not speaking about a mortared wall where you place the bricks and then you can slightly adjust them. You always have these holes inside the bricks. So, even the special pieces for the corner have these holes. In the end, you have a lot of parameters combined that made the problem of the corner even more complex.

WW: The idea was to make it appear as if the brickwork screen was folded over the corners, combined with the ambition not to cut any single brick or block on site. This means that we needed to create a kit of parts and, depending on how the regular block was arriving at the corner and on the resulting leftover space, the bricklayer could then select the right corner piece on the basis of some clear and simple predefined rules.

AC: You had the full block, the 2/3 block, the 1/3 or none.

WW: Yes, something like that. I remember that we defined that logic, and this was the input we gave to the team that prepared the script, to see how that would work for the complete form. For that, the script was extremely useful.

Of course, you can draw it in a more traditional way, and maybe it works, but at the end of the day one has to build it on site, and with all the given construction tolerances you would end up with a

different situation compared to the theoretical drawing. So, to anticipate that, we established a set of clear rules. Maybe, for a specific course, you would have had on the drawing a 2/3 block applied at the corner, but then, in reality, it could be that one had to apply a 1/3 or even no block. So we developed a system that came with some clear rules, and, depending on the specific site condition, the workers could lay a full, 2/3, 1/3 or no block by applying the defined rules. The bricks were regular and produced as such, they didn't need to be cut, and you simply saw on site which one would work the best. And this gave the irregularity on the corner.

AC: When did you feel the need to have the support of the "Digital Technology" group in the design process?

WW: From my perspective, it was for two reasons: for developing the irregular edge solution and for the colour explorations. The colour mix was another topic that needed different rounds of design development. If you look at the brickwork of the existing building there is a wide colour range that goes from brown to purple. We had the intention to work with these colours again in the TM2 facades, and explored different ideas for the distribution of the colour. The script was helping us to test diferent options, each with a specific mix and distribution of colours. The script gave us fast results, showing the effect of each mix, and enabled us to decide on the preferred way forward.

AC: When I spoke to Andreas Reeg, he told me that the design process was a combination of analogue and digital tools. He was using physical models, sketches and small 3D models to define the rules, and then there was Kai with the script. Once the rules were defined, the information was introduced into the script, which took into consideration the whole building, and, as you said, controlled the design in a very precise way.

WW: That's exactly how it went. First, we made physical models. We built, at a particular scale, the blocks in foam, we had two or three of these regular surfaces with the bricks meeting at the corner or the crease, and we explored in the model the options to resolve these edges and how we could introduce a system. After this, the most promising solutions were further tested in Rhino, in very basic 3D modelling. This was a back and forth process until we found satisfying pragmatic rules which would allow for an easy production and construction process. So, yes, it was a combination of these more traditional tools, let's say, and once the rules were roughly defined these went into the script for a more precise calculation.

AC: Do you think that it would have been possible to design the brickwork if you didn't have the support of the script?

WW: Yes, it would have been possible, but there were a few processes that we could really simplify by applying a script. For example, instead of manually calculating the corner pieces for the entire project, the script provided a detailed overview with quantities for all the necessary parts. You push the button and you have the results. The same for what concerns the colour mix. If you had to calculate all of that manually, or draw it in a more traditional way, it would need lots of resources and would take a long time to get to the result. Plus, the premix of the different colours in the production and packing

became possible thanks to the script. Gima could premix the different colours so that workers on site could not make mistakes when slecting and laying the blocks

AC: But, in the end, you don't have the gradient any more.

WW: No, the gradient was an option at a certain point in the design process but it was not executed as such.

AC: I suppose that, at a certain point, the design of the facade became an autonomous issue. When did this happen? From what I analysed, I have the idea that from January 2009, in the Design Development stage, you started developing, in further detail, the construction system for the facade.

WW: For us, it is never a completely separate issue. Our complete design team was sitting together, and there were also some challenging interfaces that needed to be studied. For example, the brickwork screen had to be tied back to the concrete structure, and there was a lot of back and forth on how to do that. There were also issues related to buildability because of the corbels that are making the connection. The corbels needed to deal with the tolerances that were coming from the brickwork, but they also had to take into consideration the tolerances coming from the concrete. It was an intensive process, and this was not limited to just the facade team, but the team that was working on the concrete structure was also involved in this study. Of course you have multiple teams, each with a specific focus, but eventually there is one team in which all are working together.

Also the concrete structure and its cladding went through a process of multiple explorations to find the right solution, balancing design ambitions and cost, but also buildability.

AC: May I show you one diagram? This is a small chronology I prepared. Here is the timeline, these are the reports, and these are the different subjects, like the corner or the colour. I noticed that from 2009 the real work on the bricks started, and I think that a significant part of the effort was to rationalise, to have fewer special pieces, and to optimise the construction without compromising the desired appearance. I noticed that, at the beginning, you considered the possibility of solving the corners and the creases with larger pieces that created a kind of frame, in correspondence with the kinks. But then, at a certain point, you decided to develop a different concept for the corners.

How did you decide on the corner, which is, in my opinion, one of the most intriguing aspects of the project? What issues led you to the final solution?

WW: As I said, it really fits into how we try to do things. It should not be this perfect, engineered solution that would also be expressed as such. I remember the design review during which we rediscussed this. We agreed on the approach, looking at different foam models in which we could see all the different bricks. I remember that we said that it should be a folded or wrapped solution, which would come with irregularity, and we decided to test it and see how it would look. So, it was to rationalise, as you said, but also to manage the irregularity of it. We went through several exercises to sharpen the design rules that we were applying. There were certain areas of the building that were

completely eroded or too rough, or in which there were too many pieces falling away because they were flying and were not structurally bonded any more.

So it was a rationalisation of the irregularity, coming from the conceptual idea that it is a screen, a textile of brickwork that was wrapped over inclined corners.

AC: When I spoke with Harry Gugger, he described the corner in a very beautiful way. He said that the corner of Tate Modern 2 is the same as the window of the Signal Box; it has a certain impreciseness. It is not defined, and, in his opinion, this kind of non-perfect detail is what makes architecture interesting. I agree with him. This is like those architectonic details that seem to be "mistakes", but when you start analysing them, you find in them the reason for that architecture.

WW: Yes, it makes it more interesting by not being perfect. Depending on the angle you look at the corner from, and the light that falls on it, shadows are always different. A perfect sharp corner would always be a perfect sharp corner. We also like this kind of roughness in the solution. It's much more interesting. You wonder what it is about, how it came together, what the logic is behind it. It makes people think about it because it is not obvious all at once.

AC: The "perfect" you don't question.

I don't know if you remember, but Andreas told me that there was a moment when he understood what the two parameters could be that would solve the corner.

The first one was that none of the corner pieces should cantilever from the alignment of the surfaces that meet at the angle. The other one was that one surface should always win over the other, which was the inclined facade.

WW: It's true, it's true.

AC: In two of the initial reports, I noticed that, in the corner, the pieces of both surfaces were overlapping. It seemed that sometimes the vertical surface was winning, and other times the inclined. It seemed as if there was no rule.

WW: There was a rule, but the outcome was irregular.

AC: Why did you decide to develop the idea of the facade colouring, and how did it evolve during the design process?

WW: The starting point was the existing colours, again, but, as I said, there was a quite big range between the colours, and I remember that we had many options—whether there were gradients, gradients with different colours, and various mixes. The idea we went through in the end was to have a mix. But even in that idea, there were many options—how the combination should be, how much of each colour.

It was also a process of simplification, to have fewer colours and also clear breaks. If you see, at the beginning, you have these curves that meant that the mix was basically changing on every course, in the end we were able to create some clear zones with specific mixes, which make this gradient more

organised and rational. But for this, we also used the visual mock-up. We also tested these colours in reality, and I think we found out that we could actually have the same effect with even fewer colours. We could manage to have almost the same appearance by applying less colour.

AC: With the mock-up?

WW: And also from the back-and-forth process with the script that you just showed.

AC: When we look at the several projects of HdM from the first years until recently, we notice that around 2005–2006 there's Jindong and Tate Modern 2, where, for the first time, the brick was used in new buildings and in an innovative way. Before, you had Tate Modern 1, Caixa Forum or Küppersmühle—all of them rehabilitations, where you worked with the traditional masonry wall. From 2005, in the work of HdM, we started to see buildings where the brick is used as construction material and always in innovative systems. Almost contemporary to TM2 there's KMOMA, a museum in India, where the brick is also used in a perforated wall system.

Is there any relationship between what you tried out in the TM2 and the lastest experiments you developed in other buildings?

WW: It was not intentional, and it was more a natural influence from the projects we did some years before in China. We designed multiple projects in which we experimented on how to work with bricks in a more contemporary way. These projects in China were not realised—the majority didn't happen—so I think it's more from there, from this kind of exploration, that something stayed, and then, in the right project, it came back again.

KMOMA and TM2 were designed around the same time. I'm not sure if it is fair to say that one influenced the other, because they were developed simultaneously. I think that the influence comes more from the explorations developed in China, working and playing with the bricks to find new textures and expressions.

AC: So you think that the experiments in China may have led the office to accept the brick as building material, convincing, let's say, HdM that with the brick it was also possible to have interesting and innovative surfaces.

WW: Yes, I think it is more that we are interested in exploring and working with different materials in an innovative way, and that we have no predefined preferences. By circumstance, we came to the conclusion that it made sense to do the extension of Tate Modern with brick and brickwork because, as I said before, we wanted to create one organism. Plus, there was the intention of being different from the immediate surrounding architecture, which is actually located close to the extension. Therefore, we decided to apply brick facades to the new building, and simultaneously there were these past explorations that influenced what we did with the brickwork. I think this was the process.

AC: Around 2007, when the Tate project was being developed, the "Digital Technologies" group was founded when Kai was in the office. This was a period in which parametric design and scripting were pretty much present in the office as supporting tools of the design process

for several projects. Maybe this happened because of the architectonic research that was guiding the practice at that time, such as the interest in ornament. Or even for the kinds of projects the office had, which were very different from each other and had some geometric complexity. However, recently, we may notice that the geometric complexity of the projects is decreasing, as well as the role of some digital tools, such as scripting, which is not as relevant as before.

Do you agree with this? Do you feel that there's a difference between the period around 2007–2008 and the current years?

WW: Yes! I didn't think about it, to be honest, but it's true. Again, it is not a goal in itself, and it comes with the fact that we are probably doing projects that have less demand for such support. But it's true what you are saying.

AC: Does this somehow take you to simpler forms?

WW: Not necessarily, I think. It comes with other challenges. But it is a different expression that is true.

AC: What are the digital design tools that you find more useful nowadays for the design practice? Or that, in your opinion, may complement your architectonic interests and open new research fields?

WW: I think the degree of versatility in the scripting for certain things is still useful. I worked on a stadium recently, and it is almost impossible to create the bowl and the seating quickly without having the technology of scripting. So, we are still using that where it makes sense. For the rest, we work very basically. We use 3D modelling, but in a very easy way. We are doing very quick 3D modelling and very quick rendering, rendering, rendering. That's the process at the moment, which is also very different from what we did ten years ago. A rendering was something that was done at the very end, almost to present the project, as you would do on a presentation.

AC: To communicate the project.

WW: Yes, to communicate it, to explain it. On a daily basis, at that time, we were working more with physical models and refining things in these models. I've seen that in the span of the last ten years, very often we don't work with physical models anymore, because it takes too long. It also takes a lot of space, even afterwards, if you want to keep and archive them. It is a lot of work, it is a lot of labour, and in one of my projects I really saw the shift. It was simply too slow. The design time is so limited that you have to go much faster, and by the time the physical model is done it is already too late. So it was not following the design process any more. There, I clearly saw that we switched to 3D modelling and rendering, but rendering for daily use, to make steps in the design work.

AC: Ten or fifteen years ago, 3D modelling was a novelty, and not everyone knew how to do it. Nowadays, everyone knows how to work in Rhino, and suddenly, from the beginning of the

project, 3D modelling is a tool. It's there, on the computer, and you can change it very quickly, and try many different possibilities faster than with the physical model.

WW: That is clearly a significant shift I have seen in these last ten years.

Maybe I have colleagues who think differently, but, for me, it is not a goal in itself to have a lot of software introduced into the design process. We only work with it when we feel that we need support, and then there is a script, or whatever useful tool.

AC: It's just a tool, and you use whatever you need to support what you are developing, not for the technology in itself.

WW: Exactly!

END

C.8
Andreas Reeg

A.11
Andreas Reeg.
Architect at HdM (London and Basel) from 2008 to 2012.

“It can’t be so hard to solve this corner.”

Conversation with Andreas Reeg
Rundzei Architekten, Berlin, January 24, 2020.

Alexandra Castro (AC): Steffen Riegas suggested that I speak with you, since you were directly involved in the design of the brick facade for the Tate Modern extension in which digital tools, namely the scripting, played an important role.

Andreas Reeg (AR): I joined the office in London when they were ending the planning application—I think by the end of 2008. When I joined, the idea of the brick was already there. It was supposed to be this perforated brick facade. There were already a few scripts, but I don't know who wrote them. There was one script for each of the problems, so it wasn't very easy to use them to develop the design. It was an internal problem of the scripts, because you need to know in advance what geometric changes you want them to perform. Only in this way are they helpful.

In the project for TM2, there were complex arrangements of colours and geometries, but I think that in the initial phase, when they switched from the glass boxes version to the brick version, it was all tested in physical models. I think that, at that time, the scripting wasn't supporting the development of the design process.

AC: I know that there were two phases in the scripting. I don't know the dates exactly, but I know that Volker Helm and Dominik Nussen were responsible for the scripting in the first phase. Yesterday, I had the opportunity to speak to Volker, who told me exactly what you have just said, that the scripting was a bit complicated. I already knew that from Kai.

AR: Kai was rewriting it.

AC: Yes, he said that one day he went to London and the project had changed. Once the existing scripts weren’t able to respond efficiently to those changes, he decided to write them from scratch, and from that moment, things started working.

AR: Exactly, and, from that point, the scripting was useful for generating the plans, testing the finals, doing mock-ups, and even, in the end, for construction management.

When Kai joined, I think all of the details were already precise. In this sense, the scripting served to test the rules for the building corners. There was a big discussion about how the two surfaces should intersect, because, at the beginning, there was a different type of brick on every row, and the bricks had to be extruded from a machine. It had to be built with a metal element to make these shapes, and for the corner of the building there were, like, 3,500 different shapes. The cost consultant said it was nonsense, so we had to work on and find out options to get the same appearance but with standardised geometries. That was when the previous scripts failed, because it was so complicated to write them and to test them. At that moment, we made a lot of physical models, and we also did 1:1 scale mock-ups to test the corner. We redeveloped the rules again, and when Kai came we told him that we needed to adapt the scripts so they could reflect what we were doing. He said, "No, let's forget this. I'm going to rewrite it". So we sat down together and we wrote what the rules were. Kai was amazing. It was so quick, how he wrote all these things, and it was also working faster. It was much easier, later, to generate the 3D model and do renderings with all the colour testings.

AC: In November, at the office, Steffen took a look at the scripts and he was impressed. He said that they were quite organised and clear.

AR: They are so very well structured that I could also readapt them according to what was changing in the design. It was easy to follow it through for somebody who wasn't into the scripting. When I left, during the construction phase, when we tendered over to the construction managers, one or two architects from HdM were following the whole process. They were generating documents for all the brick types that had to be ordered using the scripting.

The scripting, in the end, was really helpful, but in the beginning, when I joined, I think it was consuming much more time than it would have had we directly modelled the different versions and tested them manually.

AC: Why did Kai enter into this process?

AR: I think it was because the project partner recommended it at some point. Kai was the head of the department, and I think he also felt that he was the only one that could do it. There was also more time pressure. We had to produce the information, and it was taking ages until something happened. The corner was still not correct, and we had to do it all over again. We arrived at a point where Kai said, "I'm coming over, let's sit down and think about it", and he decided to rewrite the script entirely. But still, as I said, the general idea was not developed with the scripting. The idea of the perforation, or the windows' positions in the facade, were not developed with the script. These things were tested and defined in physical models, small 3D models and renderings.

At a certain point, the planning authorities replied that they didn't like the fact that we used brick on the lintels. They felt this was a heavyweight facade that needed to sit on something.

AC: When did that happen? By the end of 2009? I remember that in the stage E report this issue is mentioned in the facade addendum.

AR: Exactly, that's when we decided to pull out the concrete panels, which are behind with this kind of indented profile, to have the same rhythm as the brick facade. The planning authorities were convinced that this concrete element was what the facade was sitting on. However, all these changes were manually done, because it was nonsense to change the script to model the precast. It was easier to leave out these hanging bricks, and that was very helpful with Kai's interaction.

There were also huge discussions about colour. In a very early phase, the facade was fading out into the sky. The partners then changed, because Harry Gugger left the office and Ascan Mergenthaler took over the project. I think that Harry was the one who wanted the fading effect to the top. He was also the one who pushed this to be the double brick perforated facade. Harry was very tectonic about how all these things worked.

AC: I suppose the colour gradation allowed the relationship with Tate Modern 1 to be reinforced, as the plinth of the old building is also made of red bricks.

AR: Yes, and yellow-brownish on the top.

Previously the colouring of the facade was taking rough colours from the brick. But afterwards it became a gradient fade from dark reddish to more yellowish. Ascan said that we should relate a bit more to the previous Tate and have a horizontal band of reddish brick which then slowly turns to the other one. At some point, we even went to the Tate facade, took out some bricks to see the variation that actually exists, and did a few colour versions. All the colour testing was in the scripting. We were able to change the colours and control how they were supposed to be distributed across the facade. We also did some versions in which the bricks were all brownish or yellowish, and so on.

To be honest, none of that would have been possible without the script. This was a crucial design issue for the building—how it appears and how it relates to Tate 1. It would have been a nightmare to do it manually. Whether it would have been with Photoshop, picking some bricks and putting them with another colour, or manually selecting bricks on the 3D model to be of a specific colour. In that sense, the script was absolutely necessary. It would have been a fight for ten people, working day and night, just to get to the right gradient effect.

I think there was a quite wrong break because, internally, we were happy, Tate was happy, and we were also able to reduce the number of colours and test ways of changing points where it did not look good. We arrived at the point where we could have manufactured it because it was just about 12 colours and not 365 different colours, so in that the script helped quite a lot.

In terms of the geometry, not so much. The script took the surfaces of the building and generated points on them. We had to draw the openings' polylines in Rhino, so the points inside these frames were left out. The script was considering the points near the openings and the corner conditions, and afterwards it generated the 3D. However, it was generating the geometry that we had predefined through physical testing and manual 3D models.

AC: This picture is from 2010. All these study models synthesise the different design versions developed between 2005 and 2009, when HdM got to the final version. I suppose that they took the decision to use the brick as cladding material by the end of 2007.

AR: I think they returned to the brick even a little bit later.

AC: In 2008, they presented the first renderings of the building in brick. This happened at the beginning of the "Design Development" stage.

AR: Okay. I know from Christoph Zeller, the project leader in Basel, that they changed from the glass idea, which was taking the internal arrangement of the building to the outside, to a version in which the envelope would be something different. At that point, they were lost on what the outside could be. They had the geometry, but it was very late that they decided to do it in brick and establish a relationship with the Tate. Before, it was this separated, free-standing volume from the Turbine Hall. And this is quite interesting, because, in the end, the building got even closer to TM1, matching the colour and trying to fit into the Switch House. I wasn't involved in that stage. When I joined, the overall shape, the brick facade or the windows, were roughly clear. The general idea was definitely there, so we didn't change it any more.

AC: How do you think HdM got to that specific brick arrangement, to the idea of a perforated pattern, through which a connection with Tate Modern 1 is established?

AR: I won't be able to answer this question. I think that Christoph Zeller, or Ben Duckworth, an associate of the project, would be the right person to respond to you. Christoph was involved in that. I know that the Flemish bond was the relation with Tate Modern. Then doubling it up, as far as I remember, in conversations, it was Harry saying that it was not transparent enough. If it had been just one stack, it would have been too dense, and no one would have been able to see through.

Then I think it was also a structural issue, with the engineers saying, "We need to make it 65 m high, so the bricks have to be able to sit on top of each other. The loads need to go down, and we cannot have only 2cm of overlap". That was when they doubled the bricks in depth.

So, making a square brick had to do with the structural situation and the geometric situation, coming from the inclined facades. On the southeastern facade, bricks were resting on just a couple of centimetres on top of each other, so it was necessary to make them deeper.

I think it was also technically a quite good decision, not just aesthetically. If you want to put them one on top of each other with mortar and you just have a couple of centimetres, you know that they are actually being held by something else. It's not the bricks that are somehow sitting on top of each other.

AC: Can you explain the construction system of the facade to me?

AR: There's the precast column system, which is the main frame structure holding everything up. Then you have the precast facade elements with their drainage connection, which is the

waterproof layer of the building, and the structural load transfer from the brick facade onto this main frame and the rear.

AC: And to which the corbels are also fixed.

AR: Exactly. These corbels are anchored to the precast elements. The precast panels are fixed to the main structure, transferring the loads of all the bricks and corbels to the rear facade.

The corbels were initially like a little brick standing in the hole of the brickwork header.

AC: Were they in concrete?

AR: There were many versions. They were also in stainless steel, but open. In a previous stage, we didn't want to have any other element interfering with the brick facade. We wanted the brick facade to appear as though each block was sitting on top of each other, going up, literally. So we had these very complicated steel elements with only the top and the bottom in stainless steel, and then everything else was just a hole. When you were rendering it you didn't see them. It was a dark hole in front of the precast elements.

In this initial version, we had bricks glued to the bottom of the precast elements on the lintels. Everything was trying to hide the precast elements. But then, when we had the planning authority issue with the lintel, we realised that they were right. It's a brick facade, so it always sits on something. You need a lintel on the window because it is transferring the loads. When you have an opening, there's always the structural element. So why were we hiding all of this?

From this moment, we realised that it looked good and that the corbels could also be like a precast element, especially at the bottom where we have the anticlimbing system, where the surface is flush and the headers are filled so that nobody can climb up. So we decided to pull the corbels out to the front and show them in the facade. That was when Jacques said, "Yes, that's it!" He really liked the image of these layers of brick with the dots of concrete in them.

AC: In the end, the corbels turned out to be in stainless steel.

AR: At the very end, yes. In the construction phase, it was decided to make them out of stainless steel but with the same geometry as the brick. So you would see the stainless brushed steel grey surface because the manufacturer who built it said it would be a lot faster for him. But the change to have them all in concrete came from the decision taken at the anticlimbing, where the corbels would be visible and not clad with 2 cm of brick in front.

For the brick facade, we talked with two or three companies. There were a lot of details for how the bricks came together. These two bricks are put together into one block with a slightly special mortar, more weather-resistant, and they are extruded bricks. I mean, there are two ways to manufacture the bricks. One way is to put them in a form; you bake them, and then you have the shape. In the other way, you have the clay mass, and you push it through a steel profile, and then you slice it with a wireframe into the right shape. With this one, the edges are perfect. It's like a sausage that was kind of squeezed through something.

AC: Was this the system you choose?

AR: Yes, it had to be the system because we needed the holes in the bricks, and all the tests we did with these manufacturers to drill the holes were failing. The bricks were breaking, every three or four, or the holes weren't really in the right position. I don't remember how many thousand bricks we have on the facade, but just imagine how many holes we would need. At least four holes in each brick, so it would have been more than 1.2 million holes to drill. In the end, I think it was a German manufacturer that was chosen.

AC: I think it was Gima.

AR: Yes, Gima, who had the system for this extrusion technology. They were able to have a little steel rod in the clay, so the holes were in the wet version and then were baked to be fixed.

Into the holes in the bricks a little rubber pin is placed, then a stainless steel pin which connects this brick to the next one. This stainless pin was glued to the top brick. There was a bit of resin put into the hole of the top brick, so that the pin was fixed. However, in the bottom brick the pin was just stuck into this rubber element to allow for some movement. If it had been glued on the two sides, we would have gotten cracks every second level, and it would kind of turned and moved.

The corbels also had additional stainless steel rods going through the blocks, above and below, connecting the brickwork to the main frame structure in the back.

AC: The corbels had the dimension of the headers.

AR: Exactly, they were header size.

Then the bricks which were sitting above and below the corbels all had six holes. They were connected to the next brick, but also the corbels.

Geometry-wise, the bricks were always the same except for the reveals, where you sometimes have half-size header bricks, and the corners, where you have some cut-off versions to do the transitions. However, the bricks still vary a lot because they have different holes in them. On each facade, due to the inclination, the holes are differently positioned. So, you have the vertical facades, in which the bricks are all the same type, and you have the four inclined facades, where all of them have different angles.

AC: Which interferes with the positions of the holes.

AR: Exactly. The bricks in each of the inclined facades were of a different type.

AC: In the end, you have the bricks for the vertical facades and the bricks for the inclined facades.

AR: Exactly, and the bricks for the reveals, which were slightly special, and for the windows sills, because they didn't have the holes on top, and then you had the corner conditions, which were again four different types for each of the corners.

AC: What kind of technical or structural issues are behind the design of the facade? Regarding the facade structure, for example, I know that the columns were positioned in the intersection between the floor slabs and the creases. That's why the distance between them is irregular.

AR: It is irregular, but it is following the brick grid. The brick grid defined where the columns could theoretically sit, every 12.5 cm plus a header grid. There was a geometric issue because the inclined and vertical columns somehow had to meet, roughly, and that's why they were sometimes shifted over.

With the structural engineers, we had huge discussions on how flexible this brick facade could be to adapt to the construction tolerances. The engineers were worried about these huge columns having a variation in size of just 2-3 cm. This is just 0.1% of tolerance. So they said that the brickwork wouldn't work because you can't adapt 2-3 cm in a single little steel pin rubber. Then I said that we couldn't adapt in one, but we could within all the rows we have till we get to the top. With half a millimetre each, it adds up to a few centimetres, which would be feasible.

AC: The tolerance shouldn't be between two blocks.

AR: Exactly. There are so many small elements that can be slightly off, to then match in terms of tolerance. Then the engineers understood.

We always thought the bricks were going to be mortared on site. We thought they would put the bottom block, then the mortar, and after they would put the other one on the top. But two manufacturers said it was nonsense. They wanted to do this in the factory to ensure that the bricks would arrive on site as a whole block. It's obvious, and you have these four faces that you need to make nice and smooth. There were also huge discussions on how the mortar would be if it was slightly pushed in, totally flush, slightly curved, and so on.

AC: Now it is flush.

AR: Yes, it's flush, but they were able to do that only in the factory.

AC: I read in the reports that having a double brick was fundamental for bringing light to the interior of the building. Otherwise, the holes between the bricks would have been too small. The reports also explain that "(...) the composition of these 'cuts' (which is a direct result of the placement of internal spaces) provides a further means to moderate the scale and massing of the building. Although dependant on the internal uses to achieve the required daylight factors and natural ventilation requirements in general, windows are 1050 mm high and at desk level to allow for views from seated or standing positions, and 750 mm high and at the ceiling level to allow daylight to penetrate deep into the floor plan."

AR: The whole building had a very special energy requirement. It was supposed to be very sustainable in terms of the use of energy. There's a huge heat transfer machinery that uses the heat from the Switch House to generate cool air for cooling and conditioning the Tate itself, which is quite innovative. The engineers were also responsible for the daylight calculation and the

ventilation of the whole building. So the proper cuts in the brickwork were, as you described, in areas where there were offices or teaching spaces. They were determined mainly by health and safety regulations that demand that you not sit in a space where you do not have a window. Then the other windows behind the brickwork were placed in the amount needed to get enough daylight into the space to save energy and fulfil the daylight requirements.

AC: I had, in fact, been aware of this idea that there were very precise requirements about daylight or ventilation that determined the number and dimension of the windows.

AR: It was really like this. We decided on the cut of a window, and then the engineers calculated whether that was enough. If it was not enough, we would do one more row of windows behind, depending on the daylight requirement. Behind these windows it is all circulation spaces. These are the concourses which are also exhibition areas, and here it was also a question of design. In these spaces, we wanted to make the brickwork visible from the inside. So, there was a compromise between having not too much daylight for the exhibition spaces but still having this view out to the brickwork. But I think that, for 70% of the facade, it was just the technical requirement.

Then there was a big discussion on the opening system for the windows because of cleaning. Some windows are automated for night cooling. So at night they open, and the concrete ceilings are cooled down. This happens with the very top windows. These were there sometimes for daylight, but mostly because of ventilation. The other windows, which were just for daylight, had to be opened for cleaning. The Tate wanted the windows to be able to be cleaned from the inside. There were consultants for that, who were responsible for building maintenance. We also had a 1:1 scale mock-up of a floor. On this, we tested the window frame sizes to see what is openable and what is fixed, and we also had a cleaning person leaning over these internal precast elements to see how far they could reach out. So, there is a fixed part, a little small one which can be opened, then a fixed one and another one that can be opened so you can reach out and clean the glazing. That was basically the compromise, to have a lot of fixed elements which could be cleaned from the inside.

AC: These daylight and ventilation requirements determined where the brick wall should absolutely be cut out. However, this external veil has its own architectonic composition. The arrangement of the cut-outs seems to be random, but I suppose it was also controlled in terms of design.

AR: Of course! This is not an office building, it is a museum, and there are a lot of concourse areas and public zones. HdM always intended to enable the public to go all the way to the top to see over the city, to take advantage of the fact that it is a high building. This is a window of a circulation area, this one of the little cafe space. Here there's the intermediary gallery space to look out for, and this is a special condition with the terrace. So, all the slightly larger windows are actually done on purpose for these views out of the building. These smaller strips, which are, I think, 1.05 m, are the ones for the daylight requirements.

AC: Are they at ceiling height?

AR: No, they are at floor level, so you can look out.

AC: But you also have the windows at ceiling height.

AR: Yes, you have these, which are either for ventilation requirements or daylight requirements.

AC: How high are the windows?

AR: They are related to brick constraints. All storeys were of different heights, and they were all a multiple of the brick grid. Actually, the brick defined quite a lot of the overall design. So sometimes, when you were splitting it, there wasn't always exactly 75cm, and it had to be 15cm more or less to fill the overall height.

AC: So these higher windows were positioned for the views out.

AR: Exactly, and there are mainly public functions or the concourses behind them.

AC: When you look at the facade, you see a big window at level 5 that runs for almost the entire perimeter of the volume.

AR: That's for the learning spaces.

AC: There's also a continuous one at level 9 and the terrace. I don't know whether this was made on purpose, but it creates a kind of tripartition of the facade, where you have the base, the cap and the in-between part.

AR: Yes, the terrace was absolutely designed with a 360º degree view. That is without question.

With the restaurant at level 9, it was a functional decision. When people are there, they appreciate the view and do not want to sit behind the brick facade to see only a bit out.

At level 5, it was mainly daylight requirements because it is a teaching area, so it was clear that we needed a lot of windows. There was also the decision based on the fact that this cut is above the Switch House, and it signals the next level of the tower.

But it is hard to say that all these decisions were for one specific reason. There were so many people involved. Jacques and Pierre said something. Then there were two partners, two associates, two project leaders, then me, responsible for the facade. Many people, lots of views and then at some point it is just on the wall and you say, "Ok, let's do it in this way". You don't really know how it ended up being exactly at this position. Is it because of the daylight requirement, or did we just make it a little bit longer because of proportions?

Of course, it is designed. The position of the cuts is a conscious decision, and it is not defined by the scripting or only by daylight requirements.

AC: I also noticed that the windows are often located at the corners and creases, which contributes to the continuity between the faces of the volume.

AR: I can't answer because when this was done, I was not yet involved. I think it was also pretty much decided on models. However, that changed in the following process because of the daylight requirements and so on. I think there was never a decision to say there should be a cut on the crease. It is just that there are so many creases. Every facade is folded, especially in the upper part, so you always hit the crease. Otherwise, you have a four metre window.

The building geometry is the result, on the bottom, from the circulation around the building and, on the top, from the perfect brick rectangle. The window cut-outs were never considered in relation to the brick or something, and these were just design questions or functional requirements.

AC: What kind of constraints emerged from using the brick, which is a modular material? The position and dimensions of the windows and the storey heights are related to the brick dimension. In what concerns the concrete structure of the facade, I also read that the columns were positioned where the crease intersected the floor slab. However, later this was slightly adjusted to match with the brick grid.

AR: Because of the brick grid, exactly!

The brick facade defines, in a way, where the windows need to stop. Otherwise, for the windows, you get a special condition, and also a different appearance, because there is a brick that needs to be cut. It didn't make sense, aesthetically and construction-wise.

The columns, as you said, were trying to meet at these points where crease and slab intersect each other. But I think there were a few, like this one, for example, which were individually placed because they were needed structurally.

AC: Not all the columns are positioned at these intersection points. From the interior, I think I saw at least two situations in which the fold of the column is visible from the inside.

AR: It is in the staircase void, because there is no slab hitting it. It happens especially here, in this corner, because you have the stair going from level 1 to level 2, and you've got this column that needs to do the kink. This column was needed because, structurally, the slab above needed to be supported.

Initially, as you said, the columns were placed exactly at the intersection, but, later on, they were slightly offset to be adjusted to the brick system. Also, geometrically, they don't meet perfectly. There is one column that sits vertically, and the other one is inclined.

Here, and on the opposite side where you have the stairs from level 2 to 4, you have these two or three situations where you see the crease point from the inside. In all the other conditions, it is always the vertical column sitting on the slab and then the inclined one going underneath, so you don't see how they connect.

To answer your question, the brick facade defines where the columns sit, where the openings start and stop. It defines the floor heights and even the louvres for the ventilation machinery.

On the west facade, these openings do not have glass behind them. It is machinery and openings for ventilation. It was clear that we had the header free, so we had 32% perforation, and the engineers had to calculate how much we needed to get the fresh air in. Where you see a few white elements in these elevations, the header is free. This is where air is taken in for office spaces or all the learning spaces behind. All of this was defined because the brick only allowed for 32% perforation. Yes, it was quite a bit of dependency.

AC: When did Kai start working on the project? Why did the team ask for the help of the DT group?

AR: That had even started before my time because Volker was scripting parts of the brick facade. There were many repeating situations, like the sill, the reveal and the lintel, that followed previous rules. The corner was complicated, and they never solved this in the initial script. The final script was basically to develop the 3D model, which was then used to visualise certain decisions and make 2D drawings. It was easy to make one of these drawings, but not the whole facade elevation. As we said, there were 336,000 bricks. Of course, you can use a grid, but it would change at every window or every corner condition.

AC: And if you use the scripting to do it, you will be sure that it is controlled and precise.

AR: Exactly, that is correct and controlled! But initially, as we said before, there were various scripts written for different problems independently. It was only when Kai arrived—and we reopened this issue—that the script began to include all of the rules. The anticlimbing as well, which was also quite a special condition, for how we go from solid to perforated. The bricks were slightly stepping back, and I think, initially, we needed about 380 different bricks per facade to do these 3.5 metres. At some point, the engineers said, "Sorry, but probably this is not going to happen. You will need to find a way of getting this effect but with fewer bricks". This was when I studied it with manual 3D models, physical models and drawing it up. Then, when we had this defined and the rule was clear, Kai looked at it and scripted it so that we could generate the 3D model very quickly.

AC: So, you defined the rules using physical models.

AR: We defined them on physical models, drawings and manual digital models, just taking out some parts and modelling, doing different tests, and doing it in physical 1:1 scale models. We cut the bricks out of styrofoam and laid them on each other, especially for the corner.

AC: Like these?

AR: Yes. These models were done to test what the effects were. And there were some only for the corner itself, for every four corners.

AC: So, only afterwards would you ask Kai to put this information in the script.

AR: We made the decisions based on these, and Jacques and Pierre were overviewing and deciding how we should do it.

But then there was the moment in which we needed to visualise it as an entirety. We looked at the four corners, but we didn't have the perception of what everything was looking like. With the old scripts, it was not possible because we could not adapt them in the right way, or they weren't generating the overall facade. The previous scripts were just creating the whole standard brick grid and weren't taking care of all of the special conditions, like corners, creases, sills, reveals, and so on.

That was when Kai came in. It was also when we needed to talk about the colouring of the facade. How we should manage all this and how we could generate 2D drawings, which were also useful for manufacturers. All of that was introduced in the script as well.

AC: So, what were the issues controlled in the scripting?

In the report from 2009, it mentioned that "the overall building geometry has been rationalised and thoroughly analysed using scripted 3D models fully co-ordinated to brick dimensions. The scripting process has allowed detailed design development of the brick reveals, corners and creases. The parametric model produced by the script has automated the setout of openings and the facade structure so that all facade elements relate to the coursing geometry of the brick skin." Kai told me that he decided to set out the data structure on a point cloud. Each brick was represented by a point that was informed with all the parameters regarding the type of the brick, the size, its position, its colour, its geometric constraints.

AR: The main change in Kai's script was that he was working with this point cloud. The previous ones were always generating the geometry of the brick and placing it onto the modelled surfaces. That was what took so long. Kai also had the facade surfaces, with the rectangle at the very top and the starting point.

AC: Is this one the starting point at the roofline?

AR: Either one of these four points, because this rectangle is always a multiple of a brick dimension plus a header. You have a perfect brick at each of the rectangle corners. It's the rule. That's how it is set out at the very top.

From there on, the script generated a point cloud onto the surfaces based on the starting point and went down properly. Then it changed the name of each one of the points according to its location. Whether it sits inside a window, where it became the name 0 because there's no brick, or it is at a reveal position because it becomes a header, or in a sill position, where it becomes one brick with four holes in it.

The script also took into account the special conditions of the structural engineers. You have the visual appearance of the bricks, like reveals and sills and so on, but, as I said before, each brick had different holes which you can't see. The brick looks the same in two different facades, but it is actually totally different in terms of production. This was on the script as well. I defined with

Kai the name the points should have. They were also informed by the manufacturer that was involved in the whole process of doing the mock-up. So we went to the factory and asked what information they needed to know to produce and identify each type of brick, not just the visual differences but also functional differences in terms of the holes.

Then, the script did this point cloud. It defined all points according to the different names and brick types, and, afterwards, generated one block, a Rhino block, for each of these brick geometries.

This was a huge improvement in terms of the time that it took to generate the 3D model. It was also really good because you could take the point cloud, and, instead of asking to place polysurface blocks onto it, you could ask for 2D surfaces, polylines filled with the colour X to generate the plan view, so then we had the elevations drawn by the script as well. As I said, this was also extremely helpful in terms of colour testing. But also for the 2D information required to explain the process and to generate lists and schedules. It was important to have the control that, on this facade, we needed the brick type A, B or C, either for the brick manufacturer to produce or for the bricklayers to have an elevation showing where each brick needed to go.

AC: Did the scripting also consider the change of the brickwork pattern from solid to perforated at the anticlimbing?

AR: A small script I wrote for myself was generating the condition for each of the five facades for the anticlimbing with the different variations we tested. But, for that, it was not the main script that helped. The main script was generated when all of this was clear and defined. When Kai was writing the script, the geometry was already defined. There was no discussion any more about the corner geometry or the reveal. That was all set. The only thing that was left over was the colour, and how do we colourise all this. But this happened later.

AC: I think that the corner is one of the most particular aspects of the project. How did you decide the geometry of the corner? It is a "strange" corner.

Jacques, at a conference, said, "How we use the edge where the two sides come together to create this kind of porosity which defines or also reveals the construction behind it, is a simple but important detail for how we use construction as part of the idea of the whole building."

I imagine that the corner raised a lot of discussion. It could have been a more traditional corner. For example, in this image from 2008, the corner is completely different. In the report from 2008, it is mentioned that "larger brick units are proposed to the corners and creases to ensure consistency of the overall texture of the facades." So, in 2008, I suppose that you were thinking of larger bricks that allowed the corner to be sharp, but then everything changed.

AR: It's quite interesting that they wrote this because, internally, we discussed that this was, exactly, what we shouldn't do. One of the issues for this solution was that it generated hundreds of different types of brick geometries that had to be produced and would be used only for one position. At the same time, and you can see it very clearly here in comparison to this one, in the crease and in the corner, it was framing the surfaces.

AC: We would see in the corners and creases a kind of solid line.

AR: Exactly, you had these solid lines, which are a kind of frame. At least me and Wim Walschap, who was the associate in charge of the facade and worked with me quite intensely on solving the brick issues, had the feeling that it would frame it. Ignoring the problem that all these would have been special bricks, in our opinion, it didn't work. Then I studied the brick facade quite intensely, and, for me, this is like grid paper. Now you take one vertical, you incline one, you fold them in a corner, and if you try to merge them, you have no repetition. There is no joining of these two grids. It started to repeat at 178 m or something. That's where you have the first brick you could use again for the next one. When I did this exercise, we realised that we needed to find a different solution, because every row of bricks would have one special brick in each corner. We couldn't do this, and it was also not feasible. It's a very simple and standard grid, we are not shifting it in the facade to generate different openings, but suddenly, the corner is something special.

The other issue was that it was solid.

In the crease, it was quite easy to solve because we could take the standard brick and slide it a little bit into the opening of the other one. There was only a small tweek to be done to match two or three bricks on each crease. You could leave certain bricks to generate a more perforated approach and not a solid line like this one. For the corners it was complicated, because you always had one brick standing out, cantilevering, which was unseen from the other side and was dominating the corner. This was the situation in the building where we did a lot of 1:1 scale physical models, where we came up with the idea of first trying just two bricks, for the vertical facade, to be cut according to the inclination of the other one.

AC: Is this the corner rule?

AR: Exactly! We developed this rule. This is always the vertical facade, which has two cut bricks that we decided not to cut on site. Initially, we developed it in such a way that you could cut the brick on site, so it would have always been the same brick that would then be cut. However, the structural engineers were worried that you might cut through a hole. Then it would be opened, and water would go into the other one. So, it should also be one closed extruded brick that had one specific length. I manually modelled the facade, and I realised that it would help to have the appearance of a continuous perforation if I only used two bricks.

Then the inclined facade was always cut on an angle, and you could place, depending on the left-over to the corner, the standard full brick, a 2/3 brick, a 1/3 format, or none at all.

AC: So these four options depended on the dimension we have left to the corner.

AR: It depended on the dimension to the theoretical corner point.

For the vertical facade, it was this brick cut on the angle. Either you have no brick, or you have one that has this dimension. Again, two types of bricks, because we realised that this was the only thing that repeated on this version. I think only the southeast had three. You could always fit either this or this dimension behind the other bricks. That was one repetition that happened, which none

of us was able to calculate and say that it was because of this. I think it was because this is the vertical grid which is then cut by one element, and it was always this result of having this and this one.

AC: Does the inclined facade always go in front of the vertical?

AR: Exactly! The inclined is always in front of the vertical. “The inclined wins” we callled it internally.

AC: They do not intersect.

AR: In a way they do, because the next brick sits here, so they do because it is inclined.

That was the "Aha!" point that we had when we were physically or virtually modelling in 3D. I realised that it was working. The rule just said that there should never be a brick from a row cantilevering in front of the other one. In previous versions, we had full bricks standing out, and all of a sudden, you had these spines coming out. It still sometimes appears like this, especially if you are on site. With this rule, you still have quite a lot of different bricks, because this brick, or also this brick, is special on each of the four corners, since the inclination of the facades and how they join is different.

AC: So, in the vertical facades, you don't have special bricks.

AR: No. Where you have the corbel, the bricks are different because of the holes, but the geometry is the same. So, in the vertical facades, you have three types of bricks.

AC: Then each inclined facade also has its three special bricks, plus the bricks for the reveals and sills of the windows.

AR: On the sill, you’ve got a special brick, but it is really just the top one which has no holes. So that’s the same on all facades, no matter what the inclination is.

AC: Then you have the corners, and here there is the rule for the corners.

AR: Exactly!

AC: For the corners, there are four situations, because each corner is different from the other ones. Then the creases.

AR: But in the creases, there was just the rule of leaving a block out or not.

AC: Are the bricks cut in the creases?

AR: No, there weren't any special bricks in there. Again, it was the inclined surface going behind the vertical, and the one allowed to place its last full brick. If that's the rear, the brick is left out once it starts to protrude on the inside. This was the rule.

There was a point when we realised that if you give priority to one of the surfaces it makes it a lot easier, and we still have overlaps, which was important for the structural engineers. However,

for them, it was not a problem if the bricks were not structurally connected. In this way, visually, it was still looking like it was interlacing. In the beginning, it's scary when you see the rule because you think you are going to have a joint, that it will be separate surfaces. But actually, since it is inclined, the rows are still intersecting. One row above, the brick is stepped back, so it is sitting on top of the other surface.

AC: What you are saying is that, technically, this was the best solution, and it would have been complicated to find another one in which everything would match.

AR: We spent, like, half a year testing different versions. At some point I was going nuts. But it was also a strange condition because I was sitting in London, Wim was in Basel, and I was preparing all the information for the reports and meetings with Jacques and Pierre. It was really complicated, because sometimes I thought, "Oh, that's the solution". So, I was very keen on presenting and explaining it, because it is not easy to understand just with a drawing. You've got the drawing here, but you still need to explain why it works or what had generated it, and then the response came back that they were not happy, or that it was too perforated, or it was still too solid.

At some point, Wim Walschap said, "You fly over, and we will have this meeting". We discussed all the different rules that we had, and then Jacques and Pierre agreed that it should work. Afterwards, we tested it on the 1:1 scale mock-up. Up to that point, they were still not really convinced. I did these millions of renderings of the corner, but it was only when they saw it in the mock-up that they agreed that it was actually working.

AC: You have two different approaches to the corner. At the anticlimbing, which is a flush surface, you have a sharp edge. A regular piece was placed at the corner. There's the standard grid that, at a certain point, before the corner, stops, and a special brick is placed there, always with a different length.

AR: The anticlimbing was an area that was generating most of the different types of bricks. The big change happened when we decided to make the transition from solid to perforated by pushing back the headers only into a certain dimension. We always used the same header and laid it with mortar. So, at the anticlimbing, you have this block and this block connected with the steel pin, but the header is free. It is not connected to this one or this one, but it is just sitting with mortar on the bottom one. This enabled us to use the same brick. We decided only to push it slightly to the back at each row, and once it reached too far to the back and was closing off the gap behind the bricks, it was left out.

That was quite an important moment because it reduced the types of bricks. In this section, you see that all of these headers are special because they are keeping the same rear location, but the brick was reducing in size. We did the renderings, which helped a lot, and Jacques and Pierre said that it could work because, from the angle that you look at it, it appears as if the brick had already gone, although it is not. It is only pushed back.

For the corner, I think it is a similar rule as above, where the inclined surface wins and goes in front. The rule considered that on the inclined facade there would be a specially manufactured brick. Then this one here, in the vertical facade, was cut according to how it joined the other one.

AC: So, the corner is a special brick.

AR: Yes, because you have the vertical and inclined surfaces.

So, that's the standard header, this one is already a special one, and that's a standard special one, which was made for this position. We have, like, twenty special bricks per corner. Then these ones were cut according to how they hit, basically, the rear of these.

AC: Here, you don't have a header because it would be too small.

AR: Exactly. We decided to establish a minimum size, which is the header. If the brick still fitted, it would go in there, but if it didn't, it would get bigger, becoming a block with a different length.

AC: Another important issue in the brickwork is the colour gradation. I have these drawings from 2008 and 2009.

AR: That is what I did with the script we had. This is an idealising phase of it, and it was the condition developed in these initial renderings. We analysed TM1, and we saw that there are roughly five different colours at the bottom. Then you have these other two fields. This one, that regards the new bricks, when the Tate Modern was built, and the elder ones with the darker colours.

AC: So this one is from when Tate Modern 1 was built?

AR: The new parts are the brighter versions. Originally there were already these differences, but most of the bottom parts had to be rebuilt, and that's why it looks a lot newer than the older versions of it. Then, in TM2, there was a rationalisation phase, in which we decided to have these five or six red tons, which are changing in the steps, anticlimbing, Turbine Hall and then the top.

AC: So, these three diagrams correspond to the evolution of versions.

AR: Exactly, to rationalise it. We were constantly talking to the manufacturers, and they said that it was not a problem for them to produce this. However, within all these zones, we also had these special geometry bricks. Suddenly, we had this variation of fifteen colours multiplying the already existing number of different bricks. So even if the manufacturers said they could do it, even if it would cost some money, the consultants said that it was nonsense, that we wouldn't be able to distinguish them. We would also need them on site, so we would need the whole construction site just to set out our 380 different types of bricks. So, we had to rationalise the colours within each zone. This was the result. We decided to have this set of just eight colours, which are then mixed in the facade, in a different percentage on each of these zones.

AC: In the facade, the colours would be mixed.

AR: Exactly, in the lower level, you have only these six reddish colours. Then up here, you have, like, forty percent of the reddish ones and sixty percent of these three. Then at the highest level, you have about eighty percent of these three and a few of the reddish ones.

AC: Should this look like this?

AR: Yes, that was the test. This one was the perfect gradient, and it was done when we started using Kai's script. These diagrams were drawn in Rhino, and the script was analysing the different rows of bricks and applying the different colours, like it was defined here. That was the big advantage of the script. We were able to test these different versions very quickly.

This distinction between levels looks like a hard step, but when we rendered and visualised the facade, you don't see it, because you still have these brick colours in here. So, in the end, it is not a line, as you see in the diagram. There was the moment in which everybody said that probably it was going to work, but in the end, it only used some of these brownish tons. I remember that we did one more mock-up on the Tate facade where we decided on these six brownish colours. Everybody agreed that it was looking good and the decision was taken.

AC: So, there aren't any of these reddish ones.

AR: Exactly, the decision was that we were not corresponding to the red, we were just keeping these brownish tons, and there would be no gradation. The gradation would happen by the anticlimbing.

AC: Yes, in fact, you see a gradation because of the perforation.

AR: Yes, the perforation is doing that slight gradient from the bottom to the top.

AC: I've been to London in November, and the corner is a bit strange because it seems like everything is going to fall.

AR: Yes, I agree, you can't imagine how many different corner conditions we visualised. That was definitely the most complicated situation.

AC: I can imagine. It's not easy because, besides the vertical and the slope, you also have the stepped.

AR: When I joined, I thought, "No, it can't be so hard to solve this corner." But then, "Oh no, it can't be! What is this?" You try to calculate it, and you can't. You try to model it, and it isn't easy. It starts to drive you nuts at some point.

AC: Why did you give up the colour gradation?

AR: It was because of the cost, but I think that in the end, it was a good decision having just brown colours.

AC: How was the design process? How did you design it? Did you start with the 3D, and then you went to the 2D?

AR: I did physical models, sketches, tried to draw it in 2D and then looked at it in 3D. It was back and forth. Then it was making something 2D out of the 3D, doing it in Rhino and sketching over, then doing it in a physical model to see how it feels. In the end, it was Rhino, the script and AutoCAD 2D drawings, but also Illustrator, Photoshop, and so on for the renderings.

AC: In your opinion, what are the most relevant design tools in the practice of HdM?

AR: Physical models. As architects, most of us are quite quick in translating a 2D drawing into a 3D, but everybody else isn't. So it is hard to explain from 2D plans how something works. Then a 3D model is something where everybody is stuck in front of the computer, looking at the monitor. So, you generate visualisations in which you pick the best perspectives, and it looks really good, but then two metres further to the right it doesn't look that good any more. All of this you see in a physical model. Everybody sees in a physical model—you, the client, the contractors, and so on.

At HdM, I was always impressed by the number of physical models. Also, by all the interns and even the workshop employees. There was so much stuff produced, and tests to make sure that, in reality, in a physical situation, it looks the same as you modelled it. In 3D, you also leave a lot of stuff out. How do you visualise mortar, which is something placed by hand and that always looks a bit different? In the rendering, it is all the same and perfect.

AC: The construction of mock-ups, I think, is also something particular in the work of HdM.

AR: Yes. That's also due to the size of the projects, because I think that almost every large project has mock-ups done to make sure we do the right thing for the project. In the office, they develop a lot of physical objects. Elevations and plans are important, but in the specific case of Tate Modern, the 3D was crucial to handle the project, to make it buildable and to generate all the information that the manufacturers needed.

AC: And also, I suppose to control the integration of all the parts.

AR: Exactly. The building was never physically modelled entirely. It was modelled for the overall geometry in these small study models. We also made models of a particular situation, and there was the 1:1 scale detail of the corner. But these were always separate pieces. The visuals, the renderings and the 3D were important to get overall extents of the facade, and especially for information handling. The script was particularly important for doing the final colouring facade and producing the 3D, but also for the construction information. The contractors got lists of the bricks that had to be in every row.

AC: That was one question I had for you. How was the design information transmitted to the construction site?

AR: As I said, the point cloud defined the brick "SB4 southwest" or something, type 1, 2, 3, 4, 5. There were these sheets of brick types explaining what dimensions they had, where they had

the holes exactly and the code of colour each was supposed to have. The script generated a list of all different types and how many colours were needed. So, the manufacturer knew the amount that he had to produce.

Then there was this list produced floor by floor, elevation by elevation, for the bricklayers to know what needed to go where. In the end, this was a bit reduced just to get the overall amount of the different geometrical types of bricks. For the colour, you would sort this out from the bricks that you got from the brick manufacturer, and you placed them. So, in the end, it wasn't defined where the colours should exactly go. The type of brick that should go in this corner was specified, but the colour could be between three or four colours, so the bricklayer could place as he wished.

AC: Did the bricklayers have 2D drawings of the special parts of the building?

AR: Yes, for each row we did a full elevation of each type, even if this was done only for the special conditions.

AC: But the corners are all different.

AR: All four corners are different, but there was the rule. So, they took the last brick and confirmed. If it was cantilevering in front of the other surface, they would take the smaller one.

AC: There was a bricklayer specialised in the corner...

AR: I think they had a bricklayer team responsible for the general elevations and another one for the reveals, the corners, the creases and so on.

The bricklaying was a lot less of a nightmare than the precast or the windows. The beginning was quite complicated, because they had to get used to the process and there was also the anticlimbing, which was all special. But if you follow through the time-lapses, you can see that these two first floors took quite a long time, but then, all of a sudden, it speeds up and gets a lot faster.

AC: When they arrived at the top, did it match perfectly?

AR: Yes, it did.

END

Biographies

Jacques Herzog

Jacques Herzog studied architecture at the Swiss Federal Institute of Technology Zurich (ETHZ) with Aldo Rossi and Dolf Schnebli from 1970 to 1975. Together with Pierre de Meuron, he established Herzog & de Meuron in Basel in 1978. He has been visiting professor at Harvard University, USA since 1989, and was professor at ETH Zürich and co-founder of ETH Studio Basel – Contemporary City Institute, from 1999 until 2018. Jacques Herzog and Pierre de Meuron were awarded the Pritzker Architecture Prize (2001), the RIBA Royal Gold Medal (UK, 2007), the Praemium Imperiale (Japan, 2007), and the Mies Crown Hall Americas Prize (USA, 2014). In 2015, they co-founded the charitable foundation "Jacques Herzog und Pierre de Meuron Kabinett, Basel".

Kai Strehlke

Kai Strehlke joined in 2015 the Blumer Lehmann AG, where he is working on the interface between digital data and CNC manufacturing of large scale timber structures. Between 2016 and 2021 he was teaching digital manufacturing at the Bern University of Applied Sciences. In 2015 he was invited by the Technical University Graz in Austria as a Guest Professor at the Institute of Architecture and Media. Between 2005 and 2015 he has built up and led the Department of Digital Technologies at the architectural office Herzog & de Meuron in Basel. He integrated a digital workshop in the office with different CNC technologies and with his team he supported various projects on geometrical issues as well as on parametric design. From 1997 to 2004 he researched and lectured at the chair of CAAD at the Swiss Federal School of Technology in Zurich and submitted his PhD with the theme of “The Digital Ornament in Architecture, its Generation, Production and Application with Computer-Controlled Technologies”.

Steffen Riegas

Steffen Riegas graduated from the Muenster School of Architecture in 2007. Prior to his collaboration with Herzog & de Meuron, he gained experience working with UNStudio in Amsterdam and 3XN in Copenhagen. He joined Herzog & de Meuron in 2010 as an architect in the Digital Technologies Group (DT), which supports project teams with the integration of digital tools in design and building processes. Working in this role on various projects, he was particularly involved in the realization of the Messe Basel New Hall and the Nouveau Stade de Bordeaux. After two years gaining experience in other international offices he became Head of Digital Technologies in September 2014, and was appointed Associate Partner in 2020.

Steffen continues to lecture at universities and conducts workshops on the application of digital design tools in the architectural practice.

Volker Helm

In 2017 Volker Helm became a professor for digital methods in architecture at the University of Applied Sciences and Arts of Dortmund.

After successfully completing his studies in Architecture at the University of Siegen (Germany), he specialised in CAAD as part of a Master of Advanced Studies under the supervision of Professor Ludger Hovestadt (ETH Zurich). He subsequently worked for six years at the Herzog & de Meuron architectural office in Basel where he specialised in the development, programming and realisation of complex geometries. From 2010 to 2017, Volker Helm worked with Professor Fabio Gramazio and Professor Matthias Kohler as a Research Associate at the ETH Zurich within the Department of Architecture and Digital Fabrication. In addition, in 2016 he was a postdoc at the National Centre of Competence in Research (NCCR) Digital Fabrication (ETH Zürich). In 2015, he successfully completed his doctoral degree under the supervision of Prof. Dr. Georg Trogemann (Academy of Media Arts in Cologne - Department of Experimental Informatics) and Prof. Matthias Kohler (ETH Zurich - Chair of Architecture and Digital Fabrication).

Harry Gugger

Harry Gugger studied architecture after an apprenticeship as toolmaker and studies in machine engineering and German literature. From 1984 to 1989 he studied at the ETH Zürich with Flora Ruchat and at the Columbia University New York with Tadao Ando. 1990 began his collaboration with Jacques Herzog and Pierre de Meuron. As a partner he helped to develop Herzog & de Meuron from a small office to a global company.

Among many other projects, he was in charge of: Signal boxes I & II (1991-1994 / 1995-1999, Basel); Engine Depot (1991-1995, Basel); Library of the University Eberswalde (1994-1999); Tate Modern (1995-2000, London); Schaulager Basel for the Laurenz Foundation (1998-2003); Caixa Forum Madrid (2001–2008). The Laban Dance Centre (1998-2003, London) was awarded the RIBA Stirling Prize 2003. 2004 Harry Gugger received the Swiss Art Award Prix Meret Oppenheim.

From the outset, his practice was paired with manifold academic work. Since 2005 Harry Gugger is tenured professor at the EPF Lausanne (EPFL) where he founded the Laboratoire pour la Production d'Architecture. His laboratory was in charge of the National Participation of Bahrain at the Venice Architecture Biennale 2010 winning the Golden Lion award. 2011 Harry Gugger transformed his laboratory into Laboratoire Bâle a satellite laboratory of the EPFL dedicated to urban and architectural design based in Basel.

In 2010 Harry Gugger founded Harry Gugger Studio which works on projects of all scales with a focus on urban design. From this practice synergies emerge with the research of his laboratory at the EPFL. Besides many other engagements in juries and commissions Harry Gugger acts as a board member of the LafargeHolcim Foundation for Sustainable Construction since 2010.

Nicholas Serota

Nicholas Serota is Chair of Arts Council England and a member of the Board of the BBC. He was Director of Tate from 1988 to 2017. During this period Tate opened Tate St Ives (1993) and Tate Modern (2000 and extension 2016), redefining the Millbank building as Tate Britain (2000). Tate also broadened its field of interest to include twentieth-century photography, film and performance, as well as collecting art from Latin America, Asia, the Middle East and Africa. The national role of the Gallery also became more significant with the creation of the Plus Tate network of 35 institutions across the UK and Northern Ireland.

Between 1976 and 1988 he was Director of the Whitechapel Art Gallery where he curated numerous exhibitions including Robert Ryman, Carl Andre, Gerhard Richter, Eva Hesse, Max Beckmann: The Triptychs, Anselm Kiefer, Philip Guston, Georg Baselitz and Bruce Nauman. In recent years he has curated or co-curated exhibitions of Donald Judd, Howard Hodgkin, Cy Twombly, Gerhard Richter, and Matisse: The Cut-Outs.

Nicholas Serota has been a Trustee of the Architecture Foundation and a commissioner on the Commission for Architecture and the Built Environment. He was a member of the Olympic Delivery Authority which was responsible for building the Olympic Park in East London for 2012.

Wim Walschap

Wim Walschap joined Herzog & de Meuron in 2007 with extensive experience as an architect, both from independent work as well as from collaborations on residential, commercial, and institutional projects in all phases. He has led different teams on projects ranging from pavilions to high-rises, including The Tate Modern Project in London, Helsinki Dreispitz in Basel, and the competition-winning M+ museum in Hong Kong. From concept to completion, he works with a hands-on approach and awareness of the fundamentals of construction. In 2010 he became an Associate of the firm, and a Partner in 2014.

Wim graduated from Hoger Architectuurinstituut Sint-Lucas, Brussels, Belgium in 1993. Amongst others he worked with Robbrecht en Daem Architects in Gent for over 8 years.

Andreas Reeg

As founder and managing director of rundzwei Architekten, Andreas is involved in all projects of the office and is mainly responsible for the success of each project he supervises. He represents and presents the contents of the office to the outside world and is often invited to give guest lectures at universities and institutes on projects and ideas of rundzwei Architekten. He is also regularly asked to participate in jury sessions of national architectural competitions. He has recently been appointed as an expert for sustainable architecture and urban development by the Berlin Senate Department for Urban Development and Housing.

Before founding rundzwei, Jan Andreas Reeg worked for the Berlin office Phase eins, ACME in London, and Herzog & de Meuron in London and Basel. At Herzog & de Meuron, he was responsible for the façade of the Tate Modern Museum as well as for an 11-story residential project by Herzog & de

Meuron in Basel. Andreas Reeg studied architecture at the TU in Berlin and graduated with a diploma. In 2005, he received a scholarship to the Pontificia Universidad Catolica de Santiago de Chile, where he received a diploma with distinction for his academic achievement.

A native of Berlin and father of several children, he is fluent in English and Spanish.

Note The biographies were provided by the interviewees in 2020 and 2021.