

Embodiment of Architectural Thought

Progressive development of form as training method for early stage Education

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D
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EMBODIMENT OF ARCHITECTURAL THOUGHT

PROGRESSIVE DEVELOPMENT OF FORM AS TRAINING
METHOD FOR EARLY STAGE EDUCATION



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Dissertation prepared within the scope of the Ph.D. Program in Architecture,
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Resumo

A presente investigação endereça o problema do ensino da arquitetura, trabalhando sobre o desenvolvimento de um exercício metodológico destinado a preparar o estudante para a aprendizagem da arquitetura. O objetivo da Tese é o desenvolvimento de uma hipótese para desbloquear a imaginação do estudante, indispensável ao exercício do projeto, a partir do desenho e especificamente do desenho analógico.

O desenho é um aspeto determinante no ensino em arquitetura, servindo simultaneamente enquanto instrumento de comunicação e ferramenta de pensamento. Apesar da emergência dos *softwares* e ferramentas digitais, o desenho continua a desempenhar um papel crucial no desenvolvimento da imaginação e da intuição projetual dos estudantes. Na secção A da Tese, são apresentados os fundamentos teóricos de articulação do problema com os desafios educativos identificados nas faculdades de arquitetura (Capítulo 1). Adicionalmente, são explorados o conceito de projeto e as teorias prevalentes neste campo (Capítulo 2).

A pesquisa subsequente aborda um conjunto de parâmetros que considera a qualidade da aprendizagem em arquitetura, categorizando as estruturas mentais pelas quais se processa, com apoio na investigação que se reconhece desenvolvida neste campo. (Capítulo 3). O capítulo seguinte (Capítulo 4), reflete sobre o conceito de Forma e o seu impacto no processo de conceção, com base nas teorias de “Form-Finding”.

Na secção B deste capítulo, são testadas (em laboratório) as descobertas realizadas na secção anterior, mediante a metodologia definida no ‘método operativo’. Os estudantes envolvidos passam por um programa específico composto por duas etapas: primeiro aprendendo e depois refletindo sobre a aprendizagem realizada, através:

- 1 - da produção de estruturas formais experimentais
- 2 - de composições com os temas arquitetónicos testados (Capítulo 5, 6).

Uma vez que todos os passos deste procedimento experimental se apoiam no desenho e especificamente no desenho analógico, tornou-se necessário verificar quais as condições necessárias para se alcançarem resultados eficazes, capazes de fomentar e desenvolver uma reflexão criativa e intuitiva, de uma forma espontânea e condizente com o exercício do projeto. Estes aspetos são discutidos extensivamente no capítulo final da Tese.

Palavras-chave: Ensino de Arquitetura; Desenho ou Projeto; Modos de ensino; Modo de Pensamento, Procura da Forma; Pensamento Visual, Esquício; Imaginação; Intuição; Criatividade

Abstract

This research revolves around the issue of teaching architecture to develop a methodical exercise aimed at facilitating the design process, applicable at introductory levels of the architecture field and prior to students' entry into design studios. The objective of this study is to investigate a hypothesis regarding the integration of form design processes and creative development of visual choices through methods based on freehand drawing and graphic thinking.

Sketching has long been a focal point in the architectural education process, serving as a communicative language and a research tool for architects. Despite the emergence of modern aspects of digital tools and computer software, sketching continues to play a crucial role in assisting students in entering the imaginative realm and achieving intuitive design capabilities.

In section A of this research, theoretical foundations are presented regarding the articulation of the problem and educational challenges in architectural faculties (Chapter One). Additionally, an exploration of the concept of design and theories prevalent in this field is undertaken (Chapter Two). Furthermore, the subsequent research delves into the parameters influencing the quality of learning and categorizes the mental structures of students' learning based on the theories of researchers in this field (Chapter Three). In the following chapter (Chapter Four), reflections are provided on the concept of Form and its significance in the design process from the perspective of Form-Finding theories.

In Section B, key findings from the previous section are experimentally tested (Laboratory research) within the framework of an instructional-exercise method. Participating students undergo a specified program in two stages: first, learning, and then reflecting on the lessons with a focus on creativity, imagination, and intuition in two sections:

- 1- Producing experimental form-based structures
- 2- Compositions with architectural themes Tested. (Chapter 5, 6)

As all the procedural steps in this experiment lean on sketching and free-hand design, observations have been made on the necessary materials to achieve effective results in the exercise process, fostering and developing creativity and intuitive reflections through sketches in a spontaneous and concurrent manner with the design behavior. These details are extensively discussed in the concluding chapter.

Keywords: Architecture Education, Design, Learning style, Thinking mode, Form-Finding, Visual Thinking, Sketching, Imagination, Intuition, Creativity

Introduction

The issue of teaching design and how architecture students become familiar with the act of design as a complex process, often referred to as multicriteria decision-making, has always been a thoughtful subject in architectural education. The diverse approaches used in various architectural schools are also highly varied, and it is challenging to reach a consensus within a unified instructional method. This thesis endeavors to outline a problem statement regarding the challenges and threats faced by architectural faculties in dealing with this dilemma, aiming to propose solutions for reevaluating introductory education before entering design studios. In the first chapter, a comprehensive description of the problem and concerns in the field of architectural education is presented, along with an initial comparison of introductory teachings in some architectural faculties.

The need for a precise understanding of what should be learned before entering the design studio necessitates a more detailed comprehension of the concept of design and its associated components. In the second chapter, this concept (design) is thoroughly examined in a context beyond theoretical considerations, viewed through the lens of design methodology. Parameters influencing design activity and prevalent theories in this field are scrutinized, and key and sensitive points requiring preliminary readiness before entering the studio are extracted. With a more nuanced understanding of design and an examination of it from the perspective of design education - which can significantly differ from the act of design and professional design operations - the issue of learning is addressed in a broader sense.

Thus, in the third chapter, a reflection is made on the learning ability, thinking mode, and learning styles of architecture students, exploring diverse classifications introduced by researchers in the field. Since each category entails distinct characteristics and learning approaches, the educational processes and methods required for teaching each group can vary based on their thinking modes. Through the conducted research, recommendations are provided for identifying the thinking modes of students and adopting optimal teaching methods tailored to each. Emphasizing the creative dimensions of the design process and focusing on creative education can be a key objective at introductory levels of the architecture field. Creativity, whether in the design or learning domain, can have a significant impact. As highlighted in the second chapter, one of the most crucial aspects of the design process is the transition from mental ideas to tangible physical structures, or forms, which occurs through imagination.

In the fourth chapter, while dispelling ambiguity around the concept of form and elucidating this aspect as one of the most crucial visual characteristics of an architectural structure, the Form-Finding methods and prevalent theories in this domain are examined and evaluated. Chapter five builds upon these methods, introducing an instructional-exercise method to enhance creative approaches towards the progressive development of form and intuitive shaping in future design projects. This method is experimented with as a laboratory process, and its impact is assessed in the sixth chapter, focusing on how well-educated students confront architectural challenges. Positive and reflective feedback from these exercises is observed. The exercises conducted in this laboratory process primarily involve freehand design and rely on graphic thinking and sketching methods. The goal is to familiarize architecture students with form before engaging in their main design tasks and to develop their Formal lexicon. This creative exercise in ideation and Form development serves as a valuable preparation for upcoming design projects. The results obtained from the conducted observations, coupled with the act of drawing and designing during the exercises, reveal a form of simultaneous and kinesthetic activity that leads to intuitive decision-making. As a culmination of the research, the seventh chapter of this thesis relies on the observations made during the laboratory process. It highlights important aspects of sketching applications in the development and creativity in form design practices, unlocking students' imagination to move away from analytical thinking modes and enter the realm of intuitive thinking mode.

A brief contemplation of a subtle point

Students' design projects are judged based on a kind of comparison during the education period. Even if the analogy is not discussed, presumably some works, "in terms of architectural affluence" compared to successful and eye-catching projects, were in a lower level and sat in a lower position. This procedure's presence during my educational experiences at academic centers—in Iran—, was obviously beheld. There were always weak students whose design abilities, in comparison with experienced and talented students, were low, due to which, when developing their projects, these students were faced with lots of challenges; thus, their design processes were developing very slowly and leading to results lacking in decent quality. During my teaching times and through a research study based on interviewing with these students, I traced some roots of this problem and gained insight into its quiddity. These individuals' minds lacked operational planning for defining a successful path between starting point and destination. Desperately, they were of the opinion that there are paths they weren't able to pass. The mentioned students lacked the indispensable abilities to embody their mental concepts into objective and tangible physical structures. In the cases when they were able to codify the project's program in a good way, analyze the project's site well, extract the project's physical program, and achieve observable theoretical foundations, these students couldn't convert these materials into a **Formal** and spatial structure which was inconsistent with their findings and presenting proper and innovative spatial strategies. Furthermore, their efforts focused on designing an appropriate Form to respond to the project's program were either an accidental and unconscious occurrence, an imitation of projects they faced during their studies, or using the simplest possible Forms to respond to the project's program. Thus, at final stage, the design activity couldn't be completed, and students, before achieving a correct spatial definition, were directed towards functional issues and focused on coordinating the project's program with design criteria, in a way that their design process was developed according to these principles. For them, managing this process was more accessible in two-dimensional plan mode. However, managing the space and its concepts and perceptual dimensions in plan mode is very hard and just students who are equipped with proper spatial visualization are able to, during designing the plan, consider all aspects; not all students are equipped with.

Iran's educational system and some other countries that will be mentioned further suffer from some defects, one of which needs to consider primary and basic educational courses focused on the free hand design process and introducing and analyzing spatial structures and concepts using form creation and sketching.

Although, in many schools of architecture, the advent of the computer has affected the educational process and has largely isolated and even completely erased practical training and freehand drawing and sketches, fortunately, **Porto Architecture Faculty** Along with the studio-based learning process, there are elaborated and strict trainings for freehand drawing and expressive methods related to it, which itself is a factor for pursuing the development of an educational method of a creative introductory design process based on traditional methods and freehand drawing in the present research. It is worth mentioning that new architecture education disciplines lack courses focused on free hand drawing and idea investigation through hand sketching, production and development of architectural form, and methods architects use for achieving their design's physical embodiment.

On the other hand, research and studies focused on 'design education in architecture' are mostly theoretical ones rather than offering practical strategies; however, design is an activity whose learning is highly dependent on practical experiences rather than studying theoretical texts. Although a large number of architecture students, in a practical way, face projects focused on designing an architectural building, their prior design knowledge hasn't been gained through systematic disciplines and specific methods but rather through facing collaborative and experiential processes so-called interactive. The program and requirements lead them toward designing, and through this trajectory, their project is continually corrected by their mentors to achieve a suitable answer. The repetition of this process provides students with a methodology serving as a beacon for their future design processes. At first glance, this process, due to its freedom of action and being based on individual experience for achieving the solution –a kind of creative processes--, may look reasonable; however, reviewing the success rate of designs made generally, based on comparing designs showcasing rich architectural values with ones of low quality, narrates the fact that, dismally, many architecture graduates complete their education period without achieving design skills and a personal design method serving as a reliable tool during their professional activities. Thus, at architecture schools, we face works and designs suffering from design weaknesses and an inability to embody ideas and thoughts into tangible and objective formal structures. These works cannot be considered even as student practice showcasing visual, aesthetic, spatial, innovative, and design values – characteristics of every architectural work.

It is felt that design education lacks a fundamental **theory of design learning**. Such a disadvantage has caused designer pedagogy subject to inefficient educational methods derived from theories that cannot properly describe and explain the special nature of the **ability to design** and cultivate

it.¹ Two of the most prominent contemporary designers, *Lawson & Dorset* (2005; 2009),² based on the results of expertise design studies' results, as well as general studies of expertise and general knowledge acquisition model of *Dreyfus Brothers* (1986),³ codified a primary model for describing and explaining the growth stages of designing ability comprising educational implications for developing design training methods. *Lawson* (2004a; 2004b)⁴ claims that the growth of the ability to design among novice designers is dramatically dependent on the growth of their design schemas.

In our everyday life, through the confrontation with design artifacts, we get a lot of schemas about them that promote the development of "design schemas." But without seriously learning and acquiring, the mental treasury of the person's design schemas remains superficial and few *Lawson*, (2004).

For this reason, *Lawson* (2004) contends that design knowledge in its essence is more of an event than a semantic one; it relies more on the application of tangible experiences from design backgrounds to the learning of abstract concepts through lectures with common theoretical teaching methods. Preparation of an educational approach for facilitating novice designers' designing ability growth requires an instructional design. The instructional design is known as prescription of optimal educational methods to achieve the desired changes in students' knowledge, attitudes, and skills.⁵

Contrive a teaching method

This research intends to contrive a **practice method** focused on the **design process** by considering the capabilities of modern architecture's educational systems and recognizing the analytical structure of architectural student's learning style.

Not only should this method, at academic levels, be **compatible** with this field's various educational qualities, systems and facilities of educational centers around the world- but it should consider diverse learning levels of architecture students, their talent level as well as their potentials and multiple learning ranges, in early stages of architecture education.

Further, we expect this method to enhance and **nurture** a student's mind, which increases the possibility of subconscious positive reactions, when it comes to choosing **integral** solutions for embodying their thought and

¹ Talischi, G. (2012). Nurturing the Ability of Design in Amateur Designers. Journal Honarhaye Ziba, Tehran University

² Lawson, B., & Dorst, K. (2005). Acquiring Design Expertise, Lawson, B., & Dorst, K. (2009). Design Expertise. Architectural Press.

³ Dreyfus, H., & Dreyfus, S. (1986). Mind Over Machine: The Power of Human Intuition and Expertise in the Era of the Computer. Free Press.

⁴ Lawson, B. (2004a). What Designers Know. Architectural Press. (p. 108).

⁵ Reigeluth, C. M. (1983). Instructional Design Theories and Models: An Overview of Their Current Status. Lawrence Erlbaum Associates.

transforming it into sensible Forms. This method mainly focuses on various **Form design** techniques as tools that can be applied with compound strategies and manipulation of solid and pure masses. Additionally, all these techniques rely on sketching skills, in such a way that new compositions with a wide range of alternatives are being created. This process involves four stages of Form-making:⁶

- 1- **Morphology:** developing and cognition of a wide range of Form-based compositions.
- 2- **Form-finding:** discovering various Form-based compositions that are predisposed to use in further creative purposes.
- 3- **Form-giving:** learning how to apply tools and strategies for modifying pure and simple masses to the desired shapes.
- 4- **Form transformation:** Transmitting and incorporating the ideas by using tools and techniques, to the innovative qualities.

This method concentrates on the foundation of an educational method (or a method for design exercise), focusing on the early stages of design training courses.

One of the important concerns in the architecture academic society has ever been “the design issue in architecture” And subsequently “design teaching” and “design practice”. Despite detailed studies on this issue, we haven't yet succeeded in finding a rational and operational solution that could be comprehensive, not pervasive, considered and used by educational institutes as an educational approach.

Most of the time we witness experiential methods which have been tryout, for a short period of time, by architecture instructors at several colleges, and the superficial aspects of this method, without perceiving its essence, has been copied and used by other people.

The intricate problem in early stage of architecture education which gets more attention, as I mentioned, is that, the design teaching process, is a complicated, theoretical and excessive intellectual approach to architecture design issue, whose aims are reaching a direct conclusion, resulting in a serious architecture task. A sample of architecture which ensures a strong idea and an observable concept. What it seems like we want to claim that the work is going to move the architectural boundaries, because otherwise, we do not consider it worthwhile!

Learning how to think as an architect is not a simple task. This issue requires extraordinary mental abilities and thinking patterns which are rarely attainable through the educational system in a short period of time. One of the most important points in shaping the essence of architectural character of novice students is knowing specifically what to teach them and how to

⁶ This method consists of fourteen individual techniques that are designated comprehensively in the sixth chapter.

do it. The way in which we have learnt and discovered architecture may not be proper to be generalized to all generations. There are important questions in this regard.

1- Should architectural design practice and study necessarily start with an architectural project?

2- Do the students, without having wide experiential background and study areas, have the capability of saying what is important in their work in the early stages of their education?⁷

It may be interesting to invite architecture students to think like a professional architect, but expecting remarkable architectural concepts as a result is excessively optimistic. The reason behind, can be the fact that the source which feeds architectural thinking, has not yet been shaped in students.⁸

3- How much is a design process affiliated to intuitional methods? What are the distinctions between the intuitional and systematic processes? Is there any pathway through the systematic process to the intuitional process?

So, it is necessary to differentiate between **design practice** issues and **architectural design**.

A large number of educational processes focus on Architectural projects and providing students with opportunities to have effective interactions with each other and their professors. Learning in this atmosphere is considered an empirical process that will be enhanced and evolve over time. However, based on students' mindsets and learning styles, the lack of step-by-step instructions and systematic teaching content is felt more than ever.

There is an optimistic hypothesis which makes us expect that the sequence of events in the design studio, will spontaneously leads students toward the purposive path by providing proper conditions in the studio and through defining an elaborated program of designing an architectural project, whereas the weakness of students in higher semesters and in professional experiences shows that this method has not been successful.

While talking about architectural design education, we encounter two important issues: The first one, the education itself, is an extensive scientific issue, which features observable aspects and has been the subject of many detailed researches such as Professor *John Biggs's* researches published in his book named *Teaching for Quality Learning at University*.⁹ The second, is

⁷ Swisher, M. T., & Balmer, J. (2012). *Diagramming the Big Idea*. Routledge.

⁸ Here, we should note that there is a tiny while observable difference between design ability and design expertise. Through a chain of practices as well as earning necessary skills, design ability turns into an expertise, through a period of experiences. At this stage, the mental process of dealing with design issues may appear totally different, unpredictable and uncoded, while in practice process, we could experience specified and targeted frameworks. Thus, derived from methodology and the essence of an activity named practice, the orientation of this research would be supported by skill upgrade and development

⁹ Biggs, J., & Tang, C. (2011). *Teaching for Quality Learning at University*. McGraw-Hill Education (UK).

formation of the thinking structure and the way of executing mental decisions, in the form of a complex mental activity named Design.

So, when thinking about systematic practice programs for shaping a coherent operational structure in the design process, we cannot ignore the role of these two components. Further, a specific educational method won't be effective unless it features operational and executive content with its different components codified correctly. The more we channel and act independently on these patterns, the more successful we will be in reaching the design stage.

Juhani Pallasmaa says: "an architectural project is not only a result of a problem-solving process, but it is also a metaphysical proposition that expresses the maker's mental world and his/her understanding of the human life world.", and we can comprehensively investigate it as a primary pattern for studying.¹⁰ Through this process, one of the most fundamental stages of architecture creation is the creative and correct usage of ideas. The stabilization of the most important part of qualitative values of outstanding works occurs through the process of converting the idea into form.

Actually, the topic **Embodiment of Architectural Thoughts** in this research is an interpretation of the aforementioned theme. In case if we want to independently investigate the **components and details** on a larger scale, we would be dealing with a series of operations on Form, which makes us able to define these operations as **Systematic Strategies** that are expressed as a mechanism and instruction that can be used in design practice. An architect's capability of purposefully ordering and organizing the space showcases his/her conversance with form creation and form's simultaneous combination and merger with concepts. When making the mentioned form, the number of decisions an architect makes through designing and building a building simply reaches more than.¹¹

Thus, one of the most important goals of design is giving **form to space and spatial masses** in such a way that they showcase specified and tangible coordinates. The form is dependent on visible matter and space is contingent upon form.¹² This visible matter could be imagined from a subjective concept to an enormous spatial mass. Therefore, it is of utmost importance that architecture students get familiar with the concept of Form. The question is **how** and in **what** way?

¹⁰ Pallasmaa, Juhani, 2009, *The Thinking Hand : Existential and Embodied Wisdom in Architecture*, John Wiley and Sons Ltd, United Kingdom, page 108,109

¹¹ Swisher, M. T., & Balmer, J. (2012). *Diagramming the Big Idea*. Routledge.

¹² Ibid

It sheds light on our destiny (in design education) if we notice the tiny affinity between form and the terms in linguistic science. Based on every principle, we cannot put the words together and make a sentence, as well. *Jorg Grutter* quotes Philip Drew “As each language consists of words, the language of forms is also formed from basic motifs and forms”.¹³ We can simplify and decompose forms into basic Three-dimensional structures, which could be considered the design’s primary core. In a pure state, basic forms do not showcase any application; however, they are the basic elements of composition. The basic elements from which, various ideas could be extracted. The mentioned forms, due to diverse reasons, could change as continuous currents through the design process.¹⁴ By making use of specified tools and techniques, it is possible to create a **Generative Form Grammar**¹⁵, which can provide Students with a source that builds and develops their mental form-based knowledge. Thus, after a while, by observing and practicing the instructions, they could discover, experience and produce new expressions. But through this path, however, we aim to design a practice method, as mentioned before. Further, a large number of strategies have been suggested and numerous observable experiences have been executed at some architecture schools. However, the method which this research aims to identify and develop, takes advantage of freehand skills, as well as graphic thinking.

Drawing is a “means of pulling out, revealing and concretizing internal mental images and feelings”¹⁶, or according to *Kant*: “The hand is the window on to the mind.” For a designer, “sketching and drawing are spatial and haptic exercises that fuse the external reality of space and matter, and the internal reality of perception, thought and mental imagery into singular and dialectic entities.”¹⁷ Learning a skill is primarily a matter of embodied muscular mimesis acquired through practice rather than conceptual or verbalized instruction.”¹⁸

On the other hand, freehand drawing provides a great possibility for thinking entitled visual thinking. This type of drawing pursues the designer’s thought flow, from one idea to another with the speed of mental arithmetic. The designers, therefore, could direct their thought’s progress, in an

¹³ Gutter, J. K. (1996). 19 Aesthetic in Architecture [Pakzad, J., Trans.]. Shahid Beheshti University.

¹⁴ Knouer, R. (2010). Transformation. Tarahan-e-Honar.

¹⁵ **Generative grammar** is a linguistic theory that regards grammar as a system of rules that generates exactly those combinations of words that form grammatical sentences in a given language. In fact, this term is a system of linguistic analysis consisting of a limited, unchanging set of rules employing a list of symbols and words to generate or describe every possible sentence in a language. My concept and development of generative design grammars are inspired by the notion of shape grammars (Stiny, 2008, Stiny & Gips, 1972) – a classic example of how a grammar can capture the style of a design and be used to generate multiple designs within that style as Knight (2000) summarizes that a shape grammar is a set of shape rules that can be applied in a step-by-step manner to generate a set or language of designs.

¹⁶ Pallasmaa, J. (2009). The Thinking Hand: Existential and Embodied Wisdom in Architecture (p. 92). John Wiley & Sons Ltd

¹⁷ Ibid, page 89

¹⁸ Ibid, page 119

illustrated way, up to achieving a proper solution. This showcases the superiority of executing this practice process with hand, in comparison with implementing it with other ways such as *model making* and other options. The emergence of various model making software and their widespread usage through the design world, it is more significant to encourage architecture students to execute the mentioned practices by sketching.

According to the aim of this research, it isn't supposed to turn a blind eye to the key role of computers in design. Further, there is no intention to oppose the continuous presence and usage of computers through educational processes. Based on *Juhani Pallasmaa*, however, the key point is, we should know that for which aspects of complex thinking and design processes we should take advantage of computer. It is impossible to digitize imagination and internal sense or produce them through simulation and algorithmic methods. In addition, this aspect of architect's thought could not be replaced. If architecture students turn a blind eye to using hand in the design process, due to growing technological progresses, we will face complete elimination of the valuable aspects of traditional design processes. One of the key points of this research is, therefore, achieving a method which ignites form making, and binding it to sketching skills.

This research tends to answer several significant questions,

- 1-how could we facilitate design for amateur architecture students?
- 2-Is it possible to define a teaching content as a design practice method for nurturing and training the students' mind?
- 3-How can sketching skills be used through design process and form-finding progress?
- 4-could sketching increase the possibility of perceptual intuition through form design technique?
- 5-Despite the advanced achievement in software and computer-based design process, why do architects need to use their hand while thinking and designing?

Enhancing imagination and creativity

The classical philosophers said, the soul never thinks without a phantasm, which is to say that thought needs a material image, something to carry the thought. So, we begin to think of imagination as bridging the gap between perception and understanding. What's implied is that there is actually a space in the mind where the work of picturing takes place. The imagination is different from other mental processes like perceiving or remembering insofar as to perceive something requires that something has to be there. And that's not required of the imagination. And even to remember something-- the event or the object or the person-- it had to have already

been there in order to remember. But the imagination creates its image. The image isn't there until the imagination produces it. Imagination is also different from a concept because imagination requires the materialization of thought. For example, I can conceptualize freedom. I can even explain to you what freedom is as a concept. But it's very difficult to show you freedom. To show you freedom, I would have to construct a picture. I would have to construct a scene. Then I could help you imagine freedom in that materialization, in that scene, in that picturing. So, we should think of the imagination as the capacity for producing images, the mental capacity to picture things.¹⁹

This knowledge and awareness are achieved through the senses; and due to the repetition of the observations, human being, by making use of their wisdom and information, solves the unknown. We call this act of wisdom, thought or thinking. This knowledge, whether intuitive or empirical, in our mind and our thought, appears as imagination and acknowledgement.

For Human, *imagination means that a chair's idea and a chair in the form of an idea, are one thing; and the way through which the mental image enters the reality world, is blocked. Awareness needs things, while imagination is a kind of awareness, which produces its goal Streminger, (1980)²⁰ and has two aspects – conceptual and exemplary?*

According to Comara Swamy,²¹ an artist begins his/her work with a word formed in his wisdom. This stage showcases the stage of artistic imagination and inspiration. That is, cultivating the thought in mind, in such a way that it could be imitated on the outside. Some believe that sketching is the starting point of the design process, which shapes the world of designer imagination many times in the middle and the end of this process. The origin of depicting the imaginations and presenting mental designs of the architect is the sketch, which requires specific skills and tools²². The designer participates in “active observation” by drawing a glimpse of his observations and during the process of “thinking design” by presenting sketch and schematic designs, he experiences thinking and imagination. Glenn Murcutt explains in a senior academic class: “As soon as communication between thought and design begins, the discovery begins, and when we lose the ability to draw, we actually lose some of the ability to think”.²³

¹⁹ Hays, K. M. (2016). Architecture's Appearance and the Practices of Imagination. *Log*, 37, 205-213.

²⁰ Streminger, G. (1980). Hume's Theory of Imagination. *Hume Studies*, 6(2), 91-118.

²¹ Famous Indian philosopher

²² Bilda, Z., Geno, J., & Purcell, T. (2006). To sketch or not to sketch. *Design Studies*.

²³ Rice, S. (2008). Sketching To Learn, Learning To Sketch (p. 2). [Ph.D. Thesis, Faculty of Architecture, Design and Planning]. University of Sydney.

Thereby, another important issue for achieving the proper design process is considering and nurturing each architecture student's individual skills and abilities in the particular time, especially in the early stage of their education. Skill is considered to be the correct and creative way of working, which is achieved through experience and practice, and repetition of the action, in addition to which the inability of the individual to achieve it would also be effective, which results in the person having a special creative way to do the work to his own benefit. In the field of architecture, a set of graphic skills is those skills that enable the designer to use the design process to express and present their ideas. During human civilization, idea processing has played an important role in social change and human progress. It is safe to say that one of the most important issues that an architect faces in any design problem is the stage of designing, choosing, or building a "form" of his architectural space. A sophisticated mental equation governs all human behavior that makes it difficult to analyze the process or incident that results in a reaction. For example, in the design of an architectural product called architecture. Perhaps, in a mystical, philosophical attitude, a supernatural origin is thought to be inspired by the architect, or elsewhere, an abstract and creative perception of the peripheral patterns leading to the conceptualization and selection of the form in a mental image, and with the help of using a pen by architect as a role to be reflected on a sheet of paper. Through the book "*Graphic Thinking*", Paul Laseau (2008)²⁴ introduces the sketch as the language of drawing and design. Of course, Bryan Lawson (2005)²⁵, through the book "How Designers Think", points to the sketch's self-learning aspect; and through the book "The design studio", Schön (1985)²⁶, in the field of design methods, points to sketch and its application.

A major pathology regarding the general status of the sketch in the education of architecture, uncertainty about the proper entry requirements to sketching which is appeared following lack of effective and continuous adjectives for lecturers and learners in the distinct learning, and assessment process of the "Draw" and "Sketch" in the range of plan, schematic and sketch.

According to the studies, taking some distance from these rituals and fading out the proper theoretical-practical cycle of sketch has led to dropping the use of "sketch capabilities" in the field of pedagogy in the architecture training process, which is at least clearly in the status of the design process in many architectural faculties that the digital tools replaced the sketching ability, the quality of architecture education that can be traced and it should

²⁴ Laseau, P. (2008). *Graphic Thinking*

²⁵ Lawson, B. (2005). *How Designers Think: The Design Process Demystified* [Nadimi H, Trans.]. Shahid Beheshti University Press.

²⁶ Schön, D. (1985). *The Design Studio*. RIBA Publications.

be asked whether this is not one of the main reasons for moving away from creativity and imagination in the field of architecture and profession.

To develop a design system centered at sketching, the first step is to find a common language between the instructor and the student. A common design language which can be a vehicle for getting forward the problem at hand with an implicit certainty regardless of the theoretical knowledge backgrounds and the shortcomings inherent in verbal educational systems.

As we know, design is an evolutionary process which builds upon itself along the path and advances forward. An architectural idea may start as vague and unclear lines and turn into a thoroughly technical document with all the details needed for the construction phase. As we get to the final phases of the design process, scales, measures, organizations and regulations are more highly pronounced and ideas, imaginations and mental pictures are the main theme of the initial phases of design.

Scope of the Research:

This research will involve examining the methodology of the **Form-Finding** and the integration of form design processes and creative development of visual choices through methods based on freehand drawing and graphic thinking as an introductory practice in early-stage architecture education. It is directed toward pre-studio preparation, therefore, it will review current educational issues facing schools, as well as the background of architectural education. Since the research is limited only to the subject of Architectural Form design in a pedagogic perspective, it will concentrate on the subject of Form in relation to space and the way externalize architectural thoughts to the visual and tangible qualities and the methods and tools which would be suitable in educational programs.

Research Method

1. Research outcomes

This research would present an introductory design practice method prior to the design studio. These practice methods are preferred to be developed systematically. Still, other non-computer-aided experimental processes in the field of form design training can be used if appropriate educational criteria are obtained. The systematic design practice procedure, which can facilitate converting imaginary ideas into the materialization architectural form, and make the students free from the limitations of individual biased, one on one, studio-oriented teaching system.

To elaborate on the methodology used for the purpose of this research, with regards to the research results and objectives, we can consider this study as both the **applied** and **developmental** types of research.

The applied research seeks to find solutions to real world problems and for the case of this study, the method developed can help students address the issue of design in the early years of their education and also play a role of a contributor to improve the educational tools used. The applied research objectives in this study are as follows.

- 1- Short term specific application in order to reach predefined results
- 2- Innovative process and scientific investigation in order to develop a design system with educational purposes.
- 3- Converting idea into action with a specific direction.
- 4- Suggesting a design practice method as an introductory course for the design studio in architecture education.

On the other hand, the main body of this study is devoted to developmental research.²⁷ The developmental research objectives that are sought in this research are as follows.

- 1- Systematic application of knowledge or concepts that are driven from the research in order to develop new methods and systems
- 2- Using the findings and knowledge resulted from the research and scientific experiences

2. Research conduct process

This study uses a mixed research method with regards to its conduct process. Thus, we take advantage of both **quantitative** and **qualitative** methods for different parts of the research.

3. Logic

Given the fact that the method and hypotheses developed by this study is based on the research and findings which were driven from previous observations and experiences, this research can be categorized as **inductive research**.

4. Time effect

This research, with regards to its design, is considered as **prospective** research. The objective of the method developed by this research is to strengthen the students` design abilities and form finding capacities over solving the architectural problems. Getting expert in using this method needs effort and time, therefore architectural institutes can device this method in the early stages of architectural education. Depending on the

²⁷ This type of research embodies any kind of a systematic activity that is based on the available knowledge basis which is resulted from the past research and experiences, in order to develop a specific subject (the subject of form in this study), new methods or enhancement of existing methods (form design methods in this study).

condition and the level of practicing this method, it is expected to see the optimum impacts over the next two or three semesters.

5. Research Objective

With regards to the research objective, this study can be considered as **analytical-experimental research**. In this method, numerous educational hypotheses will be tested, and the cause-and-effect relationships will be investigated by manipulating a variety of systematic form design methods and techniques. Proving the possibility of combining freehand sketching (design) techniques along with codified form generation methods and investigating their effect on students' design process is the important approach of this research.

6. Data Acquisition

Collection and analysis of the data in this research mainly achieved by a pilot study conducted on some students of the introductory to design course in Iran university of science and technology university and also the data provided on the digital library of science-direct, Scopus, and other online data platforms.

An Overview of the thesis structure

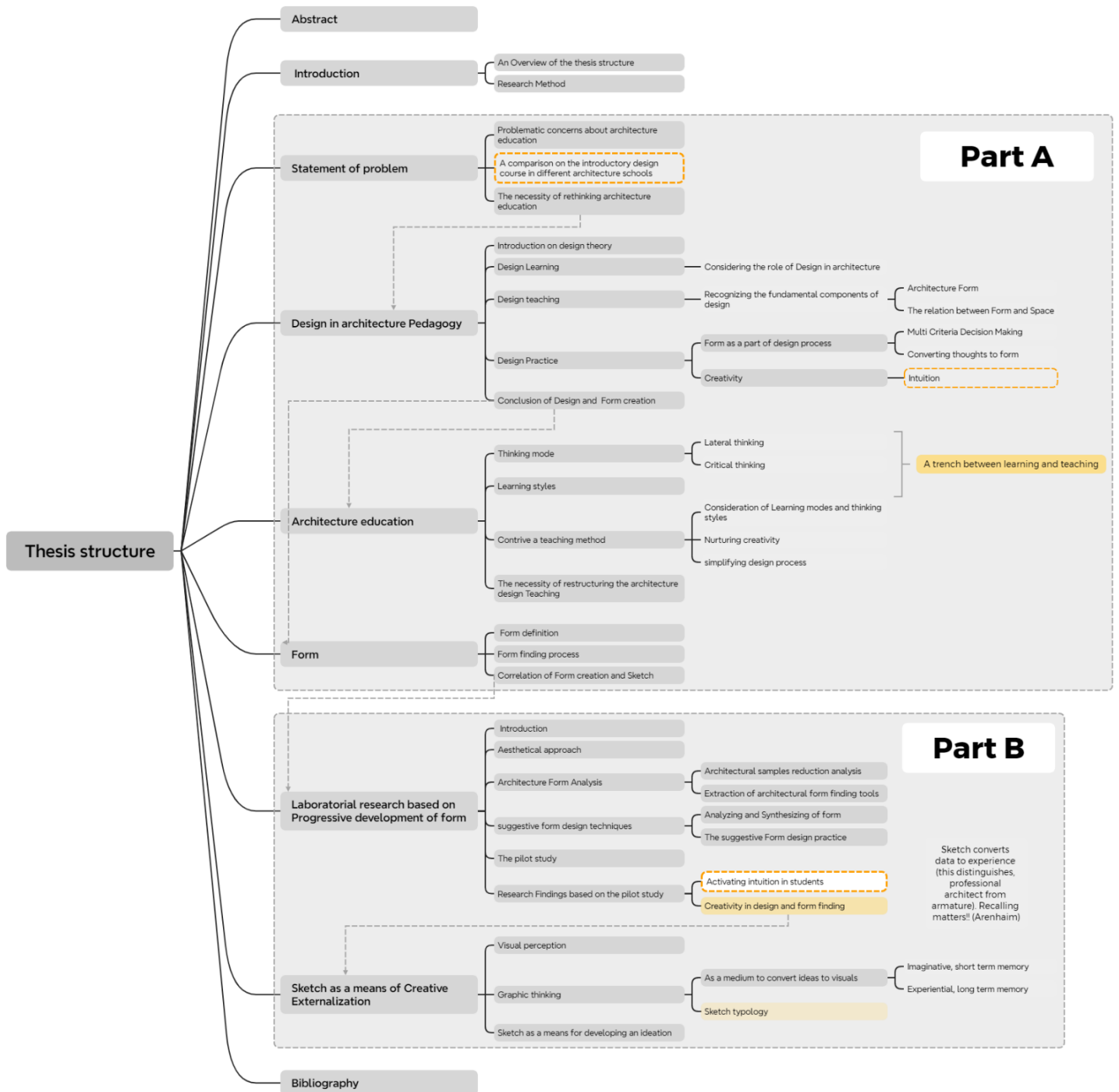
This research project is divided into two main sections. In the first section (A), after addressing the research question and elucidating the concerns related to architectural education, along with highlighting certain inefficiencies, the theoretical foundations of the project and the research literature are detailed in three main categories. These chapters include:

- 1- Architectural Education
- 2- A Note on Design in architecture pedagogy
- 3- Demystifying the Form conception and its role in design

In the second section (B), the focus is on proposing and introducing a pre-studio educational method as a preliminary design and process-based architectural education. Subsequently, a laboratory-based research process is delineated to examine the impact of this method on enhancing the creative design abilities and active learning of architecture students. This section comprises two main chapters. The **first chapter** discusses the method itself, while the **second chapter** elaborates on the laboratory research process. In the concluding chapter of this section, the simultaneous impact of creative form design exercises through graphic thinking and sketching has been identified and presented as a final conclusion. These aspects encompass:

- 1-Unlocking Imagination
- 2-Intuitive and spontaneous thinking
- 3-creative design reasoning

These elements have been elaborated upon in detail in this chapter. Additionally, recommendations for architecture faculties regarding the implementation of creativity-centric education focused on freehand design and form design exercises at the initial stage of architectural education, based on the adopted approach in this thesis, have been provided.



Part A:

Foundation

CHAPTER 1.

Statement of Problem

Design education suffers from the lack of a fundamental theory of design learning and the lack of a codified and systematic topic which could be taught as “Introduction to Architecture

This chapter encompasses the topics as follows:

- 1-1. Problematic concerns about architecture education
- 1-2. The advent of the computer as a new visualizer tool
- 1-3. Various attributes of architecture students
- 1-4. Comparison on the introductory design course in different architecture schools
- 1-5. Necessity of rethinking architecture education

1-1. Problematic concerns about architecture education

It has been a while that architecture education was criticized by experts due to many flaws and problems relating to teaching architectural design. This can be as a result of the transition in architecture education from traditional to the modern academic system. This new educational approach revolves around the problem solving in architecture and takes a more rational approach for design. Thinking rationally in the design process creates a flaw in the design outcome, which is about creativity and artistic virtue. Some architecture students are basically more creative and think intuitively, which results in more appealing and architectural authenticity by default. Concurrently there is also another group of students who think rationally, and due to the lack of creative educational approaches in the academic system, they couldn't find an opportunity to foster innovative strategy in the architecture design studio. As creativity is entangled with imagination and intuition, and enhancing them is extremely important for any designer, including architects. Architecture education should take a new approach toward design teaching which improves these artistic aspects which leads to a higher quality of design in architecture accompanied with other rational architectural problem-solving strategies. Focusing on design education and the various stages of the design process reveals that many students suffer from the stage of transforming and converting their thoughts and ideas into tangible physical gestures. The embodiment of thoughts or creating FORM, which is a significant phase of the design stages, entails strong imagination and an intuitive mode of thinking. Practicing form creation and its strategies not only strengthens and broadens Formal knowledge but also fosters imagination and intuition when being practiced using freehand sketches. These extremely related attributes of architectural design education, helps students achieve intuition in their design which is the result of experience and practice and leads to maximum creative artworks. This thesis also represents a pedagogical attitude toward the practice method of form design techniques that lean on sketching skills and has been studied and examined on different groups of students, and the creativity ratio achieved is undeniable indeed.

In recent decades, we have witnessed the growth of various aspects of the virtual world. The development of VR, as well as the emergence of spaces that appear in the environments of computer games, animations, and movies, are seemingly the result of design processes but in the form of the virtual world. Spaces that are visible but presence in them are in the manner of virtual perceiving and in the form of imagination. An imagination that is so close to reality that the user spends hours exploring the digital world created by the digital artists, where the user discovers the virtual environment by playing the role of a virtual character in the game.



Figure 1 samples of imaginative architectural spaces: These images have been designed with digital devices or AI, and most of them are just considered as concept art that introduced a futuristic spaces which can use in video games and animated movies purposes. Many of these worked are not designed by architects and vastly available in virtual space and social media.

Today's world is experiencing a sort of parallel virtual world which is hidden in individuals' daily routines of everyday life. Architects with variety of knowledge and skills, with various cultural backgrounds enter architecture schools, are grown up in such virtual world. They have experienced spaces that have not yet been built. They have circulated and moved throughout the architecture space. They have seen spaces in Sci-Fi movies that are seen for the first time and are completely novel. Such spaces are made based on the need and because of the broadening of the human's mind perception of the universe and its dimensions, via the digital tools. This is, however, building such spaces is not feasible at the current moment due to the lack of technology in construction science.

In this situation mentioned above, students in architecture schools face the architectural history and the previous epoch of the manmade built environment. Comparing this flux of real architectural heritage with the virtual world is thought provoking.

This conflict in the student's experience prior to university entrance, of the digital futuristic spaces, and the Design course with the limitations of construction science and the country's regulations are presumably the cause for duality and challenges for the students.

On the other hand, many architectural competitions' approach toward architecture design is totally imaginative and they nurture and praise innovative, futuristic design. One of which is **eVolo**²⁸ international competitions. The main architectural subject of this competition is designing a skyscraper for the future and the next generation. In such competitions futuristic ideas, mostly impossible to be built at the moment, are designed with various approaches, which creativity and futurism and imagination is common among all of them.



²⁸ eVolo is an architecture and design journal focused on technological advances, sustainability, and innovative design for the 21st Century. It's objective is to promote and discuss the most avant-garde ideas generated in schools and professional studios around the world. It is a medium to explore the reality and future of design with up-to-date news, events, and projects.



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Figure 3 samples of eVolo winner project: Another example of a project presented in the eVolo contest. This strange structure is a display of a residential complex in the future! Dichotomy and ambiguity created for architecture students from seeing projects like this is considered a disruption in the education system. In this research, without the intention of directly criticizing ideas for the future, the question is raised that the contradiction of the educational system in architecture schools with what happens in the atmosphere of architectural competitions has consequences for the formation of the correct understanding of design thinking among architecture students.

Such competitions and trends in the architecture world is considered a call for the young architects to follow this trajectory which is totally different from that of the architecture schools. In the meantime, we are witnessing the educational disciplines in some architecture schools differ from the previous conventional procedures that are running in architecture institutes. To name a few: SCI-Arch, university of South Florida, Manchester School of Architecture, University of Greenwich London UK, University of Liverpool, National university of Engineering Colombia GSSAP, Yale school of architecture, university of Strathclyde, The Hong Kong Polytechnique university, Cornell university college of architecture, University of Vienna, university of Pennsylvania school of design, Bartlett school of architecture UCLA, Pratt institute, FAUA Uni, Victoria university of Victoria New Zealand, The Cooper union. These schools' architectural products are felt to be somehow different from other architectural institutes. The architectural products are so unique and peculiar that even the subject of the project or the function is not predictable.

³⁰ 2014 Skyscraper Competition, Work of: Qiu Song, Kang Pengfei, Bai Ying, Ren Nuoya, Guo Shen China

Sand Babel is a group of ecological structures designed as scientific research facilities and tourist attractions for the desert. The structures are divided into two parts. The first part, above ground, consists of several independent structures for a desert community while the second part is partially underground and partially above ground connecting several buildings and creating a multi-functional tube network system. The main portion of each building is constructed with sand, sintered through a solar-powered 3D printer. The top structures are based on the natural phenomena called Tornadoes and Mushroom Rocks, which is very common in deserts. It utilizes a spiral skeleton structure, which is tall, straight and with strong tension, to meet the requirements of residential, sightseeing and scientific research facilities. The dual funnel model not only improves cross-ventilation, but also generates water condensation atop the structures based on temperature differences. The net structure for the portion of underground and surface is similar to tree roots. This design not only helps to keep flowing sand dunes in place but also facilitates communication among the buildings.

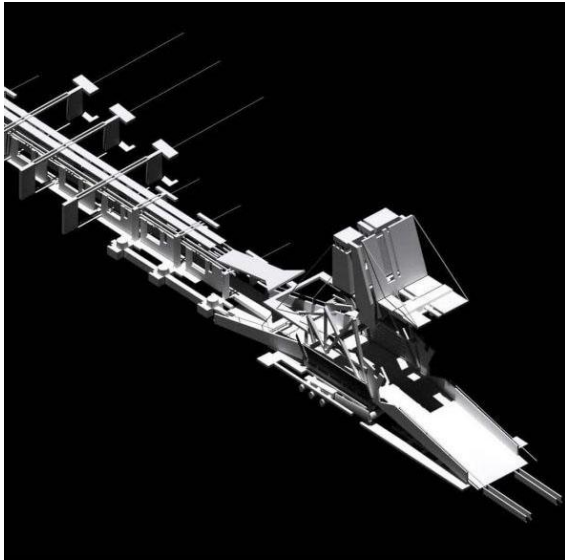


Figure 4 Work of Courtney Roose, MArch, Victoria University of New Zealand

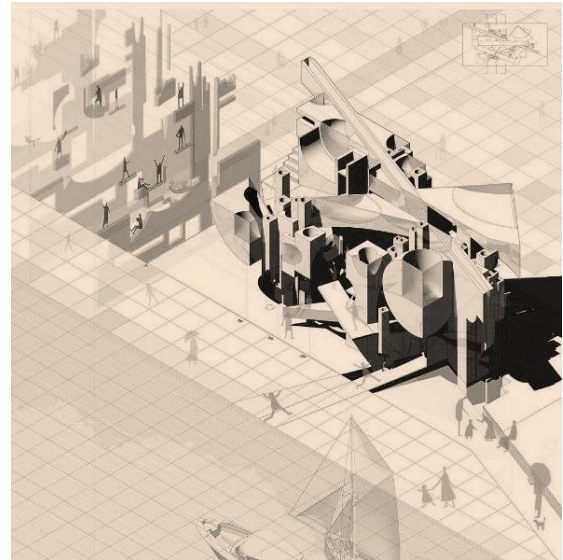


Figure 5 Michael Hollander, Drawing excellence Award, Pratt Institute of Architecture



Figure 6 Yazeed Almasi, Pipe 942, Pratt Institute of Architecture



Figure 7 Franklin Mwanza, M.Arch Thesis Victoria University of Wellington, New Zealand

The showcased images on this page vividly demonstrate the rich tapestry of architectural schools, each weaving its unique approach to design and form discovery. What emerges is not a simple divergence of viewpoints but a broader concern regarding the accessibility of these architectural wonders to students, particularly through virtual platforms. The transformative power of technology has made it possible for students to explore and engage with architectural marvels from around the world, expanding their horizons beyond the confines of their immediate academic environment. This newfound accessibility acts as a catalyst, sparking the curiosity of students eager to unravel the intricate design processes behind these projects. Virtual platforms serve as windows into the studios and minds of renowned architects, allowing students to scrutinize and compare these approaches with the methodologies employed in their own educational institutions. This comparative analysis becomes a cornerstone for intellectual growth, fostering a dynamic environment that fuels the evolution of diverse design perspectives.

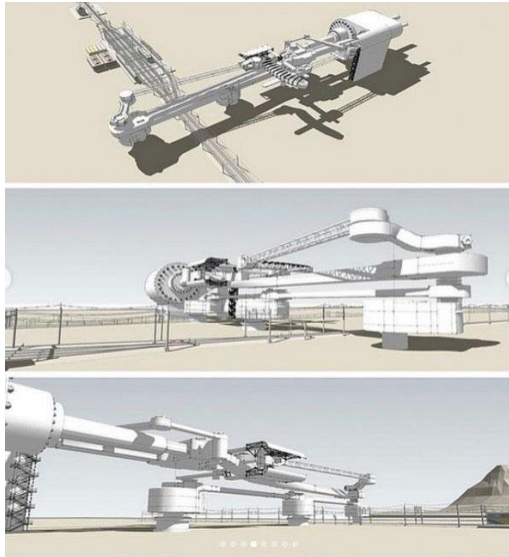


Figure 8 Marc Honore, MArch Thesis, Victoria University of Wellington, New Zealand



Figure 9 University of Los Angeles, Thesis Project of student

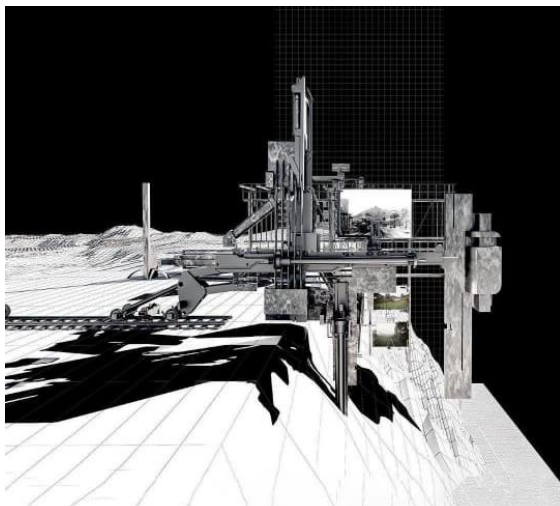


Figure 10 Callum Brookland, "The Valley of Abandoned Dreams", MArch Thesis, Victoria University of Wellington, New Zealand



Figure 11 Project of Aleksa Milojevic and Adam Rostek Advanced studio with **Peter Eisenman**, **Frank Gehry**, and Daisy Ames, Yale University

The underlying question gains prominence: What defines the correct approach to design, and which method provides the most comprehensive perspective? The exposure to a multitude of design philosophies challenges students to think critically about the essence of architecture. It prompts them to question preconceived notions, encouraging a synthesis of ideas that transcends geographical and institutional boundaries.

The accessibility of diverse design perspectives through virtual platforms has enriched architectural education but introduced a challenging complexity. While students benefit from exposure to varied methodologies, the abundance of conflicting design philosophies has created a dynamic yet chaotic environment. Navigating this maze of divergent ideas raises a problematic concern—defining the correct approach to design becomes increasingly perplexing. The once stimulating educational landscape now wrestles with conflicting perspectives, leaving students in a state of uncertainty as they strive to discern the best design process. This tumultuous sea of ideas highlights the need for a nuanced and guided approach to architectural education. Amidst the chaos, there is a call for strategies that help students make sense of the diverse influences and distill this wealth of information into a coherent understanding, ensuring a more focused and informed journey in the world of architecture.

There seems to be chaos in the design approach of different universities and architecture schools throughout the world. Some of these schools are focused on problem solving in its functional way and the focus of the other architecture schools are mainly on the rational design process that student should learn in the architecture studio. Some other architecture schools are more concerned by the creativity and fostering imagination in the students. This is visible through the difference in the best works of their projects.

What seems to be contemplative in different architecture schools is the **importance of creativity** to the degree that students are more relieved from architectural design criteria during the design process. Some such as Bartlett work even for design off the planet and ask students to be more creative and imaginative, while some has taken a more preservative approach.

This dichotomy of opinions and approaches has raised questions about what the better attitude to design is. Which one is certifiable? Without any foreordain, it is possible to assume that the answer lies in the autonomous evinced of creativity. Both approaches seem to be correct, but the role of creativity in the design process should be more considered in the first group and the role of functionality in the second group.

Most of the architecture school's course descriptions are fine and imperative in terms of functionality, and it seems like creativity is considered a default aptitude for the students. Indeed, there is no creativity course provided for the students in the bachelor degree.

In order to solve such problems, this research suggests an introductory course in the architecture curriculum which trains students to be more creative in terms of finding the most optimum form prior to encountering their first design problem. This course, plays an important role in helping students, integrate functionality as well as creativity. The Form practice course, which can be offered in the introductory design, makes students familiar with a vast variety of ways to finding forms where necessary.

As architectural form is entangled with architecture space, this skill makes a great improvement in creating architectural spaces in their future designs.

1-2. The advent of the computer as a new visualizer tool

The subsequent notable issue is the emergence of computer and software helping architects in modeling and design process that has led to disconnection between disciplines of traditional architecture education and modern experiential educational methods which are not very long-lasting and are resulted from either teachers' individual experiences or architecture institute education. Many teachers teaching at architecture schools, have been educated at a period featuring hand as the most important and only tool for thinking and drawing architectural thoughts. Aside from differences between viewpoints regarding cognitive

epistemology of Form and Space and theories raised during the recent half-20 century -- focusing on the quiddity of architecture and space--, if we merely evaluate the educational programs in a detailed way, we will face a contradiction; in other words, we will face this question: "how could a generation educated by traditional hand-based pedagogies, educate a new generation interested in using and designing with computer, by making use of traditional educational methods?". Yet, belief in capabilities and advantages of traditional architecture education – based on hand--, at many universities in the world, among young generations of teachers and students, consider as a reactionary and inefficient method or to put it another way "it has outlived its usefulness".

In recent decades, researchers like Bryan Lawson have focused their studies on design's concept; however, design education suffers from the lack of a fundamental theory of design learning and the lack of a codified and systematic topic which could be taught as "Introduction to Architecture" to architecture students during the early stage of their architecture pedagogy.

In drawing lessons, not everything is based on theory; on the contrary, it is practical experience what increases the capacity to evolve graphically. But practice needs theory to progress, to get knowledge and to grow in the creative world. Drawing is not only the way to express something, but also to feel something. As described by Valéry "There is a huge difference between seeing a thing without a pencil in our hand and drawing it" ³¹ The act of drawing consists of reaching the ability to react to things, it is the first step to externalize an idea, or as Nauman (1991) would say: "Drawing is equivalent to thinking. Some drawings are made with the same intention as writing: they are notes that we make. Others try to solve the execution of a particular sculpture, or to imagine how it would work. They all allow a systematic approach at work, even if they often stress their internal logic to absurdity". And regarding the fact of being a part of the act of drawing, and as a result of an abstraction state, Jackson Pollock experiences this formula by a deep connection of being part of the picture. Mastering drawing in daily practice of learning architecture is not based only on drawing architecture, but on learning to think about architecture. What we can transmit to our students in the classroom depends overall on the communication skills of the teacher and the professor. The ability to communicate the need of drawing in any of the visual arts disciplines during the first stage of college is, nowadays, clearly laborious but not impossible. We know about the graphical immaturity of students at the beginning of their architecture learning, and we know from the point of view of our curricula, what we can offer them or rather show them: the essential in drawing can increase their capacity to think, to feel, to enhance their creative abilities, even increase their interest on curiosity and ingenuity. In other words, the teacher can teach to manipulate instruments, new methods and the latest techniques,

³¹ Valéry, P. (2005). *Piezas sobre arte*. A. Machado Libros, S.A.

but the challenge is trying to show students how to be inside each drawing.³²

1-3. Various attributes of architecture students

Another problematic issue as a valid parable is Iran³³, Turkey, Greek and Portugal. Some Students enter architecture through math_entrance exam, and suppose they are studying an engineering field. Thus, save for those who have had artistic experiences in visual art, others aren't armed with artistic abilities to face artistic aspects of architecture.

This issue can be traced in other architecture schools as well. Because the architecture program in different universities of the world, are put in the subcategory of Art while it is located in the engineering category in some others. This distinction in the discipline approach would be better to be integrated and unified through combining the courses in a balanced way, in which functionality and creativity play their role. However, during the bachelor's degree's educational process, these students aren't provided with enough time to, while studying educational topics, eliminate their weaknesses in visual arts and architecture's artistic aspects. Due to the mentioned fact, these students, compared to experienced ones, need more education and systematic practices to get ready for facing professional design processes, in a shorter time. Thus, the need for a scientific and practical method of developing and reinforcing architecture students' minds and upgrading their design abilities, could be urgently felt.

Riding and Cheema also propose a second dimension that refers to whether an individual has a tendency to represent information mentally in words (labelled 'verbalizer') or in pictures (labelled 'imager').³⁴ Those individuals with a global, holist or intuitive cognitive style are likely to show intuition and a tendency to see a whole picture rather than to break something into parts in order to intellectually process it. Those with atomistic, serialistic, analytic cognitive style will tend to break things down into parts and often process information in a sequential manner³⁵. Research by Peterson and Sweitzer (1973) suggests that architecture students were on average more field dependent (holistic or global cognitive style) than the student population as a whole and that they were less variable in their measurements of field dependence. By contrast, however, Bergum (1977) suggested that architecture students were on the whole, more field independent (analytic cognitive style) than business studies students.³⁶ They were significantly more analytic than a standardization sample of 1448

³² Torres, A., et al. (2015). [Title of the Article]. *Procedia - Social and Behavioral Sciences*, 191, 2505-2514

³³ Architecture in Iran is considered as a subcategory of engineering

³⁴ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. *Design Studies*, 27(2), 167-181.

³⁵ Ibid

³⁶ Ibid

school pupils between the ages of 12 and 16³⁷. In the first two years, analytic students on average achieved higher rank positions than intermediates, who in turn attained higher rank positions than wholists. By the students' third year, all three groups appeared to have converged to a similar level, the analytic students having fallen by an average of 13 percentiles. When problems are complex and ill-defined, students with various differing learning styles had the scope and freedom to adopt an approach to designing that best suited their learning style the result being success across all style groupings. The rigid nature of first year a constraint and preferred the freedom of subsequent projects where there was a greater opportunity to think independently. Those who have a tendency to process information holistically (wholists) may find it easier to cope with this increased demand, whereas those who prefer to process information in parts (analytics) may try to treat each line of thought independently and sequentially thus miss the important connections between them. Analytic students interviewed claimed to have a preference towards the technical, analytic side of their design work³⁸. A wholist student implied a more intuitive approach. The complex nature of the projects in the third year would have provided an opportunity for the wholist student to flourish in this respect, whereas in the students' earlier years, where projects were smaller, a rational approach may have been advantageous. On the whole, those students who are considered as "intermediate" tended to perform reasonably consistently across their three years of study, possibly as a result of their relative ease of access to different modes of thinking.³⁹

It is worth considering that architecture students' mental attributes play a major role in their thinking style and learning style. It is more probable that architecture students with mathematical background foster a more rational, critical thinking style and the art-based students foster a more creative thinking style. Consideration of having both groups of students in the architecture studio leads us to find an integrated solution which functions well for both groups of students.

Regardless of the traditional⁴⁰ way of learning architecture and the transmission of this knowledge in early civilizations, the first sparking of academic architecture education can be traced to France. In the early nineteenth century the French state created a new method of reproduction with the formation of a school intended to train architects, the École des

³⁷ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. *Design Studies*, 27(2).

³⁸ *ibid*

³⁹ *ibid*

⁴⁰ In this thesis the traditional ways mean the architecture education system starting from Beaux-art till the emergence of computers and the change in the design education system in the 20th century.

Beaux Arts. Through the next century and a half, the field's reproduction system gradually became embedded in national higher education systems.⁴¹

The first application of the design studio in architectural education dates back to 1819 when the classical atelier system of the French Royal Architectural Academy transformed into École des Beaux-Arts. The atelier system in the Beaux-Arts program not only aimed to improve “artistic” but also “analytical and structural thinking skills” of the students.⁴² The curricular structure of the Beaux-Arts School was twofold: **practical** and **formal**, in which the design studio was not central but lateral. The practical education was more like craft training in which the students were learning to work with different materials such as stone, timber, metal, clay and glass. The formal education concentrated on the problems of architectural form through observation, representation and composition, and introduced the theories on space, color and design.⁴³

The École des Beaux-Arts stemmed from a teaching system reinstated in the wake of the French Revolution, with the creation of the Institute de France on October 25, 1795, and the reestablishment of the Prix de Rome in 1797. The running and principles of the school then largely hinged upon those in use during the last decades of the Ancient Régime. As its name indicates, Beaux-Arts architecture was aligned to other artistic fields, especially painting and sculpture, rather than to construction and engineering. As an example of that bias, for instance, the jury of the Prix de Rome in architecture comprised all members of the Académie des Beaux-Arts, whatever their field: painting, sculpture, music, or architecture. This approach stemmed from a choice made in two Historicism, the Beaux-Arts, and the Gothic the mid-eighteenth century to dissociate two forms of expertise that had been closely interrelated since the Renaissance: engineering and architecture. This divorce designated the architect as artist, a conception partly originating from Alberti, who, as early as the mid-fifteenth century, established a clear difference between design and construction. It was given new impetus after 1750 with the popularity of painter-architects such as Giambattista Piranesi in Rome and Étienne-Louis Boullée in Paris. Without rejecting the classical legacy of the Italian seicento and the classical orders of architecture, **this transformation led to a new approach to design based on composition and focused upon the plan as the formal expression of the project.** The ordered symmetrical composition in plan, composed of elementary spaces with regular shapes (hallways, vestibules, stairs, galleries, amphitheatres, etc.), was matched in elevation by a composition of masses or volumes likely to strike a chord with the

⁴¹ <https://www.archsoc.com/kcas/Historyed.html>, A History of Architectural Education in the West

⁴² Drexler, A. (1984). *The Architecture of the Beaux-Arts*. Secker & Warburg.

⁴³ Balamir, A. K. (1985). Mimarlık Söyleminin Değişimi ve Eğitim Programları [The Change of Architectural Discourse and Education Programs]. *Mimarlık*, 23(8), 9-15.

audience, not unlike color composition for painters. **Drawing and painting** were in fact a crucial skill for the architect, allowing him both **to display his artistic talent and to represent and defend his projects**. The method was a legacy from the final decades of the Académie royale d'architecture (from the end of the 1760s to 1793), then dominated by Boullée's personality and subjected to the influence of sensualist philosophy. As Pérouse de Montclos has already noted, the ateliers (design studios) in which students in the late eighteenth century prepared their competition entries could be viewed as laboratories for the future architecture of the nineteenth: not only did they prefigure the integration of new administrative and institutional programs, but they also anticipated the **character-theory** developed in the Course d'architecture of Jacques-François Blondel, the leading architecture teacher in Paris in the mid-eighteenth century. The nineteenth-century Beaux-Arts also maintained older traditions in its pedagogical method, organized around various monthly competitions that allowed students to learn gradually, eventually able to compete for the coveted Rome Prize. Each year, only one student received the ultimate reward which opened up the possibility of a brilliant career in government architectural services.

The École's pedagogic system had three main characteristics: first, it was organized around a series of **design competitions rather than formal classroom training**; second, it put express emphasis on the **artistic dimension of architecture**, neglecting the more practical aspects that would have to be learned in parallel on the job; and third, it structured its curriculum in **three distinct stages**. Students were first initiated into **the basics of their art** through independent classes or in architecture firms; then they received **advanced training in design studios** (the famous ateliers supervised by leading architects but organized by the students themselves), where they prepared The French Beaux-Arts 3 the École's competition projects; finally, they could compete for the Prix de Rome, a competition open only to the most distinguished students. The system was more or less based on the method set in place during the Ancient Régime, where students were also placed under the aegis of three successive instructors: the teacher in charge of beginner classes, the one who ran the studio where students prepared for official competitions, and finally the Academician under whose name students registered for the crowning Prix de Rome competition.

Drawing made up the common base of architecture students' education: the acquisition of drawing skills started as early as the teenage years of the architect-to-be and stood as **a common language**, used to **develop competences, ideas, and projects** and also to communicate with peers, clients, or craftsmen in charge of constructing buildings. In retrospect, the importance of drawing may seem greater than it was, as the lavish Beaux-Arts drawings now kept in archives and museums are the only thing left of

that teaching; **no record of the verbal exchanges** carried in the Beaux-Arts studios exists nor is there any nineteenth-century treatise on Beaux-Arts pedagogy. Historicism, the Beaux-Arts, and the Gothic Students could officially enter the school only after competitive examinations. So, both students from and outside the school studied together in studios – the latter preparing for their future entrance examination. It meant that, **once admitted, students already had strong foundations**. Upon entrance, students took part in concours d'émulation (competitive projects organized monthly). As students won these competitions, they moved up the hierarchy of the school, split into two classes. Only those admitted to the first class were able to vie for participation in the Prix de Rome. Students could receive one or two valeurs (points) for each of these competitions, six of which were necessary for first-class admission and nine to apply for the diploma established after 1867. Some students never made it beyond the second class, but they could still bear the title of “former student of the École des Beaux-Arts.” Among those who made it to the first class, only very few eventually became Prix de Rome winners or second prize winners.

This “sketch” examination, which in 1824 took place on May 14, lasted 24 hours, during which it was forbidden to leave the school or to have any contact outside the building. The authors of the eight selected sketches were then asked to submit fully developed drawings by September 21 of the same year. Candidates were thus granted a four-month period to complete their final documents. One aspect was essential: their final plans had to be kept scrupulously to their original sketch, otherwise they were automatically disqualified. The sketch not only outlined the **overall idea of the composition**, but it also **detailed** the number and position of elements (windows, doors, columns), as well as the main lines of the elevation and the orders used. The ensemble of these elements was called the “parti,” namely the primary idea directing the whole design. The final project delineated all details, from the exact width of walls to that of windows and provided an accurate graphic definition of the building. Final adjustments were subject to thorough research and discussions, especially between the candidate and his tutor. **The importance of the final phase of the project was great; it allowed the candidate to demonstrate his talent in drawing and his capacity to seduce the jury, but also his ability to develop an initial idea into a final project on a larger scale.** The competition programs were written by the Professor of Theory of the School, and projects were evaluated by members of the Institute. As for the necessary training for these competitions, it was gained outside the school in independent studios located in the neighborhood and was managed by the students themselves. For many years, the only books published by the school were collections of model engravings made up of student works, drawn from either school competitions or projects carried out by Prix de Rome winners in Rome from

a principal axis of symmetry and a strongly hierarchical plan organized around the principal rooms, the architect had to assemble, according to predefined patterns, a series of autonomous units or “elements”: hallways, stairs, galleries, courtrooms, amphitheatres, etc. The system consisted of two phases: **learning to draw each element separately, then learning to combine them to form an overall plan.**⁴⁴



Figure 12 Sample of art works of architecture concours of Beux-art-1960

The Weimar Bauhaus School is another influential school that brought an “architectonic approach” to architectural education in a way that covers variegated categories of art and design within a wide view range. Focusing on three-dimensional perception in comparison to the two-dimensional compositional approach of the Academy, the Bauhaus School differed from École des Beaux-Arts by providing the students with an ability to unfold their creativity, imagination and personal expression^{45, 46} Gropius introduced the philosophy of the Bauhaus in 1919 by manifesting that “there is a close relation among all disciplines of arts and craft”⁴⁷ The curricular structure of the Weimar Bauhaus School consisted of three periods: the **Introductory** Course introducing knowledge on form and composition, the **General** Course introducing knowledge on space and surface design as well as construction, and the **Architectural** Course focusing on steel and reinforced

⁴⁴ Garric, J.-P. (n.d.). The French Beaux-Arts: Historicism, the Beaux-Arts, and the Gothic

⁴⁵ Balamir, A. K. (1985). Mimarlık Söyleminin Değişimi ve Eğitim Programları [The Change of Architectural Discourse and Education Programs]. *Mimarlık*, 23(8), 9-15.

⁴⁶ Paşin, B. (n.d.). Rethinking the Design Studio-Centered Architectural Education: A Case Study at Schools of Architecture in Turkey.

⁴⁷ Benton, T., Benton, C., & Sharp, D. (1975). *Form and Function: A Source Book for the History of Architecture and Design 1890-1939*. Open University Press.

concrete buildings. The required knowledge and skills advanced as the student passed into an upper class. While the basic knowledge on form, composition and color were introduced by means of analytical drawing, painting, observation and bodily performance during the Introductory Course, the advanced theoretical knowledge on space, material, function, economy and aesthetics were taught in various theoretical and technical courses and the design studio in the Architectural Course (Salama, 1995, p. 54).⁴⁸

The Bauhaus education may be considered as the basis of a design studio-centered architectural education and quite contrary to École des Beaux-Arts. In Bauhaus, the theoretical and the practical aspects of architecture were integrated within an interdisciplinary environment. Between 1930 and 1960, schools of architecture in various countries followed two different approaches: the twofold structure of École des Beaux-Arts in which ateliers were **separated** from theoretical courses and the three-staged Bauhaus system in which practical and theoretical studies were **integrated** in ateliers. The architectural education in the US had been under the dominance of École des Beaux-Arts until the foundation of the New Bauhaus School by Sibyl Moholy-Nagy in Chicago in 1936.⁴⁹

Concomitantly with the 1960s movement of design research, various studio teaching models emerged. Models such as the case problem model, the analogical model, and the interactional mode. Situated learning, situated cognition, cognitive apprenticeship, problem-based practices, and education connoisseurship are just some of the terms used to describe the learning model consistent with the type employed in the design studio. Each of these models are, in some way, based on a psychological or cognitive phenomenon called 'scaffolding' or 'modeling' which explains how understanding may be structured between the participants engaged in the invention dialogue.⁵⁰

Also, by the 1990s Critical Inquiry and Process-Oriented Design Pedagogy has been propounded and implemented in design studios. However, the essence of architectural pedagogy has still followed the studio-oriented process but instead of the traditional trends, mostly leans on interactive communication between mentor and student. the process called the one-on-one crit in the studio, which every student “gets” from a design teacher two to three times a week throughout the study program, is (and has been for over a century) the predominant practical design–learning format employed in design education throughout the world. Its major feature is the

⁴⁸ A. Salama, “New Trends in Architectural Education: Designing the Design Studio”. Tailored Text & Unlimited Potential Publishing, North Carolina, 1995, USA, 27606

⁴⁹ Paula S. M. Dozois, Construction Through Critique: the dialogic form of design studio teaching and learning

⁵⁰ Ibid

one-on-one desk critique (crit)⁵¹, in which student and teacher discuss the student's work in progress on a regular and frequent basis.⁵²

Through this process the student begins by reporting the state of the project and describing its development since the previous crit. The teacher may ask for clarifications, and the ensuing discussion is meant to help the student make progress in the desirable direction. In this way students are meant to "learn by doing." A rough calculation shows that in a 5-year program, a diligent student who does not miss classes is likely to participate in some 250 to 350 one-on-one crits throughout his or her degree program. The teachers who "give" the crits are experienced designers who, for the most part, practice design as their major occupation and teach it as adjunct faculty. At the same time, many students find it difficult to submit their work to what is perceived as criticism so frequently and often misinterpret a critique of their work as waged against them in person, which may result in anger, hurt feelings, or resistance. Most students, like full-fledged designers, have a strong sense of possession of their projects and may therefore dread the possibility that too much input by the teacher may lead to compromised ownership of their projects. Moreover, especially in the early stages of their studies, are quite dependent on their teachers, and feel insecure until they receive from the teacher both approval and explicit guidance for the advancement of their projects. Teacher–student communications, especially the crit, are therefore sensitive and sometimes even charged settings, and teachers must exert much care to ensure their effectiveness as a learning opportunity for students. However, they are not trained as teachers and rarely receive thorough, relevant feedback regarding their teaching performance.⁵³

The design studio is the heart of architectural education where most schools of architecture devote 30% to 50% of their curriculum to design training and teaching. The design studio is the kiln where future architects are molded and the main forum for creative exploration, interaction, and assimilation. However, theorists, academics, and researchers voiced the opinion that most design studio teaching continues to provide students with little understanding of the value of design as a technique, a process, or a set of purposive procedures.⁵⁴

Perhaps one can blame the numerous, top-down university initiatives or committee interferences that based their thinking on abstract theories of learning and standard pedagogical formulas of university education ignoring

⁵¹ Short form of critique

⁵² Goldschmidt, G., Hochman, H., & Dafni, I. (2009). [Title of the Article]. Faculty of Architecture and Town Planning, Technion–Israel Institute of Technology.

Also: Doidge, C., et al. (2000). *The Crit: An Architecture Student's Handbook*.

⁵³ Ibid

⁵⁴ Salama, A. M. (2005). A Process Oriented Design Pedagogy: KFUPM Sophomore Studio. *CEBE Transactions*, 2(2).

the reality of architectural professional practice as well as the reality of the built environment and of the desires and aspirations of its users for a good sustainable equitable environment.⁵⁵ However, the lack of teachable educational content in relation to understanding the essence of design and the correct implementation of theoretical topics in the design process through codified exercises or step-by-step procedures is a criticism that comes to the studio-oriented education system. Significantly during the past years, with the outbreak of the Covid pandemic and the virtualization of educational classes, the one-on-one educational process and the face-to-face interaction between the instructor and the student have fluctuated and affected the level of communication. A process that was carried out only through a two-person conversation and possibly the use of simultaneous sketching while talking or advancing the design process through mockups and detailed reviews for drawings and plans in a virtual classroom was either not possible or had low quality.

Most obviously, communication channels change. Sitting adjacent to a tutor, listening to their comments as they work, the students observe the acts of knowing-in-action and reflection-in-action which Schon identifies. How can this be achieved when the " bandwidth is substantially less than that available when teacher and student are co-located? The tutor must address these changes by considering both the technology and the procedures of teaching. One immediate reaction is to try to recreate the face-to-face setting by relying on communications technology to establish a maximum facsimile of immediacy, using video and audio systems to convey presence. It is possible, however, to overcome many of the problems of remote presence by developing new conventions of communication such as acknowledging receipt of a communication immediately, periodic announcements.⁵⁶

After the Corona pandemic, many educational institutions are seeking to develop their virtual education system and evolve the relevant platforms, but it is obvious that such an action needs to be reconsidered in relation to the way of presenting courses and the teaching process.

Especially in relation to architecture as a practical field or at least for the units whose practical nature is more important than theoretical dimensions, the development of the educational process will require the formulation of different educational content or different teaching methods. **Therefore, it is expected that in the future, we will witness a new wave of virtual education system in parallel with the past educational methods, which is definitely going through the initial stages of their experience.**

⁵⁵ Tzonis, A. (2014). A framework for architectural education. Department of Architecture, University of Technology Delft, 108 Oude, Delft 2611, the Netherlands.

⁵⁶ Kvan, Thomas, (2001). The pedagogy of virtual design studios, Automation in Construction 10, P 348-349

The future of architecture will for sure have transformation due to the extreme pace of advancement of technology. The new world, Metaverse, where everything including humans are going to be experienced virtually would broaden the realms of imaginative world, due to the eliminations of most of the real-world limitations in terms of construction and so on. The importance of Creativity at this time would get intensified in architecture education.

These advancements of technology would create the possibility of creating habitats on other planets as well. This situation will change many of the current limitations of the construction system and the leading designers, who are experts in the act of design itself, are the ones who can shape the future world.

1-4. Comparison on the introductory design course in different architecture schools

The design course is the main course in architecture education in all architecture schools around the world. Becoming able to design in accordance with the architectural criterion is a complicated process which should be attained during 5 design studio courses. Considering all the architectural limitations of an architectural problem, while trying to find the best yet creative design is a challenging and difficult task. Architecture schools have different approaches in this regard to prepare students to encounter the architectural problem in the design studio and one of which is to insert an **introductory design course** in the curriculum.

In some other schools there is not any course called “introductory design” but some courses are presented as prerequisites for the design studio. These courses contain various contents, and the course description is mostly related to the **presentation’s skills and architectural expression** and there is no systematic learning procedure for students about the concept of “Design”.

Although learning presentation skills is extremely important for an architecture student, it is not enough to face the challenge of design in the architecture realm. The missing course seems to be related to the concept of DESIGN itself. Design research and Design thinking skills are necessary for any design related major students including architecture students.

The selection of universities is based on the inclusion of four universities from the United States, each with distinct approaches to architectural education. Harvard University, globally renowned for its extensive history in architectural education, stands out for its formulation of frameworks, international standards, and its recognized academic teaching practices. Yale University and UC Berkeley, distinguished as institutions with unique pedagogical schools, have played influential roles in shaping architectural

discourse especially in Modern era. The School of Architecture at SCI-Arc is emblematic of pioneering institutions with innovative and experimental approaches, particularly in experimental architecture, influenced by the incorporation of cutting-edge digital tools in the design process.

In Canada, McGill University was chosen due to its reputation and a rich history of architectural education in North America. In Europe, three universities were selected: the University of Porto, recognized as one of the twenty leading schools in Europe, where I pursued my studies; Politecnico di Milano, ranking first in the number of faculties in Europe and globally recognized as one of the most prominent architecture universities; and Delft University of Technology, ranked second in world according to the QS website, and highly regarded for its contributions to architectural education. From Asia, the National University of Singapore, ranked 6th in the QS ranking, was chosen, and from Australia, the University of Wellington was selected for its leading role in synchronizing educational processes with the presented digital methods.

Here is a list of course description on **introductory design course** in different architecture schools:

Table 1 The course description comparison between universities

University	World Ranking	Pre-Design course title	Course description
University of Singapore	6	-	During the first three years, students' progress through six design courses where they are introduced to 18 foundational themes in architecture. This largest component of the curriculum takes place in design studios, where students tackle different design challenges hands-on, and are responsible to find their own critical and creative approach to solving given design problems
University of Berkeley	8	Introduction to visual representation and drawing	Introductory studio course: theories of representation and the use of several visual means, including freehand drawing and digital media, to analyze and convey ideas regarding the environment. Topics include contour, scale, perspective, color, tone, texture, and design.
Yale University	51-100	Introductory Courses for Nonmajors and Majors	Students majoring in Architecture are required to take fifteen course credits, including prerequisites and the senior requirement. Majors are expected to take the three prerequisites by the end of their sophomore year and to complete a core of four courses, for five course credits, by the end of their junior year. They must also base their studies in one of two areas of concentration: the Design concentration or the History, Theory, Criticism of Architecture, and Urbanism concentration. Majors are also required to complete three orientation sessions: advanced technology orientation, library orientation, and shop orientation. Within the concentrations, electives are categorized under four broad subject areas: history and theory of architecture and the city; urbanism and landscape; materials and design; and structures and computation.

			The Design concentration explores the role of architecture in shaping the world around us. It introduces complex processes involved in solving spatial and programmatic problems. Creative work is grounded in the study of history and culture, and in the analysis of social conditions influencing architecture. Design studios provide a forum for production and discourse. Studio projects address issues of architectural form, space, composition, site, tectonics, and programs within broader humanistic ideals.
Politecnico di Milano	10	FUNDAMENTALS OF REPRESENTATION -	The course in Fundamentals of representation provides graphic skills, manuals and technical, necessary for the understanding and the design of architectural space through the basic projective forms of representation, that is, plans, elevations, sections, axonometric and perspective, as well as through non projective forms, and three-dimensional models, physical and digital. The course aims at training and testing the essential knowledge for elaborating graphic representations of projects and built architecture. Teaching objectives: The teaching aims at knowledge and understanding of the themes of architectural representation, its historical development, the relationship with other disciplines and the languages of architecture and therefore intends to provide the theoretical, methodological and operational bases of the discipline, focusing it on architectural, urban space and territorial. The teaching objective is the knowledge and learning of the techniques necessary for the understanding and configuration of architectural space through the fundamental geometric-projective forms, deepening the relationships between space, figure, measurement, model; working on the connections between geometric structures and graphic devices; highlighting the role of projective principles and procedures in the generation of analog and digital images and models, in visual perception and in optical devices, with reference to their use in surveying and design. The course aims, as a whole, to achieve knowledge and understanding of the principles and procedures underlying the analogue and digital representation of space, and their main applications within the practice of the architectural profession.
Delft University of Technology	2	Design – Bachelor's degree	The learning trajectory of Design (60 ECTS) is the biggest learning trajectory and consists of 6 design projects of 10 ECTS each. Learning is best done through plenty of practice. The assignments get more complex and challenging: from a small building to a design of a city or public space, from collective spaces to area development. The projects cover design assignments on architecture, building technology, urbanism, and landscape architecture. You present your designs, amongst others, by means of architectural drawings, scale models, and computer simulations. You will acquire the necessary skills to do so as part of the learning trajectory 'Representation, Visualization and Form'. The learning trajectory 'Design' consists of the following 10 ECTS projects: 1. House and Settlement in the Landscape 2. Design and Engineering

			3. City and Public Space 4. Dwelling and Dwelling Environment 5. Area (Re)Development 6. Building and Technology
		Form Studies-Master`s degree	The MSc1 studio Form, Structure & Aesthetics researches how aesthetical values can be achieved as a result of the integrated design process. Developing form, structure, aesthetics, and sustainability at the same time help to understand the current role of the architect. The main topics of the studio: The expression of structure and detail in architecture The aesthetical consequences of sustainable solutions in architecture. The MSc1 and MSc2 studios make intensive use of physical models and hand drawings to develop and test design concepts. The design method is intuitive, experimental, reflective and efficient. By using the various scales simultaneously during the design process, you learn to unravel complex spatial and structural problems. The physical model, in combination with the drawing, offers the possibility to get a good understanding of the coherence between spatial solutions. The desired expression is legible in the proportions and materialization of the models. Documenting the results and reflecting on the process and its outcome, is seen as an essential part of the studios.⁵⁷
McGill	51-100	Communication, Behavior & Architecture	Introduction to design; development of design judgement and communication skills in a series of exercises addressing light, scale, space, form and color in the built environment; introduction to techniques of oral and graphic presentation, including model making, photography, sketching and architectural drawing. The course is based in the studio and includes lectures, seminars and field trips.
Porto University	250-300	Drawing 1&2	Objective of Drawing 1 The Drawing Discipline, by promoting the representation and knowledge of the visible world and mental images through manual graphic recording, has the following objectives: - Develop in the student the capacity for observation, skill, and knowledge of the act of drawing and sensitivity to plastic and aesthetic values. - Create conditions for the student to face the act of designing with agility, spontaneity and awareness. - Encourage the presence of non-systematic, symbolic, and poetic components in the design process. - Promote satisfaction and knowledge of the need and pleasure of representation; the expression of number and measure; visual memory of outer and inner reality. - Recognize that drawing is the graphic expression of an intentionality that must seek its matrix in external reality and in the heritage of Design and Architecture. - Understand that you learn to draw by drawing and drawing yourself, that is, the intentionality of the drawing is also in the matrix that is the author. Learning outcomes and skills

⁵⁷ <https://www.tudelft.nl/onderwijs/opleidingen/masters/aubs/msc-architecture-urbanism-and-building-sciences/master-tracks/architecture/programme/studios/form-studies>

			At the end of the academic year, the student, through drawing, must have acquired skills and abilities of observation, representation, memorization, expression, organization and project development. Objective of Drawing 2 Develop the practice of drawing - the singularity of its expression and individual adaptation (modes, techniques, codes, and systems of representation) - in order to favor a free and effective construction of images in a close relationship with the figural conception of the architectural project. Learning outcomes and skills Mastery, through "raised hand" drawing, of the graphic and plastic representation of shapes, volumes, and spaces. Instrumental mastery of the means and processes of representation. Methodological and critical mastery of different systems of representation and figuration. Mastery of measurement, scale, expressions and composition of drawn images. Ability to record, analyze, design and communicate architecture. Skills in the scope of image and project conception. Ability to critically develop autonomous and personal research and project processes.
SCI_ARC		Fundamental Design Studio 1 (1GA)	The 1GA studio introduces students to the central problems of architecture—geometry, form, and space—through the technologies of their description—diagramming, drawing, and model making. Introductory exercises emphasize the role of drawing and analysis as both descriptive and generative. Students pay close attention to the development of ideas that inform an iterative and creative process for working with many different media: from physical models to two-dimensional drawings, to digital interfaces. The course culminates in the design of a small public building in Los Angeles.
		Fundamental Design Studio 2 (1GB)	The 1GB studio is a continuation and expansion of the fundamental issues of architecture that were introduced in 1GA, the first studio of the core sequence. The emphasis of 1GB will therefore be to continue to develop both knowledge of discipline and sophisticated techniques for thinking about and creating architecture. The studio will begin with studies of a set of overarching conceptual, formal, and organizational strategies in significant architectural precedents. The studio will focus on the interaction between two and three dimensions, as well as various methods for the derivation of architectural form. Following analyses of precedents, site, program and type, the semester will culminate in a well-drawn and highly articulate project for a house (a duplex). The project should aim for intelligible conceptual relationships between form, siting, diagram, program and tectonics.
Harvard	5	Transformations	Architecture is not a single monolithic thing, rather it is comprised of disparate parts and organizational systems operating at different scales. Design is the considered assembly of these elements. This course is an introductory architectural design studio focused on building foundational architectural concepts and design methodologies studied through a process of making. A series of physical modeling

			assignments explore spatial and organizational transformations as a consequence of the changing interactions among material, fabrication technique, and form. Resultant expressions of space, scale, and perceptual effects are discussed in relation to architectural theory and history discourse. ⁵⁸
Victoria University of Wellington	151-200	Introduction to Design Processes	Studio-based projects introduce concepts and processes used in human environments. These concepts and processes are examined in relation to the physical, social and cultural contexts in which designers operate. SARC 111 introduces and guides students through a range of design processes and principles that can be applied to design projects in the built environment disciplines. Throughout the course students will engage in studio learning practices to explore and develop confidence in spatial language. They will also acquire a variety of skills that will help them to address complex problems with creative solutions. The design projects set as coursework in SARC111 build in scope from the scale of the body to the scale of the landscape. This course is primarily delivered in-person, but online engagement is available in scheduled classes for students who, at the time of enrolment, registered as distance students (off-campus or overseas). Limited online engagement may also be provided to students in special circumstances. Students who pass this course should be able to: - Identify a range of design precedents and apply a variety of design strategies. - Generate simple three-dimensional compositions using basic vocabulary of formal and spatial elements. - Develop an initial concept into a sketch design which acknowledges elementary structural relationships and the possibilities of construction materials and technologies.⁵⁹

The following points and approaches can be deduced in summary by examining the primary education processes in the above faculties.

1. Design studios and projects:

- The curriculum emphasizes hands-on design through six design courses, covering 18 foundational themes in architecture.
- Design studios play a crucial role where students tackle different design challenges, developing critical and creative approaches.
- Design concentration explores the role of architecture, addressing issues of form, space, composition, site, and programs.

2. Concentration areas:

- Architecture majors choose between the design concentration or the history, theory, criticism of architecture, and urbanism concentration.
- Electives within concentrations cover history, theory, urbanism, landscape, materials, design, structures, and computation.

⁵⁸ <https://architecturestudies-undergrad.harvard.edu/courses-haa>

⁵⁹ <https://www.wgtn.ac.nz/courses/sarc/111/2023/offering?crn=18165>

3. Representation and visualization:

- Courses focus on theories of representation, visual means (freehand drawing, digital media), and fundamental graphic skills.
- Learning trajectories involve developing skills in representation, visualization, and form through projects of increasing complexity.

4. Learning trajectories:

- The design learning trajectory includes projects such as house and settlement, design and engineering, city and public space, etc.
- Msc1 studio explores integrated design processes, emphasizing aesthetics, structure, and sustainability simultaneously.

5. Drawing courses:

- Drawing courses aim to develop observation, representation, memory, expression, and project development skills.
- Mastery of graphic and plastic representation, different systems of representation, and critical development of personal research are emphasized.

6. Introduction to architecture:

- Introductory courses explore foundational architectural concepts, design methodologies, and historical discourse.
- The course involves physical modeling assignments, discussions on spatial language, and addressing complex problems in human environments.

7. Design processes and principles:

- Courses guide students through design processes applicable to the built environment disciplines.
- Projects in this course progress from the scale of the body to the scale of the landscape.

8. Online and in-person learning:

- The curriculum offers a blend of in-person and online engagement, catering to distance students.
- Students are expected to identify design precedents, apply design strategies, and develop initial concepts acknowledging structural and material considerations.

In a general classification considering the objectives, content, and processes, a high level of inference can be drawn regarding the distinctive nature of architectural education at the foundational levels. While in practice, the alignment of educational goals with the curriculum in each of the above-mentioned faculties is closely related to the teaching methods of the faculty members in each section, the educational flow generally adheres to a specific course. An important point is the existence of a gap in the space between basic education, primarily labeled as representation and drawing, and the instructional processes within the studio and architectural design. This gap becomes more noticeable with the influx of students entering the architecture faculty without prior backgrounds, especially from mathematical disciplines. The possibility of defining a preliminary educational process between foundational levels and studio levels can be considered as a study approach.

1-5. Necessity of rethinking architecture education

Bridging the Gap: The Imperative for an Introductory Design Course in Architecture Schools

The world of architecture is a fascinating blend of artistry and functionality, where design plays a pivotal role in shaping the built environment. However, a critical observation reveals a significant disparity among architecture schools regarding the inclusion of an "introductory design" course in their curriculum. While some institutions prioritize this fundamental aspect, others seemingly neglect it. Moreover, the existing prerequisites for design courses often focus on presentation and visualization skills, which, although valuable, fall short of nurturing essential design thinking and research abilities. This research explores the implications of this divide and advocates for a unified approach to introductory design education in architecture schools.

The Role of Prerequisites

In many architecture schools, introductory design courses are absent, with prerequisites concentrating on presentation and visualization skills, which are crucial but insufficient for comprehensive design education. These prerequisites are typically presented to students before or in tandem with the design studio. While these skills indirectly influence artistic attitudes, they do not delve deep enough to fortify design thinking and research abilities. Design, viewed both as a tool and an independent act, and requires a more nuanced understanding that should be ingrained as an unconscious habit.

The Limitations of Existing Courses

An inherent shortcoming of current introductory design courses is their confinement within the realm of architecture. These courses often fail to familiarize students with the broader basics of design, the historical evolution of design, and the critical components of design thinking and research. Essential aspects such as product design, process-oriented design,

and problem-solving design, which can be invaluable precursors to architectural problem-solving, are overlooked. This narrow focus impedes the holistic development of students, limiting their capacity for creative and innovative design thinking.

The Need for a Unified Approach

A crucial aspect that emerges from this research is the necessity for a unified opinion on the subject of design in architecture schools. There is a compelling argument for establishing a foundational understanding of design principles, history, and methodologies before students embark on design studios. This preemptive knowledge can significantly enhance students' capacity for design, providing a well-rounded perspective that extends beyond the traditional confines of architecture.

Beyond Architecture: Embracing Diversity in Design Education

The call for a unified approach extends beyond architecture to encompass a more diverse range of design disciplines. While architecture remains the focal point, exposing students to broader design perspectives, such as product design and problem-solving design, can contribute to a more versatile and adaptable design mindset. Integrating these diverse perspectives into the curriculum can foster a richer understanding of design principles and enhance students' ability to apply these principles across various contexts.

Conclusion

In conclusion, the absence of a standardized introductory design course in architecture schools poses a significant challenge to the comprehensive education of future architects. The current focus on prerequisites that emphasize presentation and visualization skills falls short of cultivating the essential design thinking and research abilities. A unified approach to introductory design education, encompassing a broader understanding of design principles and methodologies, is imperative. By broadening the scope of design education to include diverse disciplines, architecture schools can produce graduates with a more versatile and adaptive design mindset, ready to meet the challenges of a dynamic and evolving built environment.

CHAPTER 2.

A Note on Design in architecture pedagogy

To design is to plan for the making of something new. In the case of architecture, this "something" is an artifact of the physical environment. Designing entails generating, transforming, and refining images of different aspects of that still non-existent artifact and making representations of it which enable communication and examination of the ideas involved.

Christopher Alexander

This chapter encompasses the topics as follows:

- 2-1- Design Methodology
- 2-2- Design Thinking
- 2-3- Design Activity
- 2-4- Position of intuition in design
- 2-5- Design Education
- 2-6- Functional Elements in Architectural Design Education

Introduction

One important issue in the design realm is the fact that “Can we describe how we design”? This is the question that Michael Brown propounded in his book, “Architectural Thought,” and he continued:

The first and impulsive answer to the question is ‘no.’ it is largely believe that design is a mysterious and individual activity which is beyond description; it happens but is not amenable to analysis. The same could be said of a significant number of human activities, but we do not immediately conclude that they are beyond description. For example, a large segment of the population is engaged in some economic activity. The underlying description of that activity, of its primary organization, may not be agreed upon. Still, both free-market proponents and Marxists would hold that a theory – an explanation – can, perhaps, must exist. What is more, the way economic activity is conducted will depend a great deal on which theory is held to be operative. Theory and practice are not unrelated matters.

What is essential is to find out and investigate the actual process of design. Afterward, we can contrive a design analogy.

By analogy, can there be theories of design? ‘Theories’ is advisedly used in the plural on the assumption that there is unlikely to be a single all-embracing theory that is able to explain the process of design adequately. Theory is here meant not as the antithesis of practice but in the sense of explanation. It is typically used in science to describe a series of related phenomena. It is vital at this stage to make an apparent distinction between a Design Theory and Design Methodology. A theory is, at least initially, a non-prescriptive explanation that does not have an architectural end in view.

On the other hand, design methodology describes specific operations that are believed to be helpful in the design sequence. Such operations might include matrixes, flow charts, or brainstorming. However, these are tools that one may employ but are neither essential nor an analysis of the design process itself. Design theory is also totally unrelated to design appreciation, a horrendous topic prone to a host of pitfalls and, in any case, unlikely to be discussed meaningfully.

In order to teach design, we do not need to focus on design theory. It is important to know about design theories; however, this research focuses on design education in the context of practical training in the design studio; therefore, we will not go into the theoretical dimensions of design topics. Hence, what will be investigated is more about design methodology. As mentioned by Brown, it is extremely important for architecture educators and students to understand the difference between design theory and design methodology. In architecture design education, we are looking for

the theories of design methodology. Getting deeper into design methodology leads to higher educational paths.

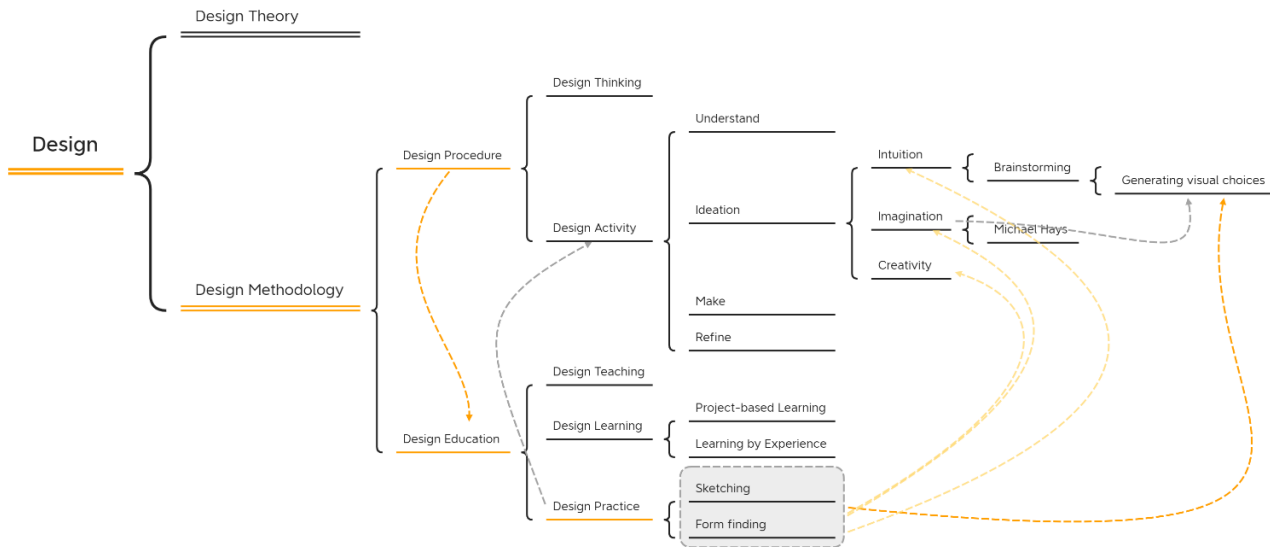


Figure 12 Design activity in the context of design process stages

2-1. Design Methodology

Merriam Webster dictionary has defined “Methodology” as: a particular procedure or set of procedures. A brief look into the design methodology, from the perspective of Nigel Cross would be beneficial:

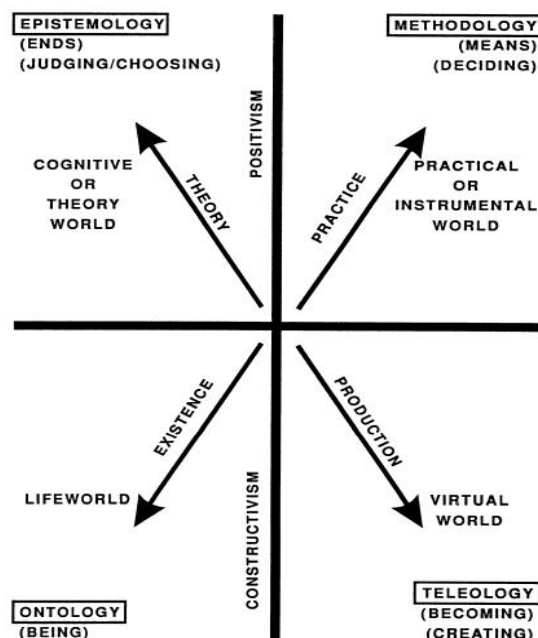


Figure13 Analytical scheme for state of the art of design methodology

The new 'Design Methods Movement' developed through a series of conferences in the 1960s and 70s. However, the 1970s also became notable

for the rejection of design methodology by the early pioneers. Christopher Alexander said: 'I've disassociated myself from the field ... There is so little in what is called "design methods" that has anything useful to say about how to design buildings that I never even read the literature anymore ... I would say forget it, forget the whole thing ... If you call it "It's A Good Idea To Do", I like it very much; if you call it "A Method", I like it but I'm beginning to get turned off; if you call it "A Methodology", I just don't want to talk about it.' (Alexander, 1971) And J. Christopher Jones said:⁶⁰ 'In the 1970s I reacted against design methods. I dislike machine language, the behaviorism, the continual attempt to fix the whole of life into a logical framework.'⁶¹

The first generation (of the 1960s) was based on the application of systematic, rational, 'scientific' methods. The second generation (of the early 1970s) moved away from attempts to optimize and from the omnipotence of the designer (especially for 'wicked problems'), towards recognition of satisfactory or appropriate solution-types⁶² had introduced the notion of 'satisficing') and an 'argumentative', participatory process in which designers are partners with the problem 'owners' (clients, customers, users, the community). However, this approach tends to be more relevant to architecture and planning than engineering and industrial design, and meanwhile these fields were still developing their methodologies in somewhat different directions.

So the development of 'second generations' of design methodology in architecture and engineering appeared to diverge from each other in the 1970s and 80s.⁶³ It has been pointed out that these two fields have tended to diverge especially in their models of the design process, to the detriment of both. Perhaps a third generation of the 1990s might be based on a combination of the previous two; or, as in the model proposed by Cross (1989),⁶⁴ on understanding the 'commutative' ⁶⁵ nature of problem and solution in design. There was also a broader renewal of interest in design methodology in the late 1980s - especially in AI developments, where hope springs again for design automation and/or intelligent electronic design assistants.

By looking into what has shaped the design methodology, we clearly understand that design methodology cannot be a fixed idea, as Alexander has also mentioned. But through the years, there are some definitions of

⁶⁰ Alexander, C. (1971). The State of the Art in Design Methods. DMG Newsletter, 5(3), 3-7.

⁶¹ Jones, J. C. (1977). How My Thoughts about Design Methods Have Changed During the Years. Design Methods and Theories, 11(1), 48-62.

⁶² Simon, H. A. (1969). The Sciences of the Artificial. MIT Press

⁶³ Roozenburg, N., & Cross, N. (1991). Models of the Design Process: Integrating Across the Disciplines. Design Studies, 12(4), 215-220.

⁶⁴ Cross, N. (1989). Engineering Design Methods. John Wiley & Sons Ltd.

⁶⁵ Archer, L. B. (1979). Whatever Became of Design Methodology? Design Studies, 1(1), 17-18.

design methodology mentioned by expert as followings which try to define design methodology in relation with science:

'Scientists try to identify the components of existing structures, designers try to shape the components of new structures.'⁶⁶

'The scientific method is a pattern of problem-solving behavior employed in finding out the nature of what exists, whereas the design method is a pattern of behavior employed in inventing things ... which do not yet exist. Science is analytic; design is constructive.'⁶⁷

'The natural sciences are concerned with how things are ... design on the other hand is concerned with how things ought to be.'⁶⁸

Following by these investigations, there is another attention, from theorists, which define some expressions as: **Design science, scientific design, and science of design.**

Although the resemblance of these terms is so close, there is a significant distinction among them, which is worth mentioning because it will help to clarify what the design study and contriving a design method really seeks. **Design science** is all the arguments that theoretical science can make in explaining the design problem. Most of these arguments rely on rational and logical analysis that science can provide facts for, or it is possible to prove it through laboratory processes. **Scientific design** is more related to the design activity itself. It can be considered a branch of design that uses scientific methods and facilities that can be used and cited through the results of scientific research. This process can be executed in parallel with other design methods. Regarding the **Science of design**, perhaps it is better to substitute other terms instead of science. In this way, it will be more distinguishable from design science. For instance, it is suggested to use Knowledge of design or design insight, also design expertise or design skills. Obviously, this attitude defines the term ' Science of design" as a proficiency, acquired through vast Knowledge and experience in the design realm, in the category that it has affiliated with a given design activity. This method of inference is based on the concept of "science of design", the subject of design education and design learning, which will be discussed in the next chapter. This so-called science of design is what an instructor should conduct to the apprentice with the aid of designated practices, and it is entirely different from "design science" and "scientific design procedure".

⁶⁶ Alexander, C. (1964). Notes on the Synthesis of Form. Harvard University Press.

⁶⁷ Gregory, S. A. (Ed.). (1966). The Design Method. Butterworth.

⁶⁸ Simon, H. A. (1969). The Sciences of the Artificial. MIT Press.

It feels necessary to conclude by a short summary of some expression in the related area, which makes focus on design methodology easier than before

So let us agree here that the science of design refers to that body of work which attempts to improve our understanding of design through 'scientific' (i.e., systematic, reliable) methods of investigation.

Models and strategies for executing design projects:

We have had a new generation of systematic models of the design process, particularly in engineering design, and particularly from Germany ⁶⁹We have also seen the emergence of 'concurrent' models of product planning and development ⁷⁰Pugh (1991)». In architecture and planning there has been development of the 'argumentative' process models (McCall (1986), and the paper by Grant in this volume).⁷¹

Theoretical analysis of the nature of design problems:

There has been significant new work on problem 'types', for example by SchOn (1988)⁷² and by Oxman (1990).⁷³ In this category we might also include the new work on formal languages and grammars of design.⁷⁴⁷⁵⁷⁶

To investigate design methodology deeper, we can break the methodology or the procedure into two general categories of "design thinking" and "design activity". If we find out how the expert designers think and what they actually do it would be easier to claim what the design method stands for.

Thomas Maver (1970)⁷⁷ suggested the process of design as the decision sequence of "analysis", "synthesis", "appraisal", and "decision" at progressively detailed stages of the design process. They explained diagrams of the architectural design process detailed in decision order as shown in Figure 14. The process in the illustration is like a close loop which repeats in itself, and it is an introverted approach.

⁶⁹ Hubka, V. (1982). Principles of Engineering Design. Butterworth Scientific Press.

⁷⁰ Andreasen, M. M. (1991). Design Methodology. Journal of Engineering Design, 2(4), 321-335.

⁷¹ McCall, R. (1986). Issue-Serve Systems: A descriptive theory of design. Design Methods and Theories, 20(3), 443-458.

⁷² SchOn, D. A (1988), "Designing: rules, types and worlds." Design Studies 9(3): 181-190

⁷³ Oxman, R. (1990). Prior Knowledge in Design. Design Studies, 11(1), 17-28.

⁷⁴ tiny, G. (1980). Introduction to Shape and Shape Grammars. Environment and Planning B, 7, 343-351.

⁷⁵ Flemming, U. (1987). The Role of Shape Grammars in the Analysis and Creation of Designs. In Y. E. Kalay (Ed.), Computability of Design. John Wiley & Sons Ltd.

⁷⁶ Design methodology and relations with science, M.J. de Vries, N.Cross and D.P. Grant, Nato ASI series.

⁷⁷ Maver, T. W. (1970). A theory of architectural design in which the role of the computer is identified. Building Science, 4(4), 199-207.

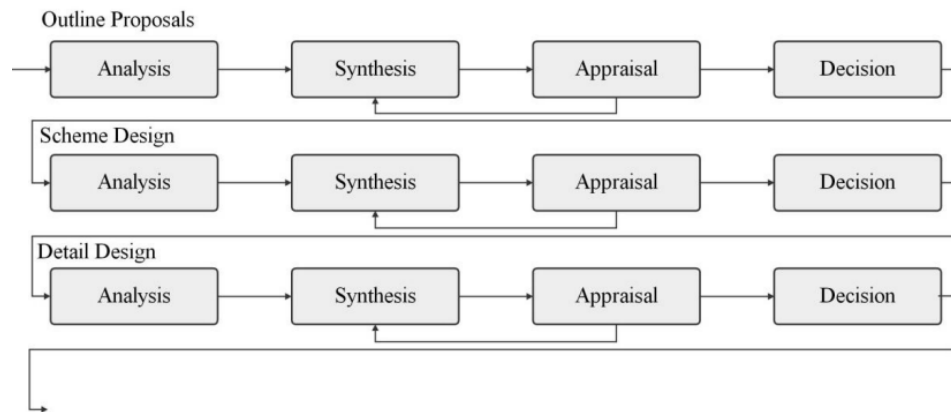


Figure 14 Markus & Marver Diagram of Design Method (Lawson, 2006))

Another perspective on design process was sketched by John Wade (1977).⁷⁸ He describes design as an activity to generate proposals that are going to change the existing conditions into better ones. He splits design into 3 parts such as; initial state, method or process of transformation and imagined future statues. In Wade's terms, design is identified by the process of converting existing elements and issue to the imagined future ones and these steps are exactly outcome of his definition and consideration about design itself (Figure 15).

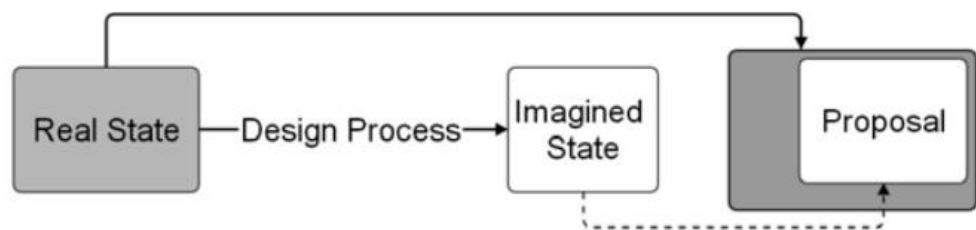


Figure 15 Design Process, Wade, J,W (1977)

It is possible to continue the discussion on the exploration of the maps of design process but a considerable number have been developed by Synder (1979).⁷⁹ Maps of the design process similar to those previously argued for architecture have been proposed for the engineering design process (Asimow, 1962; Haik, 2010)^{80 81} and the industrial design process⁸² and, even in some models for town planning⁸³ These abstract maps from varying fields of design show a considerable degree of agreement that suggests the design process is the same in all fields, but unfortunately most of the writers quoted here have not offered any evidence that designers or architects

⁷⁸ Wade, J. W. (1977). *Architecture, Problems, and Purposes*. John Wiley & Sons.

⁷⁹ Snyder, J. C., Catanese, A. J., & Macginty, T. (Ed.). (1979). *Design and the Design Process*. In T. McGinty (Ed.), *Introduction to Architecture* (pp. 152-190). McGraw-Hill.

⁸⁰ Asimow, M. (1962). *Introduction to Design*. Prentice Hall.

⁸¹ Haik, Y., & Shahin, T. M. M. (2010). *Engineering Design Process*. Cengage Brain

⁸² Archer, B. (1968). *The Structure of the Design Process*. In *Emerging Methods in Environmental Design and Planning*. MIT Press.

⁸³ Levin, P. H. (1966). *The Design Process in Planning*. *Town Planning Review*, 37(1), 5.

systematically follow their maps. By exploring different design process methods in variety of time periods which are collected in table 2, in different steps and stages most of them have commonalities to separate and highlight limited phases.

Table 2 Table 2 Different Outlooks of Design Process (Snyder, 1997))

	Design Process Theories	Design process Defined steps				
1	Thornley Student Design Process (1) (1963)	Accumulation of Data	-	Separation Of Main concept or Method	Form Development	Presentation of Solution
2	Thornley Student Design Process (1) (1963)	Program Formulation	Investigation Assessment Of Design Possibilities	Create	Refinement	Presentation
3	Gunter and Corkill Systematic Approach of Architectural design (1970)	Basic Definition Preliminary Program	Investigation, Analysis, Program, Abstraction	Synthesis And development Volumetric Design Proposal	Reevaluation And Modification	-
4	H. Rittle's Summary of Design Process (1971)	Problem Identification	Collect & Analyse Information	Workout Solution	Solution Assessment	Implement and communicate
5	R.Whitaker's Eight Step Design Process (1971)	Recognition Definition	Preparation Analysis	Synthesis	Evaluation	Execution
6	J. C. Jones's Design Method (1972)	Idea	Information Analysis	Synthesis	Evaluation	Optimization
7	M. Asimow Engineering Design Process (1972)	Feasibility	-	Preliminary Design	Detailed Design Planning	-
8	Riba Architecture Service (1972)	Inception	Feasibility	Outline Proposal Schematic Design Detail Design	-	Production Tender Action Project Planning Completion Feedback
9	G. T. Moore's Design Process (1974)	Identify Problem	Programming or Analysis of User Requirements	Synthesis	Choosing From Alternatives	Post Occupancy Evaluation Implementation
10	Five-Step Design Process (Snyder, 1979)	Initiation	Preparation	Proposal	Evaluation	Action
11	Gavin Ambrose & Paul Harris (2009)	Define and Research	Ideate	Prototype	Select and implement	Learn
12	AIA Basic and Supplementary Services (AIA)	Predesign Services	-	Schematic Design	Design Development	Contract Documents Bidding Administration Of Contract Post Design Service

By a deep comparison of the defined stages of design process, we can find the common places in some cells of the table. One of the main features of the table is seemingly the united opinion about the final stages. The

disagreement seems to be for the second and third parts of the design process. To find the most and accurate understanding of the explanation, an analysis and summarizing process got done as below:

Design Process Stages Analysis					
	Main Topic 1	Main Topic 2	Main Topic 3	Main Topic 4	Main Topic 5
1	Accumulation of Data		Separation of Main concept or Method	Form Development	Presentation of Solution
2	Program Formulation	Investigation Assessment of Design Possibilities	Create	Refinement	Presentation
3	Basic definition Preliminary Program	Investigation, Analysis Program Abstraction	Synthesis and development volumetric design proposal	Reevaluation and Modification	-
4	Problem Identification	Collect and analyze information	Workout solution	Solution assessment	Implement and Communicate
5	Recognition definition	Preparation Analysis	Synthesis	Evaluation	Execution
6	Idea	Information Analysis	Synthesis	Evaluation	Optimization
7	Feasibility	-	Preliminary design	Detailed design planning	-
8	Inception	Feasibility	Outline Proposals schematic design Detail design	-	Production, Tender, Action, Project planning, Completion, Feedback
9	Identify Problem	Programing or analysis of User Requirements	Synthesis	Choosing form alternatives	Post occupancy evaluation, Implementation
10	Initiation	Prparation	Proposal	Evaluation	Action
11	Define and Research	Ideate	Prototype	Select and Implement	Learn
12	Pre design Services	-	Schematic design	Design development	Contract, Documents, Bidding, Administration of Contract, Post design service

Figure 16 Design Process Stages Analysis

It appears that some of the design stages in the above table correspond to the views of the relevant theorist, with different degrees of emphasis or delay compared to other stages. Considering the meanings conveyed in each stage, if we intend to introduce a new classification in the design process based on the concept's meaning and its hierarchical nature, we must make adjustments in the table. Therefore, in the above table, concepts with the same meanings, regardless of their position in the design stages, have been distinguished with a specific color. Consequently, in the table below, common concepts corresponding to the stage they can be addressed in have been categorized under the relevant stage. Each of the main topics can symbolize a stage in the design process, and the phrases listed under them represent a set of actions that can be undertaken in that stage.

Design Process Stages Analysis					
	Main Topic 1	Main Topic 2	Main Topic 3	Main Topic 4	Main Topic 5
1	Accumulation of Data	Collect and analyze information	Separation of Main concepor Method	Form Development	Presentation of Solution
2	Feasibility	Feasibility	Outline Proposals schematic design Detail design	Refinement	Presentation
3	Program Formulation	Investigation Assessment of Design Possibilities	Synthesis and development volumetric design proposal	Design development	
4	Basic definition Preliminary Program	Investigation, Analysis Program Abstraction	Synthesis	Evaluation	Optimization
5	Problem Identification	Programing or analysis of User Requirements	Synthesis	Evaluation	Contract, Documents, Bidding, Administration of Contract, Post design service
6	Recognition definition	Information Analysis	Synthesis	Evaluation	Implement and Communicate
7	Identify Problem	Prparation	Create	Reevaluation and Modification	Execution
8	Define and Research	Preparation Analysis	Workout solution	Solution assessment	Production, Tender, Action, Project planning, Completion, Feedback
9	Idea	Ideate	Preliminary design	Choosing form alternatives	Post occupancy evaluation, Implementation
10	Inception		Proposal	Select and Implement	Action
11	Initiation		Prototype	Detailed design planning	Learn
12	Pre design Services	-	Schematic design		

Figure 17 Design Process Stages Analysis

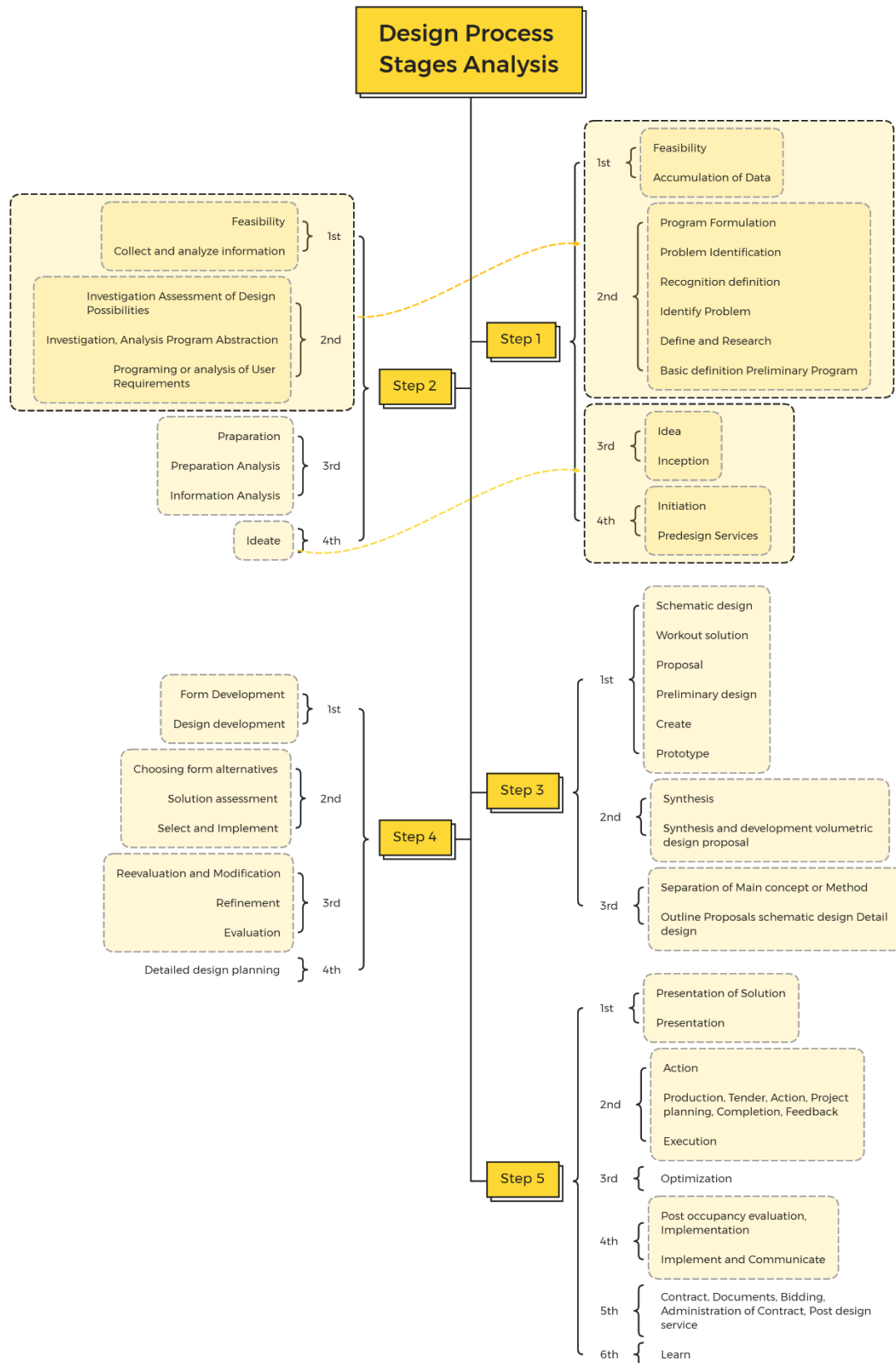


Figure 18 Based on the previous table, it is possible to define steps for the design process, including several related activities.

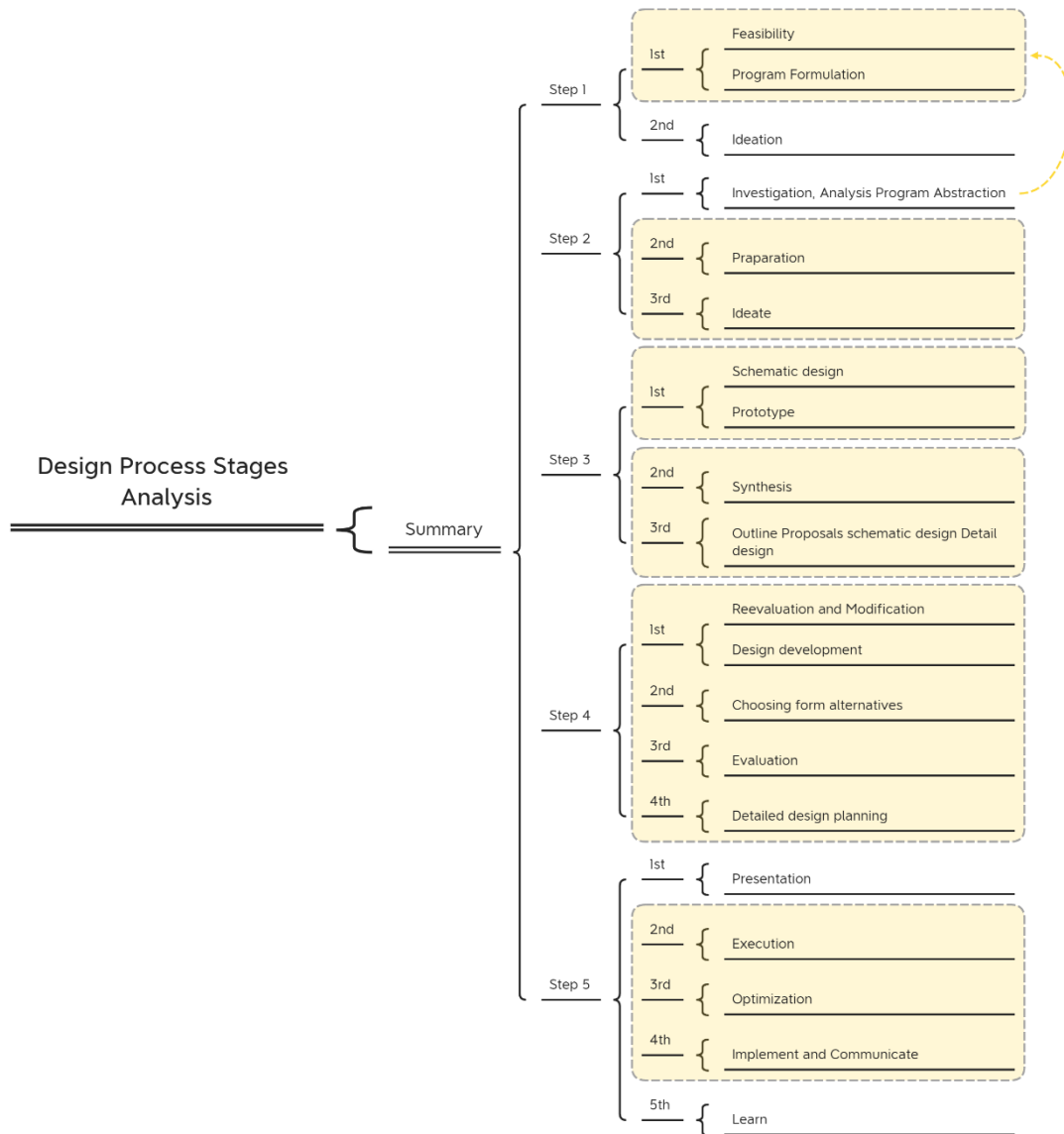


Figure 19 Design Process Stages categorization based on meaning

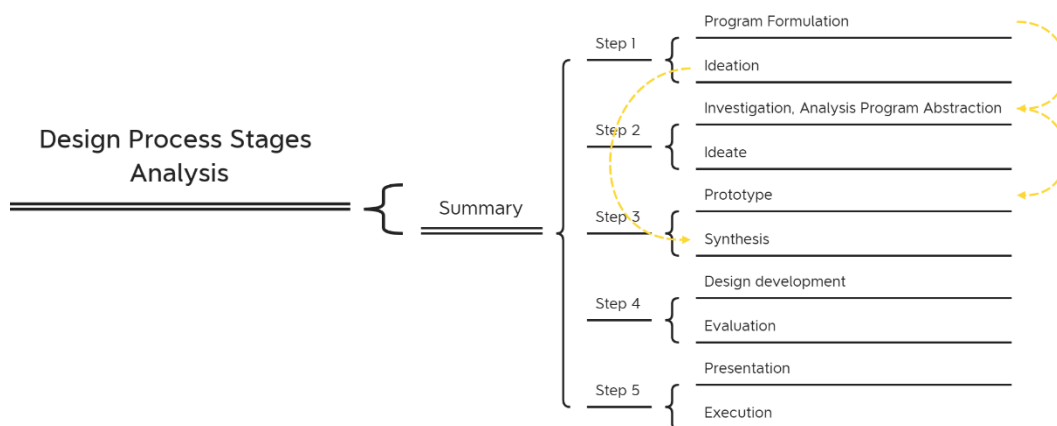


Figure 20 Summary of Design Process Stages in 5 steps

The initial steps of the design is agreed by most expert to be the understanding of the design problem. Deeper understanding of the design problem is probably leading to a higher quality result.

The disagreements seem to be more on the second and third steps of the process. It seems like two different scenarios are going to work in this work.

The first which start with investigation, is more likely to be a rational design process, which in the next levels gets continued rationally, and keeps the design process in the path of investigation.

The second which may even start by an idea is seemingly to be a more intuitive process, and the second and third steps of the design gets repeated over and over in this style.

Finally, whatever process has led to design, the final result should be presented and executed of course.

The comparison of all different stages in the same column, it's understandable that they are repeating the same language in different words which means that the root of all is a linear process and this process most of the time creates an end-product. Based on review of traditional models it could be admitted that:

1. The methods are repeating same or equivalent steps with differing in keywords.
2. Most of the procedures for design are illustrated as linear processes.
3. There boundaries of the stages are strict, and the procedures are not flexible enough
4. There is no specification for scale of the project
5. These methods are behaving design as research problem solving with narrowing down in details step by step and packing previous stages as they are finished.
6. They seem to be out of control by increasing complexity and the scale of project ⁸⁴
7. The realm of management is more dominant on these processes rather than architectural footprint.
8. They seem to have been derived more by thinking about design than by experimentally observing it, and characteristically they are logical ⁸⁵

⁸⁴ Osterhuis, K. (2012). Simply complex, toward a new kind of building. *Frontiers of Architectural Research*, 1(4), 411-420.
<http://dx.doi.org/10.1016/j.foar.2012.08.003>

⁸⁵ Lawson, B. (2006). *How Designers Think: The Design Process Demystified*. Architectural Press, Oxford: Routledge.

9. In the traditional design process framework the tools and methodologies are invisible and unreadable

10. The solutions that arise from the synthesis stage of the design process, most of the time are incomplete, may not indicate all the necessities, and they must be evaluated rationally in the evaluation stage⁸⁶⁸⁷

Concerning the design process, various theorists introduced processes that include 3 to 5 stages, which are mentioned in table (2). Each of these processes has been explained using a specific term that, according to its theorist, represents a design behavior or a stage of the design process. According to the concepts used for each stage, if we could have a broader view of all of these stages in general and together, It seems that some of these steps, although represented in the same stage by different theorists, have significant differences in terms of meaning, which causes a distinctive hierarchy. In such a way that if we combine all the commonalities of these steps and consider the steps that are semantically on the same level as a single step and then depict all the steps on a timeline, We will have approximately ten stages, each of which has a specific place on the timeline.

The fact that some theorists ignored some stages or did not consider them means that they either assumed it to be a part of a certain stage and integrated it with the phase before or after it, or in the design process, they made that stage intuitively and imperceptibly. An untraceable and unconscious reaction took place that could not be expressed. Based on these ten steps, we can consider the design process from beginning to end as a general path. As mentioned, a designer may not use some of these steps or have simultaneous or parallel operations in his design activity or design thinking. Therefore, there cannot be any fixed process in examining the process of professional designers as a codified movement. But in the context of education, the problem is entirely different. In the implementation of training processes, it is necessary to propose a hierarchy to start a design process. Therefore, setting such a timeline can be a guide.

Another visible issue deduced from table (2) and displayed in the diagram depicted in figure (21) is that we are faced with two genres that show two different types of thinking in the design process. The terms that are more indicative of analytical thinking and the terms that represent intuitive thinking. Although an expert designer may switch from one mode of thinking to another mode of thinking in his design process in different periods of time, in general, the classification of designers or design processes into two spectrums, intuitive and analytical, is not far from

⁸⁶ Jeong, S. K., & Ban, Y. U. (2011). Computational algorithms to evaluate design solutions using Space Syntax. *Computer-Aided Design*, 43(6), 664-676. <http://dx.doi.org/10.1016/j.cad.2011.02.011>

⁸⁷ Chokhachian, A., & Atun, R. A. (2014). A framework for exploring the role of parametric design on design procedure. In *Unspoken Issues in Architectural Education - International Conference*, 2014.

expected (requires a reference). In the meantime, what is more, indispensable in this research is the significant aspects of the place of intuitive thinking in the design process, which the architecture education system has neglected, or it has not had the proper tools to teach and practice this way of thinking, or over time and With the development of new educational procedures as stated in the first chapter, it has lost it. Educational processes that enable the architect to make significant intuitive decisions in addition to analytical categories.

Design operations in the design process can be divided into two main branches that co-occur and overlap during the design process. As mentioned in passing, one is design thinking, and the other is a design activity. While examining these concepts, this research intends to analyze the place of intuition in architectural design so that we can fulfill the clear need in the field of design education and develop exercises to improve the level of intuitive knowledge or intuitive behavior of students.

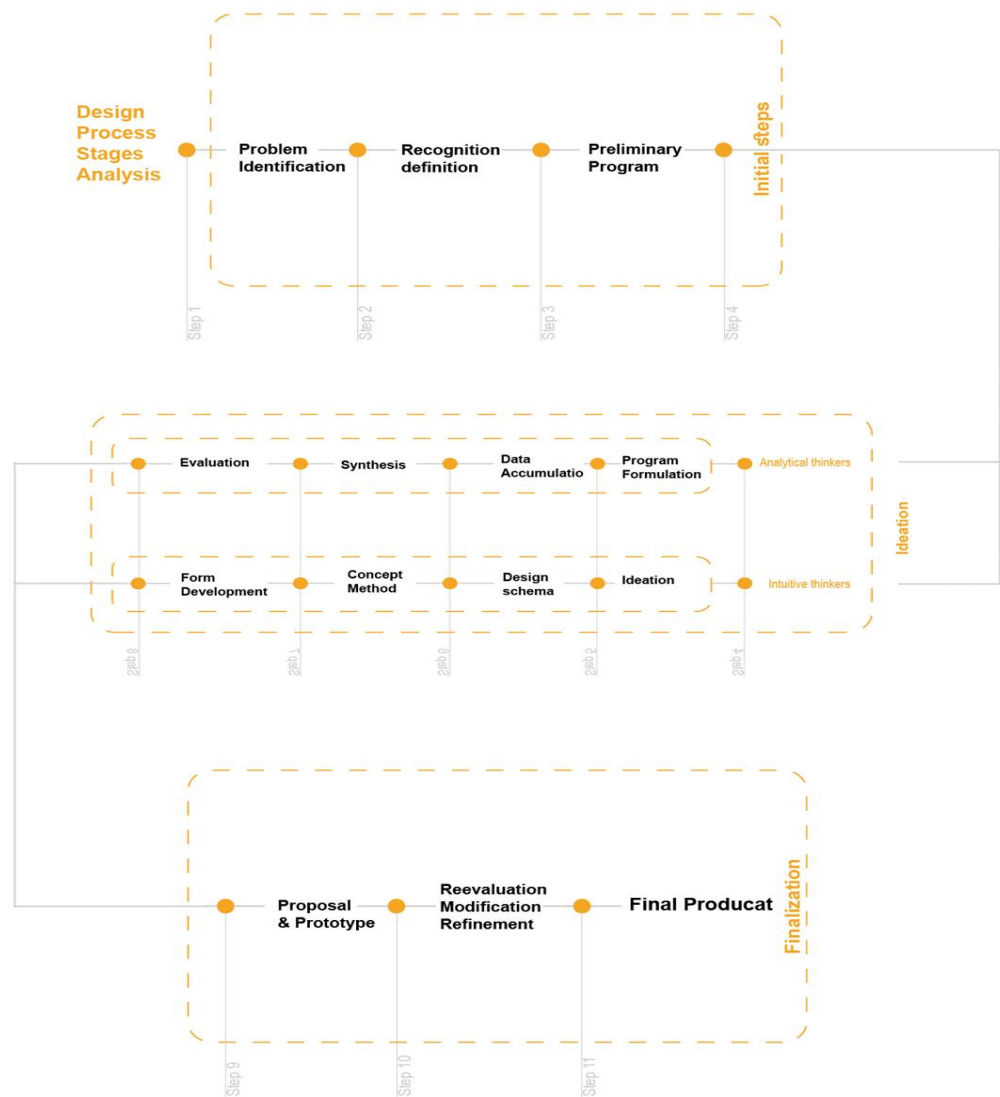


Figure 21 Different trajectory of Design Process between intuitive and analytic mindset

What has been considered in this research in relation to the design issue is the intuitive attitude towards the design process, as this issue can be traced in the academic scale, many academic programs unintentionally triggered students to think logically and analytically instead of intuitively. According to Nigel Cross and many theorists in the design field, the most important factors of the design process are extracted from outside the design realm. The fact that numerous designers and architects are not verbally able to trace their actual design process is proof of intuitive reflection in their design activity. One reason academia has ignored intuition in their pedagogies is the instructors' fear of the inherent and intangible quiddity of the intuition issue, making it unteachable and impracticable. Whereas based on psychological investigations in this context, it has been proven that not only intuition is a consequence of innumerable experiences and vast knowledge in a particular field, but also it is possible to practice and learn how to think intuitively. This research investigates the role of intuition and imagination in the architectural design field and suggests following a more intuitive and imaginative design practice in the architecture design studio. All in all we can summarize that we are looking for intuition and imagination in the design process, investigate it thoroughly. Afterwards we intend to find design practices which fosters intuition and imagination in the architecture design studio.

2-2. Design thinking

In order to have more categorized perception of the design thinking and its maturity process theoretical aspects could be divided into five categories, recognized as to have clear backgrounds and distinguished academic and theoretic backgrounds following, with the foundational works:

1. Design thinking, the artifacts materializer ⁸⁸

The idea of artificial for the first time founded by Herbert Simon (1916–2001) and his research was extended from computer sciences into cognitive problem-solving procedures. Simon assumed that design should include all of the conscious events or activities in order to create artifacts and therefore he distinguished design from social and natural sciences, but not from engineering discourse. He believed that the design has to be about creation, while other sciences are dealing with currently existing facts. His idea about —the science of the artificial|| was a kind of investigative approach toward design profession that opened footprints of research to design. His viewpoint on the design was in a way that he believed the **design is a system to transform existing conditions into preferred ones**⁸⁹. There

⁸⁸ Simon, H. A. (1969). *The Sciences of the Artificial*. MIT Press.

⁸⁹ *ibid*

are some critical writings about Simon's ideas, because he has distinguished the activities that create or generate something new and activating which are dealing with present reality, but at the same time he didn't put clear reference on artistic creation and engineering. The difference between engineer and designer way of thinking which is sometimes problematizing in practice is not considered by Simon's manifestations ⁹⁰

2. Design thinking, the reflexive practice ⁹¹

The theoretical framework of —the reflective practitioner|| is introduced by Donald Schön (1930–1997) by focusing on logics of invention. He has considered the role of technical knowledge in contrast with artistry mediums. In contrast to Simon's ideas Schön illustrated the picture of design as a practice-based activity with the emphasize on the relation of creation and reflection. The practice-based methodology toward design was not something to be detachable from the work of architects and also has some managerial notions, too (Bousbaci, 2008; Dorst, 1997) ⁹²⁹³. Schön believes that a designer is one who —converts indeterminate situations to determinate ones|| (Schön, 27 1983). ⁹⁴In order to have comparison of Simon and Schön's ideas, Simon created an objective framework for the field of design and design thinking, while on the other hand Schön emphasizes it with explanations of designers in practice.

Buchanan (1992) has another perspective on design thinking as a matter of **dealing with wicked problems with an essential vagueness and without any single answer as solution**. Buchanan introduced the concept of contextualization and placement as a tool for purposely generating and shaping design conditions. Also, this perspective on design opens a platform for collaborative design by means of bringing user into the design process. As Wylant (2010) admits: —Design thinking is the discipline of cycling through many contextual exercises of placements to understand how sense can be made of something and given this, the designer is then in a position to choose which contexts should dominate and the manner in which they should||. Buchanan's process based perspective helped to achieve better understanding of design thinking in a progressively complex technological environment. He proposes four diverse areas of design thinking as rooms of interventions that problems and solutions could be possibility reconsidered:

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⁹⁰ Johansson-Sköldberg, U., Woodilla, J., & Çetinkaya, M. (2013). Design Thinking: Past, Present and Possible Futures. *Creativity and Innovation Management*, 22(2), 121-146. <https://doi.org/10.1111/caim.12023>

⁹¹ Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Basic Books.

⁹² Bousbaci, R. (2008). "Models of Man" in Design Thinking: The "Bounded Rationality" Episode. *Design Issues*, 24(4), 38-52. <https://doi.org/10.1162/desi.2008.24.4.38>

⁹³ Dorst, K. (1997). *Describing Design: A Comparison of Paradigms*. Delft Institute of Technology.

⁹⁴ Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Basic Books.

⁹⁵ Buchanan, R. (1992). Wicked problems in design thinking. *Design issues*, 8(2), 5-21.

- Symbolic and visual communications (or graphic design)
- Material objects (or industrial design)
- Activities and organizational services (or service design)
- Complex systems or environments for living, working, playing and learning (or interaction design). This classification is going to be one of the basic platforms of proposed parametric design thinking procedure model in chapter 4.

3. Design thinking, the problem-solving action ⁹⁶

Cross and Lawson are both scholars in design thinking discourses from reflective and practical point of views but at the same time they have some dissimilarities in their ideas. Cross mainly is focused on what the designers are **doing all through the design procedure**, however, Lawson emphasizes the **psychology of creativity** during design process. They both have a kind of **practice-based ideas** rather than philosophical standpoints. Also, they have logical processes and understanding to make generalization from observation and creating patterns through practical experiences and substantially could be redefined practically in design. But finally, both of them suggest a —modell of the design process: and in both perspectives the realm of process based attitude is extractable

4. Designerly Thinking, Practice-Based activity and mode of cognitive approach ⁹⁷

Bruce Archer introduced the concept of a "Designerly way of thinking" to establish design as a distinct discipline with its own intellectual foundation. He described it as a unique approach characterized by creativity, visual reasoning, and problem-solving through making and doing. It focuses on addressing complex, "wicked" problems by synthesizing diverse elements into practical solutions. Central to this method is a human-centered approach, emphasizing empathy, user needs, and tacit knowledge gained through practice, such as sketching and prototyping. Archer's work highlighted the importance of visual and material communication, setting design apart from the analytical focus of science and the interpretive nature of the humanities. This concept laid the foundation for modern design thinking and its role in innovation.

5. Design thinking, meaning formation ⁹⁸

A different perspective on design thinking is introduced by Krippendorff (2006) with semantic background. He explains the designer and work of

⁹⁶ Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues*, 8(2), 5-21.

⁹⁷ Cross, N. (2006). *Designerly Ways of Knowing*. Springer.

⁹⁸ Krippendorff, K. (2006). *The Semantic Turn: A New Foundation for Design*. Taylor and Francis.

designer as matter of meaning creation rather than artifacts in Simon's view. For Simon the core of design process is creating artifacts, and the meaning is the quality of it, however for Krippendorff the core is creating meaning and the artifact goes as a medium for communication and representation. The semantic approach of Krippendorff has transformed —science for design||, as —a systematic collection of accounts of successful design practices, design methods, and their lessons, however abstract, codified or theorized, whose continuous rearticulation and evaluation within the design community amounts to a self-reflective reproduction of the design profession||⁹⁹ The semantic based method of Krippendorff differentiates it from the practices of Lawson and Cross at the same time. Verganti (2009) has stretched Krippendorff's ideas into innovative processes, deliberating that —innovation in meaning is as imperative as technological innovations that are frequently related to the concept of innovation which can be further study topic in design thinking discourse

Table 3 Comparison of different design thinking theories

Founder	Background	Core Concept	Reflection on Design Activity	Year	Framework
Simon	Economics & Political Science	The Science of The Artificial	Research in Design	1969	Theoretical
Schon	Philosophy & Music	Reflection in Action	Practice-based Design	1983	Practical
Buchanan	Art History	Wicked Problems	Contextualization in design	1992	Contextual
Lawson & Cross	Design & Architecture	Designerly Ways of Knowing	Process-based Design	2006	Cognitive
Krippendorff	Philosophy & Semantics	Creating Meaning	Semantic Based	2006	Semantic

Through all these diverse perspectives in design thinking, it's comprehensible that each point of view indirectly gives a clue about the nature of design in itself. In other words, the previous step on design thinking theories is the **definition of design** where in this discussion has got different coats such as **theoretical, practical, contextual, cognitive and semantic** (Table 2)

In more contemporary field of design thinking, Nigel Cross (2011), a prominent design researcher and the author of —Design thinking: Understanding How Designers Think and Work||, has updated his sentiments and come up with some valuable descriptors. Some of the feedback are discussed below in order to create a comprehensive system for design

⁹⁹Ibid.

thinking. 30 The first one is dealing with the emergence of design thinking. The directions taken during the investigation of the design problem are influenced by what is learned during the procedure, and by the limited overview of what might happen ahead. Features appear as unclear ideas for resolving a design problem; in other words, both problem and solution develop together. Design thinking is opportunistic which means the route of exploration cannot be projected in advance. Secondly, design thinking is reflective as Donald Schön admitted. A designer's thinking processes seem as centralized around the correlation of internal mental procedures and their external appearance which is an action and reflection procedure similar to cause and effect model. **The designer uses a medium, which might be a sketch or a three-dimensional model that enables half shaped ideas to be articulated and to be reflected upon and developed, revised, reviewed, rejected, considered or retreated.** Next, design thinking should be considered as a co-evolutionary method. It's hard to understand a design problem without engaging ourselves in its investigation and progress. In other words, our ideas help us to understand the problem accurately gives clues to our ideas pursue to address. Conversely, we need to understand something of a design problem before we can bring our creative and systematic design thinking to bear. The design problem and the design solution grow and become mature accordingly. As a final point, there is no need to have a global language for design, but we need to strengthen our global design conversation. We could learn so much from users and designers in other parts of the world if we develop a multi-cultural system of thinking. There is a necessity to give more importance to the user, which means to create solutions from a user-need outlook rather than through the conventional method of questioning a potential market. Having that attitude will help us use design thinking as a more-balanced system to creative results ¹⁰⁰

In order to highlight the importance of design thinking in problem solving Kees Dorst (2011) compares two different problem-solving methods in logical and predictable ways. And he highlights the patterns that we are using in problem solving with diverse settings but similar rules. He shows a simple equation that we use to identify, predicts, and prove or to derive as a conclusion from something known or assumed we act as below:

What (The Elements) + **How** (Operation Principles) = **RESULT** (Observation)

In this kind of framework, we know the elements, also we have the rules and principles that how they will affect each other we will be able to predict the result. For instance, in computer applications, if we create a box and we

¹⁰⁰ Collins, H. (2013). Can Design Thinking Still Add Value? Design Management Review, 24(2), 35-39. <https://doi.org/10.1111/drev.10239>

know the component which transforms it, then by applying the forces we will be able to predict and observe the outcome. (This is called deduction)

Now consider a situation that we have two images one is the form before transformation (the element) and the other is the form after transformation (the result) but we don't know the HOW, the components and rules that create this transformation. In this case recommending of working principles that can explain the outcome and perceived behavior as a hypothesis will be a creative approach. (This is called induction)

This perspective to problem solving was the core context of discovery in science and was the clue that hypothesis was formed and after being experimented to falsify or accept them. This form of analytical and logical reasoning helps us to forecast and clarify phenomena in the world.¹⁰¹ By means of explained equations, now we are going to discuss that why design cannot be a distinct process and needs more systematic way of thinking and application.¹⁰²

2-3. Design Activity

Design activity involves endowing form and ensuring functionality of a given product. The function of many products depends on devices that modify force or motion and consist of a number of interrelated units.¹⁰³

To meet a design requirement, the designer needs to conceive a form and express the connectivity of its parts in order to meet the desired goal. A proportion of the mental sculpting involved is geometric in nature because shape often permits the achievement of a given function. The design procedures presented here follow this approach, with an initial proposal for the geometric configuration followed by analysis to justify the proposal or provide guidance for its modification. Boden (1990) discusses creativity in terms of the connection of conceptual spaces in the mind. In order to create a design, it is often necessary to combine ideas from different fields or disciplines. This may or may not take place as part of a structured design procedure or in a prescribed time period. Over-reliance on procedure should, in some cases, actually be guarded against, as this may stymie the activity.¹⁰⁴

¹⁰¹ Dorst, K. (2011). The core of 'design thinking' and its application. *Design Studies*, 32(6), 521-532.
<https://doi.org/10.1016/j.destud.2011.07.006>

¹⁰² Chokhachian, A. (n.d.). *Studies on Architecture Design Procedure: A Framework for Parametric Design Thinking* (p. 48)

¹⁰³ Childs, P. R. N. (2014). *Mechanical Design Engineering Handbook*. <https://doi.org/10.1016/B978-0-08-097759-1.00004-6>. Elsevier Ltd.

¹⁰⁴ Ibid

The design activity is a framework that breaks down the visualization design process into a series of four design activities: understand, ideate, make, and deploy.¹⁰⁵

In the context of industrial design, Design activity involves endowing form and ensuring functionality of a given product.¹⁰⁶

According to Sim and Duffy¹⁰⁷ the apex of design activities is synthesis. Synthesis is considered here as a compound activity as it involves search, exploration and discovery of design solutions, and composition and integration of these solution.¹⁰⁸

Figure 1, presents a taxonomy of design definition activities in which synthesizing is the result of abstracting and generating design concept(s) and structuring concepts to form a whole.¹⁰⁹

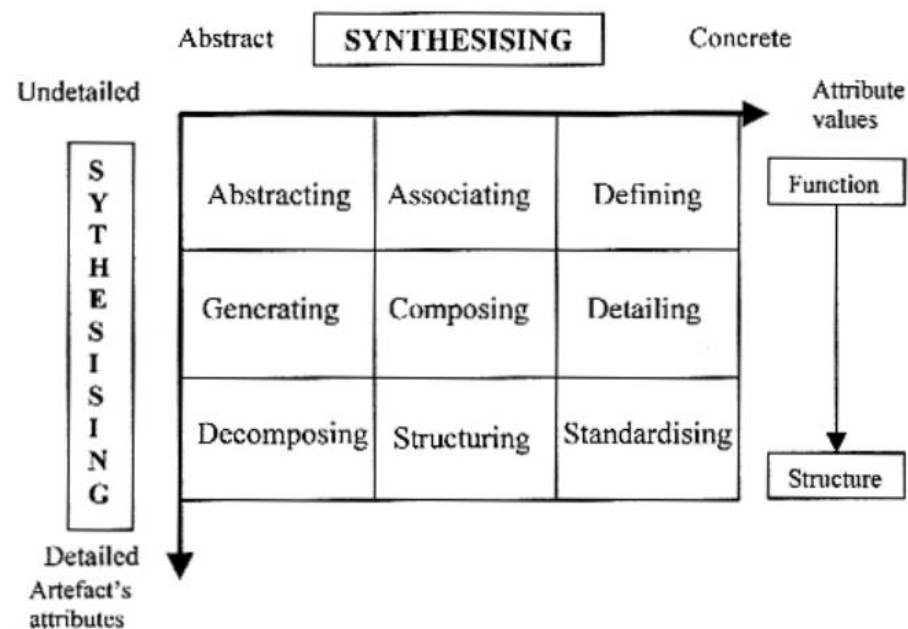


Figure 22 Taxonomy of Design Definition Activities

Obviously, design activity consists of codified stages that, in the aggregate, help designers externalize their thoughts in the form of tangible quiddity and pave the way for them to achieve solutions. In architecture, this physical gesture is predominantly represented by means of Form, Mock-up, visual content, or verbal explanation. One of the most essential parts of these stages is Ideation, in which designers tend to generate ideas. This Phase

¹⁰⁵ McKenna, S. (2017). The Design Activity Framework: Investigating the Data Visualization Design Process [Ph.D. dissertation, University of Utah].

¹⁰⁶ Childs, P. R. N. (2014). In Mechanical Design Engineering Handbook. Elsevier Ltd

¹⁰⁷ Sim S.K. and Duffy A.H.B. Towards an ontology of generic engineering design activities. Research in Engineering Design, 2003, 14(4), 205.

¹⁰⁸ Zainal Abidin, S., Christoforidou, D., & Liem, A. (n.d.). Thinking and Re-Thinking Verbal Protocol Analysis in Design Research.

¹⁰⁹ Ibid

entails brainstorming and representing creative alternatives. Hence intuition and imagination are considered a turning point in design activity.

The phrase “ideation” has been defined as the capacity for or the act of forming or entertaining ideas. This seemingly simple phrase can be the most difficult phase of the design process. In fact, the design is mostly shaped in this phase. Maybe the most complicated phase of the

2-4. Position of intuition in design

Intuition, Imagination, Creativity

Indeed, perhaps one of the most important characteristics of expert designers is their ability to approach challenging and ambiguous projects with optimism and confidence, adapting to changing constraints with the ability to make real-time aesthetic (i.e., feeling-based) judgments. Numerous authors have emphasized the importance of intuition in the processes of design, including perspectives drawn from industrial design,¹¹⁰ engineering¹¹¹, mathematics¹¹², etc. In a systematic analysis of interviews with Nobel laureates in physics, chemistry, and medicine, for example, Marton et al. describe scientific intuition as “characterized as having a certitude based on a feeling or a perception of almost aesthetic or quasi-sensory nature... [It] seems to develop through extended and varied experiences of the object of research and is apparently based on an initially vague, global, not fully conscious, anticipatory perception of the solution searched for”¹¹³. In generative design activities where, envisioning possible alternative futures is the goal of the research process, intuition plays an essential role as it allows “a simultaneous grasp of the whole, well in advances of knowing its parts in detail.”

Suri observes that the ultimate intent of all design research is “to expose patterns underlying the rich reality of people’s behaviors and experiences, to explore reactions to probes and prototypes, and to shed light on the unknown through iterative hypothesis and experiment.”¹¹⁴ Indeed, the intuitive nature of design activity involves constant reflection on the process of making throughout the design research activity [18, 46]. In this regard intuitive design is a process of intentional self-leadership that both inspires imagination and informs how individuals interact in the world¹¹⁵.

¹¹⁰ Tovey, M. (1997). Styling and design: intuition and analysis in industrial design. *Design Studies*, 18(1).

¹¹¹ Faste, R. (1995). The Role of Aesthetics in Engineering. *Japan Society of Mechanical Engineers (JSME) Journal*.

¹¹² Burawoy, M. (1998). The Extended Case Method. *Sociological Theory*, 16(1), 4-33.

¹¹³ Maritain, J. (1953). *Creative Intuition in Art and Poetry*. Pantheon Books.

¹¹⁴ Spinoza, B. (1677). *Ethics*

¹¹⁵ Searle, J. (1983). *Intentionality: An Essay in the Philosophy of Mind*. Cambridge University Press.

Intuition in design practice

Intuition is a reflexive and innate kind of knowing, a form of inner guidance responsive to insights arising from the synthesis of inward and outward focus [13]. Intuitive thought emerges through a subconscious **“scanning” of the senses**: externally through our embodied perceptions, and internally as a kind of pre-cognitive experience beyond rational or verbal awareness. Yet while intuition may be defined in this way as subconscious and **“unaware”** experience, it can also be understood as a conscious and reflective act of assessing the results of an action performed. In this second sense, intuition is understood as a rational and highly cognitive activity. Our concept of intuition shall be kept somewhat flexible to include both the constructive and evaluative processes of subconscious intuition as well as its reflective nuances as a conscious act.

Most researchers agree that intuitive events originate beyond consciousness, process information holistically, and involve perceptions that are frequently accompanied by emotion (e.g., feeling uplifted, or anxious). People who score high on intuition in psychological tests also tend to score high on creativity and divergent thinking¹¹⁶, critical attributes for design practice and creativity training¹¹⁷. Dane and Pratt identify three kinds of intuition that may explain its importance to human evolution: problem solving intuition, moral intuition, and creative intuition¹¹⁸. We feel that a finely tuned sense of intuition underlies the best design practices in each case, in part because designers both learn and innately experience what others have not yet experienced through the act of creating and sensing the results of a given design. In doing so they hone the conscious ability to engage in intuitive insight, affective cognition, and the openness to extra-rational modes of thinking and bodily awareness that are necessary for aesthetic judgment and the perception of quality¹¹⁹. **Intuition is also central to creative motivation**, since, as Thomson writes, the creative individual’s “psych neurobiological capacity to flexibly and dynamically shift states enables heightened intuitive processing that directly informs the inspiration process.”¹²⁰

The power of intuition is magnified in practice through constant cycles of expression and testing that validate or contradict our intuitive knowing

¹¹⁶ Thomson, P. (2006). Are the Muses Real? Intuitive Inspiration, Possession and Dissociation. In J. Fisher (Ed.), Technologies of Intuition. YYZBooks.

¹¹⁷ Rode, J. (2011). Reflexivity in Digital Anthropology. In Proceedings of the Conference on Human Factors in Computing Systems (CHI 2011).

¹¹⁸ Dane, E., & Pratt, M. G. (2009). Conceptualizing and Measuring Intuition: A Review of Recent Trends. International Review of Industrial and Organizational Psychology, 24.

¹¹⁹ Faste, R. (1995). The Role of Aesthetics in Engineering. Japan Society of Mechanical Engineers (JSME) Journal.

¹²⁰ Thomson, P. (2006). Are the Muses Real? Intuitive Inspiration, Possession and Dissociation. In J. Fisher (Ed.), Technologies of Intuition. YYZBooks.

and facilitate learning¹²¹. Schön has identified two primary ways in which designers reflect on these intentional processes of making: reflection in action (insight gained through the action of performing design activity), and reflection on action (insight gained by stepping away and assessing the results of that activity)¹²². By combining these two approaches, designers draw on their internal, intuitive, best guess judgments about how and what course of action to pursue. In this regard sketching is both a mechanism for seeing and imagining previously unrealized solutions¹²³. Learning to become aware of and trust in these inner motivations is central to the reflective mindset necessary in the performance of a task that best accomplishes the designer's goals¹²⁴. In other words, a designer's aptitudes are shaped by their reflective and iterative application of intuitive methods.

In the design architecture studio in academy, different design studios, with different professors are not helping students in finding their ways towards principals in architecture. This makes reflection difficult for the students, especially the freshman students. To be forced to practice the design problem in the design studio, makes the design practice more difficult and time consuming which makes the design practice less generative. This process does not completely help students find their way towards intuition.

To know that they are making the right decisions, designers must be confident trusting their intuitive knowledge and have fluency when performing the necessary subjective judgments enabling creative discovery and evaluation¹²⁵. **Among the primary ways that designers accomplish this is by creating tentative "sketches" of possible designs to evaluate their potential as useful and usable eventual outcomes.** Buxton identifies two primary aims of sketching behavior in design: generating as many different ideas as possible to make sure that the designer is "making the right thing," and iterative cycles of prototyping development to increase the fidelity of a design such that the designer can be sure that they are "making it right."¹²⁶



Figure 23 Interpretation of Sketching act in Design

¹²¹ McKim, R. (1972). Experiences in Visual Thinking. Brooks/Cole.

¹²² Petitmengin-Peugeot, C. (1999). The Intuitive Experience. Journal of Consciousness Studies, 6(2-3), 43-77.

¹²³ McKim, R. (1972). Experiences in Visual Thinking. Brooks/Cole.

¹²⁴ Noë, A. (2005). Action in Perception: Representation and Mind. MIT Press.

¹²⁵ Osborn, A. F. (1953). Applied Imagination. Scribner.

¹²⁶ Buxton, B. (2007), Sketching User Experiences: Getting the Design Right and the Right Design, Morgan Kaufmann Publication

Both types of behavior can be considered cognitive mechanisms used by the designers to ensure that a landscape of possibilities has been explored and the “best” option(s) pursued. Through iterative processes of expressing and developing numerous such designs, possible solutions can be experienced first-hand by the designer and key stakeholders, and the most important perceived features (and failures) of the design can be identified and addressed.

In time, such practices lead to a highly trained sense of **generative intuition regarding the aesthetics of form**, as well as a heightened and critical attunement to empathy—the synthetic intuition of others’ feelings.¹²⁷

To summarize, intuition is a critical aspect of design expertise. While intuition in design is generally described as an innate and automatic skill, we believe it is more appropriately framed as an ability that may be learned through experiential practice. This is true in both generative and evaluative aspects of the design process. The framework presented in Figure 1 highlights the role intuition plays as an internal aid in both divergent and convergent design activities.

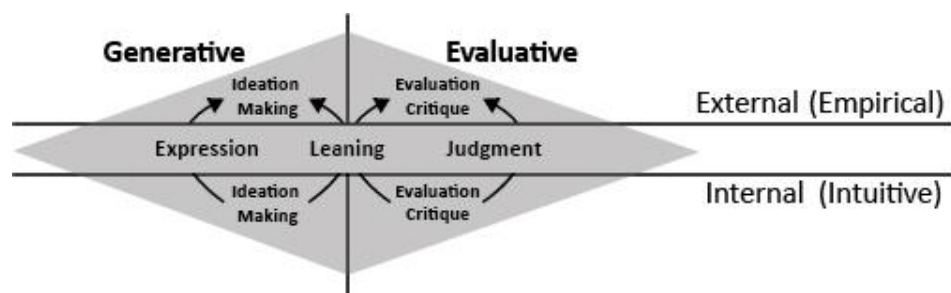


Figure 24 Experienced designers leverage intuition to guide both expressive and judgmental acts. Over time, intuition is learned.

Binder et al. note that design action is performative in that involves expressive and experiential processes of awareness; they write “Ways of gaining knowledge that some might refer to as techniques need to be invented anew every time: they do not exist as entities independent from the individuals and groups of people who perform them.”¹²⁸ Kuutti et al. have emphasized that there is a difference between what can be known by an external observer and one involved in an activity, for example, and that acting in concrete situations is a valid form of producing new knowledge¹²⁹.

¹²⁷ Glegg, G. (1969). *The Design of Design*. Cambridge University Press.

¹²⁸ Binder, T., De Michelis, G., Ehn, P., Jacucci, G., Linde, P., & Wagner, I. (2011). *Design Things*. MIT Press.

¹²⁹ Kuutti, K., Iacucci, G., & Iacucci, C. (2002). Acting to know: Improving creativity in the design of mobile services by using performances. In *Proceedings of Creativity & Cognition*.

Second, building on the previous point, we believe that quality design practice is essential for quality design outcomes, and **intuition is a well-established mechanism for successful design practice and scientific discovery**. Dourish emphasizes that tacit design knowledge applies generally to situations in which we understand “**what to do**” **without being able to express “how to do it.”**¹³⁰ Zimmerman et al. observe that design research is essentially practice-based action as it is realized through the practice of doing design¹³¹. Given this, it seems reasonable that research on intuition can and should directly incorporate intuitive methods. Our aim was to structure the performance of an iterative design task in such a way as to capture and document the internal and intuitive decision-making processes confronted by the designer in practice. We believe it is essential for designers to practice and learn directly from their work, and HCI researchers are no exception.

Human-self interaction

Self-reflection is an essential aspect of creative design. Yet while it is routinely acknowledged and studied in HCI design research¹³², intuition itself is seldom addressed in HCI literature independent from the influence of external reflection and feedback. Indeed, most discussions of reflectivity in design center on user testing or other forms of social engagement, such as participatory design or cultural probes¹³³. Design students and educators are quite familiar with the role of “**critique**” as an educational practice that is used to enhance reflection on design practice and teach critical thinking, for example. Clearly such reflective practices are critical to enhancing the use of successful designs, allowing technology to shape and to scale “external” or distributed cognition, as with crowdsourcing systems for instance.

On one hand **intuition** has been defined as “**reflexive knowing**” (a kind of precognitive experience beyond rational and verbal awareness), and on the other it involves what could be understood in a Schönean sense as the combining of “**reflection in action**” and “**reflection on action**,” a reflexive stepping away and assessing the results of design activity. In practice we believe it is very difficult to separate these two intuitive modes, since what we do is informed by our guiding “inner voice,” which itself is an intuitive response to the perceptual/cognitive situation presented.

¹³⁰ Dourish, P. (2001). *Where the Action Is: The Foundations of Embodied Interaction*. MIT Press.

¹³¹ Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010). An Analysis and Critique of Research through Design. In *Proceedings of Designing Interactive Systems*.

¹³² Fleck, R., & Fitzpatrick, G. (2010). Reflecting on Reflection: Framing a Design Landscape. In *Proceedings of the Australasian Computer-Human Interaction Conference (OZCHI 2010)*.

¹³³ Gaver, B., Dunne, T., & Pacenti, E. (1998). Cultural Probes. *Interactions*, 6(1), 21-29.

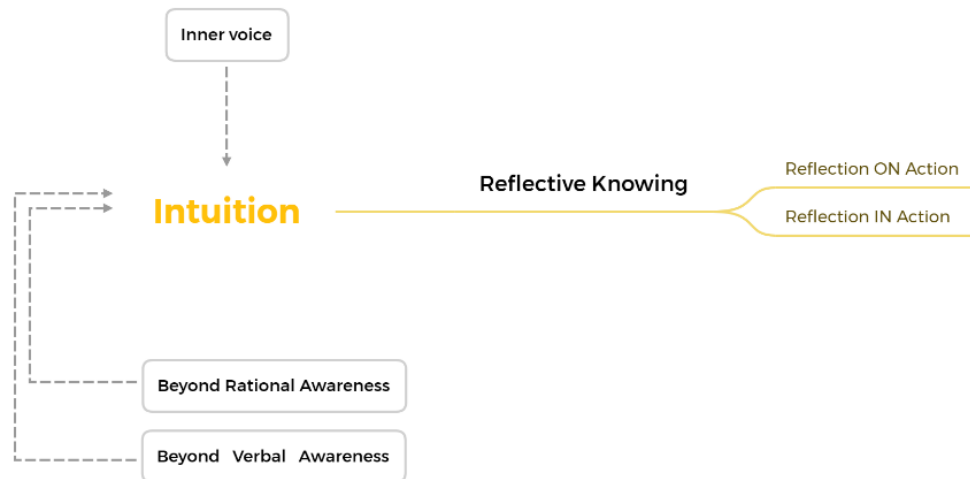


Figure 25 Different states of emerging intuition

As the diagram presented in Figure 1 represented, what we learn from the world affects our intuitive actions or “inner” response. Moreover, we have used the notion of intuition interchangeably to refer to both generative activities and evaluative activities, which could be perceived as two rather different acts of consciousness. Or are they? We believe suggesting that they are different acts of consciousness is an after-reflection on the nature of intuition, but that in actuality firsthand intuitive experience is both generative and evaluative: it is the generation of an intent based on an (internal) evaluation about what to intend. We acknowledge our framing of these issues has involved substantial methodological prescriptions, but in practical terms, for the designer making an intuitive impulse, reflective action and perception are tightly coupled in performance.

Four key motivators that characterized the experienced intuitions were identified: **curiosity**, **efficiency**, **inspiration**, and **insight**, described in greater detail below.

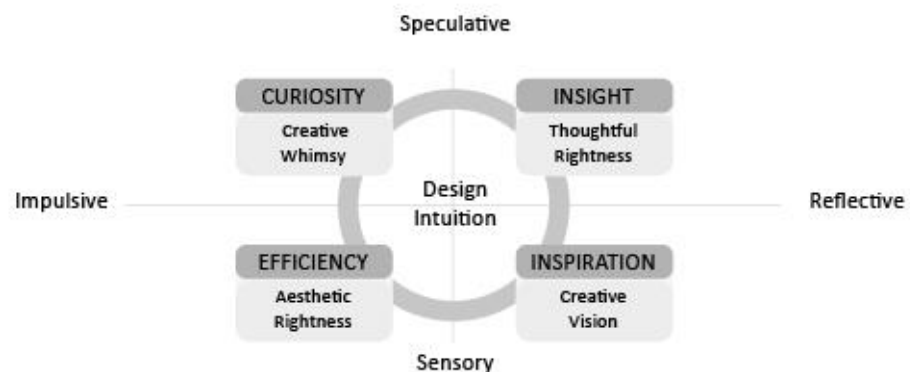


Figure 26 The relation of intuition with: Curiosity, Insight, Efficiency and Inspiration

First, the findings revealed numerous intuitions that were driven by curiosity, or creative whimsy. Curiosity is essential to design intuition as a prompt for speculative and impulsive creative action. This is essential for advancing the design action in the absence of concrete insights or external guidance. Indeed, not only did curiosity drive me to perform this study, it led me to experiment with and re-arrange cardboard pieces, see if it was possible to construct spherical shells, and explore their mathematical complexities. In this regard, the designer's curious impulse to ask, "what if?" Critical motivation is factor in the quest for knowledge. Creative whimsy also allows the navigation of functional constraints, such as a lack of materials or technical setback. When undeterred by a commitment to unknown outcomes, designers are empowered to learn by doing and gain new insights and confidence through design intuition.

Second, **intuition is critical for the efficiency of design** because it allows for "feeling based" aesthetic judgments to be made that allow for immediate action. Such decisions tend to value elegant, holistic solutions that resolve ambiguity and refresh the cognitive stage. In my first and third iterations, for example, the simple introduction of a "finishing detail" cleared the canvas for the next phase of action. The desire for aesthetic "**rightness**" also streamlines the process of design: cutting a full sheet of identical triangles maximizes the pieces while eliminating waste; holding a finished model that "feels right" in the hand is an indication that the mathematical model is good. **Although it sometimes leads to failure on deeper reflection, designers must learn to trust their intuitive aesthetic judgments to maintain creative momentum—the synthesis of alternative courses of action.** These insights are supported by recent design theory; in an examination of the role and development of expertise in design, Cross notes that often design process follows a pattern of 'opportunistic solution development' which has been hypothesized to reduce the cognitive cost of efficient design behavior¹³⁴.

Third, beautifully crafted objects also attract attention and playful interaction, leading to the inspiration necessary to drive creative vision. The intuitive reflection upon sensory stimuli is what motivates the desire to achieve aesthetic rightness. When we are pleased with our accomplishments we are driven to achieve more. At many steps in my process of self-reflection, pleasure was derived from a reflective sensation of what else might be possible. For example: how the sun's drifting shadow, projecting across the cosmos, illuminates the geometry of spherical cardboard and inspires countless possibilities that were previously unsensed; how the shell of the structure could be wrapped in elastic or spandex; how it ought to be possible to create something equivalent to a

¹³⁴ Cross, N. (2004). Expertise in Design: An Overview. *Design Studies*, 25(5).

Hoberman sphere [30] that transforms each face of a cube into a sphere; how scaling this up to an architectural structure would allow the Pompidou to turn into into Epcot center, etc.

Finally, it is **only by drawing on the intuitive knowledge of what has worked in the past that insight can be realized and actualized.**

Insight requires an intuitive struggle to achieve an understanding capable of grasping the “rightness” of the knowing involved. Such intuition provides designers with a means to frame their practice more intelligently through speculative hypothetical questioning and the learning that results. At many points in the sphere project, I advanced blindly into areas with little prior knowledge (e.g., a deep immersion into spherical geometry) and came away with new insights on ways to achieve my goals—whether through the pursuit of new learning or the development of new tools, like improved software features for cutting cardboard that dynamically adjust for material thickness in response to an envisioned 3D form. These intuitions not only enabled the anticipation of future errors, they guided the deeper courses of action necessary for complex design.

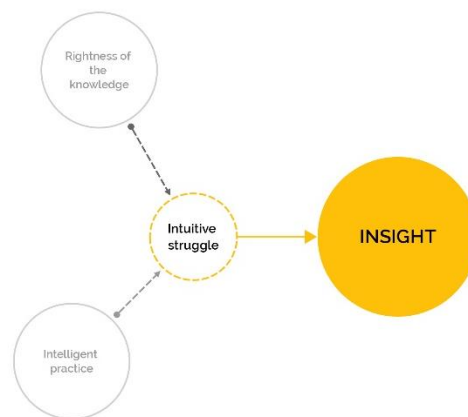


Figure 27 The relation of effective factors on insight

Intuition is the ability to acquire knowledge without the explicit use of reason or inference, and it is “in this immediate, pre-representational and pre-discursive experience of the world that all our cognitive activity seems to be rooted.” In this framing, the design of HCI systems extends beyond computers or systems of people to all intuitive interactions we have with the world—not just with digital tools or with cardboard spheres, but to the differentials of self that we pass to the world we inhabit. Applied to design activity, intuition provides a means for intelligently framing and acting upon immediate options to guide the possibility of their eventual outcome.¹³⁵

¹³⁵ Faste, H. (Year). Intuition in Design: Reflections on the Iterative Aesthetics of Form.

Imagination is a power of the whole of human consciousness that employs **intuition, perception, thinking, and feeling.**



Figure 28 The relation of Imagination with intuition, feeling, perception and thinking

Further information about imagination is provided by writers outside the field of music. Among them are religious thinkers and philosophers, particularly aestheticians. Religious thinkers affirm the importance of imagination in a different way. Imagination is assigned the function of **mediating between appearances and truth**, since it tolerates images that oppose the laws of nature. Kroner (1941) suggests that imagination can both conceive and **generate miracles and myths**. He goes so far as to state that one can come to belief only with the assistance of imagination.

Philosophers, especially aestheticians, also offer various definitions and functions for imagination. For example, Hume views imagination as a distinctive type of thinking and holds that the **data of imagination are ideas**¹³⁶. Kant (1781/1965) writes about "productive" imagination that brings sensation and understanding together creating a "second nature out of the material supplied to it by actual nature" (p. 165). To illustrate, imagination finds ways of representing the arts to members of an audience who in turn use their imaginative power to surpass what is observed or heard¹³⁷. Furthermore, Husserl (1920/1958) holds that while imagination may rely on experiential and perceptual data, it can go beyond these data to non-empirical intuitions that do not stem from sensory existence.

The function of intuition in imagination is also central in the aesthetic of Croce (1922/1965), who considers intuitive knowledge obtained through imagination to be one of the primary forms of knowledge. Intuition includes both unifying perceptions of the real and images of the possible; thus, Croce can say that imagination is the "intellectual intuition of art" (p. 295)

Coleridge (1965/1975) distinguishes between a primary and secondary imagination. Primary imagination is the usual instrument of perception common to all people. Secondary imagination, however, differs in both degree and mode of operation. "It dissolves, diffuses, dissipates, in order to re-create; or where this process is rendered impossible ... it struggles to idealize and unify" (p. 167). Thus, for Coleridge, secondary imagination is

¹³⁶ Wilbanks, J. (1968). Hume's Theory of Imagination. Martinus Nijhoff.

¹³⁷ Warnock, M. (1976). Imagination. University of California Press.

creative or artistic and involves intuition, whereas primary imagination is reproductive and grounded in perception.

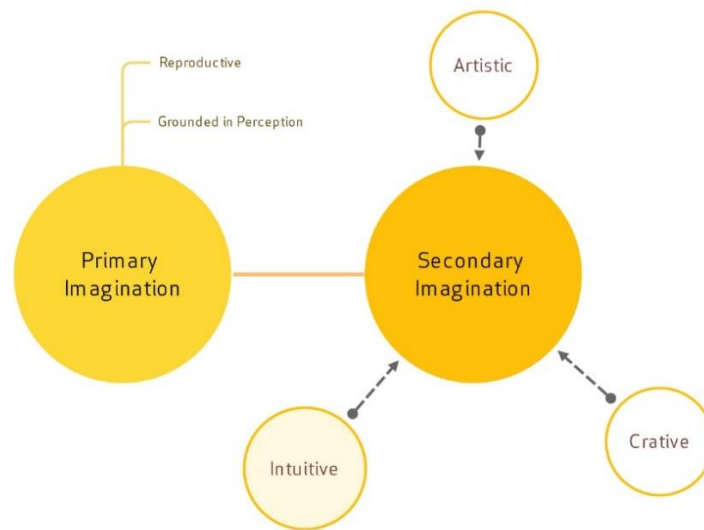


Figure 29 different types of imagination

Another view of imagination is presented by Langer (1953), who holds imagination to be humankind's utmost conceptual power. It is the source of insight and belief, the oldest faculty that is uniquely human, and the power that generates the arts and is directly affected by them¹³⁸. Langer also holds that epistemologists who define the image as a replica of sense impressions miss the mark. The important trait is that they are symbolic. Symbols may be visual or auditory; they may be vague, fleeting, or even sensuously different from what they represent. Thus, the work of art is the image of a feeling that Langer calls the "Art Symbol"¹³⁹. **"Art [including music] is the creation of forms symbolic of human feeling"**¹⁴⁰. The emotive content, art's form, is presented directly to the imagination, and the meaning (vital import) is apprehended intuitively (Langer 1957)

In summary, four facets of imagination seem to emerge from an analysis of the various conceptions of imagination just reviewed.

First, intuition is given prominence by Kant, who suggests an intuitive or transcendental nature for imagination. Husserl writes specifically of the intuitive nature of imagination. Kroner and Eliade both set the intuitive nature of imagination in opposition to perception. Croce states that intuitive knowledge is obtained through imagination. Ives also suggests the intuitive

¹³⁸ Langer, S. (1957). Problems of Art. Charles Scribner.

¹³⁹ ibid

¹⁴⁰ Langer, S. (1953). Feeling and Form. Charles Scribner.

or transcendent nature of imagination. Similarly, Copland describes imagination as having an intuitive function.

Second, perception is also an aspect of imagination, especially in the reproductive imagination presented by Kant. Warnock likewise discusses perception's role in imagination. Coleridge views perception dominant in **primary imagination; intuition prevails in secondary imagination**. Howard includes perception in his imagination continuum. Busoni suggests that imagination imitates nature, thus giving perception importance. A third facet of imagination that emerges from the writings cited here is thinking, sometimes termed reasoning or cognition. Hume considers imagination the faculty of mind that produces ideas, prerequisite to thinking. Warnock assigns imagination a cognitive function. Langer suggests that art presents forms of feeling for contemplation. Contemplation establishes the link to thinking. Ives appears to assign a cognitive dimension to "substance" in his conception of imagination. Although Copland gives particular prominence to intuition, he also assigns thinking a place in his conception of imagination.

Thus intuition, perception, thinking, and feeling recur throughout the various conceptions of imagination. Generally, they do not appear in isolation but occur in some combination. At times, one may be given prominence over another. At this point, imagination might be viewed as a power of the whole of human consciousness that employs intuition, perception, thinking, and feeling. A close inspection of the meaning of each of these four facets of imagination is fundamental to the ensuing discussion.

Intuition might be defined as an immediate rather than a mediated mode of knowing. In this usage, intuition does not necessarily have to rely on the senses or reasoning, that is, mediated knowledge, for its content. Instead, knowledge is gained directly, without intervening agents or causes, as a kind of gestalt, a grasp of the whole, an insight. The insight may occur as a leap from the known to the unknown in the manner described by Dewey (1934/1958): "**When old and new jump together, like sparks when the poles are adjusted, there is intuition**" (p. 266).¹⁴¹

Ideation; brainstorming; chainstorming; cheatstorming; tweetstorming

Based on observations from these studies, we conclude with the somewhat provocative suggestion that **ideation need not require the generation of new ideas**. Rather, we present a model of ideation suggesting that its value has less to do with the generation of novel ideas than the cultural influence exerted by unconventional ideas on the ideating team. Thus, brainstorming is more than the pooling of "invented" ideas, it involves the **sharing and interpretation of concepts in unintended and (ideally) unanticipated ways**.

¹⁴¹ Reichling, M. J. (1990). Images of Imagination. *Journal for Research in Mathematics Education* (JRME), 38(4), 282-293.

Ideation need not be limited to the generation of new ideas. From this perspective, the value of group ideation activities such as brainstorming has less to do with the creation of novel ideas than its cultural influence on the ideating team.

Brainstorming Effectiveness as an Ideation Technique

The term brainstorming is best identified today with Osborn's book on creativity titled *Applied Imagination*, first published in 1953¹⁴². Osborn, who worked as an advertising executive in the 1940s and 50s, wrote a detailed examination of the creative problem-solving process, and introduced brainstorming as one part of this process.

- (1) **Fact-finding: Problem-definition** and preparation; **gathering** and **analyzing** the relevant data.
- (2) **Idea-finding: Idea-production** and **idea-development**; thinking of tentative ideas and **possible** leads and then **selecting** and **combining** them.
- (3) **Solution finding:** Evaluation and adoption; verifying the offered solutions, and deciding on and implementing a final selected set.

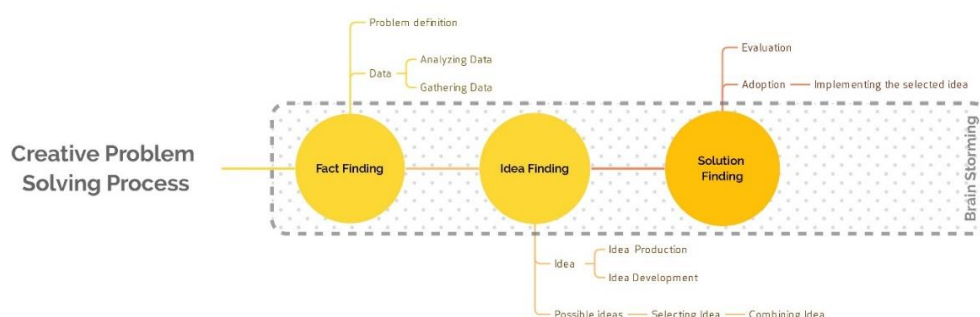


Figure 30 The creative problem solving stages

He claimed that Idea-finding is “the part of problem-solving that is most likely to be neglected” by groups¹⁴³ and offered four guidelines that should be carefully followed in order to conduct a brainstorming session effectively and yield the best results:

1. Criticism is ruled out: Adverse judgment of ideas must be withheld until later.
2. “Free-wheeling” is welcomed: the wilder the idea the better; it is easier to tame down than to think up.
3. Quantity is wanted: The greater the number of ideas, the more the likelihood of useful ideas.

¹⁴² Osborn, A. F. (1963). *Applied Imagination: Principles and Procedures of Creative Thinking* (3rd ed.). Scribner.

¹⁴³ Ibid

4. Combination and improvement are sought: In addition to contributing ideas of their own, participants should suggest how ideas of others can be turned into better ideas; or how two or more ideas can be joined into still another idea.¹⁴⁴

Since then, many have built on these rules as brainstorming has become an increasingly popular method for idea generation in business and academic contexts. For example, Osborn's rules have been adapted to be more playful and memorable for educational purposes (e.g. "Gleefully suspend judgment," "Leapfrog off the ideas of others"¹⁴⁵), and additional rules such as "be visual," "stay focused on the topic," and "one conversation at a time" have been added to better guide brainstorming sessions in the context of corporate design consulting¹⁴⁶

Limitations of Brainstorming

Since only one person speaks at a time in a group setting, others are inhibited from expressing their ideas while another team-member is speaking, potentially slowing their ability to generate new ideas of their own. It is not the lack of speaking time in total that causes the alleged inhibition, as many times the flow of ideas ends before the end of a brainstorm session. Rather, it has been claimed that some participants' ideas are **suppressed** or **forgotten** later in the process, as they may seem less relevant or less original than others being expressed. Furthermore, being in a situation where participants must passively listen to others' ideas may **distract** and **interrupt** their thought processes and ability to record their own ideas. Examples of studies looking into this hypothesis can be found in.¹⁴⁷

Evaluation apprehension

Creativity by definition is an unconventional act, and being creative therefore involves **taking personal risks**¹⁴⁸ Even though one of the most important rules for successful brainstorming is to "**defer judgment**," the fear of being criticized for having original ideas is often pervasive. Numerous authors have studied this phenomenon of "evaluation apprehension." Maginn and Harris,¹⁴⁹ for example, performed an experiment in which a brainstorming group was told that there were expert evaluators watching them through a one-way mirror. No major difference was observed

¹⁴⁴ *ibid*

¹⁴⁵ Faste, R. (1995). A Visual Essay on Invention and Innovation. *Design Management Journal*, 6(2).

¹⁴⁶ Kelley, T., Littman, J., & Peters, T. (2001). *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm*. Crown Business.

¹⁴⁷ *Ibid*

¹⁴⁸ Faste, R. (1993). An Improved Model for Understanding Creativity and Convention. In C. A. Fisher (Ed.), *ASME Resource Guide to Innovation in Engineering Design*. American Society of Mechanical Engineers.

¹⁴⁹ Maginn, B. K., & Harris, R. J. (1980). Effects of Anticipated Evaluation on Individual Brainstorming Performance. *Journal of Applied Psychology*, 65(2), 219-225.

between brainstorming performance in this condition relative to a control condition in which participants were not informed that they were being observed. In another study,¹⁵⁰ groups of brainstorm participants were informed that some members of the group were “undercover” experts on the topic at hand. In this case, productivity loss was observed in groups that had been informed of their presence relative to a control group that had not been told.

Free riding It may be the case that a brainstorming participant’s motivation to work decreases if they do not perceive that they will be recognized for their participation. Since brainstorming is a group activity in which all the generated ideas are ultimately grouped together, it is often the case that the generated results are not attributed to their specific contributor. Indeed, lower identifiability of ideas may increase participants’ motivation to contribute less, compared to an individual task where they know that their contribution will be recognized. Furthermore, many studies have shown that there is a lower perceived effectiveness of the individual in a group setting¹⁵¹¹⁵²

Briefly explained, we can summarize the correlation between design and its significant fragments which are involved in the design process such as ideation, intuition and imagination with sketching, and form finding, in the following diagram:

¹⁵⁰ Collaros, P. A., & Anderson, L. R. (1969). Effect of Perceived Expertness upon Creativity of Members of Brainstorming Groups. *Journal of Applied Psychology*, 53(2), 159-163.

¹⁵¹ Diehl, M., & Stroebe, W. (1987). Productivity Loss in Brainstorming Groups: Toward the Solution of a Riddle. *Journal of Personality and Social Psychology*, 53(3), 497-509.

¹⁵² Faste, H., Rachmel, N., Essary, R., & Sheehan, E. (n.d.). *Brainstorm, Chainstorm, Cheatstorm, Tweetstorm: New Ideation Strategies for Distributed HCI Design*.

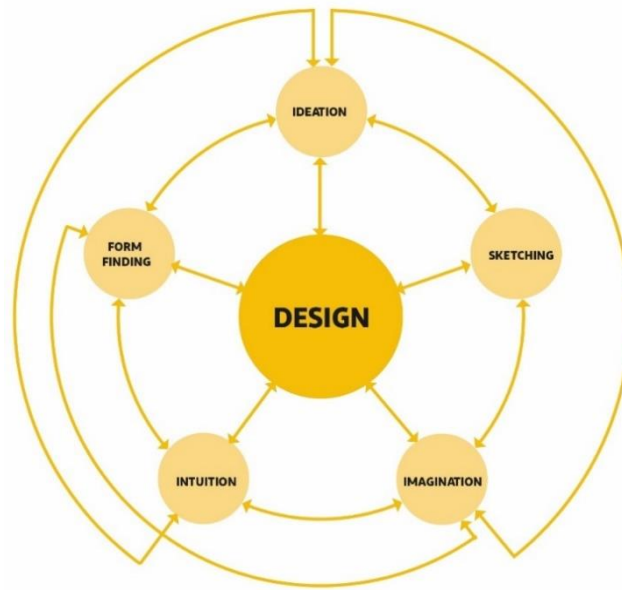


Figure 31 Design relation with sketching, imagination, intuition, form finding, and ideation

Methods that may stimulate creativity

In design, as a form of problem solving, reasoning proceeds from objective and functional assessment to means or (product) decisions but does not follow a formal scientific process in which, by deduction, one reaches a logical result from posed premises. To improve this process, creative methods are seen as important to stimulate original and quality solutions. Jones (1963 and 1970) already emphasized the importance of methods that aid in the search for ideas in design processes. In such early texts Brainstorming, Synectics, Morphological Charts and Removing Mental Blocks are mentioned as appropriate tools. When such methods are informally practiced, however, sidestepping may occur and opportunities might be missed. Thus, techniques such as “Brainstorming” or other creativity enhancement methods, criticism and decision-making activities should intertwine with traditional design, drafting, prototyping and testing activities, to provide the foundation for greater quality and originality of product, as well as awareness in the design process¹⁵³

2-5. Design Education

It is perfectly acceptable for architectural education, say, to have the instrumental aim of providing competent designers of buildings, but this cannot be an aim of general education.¹⁵⁴ The adaptation of the educational system to the conditions of professional work, due to having some benefits, also creates problems in the form of infrastructure in the education system.

¹⁵³ Kowaltowski, D. C. C. K., Bianchi, G., & Teixeira de Paiva, V. (n.d.). Methods that may stimulate creativity and their use in architectural design education.

¹⁵⁴ Cross, N. (2006). *Designersly Ways of Knowing* (p. 3). Springer-Verlag London.

Among these, it is possible to point out the direction of students toward functional arguments and analytical thinking, which were discussed in detail in chapter two.

Anita Cross (1980) has pointed out that 'Since general education is in principle non-technical and non-vocational, design can only achieve parity with other disciplines in general education if it is organized as an area of study which contributes as much to the individual's self-realization as to preparation for social roles.'

Peters, R S in his book: *Education as Initiation* (1965) discussed three criteria about education. The first one is: 'we may be educating someone while we are training him: but we need not be. Deciding what is worthwhile is obviously value-laden and problematic. The second one he emphasized that the manner in which people are educated is just as important as the matter which is transmitted. Peters' third criterion encompasses the consideration that: 'We often say of a man that he is highly trained, but not educated. What lies behind this condemnation? It is ... that he has a very limited conception of what he is doing. He does not see its connection with anything else, its place in a coherent pattern of life. It is, for him, an activity which is cognitively adrift.'¹⁵⁵

In the topic of education, sometimes a lecturer tries to teach the students from the perspective of the deepest aspects of his achievements, while this attitude may not be helpful. The principles of design, which are discussed in theoretical and professional dimensions, is a field that has been deduced from the study of the design behavior of professional designers and studies on the fundamentals of opinion and thought that is significant in this field and naturally can never be equated or used in the early stage of education. Therefore, the requirements of a creative educational approach do not follow the rules of the professional world. As Peters points out, in the first criterion, choosing what is important to teach is an important criterion.

The second issue that can create a suitable atmosphere for creative education is the discussion of how to convey a subject, which, according to Peters, can be as important as the educational content itself. Another neglected issue that we face in the educational environment is not paying too much attention to the educational content rather than the method of transmission. As a hypothesis, teaching design through contriving a game, the possibility of learning the process of dealing with the subject with more independent design languages can be more fruitful in transferring the concept of design, compared to confronting a student with a logical program and predefined frameworks! In other words, design education may

¹⁵⁵ Peters, R. S. (1965). *Education as Initiation*. In R. D. Archambault (Ed.), *Philosophical Analysis and Education* (pp. [Page Numbers]). Routledge and Kegan Paul.

not necessarily start with the definition of an architectural project, even on a small scale, but it should be created from a language of design patterns or practice systems and the development of creative ideas in an atmosphere outside of architecture, such as sculpture!

But the third issue raised by Peters reveals a more important point. He continues: It is... that he has a very limited conception of what he is doing. He does not see its connection with anything else, its place in a coherent pattern of life. It is, for him, an activity which is cognitively adrift.¹ It is concluded that mere teaching cannot guarantee the creation of a deep understanding and the formation of a kind of insight in the student. In the discussion of architectural design, this issue can be clearly traced. Carrying out a design training process, even if they are followed correctly in such a way as to create skills in the learner, cannot become a type of actual intelligence and insight in the field of design and step into the field of intuition. This requires that the type and the essence of exercises are defined in such a way that the student understands the concept of design correctly and identifies all the components involved in it. This is definitely impossible in a single educational course and requires a sequence of integrated educational processes that support each other and are defined in a reasonable hierarchy like Nigel cross asserted "Education must be designed deliberately to enhance and to develop students' intrinsic cognitive processes and abilities. It entails a fundamental change of perspective from that of a vocational training for a design profession, which is the only kind of 'design education' we have had previously. Design in general education is not primarily a preparation for a career, nor is it primarily a training in useful productive skills for 'doing and making' in industry. It must be defined in terms of the intrinsic values of education.

Based on his (1979) studies of design behavior between scientists and architects Lawson (1980) has commented: The essential difference between these two strategies (scientists approach and architect approach in problem solving) is that while the scientists focused their attention on discovering the rule, the architects were obsessed with achieving the desired result. The scientists adopted a generally problem-focused strategy and the architects a solution-focused strategy. Although it would be quite possible using the architect's approach to achieve the best solution without actually discovering the complete range of acceptable solutions, in fact most architects discovered something about the rule governing the allowed combination of blocks. In other words, they learn about the nature of the problem largely as a result of trying out solutions, whereas the scientists set out specifically to study the problem. These experiments suggest that

scientists problem-solve by analysis, whereas designers problem-solve by synthesis.¹⁵⁶

Lawson repeated his experiments with younger students and found that first-year students and sixth-form school students could not be distinguished as 'architects' and 'non-architects' by their problem-solving strategies: there were no consistent differences. This suggests that architects learn to adopt their solution-focused strategy during, and presumably as a result of, their education. Presumably, they learn, are taught, or discover, that this is the more effective way of tackling the problems they are set.

A central feature of design activity, then, is its reliance on generating fairly quickly a satisfactory solution rather than on any prolonged analysis of the problem. In Simon's (1969) inelegant term, it is a process of 'satisficing' rather than optimizing, producing any one of what might well be a large range of satisfactory solutions rather than attempting to generate the one hypothetically optimum solution. This strategy has been observed in other studies of design behavior, including engineers (Maples, 1960), urban designers (Levin, 1966), and architects¹⁵⁷

This argument clarifies another essential matter. Taking into account what we discussed in chapter two about two different types of thinking, analytical thinking, and creative thinking that each of them represents convergent and divergent thinking, respectively, therefore in the Lawson experiment, scientists can be considered as symbols of analytical thinking mod, and architects are symbols of creative and intuitive thinking mod. The focus of the creative thought process is obviously on the answer, as opposed to the analytical thinking, which is on the solution. Therefore, at this stage, it can be concluded that in codifying a creative teaching method, rather than getting the students' minds used to reasoning and deducing to discover relationships, formulas, and rules, it is appropriate to guide them toward discovering the nature of what is being designed. Therefore, we can return to the discussion of Buxton¹⁵⁸ regarding the production of visual choices in order to find the solution to the design process, which was mentioned in this chapter and in the topic intuition in design practice. If students' understanding of the solution could be simplified with the help of preliminary answers, although these answers may not be very accurate or sometimes, they may be wrong, but as a type of speculation, they can be a suitable platform for testing and achieving the solution.

¹⁵⁶ Cross, N. (2006). *Designers' Ways of Knowing* (p. 6). Springer-Verlag London.

¹⁵⁷ Eastman, C. M. (1970). On the analysis of intuitive design processes. In G. T. Moore (Ed.), *Emerging Methods in Environmental Design and Planning*. MIT Press.

¹⁵⁸ Buxton, B. (2007), *Sketching User Experiences: Getting the Design Right and the Right Design*, Morgan Kaufmann Publication

As a feature of design activity N. Cross mentioned the importance of the use of several initial, conjectured solutions by the designer. He confirmed that the role of the conjectured solution as a way of gaining an understanding of the design problem, and the need, therefore, to generate a variety of solutions precisely as a means of problem analysis. They also seem to have learned the value of rapid problem-exploration through solution-conjecture. They use early solution attempts as experiments to help identify relevant information about the problem.¹⁵⁹

It has been confirmed by Darke's (1979) interviews with architects, where she observed how they imposed a limited set of objectives or a specific solution concept as a 'primary generator' for an initial solution.¹⁶⁰

In comparison, novice designers often become bogged-down in attempts to understand the problem before they start generating solutions. Another difference between novices and experts is that novices will often pursue a 'depth-first' approach to a problem – sequentially identifying and exploring sub-solutions in depth, and amassing a number of partial sub-solutions.¹⁶¹

This method can be considered as a reverse design method in the design process that is, achieving a solution through the answer itself. A response is created as a prototype and is completely sensory. Now the question arises, what is the characteristic of this initial answer in the form of visual choices? What kind of information is it and what are its qualities? How does it occur, and how is it produced?

There is a great wealth of knowledge carried in the objects of our material culture. If you want to know how an object should be designed – e.g. what shapes and sizes it should have, what material it should be made from – go and look at existing examples of that kind of object, and simply copy (i.e. learn!) from the past. This, of course, was the 'design process' that was so successful in generating the material culture of craft society: the craftsperson simply copied the design of an object from its previous examples. Both Alexander (1964) and Jones (1970) have emphasized how the 'unselfconscious' processes of craft design led to extremely subtle, beautiful and appropriate objects. A very simple process can actually generate very complex products. Objects are a form of knowledge about how to satisfy certain requirements, about how to perform certain tasks. And they are a form of knowledge that is available to everyone; one does not have to understand mechanics, nor metallurgy, nor the molecular structure of timber, to know that an axe offers (or 'explains') a very effective way of splitting wood. Of course, explicit knowledge about objects and

¹⁵⁹ Cross, Nigel, (2006), *Designing Ways of Knowing*, Springer-Verlag London p 6-7

¹⁶⁰ Darke, J (1979) The Primary Generator and the Design Process *Design Studies* Vol 1, No 1, p 36–44

¹⁶¹ Cross, Nigel, (2006), *Designing Ways of Knowing*, Springer-Verlag London 26

about how they function has become available and has sometimes led to significant improvements in the design of the objects. But in general, 'invention comes before theory' (Pye, 1978); the world of 'doing and making' is usually ahead of the world of understanding – technology leads to science, not vice versa as is often believed. A significant branch of designedly ways of knowing, then, is the knowledge that resides in objects. Designers are immersed in this material culture and draw upon it as the primary source of their thinking.¹⁶²

This culture relies not so much on verbal, numerical and literary modes of thinking and communicating, but on nonverbal modes. This is particularly evident in the designer's use of models and 'codes' that rely so heavily on graphic images – i.e. drawings, diagrams and sketches that are aids to internal thinking as well as aids to communicating ideas and instructions to others. As well as these graphic models, there is also in design a significant use of mental imagery in 'the mind's eye' ¹⁶³The field of nonverbal thought and communication as it relates to design includes a wide range of elements, from 'graphicacy' to 'object languages', 'action languages' and 'cognitive mapping'.¹⁶⁴

The best answer in this context comes back to Michael Hayes' definition of imagination. In fact, imagination is the conduit for discovering such special types of visual qualities. The qualities that still have no referent in the outside world. As mentioned earlier and based on diagram (y), the correlation of imagination with intuition, ideation, form and sketching is evident. Therefore, the nature of these visual choices is of imagery information, the way of its demonstration can be through graphic thinking or sketching, and the way of understanding it can be ascertained through its form. Thus, we can conclude that developing the ability of architecture students to recognize the form and improve their skills in implementing those choices through graphic thinking and sketches can be influential in formulating a practice process for teaching design.

Essentially, we can say that designerly ways of knowing rest on the manipulation of non-verbal codes in the material culture; these codes translate 'messages' either way between concrete objects and abstract requirements; they facilitate the constructive, solution-focused thinking of the designer, in the same way that other (e.g. verbal and numerical) codes facilitate analytic, problem-focused thinking; they are probably the most effective means of tackling the characteristically ill-defined problems of planning, designing and inventing new things.¹⁶⁵

¹⁶² Cross, N. (2006). *Designerly Ways of Knowing* (pp. 6-7). Springer-Verlag London.

¹⁶³ Darke, J. (1979). The Primary Generator and the Design Process. *Design Studies*, 1(1), 36–44.

¹⁶⁴ Cross, N. (2006). *Designerly Ways of Knowing* (p. 26). Springer-Verlag London.

¹⁶⁵ Cross, N. (2006). *Designerly Ways of Knowing* (p. 10). Springer-Verlag London.

On the other hand many design teachers often have a background as practicing designers before transitioning into teaching roles. These design teachers tend to be firstly designers and only secondly and incidentally teachers. This model may be defensible for specialist education, but in general education all teachers are (or should be) firstly teachers, and only secondly, if at all, specialists in any field.¹⁶⁶ Design is a discipline that heavily relies on practical skills, creativity, and architectural knowledge. Therefore, having real-world experience as a designer can provide valuable insights and credibility to design teachers. However, it's important to note that while design teachers may prioritize their design expertise, this doesn't diminish the significance of their role as educators. Good design teachers possess not only technical skills but also pedagogical skills, such as effective communication, mentorship, and the ability to facilitate learning. Teaching design requires the ability to convey concepts, provide constructive feedback, nurture creativity, and guide students in their design process.

One of the solutions that can be considered in creating an active educational process in design education is the implementation and simulation of the design process by the Mentors themselves or a number of their experienced assistants simultaneously in the educational process and in parallel with the students' training processes. As in the past educational system, students received a kind of one-on-one training as a result of working simultaneously in educational studios with upper-year students. This process can help students learn how to face and respond to problems based on the way that their mentors or their assistants treated with. This concurrent procedure on the same Design task would be more effective for students compared to the conventional design process in that each student has been assigned to do the design task individually by trial and error and browse books, journals, or even buildings in search of design ideas.

The third important issue in design education is a kind of controversial belief. Although many Empirical studies of design activity have frequently found 'intuitive' features of design ability to be the most effective and relevant to the intrinsic nature of design. Some aspects of design theory, however, have tried to develop counter-intuitive models and prescriptions for design behavior and they claim that learning a systematic process does not actually help student designers. However, a study by Radcliffe and Lee (1989) did show that a systematic approach can be helpful to students. They found that the use of more 'efficient' design processes (following closer to an 'ideal' sequence)¹⁶⁷

¹⁶⁶ Cross, N. (2006). *Designerly Ways of Knowing* (p. 3). Springer-Verlag London.

¹⁶⁷ Ibid

Education for creativity

In design at least, we have seen that there are a number of skills which experienced designers seem to have acquired that assist in releasing their creative potential. True, we have also seen that designers judged to be creative seem to share some common personality characteristics. The evidence is thus confusing, as it often is in psychology. Are we creative because we are born that way, or are we creative because we have learnt to be? We simply do not have a reliable answer to such a question, which in any case is not really the business of this book. Suffice it to say here that there is enough evidence that we can improve our creativity to warrant careful attention to the educational system through which designers pass. In particular an issue here is the extent to which we should make design students aware of previous design work. One school of thought may suggest that students should be allowed a free and open-ended regime in which free expression is encouraged. Another might argue that designers have to solve real-world problems and they should pay attention to the acquisition of knowledge and experience. Certainly there is much evidence on the side of the open, free and expressive school of thought. Many studies have, for example, demonstrated the mechanizing effect of experience. Quite simply, once we have seen something done in a certain way, or done it ourselves, this experience tends to reinforce the idea in our minds and may block out other alternatives. In one of the most dramatic demonstrations of this phenomenon subjects were asked to perform simple arithmetic by pouring water between three jugs of different capacities. For each problem the actual size of the three jugs was varied, but for several problems in sequence the solution remained essentially the same. Later, a problem with an alternative and much simpler solution was presented, the subjects typically failed to notice and continued to use the more complex answer.¹⁶⁸ An engineering lecturer once told me that he enjoyed teaching undergraduates because 'they didn't know certain things were difficult'. Consequently he found students occasionally came up with novel solutions to problems which had already been thought to be well understood. Whilst he may have been right, what he failed to point out was that this was actually very rare, and much more normally his students suggested solutions which were already known not to work or be satisfactory. One tends to remember student successes rather than their failures! By comparison Herman Hertzberger in his excellent book *Lessons for Students of Architecture* suggests the importance of gaining knowledge and experience: Everything that is absorbed and registered in your mind adds to the collection of ideas stored in the memory: a sort of library that you can consult whenever a problem arises. So, essentially the more you have seen, experienced and

¹⁶⁸ Luchins, A. S., & Luchins, E. H. (1950). New Experimental Attempts at Preventing Mechanization in Problem Solving. *The Journal of General Psychology*, 42(2), 279-297.

absorbed, the more points of reference you will have to help you decide which direction to take: your frame of reference expands. (Hertzberger 1991) It remains the case, however, that design education all over the world is largely based on the studio where students learn by tackling problems rather than acquiring theory and then applying it. Learning from your own mistakes is usually more powerful than relying on gaining experience from others! The popularity and success of the studio system has more recently led some design educationalists to assume that all learning can be this way. There are, however, problems with such a system, for the student is not only learning through the studio project, but is also usually performing and being assessed through it. What might have made a good learning experience may not necessarily have generated a high mark. Unfortunately, too, the emphasis in such studios tends to be on the end product rather than the process. Thus students are expected to strive towards solutions which will be assessed, rather than showing a development in their methodology. Often, too, the inevitable 'crit' which ceremoniously concludes the studio project tends to focus on retrospective condemnation of elements of the end product rather than encouragement to develop better ways of working (Anthony 1991). A study of design education in schools (Laxton 1969), concluded that children cannot expect to be truly creative without a reservoir of experience. Laxton developed a rather elegant model of design learning using the metaphor of a hydroelectric plant (Fig. 32).

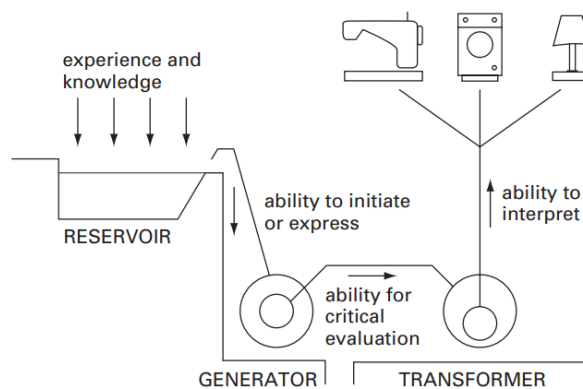


Figure 32 Laxton's ingenious hydro-electric model of design learning

He argued for a three-stage model of design education in which major skills are identified and developed. The ability to initiate or express ideas, Laxton argued, is dependent on having a reservoir of knowledge from which to draw these ideas. This seems similar to Hertzberger's exhortation to students of architecture to acquire knowledge. Laxton's second skill is the ability to evaluate and discriminate between ideas. Finally, the transformation or interpretative skill is needed to translate ideas into the

appropriate and relevant context. Kneller (1965) in his study of creativity makes a similar point: One of the paradoxes of creativity is that, in order to think originally, we must familiarize ourselves with the ideas of others . . . These ideas can then form a springboard from which the creator's ideas can be launched. Design education, then, is a delicate balance indeed between directing the student to acquire this knowledge and experience, and yet not mechanizing his or her thought processes to the point of preventing the emergence of original ideas.

The ECC methodology will be used to integrate design practices experience into knowledge through the evaluation-creation cycle, which as Kolb¹⁶⁹ suggests, is "the process whereby knowledge is created through the transformation of experience". This is a process of reflection and extraction of tacit knowledge embodied in buildings or design drawings. The evaluation process involves converting tacit knowledge into explicit understanding that can be used to develop explicit design support in the empirical phases of the study. This requires more than a theory of what is, it also requires using theory for predicting and testing what would be desirable.¹⁷⁰

The ECC methodology will be used in the study to guide knowledge creation in accordance with design science methods through the analytic and the synthetic practices of the evaluation-creation cycle at two levels: theoretical and empirical. This article is focused on the theoretical part of the study. Research at the theoretical level is focused on the evaluation of existing design work, the practices and the principles that support practices, and providing descriptive theory. The importance of theory is that it not only aims at describing practices and explaining the design principles that support them, but also at using this understanding, as Blessing and Chakrabarti suggests, in order to develop prescriptive design support in the form of enhanced principles, methods and tools to improve design in the synthetic part of the methodology.¹⁷¹

The evaluation process is a scientific approach based on observation and reflection. The process involves analysis of several individual cases of the same class of building types that could lead to discover supporting principles. These represent a set of priorities that good design may comply with in order to produce architecture in conformity with human values. The students are now engaged in classifying the data to measure the quality of

¹⁶⁹ Kolb, D. A., et al. (1999). *Experiential learning theory: Previous research and new directions*. Case Western Reserve University, Cleveland, OH 44106. Retrieved from <http://www.researchgate.net/publication/284458870>

¹⁷⁰ Bashier, F. The ECC methodology for architecture design theory and practices research.

¹⁷¹ Ibid

design outcomes based on their ability to meet the prevailing technological, economic, and environmental values of our time.¹⁷²

Design practice should be done in a way that fosters intuition in students. Design education should be focused in design activity and design thinking.

This is an important question:

What is the design course which entails creativity, imagination and intuition in design?

What design learning process creates the best opportunity for imagination, creativity and intuition in architectural design studio?

2-5. Functional Elements in Architectural Design Education: summarizing Key Components of Design teaching

The question of whether the design process can be described and introduces the distinction between design theory and design methodology. Design theory is seen as an explanatory, non-prescriptive understanding, while design methodology involves specific operations helpful in the design sequence. The focus is on investigating the actual process of design rather than delving into theoretical dimensions.

The discussion delves into the historical development of design methodology, highlighting the rejection of design methodology by early pioneers and the emergence of different generations of design methodology in the 1960s, 70s, and 80s. The concept of "science of design" is introduced, emphasizing its distinction from design science and scientific design procedure. The text emphasizes the importance of understanding the difference between design theory and design methodology in architectural education.

Design methodology is explored further, considering definitions from experts and theorists. Different perspectives on design processes are presented, including Thomas Maver's decision sequence and John Wade's three-part approach. The text acknowledges the diversity of design process models and analyzes commonalities and differences among them. It concludes with a call for a more intuitive and imaginative approach in the architecture design studio, emphasizing the need to foster intuition and imagination in the design process.

By exploring different theoretical aspects of design thinking and its maturity process, categorizing them into five key categories:

1-Design Thinking as Artifacts Materializer:

Herbert Simon introduced the concept of artificial intelligence and extended it to cognitive problem-solving procedures.

¹⁷² Ibid

Design, according to Simon, involves creating artifacts and transforming existing conditions into preferred ones.

Some criticisms note Simon's lack of clarity regarding the distinction between artistic creation and engineering.

2-Design Thinking as Reflexive Practice:

Donald Schön focuses on the logic of invention, emphasizing the role of technical knowledge in contrast with artistic mediums.

Schön sees design as a practice-based activity involving creation and reflection.

Buchanan introduces the concept of contextualization and placement for dealing with wicked problems, allowing for collaborative design.

3-Design Thinking as Problem-Solving Action:

Cross and Lawson offer practice-based perspectives on design thinking, with a focus on what designers do throughout the design process.

Both suggest a model of the design process, emphasizing a process-based attitude.

Designerly Thinking, Practice-Based Activity, and Mode of Cognitive Approach:

Reiterates the perspectives of Cross and Lawson on practice-based ideas in design thinking.

4-Design Thinking as Meaning Formation:

Krippendorff introduces a semantic perspective, emphasizing meaning creation over artifacts.

Design is seen as a systematic collection of accounts of successful design practices, methods, and lessons. The text concludes with more contemporary perspectives on design thinking, including Nigel Cross's updated sentiments. It emphasizes the emergent nature of design thinking, its reflective aspect, co-evolutionary method, and the importance of a global design conversation. The need to prioritize user needs and foster a multi-cultural system of thinking is highlighted.

Additionally, Kees Dorst compares two problem-solving methods, one logical and predictable, and the other creative, emphasizing the need for a more systematic way of thinking in design.

The concept of design activity, emphasizing its role in creating tangible and functional products. It presents design procedures that involve conceiving form, expressing connectivity, and analyzing proposals for modification. Creativity, according to Boden (1990), involves connecting conceptual spaces in the mind, often combining ideas from different fields. The text introduces a design activity framework, breaking down the design process into four activities: understand, ideate, make, and deploy.

In the context of industrial design, the activity involves shaping form and ensuring functionality. Synthesis is identified as a crucial aspect of design activities, involving the search, exploration, discovery, composition, and integration of design solutions. A taxonomy of design definition activities is presented, highlighting synthesis as the result of abstracting and generating design concepts.

The text underlines the codified stages of design activity, helping designers externalize their thoughts into tangible forms such as mock-ups, visual content, or verbal explanations. Ideation, a significant part of the process, involves brainstorming and generating creative alternatives, with intuition and imagination playing a crucial role.

Attentioning the role of intuition in design, emphasizing its significance in expert designers' ability to approach challenging projects optimistically and make real-time aesthetic judgments. It discusses the importance of intuition in various fields, including industrial design, engineering, and mathematics. The text draws on a systematic analysis of interviews with Nobel laureates, describing scientific intuition as a certitude based on a quasi-sensory perception.

The intuitive nature of design involves constant reflection on the process of making throughout design research activity. Intuitive design is described as intentional self-leadership that inspires imagination and informs interactions in the world. The text delves into the reflexive and innate nature of intuition, discussing its subconscious "scanning" of senses and its role in generative design activities.

Intuition in design practice is characterized by its role in problem-solving, moral considerations, and creative processes. The text emphasizes the connection between intuition, creativity, and divergent thinking. Designers with a finely tuned sense of intuition are better equipped for successful design practices and creative motivation.

The power of intuition is magnified through constant cycles of expression and testing, which validate or contradict intuitive knowing. Designers reflect on intentional processes of making through reflection in action and reflection on action. Sketching is highlighted as a mechanism for seeing and imagining solutions, contributing to a reflective mindset.

The studies that have been investigated also address challenges in design education, suggesting that different design studios may hinder students' intuition development. It emphasizes the importance of trusting intuitive knowledge in making design decisions and creating tentative sketches for evaluation. In conclusion, this chapter argues that intuition is a critical aspect of design expertise, influencing generative and evaluative activities. It highlights the need for designers to practice and learn directly from their work, incorporating intuitive methods into design research.

As a result of the studies in this chapter, several suggested strategies have been outlined and can be considered for use in the topic Design teaching in architecture pedagogy. They have been outlined in the following examples.

The following case studies illustrate the importance of noticing these issues at an early stage of education. Some of these cases can mainly be considered in the subject of introductory design teaching and in the first year, focusing on creativity, divergent thinking, intuition, problem-solving strategies, nonverbal communication, the role of teachers in education and other cases. Therefore, in chapter three, we will have an overview of the process of teaching architecture, focusing on the dimensions of learning

quality, the classification of mental capabilities and the learning process based on students' thinking modes.

1-Divergence in Educational Goals:

Architectural education may focus on producing competent designers of buildings, but this instrumental aim is not suitable for general education. Adapting education to professional work conditions has benefits but poses challenges, such as directing students toward functional arguments and analytical thinking.

2-General Education in Design:

Anita Cross emphasizes that design in general education should contribute to both self-realization and preparation for social roles.

Peters (1965) discusses three criteria for education: training vs. education, importance of the manner of education, and the need for a coherent pattern of understanding.

3-Creative Educational Approach:

Design education should not rigidly follow professional rules and should consider creative teaching methods.

Teaching design through games may be more effective in fostering independent design languages compared to logical programs.

4-Insight in Design:

Mere teaching does not guarantee deep understanding and insight in design.

Nigel Cross asserts that education must deliberately enhance intrinsic cognitive processes rather than being solely vocational training.

5-Difference in Problem-Solving Strategies:

Architects, in contrast to scientists, adopt a solution-focused strategy in problem-solving.

Designers rely on 'satisficing'—producing satisfactory solutions quickly—rather than prolonged problem analysis.

6-Importance of Initial Solutions:

Designers use initial, conjectured solutions for understanding design problems and problem analysis.

Novice designers often struggle with understanding the problem before generating solutions.

7-Knowledge in Objects and Nonverbal Communication:

Objects in material culture carry knowledge about design requirements and solutions.

Designers rely on nonverbal modes, including graphic images, models, and codes, for effective communication and thinking.

8-Role of Design Teachers:

Design teachers with real-world experience bring valuable insights but need pedagogical skills.

Simulating the design process alongside students by experienced mentors can enhance the educational process.

9-Controversy in Design Education:

Some argue for intuitive features in design education, while others advocate for systematic approaches.

A study shows that a systematic approach can be helpful to students.

10-Education for Creativity:

The origin of creativity—whether innate or learned—is uncertain.

The balance in design education between free expression and the acquisition of knowledge and experience is crucial.

11-Three-Stage Model of Design Education:

Laxton proposes a three-stage model: initiation of ideas, evaluation and discrimination of ideas, and transformation of ideas into a relevant context.

Design education must balance acquiring knowledge without mechanizing thought processes.

12-ECC Methodology:

The Evaluation-Creation Cycle (ECC) integrates design practices experience into knowledge through reflection and extraction of tacit knowledge.

The ECC methodology guides knowledge creation at theoretical and empirical levels to improve design.

13-Fostering Intuition in Design Education:

Design practice should foster intuition in students.

Design education should focus on design activity and thinking to create opportunities for creativity, imagination, and intuition in architectural design studios.

CHAPTER 3.

Architecture education

If novelty, is the essential part of creativity definition, it is therefore more important for architecture schools to contrive a teaching method for nurturing a novel way of thinking, which is derived from divergent thinking style.

This chapter encompasses the topics as follows:

- 3-1. Educational system based on active learning
- 3-2. The eminence of students' 'Thinking Modes' within the educational paradigm
- 3-3. Learning styles pattern for each thinking mode classification
- 3-4. Contrive a teaching method
- 3-5. Restructuring the architecture design Teaching

3-1. Educational system based on active learning

Architecture is a unique human activity that blends artistic creation with scientific knowledge and technological innovation. Architecture has both aesthetic and utilitarian objectives¹⁷³. Therefore, it is expected that a training path to become an architect entail both criteria, a path that indicates the direction in which a student learns how to learn architecture, a major, with two different aspects. Architecture has not developed as an academic pathway with a clearly defined way. Much of architectural education is concerned with developing students in order for them to become well-rounded, competent, and imaginative designers of buildings and the spaces between them (Roberts, 2005). To facilitate learning in this way, Universities increasingly accept vocational qualifications for entry.¹⁷⁴ This could be assumed as a suitable solution, but there seem to be so many problematic items in regard to this pre-university education which is investigated in the next part. But it has to be paid attention that many students in the world are not necessarily required to pass such courses before they enter the architecture academic system.

Today simple graduation from university does not guarantee becoming a versatile and socially aware architect. The architecture students vary in their pre-university educational backgrounds. In different countries, the entrance exam differs in terms of the syllables and the evaluation criteria. In countries such as Turkey, North Cyprus, Iran and Portugal students enter the architecture course with a science-based major at secondary school, while in so many other countries the background education has to be in an art-related course. Architecture education is expected to produce a talented workforce who are not only knowledgeable and skillful but creative and versatile.¹⁷⁵ Architecture students are expected to produce creative and innovative designs yet functional; able to meet the challenges of sustainability. They also should meet the needs of the design criteria like creativity and novelty. Architecture students are required to approach their design projects in a creative way, proposing solutions beyond the ordinary¹⁷⁶. They should also have been able to cope with different design problems with a suitable approach. This expectation creates a challenge when considering the different learning approaches of students, influenced by their background educational system to the design problem. Architects have, until comparatively recently, been educated in an apprenticeship in architectural practice. It is only since the post-war construction boom prompted a more organized approach to education that university courses

¹⁷³ Taleghani, M., Ansari, H., & Jennings, P. (2011). Sustainability in architectural education: A comparison of Iran and Australia. *Renewable Energy*, 36, 2021-2025.

¹⁷⁴ Atkinson, R. (2010). Architecture at A-Level: A Case Study. *Journal Title, Volume (Issue), Page numbers*.

¹⁷⁵ "Ayyıldız Potur, A., & Barkul, Ö. Creative thinking in architectural design,

¹⁷⁶ Ayyıldız Potur, A., Barkul, Ö., & Doheim, R. M. (Year). Creative thinking in architectural design education. *Journal Title, Volume(Issue), Page numbers*.

began to supplant the apprenticeship model, and only since 1980 that the majority of architects were educated in this way¹⁷⁷. Architecture has not, therefore, developed as an academic pathway with a clearly pre-determined process. (Atkinson, 2010) To put the next step in intensifying the education quality, it is extremely essential to find out the flaws in the education system, which does not function to the fullest in academia. Investigation on how the education system can make balance in the student's learning patterns and the way that can facilitate the path in which they are going to cope with design problems. The design studio is the core of all architecture courses and the most dominant in architectural education¹⁷⁸ Therefore, to investigate the origin of the problems, we have to put the design studio under scrutiny. Architectural education is studio oriented, and all other courses are auxiliary and complementary. The experience that students go through in the design studio course is different than all other theoretical courses.¹⁷⁹ Therefore, investigating the problems regarding the design studio course, is the priority of focus in this regard.

In Porto University, in the first and second years, all tasks and presentations were done by Free-hand drawing. Free-hand drawing is considered a research tool. Drawing is not just seen as a communication tool but as a tool that helps student to think. The idea is that a pen or pencil is the extension of our hand, so as we are used to moving our hand while speaking, architects' interactives are usually accompanied by some graphical expression that is reflected on the paper. Therefore, drawing is a complementary tool to other tools that architects use to think and communicate with.¹⁸⁰ The imperative objective in the first year in FAUP¹⁸¹ is that students acquire the necessary skills for entering the design studio. These skills and tools are not planned to lead to the final result rather they contrive to help students develop their ideas and move toward the final result.¹⁸²

It is worth mentioning that we can trace the same methodology in Alvaro Siza Vieira¹⁸³ sketches that are not attempt to depict the final result rather trying to foreseen situations or creating some sort of visualization of the feasibilities.

¹⁷⁷ Bradley, J. V. F. (n.d.). Learning in practice, a retreat, an opportunity or imperative?

¹⁷⁸ Doheim, R. M., & Yusof, N. (2020). Creativity in architecture design studio. Assessing students' and instructors' perception. Journal of Cleaner Production.

¹⁷⁹ ibid

¹⁸⁰ Carneiro, Alberto (1995), *Compo Sujeito e Representacao do Desenho*, FAUP and Vieira, Joaquim (1995), *O Desenho e o Projecto Sao o Mesmo?*, FAUP

¹⁸¹ The **Faculty of Architecture of the University of Porto** (*Portuguese: Faculdade de Arquitectura da Universidade do Porto*)

¹⁸² Paulino, Raquel, (2013), *O Ensino da Arqitetura na 'Escola do Porto'*, Ph.D. thesis FACULDADE DE ARQUITETURA, Porto University

¹⁸³ Álvaro Joaquim [Carneiro] de Melo Siza Vieira GOSE • GCIH • GCIP, known as Siza Vieira is the most awarded Portuguese architect of all time.

At Porto University, the drawing course gives the ability to students how to use drawing techniques for expression and operate different kinds of graphical illustration. In the other hand, in the design Studio at FAUP, a certain approach is being taught. This approach includes a sequence of thoughts, technical issues, and concerns that resulted in personal interest in references. So that the final result of the architecture does not affect by the approach of educational discipline, but rather by the reference of the student. In this context, drawing is a tool to conceive the design, a tool to unfold and unlock the issues and problem.

Hence, this idea that a natural way of drawing is along with the natural line of thoughts. So, it will help architects embody their immediate thoughts. The method that has been elaborated in this research is an open-ended practice that helps the students to unlock their imagination, taking away prejudices and instead of conjuring an approach to design, willing to teach them how to use their hands as a means of externalizing.

There is some research conducted on the various attributes of the design studio course of architecture. Regardless of different disciplines which have been mentioned in the state of art of this thesis, what must be taken as a teaching strategy is how to substitute the teaching program based on active learning more than passive learning.

There are numerous definitions and types of active learning, but what is common in all of them is the engagement of learners in the learning process. Active learning is generally defined as any instructional method that engages students in the learning process ¹⁸⁴ which can be manifested through different strategies in different areas of knowledge. Active learning can be interpreted internally, as something relating to the learner; according to King, “active learning simply means getting involved with the information presented-really thinking about it (analyzing, synthesizing, evaluating) rather than just passively receiving it and memorizing it” ¹⁸⁵ In short, active learning in this context requires students to do meaningful learning activities and reflect on what they did. Student activity and engagement are the core elements of such an approach. ¹⁸⁶Active learning may take place both inside and outside the classroom. ¹⁸⁷Active learning also can be interpreted externally, which is a method of teaching that can even be affected by the environment. In short, active learning requires students to do meaningful learning activities and think about what they are

¹⁸⁴ Hedden, M., Worthy, R., Akins, E., Slinger-Friedman, V., & Paul, R. C. (2017). Teaching Sustainability Using an Active Learning Constructivist Approach: Discipline-Specific Case Studies in Higher Education. *Sustainability*.

¹⁸⁵ King, A. (1993). From sage on the stage to guide on the side. *College Teaching*, 41, 30–35.

¹⁸⁶ Farrow, C. B., & Wetzel, E. M. (2022). Faculty Perceptions of Interactive Learning Spaces within Construction Programs. *Journal of Civil Engineering Education*, 148(2), 04021017

¹⁸⁷ Hedden, M., Worthy, R., Akins, E., Slinger-Friedman, V., & Paul, R. C. (2017). Teaching Sustainability Using an Active Learning Constructivist Approach: Discipline-Specific Case Studies in Higher Education. *Sustainability*.

doing.¹⁸⁸ The core elements of active learning are student activity and engagement in the learning process.¹⁸⁹ Perhaps it is best, as some proponents claim, to think of active learning as an approach rather than a method.¹⁹⁰ Active learning moves students away from passive, listening roles toward greater interaction and participation.¹⁹¹ During active learning, students tangibly engage with faculty, students, and the classroom.¹⁹² Generally, researchers have separated teaching from the setting in which the learning occurs.¹⁹³ However, physical environments are rarely neutral and can either support or detract from learning experiences.¹⁹⁴ Informal student activities can improve the effectiveness of lectures. Adopting instructional practices to engage students in the learning process is the defining feature of active learning.¹⁹⁵ Research into how students learn suggests that students need to be more actively engaged with the course material to maximize their understanding. Strategies such as teams solving problems in class and the use of student response systems with conceptual questions.¹⁹⁶ Active learning is defined by the engineering education community as the “involvement of students in their own learning.” Active learning encompasses a variety of instructional techniques in which students participate in activities during class time that involve more than passive listening.¹⁹⁷

Table 4 the summarized data around the impact of active learning

	IMPACT		
1	Developing student's creativity and critical thinking	7	Education is more enjoyable for students
2	Traditional learning makes 1.5 times more probability to fail than usual	8	Increase in the student's performance
3	Longer reclamation of information	9	Increase in student's confidence and attendance
4	Social connectivity and interactivity	10	Increase students' awareness, and internalization of this structure to help them navigate the course

¹⁸⁸ Bonwell, C. C., & Eison, J. A. (1991). Active Learning: Creating Excitement in the Classroom. ASHE-ERIC Higher Education Report No. 1. George Washington University, Washington, DC.

¹⁸⁹ Prince, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, July, 223.

¹⁹⁰ *ibid*

¹⁹¹ *ibid*

¹⁹² Farrow, C. B., & Wetzel, E. M. (2022). Faculty Perceptions of Interactive Learning Spaces within Construction Programs. Journal of Civil Engineering Education, 148(2), 04021017.

¹⁹³ Gislason, N. (2010). Architectural design and the learning environment: A framework for school design research. Learning Environments Research, 13.

¹⁹⁴ Brooks, D. (2011). Space matters: The impact of formal learning environments on student learning. British Journal of Educational Technology, 42(5), 719-726.

¹⁹⁵ Prince, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, July, 223.

¹⁹⁶ Zappe, S., Leicht, R., Messner, J., Litzinger, T., & Lee, H. W. (2009). “Flipping” the classroom to explore active learning in a large undergraduate course. American Society for Engineering Education.

¹⁹⁷ *ibid*

5	The cultivation of self-confidence and self-efficiency.
6	Professional skills including communication, interpersonal skills, and teamwork have been emphasized and are often taught using active learning strategies

Table 5 the summarized data around the challenges and ways of motivation in active learning

	CHALLENGES	MOTIVATION
1	Applying knowledge	Analysing, evaluating, and creating, is a motivational loop
2	Miscommunication	Making them think about what they are doing
3	Time constraints	Sufficient challenge and relevance
4	Lack of group work and leadership skills	Engagement with technology encourages active learning
5	Space limitations and limited resources	Encourage them to be lifelong learners
6	Online sessions	Using visualizations and infographics

Table 6 the summarized data on lateral thinking in the context of architecture education

	APPLICATION		
1	Helping them with problem representation scheme	7	Industry collaboration
2	Theoretical assignments followed by active learning	8	Working in small groups, engaging in group discussions and classroom presentations
3	Computer Supported Collaborative Learning (CSCL)	9	Case-based teaching architecture and Problem Based Learning
4	Multiple campus classrooms that can create one all-inclusive classroom	10	Guided design
5	Using and furnishing corridors as a space for learning	11	Cooperative learning
6	E-Learning scenarios focused on autonomous active learning like the Personal Learning Environment (PLE)	12	Role-playing, and simulations
	STRATEGIES		
1	Investments of time and energy	7	Activating the emotional part of students' brains
2	Match the needs of students and course requirements with teaching styles and personalities	8	Learn by building their own understanding and refining it in response to experience.
3	High flexibility and mobility in the classroom	9	Using media art
4	Connect new information with existing mental models	10	Healthy and positive relationship between instructors and students

5	Engages in teamwork and collaborative learning opportunities	11	Offering different teaching strategies
6	Be strategic in classroom assignments	12	Provide simplified, timely, and explicit feedback to help students conduct self-assessments and encouragement

Table 7 the important suggestion for the implementation of active learning via educators and the educational environment

	ACADEMIC EDUCATORS		
1	Mentors in different disciplines should become learners in the classroom	9	Industry collaboration
2	Walking through the streets and visiting sites and 'group activities and the poll questions	10	Motivation and opportunities for learning
3	Ask for student feedback	11	Case-based teaching architecture
4	Placing focus on social interaction	12	enhance the connection between school and out-of-school learning
5	Act strategic in classroom assignments	13	Healthy and positive relationship between instructors and students
6	Studio-based learning	14	Utilizing multiple media
7	project-based learning,	15	Integrates theory and practice
8	Activating the emotional part of students' brains	16	Provide simplified, timely, and explicit feedback to help students conduct self-assessment, encourage
	ENVIRONMENT		
1	Multiple campus classrooms creating one all-inclusive classroom		
2	Flexibility, such as wheeled furniture, so users decide how best to configure the space.		
3	Room design, technology, pairing classes with the appropriate classroom		
4	Furnishing and transformation of the corridor to space for interactions		
5	Technological tools	Use of media arts	
6	E-Learning scenarios focused on autonomous active learning like the Personal Learning Environment (PLE)		

Table 8 the important items for implementation of active learning for the learners

"ACTIVE LEARNING" IMPLEMENTATION THROUGH THE "LEARNER"			
1	Share their views with others	7	The student be actively engaged in a personally meaningful task
2	Construct their understanding of a concept	8	Learn by building their own understanding and refining it in response to experience.

3	Connect new information with existing mental models	9	Student involvement
4	Engages in teamwork and collaborative learning opportunities	10	Creating their own conceptualizations and then validating them in the real world
5	Formulate their own goals	11	Increase students' awareness, internalization of this structure to help them navigate the course, engage in active learning
6	Working in small groups, engaging in group discussions and classroom presentations	12	Interest in first-year design courses, commitment to active learning approaches, and desires for changes in course structures and costs have come together in a variety of teaching approaches

Students' Educational Background

The syllabus and courses which is taught to students in the pre-university courses are important to focus on, because of the direction which makes for the student's minds, prior to their entry into the architecture schools. Most students of architecture enter higher education with little experience of this form of learning, and therefore a large part of architectural education is concerned with the development of new abilities, values, and conceptions so that eventually they are able to think and do as architects. For new students in architecture, a move to a system where the answers are uncertain, and the route to that endpoint ambiguous (Lawson, 1997) and not following any set methodology, may prove a frustrating and difficult challenge. As they progress, they will develop ways of countering these difficulties, which places a demand on schools of architecture to instil new ways of thinking and doing in their students from an early stage.¹⁹⁸ It can be a solution for some students with intuitive learning style but students with logical learning style may get lost in the process. Much of the discourse on architectural education suggests that an individual's cognitive style might be relevant in architectural education. Authors such as Schon (1983) and Proudfoot (2000) have suggested a continuum between an intuitive, phenomenological approach to design learning and an approach based upon technical rationality.

Design Studio

One main course in architecture education is the design studio, which proposes a real design problem, same as that in the architecture profession. Instructors struggle to integrate all the information acquired in the design studios either because of the lack of coordination or mismatching between

¹⁹⁸ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. *Design Studies*, 27(2),

the information offered and the design studio sequence or because students follow different study plans.¹⁹⁹ The design studio is the nucleus of the architectural program where the architecture student explores and experiments with various architectural projects and imparts the basic skills and knowledge required for the architectural profession.²⁰⁰ Learning in the design studio begins with ill-defined problems, a general characteristic of professional education, and observed that learning in the studio developed through a process he called 'reflection-in-action'.²⁰¹ This is where many challenges come to happen. The ability to cope with ill-defined problems is not obtained through the study in science-based majors at schools. According to Hamdi, competent practitioners need to develop parallel thinking (the brain's heart), which relates to learning by trial and error, dialoguing with experience, and finding association between different concepts. Practitioners also need quantum thinking (the brain's spirit), which involves the ability to question, apply holistic approaches, adapt objectives, change assumptions and break rules.²⁰² The ability to shift between these modes of thinking is not practiced at school for many architecture students. These difficulties include the lack of a clearly defined design methodology and the misunderstood role of the systematic approach to design in the studio.²⁰³ The growing dissatisfaction with design failures in architectural design studios appears to be the main concern of researchers and academicians around the world.²⁰⁴ In a time when the world is becoming complex, the field of architecture faces the challenges of climate change, globalization, urbanization, and social transformation on an unprecedented scale. The design studio environment has remained the same throughout the past century. As the Studio Culture Task Force of the American Institute of Architecture Students (AIAS).²⁰⁵ Noted, the changes in architecture education are not aligned with today's fast-changing world, especially in the context of architectural practice²⁰⁶; all these changes and difficulties are adding more complexity to the design problems of architecture studios which makes the change in this course, as the most important course of architecture major, more important. Lawson²⁰⁷ mentioned evidence of the design process difficulty. He stated what design

¹⁹⁹ Mahgoub, Y. (2007). Design studio pedagogy: From core to capstone. In A. M. Salama & N. Wilkinson (Eds.), *Design studio pedagogy: Horizons for the future*. Arti-Arch.

²⁰⁰ Hamza, T. S., & Hassan, D. K. (2016). Consequential creativity: Student competency and lateral thinking incorporation in architectural education. *International Journal of Technology and Design Education*, 587–612.

²⁰¹ Kvan, T., & Yunyan, J. (2005). Students' learning styles and their correlation with performance in architectural design studio. *Design Studies*, 26(1), 19–34.

²⁰² Till, J. (2005). *The negotiation of hope*. In *Architecture and Participation* (1st ed., pp. 19–41). London: Spon Press

²⁰³ Schon, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Basic Books Inc.

²⁰⁴ Salama, A. (1995). *New Trends in Architectural Education: Designing the Design Studio*. Tailored Text & Unlimited Potential Publishing

²⁰⁵ Koch, A., et al. (2006). *The redesign of studio culture*. The American Institute of Architecture Students.

²⁰⁶ Bashier, F. (2014). Reflections on architectural design education: The return of rationalism in the studio. *Frontiers of Architectural Research*, 3, 424–430

²⁰⁷ Lawson, B. (2005). *How designers think: The design process demystified*. Massachusetts: Elsevier/Architectural

instructors suffer when they ask their students to go through the generation phase to find alternatives and new ideas; “they can’t detach themselves from a particular solution or design to look at others’. In addition, some misconceptions hinder students to believe in their ability to think creatively; examples of such misconceptions are: creativity is a natural talent and cannot be taught; creativity comes from the rebels, release, intuition, craziness, scatter-gun success²⁰⁸ Creating an atmosphere where creativity is fostering seems to be essential in the design studio, and the students and tutors suffer lack of understanding the ways in which they can nurture their creative abilities.

Facing the design challenges illustrates how students use their cognitive style to solve the design problems. Much of the discourse on architectural education suggests that an individual’s cognitive style might be relevant in architectural education. Authors such as Schon (1983) and Proudfoot (2000) have suggested a continuum between an intuitive, phenomenological approach to design learning and an approach based upon technical rationality. Lawson (1997) suggests that architects tend to approach the design process using a number of parallel lines of thought in a simultaneous, rather than sequential, manner at both the detailed and global levels²⁰⁹It is, therefore, extremely important for the architecture students to be taught how to become able to solve a design problem holistically, which is done by intuition. Students may need to approach design using an increasing number of parallel lines of thought²¹⁰

The theoretical and technical courses offered in any architectural program are designed to provide complementary knowledge and skills acquired to the design studio projects to allow students to tackle their atmosphere in which students learn design problem solving through observation of their peer’s approaches. Collaborative learning can be used in architectural education to overcome technical and practical constraints design projects with a comprehensive manner and holistic approach²¹¹ In some universities, collaborative learning is used as a means to provide and to increase student motivation and engagement, especially when students are from different institutions (Rodriguez et al., 2018). In such an education system the role of the teacher or mentor is extremely important. The approaches of the mentors of this course vary.²¹² Demirkan described the instructor as a facilitator that provides information and resources to the

²⁰⁸ De Bono, E. (1993). *Serious creativity: Using the power of lateral thinking to create new ideas*. New York: HarperBusiness

²⁰⁹ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. *Design Studies*, 27(2)

²¹⁰ Lawson, B. (2003). *How Designers Think: The Design Process Demystified*

²¹¹ Doheim, R. M., & Yusof, N. (2020). Creativity in architecture design studio: Assessing students’ and instructors’ perception. *Journal of Cleaner Production*

²¹² Kulog˘lu, N., & Asasog˘lu, A. O. (2010). Indirect expression as an approach to improving creativity in design education. *Procedia - Social and Behavioral Sciences*, 9, 1674–1686.

designer's inquiry and professional growth.²¹³

Therefore, we can see this as a variable that influences the quality of teachings. This can lead to vague results for students, due to the fact that their quality of learning depends on the quality of their teacher and their peers. It can show how a student's professional future is vulnerable, which is a good point to ponder. There are two other factors regarding collaborative learning. Firstly, it is more adjustable for extroverted people, but a great number of students are introverted. Secondly, the teacher has to be a professional architect that has passed through all the phases of facing design dilemmas. But unfortunately, it is seen that in the regulations of teacher employment, a Ph.D. certificate is an obligation.

The Design Problem and Creativity

Unlike the engineering fields of study, in which mainly problem-solving leans on data analysis and the solutions are indisputable and usually obtained through step-by-step formulas, the solution in the field of architecture is intuitive in nature and highly dependent on creativity. The solutions are numerous, and flexibility is more, compared to the area of engineering. Even in some cases, decisions are not only logical but also emotional and based on the vision of the architect and his ideological perspicacity. Design solutions have some attributes, such as "creativity," which makes the problem-solving process distinctive from other disciplines. Approaches to design learning has been explored as a personal journey through the experiences of well-known architects²¹⁴ Entering this journey, mentioned by Zumthor, should be taught in architecture schools and the rest of the path has to be gone by the designer.

Creativity is considered a core skill and a must in architecture education to assure the quality of architecture graduates.²¹⁵ Being creative is adding value to the design work²¹⁶

The interpretation of creativity in the architectural context varies from a level of education to another. The more constraints, complexity, and challenges in the design problem within the architectural context, the higher the expectations of creative work.²¹⁷ Teaching and assessing creativity is a confronting dilemma in architectural education. Stressing the potential of architecture field in enabling creativity in theoretical and

²¹³ Demirkan, H., & Demirbaş, Ö. O. (2010). The effects of learning styles and gender on the academic performance of interior architecture students. *Procedia - Social and Behavioral Sciences*, 2(2), 1390-1394.

²¹⁴ Zumthor, P. (1998) *Thinking Architecture*. Baden Baden: Lars Müller.

²¹⁵ Williams, A., Askland, H. H., & Boud, D. (2012). *Assessing creativity: Strategies and tools to support teaching and learning in architecture and design*. Final Report.

²¹⁶ Doheim, R. M., & Yusof, N. (2020). Creativity in architecture design studio: Assessing students' and instructors' perception. *Journal of Cleaner Production*, 249, 119418

²¹⁷ *ibid*

practical perspectives, Philip (2015) acknowledged the difficulties faced by instructors in embedding creativity into the curriculum and in measuring creativity in students' work. It was reported that students might understand creativity in theories taught during lectures but face difficulties when applying creativity into project design.²¹⁸ This fact, is where the students face the most challenge and there are fewer courses in the education system to train students in this way.

In problem-solving-based projects where creativity is emphasized, students found 'learning to fail' and 'ambiguity is good' concepts are difficult to apply because of the need to find a workable solution to solve a given problem²¹⁹This would lead to confusion and impede creativity among students²²⁰ The term of creativity in modern times related to the engagement of psychological and educational began with Guilford who made the cognitive basis of creativity important separation between convergent thinking and divergent thinking. Although 'convergent thinking' is adjusted towards obtaining the single best answer to a given question (closed-ended; well-defined problems), 'divergent thinking' involves processes like changeable perspective, transforming, or producing multiple answers to questions (open-ended; ill-defined problems) from the available information and thus supports production of novelty.²²¹ Therefore, definitions of creativity referring to divergent thinking contain fluency, flexibility and originality as Guilford's attention (Roskos-Ewoldsen, Black, & Mccown, 2008), and many definitions of creativity refer to the core concept of 'novelty' (Torrance, 1966), with utility which are generally accepted as new and²²²Also, Plucker, Beghetto, and Dow (2004) emphasized on the importance of the 'novel' and 'useful' traits derived from analysis of the creativity literature about definitions of the creativity. To this point, Runco and Chand (1994) stated that novelty is an essential aspect of creativity. (Ulger, 2015) Diagram 2 illustrates the traits and attributes of divergent thinking and convergent thinking. Based on these learning styles, it is essential for architecture schools to have systematic approach in which students with both learning style flourish.

If novelty, is the essential part of creativity definition, it is therefore more important for architecture schools to contrive a teaching method for

²¹⁸ Chang, P. F., Hsiao, S. S., Yeh, T. L., & Wu, J. C. (2000). The development and implementation of the technological creativity course: An interdisciplinary approach. In 2000 International Conference of Engineering Education, ICEE 2000 Conference Proceedings.

²¹⁹ Kazerounian, K., & Foley, S. (2007). Barriers to creativity in engineering education: A study of instructors and students perceptions. *Journal of Mechanical Design*, 129(7), 761-768.

²²⁰ Doheim, R. M., & Yusof, N. (2019). Creativity in Architecture Design Studio: Assessing Students' and instructors' perception. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2019.119418>

²²¹ Runco, M. A. (1993). Cognitive and psychometric issues in creativity research. In *Understanding and recognizing creativity: The emergence of a discipline* (pp. 331-368).

²²² Batey, M., & Furnham, A. (2006). Creativity, intelligence, and personality: A critical review of the scattered literature. *Genetic, Social, and General Psychology Monographs*, 132, 355-429.

nurturing a novel way of thinking, which is derived from divergent thinking style. This illustrates the importance of putting more focus on teaching divergent thinking method in architecture schools. In order to achieve a creative design, it is important for architecture students to learn how to be able to act both divergent and convergent, in order to create a product, which is both useful and novel.

Table 9 Traits and attributes of divergent thinking and convergent thinking in design problems

convergent thinking	divergent thinking
single best answer	multiple answers
closed-ended problems	open-ended problems
well-defined problems	ill-defined problems

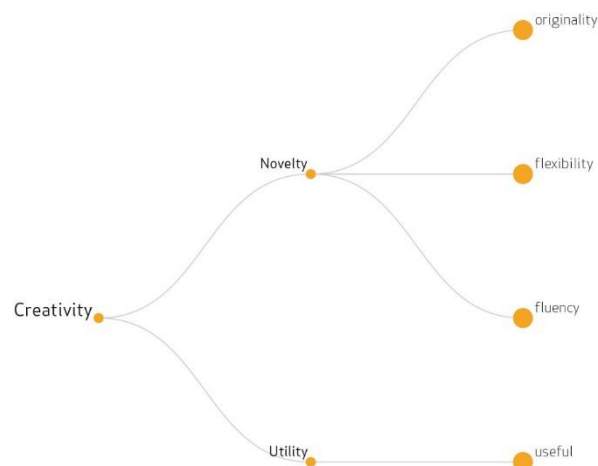


Figure 33 Attributes of Creativity

Assessment in the context of Design Studio

A key issue facing educators in the studio is deciding on what to focus on when assessing creative work. Some studio educators highlight that assessment of creative work throws up challenges, because of the very complex nature of getting to the final ‘creative’ artefact. Whether assessment should focus on the ‘processes, the ‘person’ and/or the ‘product’ in the creative disciplines remains under debate today.²²³

The studio mode of learning and teaching continues to be examined as a mode of learning and teaching in the creative disciplines, with much attention being paid to educational outcomes and how they are realized.²²⁴

²²³ Harpe, B., and Peterson, F., (2008) A model for holistic studio assessment in the creative disciplines, ATN Assessment 08: Engaging Students with Assessment

²²⁴ Kellogg, C. (2004) The Studio Culture Summit: An Overview Report. Washington, DC: American Institute of Architecture Students (AIAS).

For this reason, rather than basing comparisons on students' awarded marks, it was more appropriate to use a measure based on their rank position in the cohort. This reflects the assumption that it is easier for assessors to judge if student A appears to have learned more than student B, than to assign a percentage mark to that student. (Roberts, 2005) This shows how assessment in design studio lacks criteria that teach the student, what to focus, and on what to avoid in the learning process. It is crystal clear that if the student's peers have a better understanding of the project, that student may learn more, but receives a lower mark than another student, in another studio, who has learned less, but receives a higher mark. This can be a real challenge for students and their future professions. The architecture education system has to find a solution in this regard.

3-2. The eminence of students' 'thinking modes' within the educational paradigm.

Critical thinking has been described as "reasonable reflective thinking that is focused on deciding what to believe or do" (Ennis, 1991). It is about becoming a better thinker in every realm of people's lives and using your best thinking capabilities to help in taking the best decisions. Critical thinking involves different skills such as precision, logic, fairness, and relevance, which would allow critical thinkers to display a skeptical attitude, apply tactics and strategies to assure their understanding, be active and open to new ideas²²⁵It maximizes the quality of thinking abilities²²⁶Critical thinking and creative thinking are two different approaches in terms of the skills required for each. Creative thinking is divergent, while critical thinking is convergent. However, applying both approaches in conjunction enriches the learning experience and improves problem-solving and decision-making skills²²⁷Problem-solving involves both critical and creative thinking, and ignoring either would limit the quality and the efficiency of problem-solving. According to Brown et al (2013), problem-solving involves all types of thinking including logical, tentative, and creative. Knowing the importance of both creative and critical thinking, and understanding the relationship between both, instructors can boost and improve the capacity of their students²²⁸²²⁹ Whereas creative thinking is divergent, critical thinking is convergent; meanwhile creative thinking tries to create something new, critical thinking seeks to assess worth or validity in something that exists; whereas creative thinking is carried on by violating accepted principles, at

²²⁵ Paul, R., & Elder, L. (2013). *Critical Thinking: Tools for Taking Charge of Your Professional and Personal Life*. Pearson Education.

²²⁶ Doheim, M., & Noraini, Y. (2020). Creativity in architecture design studio: Assessing students' and instructors' perception. *Journal of Cleaner Production*, 249, 119418

²²⁷ Osborn, A. (1957). *Applied Imagination: Principles and Procedures of Creative Thinking*. Charles Scribner's Sons.

²²⁸ Baker, M., & Rudd, R. (2001). Relationships between Critical and Creative Thinking. *Journal of Southern Agricultural Education Research*, 51(1).

²²⁹ Doheim, M., & Noraini, Y. (2020). Creativity in architecture design studio: Assessing students' and instructors' perception. *Journal of Cleaner Production*, 249, 119418

the same time, critical thinking is carried on by applying accepted principles. Although creative and critical thinking may very well be different sides of the same coin, they are not identical.²³⁰ Burden and Byrd (1994) categorize critical thinking as a higher-order thinking activity that requires a set of cognitive skills.²³¹

Table 10 critical and creative thinking comparisons

Critical thinking	Creative thinking
convergent	divergent
assess worth or validity	create something new,
applying accepted principles	violating accepted principles

Students may need to approach design using an increasing number of parallel lines of thought.²³² This may lead to the adoption of particular ways of learning but may equally well impact problem-solving or workplace activities. (Roberts, 2005) Accordingly, it is important for architectural students, to improve both abilities, critical thinking, and creative thinking. The existing curriculum of a design course should be focused on nurturing these abilities in students.

Thinking Modes in design process

Much of the discourse on architectural education suggests that an individual's cognitive style might be relevant in architectural education. Authors such as Schon (1983) and Proudfoot (2000) have suggested a continuum between an intuitive, phenomenological approach to design learning and an approach based upon technical rationality. Lawson (1997) suggests that architects tend to approach the design process using a number of parallel lines of thought in a simultaneous, rather than sequential, manner at both the detailed and global levels²³³ A global cognitive style may also be beneficial in terms of the open-ended nature and often uncertain nature of the architectural design. Research by Witkin suggests that tolerance of uncertainty and ambiguity may be related to cognitive style, with those with an analytic approach tending to impose their own (possibly naive) structure on an uncertain situation, whilst those with a global approach feel able to cope with uncertainty without imposing

²³⁰ Beyer, B. K. (1987). Practical strategies for the teaching of thinking. Boston, MA: Allyn and Bacon, Inc.

²³¹ Baker, M., and Rudd, R., (2001), Relationships between Critical and Creative Thinking, Journal of Southern Agricultural Education Research, Volume 51, Number 1, 2001

²³² Lawson, B. (1997). How designers think: The design process demystified. Architectural Press

²³³ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. Design Studies, 27(2)

structure ²³⁴ Those with a preference for thinking in a holistic, global manner, perform less well than their peers in the early stages of their education but tend to improve as they progress through their education ²³⁵

Allinson and Hayes (1996) argue that cognitive style forms a bipolar dimension between a tendency for an individual to think analytically and a tendency for an individual to think intuitively. ²³⁶Schmeck (1988) argues that the dimension runs between global thinking and analytic thinking, with an ideal situation being represented by a synthesis of the two (a 'versatile' cognitive style) ²³⁷ Riding and Cheema (1991) suggest a dimension that differentiates between a preference for organizing information as wholes (labelled 'wholist') or to break down that information into smaller parts (labelled 'analytic') ²³⁸

Table 11 Global and Analytical thinking comparisons

Global thinking	Analytical thinking
tolerance of uncertainty and ambiguity	impose their structure on an uncertain situation
organizing information as wholes	break down that information into smaller parts
represent information mentally in pictures	represent information mentally in words

3-3. Learning styles pattern for each thinking mode classification

Riding and Cheema also propose a second dimension that refers to whether an individual has a tendency to represent information mentally in words (labelled 'verbalizer') or in pictures (labelled 'imager'), ²³⁹Those individuals with a global, holist or intuitive cognitive style are likely to show intuition and a tendency to see a whole picture rather than to break something into parts in order to intellectually process it. Those with atomistic, serialistic, analytic cognitive style will tend to break things down into parts and often process information in a sequential manner. ²⁴⁰Research by Peterson and Sweitzer (1973) suggests that architecture students were on average more field dependent (holistic or global cognitive style) than the student population as a whole and that they were less variable in their

²³⁴ Witkin, H., Dyk, R., Faterson, H., Goodenough, D. R., and Karp, S. A., (1962), Psychological differentiation Wiley, New York

²³⁵ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. Design Studies, 27(2).

²³⁶ ibid

²³⁷ ibid

²³⁸ ibid

²³⁹ ibid

²⁴⁰ ibid

measurements of field dependence. By contrast, however, Bergum (1977) suggested that architecture students were on the whole, more field independent (analytic cognitive style) than business studies students²⁴¹ They were significantly more analytic than a standardization sample of 1448 school pupils between the ages of 12 and 16 (Roberts, 2005). In the first two years, analytic students on average achieved higher rank positions than intermediates, who in turn attained higher rank positions than wholists. By the students' third year, all three groups appeared to have converged to a similar level, the analytic students having fallen by an average of 13 percentiles²⁴² When problems are complex and ill-defined, students with various differing learning styles had the scope and freedom to adopt an approach to designing that best suited their learning style the result being success across all style groupings.²⁴³ The rigid nature of first year a constraint, and preferred the freedom of subsequent projects where there was a greater opportunity to think independently²⁴⁴. Those who have a tendency to process information holistically (wholists) may find it easier to cope with this increased demand, whereas those who prefer to process information in parts (analytics) may try to treat each line of thought independently and sequentially thus miss the important connections between them²⁴⁵. Analytic students interviewed claimed to have a preference towards the technical, analytic side of their design work²⁴⁶ A wholist student implied a more intuitive approach. The complex nature of the projects in the third year would have provided an opportunity for the wholist student to flourish in this respect, whereas in the students' earlier years, where projects were smaller, a rational approach may have been advantageous. On the whole, those students who are considered as "intermediate" tended to perform reasonably consistently across their three years of study, possibly as a result of their relative ease of access to different modes of thinking.²⁴⁷

Findings showed that the distribution of design students through learning style preference was concentrated in assimilating group with coordinates close to the intersection of the axes of the Learning Style Type Grid. The bipolar perceive dimension indicated that the freshman design students are more related to the analytical skills of theory building, quantitative analysis and technology. Also, the bipolar process dimension showed that they have better behavioral skills compared to perceptual learning skills.²⁴⁸

²⁴¹ *ibid*

²⁴² *ibid*

²⁴³ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. *Design Studies*, 27(2).

²⁴⁴ *ibid*

²⁴⁵ *ibid*

²⁴⁶ *ibid*

²⁴⁷ *ibid*

²⁴⁸ Demirkan, H., & Demirbas, O. (2008). Focus on the learning styles of freshman design students. *Design Studies*, 29(3)

Cross (1982) stated that while designers deal with the 'ill defined' problems, their 'mode of thinking is constructive' and they use 'codes that translate abstract requirements into concrete objects'. Also, Cross (2001) explained 'designedly ways of knowing' and differentiated design from other ways of knowing ²⁴⁹

Dewey (1933) had argued that reflective judgements are initiated when an individual recognizes that there are 'problematic situations' that cannot be solved by formal logic. ²⁵⁰ In Newland et al.'s (1987) study that was conducted with 45 subjects 'displayed an affinity for "active experimentation" and "concrete experience"; Kolb would term these students "accommodators"' (p. 4). Newland et al. (1987) called them 'dynamic learners' and explained their tendency as the desire to transform their experience into understanding through external representations as sketches and final drawings. These learners have a preference for both controlling action and sensing needs ²⁵¹The 'dynamic learners' 'can only cope with information in short bursts and therefore enjoy fast-acting learning process like brainstorming' ²⁵² Also, Newland et al. (1987) explained that simple analogies and use of metaphors would help designers in understanding the basic principles that will guide them in the final drawings. With respect to interpersonal style, 'dynamic learners' are self-centered individuals and not good team members²⁵³

As Hunt (1987) emphasized, these learners do not reflect their feelings in the design process. Newland et al. (1987) called these types of learners as 'contemplative learners' who have preference for abstracting patterns and being patient. 'Contemplative learners' exhibit an information need that is pattern seeking and can enable a thorough understanding of their environment²⁵⁴. Also, they do not rely on their feelings during the design process and learn best by external representations. The given critiques also help in developing their projects. During the design process they make an analysis of the environment and use their logic instead of their feelings. ²⁵⁵

Table 12 attributes of Dynamic Learners and Contemplative Learners regarding to design problem solving

Dynamic Learners		Contemplative Learners	
attributes	Negative attributes	attributes	Negative attributes

²⁴⁹ ibid

²⁵⁰ ibid

²⁵¹ Newland, P., Powell, J. A., & Creed, C. (1987). Understanding architectural designers' selective information handling. *Design Studies*, 8, 1-17.

²⁵² ibid

²⁵³ Demirkan, H., & Demirbas, O. (2008). Focus on the learning styles of freshman design students. *Design Studies*, 29(3).

²⁵⁴ Powell, J. A., & Newland, P. (1994). Informing multimedia: A sensitive interface to data for construction design professionals. *Design Studies*, 15, 285-316.

²⁵⁵ Demirkan, H., & Demirbas, O. (2008). Focus on the learning styles of freshman design students. *Design Studies*, 29(3).

desire to transform their experience into understanding through external representations as sketches and final drawings	self-centered	pattern seeking	make the analysis of the environment
controlling action and sensing needs	not good team members	understanding of their environment	use their logic instead of their feelings
brainstorming'		do not rely on their feelings	

What is less clear is the extent to which the relative decline in the performance of analytic students is a result of a change in the individual teaching and learning activities, such as the nature of exercises and specific design projects, or whether there is a personality factor which inhibits the speed at which students in different groups develop their architectural abilities.²⁵⁶

ELT portrays two bipolar learning dimensions, namely perceiving and processing. A combination of scores on the two dimensions classifies learners into one of four learning styles: accommodating (CE and AE), diverging (CE and RO), converging (AC and AE) and assimilating (AC and RO). From a hypothetical point of view, a learner would consciously move through all the phases of the learning cycle.²⁵⁷ However, most of the studies showed that all learners do not equally experience each phase of the cycle²⁵⁸

An individual with diverging style has CE and RO as dominant learning abilities. People with this learning style are best at viewing concrete situations from many different points of view. The style is called “diverging” because a person with it performs better in situations that call for generation of ideas, such as a “brainstorming” session. People with a diverging learning style have broad cultural interests and like to gather information. They are interested in people, tend to be imaginative and emotional, have broad cultural interests, and tend to specialize in the arts. In formal learning situations, people with the diverging style prefer to work in groups, to listen with an open mind, and to receive personalized feedback. An individual with an assimilating style has AC and RO as dominant learning abilities. People with this learning style are best at understanding a wide range of information and putting it into concise, logical form. Individuals with an assimilating style are less focused on people

²⁵⁶ Roberts, A. (2006). Cognitive styles and student progression in architectural design education. *Design Studies*, 27(2).

²⁵⁷ Demirkan, H., & Demirbas, O. (2008). Focus on the learning styles of freshman design students. *Design Studies*, 29(3).

²⁵⁸ Demirkan, H., & Demirbas, O. (2008). Focus on the learning styles of freshman design students. *Design Studies*, 29(3).

and more interested in ideas and abstract concepts. They have the ability to solve problems and make decisions based on finding solutions to questions or problems. Individuals with a converging learning style prefer to deal with technical tasks and problems rather than with social and interpersonal issues. These learning skills are important for effectiveness in specialist and technology careers. In formal learning situations, people with this style prefer to experiment with new ideas, simulations, laboratory assignments, and practical applications. An individual with an accommodating style has CE and AE as dominant learning abilities. People with this learning style have the ability to learn from primarily “hands-on” experience. They enjoy carrying out plans and involving themselves in new and challenging experiences. Their tendency may be to act on “gut” feelings rather than on logical analysis. In solving problems, individuals with an accommodating learning style rely more heavily on people for information than on their own technical analysis. This learning style is important for effectiveness in action-oriented careers such as marketing or sales. In formal learning situations, people with the accommodating learning style prefer to work with others to get assignments done, to set goals, to do field work, and to test out different approaches to completing a project.

Table 13 attributes of the four categories of learning styles according to Kolb's theory

	diverging style	assimilating	converging	accommodating
Perceiving	CE	AC	AC	CE
Processing	RO	RO	AE	AE
Problem-solving strategy	brainstorming	logical form	solve problems	carrying out plans
interests	people	interested in ideas	experiment with new ideas	new and challenging experiences
careers	arts	Science careers.	technical tasks	marketing or sales

Recent theoretical and empirical work is showing that the original four learning styles—assimilating, converging, accommodating, and diverging—can be expanded to show nine distinct styles. David Hunt and his associates (Abby, Hunt, & Weiser, 1985; Hunt 1987) identified four additional learning styles, which they identified as Northerner, Easterner, Southerner, and Westerner. The following descriptions of these styles include Hunt's analysis, which emphasizes the impact of the style's weakest learning mode on the learner's learning process.²⁵⁹

²⁵⁹ Hunt, D. E. (1987). *Beginning with ourselves in practice, theory and human affairs*. Brookline Books.

The Northerner emphasizes feeling (CE) while balancing acting (AE) and reflecting (RO). The learning strengths of this style are a capacity for deep involvement while being comfortable in the outer world of action and the inner world of reflection. "This person has difficulty in conceptualizing or making meaning of experience; consequently, the cycle runs from feelings to reflection (which remains unconsolidated) to action. The consequence of this Northerly pattern is that the flow is discontinuous and the actions are poorly organized since they are not informed by the foundation of AC meaning"²⁶⁰. The Easterner emphasizes reflecting (RO) while balancing feeling (CE) and thinking (AC). The learning strengths of this style are a capacity for deep reflection informed by the ability to be both feeling oriented and conceptual. "Persons with an Easterly pattern have trouble putting plans into action. Consequently, they spend much time buried in thought. Because the action is short circuited, their thoughts are about their feelings rather than about their direct actions; this imbalanced cycle lacks the rejuvenation provided by actions"²⁶¹. The Southerner emphasizes thinking (AC) while balancing acting (AE) and reflecting (RO). The learning strengths of this style are highly developed conceptual and analytic capabilities that are informed both by reflection and action. "Persons with a Southerly pattern are not in touch with their feelings. They reflect on the mechanics of their actions without benefit of emotional feedback. The reflection may lead to reformulation of concepts but the revision is mechanical and sterile"²⁶². The Westerner emphasizes acting (AE) while balancing feeling (CE) and thinking (AC). The learning strengths of this style are highly developed action skills that are informed both by conceptual analysis and intuitive experience. "In this pattern, the Westerner goes directly from feelings to conceptualizing without sorting out the concrete experience.

Table 14 attributes of the four categories of learning styles according to Hunt's theory

	Northerner	Easterner	Southerner	Westerner
emphasis	feeling (CE)	reflecting (RO)	thinking (AC)	acting (AE)
balancing	acting (AE)	feeling (CE) and thinking (AC).	acting (AE) and reflecting (RO)	feeling (CE) and thinking (AC).
inter strengths	capacity for deep involvement	ability to be both feeling-oriented and conceptual	conceptual and analytic capabilities	conceptual analysis and intuitive experience
difficulty	making meaning of experience;	putting plans into action	not be in touch with their feelings.	

²⁶⁰ Hunt, D. E. (1987). *Beginning with ourselves in practice, theory and human affairs*. Brookline Books.

²⁶¹ *ibid*

²⁶² Hunt, D. E. (1987). *Beginning with ourselves in practice, theory and human affairs*. Brookline Books.

Consequently, the initial conceptual framework is likely to be unclear, with little possibility to correct it through reflection”²⁶³. A “Balancing” learning style has been identified by Minimalist, Boyatzis, and Kolb (2002) that integrates AC and CE and AE and RO. In this study we employed the Learning Style Inventory (Kolb 1999a), the Adaptive Style Inventory (ASI, Boyatzis& Kolb 1993), and the Learning Skills Profile (LSP, Boyatzis & Kolb, 1991, 1995, 1997) to test a fundamental ELT hypothesis: The more balanced people are in their learning orientation on the LSI, the greater will be their adaptive flexibility on the ASI. ²⁶⁴According to the theories and analysis mentioned above, different scholars in the learning field presented different categories of human learning styles and thinking styles. An analysis of these two types of styles specifies a relation between them. First, we can have a look at the attributes relating to these categories.

Table 15 different thinking modes

Thinking Modes/Scholar	Subcategory	Definition	Involving Skills	Attitude
Cropley	Convergent	Assess words or validity in existing things The single best answer to a given question	-	Close-ended, well-defined problem
	Divergent	Multiple answers to the question	-	Open-ended, ill-defined problem
Problem-solving skills/ Ennis	Critical	Reasonable, reflective thinking, deciding what to believe or do (Ennis, 1991) convergent	precision, logic, fairness, relevance	skeptical attitude apply tactics and strategies to assure their understanding, be active and open to new ideas (Paul and Elder, 2013) seek to assess worth or validity in something that exists
	Creative	Fluency, flexibility, originality divergent	-	Novelty, new and useful, tries to create something new
Robert	Global	preference for organizing information as wholes	Visual representation constructive	translate abstract requirements into concrete objects
	Analytical	break down that information into smaller parts	Verbal representation quantitative analysis and	atomistic, serialistic, sequential manner

²⁶³ ibid

²⁶⁴ Kolb, A., & Kolb, D. A. (2005). *Experiential Learning Theory bibliography*. Experience Based Learning Systems, Inc.

			technology better behavioral skills	
	Intermediate	Ease of access to different modes of thinking		

According to Lawson, architecture students are being recommended to implement a parallel thinking style rather than a sequential one. The ability to see the whole picture would be an advantage for students in the design studio, but architectural problems have attributes that need the designer to have many abilities. To simplify the categories, we can correlate critical with convergent thinking as they have mutual attributes. We can find “Divergent-thinking” “Creative-thinking” and “Global-thinking” related to each other in terms of their approach to a problem. And from another perspective, we can find analytical, convergent and critical thinking related to each other.

Learning style also, can be divided into categories, namely: internal, external and experiential. It seems that there is a relation between intuitive learning and the related divergent, creative and global thinking style mentioned above. And the same relation would be applied for logical thinking and the related convergent, critical and analytical thinking style. These two groups of thinking modes and learning modes, follow different direction in their education process. So, the education system should have a plan, which is able to nurture students, based on their own learning mode, or in another scenario, it should have a plan to have an educational syllabus, considering the restrictions of each category.

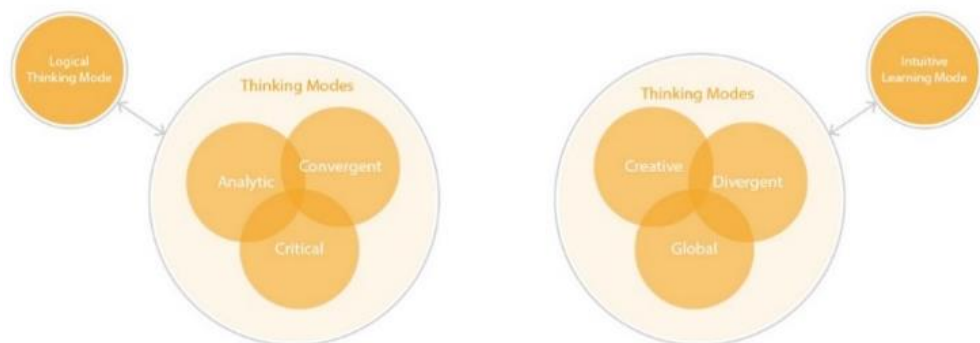


Figure 34 The relations between thinking modes and Learning modes

What we can see as the essence of architecture schools is to have a curriculum that does not satisfy the needs of students that think globally, an approach which is great for architecture education due to its open-ended nature of problems. This category needs to learn things individually and not collaboratively. But design studio approach is based on collaborative learning. Second, this system is devised on a sequential manner and creates

architectural results which lack creativity, which is an inseparable part of architectural answers needed.

The attitude towards the design problem in the studio which is in accordance with the analytical approach does not set a path that shows the students how to open the gates of creativity and intuition on a design problem.

This research was conducted to explore different flaws regarding to architecture education system, based on different categories of learning and thinking styles of students. The final aim would be to find a systematic way of teaching, in which all types of students can reach their potential and become a socially engaged creative designer, or an architect.

3-4. Contriving a teaching method

Entering an architecture school means grappling with the challenges of a new learning and problem-solving method. This phenomenon gets intensified when there is no art-based educational background in the participant. Single-answer problems are common in science-based majors such as mathematics, which in some countries, is the architecture student's educational background. In these fields of study, it is enough for the students to listen to the teacher meticulously and grasp the formula of a problem. In traditional approaches to teaching engineering classes, the instructor plays the role of information conveyor, while the students assume a receiver role with primary responsibilities of listening and note-taking. The traditional lecture is where students passively receive information from the instructor.²⁶⁵ Such students, nurtured in these kinds of practices, face big challenges when entering architecture schools usually. The reason behind this problem is the fact that architecture problems, like many other artistic majors, are not single answered. The studio is a place where formal and informal learning happens.²⁶⁶ Creativity plays a major role in architectural solutions. Creativity is the cornerstone of architecture.²⁶⁷ To design creatively means to give alternated solutions. Furthermore, architectural problems are multidimensional, and giving solutions to them needs a great amount of work and effort. This process can be facilitated when participating actively in the learning process. Being an active learner can be manifested through various methods, which in this research is going to be explored comprehensively from different perspectives.

This research aims to answer the following questions:

²⁶⁵ Prince, M. (2004). Does Active Learning Work? A Review of the Research. *Journal of Engineering Education*, July, 223.

²⁶⁶ Hamza, T. S., & Hassan, D. K. (2016). Consequential creativity: Student competency and lateral thinking incorporation in architectural education. *International Journal of Technology and Design Education*, 587–612.

²⁶⁷ Danaci, H. M. (2016). Creativity and knowledge in architectural education. *Procedia - Social and Behavioral Sciences*, 174, 1309-1312.

1. What is active learning in the context of architecture education? What are the outcomes? What are the ways to facilitate active learning for architecture students?
2. What are the ways to help students think more creatively? Can lateral thinking be helpful in active learning in architecture education?
3. What has academic literature provided to help active learning and lateral thinking in architecture education?

With the aim of answering these questions, a systematic review of the whole article papers in the context of architecture has been gathered, categorized, and analyzed which leads to effective results. This process goes beyond what was mentioned, focusing on another strategy for being more creative, which is a shift in the mindset, from vertical thinking to lateral thinking, which according to Edward de Bono is possible via some strategies. Therefore, the exploration for finding strategies for active learning was expanded by adding this item into the research area. Finally, a list of suggestions is provided for the educational system, including teacher and space requirements, and finally, the learners, to make a shift from passive learning to active learning in their architecture education.

Learning in the Studio

The design studio is the nucleus of the architectural program where the architecture student explores and experiments with various architectural projects and imparts the basic skills and knowledge required for the architectural profession.²⁶⁸ Learning in the design studio begins with ill-defined problems, a general characteristic of professional education, and observed that learning in the studio developed through a process he called 'reflection-in-action'.²⁶⁹ This is where many challenges come to happen. The ability to cope with ill-defined problems is not obtained through the study in science-based majors at schools. According to Hamdi, competent practitioners need to develop parallel thinking (the brain's heart), which relates to learning by trial and error, dialoguing with experience, and finding association between different concepts. Practitioners also need quantum thinking (the brain's spirit), which involves the ability to question, apply holistic approaches, adapt objectives, change assumptions and break rules.²⁷⁰ The ability to shift between these modes of thinking is not practiced at school for many architecture students. These difficulties include the lack of a clearly defined design methodology and the misunderstood role of the systematic approach to design in the studio.²⁷¹ The growing

²⁶⁸ Hamza, T. S., & Hassan, D. K. (2016). Consequential creativity: Student competency and lateral thinking incorporation in architectural education. *International Journal of Technology and Design Education*, 587–612.

²⁶⁹ Kvan, T., & Yunyan, J. (2005). Students' learning styles and their correlation with performance in architectural design studio. *Design Studies*, 26(1), 19–34.

²⁷⁰ Till, J. (2005). The negotiation of hope. In *Architecture and Participation* (1st ed., pp. 19–41). London: Spon Press.

²⁷¹ Schon, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Basic Books Inc.

dissatisfaction with design failures in architectural design studios appears to be the main concern of researchers and academicians around the world²⁷². In a time when the world is becoming complex, the field of architecture faces the challenges of climate change, globalization, urbanization, and social transformation on an unprecedented scale. The design studio environment has remained the same throughout the past century. As the Studio Culture Task Force of the American Institute of Architecture Students (AIAS) ²⁷³noted, the changes in architecture education are not aligned with today's fast-changing world, especially in the context of architectural practice²⁷⁴; all these changes and difficulties are adding more complexity to the design problems of architecture studios which makes the change in this course, as the most important course of architecture major, more important. Lawson ²⁷⁵mentioned evidence of the design process difficulty. He stated what design **instructors suffer when they ask their students to go through the generation phase to find alternatives and new ideas**; “they can’t detach themselves from a particular solution or design to look at others”. In addition, some misconceptions hinder students to believe in their ability to think creatively; examples of such misconceptions are: creativity is a natural talent and cannot be taught; creativity comes from the rebels, release, intuition, craziness, scatter-gun success ²⁷⁶ Creating an atmosphere where creativity is fostering seems to be essential in the design studio, and the students and tutors suffer lack of understanding the ways in which they can nurture their creative abilities.

Education for Creativity

Creativity is the cornerstone of architecture ²⁷⁷ Creativity is an original cognitive ability and problem-solving process which enables individuals to use their intelligence in a way that is unique and directed toward coming up with a product. Architectural education is one of the fields in which human creativity has been exhibited; because it can be defined as a design study that correlates with other disciplines: social sciences, management, history, operational research, philosophy, graphic design, math and etc. These features which distinguish architecture from other disciplines ascribe a different kind of responsibility for architectural education; since besides technical and professional skills, an architect must have imagination and be

²⁷² Salama, A. (1995). *New Trends in Architectural Education: Designing the Design Studio*. Tailored Text & Unlimited Potential Publishing.

²⁷³ Koch, A., et al. (2006). *The redesign of studio culture: A Report of the AIAS Studio Culture Task Force*. The American Institute of Architecture Students.

²⁷⁴ Bashier, F. (2014). Reflections on architectural design education: The return of rationalism in the studio. *Frontiers of Architectural Research*, 3, 424–430.

²⁷⁵ Lawson, B. (2005). *How designers think: The design process demystified*. Elsevier/Architectural.

²⁷⁶ De Bono, E. (1993). *Serious creativity: Using the power of lateral thinking to create new ideas*. HarperBusiness.

²⁷⁷ Danaci, H. M. (2015). Creativity and knowledge in architectural education. *Procedia - Social and Behavioral Sciences*, 174, 1309-1312.

creative at many levels.²⁷⁸ It is, therefore, crystal clear that architecture students should have the ability to be creative, and the education system and the student are responsible for acquiring this ability. Training in creative thinking can be considered as independent courses or within specific architectural curricula.²⁷⁹ In other words, the creative design process should be operated by applying creative thinking tools and techniques simultaneously with critical thinking skills.²⁸⁰ The design process has two main features: first, it is an essentially creative effort, and second, it is closely associated with drawing.²⁸¹ If students are not able to access the creative part of their mind, both the education system and they will face significant difficulties, and the outcome of the education system will not be satisfactory. This leads to putting emphasis on activating creative thinking in the students through all the possible areas of penetration.

Edward de Bono has worked on ways to activate creative thinking. In 1967 He coined the term “Lateral Thinking” which is to think beyond existing boundaries, to awaken curiosity, to break away from rational, conventional ideas and formalized procedures²⁸² Opposite to that is vertical thinking, which is a critical, evidence-based approach for processing information and generating ideas. The designer then adheres to developing this principle in depth rather than elaborating on other alternative solutions, and hence the designer's effort, in this case, becomes making the initial idea work rather than generating different ideas.²⁸³ This generative nature represents the major difference between lateral and vertical thinking modes. Therefore, complementing the selectiveness of vertical thinking with the generative qualities of creative thinking is often called for.²⁸⁴ The ability to shift between these modes of thinking is therefore extremely essential for an architecture student that has to change his /her mindset in different phases of learning. This research, therefore, has explored much academic literature to find as many possible solutions as possible in this regard.

3-5. Restructuring the architecture design teaching

Architecture education should consider an approach that caters to the diverse learning styles of students. The field of architecture requires

²⁷⁸ Hamza, T. S., & Hassan, D. K. (2016). Consequential creativity: Student competency and lateral thinking incorporation in architectural education. *International Journal of Technology and Design Education*, 587–612.

²⁷⁹ Hamza, T. S., & Hassan, D. K. (2016). Consequential creativity: Student competency and lateral thinking incorporation in architectural education. *International Journal of Technology and Design Education*, 587–612.

²⁸⁰ Hamza, T. S., & Hassan, D. K. (2016). Consequential creativity: Student competency and lateral thinking incorporation in architectural education. *International Journal of Technology and Design Education*, 587–612.

²⁸¹ Mozaffar, F., & Khakzand, M. (2009). Architectural design process in technology age. *International Journal of Industrial Engineering and Production Management*, 19(6), 53–72.

²⁸² Sefertzi, E. (2000). *Creativity*; Report produced for the EC funded project.

²⁸³ De Bono, E. (2015). *Serious creativity*. Vermilion.

²⁸⁴ Eisa, D. (2019). Concept generation in the architectural design process: A suggested hybrid model of vertical and lateral thinking approaches. *Thinking Skills and Creativity*, 33.

creativity, critical thinking, problem-solving, and attention to detail, and these skills can be developed through various teaching methods.

One way to create the potential for students with different thinking modes is to incorporate multiple teaching methods into the curriculum. For instance, students who learn better through hands-on experience can benefit from studio-based courses that involve designing and making physical models. Visual learners, on the other hand, may benefit from courses that emphasize the use of diagrams, sketches, and graphics.

In addition to traditional teaching methods, technology can also be utilized to accommodate different learning styles. For example, students who prefer audiovisual learning can benefit from online lectures, video tutorials, and virtual reality simulations.

Another approach is to encourage collaborative learning and peer-to-peer teaching, which can help students learn from each other and develop teamwork skills. Group projects and design competitions can provide opportunities for students with different thinking modes to work together, exchange ideas, and learn from one another.

Overall, by considering the diversity of learning styles in architecture education and providing various teaching methods, we can create a more inclusive and effective learning environment for students.

Many current architecture design systems are based on data analysis. Noticing and defining the functions by reviewing various case studies and considering the construction legislations and criteria. In the further phase, this information leads students to provide some diagrams. These diagrams are the primary material that submit with a design schema. This process evokes students to train and think analytically due to its logical nature; in addition, the limitations that have been defined at the very beginning of the design process are quite against creativity do not work in way which fosters creativity and the intuitional essence of an artistic trend. As we mentioned, we are encountering two different types of students with different attitudes or thinking modes: Divergent thinkers (A) and Convergent thinkers (B). The (A) group mostly engages in the problem with intuitive approaches even if restraints are defined stricter. But the (B) group would analyze the project conditions and design accordingly. The process would be the same as solving a mathematical problem, whereas, in solving a math problem, you are not supposed to be creative.

The imagination and creativity part of the design process should be triggered through a different design approach that allows students to explore alternative solutions to architecture problems. One way to achieve this is through a design thinking approach, which emphasizes creativity, empathy, and iterative problem-solving.

Design thinking involves a series of steps, including understanding the problem, empathizing with the users, brainstorming ideas, prototyping solutions, and testing and refining the design. This approach encourages

students to explore multiple solutions to a problem and to approach the design process with an open mind.

Another approach to trigger imagination and creativity is through the use of design prompts or challenges without the presence of an architectural subject-matter that encourages students to think outside the box. For example, a prompt might ask students to design a structure that incorporates Formal elements or to create graphical compositions by using geometrical orders. The author has worked with numerous students in the Bachelor of Architecture program at Iran University of science and technology. A design process is tested on many freshmen regarding to form practice design on the subject of architecture but in the absence of architecture problem. The result was fascinating and most of the students could find more creative solutions when solving the architecture problem.

It seems that form practice, in the absence of architecture problem, would enhance the probability of creativity in the design process. Maybe the reason would lie in the thinking modes of students, which for some, is automatically run based on critical thinking, which would not take students to the imagination phase. Analyzing the architecture question, trying to find out the solution, is a critical way of thinking which is less probable to put critical thinker students in the condition of creativity.

In summary, the key points for teaching architecture involve recognizing diverse learning styles, employing multiple teaching methods, integrating technology, fostering collaborative learning, understanding the balance between analytical and creative thinking, and incorporating alternative approaches to trigger imagination and creativity in the design process.

1- Diverse Learning Styles: Architecture education should acknowledge and accommodate diverse learning styles among students. The field requires skills such as creativity, critical thinking, problem-solving, and attention to detail, which can be developed through various teaching methods.

2- Multiple Teaching Methods: Incorporate multiple teaching methods into the curriculum to cater to different thinking modes. Studio-based courses with hands-on experience benefit tactile learners, while visual learners may prefer courses emphasizing diagrams, sketches, and graphics.

3- Technology Integration: Use technology to accommodate various learning styles, such as online lectures, video tutorials, and virtual reality simulations, catering to audiovisual learners.

4- Collaborative Learning: Encourage collaborative learning and peer-to-peer teaching through group projects and design competitions. This fosters teamwork skills and provides opportunities for students with different thinking modes to exchange ideas.

5- Analytical vs. Creative Thinking: Recognize the distinction between divergent thinkers (intuitive) and convergent thinkers (analytical) in architecture education. While analytical thinking is essential, creative thinking should be triggered through alternative approaches, such as design thinking.

6- Design Thinking Approach: Integrate a design thinking approach in the curriculum, emphasizing creativity, empathy, and iterative problem-solving. This involves understanding the problem, empathizing with users, brainstorming ideas, prototyping solutions, and testing and refining designs.

7- Imagination and Creativity: Trigger imagination and creativity through design prompts or challenges that do not necessarily involve architectural subject matter. This allows students to think outside the box and explore alternative solutions.

8- Form Design Practice without Architecture Problem: Consider the use of form practice without a specific architectural problem to enhance creativity in the design process. This unconventional approach may engage critical thinkers in a more imaginative phase.

One important issue in the design studios is concept and conception in architectural design. Conception is defined as the act of forming an idea or plan, and a concept serves as the key to conception. The distinction between scientific and common concepts is emphasized, with architectural concepts aiming to inspire thinking and generate possibilities rather than establish scientific theories. Architectural concepts involve a creative process, translating knowledge into formal and functional predictions and understanding the meaning of Form in architectural context. Design issues expressed verbally guide the designer's concerns and their relation to the specific design. The translation of specifications into design involves visual thinking through formal strategies, often presented as sketches or drawings proposing solutions to the design problem. Form analysis, discourse analysis, and design evaluation are highlighted as methods to understand the relationship between concept, design issues, and formal strategies. Coherence in formal strategies reflects the designer's intention and the legitimacy of translating concepts into visually compelling forms. Based on the knowledge provided in next chapter the importance of merging complex design issues in an artistic way to achieve convincing design accomplishments. Overall, the study underscores the intricate interplay between verbal and visual elements in architectural design and the significance of thoughtful translation from concept to form.

Therefore in the next chapter, before dealing with the problem of form-finding, we will delve into the concept of form from the perspective of non-formalism and interpret it as a visually compelling strategy. Then, we will

conduct detailed investigations in the field of theories related to the process of form-finding, so that the role of form in the design process will be more defined and the creative exercises that can be used to develop students' imagination in this field will be studied from the perspective of form finding and in the form of a laboratory process in the next chapter.

CHAPTER 4.

Demystifying the Form conception and its role in design

An architectural concept is, therefore, not a theoretical formation but a comprehensive understanding of specific design issues resulting from an intellectual process engaged in projecting appropriate architectural forms. Shih, Chih-ming

This chapter encompasses the topics as follows:

- 4-1. An overview on the essence of Form
- 4-2. Form position in the design process
- 4-3. Form development process in Architecture
- 4-4. Utilizing intuition and imagination as a means of Form-Finding

4-1. An overview on the essence of Form

Daughter: Daddy, why do things have outlines?

Father: Do they? I don't know. What sort of things do you mean?

D: I mean when I draw things, why do they have outlines?

F: Well, what about other sorts of things – a flock of sheep? Or a conversation? Do they have outlines?

D: Don't be silly. I can't draw a conversation. I mean things.

F: Yes – I was trying to find out just what you meant. Do you mean 'why do we give things outlines when we draw them?' or do you mean that the things have outlines whether we draw them or not?

D: I don't know, Daddy. You tell me. Which do I mean?²⁸⁵

Through their essay, (Traversing Formalisms) S. Kousoulas and J. Hernández, Based on **Bateson** metalogue with his daughter, he argued that the Form could be taken for something that is essentially unattainable. In this sense, to ask 'What is form?' implies a generalization, which necessarily dismisses or neglects certain, often essential aspects. In fact, Bateson invites us to assume that the shape of things comes out of a 'negotiation across the threshold of an outline.'

Following the footsteps of Gestalt psychologists, Arnheim argued that perception processes the information it gathers in a conceptual way, and as far as shape goes, perception is "the grasping of generic structural features"²⁸⁶. He also elaborated: "Seeing a fire is always seeing fireness, and seeing a circle is seeing roundness".²⁸⁷

From the above, it can be inferred that form is a conceptual feature of phenomena that not only implies their perceptual nature but is also integrated with the cognitive characterization of phenomena. These properties are intertwined with the functions of objects, and in cases such as fire, as Arnheim puts it, the correlation of content with appearance is such that the existence of one without the other is inconceivable. We usually remember or identify everything by its formal characteristics. But this does not only include objects or phenomena. If we want to display a mental concept in the guise of a physical nature, we inevitably need to define a physical structure. Something of material, texture, color ... as K. Michael Hays noted, we can conceptualize freedom. We can even explain

²⁸⁵ Bateson, G. (2000). Steps to an Ecology of Mind. University of Chicago Press. (Original work published 1972).

²⁸⁶ Arnheim, R. (1969). Visual thinking. University of California Press.

²⁸⁷ Arnheim, R. (1986). A plea for visual thinking. In New essays on the psychology of art (p. 143).

what freedom is as a concept. But it's very difficult to depict freedom. To show freedom, we would have to construct a picture. We would have to construct a scene. Then we could help an audience to imagine freedom in that materialization, in that scene, in that picturing. In the template of a tangible form.

Adrian Forty argues that ambiguity (at least in the English language) is partially to blame. Form, he notes, stands for shape, but it also stands for the idea or essence behind that shape.²⁸⁸ These two different interpretations alternate between form understood as a mental construct and form understood as the way an object or substance is perceived by the senses.²⁸⁹ He continued: we must remain aware that form, like any other word, is always and only a device for thought.²⁹⁰

Initially, this is important to accept Mitchell's discourse regarding the understanding of form as something that is not to be made but will be found, not constructed voluntarily but discovered as something we were already committed to without being aware of.²⁹¹

Form mostly lies active, full of potential and agency, unapproachable in terms of what it is and what it can do. Said differently, it strongly believable that the crucial issue when it comes to architectural form is not to define it properly but rather to determine the effects and the limits of its actions. Such an endeavor, necessarily syncretic and transversal, relies on a myriad minor question.²⁹²

Akner-Koler remarked the word form refers to both the cognitive activity of thinking in abstract form and the transfer of abstract form to the concrete properties, structures, and relationships of form elements in space. Form involves the haptic and kinesthetic senses as well as the direct and indirect visual perception that is stimulated through physical features. The form is the manifestation of the gestalt. The aesthetical involvement needed to organize concrete form for product development is referred as the form-giving process, which is derived from the Swedish word form-giving, meaning to create the physical form that reflects the goals of the product.²⁹³ The concept of form encompasses both abstract thinking and the translation of abstract ideas into tangible physical elements. It involves the process of mentally conceptualizing and shaping ideas before actualizing

²⁸⁸ Forty, A. (2000). *Words and Buildings: A Vocabulary of Modern Architecture*. Thames and Hudson.

²⁸⁹ (Ibid., 149)

²⁹⁰ (Ibid., 150)

²⁹¹ Mitchell, W. J. T. (2003). The Commitment to Form; or Still Crazy after All These Years. *PMLA*, 118(2), 323.

²⁹² Kousoulas, S., & Hernández, J. (2018). Exploring Architectural Form: A Configurative Triad. *Footprint*, Spring/Summer 2018, 1–6.

²⁹³ Akner-Koler, C. (2006). Challenging and expanding the aesthetical realm of form theory and practice. In *Proceedings of the 5th Nord code seminar and workshop*, May 10-12.

them in concrete forms and structures within a spatial context. Form engages not only the visual perception but also the haptic and kinesthetic senses. It recognizes that our experience and understanding of form go beyond visual observation, extending to tactile and bodily sensations when interacting with physical features and spatial arrangements.

Gestalt refers to the principle that the whole is greater than the sum of its parts. In the context of form, it suggests that the arrangement and organization of form elements create a unified and holistic experience. Form is the manifestation of this gestalt, where the combination and interaction of elements give rise to a coherent whole.

David Pole, characterizes “form” as a “polar term” which “has its meaning bound up with its correlates.” He mentions three possibilities: “form as opposed to matter,” “form as opposed to content,” and “form as opposed to formlessness.” In addition to these three basic ways of understanding form, Pole suggests a fourth possibility: “form as structure” where structure “is constituted by a system of relations, and it is opposed to content, what they relate.”²⁹⁴

Form as opposed to matter: This understanding emphasizes the distinction between the physical materiality of an object or building and its formal qualities. It recognizes that form goes beyond mere substance and encompasses the arrangement, shape, and organization of elements. Form as opposed to content: Here, form is contrasted with the content or meaning conveyed by an object or building. While content refers to the intellectual, symbolic, or representational aspects, form relates to the visual and sensory characteristics that give shape to the content.

Form as opposed to formlessness: This perspective highlights form as a counterpoint to the absence or lack of form. Form brings structure, coherence, and order to a design, whereas formlessness suggests a lack of organization or recognizable shape. Form as structure: Pole introduces the idea of form as structure, where structure refers to the system of relationships between elements. In this understanding, form is seen as the result of the interplay and arrangement of various components, rather than an isolated entity. It emphasizes the importance of understanding how elements relate to each other to create a coherent and meaningful whole.

Building upon Ingarden’s, Tatarkiewicz’s, and Pole’s conclusions, one may suggest that there are four basic meanings in which the concepts of “form” and “content” are used with reference to works of art. **Bohdan** start to describe form with simplest, commonsensical understanding of these terms:

²⁹⁴ Pole, D. (1983). *Aesthetics, Form and Emotion*. Duckworth.

1. The content of a work of art may mean everything represented and expressed in a work, while the form may describe the means and ways of representing and expressing that something.

The three following distinctions are arranged according to the principle of ever broader understanding of the term "form" in relation to works of art.

2. "Form" may be understood as a certain arrangement of parts, a structure of elements, or a global composition of elements of a work or some other object. In such a case, its correlative is content, understood as a selection of all the elements of the work, its "matter" ("material") or, as Ingarden puts it, "the material endowment" a work of art, or, to put it still differently, its "substance." When the form is understood so narrowly, the individual sensual qualities (colors, lines, shapes, sounds, sonorities, etc.) are not considered to be formal elements (only their interrelations are considered as such); they are the substance of the artwork.

3. Desirable qualities may be treated as the formal aspects of artwork if by "form" one means those things directly and sensually perceived in work. (Tatarkiewicz often uses here the term "appearance.") This definition holds for nonartistic phenomena as well.

4. Finally, theoreticians sometimes consider "form" to signify not some significant aspects or side of an artwork, but the artwork itself, in which the formal elements (in the narrower definition) and elements of content are united into certain organic wholeness, or a certain self-contained structure abstracted from the world. In this sense, we talk not about the form of artwork but artwork as an artistic form. "Form" is thus considered to be either the so-called idea of the work (which can be with some approximations reconstructed) or the material substratum of the work (which had not been subject to artistic shaping yet, e.g., the topic and the linguistic substance in literature). This type of conceptualization is noted by Ingarden in his work of 1958.²⁹⁵

D'Arcy described form as "diagram of forces." It is possible then, to think form as the result of a process rather than a static or idealized entity, the pre-conceived outcome of a formal intention. D'Arcy Wentworth Thompson writes.

The form, then, of any portion of the matter (of a work of art)...and the changes of form which are apparent in its movements and in its growth (in its development) may in all cases alike be described as due to the action of force. In short, the form of an object is a "*diagram of forces*", in this sense,

²⁹⁵ Ingarden, R. (1958). O formie i treści dzieła sztuki literackiej. In *Studia z estetyki* 2. PWN.
Tatarkiewicz, W. (1949). Dwa pojęcia formy. [Translated as "The Two senses of Form"].

at least, that from it we can of or deduce the forces that are acting or have acted upon it: in this strict and particular sense, it is a diagram - in the case of a solid (in the case of a finished work of art) of the forces which *have been* impressed upon it when its conformation was produced ... in the case of a liquid (in the case of a work in progress)...of the forces which *are for the moment* acting on it to restrain or balance its own inherent mobility.²⁹⁶

Kant claims that when we judge something to be beautiful, we are concerned only with its form. "A pure judgment of taste is one that is uninfluenced by charm or emotion (though these may be connected with a liking for the beautiful), who's determining basis, therefore, is merely the purposiveness of the form"²⁹⁷

Kant argued that space and time are mere "forms of intuition" which structure all experience, and therefore that while "things-in-themselves" exist and contribute to experience, they are nonetheless distinct from the objects of experience. From this it follows that the objects of experience are mere "appearances", and that the nature of things as they are in themselves is consequently unknowable to us. Taste, which is a judgment of the beautiful, is provoked by the form of the object. The feeling of sublime "can also refer to an object even lacking form". If it is a limitation, the without-form is, on the contrary, the without-limit. Hence, the argument has to be analyzed under this perspective: as the feeling of the beautiful results from a form (that is a limitation), its affinity has to be found in understanding. The sublime feeling, which is or can be provided by without-form, lies in reason. There is indeed a similarity between both cases in the presentation of form and without-form that should be able to be thought of by a concept but, yet in both cases, is not. This is why the concept of understanding, like that of reason, remains "indeterminate."²⁹⁸

Neo-Thomist theorists, like Jacques Maritain, propound that form is the principle of perfection of a being, which accounts for the being's essence and qualities. He continued:

"Form is the ontological secret that stands within them, that is operating in the mystery above all the proper principle of intelligibility, the proper clarity of everything a vestige or a ray of the creative intelligence at the heart of created being."

Knowing and understanding reality is possible only through forms; it is the source of immortality in things. If we reflect upon it, whenever we think of

²⁹⁶ Thompson, D. W. (1942). *On Growth and Form* (Enlarged ed.). Cambridge University Press. (Original work published 1917). Quoted in Thistlewood, D. (1984). Herbert Read: Formlessness and Form: An Introduction to His Aesthetics (p. 128). Routledge & K. Paul.

²⁹⁷ Hughes, F. D. (2007). *Kant's aesthetic epistemology: Form and world*. Edinburgh University Press.

²⁹⁸ Lyotard, J.-F. (1994). *Lessons on the Analytic of the Sublime: Kant's Critique of Judgement*, [sections] 23-29. Stanford University Press.

a person or an object, we remember them through their external aspect and physicality. It is in fact, through their form that the inner radiance of entities gets manifested with their particular reflections of the divine extensiveness.²⁹⁹

Philosophical concept

The word *form* has been used in a number of ways throughout the history of philosophy and aesthetics. It was early applied to Plato's term *eidos*, by which he identified the permanent reality that makes a thing what it is, in contrast to the particulars that are finite and subject to change. The Platonic concept of form was itself derived from the Pythagorean theory that intelligible structures (which Pythagoras called numbers), and not material elements, gave objects their distinctive characters. Plato developed this theory into the concept of "eternal form," by which he meant the immutable essence that can only be "participated in" by material, or sensible, things. Plato held that eternal forms, though they were not tangible, were of a higher reality than material objects.

For practical purposes, Aristotle was the first to distinguish between matter (*hypokeimenon* or *hyle*) and form (*eidos* or *morphe*)³⁰⁰. He rejected the abstract Platonic notion of form and argued that every sensible object consists of both matter and form, neither of which can exist without the other. For Aristotle, matter was the undifferentiated primal element; it is that from which things develop rather than a thing in itself. The development of particular things from this germinal matter consists in differentiation, the acquiring of the particular forms of which the knowable universe consists. Matter is the potential factor, form the actualizing factor. (Aristotle further posited the existence of a prime mover, or unmoved mover, i.e., pure form separate from matter, eternal and immutable). Thus according to Aristotle, the matter of a thing will consist of those elements of it which, when the thing has come into being, may be said to have become it; and the form is the arrangement or organization of those elements, as the result of which they have become the thing which they have. Thus, bricks and mortar are the matter that, given one form, become a house, or, given another, become a wall. As matter they are potentially anything that they can become; it is the form which determines what they actually become.

Aquinas further delineated the concept of form to include "accidental form," a quality of a thing that is not determined by its essence; "sensible

²⁹⁹ Dubay, T. S. M. (1999). The evidential power of beauty. Ignatius Press.

³⁰⁰ In one sense an object's form is an essence or structure (as the Greek describe like (*eidos*), which makes it the distinct object it is. And in a secondary sense, an object's form is the shape by which it can be known or recognized (by the Greek *morphe*), either as an individual or as an example of a kind. The word *morphe* was mostly used for visual aspect of forms and *eidos* was used for mental aspect of forms. We need both *morphe* and *eidos* to make a specific form identifiable.

form,” that element of form that can be distinguished from matter by sense-perception.

For the 18th-century German philosopher Immanuel Kant, form was a property of mind; he held that form is derived from experience, or, in other words, that it is imposed by the individual on the material object. In his *Kritik der reinen Vernunft* (1781, 1787; *Critique of Pure Reason*) Kant identified space and time as the two forms of sensibility, reasoning that, though humans do not experience space and time as such, they cannot experience anything except in space and time. Kant further delimited 12 basic categories that act as structural elements for human understanding.³⁰¹

Literally and artistic concept

When it comes to literary and artistic aspects of form, Encyclopedia Britannica reads:

The concept of form is also indispensable to the practice and criticism of several disciplines other than philosophy. In literature, for example, the term may refer to the schema, structure, or genre that a writer chooses for the presentation of his subject—e.g., novel, short story, maxim, haiku, sonnet, etc.; it may also refer to the internal structure of the work, and, to a great extent, a work’s critical success depends on the degree to which the artist is able to integrate the content and internal structure within the framework of its external form. In criticism of the graphic arts, the term *form* refers to the effect achieved by draftsmanship or mass as distinct from that achieved by such elements as color or texture. In sculpture and other plastic arts, form (or shape) is both tangible and visible and thus is the chief element of organization.³⁰²



Figure 35 Form investigation categories

If the world were totally regular and homogeneous, there would be no forces, and no forms. Everything would be amorphous. But an irregular world tries to compensate for its own irregularities by fitting itself to them, and thereby takes on form. D' Arcy Thompson has even called form the “diagram of forces” for the irregularities. More usually we speak of these irregularities as the functional origins of the form.

³⁰¹ Ibid

³⁰² Ibid

The following argument is based on the assumption that physical clarity cannot be achieved in a form until there is first some programmatic clarity in the designer's mind and actions; and that for this to be possible, in turn, the designer must first trace his design problem to its earliest functional origins and be able to find some sort of pattern in them. I shall try to outline a general way of stating design problems which draws attention to these functional origins and makes their pattern reasonably easy to see. It is based on the idea that every design problem begins with an effort to achieve fitness between two entities: the form in question and its context. The form is the solution to the problem; the context defines the problem. In other words, when we speak of design, the real object of discussion is not the form alone, but the ensemble comprising the form and its context. Good fit is a desired property of this ensemble which relates to some particular division of the ensemble into form and context.

The form is a part of the world over which we have control, and which we decide to shape while leaving the rest of the world as it is. The context is that part of the world which puts demands on this form; anything in the world that makes demands of the form is context. In a problem of design, we want to satisfy the mutual demands which the two make on one another. We want to put the context and the form into effortless contact or frictionless coexistence.³⁰³

The artist's self-conscious recognition of his individuality has a deep effect on the process of form-making. Each form is now seen as the work of a single man, and its success is his achievement only.³⁰⁴

4-2. Form position in the design process

"The ultimate object of design is form" was a controversial discussion that propounded by Christopher Alexander. Asserting that generating form³⁰⁵ poses one of the fundamental questions in architectural education and practice still needs to be questioned. Architectural production is frequently accompanied by debates about the legitimacy of its design approach, questioning the relationship between function and form, aesthetics and construction systems, context and structure, user needs and construction costs, in all possible configurations.

As designs became more revolutionary and progressive, the failures of the design by drawing process became more obvious, particularly in the field of architecture. It became apparent that if we were to continue separating designing from making, and also to continue the rapid rate of change and

³⁰³ Alexander, C. (1973). Notes on the Synthesis of Form. Harvard University Press.

³⁰⁴ Ibid

³⁰⁵ Agkathidis, A. Generative Design: Form-Finding Techniques in Architecture.

innovation, then new forms of modelling the final design were urgently required. It was precisely this concern that led Alexander to write his famous work *Notes on the Synthesis of Form* in 1964. He argued that we were far too optimistic in expecting anything like satisfactory results from a drawing-board based design process. How could a few hours or days of effort on the part of a designer replace the result of centuries of adaptation and evolution embodied in the vernacular product? Alexander proposed a method of structuring design problems that would allow designers to see a graphical representation of the structure of non-visual problems.³⁰⁶

Most designers are probably very conscious of the need to improve our world in this way but find it extremely difficult to incorporate findings and recommendations into their design process. The findings and data are seldom clearly expressed in a form which a designer can make sense of. Just as it is increasingly difficult to know what is safe and healthy to eat, so designing in an ecologically sound way is surrounded by myths, campaigns and, sometimes, deliberately misleading data. In all this confusion, however, designers cannot usually procrastinate as did those deciding on the third London airport. They simply must get on and make the decision in as integrated and sensible a way as they can. Their decisions then remain very visible and easy to criticize as data becomes more clearly available!³⁰⁷

Hans Scharoun show a much greater concern with the expressive qualities of design and the use of form and space to achieve specific effects rather than as an abstract assembly.³⁰⁸

Scharoun's approach to design went beyond the abstract assembly of forms and focused on creating meaningful and experiential spaces. He believed that architecture should evoke emotional and psychological responses and that the design of a building should be shaped by its context, function, and the needs of its users.

In recent years, computational tools have introduced innovative form-finding techniques, revolutionizing architectural design and production. These techniques are often described by terms such as 'generative design', 'parametric design' or 'algorithmic design', to name but a few. These offer new design paths to architects by breaking with predictable relationships between form and representation in favor of computationally generated complexities, thus enabling the development of new topologies. They shift the emphasis from 'form making' to 'form finding' (Kolarevic 2003).³⁰⁹ The critics of such design approaches claim that they disconnect architectural output from its context and its users, and lead to a decrease in spatial quality

³⁰⁶ Lawson, B. (2005). *How Designers Think: The Design Process Demystified* (4th ed.).

³⁰⁷ Ibid

³⁰⁸ Ibid

³⁰⁹ Kolarovic, B. (2003). *Architecture in the Digital Age: Design and Manufacturing*. New York: Spon Press

and a building's integration within the urban environment. Furthermore, some argue that a totally computerized approach leads to disconnection from physical modeling and drafting techniques – once essential foundations of architectural education.

Why, though, should anyone follow a method for designing architecture in the first place? Can architects not simply rely on personal inspiration or their own sense of beauty? Throughout the evolution of architectural design there have certainly always been schools of thought that have encouraged a design process based on inspiration or an initial stimulus. **However, others have promoted adherence to a specific design method, based on rules rather than intuition, and many now argue that design methods are necessary in order for architects to deal with today's hyper-complex design briefs, or to prevent self-indulgence and stylistically driven formal language.** Others affirm that emerging computational design and fabrication tools are changing the architect's role, making design methods a necessity.³¹⁰

As we mentioned in the chapter of design, the decisive role of intuition is very substantial in discovering the nature of what is to be designed. This subjective point of view on the design problem and the discovery of hidden relationships between criteria and parameters that must be analyzed in a design process mostly relies on an intuitive approach rather than a logical and inductive type of thinking. Design problems are often complex and multifaceted, involving various criteria and parameters that need to be considered. While logical and analytical thinking certainly has its place in the design process, intuition complements and enhances it by providing a subjective perspective and the ability to recognize hidden relationships and patterns.

Intuition allows designers to draw upon their knowledge, experience, and subconscious processes to arrive at innovative solutions. It enables them to make intuitive leaps, connect disparate ideas, and generate new possibilities. This intuitive approach can lead to breakthrough insights and fresh perspectives that may not have emerged through a purely logical or deductive approach.

In the design process, intuition is particularly valuable during the early stages of exploration and ideation when designers are seeking to understand the problem, generate concepts, and establish a design direction. It helps designers to navigate ambiguity, embrace uncertainty, and trust their instincts in making critical design decisions.

However, it is important to note that intuition in design does not operate in isolation. It is complemented by analytical thinking, research, feedback, and

³¹⁰ Agkathidis, A. (2016). *Generative Design: Form-finding Techniques in Architecture*. Laurence King Publishing.

iterative refinement. The design process involves a dynamic interplay between intuition and rationality, as designers alternate between intuitive leaps and logical evaluations to create well-informed and successful designs. An intuitive form-finding solution in architecture design refers to a design approach or methodology that seeks to discover or generate architectural forms through intuitive means rather than relying solely on analytical or algorithmic processes. It emphasizes the exploration of spatial relationships, visual aesthetics, and experiential qualities. Creative Design Tools, Conceptual Diagramming, and Iterative form Design Process are three attributes that can help architects to develop their intuitive intentions. Creative Design Tools enable architects to explore a vast number of design possibilities based on predefined parameters or rules. By defining constraints and goals, designers can input their intuitive design intentions through progressive development and create alternative forms or configurations that align with those intentions. Creating conceptual diagrams helps architects visualize and organize their design ideas and concepts. Diagrams can represent spatial relationships, circulation patterns, programmatic elements, and other design parameters in a simplified and abstract manner, allowing for intuitive exploration and discovery of architectural forms. Adopting an iterative form design process encourages experimentation and evolution of ideas. By constantly revisiting and refining their forms, based on feedback and reflection, architects can tap into their intuition and gradually refine their form-finding process.

Christopher Alexander's investigation about systematic form design procedure was one of these attempts. Although his theory was later recognized as inefficient by many critics and researchers in the field of design, there is no doubt that significant aspects of this theory are effective in the educational process because achieving intuitive thinking requires experience and numerous exercises in the field of creative thinking processes. It cannot be implemented at once in an educational context and within a limited time frame. But the critical point is the integration of Alexander's design theory in the field of form-making with creative methods of form-finding and form-giving³¹¹. At this stage, it is worth mentioning some notions and movements regarding form creation in design.

Design processes driven by nature.

Looking back at pre-computational times, around the end of the nineteenth century, avant-garde architects and thinkers were starting to question the historicist architecture of their time, which they felt was immoral and anachronistic because it failed to reflect both technological evolution and social structure; it did not correspond to the zeitgeist. They started to urge

³¹¹ Form-giving process: The process of organizing concrete form for product development is referred to as the form-giving process. It involves the aesthetic involvement necessary to create physical forms that align with the goals and intentions of the product. The term "form-giving" originates from the Swedish word, reflecting the idea of actively shaping and creating tangible forms that embody the desired qualities of the product.

for universal design principles that would replace individual taste and the mere reproduction of historical styles. In their attempt to do so, their attention turned to precedents from nature and science instead. German biologist Ernst Haeckel's book *Kunstformen der Natur* (1904) was a profound influence on many architects and designers. Projects such as Hendrik Petrus Berlage's Jellyfish chandelier, the Paris Métro station entrances by Hector Guimard, and many others within the Art Deco and Art Nouveau movements were greatly inspired by it.

Much of this so-called nature-inspired architecture emerged continuously from the 1920s until the '60s and '70s, including examples such as Rudolf Steiner's Haus Duldeck (1916), Frederick Kiesler's Endless House (1950) and Eero Saarinen's TWA Terminal (1962). Nature-driven architecture still occurs today, too, with works like Santiago Calatrava's City of Arts and Sciences in Valencia (1998) and Achim Menges's web-like ICD/ ITKE Research Pavilion in Stuttgart (2012). Although each of these projects employed different tools, they all mimicked the intelligent processes of living organisms, translating them into architecture rather than simply using them as inspiration for form and appearance.³¹²

Design processes driven by geometry

Geometric rules and proportions have been the main driver for other important architects. Louis Sullivan, one of the most significant architects of the modern movement, used techniques such as quadrature and triangulation to design decorative patterns (Menocal and Twombly 2000), while Frank Lloyd Wright applied geometrical rules and proportions to the design of his Unity Temple in Chicago (1908). Wright's design was based on a two-meter (7 foot) grid, enhanced with dimensions that derived from quadrature and were not compatible with the grid (Jormakka 2007). Later, Le Corbusier tried to systematize his own proportional design methods in the book *Modular* (1948), praising the golden section as the gateway to beauty. He also applied his famous Modular proportional diagram to two of his masterpieces, the Notre Dame du Haut Chapel in Ronchamp and the Philips Pavilion in Brussels (1958). Both are among his most geometrically advanced projects, proving that the Modular proportion rules could function as a toolbox offering unpredictable outputs.

Design processes driven by context

Other architects have used their response to the site and the use of morphological and typological elements as their design approach, forming the design movement known as postmodernism. Aldo Rossi, for example, used basic types often common in the historical context of Italian cities (the

³¹² Agkathidis, A. (2016). *Generative Design: Form-finding Techniques in Architecture*. Laurence King Publishing.

octagon, colonnade, arch and so on) in very pure shapes, regardless of function or scale. The octagonal tower shape, for instance, was used in his designs for a secondary school in Broni, Italy (1971), as well as the Teatro del Mondo in Venice (1979) and La Conica, the coffee pot he designed for Alessi (1983; Jormakka 2007).³¹³ For Oswald Mathias Ungers, responding to the site involved defining common silhouettes and morphological characteristics, such as materiality, texture, arches, symmetry, roofs and angles, then trying to reproduce these in a new composition. His housing complex at Lützowplatz, Berlin (built in 1979 but demolished in 2013) is a typical example of this approach (Ungers 2011).³¹⁴ Mario Botta, on the other hand, uses simple, often symmetrical, modernist forms in combination with site-inspired materials, colors and traditional building techniques. His single-family house in Ligornetto, Switzerland (1976), for example, bears the characteristic stripes often found in the region (Cappellato 2004).³¹⁵

Design processes driven by performance

In contrast to the above, a number of architects and engineers have practiced a completely different form-finding method. They have focused on the minimal possible form, deriving from structural performance and material properties. The building's relationship with its context plays only a minor role. Vladimir Shukhov's steel tower, built for an industrial exhibition

In Nizhny Novgorod in 1896, was the world's first ever hyperboloid diagrid structure. This structure was then duplicated in much of Shukhov's later work, including the telecommunication tower (Shukhov Tower) that he built in Moscow, which still stands today (figure 36).

³¹³ Jormakka, K. (2007). *Basics: Methoden der Formfindung*. Birkhäuser.

³¹⁴ Ungers, O. M. (2011). O. M. Ungers: *Morphologie/City Metaphors*. Cornerhouse.

³¹⁵ Cappellato, G. (2004). *Mario Botta, Light and Gravity: Architecture 1993–2003*. Prestel.



Figure 36, left, *Diagrid on Shukhov Tower in Moscow, by Vladimir Shukhov*
diagrid

37, right, *Munich Olympic Stadium, by Frie Otto and Gunther Behnisch*

This structure achieves a perfect combination of mathematical shape, optimized structure and material performance (Khan-Magomedov 1987).³¹⁶ Heinz Isler's concrete shell structure for the Wyss Garden Centre in Solothurn, Switzerland, built in 1962, assumes similar hyperboloid shapes, covering a span of 650 square meters (7,000 square feet), with a shell thickness of just 60 mm (2½ inches) (Chilton 2000).³¹⁷ Finally, Frei Otto, investigating tensile membrane structures, developed the Munich Olympic Stadium in 1972 (figure 37) – a definite highlight of his career (Otto and Rasch 1996).³¹⁸ Although developed at a time when computers were not used in architecture at all, the design approach adopted by Shukhov, Isler and Otto is strongly linked to contemporary performative design techniques.³¹⁹

In table No.2 in the design chapter, there are specific steps in the design process that the designer should bring the result of his/her thoughts and analysis to the fore in a tangible and discernible form. Indeed, the same discussion of converting thoughts into a formal essence. As it is known, this stage may have various expressions, such as form development, create, development of volumetric design proposal, preliminary design, schematic design, proposal, prototype, and design development.

³¹⁶ Khan-Magomedov, S. O. (1987). *Pioneers of Soviet Architecture: The Search for New Solutions in the 1920s and 1930s*. Rizzoli.

³¹⁷ Chilton, J. (2000). *Heinz Isler (Engineer's Contribution to Architecture)*. Thomas Telford.

³¹⁸ Otto, F., & Rasch, B. (1996). *Finding Form: Towards an Architecture of the Minimal*. Axel Menges.

³¹⁹ Agkathidis, A. (Year). *Introduction to Generative Design*. Laurence King Publishing.

Table 16 Highlighted outlooks of design process (Snyder, 1979)

	Design Process Theories	Design process Defined steps				
1	Thornley Student Design Process (1) (1963)	Accumulation of Data	-	Separation Of Main concept or Method	Form Development	Presentation of Solution
2	Thornley Student Design Process (1) (1963)	Program Formulation	Investigation Assessment Of Design Possibilities	Create	Refinement	Presentation
3	Guenther and Corkill Systematic Approach of Architectural design (1970)	Basic Definition Preliminary Program	Investigation, Analysis, Program, Abstraction	Synthesis And development Volumetric Design Proposal	Reevaluation And Modification	-
4	H. Rittle's Summary of Design Process (1971)	Problem Identification	Collect & Analyse Information	Workout Solution	Solution Assessment	Implement and communicate
5	R. Whitaker's Eight Step Design Process (1971)	Recognition Definition	Preparation Analysis	Synthesis	Evaluation	Execution
6	J. C. Jones's Design Method (1972)	Idea	Information Analysis	Synthesis	Evaluation	Optimization
7	M. Asimow Engineering Design Process (1972)	Feasibility	-	Preliminary Design	Detailed Design Planning	-
8	Riba Architecture Service (1972)	Inception	Feasibility	Outline Proposal Schematic Design Detail Design	-	Production Tender Action Project Planning Completion Feedback
9	G. T. Moore's Design Process (1974)	Identify Problem	Programming or Analysis of User Requirements	Synthesis	Choosing From Alternatives	Post Occupancy Evaluation Implementation
10	Five-Step Design Process (Snyder, 1979)	Initiation	Preparation	Proposal	Evaluation	Action
11	Gavin Ambrose & Paul Harris (2009)	Define and Research	Ideate	Prototype	Select and implement	Learn
12	AIA Basic and Supplementary Services (AIA)	Predesign Services	-	Schematic Design	Design Development	Contract Documents Bidding Administration Of Contract Post Design Service

In all these stages and titles, what emerges is the main shape of the design, with it being a physical-meaningful characteristic. The role of determining the form of a project is beyond solving the functional requirements and incorporating the physical program inside a box! Form creation in architecture and, basically, art is beyond narratives and prophecies. It is not a competition to achieve dazzling and exotic shapes but the ultimate fusion of space and matter. A comprehensive consensus of multiple criteria that carries and provides beauty and originality. With such an attitude, we

should think that in which part of the academic education of architecture and the design process, a significant program has been designated to improve students' proficiency in facing this part of the design process!

As mentioned earlier in the topic of design, architecture history, architects' works, books, and magazines are all sources through which students probably get to know the form, but what kind of impression is made of these forms? Imitation? Copy? Remodeling? Taking a concept and using it in a different format or taking shape and appearance and merging it with a new concept. All these things are likely to happen and have happened so far. But this process definitely has an origin related to architectural references and is of the type of inspiration. However, the boundaries of creativity and intuition are far from it. The ability to produce and create form from a basic stage like a generative process to the most ideal revelation states can have its own independent and creative exercises, which maybe until now, except for some scattered experiences, no serious action has been taken towards it.

Looking at the natural design behavior from the perspective of Le Corbusier in his famous book towards new architecture remarking a noticeable fact.

"The truth is that man has an uncanny faculty of adapting himself to new conditions. He learns to admit and even, in a sneaking sort of way, to like new and strange forms. The new form is at first repugnant, but if it has any real vitality and justification, it becomes a friend. The merely fantastic soon dies. Now, in modern mechanical engineering, forms seem to be developed mainly in accordance with function. The designer or inventor probably does not concern himself directly with what the final appearance may be and probably does not consciously care. But men are endowed in varying degrees with an instinct for ordered arrangement, and this can come into operation even when least thought of. The ordinary motor-car engine is a conspicuous example of this. Some are disorderly and "messy" in arrangement; others are well-planned and cleanly disposed of. The modern engineer, then, pursues function first and form second, but it is difficult for him to avoid results that are plastically good. The good modern painter pursues plastic form for its own sake, and if he has the necessary ability the results are plastically satisfying. These things are true of the modern engineer and the painter. Are they true of the architect, who in some ways combines the functions of both?"³²⁰

The statement he provided raises an interesting perspective on the role of form in the fields of engineering, painting, and architecture. While it suggests that modern engineers primarily prioritize function over form and modern painters pursue plastic form for its own sake, it questions whether

³²⁰ Le Corbusier. (Year). *Towards New Architecture*. Dover Publications.

the architect, who combines aspects of both disciplines, follows the same approach.

It is important to note that the roles and priorities of architects can vary, and different architects may have different perspectives on the relationship between function and form. However, in general, architects are trained to balance both functional and aesthetic considerations in their design process. Functionality is a fundamental aspect of architectural design. Architects must consider the needs and requirements of the occupants, the purpose of the building, and the surrounding context. They are responsible for creating spaces that are functional, efficient, and meet the practical demands of the users.

At the same time, architects are also concerned with the artistic and aesthetic qualities of their designs. They strive to create buildings that are visually appealing, harmonious, and expressive. Architecture is often regarded as a form of art, and architects employ various design principles, such as proportion, scale, rhythm, and materiality, to create visually satisfying compositions. While some architects may prioritize function over form or vice versa depending on their individual approach or project requirements, the aim is usually to strike a balance between the two. Architects strive to create designs that are not only functional and efficient but also visually pleasing, emotionally engaging, and contextually appropriate.

Architects often consider the concept of "form follows function," which suggests that the form or shape of a building should be derived from its intended function and purpose. This principle acknowledges the importance of both form and function, emphasizing the need for a harmonious integration of the two.

4-3. Form-finding in Architecture

Form-finding falls somewhere in between the theory and practice of Architecture. It can be described as the study of emergent properties of complex systems to establish a more intelligent, correct, and robust form. The practice itself demands drastic changes both in the way one thinks about architecture and how one produces it. It ignores the architect's tendency towards conceptual ambiguity. It is not inspired by the arts; it is not a piece of poetry or a metaphor. Form-finding is part of an answer to the question, "what is architecture and how do we go about designing it?" Bubbles, shells, sand dunes, and the like are not architecture, of course. Architecture is the set of objects and environments in which we go about our day-to-day lives. It is mankind's greatest impact on this planet, how we measure a society's greatness, and that which we leave behind.³²¹

³²¹ Isaacs, A. J. (2008). [A Thesis Presented to The Academic Faculty]. Georgia Institute of Technology.

Form-finding is a process that involves exploring various design possibilities to arrive at an optimal solution that suits the desired situation. It is an iterative and creative approach that allows architects and designers to experiment with different forms, materials, and spatial arrangements to achieve the desired aesthetic, functional, and structural goals.

The goal of form finding is not to arrive at an immediate answer but to engage in a thoughtful and deliberate design process. By exploring multiple design alternatives, architects can evaluate the pros and cons of different solutions, analyze their impact on the overall design intent, and refine the form to achieve the most optimal outcome.

Form finding also allows architects to push the boundaries of creativity and innovation, as it encourages thinking outside the box and challenging conventional design norms. Through this iterative process, architects can discover unexpected design solutions that address specific contextual challenges and create unique architectural expressions.

The origin of the form-finding term is related to the movement that refers to nature and used it to inform a more intelligent method of integrating built structures into the landscape. This does not mean that a building should look like a bubble, a tree, or a termite mound. The emergent properties in form-finding are studies of minimal systems, whose forms originate passively to their most optimum state. These emergent phenomena are often the unexpected and nontrivial results of simple interactions between simple components. Form-finding is only one of the many ways in which to go about designing architecture and being an architect. However, it would only seem wise to explore it as a design tool... especially since one only has look out a window to see it working so seamlessly, not to mention beautifully.³²²

However, in a general view, all the operations that architects perform on spatial masses to change their shape in order to achieve the optimal form include the category of form-finding. This operation is mainly done using techniques and tools for form-giving, transformation, modification, manipulation, and alteration of a basic structure. Architects may employ various design mediums, including sketches, physical models, computer simulations, and advanced digital tools, to explore different design options and assess their viability.

Form-finding notions in architecture refer to the methods

Form-finding notions in architecture refer to the methods, approaches, and concepts used to derive or discover the appropriate form for a building or structure (Ching, 2014). These notions are often employed during the design process to explore and develop the architectural form. Here are some key form-finding notions used in architecture:

³²² Isaacs, A. J. (2008). [A Thesis Presented to The Academic Faculty]. Georgia Institute of Technology

1- Function-based Form-finding: This notion focuses on deriving the form of a building based on its intended function and purpose (Pallasmaa, 2011)³²³ the design process begins by analyzing the functional requirements and spatial needs of the building, and the form is then developed to optimize the building's functionality.

2- Contextual Form-finding: Architecture is deeply influenced by its surrounding context, including the site, climate, culture, and history (Norberg-Schulz, 1980).³²⁴ Contextual form-finding notions involve studying and responding to these contextual factors to create a form that harmonizes with its surroundings and reflects the local culture and traditions.

3- Biomimicry: Biomimicry is the concept of deriving inspiration from nature's forms, processes, and systems to inform architectural design.³²⁵ By studying natural structures, behaviors, and patterns, architects can create forms that emulate the efficiency, resilience, and sustainability found in the natural world.

4- Tectonic Form-finding: Tectonics refers to the art and science of construction and assembly.³²⁶ Tectonic form-finding notions explore the expressive potential of construction techniques, materials, and structural systems.

5- Conceptual Form-finding: This notion involves deriving the form from a central design concept or idea.³²⁷ Architects develop an overarching concept or narrative that guides the design process, and the form is shaped to communicate and embody this concept.

6- Parametric Design: Parametric design utilizes computational tools and algorithms to generate and manipulate complex architectural forms.³²⁸ By defining a set of parameters and constraints, architects can explore a vast range of form possibilities and optimize the design based on specific performance criteria.

7- Sculptural Form-finding: Sculptural form-finding notions emphasize the exploration of expressive and visually striking forms.³²⁹ Architects may draw inspiration from sculptural art, experimenting with curves, volumes, and dynamic compositions to create visually engaging and aesthetically pleasing architectural forms.

These form-finding notions are not mutually exclusive, and architects often combine multiple approaches to develop the most appropriate and compelling architectural form.³³⁰ The choice of form-finding notion depends on the project's requirements, the architect's design philosophy, and the desired outcomes in terms of functionality, aesthetics, sustainability, and contextual integration.

³²³ Pallasmaa, J. (1996). *The Eyes of the Skin: Architecture and the Senses*. John Wiley & Sons.

³²⁴ Norberg-Schulz, C. (1974). *Meaning in Western Architecture*.

³²⁵ Benyus, J. M. (1997). *Biomimicry: Innovation Inspired by Nature*. William Morrow & Co.

³²⁶ Fraser, I. (2004). *Digital Design: A Critical Introduction*. London: AVA Publishing.

³²⁷ Holl, S. (1996). *Intertwining*. Princeton Architectural Press.

³²⁸ Kolarevic, B. (2003). *Architecture in the Digital Age: Design and Manufacturing*. Spon Press.

³²⁹ Stiny, G. (2006). *Shape: Talking about Seeing and Doing*.

³³⁰ Leach, N. (2014). *Digital Morphogenesis and Computational Architectures*.

Table 17 Form finding notion methods based on the related theories of this field

Form-finding notion methods			
Method	Author	The way form is created	Design Process
Function-based Form-finding	Pallasmaa	function and purpose	Analyzing and developing the functionality
Contextual Form-finding	Norberg-Schulz	surrounding context	studying and responding to contextual factors
Biomimicry	Benyus	nature's forms processes, and systems	studying natural structures, behaviors, and patterns
Tectonic Form-finding	Fraser	art and science of construction and assembly	potential of construction techniques
Conceptual Form-finding	Holl, S	central design concept	develop an overarching concept or narrative
Parametric Design	Kolarevic, B.	computational tools and algorithms	defining a set of parameters and constraints
Sculptural Form-finding	Stiny, G	expressive and visually striking forms	sculptural art, experimenting with curves, volumes, and dynamic compositions

4-4. Form development process in Architecture

So, what is 'generative design' exactly? There is no single definition of the term, but many complementary definitions with common characteristics, which vary according to different architectural theorists. Overall, it can be described as a design method where generation of form is based on rules or algorithms, often deriving from computational tools. During the late 1980s and early '90s, just before the boom of computational architecture, Peter Eisenman started applying a set of design techniques, such as scaling, fractals, overlay and superposition, influenced by Jacques Derrida's Deconstruction theory. Eisenman applied these techniques in relation to rules of order, developing several projects on this basis, such as the Biocentrum in Frankfurt (1987) and the Nunotani Corporation headquarters in Tokyo (1992; figure 38,39)³³¹

One could claim that his design method was the first contemporary generative design attempt. As software started to offer new possibilities, Eisenman introduced other techniques to his approach, such as morphing images, which was soon followed by UN studio and their concept of the 'Minimal', a computer-generated icon that merges a lion, snake and human to represent the hybrid building.³³²

³³¹ Eisenman, P. (2004). Eisenman Inside Out: Selected Writings 1963–1988 (Theoretical Perspectives in Architectural History & Criticism). Yale University Press.

³³² Van Berkel, B., & Bos, C. (UNStudio). (1999). Move: Imagination/Techniques/Effects. 3-volume set. Goose Press.



Figure 38 Biocentrum in Frankfurt (1987)

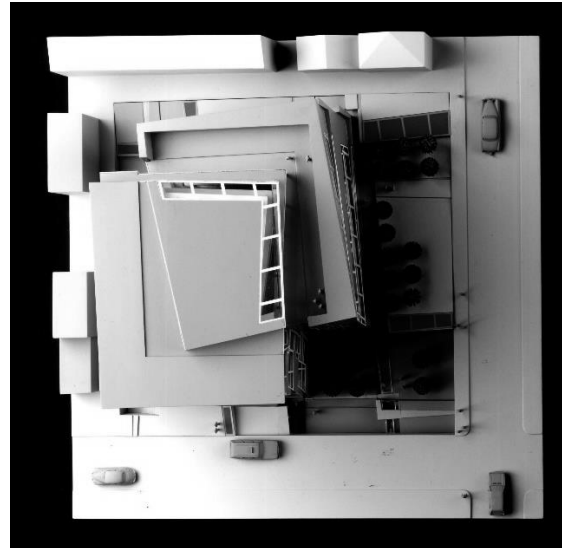


Figure 39 the Nunotani Corporation headquarters in Tokyo (1992)

The technique of folding appeared in Eisenman's Rebstockbad in 1991 (Eisenman 2004) and, as computational tools advanced further, Greg Lynn started applying new tools such as animation, splines, NURBS (non-uniform rational basis splines) and isomorphic polysurfaces, influencing a whole wave of architectural production, often described as 'blob architecture' (Lynn 1999).³³³ As algorithms and scripting become more accessible to architects and designers, and digital fabrication more affordable, parametric and panelization tools, simulation software, optimization and generative algorithms are dominating generative design techniques.

In their book *Generative Gestaltung* (Lazzeroni, Bohnacker, Groß and Laub 2009), the authors define generative design as a cyclical process based on a simple abstracted idea, which is applied to a rule or algorithm (figure 40). It then translates into a source code, which produces serial output via a computer. The outputs return through a feedback loop, enabling the designer to reinform the algorithm and the source code. It is an iterative operation, relying on the feedback exchange between the designer and the design system.

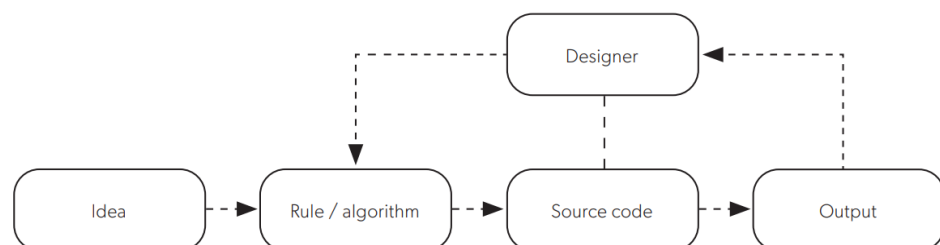


Figure 40 Generative design as a cyclical process

³³³ Lynn, G. (1999). *Animate Form*. Princeton Architectural Press.

Celestino Soddu (1994) defines generative design as ‘a morphogenetic process using algorithms structured as nonlinear systems for endless unique and unrepeatable results performed by an idea-code, as in nature’. Indeed, the notions of generative design and digital morphogenesis are strongly associated. The term ‘morphogenesis’ derives from the Greek words *morphe* (μορφή, meaning ‘form’) and *genesis* (γένεσις, meaning ‘birth’), so could be literally translated as ‘birth of form’. As with the term ‘generative design’, there is no unique definition for morphogenesis, and it seems that the terminology is changing in relation to emerging technologies and techniques.

Branko Kolarevic (2003) describes digital morphogenesis as follows: ‘The predictable relationships between design and representations. Models of design capable of consistent, continual and dynamic transformation are replacing the static norms of conventional processes. Architectural morphology is focusing on the emergent and adaptable qualities of form. Form is no longer being made, but found, based on a set of rules or algorithms, in association with mainly digital, but also physical, tools and techniques. They imply the rules; the entire process follows. Michael Hensel describes digital morphogenesis as a ‘self-organization process, underlying the growth of living organisms, from which architects can learn’ (Hensel, Menges and Weinstock 2006).³³⁴ In their latest book, Rivka and Robert Oxman (2013) categorize form generation into six dominant models in relation to its main driver: mathematical, tectonic, material, natural, fabrication and performative. They see digital morphogenesis as ‘the exploitation of generative media for the derivation of material form and its evolutionary mutation’. Its key concepts include topological geometries, genetic algorithms, parametric design and performance analysis.

On the condition to use intuition and imagination as a generative and morphogenesis form-finding process in this context, it is possible to propound several strategy as follows:

1-Conceptual Abstraction:

Start with a simple abstract idea and allow intuition and imagination to play a role in forming this abstract idea. Think about overarching themes, emotions, or concepts you want to express through architecture.

2-Rule or Algorithm Development:

Apply your abstract idea to a rule or algorithm, which could be inspired by architectural principles, nature, or artistic concepts. Use intuition to guide

³³⁴ Hensel, M., Menges, A., & Weinstock, M. (2006). *Techniques and Technologies in Morphogenetic Design*. Wiley & Sons.

the creation of rules that align with your design vision. Consider how different elements interact and influence each other.

3-Translation to techniques and Codes:

Translating our rule or algorithm into source code and sort of techniques. This step involves a balance between logical thinking and creative expression. Leverage imagination to visualize how the code will manifest in the form creation realm, creating a bridge between the conceptual and the visual output.

4-Iteration and Feedback Loop:

Embrace the cyclical nature of generative design, allowing for iterations based on feedback. Use intuition to interpret and respond to the outputs of the generative process. Consider what resonates with your design intent and what needs refinement.

5-Morphogenetic Process:

Think of the generative design as a morphogenetic process, drawing inspiration from Celestino Soddu's definition. Consider how algorithms act as nonlinear systems, allowing for endless and unique results. Let intuition guide the exploration of diverse design possibilities.

6-Embrace Dynamic Transformation:

Considering design is not static but continually transforming. Allow the intuition to guide dynamic changes, adapting the form based on emergent qualities and the evolving relationships within the design.

7-Explore Key Concepts:

Apply imagination to envision how the concepts can be creatively integrated into our design process, pushing the boundaries of traditional architectural norms.

8-Multidimensional Drivers:

Consider the six dominant models of form generation (mathematical, tectonic, material, natural, fabrication, and performative) mentioned by Rivka and Robert Oxman. Use intuition to determine which drivers align with your design intent and explore their integration into your generative process.

Progressive form development in architecture design process based on Gestalt regulation

This process involves the application of Gestalt principles and theories to guide the iterative evolution of architectural forms (Arnheim, 1954; Koffka,

1935).³³⁵ Gestalt psychology focuses on how the human mind perceives and organizes visual information, and its principles can be employed to create cohesive and harmonious architectural forms. Here's how the progressive form development process based on Gestalt regulation may unfold:

1- Analysis of Design Problem: The design process begins with a thorough understanding of the design problem, including functional requirements, site constraints, and contextual factors (Alexander, 1964; Lynch, 1960).³³⁶ This analysis sets the foundation for the subsequent form development stages.

2- Initial Form Generation: Based on the design problem analysis, preliminary design ideas and concepts are generated (Lawson, 2005).³³⁷ At this stage, the architect explores various form possibilities, taking into account the desired functionality and the contextual factors.

3- Gestalt Principles Application: The architect applies Gestalt principles to evaluate and refine the initial design ideas (Wertheimer, 1923).³³⁸ Some key Gestalt principles that can be employed include:

- **Proximity:** Elements that are close to each other are perceived as belonging together. Architects can manipulate the arrangement of elements to create relationships and groupings that convey unity and coherence.

- **Similarity:** Elements that share similar qualities, such as shape, size, or color, are perceived as belonging together. Architects can use this principle to create visual patterns, rhythms, and repetition within the architectural form.

- **Continuity:** Elements that form a smooth, uninterrupted line or curve are perceived as belonging together. Architects can employ this principle to create fluid and continuous forms that guide the viewer's gaze and convey a sense of flow.

- **Closure:** When presented with incomplete or fragmented elements, the human mind tends to fill in the missing information to perceive a whole. Architects can use this principle to suggest forms or volumes that are not explicitly defined, encouraging viewer participation and engagement.

- **Figure-Ground Relationship:** The mind differentiates between the main subject (figure) and the background (ground). Architects can manipulate positive and negative spaces to create clear figure-ground relationships, enhancing the legibility and visual impact of the architectural form.

4- Iterative Refinement: Based on the application of Gestalt principles, the architect refines the design iteratively (Le Corbusier, 1947).³³⁹ This involves evaluating the design's composition, visual hierarchy, balance, and overall harmony. Adjustments are made to achieve a coherent and visually pleasing

³³⁵ Arnheim, R. (1954). *Art and Visual Perception: A Psychology of the Creative Eye*. University of California Press.

³³⁶ Alexander, C. (1964). *Notes on the Synthesis of Form*. Harvard University Press.

³³⁷ Lawson, B. (2005). *How Designers Think: The Design Process Demystified*. Architectural Press.

³³⁸ Wertheimer, M. (1923). *Untersuchungen zur Lehre von der Gestalt II* [Investigations in Gestalt Theory II: Laws of Organization in Perceptual Forms]. *Psychologische Forschung*, 4, 301-350. [In English, the title is translated as "Investigations in Gestalt Theory II: Laws of Organization in Perceptual Forms"].

³³⁹ Le Corbusier. (1947). *The Modulor: A Harmonious Measure to the Human Scale Universally Applicable to Architecture and Mechanics*. Harvard University Press.

architectural form that effectively communicates the intended design concept and fulfills the project requirements.

5- Evaluation and Feedback: The progressive form development process involves continuous evaluation and feedback (Cross, 2007).³⁴⁰ The architect may seek input from clients, consultants, or peers to gain different perspectives and refine the form further. This feedback loop ensures that the final form is well-considered and aligns with the project goals.

By employing Gestalt regulation in the form development process, architects can create architectural forms that evoke a strong sense of unity, coherence, and visual appeal (Ching, 2014; Mallgrave, 2011).³⁴¹ These forms are designed to engage the viewer's perception and provide a harmonious experience in both functional and aesthetic aspects.

4-5. Utilizing intuition and imagination as a means of Form-Finding

Architecture indeed has two levels of expression: verbal/conceptual and visual/representational. On the other hand, the visual/representational level of expression involves visual mediums such as drawings, sketches, renderings, models, and computer-generated images to communicate architectural ideas and designs. Visual representations allow architects to illustrate the physical form, scale, proportion, materiality, and aesthetic qualities of a building or space. These visual representations can range from simple hand-drawn sketches to intricate computer-generated 3D models, providing a means to visualize and communicate the design to interlocutors.

It seems that this part of the design process is accompanied by difficulties that make designers and architects, especially Architecture students, browse books, journals, or even buildings in search of design ideas or features that are pleasant to them. Not only in terms of looking for appropriate visual expressions but exploiting them within their design tasks and projects. Presumably this visual expression must be acquired through the proper way of converting the thoughts and ideas into tangible modality which we call it conception.

Conception means the act of forming an idea, plan, etc. A Concept, a thought, idea or principle as defined, is the key to conception. Before reflecting upon how the concept can generate a creative design process, it is necessary to distinguish scientific concepts from common concepts. The main difference between a scientific concept and a common concept is that the first is constructed. This means that the first task is to eliminate obstacles in the language that interfere with precise meaning. Architectural concepts are not intended to establish scientific theories - describing how

³⁴⁰ Cross, N. (2007, March). Creative thinking in design: An introduction. In *Proceedings of the 2007 Symposium on Science of Design* (pp. 2-3).

³⁴¹ Mallgrave, H. F., & Goodman, D. J. (2011). *An Introduction to Architectural Theory: 1968 to the Present*. John Wiley & Sons.

the world is but for generating architectural thinking to elicit inspiration and possibility rather than realities. Obviously, an architectural concept seems more likely a common concept rather than a scientific concept.³⁴² However, this does not mean that any common concept can be an architectural concept. The point lies in if a "design conjecture," a formal conjecture embodying a functional prediction, can be developed. In other words, architecture is a creative design process that inspires designers to map from knowledge of formal possibility to a conjecture for formal specificity and also from knowledge of functional probability to functional prediction (Hillier, 1996: 426).³⁴³ An architectural concept is, therefore, not a theoretical formation but a comprehensive understanding of specific design issues resulting from an intellectual process engaged in projecting appropriate architectural forms.³⁴⁴

Design issues referred to by verbal expressions give useful information about what concerns a designer the most and how the concept is related to the specific design. The translation of any specification into the design at some stage must take the visual thinking form. Formal strategies, usually proposed through a series of sketches or drawings as possible solutions to the problem in hand, can demonstrate how the form is implied by a concept. This is a way of merging what is coming directly from the tangible part and indirectly from the intangible part of the concept. The form involves not only the aesthetic dimension but also functional, technical, and spatial design issues corresponding to the specific design case. Discourse analysis provides an understanding of the text concerning the relationship between concepts, design issues, and formal strategies. Through form analysis, an understanding of the work involving the relationship between the concept, design issues, and formal strategies can be constructed. Design evaluation is based on understanding the text and the work provided by discourse analysis and form analysis.³⁴⁵

Design evaluation is always intrinsic to the particular formal strategy that makes it possible for the form to embody the concept and is always extrinsic to the textual meaning itself insofar as we direct our attention to design issues that lie outside that meaning. The coherence that is of much concern in the formal strategies that connect concept and form reveals the designer's intention. The coherent relationship between concept and form can demonstrate the translation from the intelligible to the visible. The legitimacy of the translation from concept into form based on merging

³⁴² Shih, C. (2004). [Article title]. *Journal of Asian Architecture and Building Engineering*, [Volume number if available], 221.

³⁴³ Hillier, B. (1996). *Space is the Machine: A Configurational Theory of Architecture*. Cambridge University Press.

³⁴⁴ Shih, C. (2004). *Journal of Asian Architecture and Building Engineering*, , 221.

³⁴⁵ Shih, C. (2004). *Journal of Asian Architecture and Building Engineering*, , 221.

complex design issues in an artistic way is another focus of the design evaluation. It shows that the designer's accomplishment can be convincing.

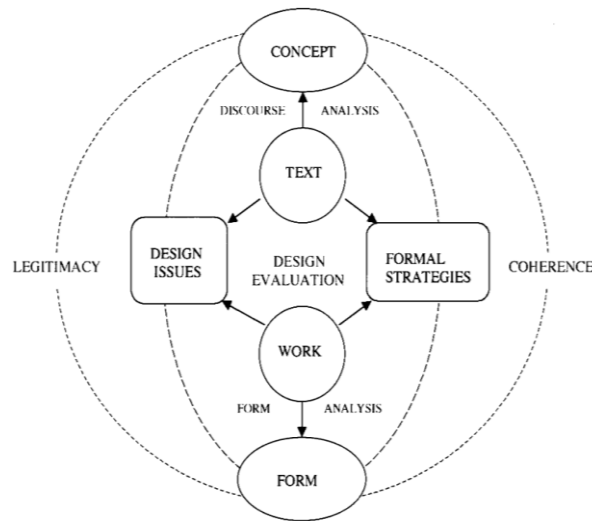


Figure 41 The position form and formal strategy in design process based on Chih-ming Shih

Generative design in architecture involves the development of forms based on rules or algorithms, often facilitated by drawing tools. As drawing capabilities expanded, so did productive design techniques, incorporating morphing images, constructing formal compositions, and sculptural forming, contributing to architecture development. The book "Generative Gestaltung" defines generative design as a cyclical process involving abstracted ideas applied to rules or algorithms, translated into source code, and producing serial output. This output informs the designer, creating an iterative process relying on feedback. It is possible to use the same process, but instead of algorithmic procedure, the development of form should focus on intuitional imagination.

Generative design is closely tied to morphogenesis, a morphogenetic process using algorithms for unique results. The term "morphogenesis" signifies the birth of form, and in architecture, it can involve the abandonment of predictable relationships in favor of intuitional imagination. Contemplating form design techniques results in unpredictable mechanisms of creation, and it will be helpful to broaden the formal lexicon of students to engage in their further architectural tasks.

In part B of the thesis, the concept of progressive form development in architecture has been tested, employing Gestalt principles, form design strategies, related tools and techniques includes analyzing the form design priorities, generating initial forms, applying Gestalt principles like proximity and similarity, iteratively refining the design, and seeking continuous evaluation and feedback. The goal is to create cohesive and harmonious architectural forms that engage viewers perceptually and fulfill both

functional and aesthetic requirements, which can evoke the creativity and imagination of students in early stage architecture education.

PART B:
Expatiate Design Practice Method and
Laboratorial Research

CHAPTER 5.

Method`s Explanation

Form-creation techniques in this research are considered a specific practice for thought-breaking barriers, breaking frontiers, opening students' minds, and unlocking imaginations.

This chapter encompasses the topics as follows:

- 5-1. Description and definition of the method
- 5-2. Elaboration of techniques (Form-giving tool kit)

5-1. Description and definition of the method

The intended process is considered a preliminary practice method for form creation in the framework of an initial phase and before students enter the main design courses. In this method, the focus is on learning and getting familiar with the way the form is founded and acquiring skills in making the form, and knowing the techniques and strategies related to its design that are supported by free-hand sketching. Also, behavioral patterns are defined in the creative development of form-based structures and making targeted changes that can be transformed into visual and mental skills over time. This approach allows students to go through synthesis, meaning the course objective is not to teach the students to solve the design problems separately but rather to understand the focal point of the different design problems so that in almost one gesture, the problems are solved. Therefore, form-creation techniques in this research are considered a specific practice for thought-breaking barrier, breaking frontiers, opening students' mind, and unlocking imaginations. Drawing skills which are implemented in this course are some conception tools to place a question and open possibilities. It's not a close figure but an open figure.

In contriving a teaching method, we need to manage the minds of novice students. For this purpose, it is necessary to define step-by-step processes in the beginning, and therefore there is a need to outline instructions to prevent deviant, imitative, accidental, chance, and other unwise movements. Therefore, it is desirable to simulate a part of the process by the professor himself or his experienced assistants. On top of that in each stage of training, the starting step and the sequences of movement are defined based on which the students start doing exercises, but how to involve their personal tastes and individual decision-making during the training process as a form of breaking the monopoly is considered. This guideline helps students to move beyond limitations.

On the other hand, the uncertainty in the final conclusions and the open-ended process will be a stimulus for creative approaches during this training process. One of the goals of this educational process will be to change the way students look at the surrounding environment and architectural works, which will help them to discover rules and use them to identify the methodology to create form and later utilize them in their design projects.

Through the techniques that are provided to the students as a toolkit, the reading of architectural works is facilitated through the lens of form and the way space is produced, and it enables them to gain the necessary insight to choose the way to give form to their desired idea by applying similar operations.

Another focus point in this method is to improve students' ability to speculate and make preliminary predictions to produce a number of visual

choices such as sketches and mental images, which can significantly help to identify the solution before starting any design process. Thus the students can conduct their own design path.

The practice of thinking out of the box is another aspect of this training method. In the studio and in the design course, students learn how to get a design solution from the question. However, through this practice, the student does not enter the field of design based on a pre-planned question, but it happens with a kind of inner investigation and intelligent application of techniques and intellectual strategies of form-finding operations. With the secondary re-reading of the obtained works, they understand the impact of concepts such as harmony, aesthetics, balance, equilibrium, connections and logical relations, articulation, removal of excesses and even various positions of establishment and arrangement of components in achieving a unified and coherent entirety.

By doing these exercises before the design studio, students can have a more successful performance in achieving proper physical gestures for their projects, along with their successful study and analysis process. Every teaching technique is combined with several practical strategies, and there will be criteria and approaches for the method of combining technique and strategy, which if we consider it as a permutation operation, we will face countless ways of thinking. This ability not only saves students from algorithmic and computational form-finding methods but practices using these methods quickly and simultaneously create a kind of intuitive skill in an individual.

As mentioned in the second chapter of this treatise, students who enter architecture schools either have basic artistic backgrounds and a history of studying in a conservatory or entered mathematics and mostly without an artistic background. Regardless of their educational background and intellectual mode, the most important point is that none of these students are really familiar with the theoretical aspects of architecture and also have limited information about the history of architecture and the evolution of ideas and theories of design and architecture. . Therefore, their approach is different from any stylistic tendencies, prejudices or bigoted thoughts towards specific architectural theories.

Hollier claimed that:

It is in the Form that we can go back to the idea, to intention and to the original idea that is the source of the process of creation of coming into being. (15) The significance of Form synthesis in the design process can help architects better adapt their desired space to the many criteria that affect the design. The process that is called Form-Finding is a method to achieve optimal physical quality "found on the Form" that fulfils the needs of the

project. Creating more and different options before making choices is a core skill to continually propose options. Any sort of practice for generating multiple options as well as iteratively testing them is a conventional architect's design behavior and is considered a design practice. Although Form-Finding is only one of the many approaches to go about designing architecture, however, it would seem wise to explore it as a design skill. The following form-based practice is an architecture course which acts best prior to the design studio course, in the context which is free from the limitations of architectural problem of the design course which is based on some "Modifying techniques" and "organization strategies" which are implemented on the form, via freehand sketches or etude maquette which according to plasma makes the most connection from hand to the mind. Form Design Learning Method directly centered on some sorts of techniques, tools, and strategies that enabled the students to have an empirical methodology regarding Form development system. Another significant goal of this method is enabling the apprentices to alter the shapes and masses into more appealing proportions and produce various alternatives by transforming and modifying them.

Eligible Participants

Freshman students are more prone to participate in this training process than any other group. In fact, the goals of this training process are planned in such a way that they can do it without prejudgment and only by focusing on designing before the formation of a specific design taste and thinking, which is sometimes created due to reasons such as the context or design norm in their academic environment. They will learn to do a creative exercise on form-giving and defining the space through the lens of form without the presence of architectural subject matter. Their spatial visualization is strengthened and they also get to know more variety of making and thinking methods in the field of form finding.

The Incorporated Educational period

As mentioned, first-year students are the main target of this educational process. Therefore, it is suggested that this process can be run after the first semester of study and the initial familiarization of students with the basic concepts of architecture, as well as some basic exercises in the field of graphic expression and visualization, as well as the perspective, architectural expression methods through freehand drawing. Practice methods in this process can be implemented in a more advanced format for junior and senior students, but as mentioned, the absence of judgment and assumptions in the application and learning of all techniques can play an important role.

Main objectives of the method

The purpose of this educational method is not to teach students a design method, but the nature of this method is a training method to improve thinking and visualization skills in a creative space to achieve multiple visual options and choices before starting or during the design activity.

Through this process, students will find the opportunity to come up with new and various yet innovative Form-based ideas that bring them insight for many architectural design purposes. Furthermore, hypothetically, they acquire a wide range of form-based compositions by practice. This ability features them to have more flexibility in choosing and testing several options within the form-finding procedure.

These exercises aim to develop students' visual and imaginative abilities and factors such as their graphic vision towards formal aesthetics, and composition, learning gestalt principles in form-based structure, and discovering the rules and relationships between forms and shapes, and the role of mass and void in defining spatial structures. They learn to get to know the constituent elements of the form (space) separately and in the form of various exercises, and they discover ways of changing it using. The critical point in this process is the student's personal experience and experiment with how to use techniques and discover the form development method before they can directly benefit from the teacher's opinion.

Prerequisites

Artistic perception and basic abilities in the field of visual arts are necessary to enter the field of architecture because essential aspects of this field are mixed with art. Spatial visualization, imagination, and familiarity with the basics of visual literacy can be very effective in understanding the problem of form and aesthetics. Also students entering this laboratory process should be familiar with basic freehand drawing skills and graphical illustrations. They should be able to draw a simple symmetric and diagrammatic perspective according to graphic principles. Meanwhile, there are some abilities required of the mentor that can be provided by him/herself or their assistant. Simulation of the design process using hand and graphic thinking by mentor or experienced architect who intentionally proposes a thinking method or shows how an architect should encounter a design problem is imperatively necessary. Hence the instructor him/herself must be skilful in improvising performance in sketching and graphical thinking method

5-2. Elaboration of techniques (Form-giving tool kit)

A series of practice are designed to help training students to shift their mind from using their left hemisphere, to the right hemisphere. Drawing ability relies mainly on the visual, spatial functions of the right hemisphere. The left hemisphere (for the majority of human beings) specializes in verbal, logical, analytic thinking. Naming and categorizing are among its favorite

things to do. In contrast to L-mode, the right half of the brain (for most individuals) functions in a nonverbal manner, specializing in visual, spatial, perceptual information. This shift should be in accordance with each part of the mind's characteristics. Using a systematic method, in form-finding level of architectural design process, using freehand sketches, can help students learn using their right hemisphere in the design process. "Drawing turns the creative mind to expose its workings. Drawing discloses the heart of visual thought, coalesces spirit and perception, conjures imagination;" (14)

This teaching process encompasses five phases as follows:

- Entrusting a toolkit to the students including fourteen techniques focusing on form **design strategies** and **form development**.
- The experiential procedure of the form creation in architecture, without considering the design's topic.
- Teaching strategies and thinking process based on **lateral thinking**.³⁴⁶
- **Evaluating** the students' strategies for creating design solutions and embodying form-based concepts and spatial compositions. Experiencing the reverse flow of process, from form towards architecture.
- **Reflecting** on how students perceive the relation between form and architecture.

Figure 42 Teaching process



- In the first phase, each technique will be defined precisely by the mentor, and some samples will be produced successively that indicate the stages of design and modification until the final product.

These techniques are listed in the next chapter. The first seven techniques are operated on the basis of **solid mass** and the next 6th techniques mostly utilize **surfaces** as the basic components of design. The last technique is using **alphabet** as the design template.

- In the second phase, the students implement the methods in the form of experimental practices and use each technique individually. In this stage, the target is to produce abstract compositions through freehand sketching without considering the architectural subject matter yet paying attention to the proportions, equilibrium, corresponding, and aesthetic terms. The apprentices utilize the advice and suggestions from their instructors to avoid any detour or error. Meanwhile, all their design process will be improvised, and no logical reasoning will be prescribed. Creative attitude and novel expression in terms of decoding the hidden correlation among the components of their design will shed light on this trajectory. Thus, the mentors should provide sufficient guidelines and cases in point so that students fully understand the assigned tasks.

³⁴⁶ Lateral thinking (horizontal thinking) is a form of ideation where designers approach problems by using reasoning that is disruptive or not immediately obvious. They use indirect and creative methods to think outside the box and see problems from radically new angles, gaining insights to help find innovative solutions.

- In the third stage, instructors give verbal analyses of the prototypes created in the previous step. Acting on this curiosity, a set of semantical expressions is being propounded, and the students will reinterpret their works based on these terms. Terms such as juncture and segregation, consistency and configuration, correspondent and contrast, fluidity and rigidity. Expectation impacts of this stage, lead students being more acquainted with a series of capabilities that are presented in the result chapter.
- Phase forth is a pilot operation that is simulated by mentors. Due to the lack of architectural knowledge of apprentices, mentors illustrate the reverse motion process from form to architecture. Also, some architectural works are being provided to clarify the relationship between Form and architecture.
- Phase fifth has instantly connected to stage four. But instead of depicting architectural concepts, students will present their own perception of form-based composition by remodifying their works to a more tangible spatial organization.

Introducing related tools and techniques

1- Horizontal and vertical cuts

In this technique, the volume is first split off into some smaller pieces using horizontal and vertical cuts. The number of cuts and their location is done as a free and individual experience by the students themselves. In the second stage, it is possible to move the fragments in the directions of the coordinate axes to achieve various compositions. These modifications include three strategies: **distance change**, **proportion change** and **arrangement change**. After achieving a balanced composition (according to the mentor), connections are designed between these components to achieve cohesion again. The design of these connections will be a part of learning the design process. In the final stage, the student will look for architectural interpretations of the obtained structure.

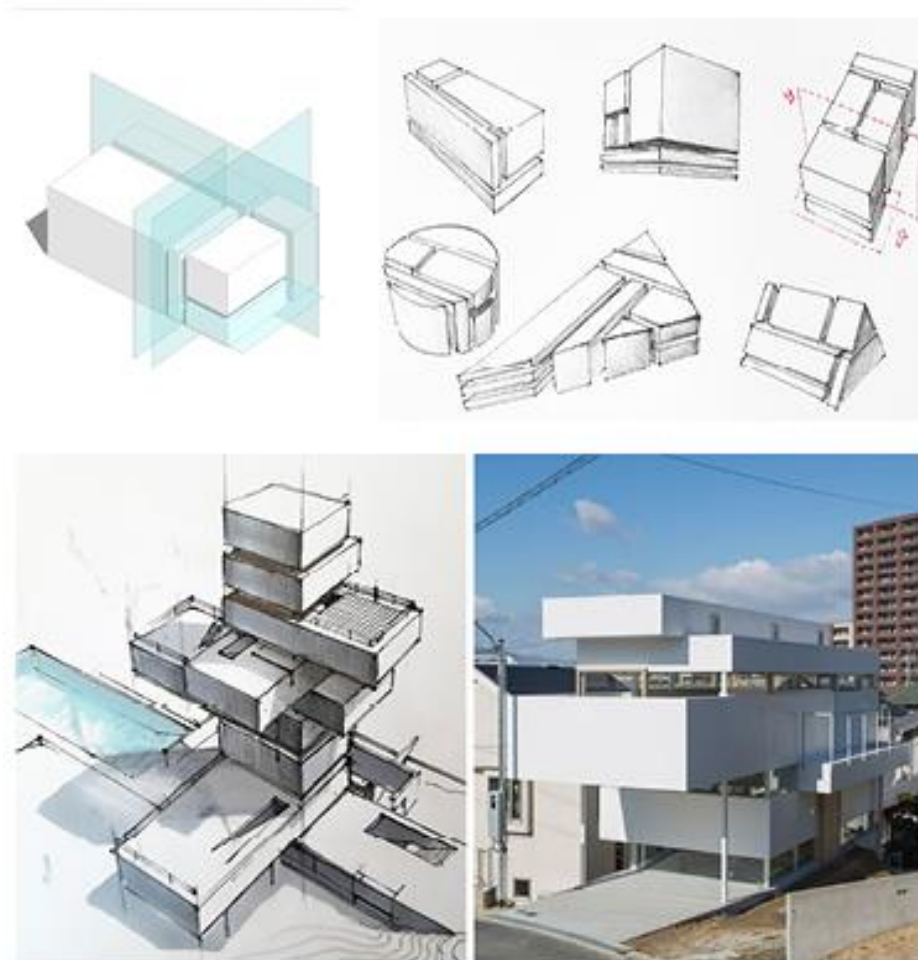


Figure 43-45 Vertical and Horizontal cut samples by the Author - 46 (Down-Right) House in Toyonaka by Tato Architects

Horizontal and vertical cuts are applied along the length and width of the cube and in non-cubic shapes along the perimeter of the imaginary cube. Performing the cutting operation by itself will not be sufficient, although the initial cutting and separation of components can be seen as the beginning

of a change in the design process and can be used as a design model, as in the example below.



Figure 47 developed Vertical and Horizontal form samples by the Author

However, there are strategies that can be implemented after this stage. Three of the most important ones can be:

- Changing the distance.
- Altering proportions.
- Modifying the arrangement.

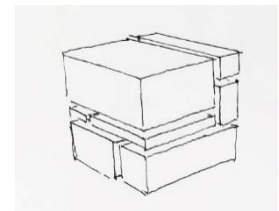


Figure 48 A sample of a cube utilized as the base for cutting technique which are depicted in fig.49 - 51

These changes can be made along the coordinate axes, and new compositions of the same initial form can be generated through them.

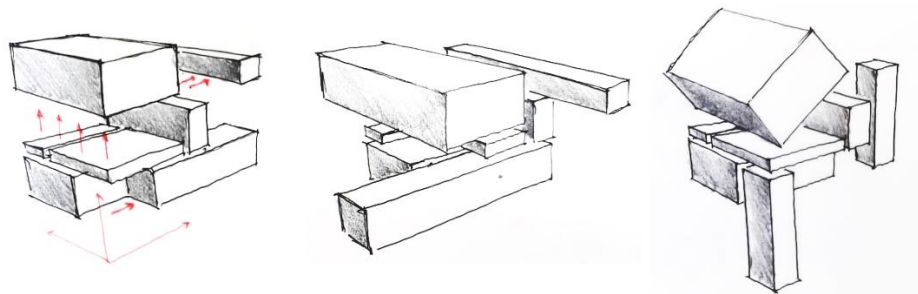


Figure 49-51 Left to right: Changing the distance, altering proportions, modifying the arrangement.

This process helps the student generate their desired form without inadvertently incorporating numerous form elements into their composition. Consequently, breaking down the initial mass into smaller components and then making modifications to achieve newer formal combinations can assist their creative approach in better understanding the principles of composition. Furthermore, the variety of created structures can enable the instructor to generate architectural interpretations, defining a path for the student to comprehend the relationship between form and architecture better.



Figure 52 Examples of Design Using Horizontal and Vertical cuts Presented by the instructor and showing how they can be linked to the Context of the Architectural Design Process.

2- Diagonal cuts

In this method, the steps are completely similar to horizontal and vertical cuts, with the difference that we have 3 diagonal cuts in the plane. Diagonal cutting planes that are **perpendicular** to the ground and only make **one angle** with the object, second, diagonal cutting planes that make an angle with the ground, and third, cutting planes that make **two angles** with the ground. The design steps are carried out according to the previous method, but the products will have a different form quality according to the angles of the diagonal cuts, which will have an impact on the final form, connections and architectural interpretation.

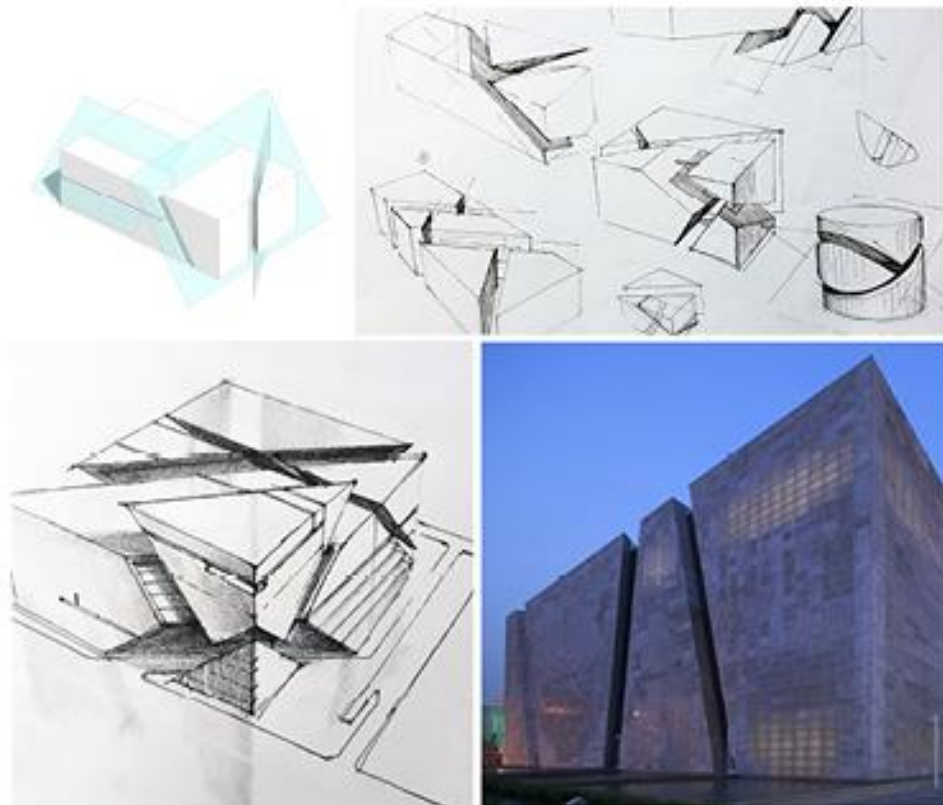


Figure 53-55 Vertical and Horizontal cut samples by the Author - 56 (Down-Right) Italian Pavilion for ShanghaiExpo 2010

In this method, students are introduced to three types of diagonal cuts, each of which creates exclusive features in the form of the final product. The reason for the separation of these cuts from horizontal and vertical cuts is the difference that arises in terms of sense and concept in the final formal structure. The architecture created through this form has its own language in terms of spatial qualities and events that occur in the section and plan due to the presence of sharp corners. Therefore, this process will deal with a different kind of form perception to the student.

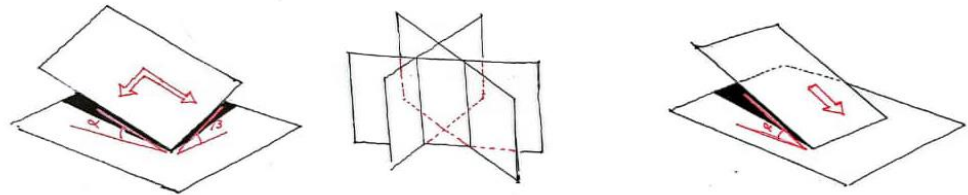


Figure 57 Two Angle with Base, 58 Vertical Angle with Base, 59 One angle with Base

In each of the above three cuts, the student realizes their impact in one of the dimensions of the produced form. For example, in single-angle cutting, the effect of cutting can be seen in the facade and section of the work, and in vertical cutting, the effect of cutting can be seen in the plan and in double-angle cutting, a combination of both is used. The challenge of working with diagonal and sloping surfaces and how to define space through these forms is the main goal of this exercise. Many students accidentally resort to sharp corner shapes to break formal structures and use this form only as an outer shell that has nothing to do with the plan in order to create more formal excitement in the work, while the conscious use of this technique and understanding The way it affects interior architecture can be beautiful spaces such as Frank Lloyd Wright's triangle geometry plans or Dallas City Hall by I.M. Pei is created.

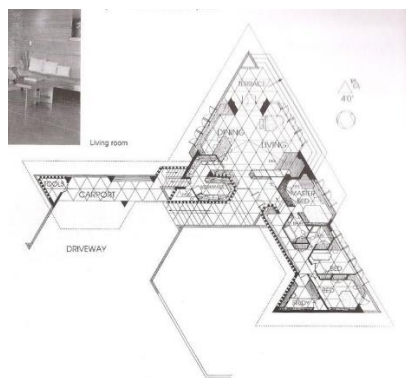


Figure 60 An architecture plan sample based on triangular order.



Figure 61 Dallas City Hall, Dallas, USA, 1978, A sample of Using diagonal cut in forming an architectural space

3- Chamfer and Bevel

In this technique, the goal is to remove or adjust sharp and perpendicular edges and corners in shapes. This technique includes two different types of tools. **Fillet and chamfer**. The final product is different in each one and perceiving the form will also vary greatly. This technique creates more flexible and fluid forms by creating flat or curved wear on the edges and corners of the forms in a sectional or complete way. This process can continue until achieving the final desired form.

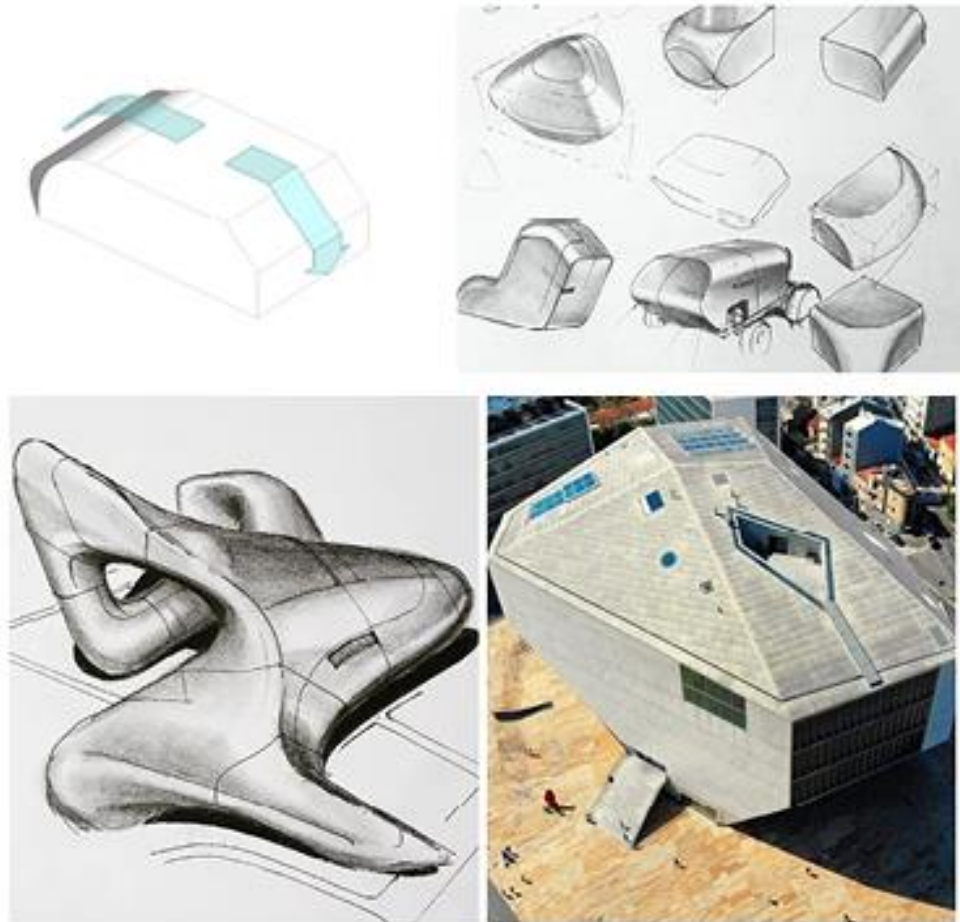


Figure 62-64 Chamfer and Bevel samples by the Author - 65 (Down-Right) Porto Casa de musica using chamfer and bevel for shaping the formal structure.

In this method, students get to know fluid and non-static structures. The design thinking will be a kind of wear and tear in the forms and shapes in such a way that the final form is made through gradual and step-by-step operations on the primary raw material. The creative point in this process, which is different from the previous two techniques, is that during the design process, the initial raw form is constantly changing, and at each stage of the process, as soon as the process of grinding the object is stopped, the existing form can be used. In this way, the student can decide how much they need to create his desired form by grinding the shape.

Since this design technique, especially with flat chamfers, has been used abundantly by brutalist expression, it can be used in idea generation as an independent design method. Demonstrates the design technique's form processing capabilities through image examples as follows.

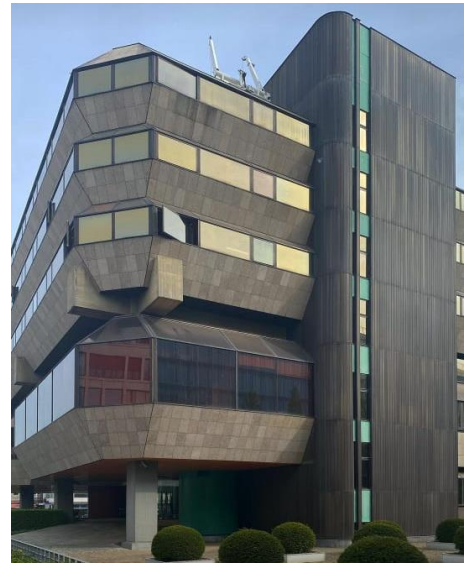


Figure 66-69 Some architecture form sample based on Chamfer and Bevel technique. up left Nanjing International Youth Cultural Center, up right Embassy of the Czech Republic, down left Administrative center Montenegro, down right Dongdaemun Plaza

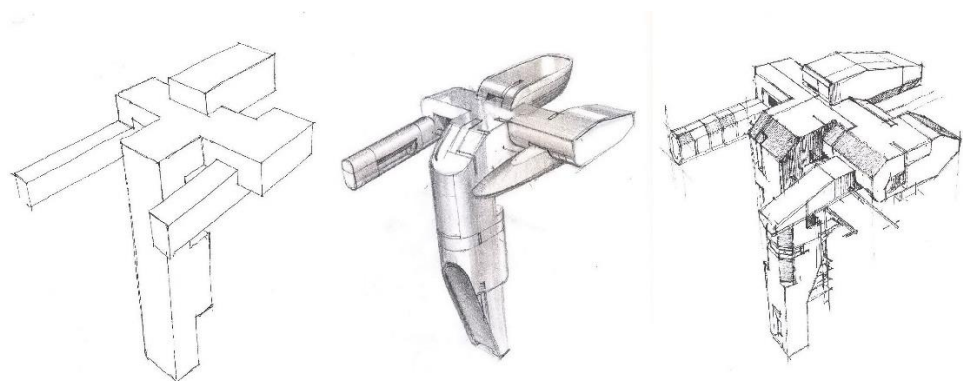


Figure 70 In this technique, the student learns how to redesign simple cubic forms using chamfering elegantly.

4- Subtract and making hollow

This technique is intelligible in the beginning and perhaps it is popular among architecture students. But a different approach is suggested to use it. First, what is going to be reduced from the base volume should be designed or selected first. Moreover, from which face of the basic form should be reduced, it is a place for reflection and decision. In addition, the method of this reduction can be varied in terms of aesthetic visage. In the second step, for a visualization exercise, students are given samples of objects that are partially empty, and they have to guess and visualize the negative form and then draw it. This exercise is very effective for developing their imagination and discovering various solutions in performing this technique. In the next step, the application of this technique in the process of form design and its representation in architectural works will be explained in 5 separate categories. First, creating the **main** formal concepts, secondly, creating **openings** and defining entrances, thirdly, empty **central** spaces, fourthly, creating empty space inside the ground and **burial architecture**, fifthly, creating **elements** such as stairs, balconies, structures, canopies and similar items by making hollow the form.

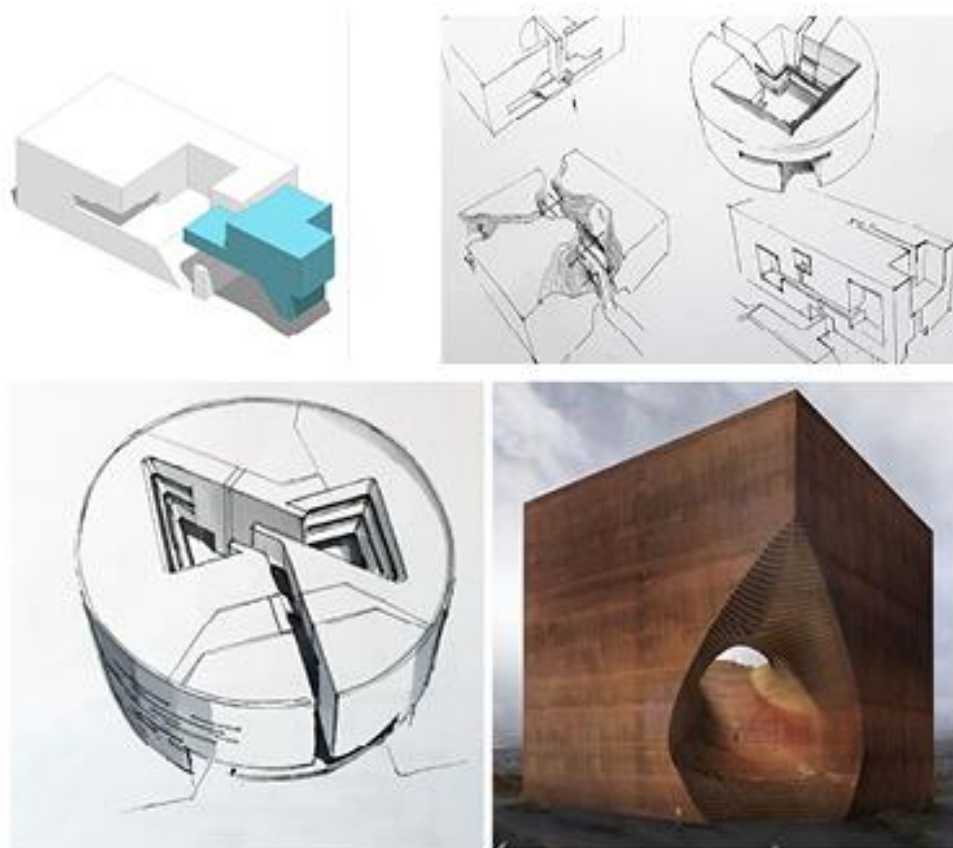


Figure 71 – 73- Subtract and making hollow samples by the Authur – 74 (Down-Right) Duhamel competition entry by Daniel Widrig

In this technique, the student learns how to design with empty space. The vacant part of formal structures is understood as the main nature of space, and one faces a wide range of negative spaces that can be consciously embedded in masses.

5- Extrude Path

In this technique, a guide-line path is designed that can be defined according to the students' taste and the mentor's guidance. Then, a specific cross-section develops along this path and creates a volumetric structure. Form diversity can be acquired by creating complexity in the guide-line path. In the advanced phases, it will be possible to widen the proportions of the section in parts of the route.

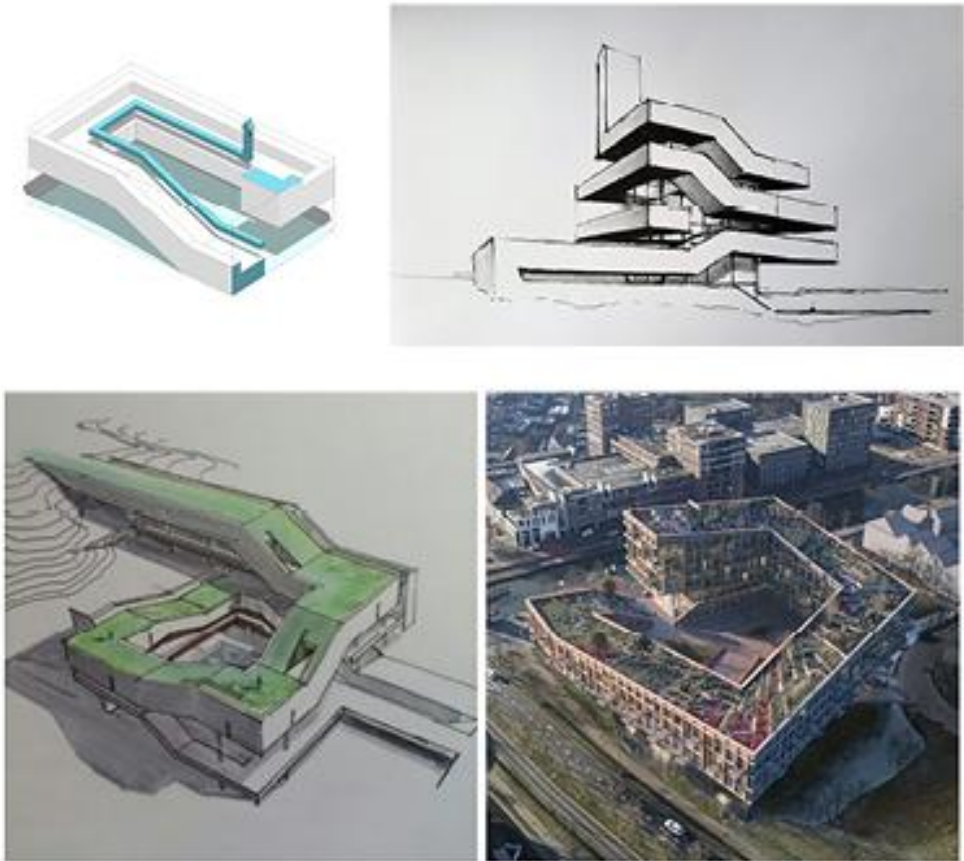


Figure 74 – 75- Extrude Path samples by the Author – 76 (Down-Right) De Brugwachter Weert by Buro Kade

In this process, two main parts of a design are taken into consideration, which, as an exercise can have creative potential. The first is the design of the movement path through which the form develops, and the second is the selection and design of the section that moves along this path. The type of path movement in professional design processes can be affected by various factors that exist in the context of the design problem, and with this exercise, the student gets to know about all the linear energy structures that can be a new capacity for architectural expressions.

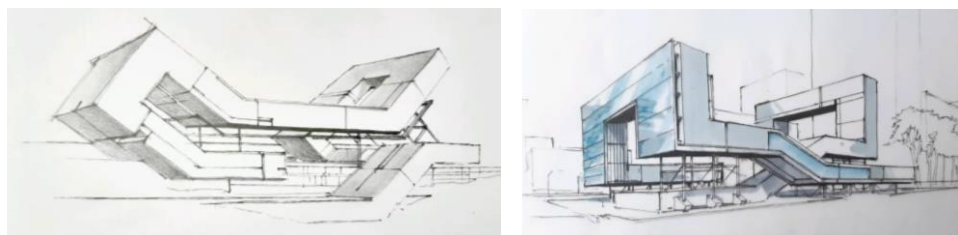


Figure 77-78 Some developed form sample based on extrude path technique.

6- Replication

In this technique, an initial module is designed or selected, then it is reproduced using simple or symmetrical repetition in different directions and next to the initial form. The number and method of composition development is based on the student's taste and mentor's survey, and various examples of formal compositions are produced.

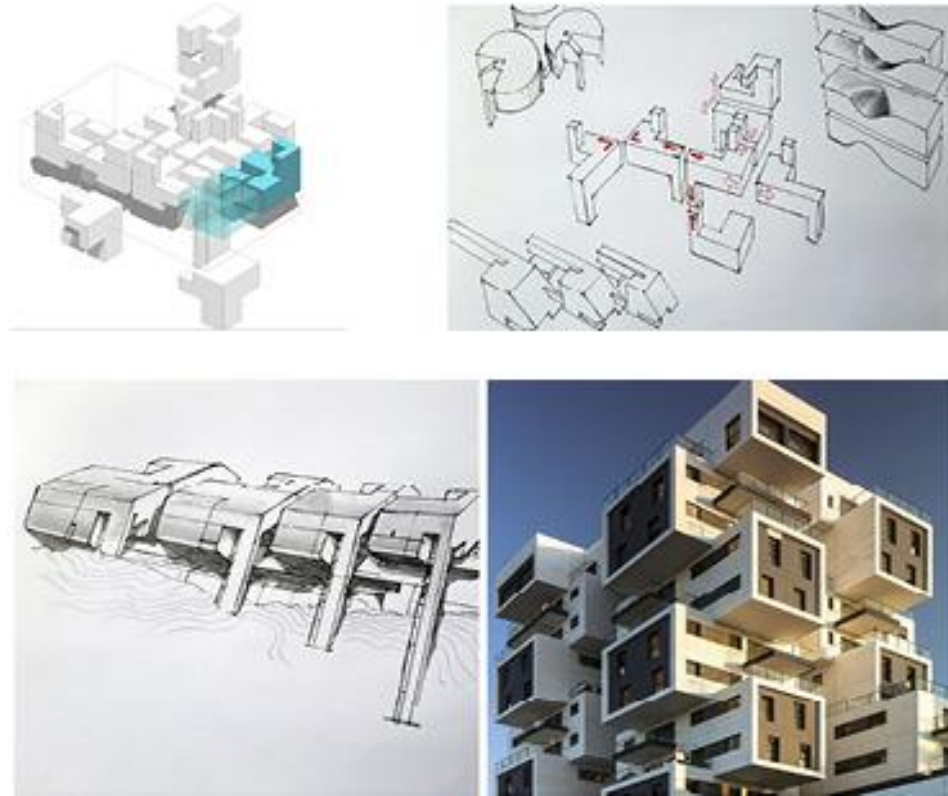


Figure 79 – 80- Replication samples by the Author – 81 (Down-Right) Gallery of 22 Haganim by Orian Architects

In this exercise, architecture students get to know many dimensions of creative physical development processes. First of all, it is essential to choose a replicating module. Choosing this module is considered part of a creative approach. A form that is worth replicating or creates various structures as a result of replicating. The second problem is the reproduction method. The method of reproduction of the basic form is effective in the formation of various compositions. It may be an arrangement type, divergent or convergent reproduction, it may be rhythmic or symmetrical reproductions, it may be in the form of an array and cycle, or it may have a linear path. The testing of each mode is accompanied by the production of huge sets of form compositions that make the minds of students very active and productive.

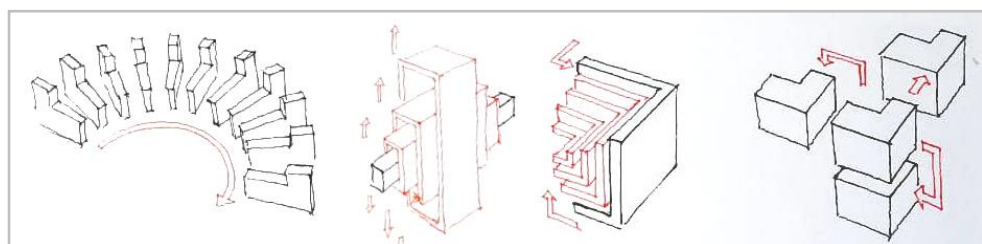


Figure 82 Replication technique samples by the author

7- Development based on Spatial Template

Each design process can be a function of a general surrounding structure that controls the scope of design development. This idea can be used as a design method that governs the process of developing the form. For this purpose, at the beginning of each process, a spatial format of geometric volumes (and later any other spatial structure) is selected, and the designer expands its design up to the limits of this format and cannot go beyond it.

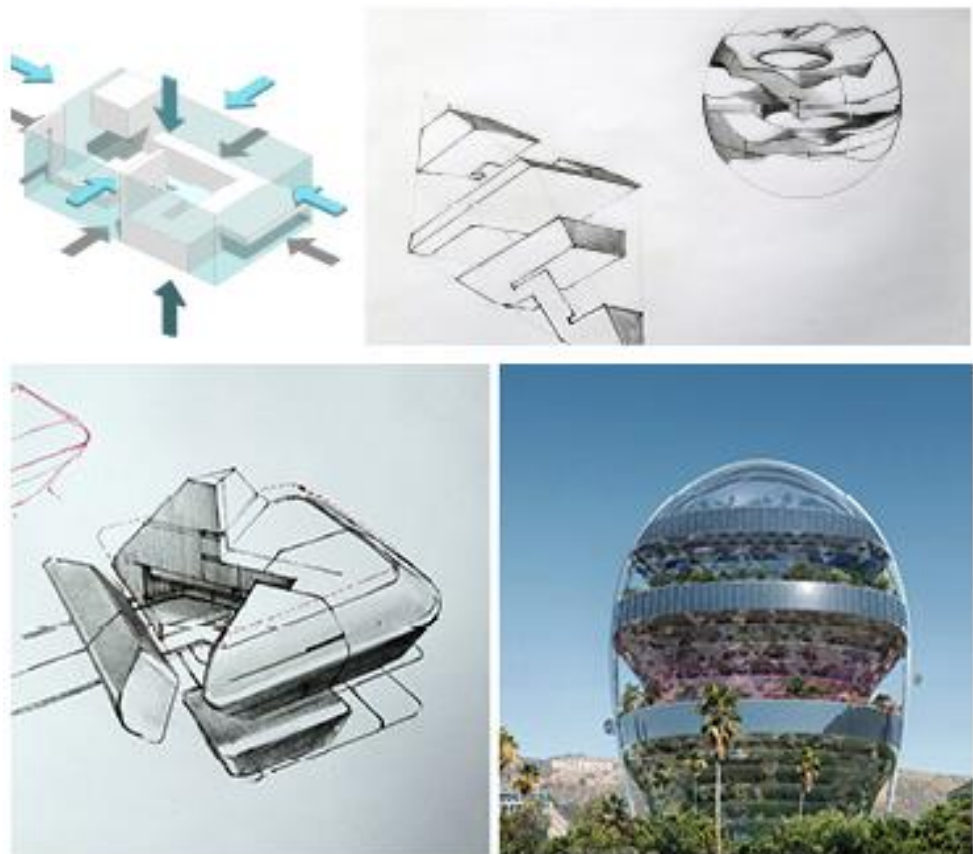


Figure 83 – 85- Development based on spatial template samples by the Author – 86 (Down-Right)
Office tower by MAD architects

Many natural organisms evolve based on a growth pattern. This process in architecture can be done purposefully by following the anatomy of planned growth in a project. In the initial steps, the definition of this anatomy is done through the design of an initial spatial template. As explained above, form development is a form of speculation or filling the space enclosed by the form with suitable formal options. This part of the exercise is a creative visualization exercise in which the student tries to explore the possible options for embedding and settling in a certain area and from among them select and embed the parts that fit well in that area, and, in this way, they will develop their desired form. The spatial format can be proposed by the lecturer or assistants, and the layout can be designed by the work of groups among the students themselves. The design of the template has its own requirements, for example, in the Seattle library, we are faced with an external membrane with a specific form, which acts as a template or container for the form inside it. In general, this template cannot be made, and it can only be used in the design phase.

8- Layering

Layering is more of an approach to space structure in terms of rigidity and transparency. In this technique, the main goal is to design the floor and ceiling surfaces by arranging the plates on top of each other and at a reasonable distance from each other. In addition to the various ideas that take place in the arrangement process, the character of the pages and their form will also be a factor in the creation of various efficient and innovative designs. The layering system can be designed horizontally and vertically.

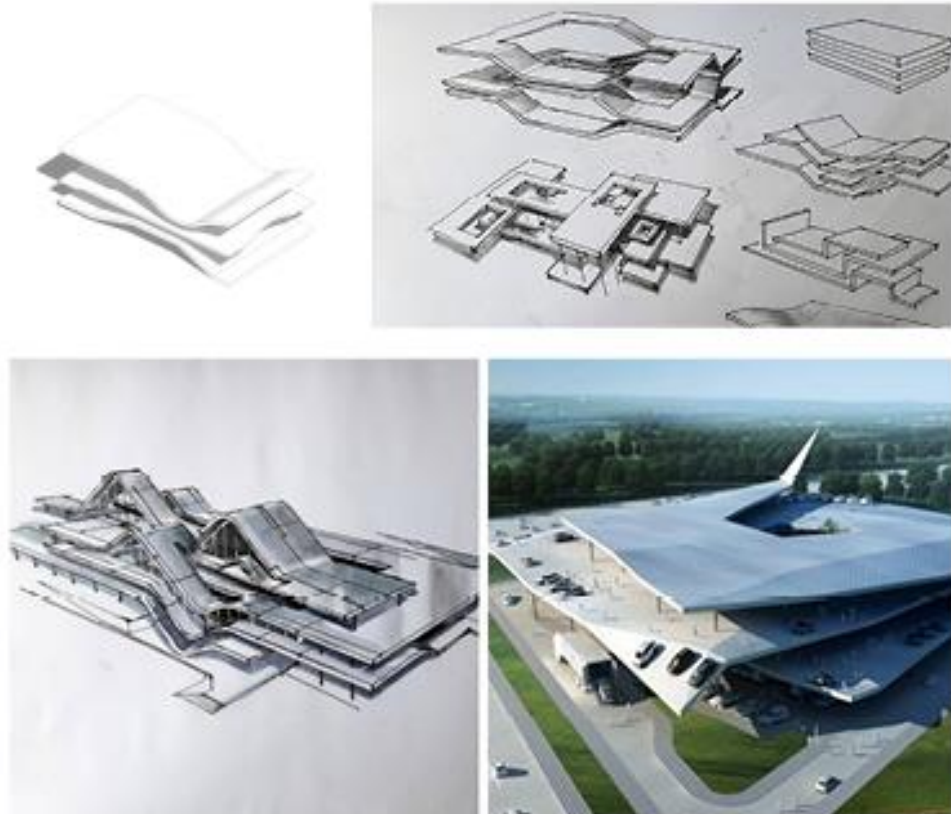


Figure 87 – 89- Layering form making technique samples by the Author – 90 (Down-Right) Gallery of Automobile Museum in Nanjing by #Gatti Architecture studio

The arrangement of the pages layered on top of each other is the directness of creating an architectural space through its primary defining elements, i.e., floor and ceiling. Therefore, we are faced with a transparent architecture, the only solid components of which are the edges of the roofs and the walls are mostly transparent. This design technique opens transitional examples of this approach like a window to students' minds.

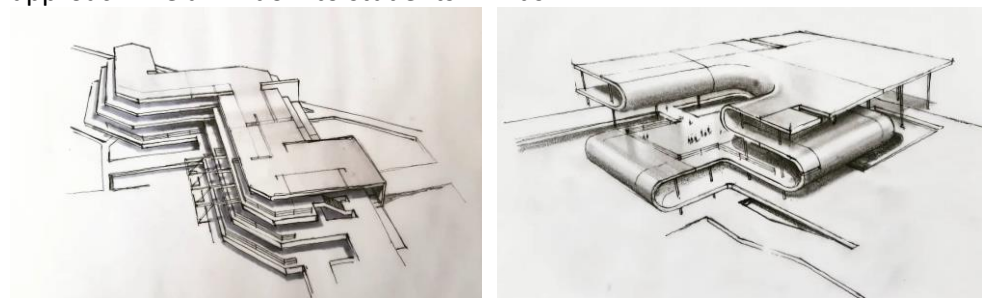


Figure 91-92 Some developed form sample based on extrude path technique.

9- Intersecting planes

The principal goal of this method is the possibility of involving surface component in combination with solid mass. In this situation, we reach a kind of visual balance between heavy and light elements in the design. The instruction procedure initially runs with selecting a volumetric mass, then planes are designed and intersected with the basic mass. Achieving an appealing visual composition is the primary goal of the exercise. A spatial sculpture that is the outcome of combining surfaces with one or more solid pieces.

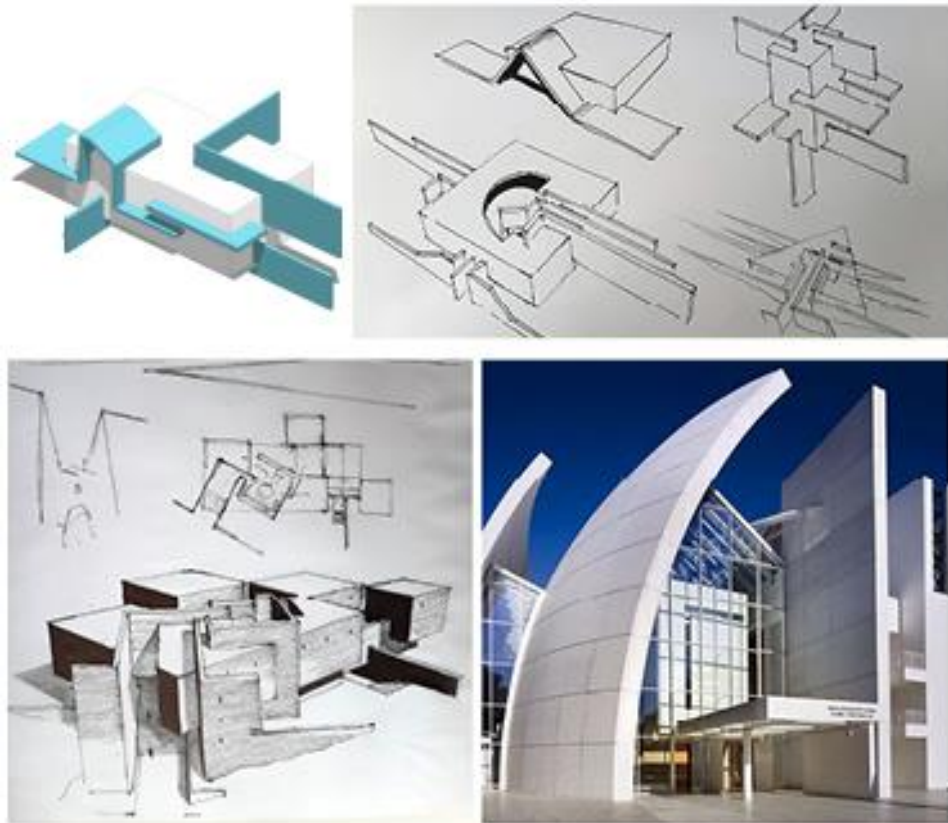


Figure 93 –95- Intersecting planes technique samples by the Author – 96 (Down-Right) Jubilee Church by Richard Meier

The way many architecture students perceive buildings is a volumetric structure rather than a shell or plate-like structure. However, architecture is not a mass nature but a vacant space. Changing this attitude in students' mind-set can be an approach to change their mentality from volume-oriented thinking through implementing exercises created specifically by using the surfaces or combining this fundamental space-making element with volumetric structures. The second point is how the concept is expressed through surfaces, which can be a platform for the ideation and creation of new spatial concepts.

10- Hollow box

An architectural building consists of empty space inside, which is enclosed by surfaces, such as walls, floors, and ceilings. Therefore, it is appropriate to pay attention to this point in form design exercises, and part of the form-making training processes can be operated on hollow boxes. In this case, by creating openings or cavities on the form's surface, there will be a direct connection between the interior and exterior space through this opening. This space serves as an **open, semi-open or transparent space**. Forms made in this way can create significant designs of various patterns on the surface of the facade.

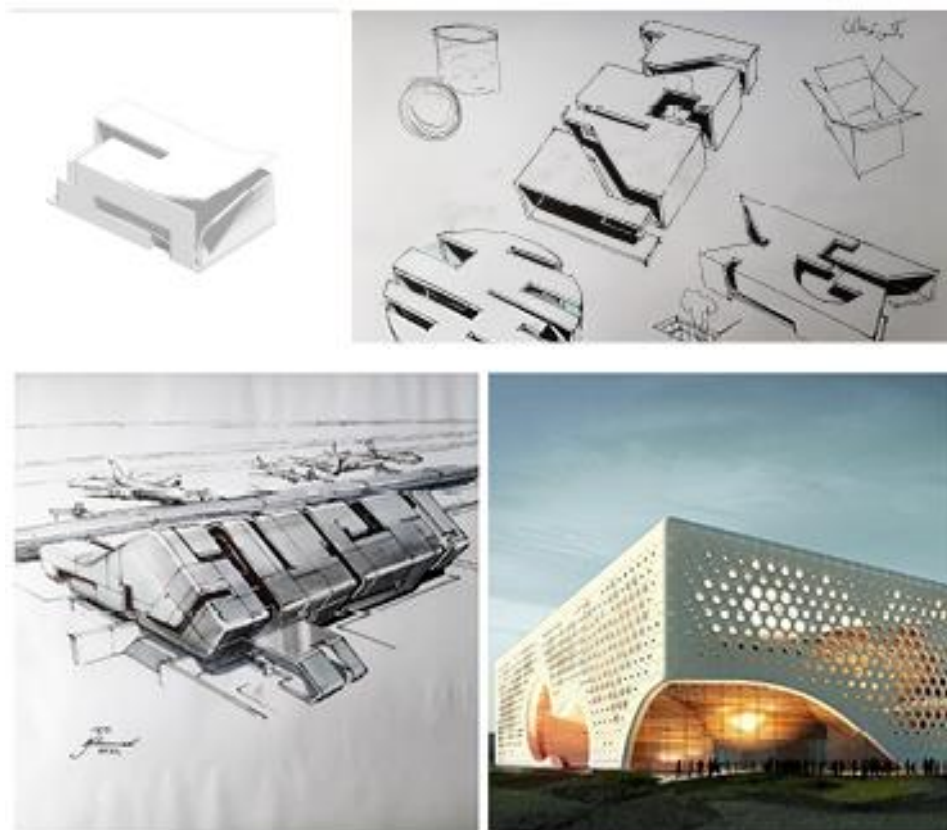


Figure 93 –95- Hollow box samples by the Author – 96 (Down-Right) Caffè Benne Cultural Center by Yzdani Studio

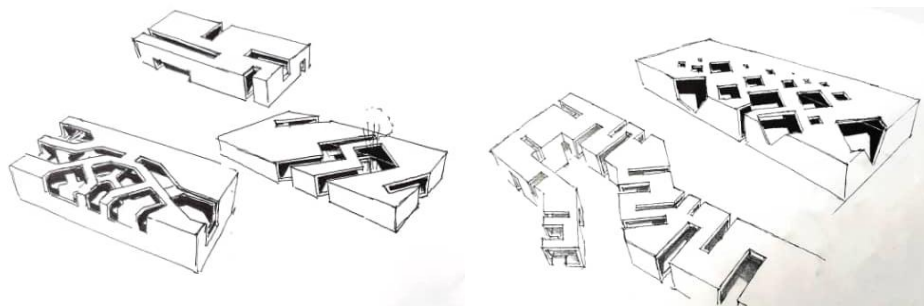


Figure 97-98 Some developed form sample based on Hollow box technique by the author.

11- Planar ribbons

This exercise is to design a **strip structure** on the perimeter of the form. The role of this ribbon strip in the design will be complementary and implement some ideas that are presented as marginal in the design; however, it is presented as another manifestation of the features of the plane next to the solid masses. These strips are not connected to the main form but can be designed around it with any characteristics. The width of this strip is mostly fixed and can be curved or flat and can be folded into the desired sections.

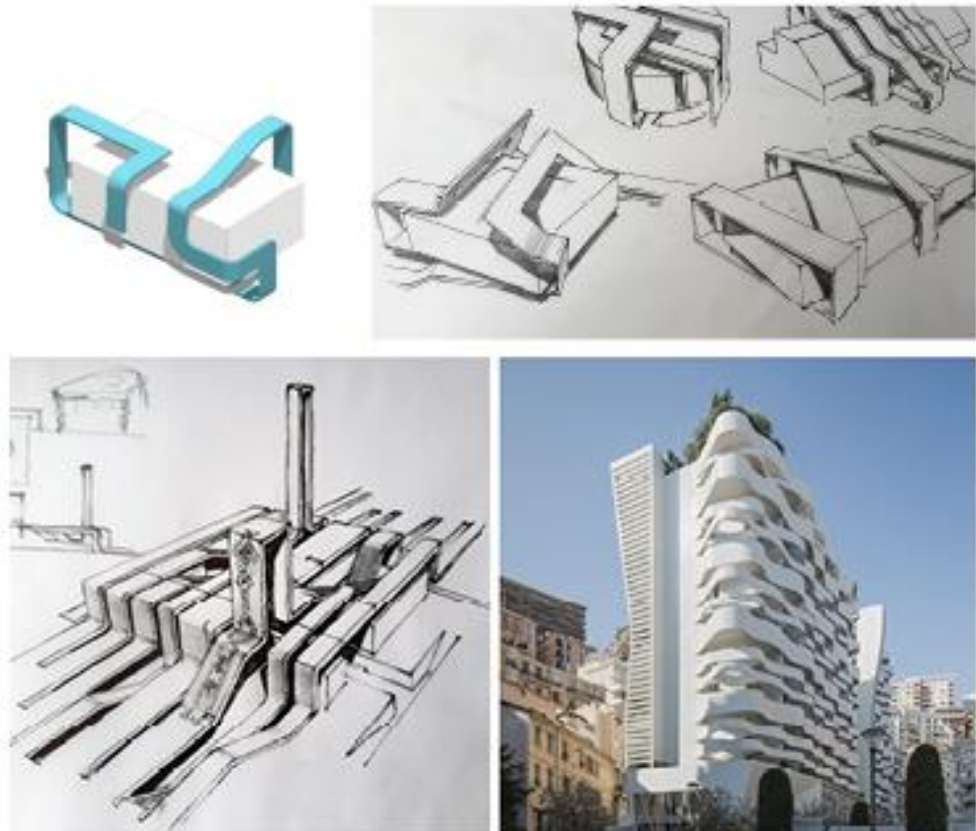


Figure 99 –101- Planner ribbons samples by the Author – 102 (Down-Right) International University of Monaco



Figure 103-104 Some Planner ribbons samples developed form based on extrude path technique.

Planar ribbons are a demonstration of creating a dynamic energy and movement flow next to the main architectural space. Creativity in the design of these ribbons not only creates a very beautiful high contrast in the design, but also provides significant functions, including the role of radiation control, creating an intermediate space for the intended uses, creating porosity and stylization of the form, and injecting movement and dynamism into the form.

12- Shells

Shells are considered the most common surface structures in architecture. Their design as a secondary layer around the form can be regarded as one of the important areas of ideation and design. With sufficient understanding of the design variety of surface-like structures, which can serve as a roof, wall, and external coverings on the main form.

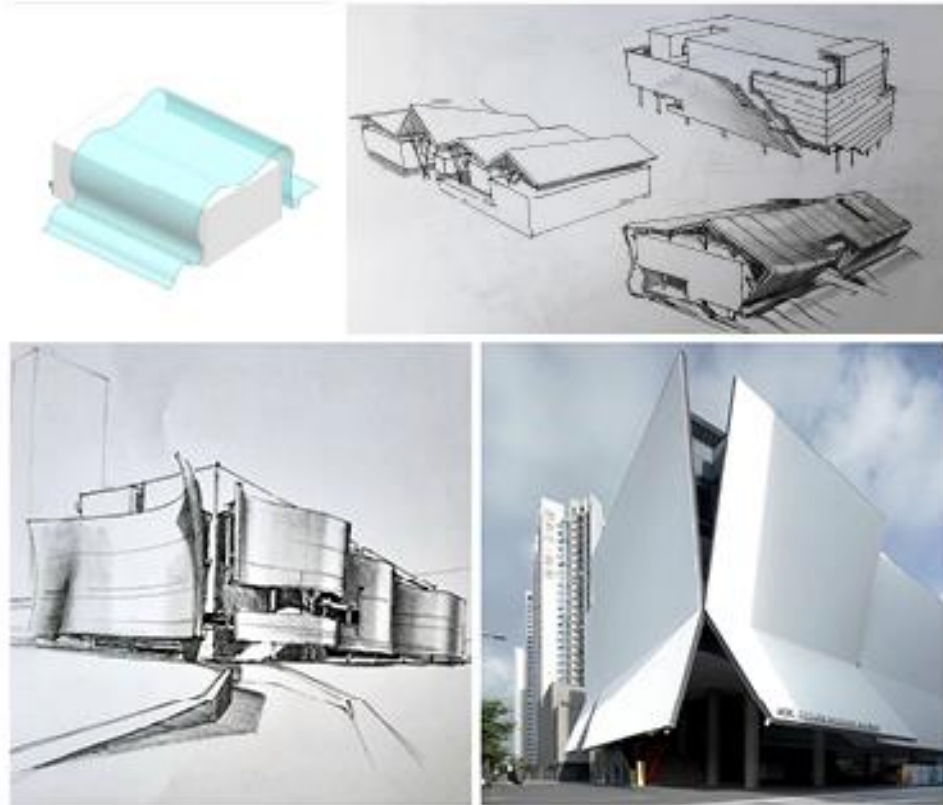


Figure 105 –107- Some Shell form samples by the Author – 108 (Down-Right) iADC design museum by Rocco design architects

Basically, the term shell comes up when an inner core is defined, and a secondary layer called the shell surrounds it. This secondary layer can follow the form of the inner core, and it cannot follow. The consistency or mismatch between the shell and the core, whether in terms of form, material, or their characteristics, is an issue that the concept of priority design determines. But creativity in the way of creating this mismatch or harmony, as well as various approaches to the design of the core and shell form, is the main topic of this technique.

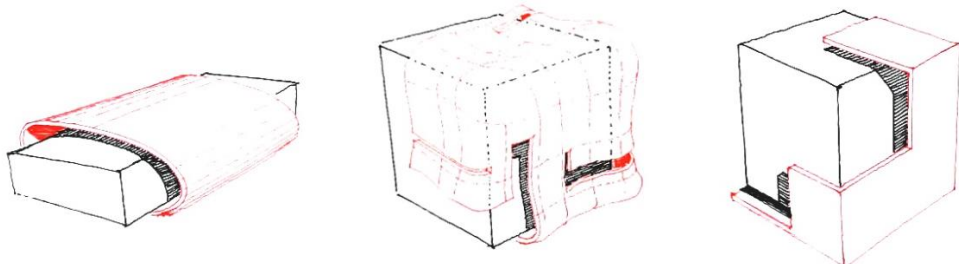


Figure 109-110 Some Planner shell samples developed form by the author.

13- Folded planes

Folded sheets include three categories: **flat, curved, and cut shapes**. The surfaces have more potential to define the enclosure space in comparison with solid volumes the created space by surfaces has more flexibility and uncertainty. Defining the enclosed space with the surface is the agenda of this design exercise. With each folding, a part of the space is separated from others. In this method, enclosed spaces are created in three ways. The spaces created by the **wall**, the spaces created by the **floor** and the **ceiling**, and the spaces created by the combination of these two or **in-between-vacant spaces**. In all three fields, students will produce many examples.

Strategies and approaches

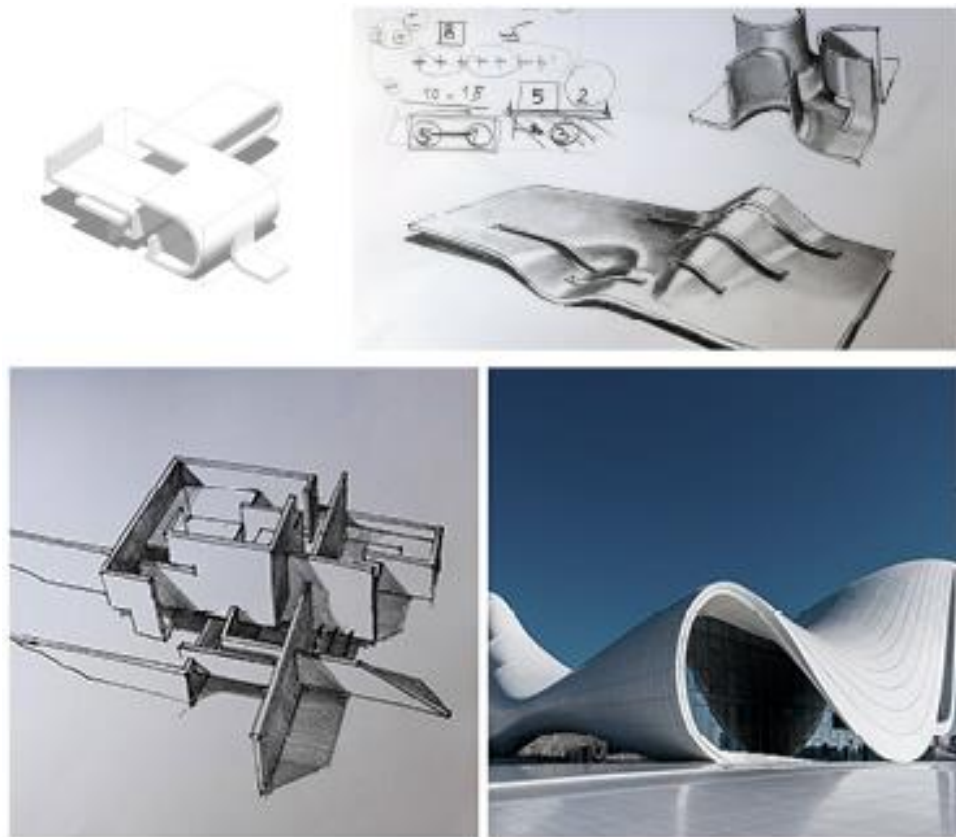


Figure 111 –112- Some Folded Plane form samples by the Author – 113 (Down-Right) Heydar Aliyev Center by Zaha Hadid

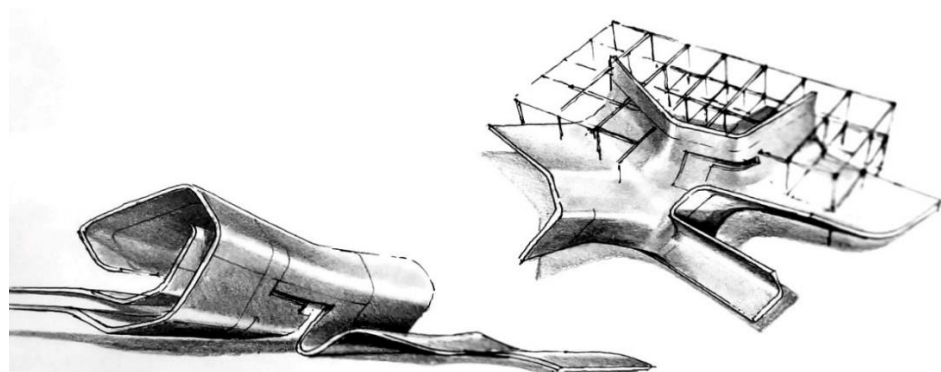


Figure 113 Some Folded Plane form samples by the Author.

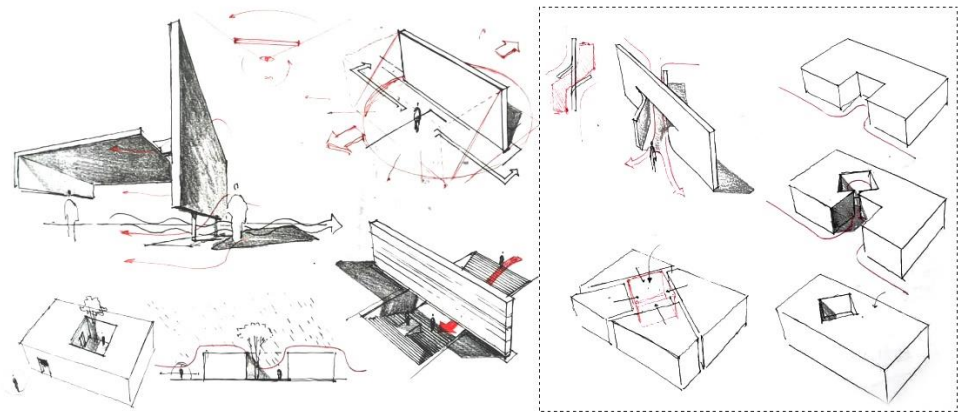


Figure 114 Some Folded Plane form samples by the Author.

The power of surfaces in defining space and their role in creating fluid and transparent spaces is undeniable. As can be seen in the above picture, the method of enclosing the space by using and dividing the space into places on the outer side of the wall and on the inner side of the wall or a place between the surfaces or outside the surfaces with these similar dimensions is noticeable. The surfaces are more flexible and when students work with the pages, they learn to define space with simple alteration, as seen below. Any curvature or folding in the surfaces creates space. You can see part of the diversity of how to place the surfaces to define the space in the image below.

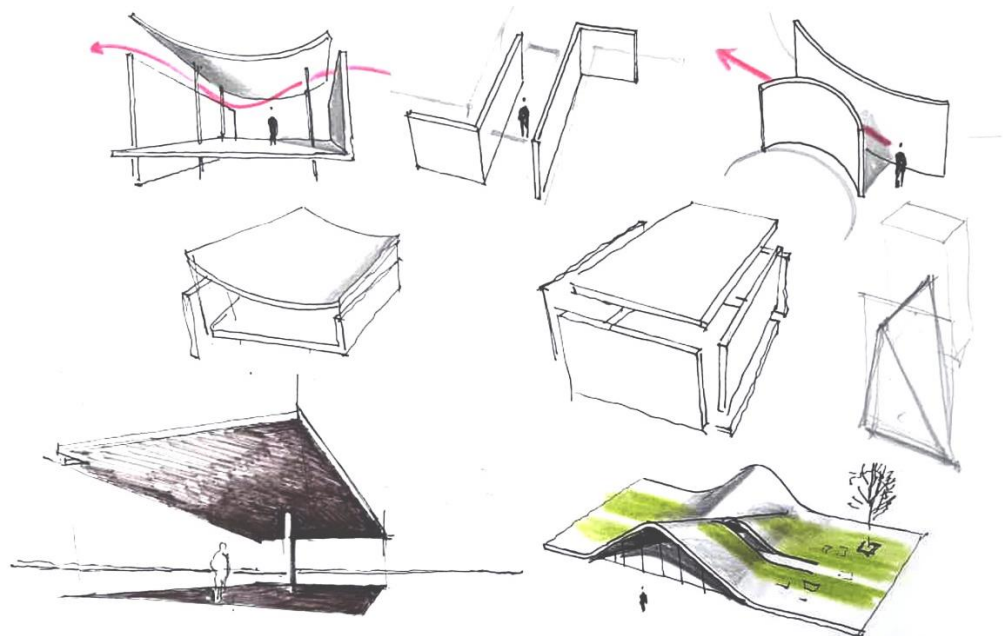


Figure 115 Some Folded Plane form samples by the Author.

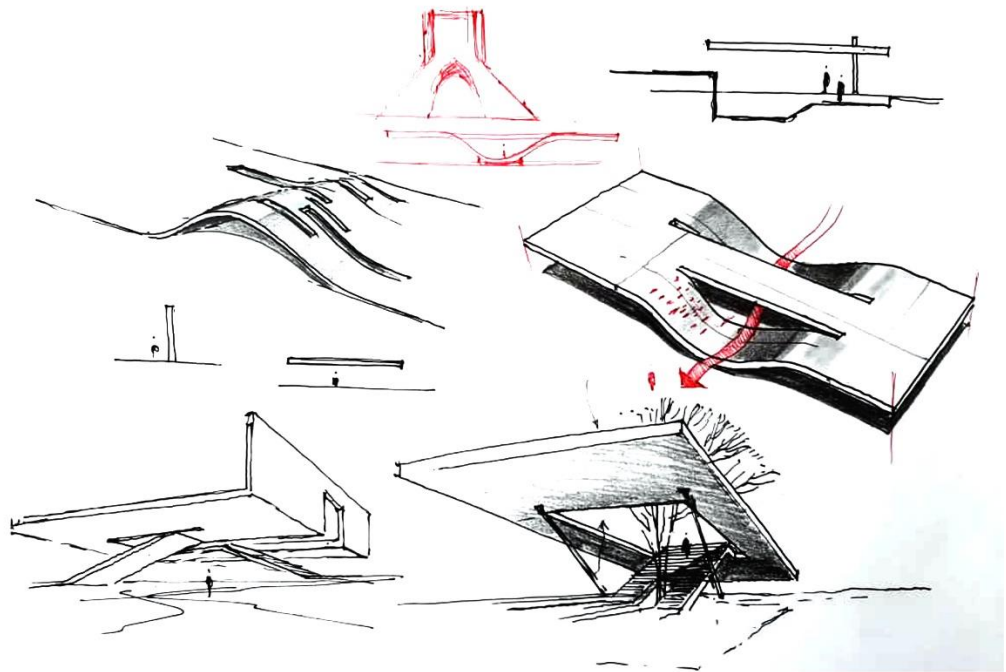


Figure 116 Some Folded Plane form samples by the Author.

Creativity in architecture often involves pushing the boundaries of surface design. Architects experiment with innovative materials and technologies to create unique and striking surfaces. This can lead to the development of iconic buildings that challenge conventional design norms. Some architects are exploring the integration of interactive and dynamic surfaces. These surfaces can respond to user input, environmental changes, or other data inputs, creating buildings that are not static but rather dynamic and responsive, captivating viewers and users alike. Surfaces significantly contribute to the visual appeal and character of architectural spaces. The choice of materials, textures, colours, and finishes can create a wide range of design expressions, from minimalist and industrial to ornate and traditional. Surfaces, such as walls, floors, and ceilings, delineate the spatial limits of rooms, corridors, and other architectural spaces.

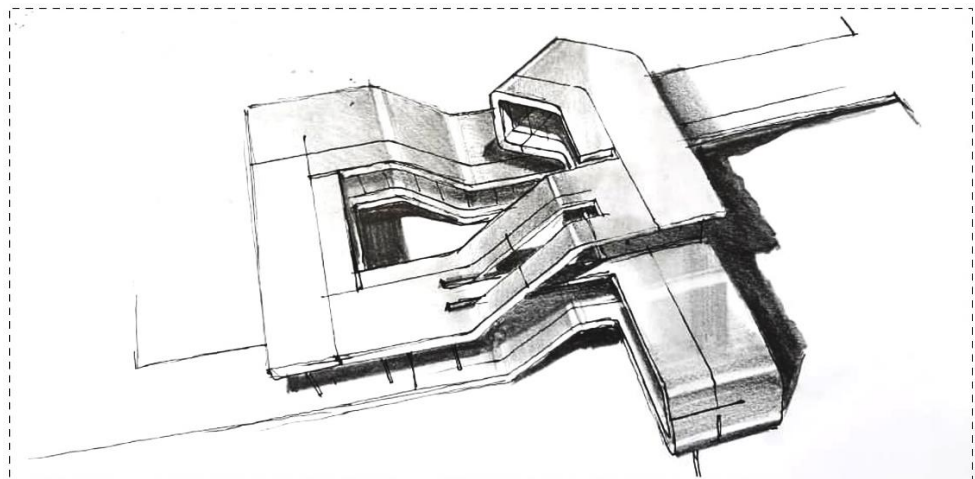


Figure 117 Some Folded Plane form samples by the Author.

14-Using the English alphabet as a template for designing new forms.

In this process, as indicated in the table 18, students are getting familiar with a creative practice out of the scope of Platonic solids. It becomes more of a game and creativity exercise that can be implemented through dynamic forms. Alteration and modifications of English letters to achieve new variations is the goal of this exercise. Students start the exercise from two-dimensional image of each letter and then developing it to three-dimensional forms. In addition, by knowing the visual characteristic of each letter, students begin to develop the diversity of their perceived image of the alphabet, and see them not as a letter, but as a form-based template. Looking at things upside down forces one to “see differently.” Things are seen apart from their usual connections. “Creativity, as has been said, consists largely of rearranging what we know in order to find out what we do not know.... Hence, to think creatively we must be able to look afresh at what we normally take for granted.” Many architectural buildings resembling the form of English letters; L-shaped, U-shaped, H-shaped, and S-shaped structures are among the most common, yet the designers did not intend to create a building with English letters, rather the constraints of the design problem resulted in creation of this form. This practice creates a way for student to start their design with making alterations on a non-platonic volume, which can be start for a change in their interpretation of the perceived world. Visual inertia is the degree of concentration and stability of a form. The visual inertia of a form depends on its geometry as well as its orientation relative to the ground plane, the pull of gravity, and the viewer’s line of sight.

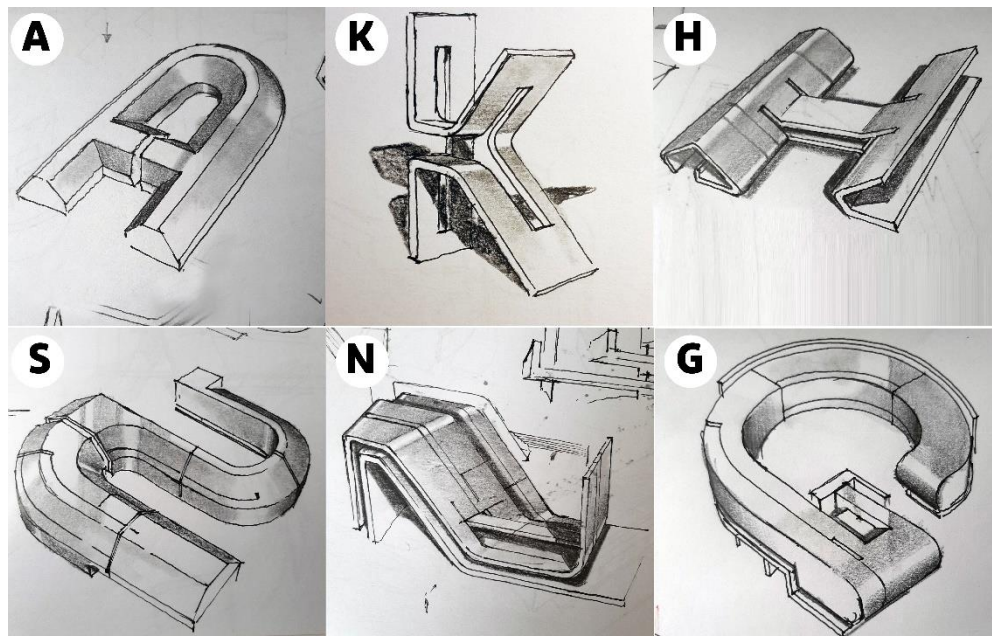


Figure 118 form samples by the Author Using the English alphabet as a template for designing forms

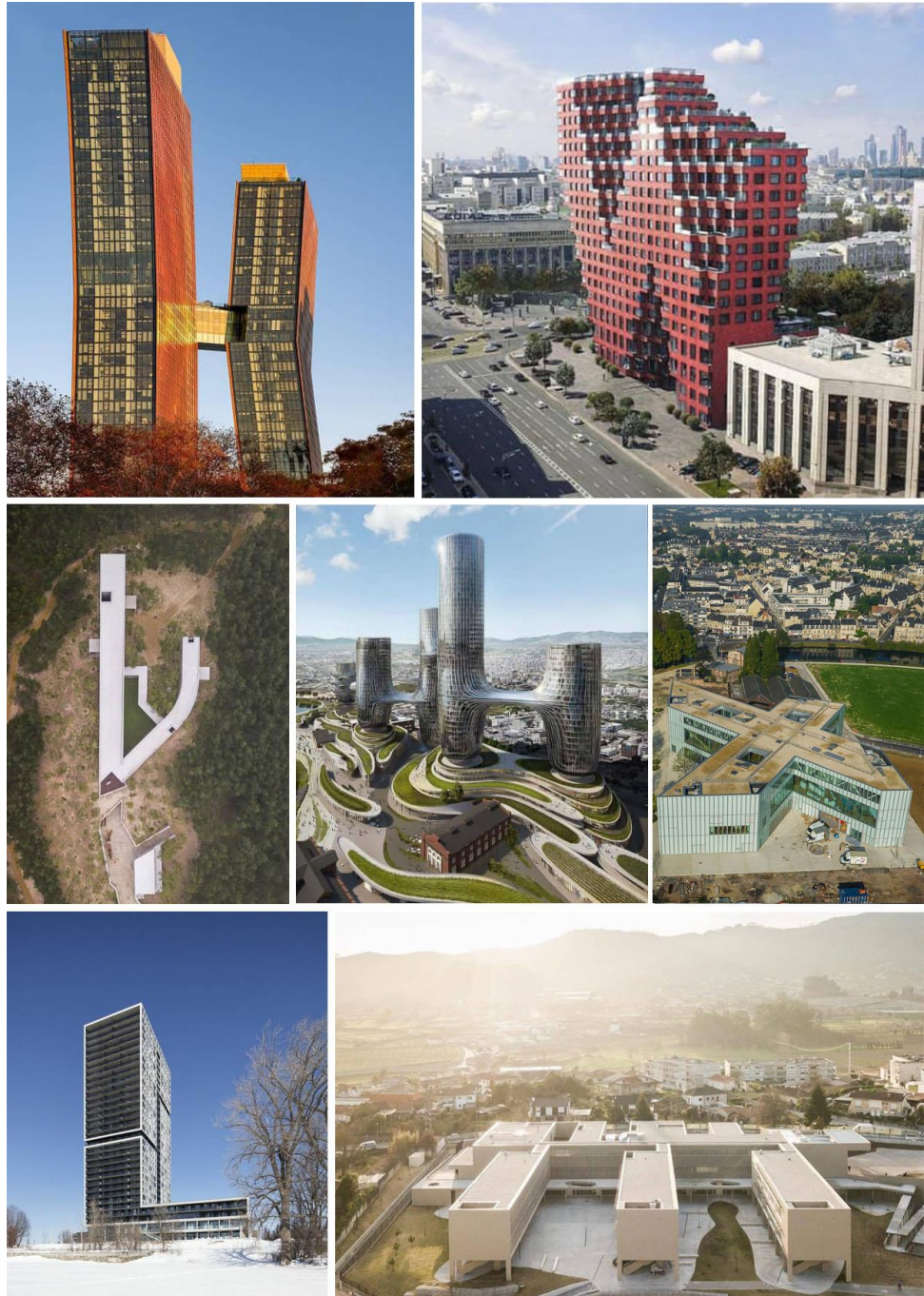


Figure 119-125 starting from top left to right: American cooper building by Shop Architect, Silhouette tower by MVRDV, Art pavilion by Alvaro Siza and Carlos Castanhira, A Proposal by Degree Zero Architect, Library of Caen by OMA, Gallery of panorama by ACDF, Escola EB3 Pitagoras Group

One of the abilities of the human mind to identify and understand is the ability to make comparisons. In above pictures, some buildings that are completely unintentionally designed similar to Latin letters. The architect's purpose in choosing this structure is the nature of its adaptability to the desired concept or project program, and through this spatial solution, it has responded to the architectural problem. Understanding these formal characteristics is a kind of creative exercise to focus the mind in identifying patterns outside the context of architecture for use in the design process.

CHAPTER 6:

Laboratorial research

Defining any sort of practice for generating multiple options as well as iteratively testing them is a conventional architect's design behavior and is considered a design practice.

This chapter encompasses the topics as follows:

6-1. Review the literature of laboratorial process based on the theories of part 1

6-2. Phase 1: TEACHING AND REFLECTING

6-3. Phase 2: IMPACT

Introduction

Architecture students encounter architectural problems, without broadening their knowledge regarding Form-based expressions. This fact has been expressed in students' works weaknesses regarding to converting their architectural ideas into tangible physical gestures. Filling this deficiency in the architectural curriculum can help students' perceiving Form in the context of architectural concepts.

Having a deep look into various architect's works through the lens of Form-based expressions, regardless of their philosophical viewpoints and theoretical approaches, has led to revealing a series of Form designing techniques. These techniques can be classified into two general categories of "modifying techniques" and "organization strategies". This research consists of a thorough explanation of fourteen techniques, which can make various operations on the geometrical volumes as well as non-geometrical masses. Through these techniques students learn how to use form giving and form transformation strategies to embodiment their spatial thoughts. This process has been tested for more than seven years in three architecture schools.

The impact of incorporating a course into architecture pedagogy, as an introductory course for the main architecture course such as the Architectural Design, and it will directly broaden the Form-based insight of students. It will additionally enhance their capability for positive reflection with further principal tasks and their understanding about the relationship between form and space. This will also increase the quality of the students' design strategy and their aesthetic aspects of their works.

6-1. Review the literature of laboratorial process based on the theories of part 1

In section A and in the subject of architectural education, important points were discussed that can be considered as solutions in the laboratory process. In Chapter 3, the concept of active learning is one of these elements that, in general, is dedicated to creating a set of parameters that can enhance the quality of students' learning and shape laboratory processes based on it. Among these elements, attention can be drawn to Guided design and the integration of collaborative and individual processes in the learning context. Additionally, strategies mentioned in diagram below. Additionally, involving the instructor's involvement in simulating the design process or presenting their perspective on the execution of initial exercise samples. The discussion then continues with Media art. The continuity of exercises and educational processes can be digitally recorded in video and documentary formats for students' review. Furthermore,

students' works and some educational processes can be presented in virtual space and media to showcase extraordinary achievements, enabling feedback to be received from other intellectual traditions, which in itself can be guiding. The creation of groups for sharing achievements among students and their updates by educational colleagues to create a dynamic space are among the discussed outcomes in Chapter 3, which can be perceived as effective in the laboratory process. A collection of these elements is illustrated in diagram number (126).

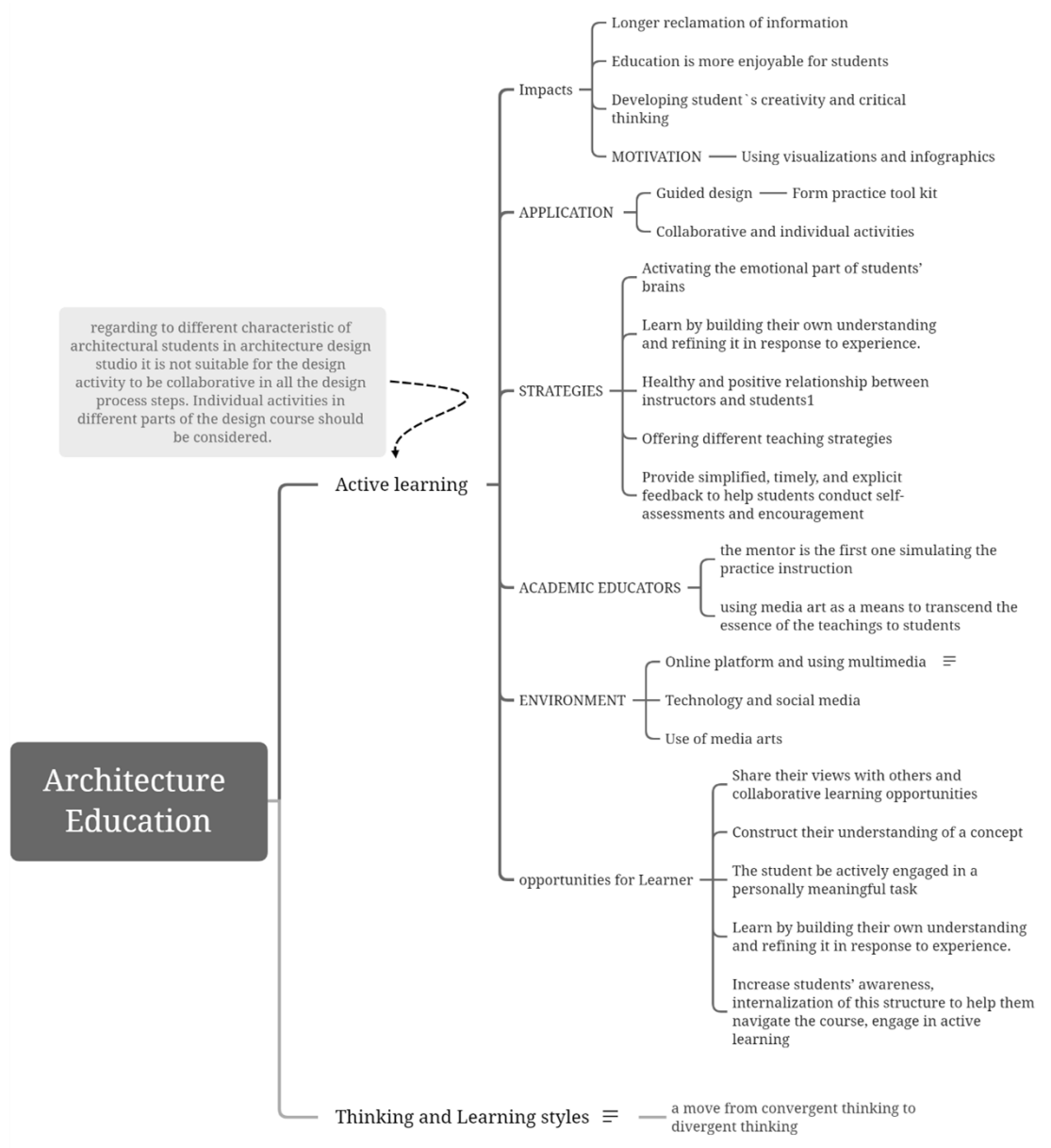


Figure 126 Architecture education Diagram

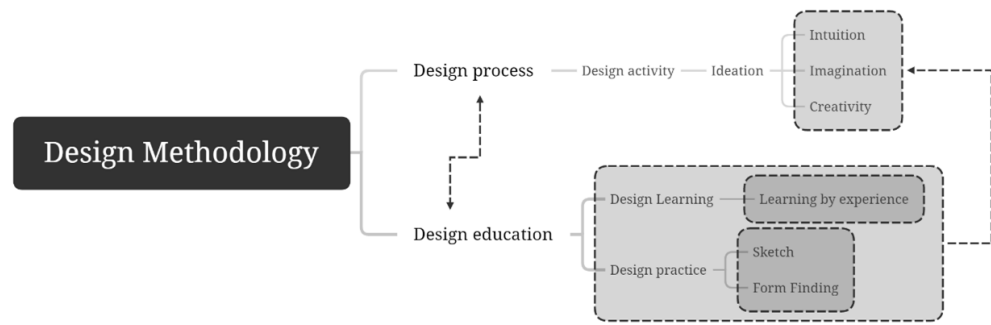


Figure 127 Design Methodology diagram

In the design section, and in Chapter 2, the focus is on the concept of Ideation, centered around three factors: imagination, intuition, and creativity. In the context of design learning, educational programs based on these three axes can be defined. The definition of creative exercises involves not specifying open-ended processes without predefined constraints. Steering students away from analytical processes and involving their sensory reasoning in making intuitive decisions will be crucial in choosing solutions, and this chapter can contribute to improving the quality of creative design education. Similarly, design exercises can rely on freehand design skills and purposefully utilize them as a research tool for form-finding (Diagram 127)

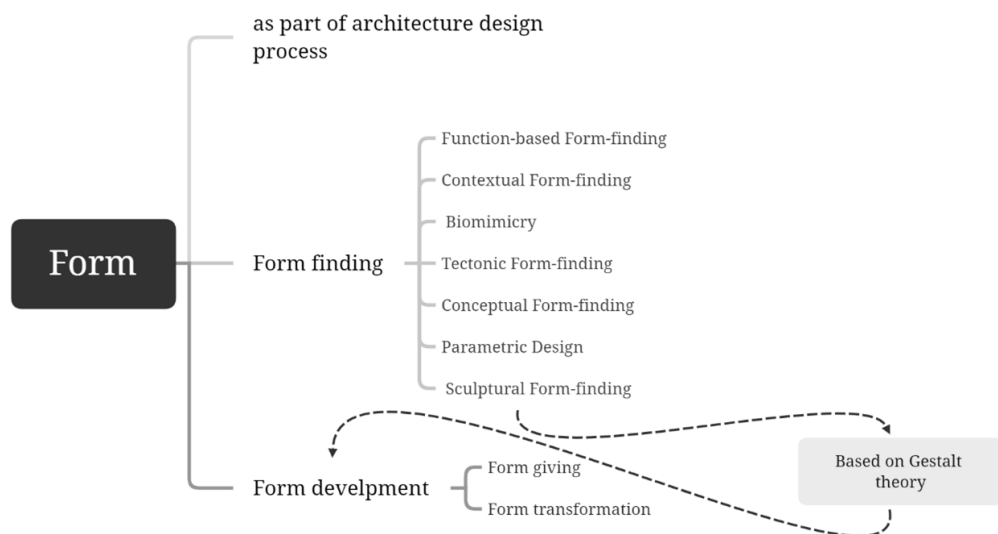


Figure 128 Form diagram

The desired exercises in the laboratory process contrived based on the form-finding process, introducing techniques and tools for this experimentation into the students' skill set. Considering the explanation of various form-finding processes in architecture in Chapter 4, the laboratory experiment is conducted based on two main domains: sculptural form-finding, grounded in gestalt theories, and form development, based on form giving and form transformation (Diagram 128). The results obtained from

observations based on this foundation and through the laboratory process reveal that the hypothesis of integrating freehand design processes and sketching with form development techniques is effective in unlocking diverse and imaginative ideas for architecture students. In essence, it presents a practical approach to embodying architectural ideas in the early stages of architectural education, preparing students for more professional design activities in studios. These results are summarized in the diagram below (Diagram 129) and are discussed in detail in Chapter 7.

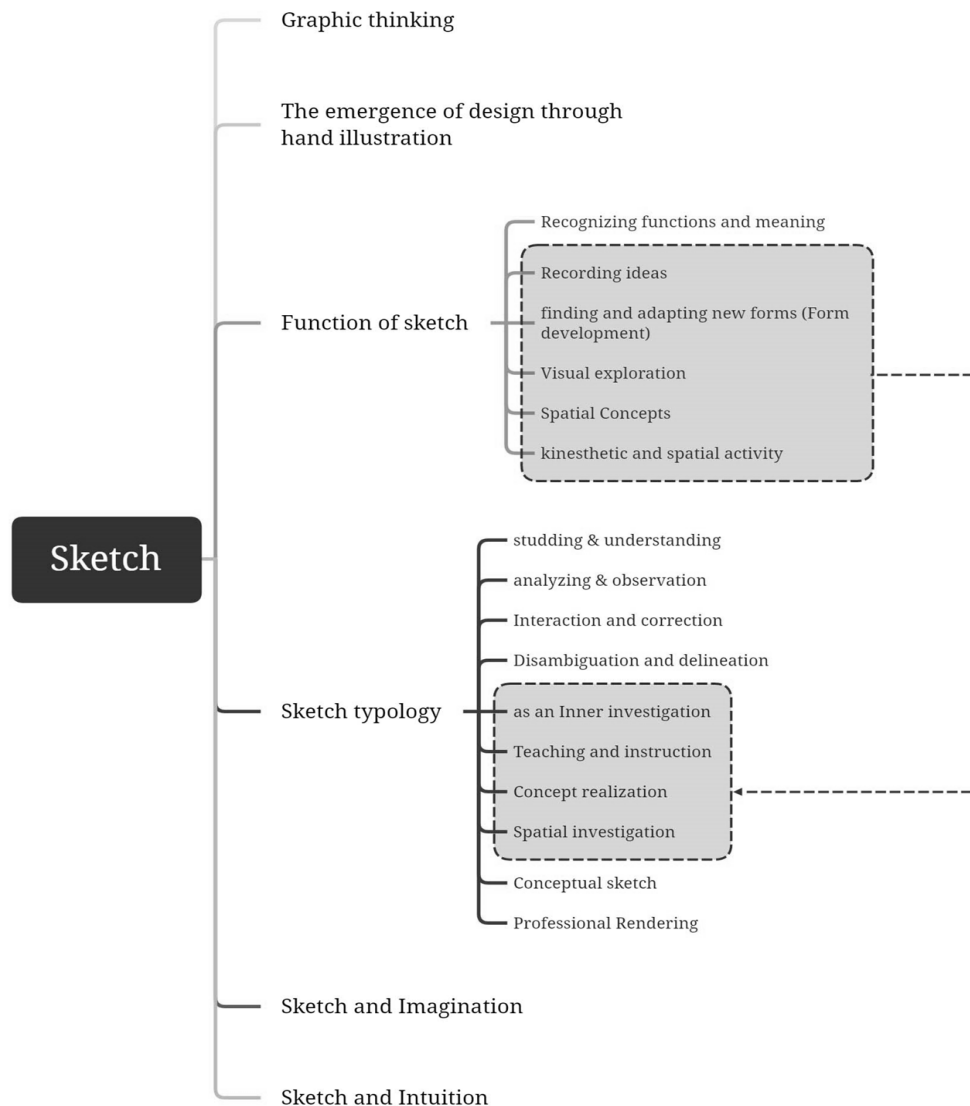


Figure 129 Sketch diagram

6-1.1. Objectives

Architecture is considered a multi-criteria decision making which has to respond to questions regarding the many correlating items to the architecture. The relation of architecture with the site, cultural context, environment, structure and so on. Psychological and philosophical theories should be considered as well. These various aspects of architecture have made difficulties for architecture students to find an integrated solution for

their ideas and concepts. As the form is the primary idea that is a step before the final answer to the architecture question, it is the place where many answers and alterations should happen and create alternatives. This state in the design process is the place where exploration and alteration can happen, be analysed, reflected, and edited many times with the most possibilities for change and consideration of different items. Therefore, it would be an opportunity for architecture student to get more familiar with form capacities and learn various techniques in the absence of architecture question to become more able to find their integrated solution for the architecture question. This research activity focuses on form's design development and the way architecture students perceive the relation between form-based structures and architecture.

Research questions

1. What is the conceivable form processing practice independent of the complexity of the architectural project?
2. What are the aims of form-finding and form-giving practices in the context of architecture discipline?
3. What is the course explanation of form design practice that can facilitate decision-making in the architecture design context?

Research Phases

This process's objectives encompass two different phases, the first one is more focused on TEACHING AND REFLECTING and the second phase is more centered on IMPACTS of the process on the students' final results.

Phase 1: TEACHING AND REFLECTING

- 1- Teaching techniques focusing on form design techniques and introducing specific techniques and design tools.
- 2- Reflecting on how students perceive the relation between form and architecture.
- 3- The experiential procedure of the form creation in architecture, without considering the design's topic.
- 4- Evaluating the students' strategies for creating design solutions and embodying architectural concepts and spatial structures into form.
- 5- Experiencing the reverse motion process, from form towards architecture.

Phase 2: IMPACT

- 1- The subjects
- 2- Students' engagement with the project
- 3- Assessment of the works
- 4- Evaluation and Refinement of the results

6-2. Phase 1: Teaching and reflecting

Part 1: Toolkit

Defining any sort of practice for generating multiple options as well as iteratively testing them is a conventional architect's design behaviour and is considered a design practice. The aim of these practices is to create more and different options before making choices which is a core skill to propose options continually. The aforementioned form-based practice can be contrived as an architecture course which acts best prior to the design studio course, in the context which is free from the limitations of architectural problem of the design course which is based on some "Modifying techniques" and "organization strategies" which are implemented on the form, via freehand sketches or mock-up makes the most connection from hand to the mind. Form Design Learning Method directly centred on some sorts of techniques, tools, and strategies that enabled the students to have an empirical methodology regarding **Form development** system. Another significant goal of this method is enabling the apprentices to alter the shapes and masses into more appealing proportions and produce various alternatives by **transforming** and modifying them.

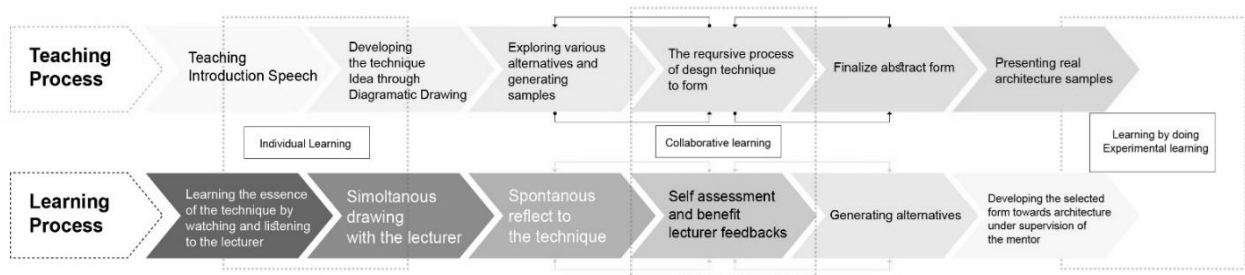


Figure 130 Teaching and Learning Process

Through this process, students will find the opportunity to come up with new and various yet innovative Form-based ideas that bring them insight for many architectural design purposes. Furthermore, hypothetically, they acquire a wide range of form-based compositions by practice. This ability features them to have more flexibility in choosing and testing several options within the form-finding procedure.

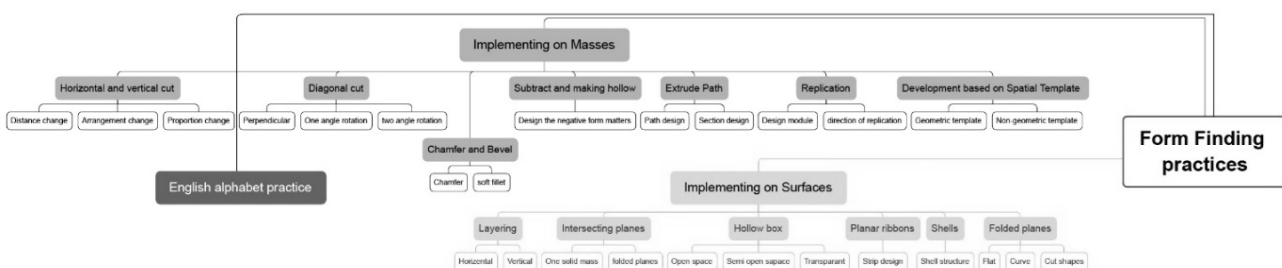
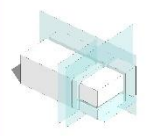
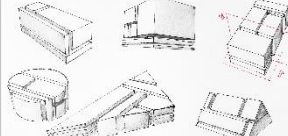
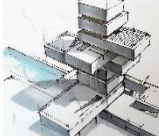
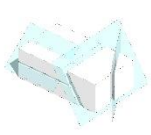
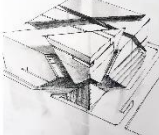
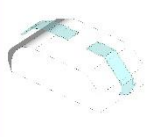
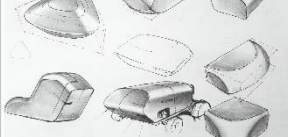
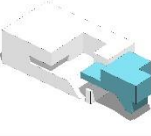
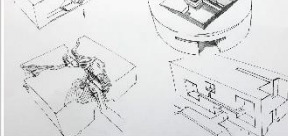
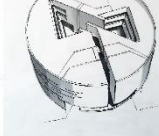
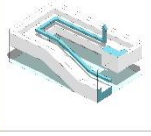
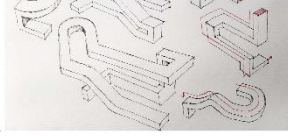
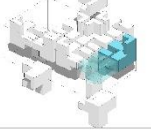
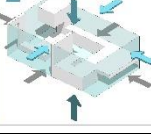
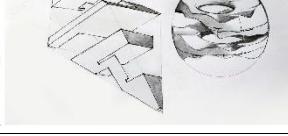
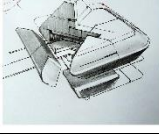
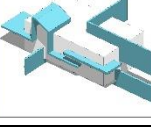
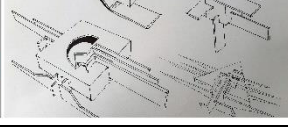
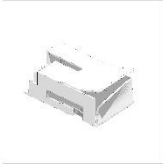
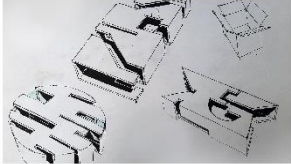
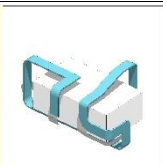
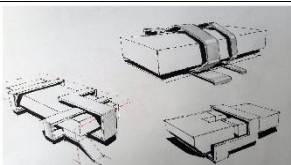
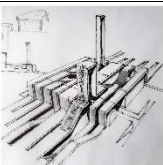
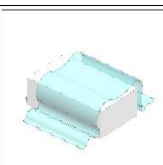
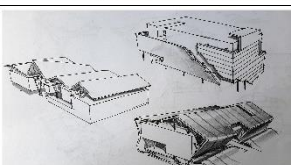
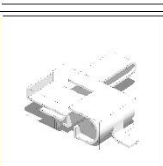
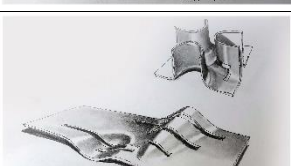
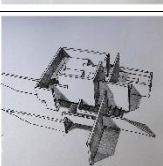
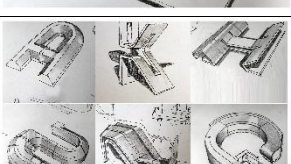


Figure 131 Form finding practices dimensions

Table 18 Introducing suggestive techniques and tools for form creation.

TECHNIQUE and explanation	Technique Diagram	Hand drawn sketch	Architecture development	Architecture Sample
1.Horizontal and Vertical cuts Helps separating different functional zones . Creating an axis by the cut, which affects the design. It creates opportunity for logical relations between zones and creating hierarchies in architecture. It helps less use of dead-end corridors in plan and also creates a more rational architecture. Therefore, it helps creating more flexibility in an architecture. Creating space-between among the different and separated forms. This negative space, between the forms, can also help ventilation, better vision and light entrance to different architectural zones.				
2.Diagonal cut Helps separating different functional zones . Creating an axis by the cut, which affects the design. It creates opportunity for logical relations between zones and creating hierarchies in architecture. It helps less use of dead-end corridors in plan and also creates a more rational architecture. Therefore, it helps creating more flexibility in an architecture. Creating space-between among the different and separated forms. This negative space, between the forms, can also help ventilation, better vision and light entrance to different architectural zones.				
3.Chamfer and Bevel Creating a fluid space. Making a sense of suspension via the form. It also helps diminishing linear borders, when used in windows or other openings. It also helps making more lightness in the solid and reducing the visual weight. The potentiality to create more surfaces in different angles which makes vast variation in the shadows and lights of the form, which according to le Corbusier is the meaning of architecture. "Architecture is the mastery, correct and magnificent play of masses brought together in light." This technique also can help dissolving the border between floors and walls or roofs and walls via chamfer.				
4.Subtract and Making Hollow This technique works with the negative space instead of the positive space in the architectural form. It helps creating openings, including central yard, ... or a giant opening for the views				
5.Extrude Path This technique is useful in creating vision continuity in a fixed path, which simultaneously with the flow of movement in the space, The form moves as well. In fact, we can say that form follow the fluidity and the movement path in the architecture. So, the form is dynamic and continuous.				
6.Replication Making symmetry in architecture. It helps using same modules which intensifies via duplicating many times in different favoured directions. This technique helps making forms which are easily developed and it most cases replication of the same mass creates lots of opportunities in Changing or extending the function of form. In addition to its vast functions, this technique creates opportunity to make rhythm in the architecture, which is one of the aesthetic laws.				
7.Development Based on Spatial Template This technique, helps the designer, make integration in the form. Considering a geometrical volume, to limit the imagination of the designer, integrates the project, aesthetically and functionally. The negative and positive space, can create the spatial volume.				
8.Layering Layering technique is about transparency in architecture. Designing based on using floors and roofs, frees the walls and its solidity.				
9.Intersecting Planes The identity of the architecture form is created via a combination of solid and surface. They also can help creating guidance spaces. They can be flexible interior items of the architecture which create vast alternatives without Changing the base structure. Surfaces also can help lightening the weight of architecture when combining with the solid architecture volume. They also can play structural functions.				

10.Hollow Box Creating opening in the surfaces of the architecture including roofs and floors. Hollowed and porous surfaces create the relation between inside and outside. This helps creating light and vision.				
11.Planar Ribbons It creates a fake roof or wall, which can have structural function as well as opportunity for different architecture functions in the work.				
12.Shells Shell structures are extremely functional in architecture including energy saving strategy for the building. It also creates a space between in the main exterior walls of the building and the shell. It defines the exterior border of the building in a way that the main structure of the building does not change.				
13.Folded Planes They are used a lot in folding style architecture and creating spaces via the use of surfaces. In this technique there is not any mass and the folding planes are playing the main role of creating architecture space.				
14.English Alphabets This is a creative strategy for making a new perspective towards the architecture form. Using new kinds of forms instead of platonic volumes. These forms are advantageous in terms of dynamism. The most important function is in creating creativity.				

Through these techniques, students will face a collection of tools and technics which can be effectively used to change the shape of raw material and spatial masses, according to the structure of mind. These technics are very simple and somewhat familiar. Even it is possible for a normal person to be accidentally familiar with them and use them in his daily activities. But something which can be developed and taught as a technic, goes out of the province of a simple “act” and enter the field of “skill”.

For each technic, this skill consists of several parts:

- 1-Improving quick, improvised reactions
- 2-Strategy in choosing and application
- 3-Controlling the situations, when facing unforeseen incidents
- 4-Management of technic towards design goal and form development
- 5-The ability to organize the product after using the technic
- 6-Aesthetics of the product
- 7-Creating unity among the composition after using the technic
- 8-Logical relation among the shapes:

INTERSECTION
CONFIGURATION
JUXTAPOSE
JUNCTURE
CORRESPONDENCE

INTERRELATION
HIGHERARCHI
COHESION
EQUILIBRIUM
CONTRADITIO

9-The ability to add flexibility to formal products, in order to let them take part in new compositions

Therefore, it will not suffice to depend on a single technic, no matter how innovative and practical it is. In order to increase efficiency and convert that technic to a skill, each part of the practice process and its effect on the output of the practices must be programmed with great precision.

The second part of the practices includes seven different technics, which are as follows:

- | | |
|---|----------------------------|
| 1-Horizontal and vertical cut | 2-Diagonal cut |
| 3-Chamfer and smoothen | 4-Subtract and make hollow |
| 5-Extrude Path | 6-Replication |
| 7-Development based on spatial template | |

These seven technics can be considered as the raw material in the design of a spatial mass (volume) in the form of a geometrical volume or a non-geometrical structure, which henceforth, will be referred to as “the basic form” in this process.

The technics will be executed on the basic form. Each technic is considered as a tool for creating a change in the basic form. In the initial stages of education, each technic is used separately, and by proceeding forward through the next stages, it will be possible to use multiple technics in combination. Using these technics, the students make find themselves familiar with each tool and its capability in form giving. Not only that, but also, they will get to know the usage of the created forms for different design purposes. Imagination of a basic form is a kind of limitation for choice and incarnation of the solemnity which can be used in manufacturing the form. This is just like the consideration of a baker about how much dough he should take for baking a loaf of bread, or how much clay should a potter take for making a vase, or what size is good for a stone in order for a sculptor to make a statue out of it.

This limitation is a part of educating and training an architect. This is due to the fact that despite having infinite material and space during the conceptual process of a design, it will not be possible in real world to have infinite resources. Therefore, a student should be gradually able to have a general imagination of the shape of their project and whatever they are intending to build, much like a sculptor. Also, the student must know the properties of a material called the basic form, and conceptually choose the proper tool.

Simple examples of each of the seven technics will be given, but practicing these technics has much larger aspects and many more practical points than these examples.

Some examples from educational levels of second part of method

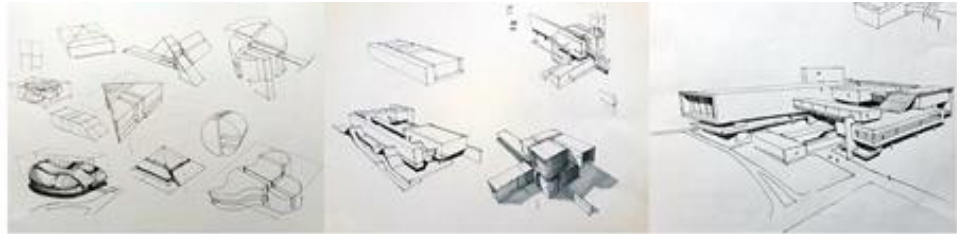


Figure 132 Part of the process taught in **Horizontal and vertical cuts** topic.



Figure 133 Part of the process taught in **Diagonal cuts** topic.

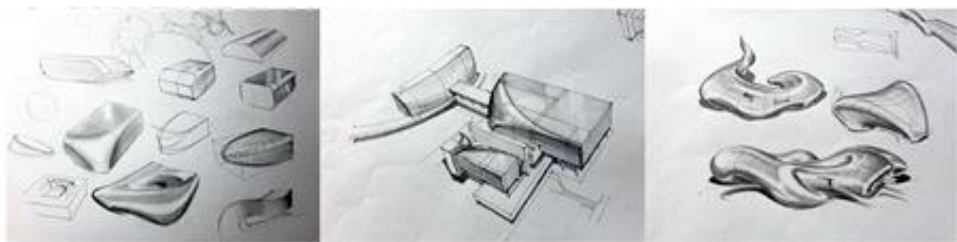


Figure 133 Part of the process taught in **Bevel and chamfer** topic.

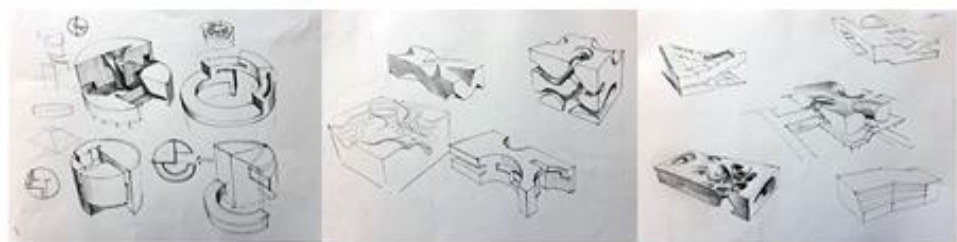


Figure 134 Part of the process taught in **Subtract and making Hollow** topic

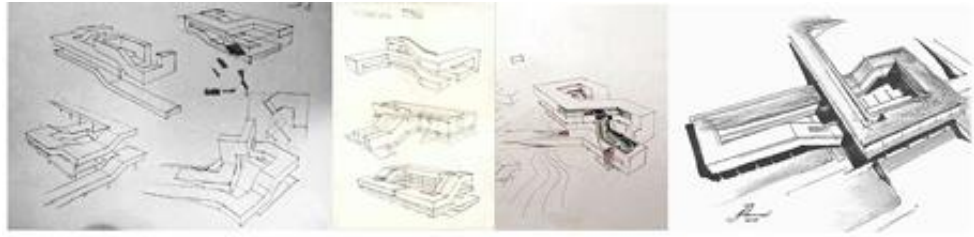


Figure 135 Part of the process taught in **Extrude path** topic.

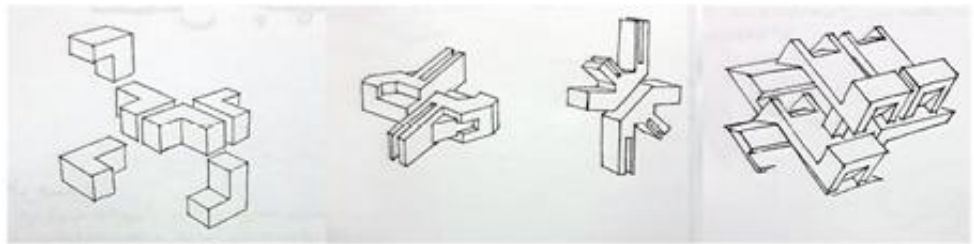


Figure 136 Part of the process taught in **Repetition** topic.

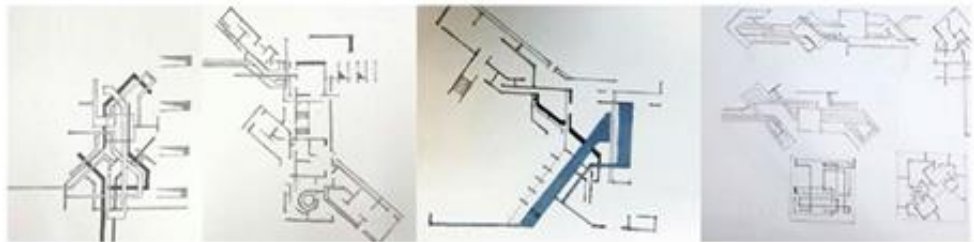


Figure 137 Part of the process taught in **Development based on spatial template**.

As a more advanced stage in the design process, the third part concentrates on different relations of surfaces in creating space. First, plane and its properties are introduced thoroughly, and all kinds of forms which can be made out of planes are described, as well as their design method. Since architectural spaces are actually hollow and also plane is a more fundamental component than volume in creating space, thus, these technics are one step closer to real architecture, regarding shape structures. It is even safe to say that these technics need a more advanced insight than that of volume technics. Architectural buildings are hollow spaces, and components like floors, walls and ceilings play the main role in creating these buildings. Therefore, the use of planes can be studied considering the methods of enclosing spaces using the flexibility of planes through 7 technics, which are as follows:

1-Layering

3-Hollow box

5-Shells

7-Folded planes

2-Intersecting planes

4-Planar ribbons

6-Continuous surfaces

In the methods of the third part, students get to know more professional structures of form for creating space. They will identify important origins in the professional field of architecture, and will be able to track these origins. For each technic, simple examples of design process in the initial form design method in the third part are presented here.

Some examples from educational levels of third part of method

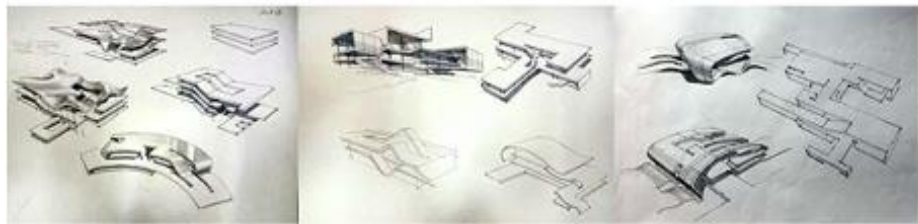


Figure 138 Part of the process taught in **Layering** topic.

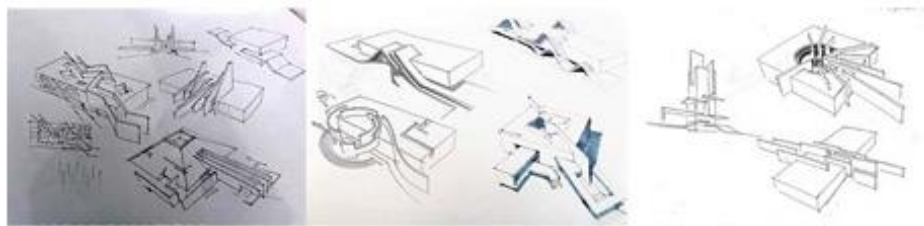


Figure 139 Part of the process taught in **Intersecting plane** topic.

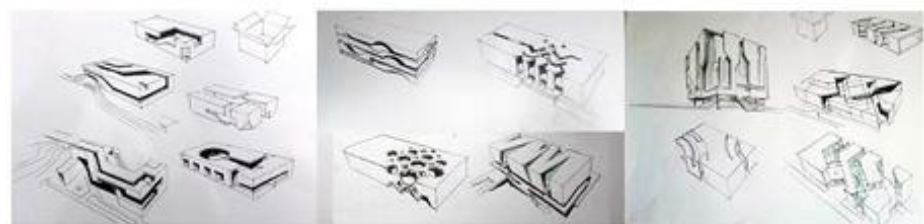


Figure 140 Part of the process taught in **Hollow Box** topic.



Figure 141 Part of the process taught in **Planer ribbon** topic.



Figure 141 Part of the process taught in **Shells** topic.



Figure 142 -143 Part of the process taught in **Folded Planes and Surfaces** topic.



Using the English alphabet as a template for designing new forms.

In this part, we will literally play a game, which— like any other game- has its own specific rules. In this section, students use the 3D form of alphabet letters as familiar, predefined structures, with which they start to design via specific rules.

The goal of this section is to separate the mind of the student from concentrating on Euclid's volumes. This will let them have an experience with new forms, which -at first- not look like they can be oriented towards architecture or even can be related to it. On the other hand, the structure of English alphabet is based on familiar geometrical structures. As we see parts of circle in O, Q, D and C, triangle in A, V, N and W, and perpendicular structures in T, E, L and F. Students are familiar with these shapes, but in this practice they will look at them with an unconventional nature. Students learn how to recognize the properties of the alphabet letters 'forms not by watching the familiar structures of the letters, but by understanding visual and dynamic energies which create them and change them via a certain

algorithm. The connotation in this stage is a <<visual occurrence>> which can be altered and developed without demolition of our inception.

As we observe in these examples, by following a structural concept and trying to maintain it while we try to create and design more varieties (as many varieties as possible), form variety is obtained. In this method, the design subject is a known, specific template (which is the English alphabet), which is the constant part of the design and can be considered as a conventional “code.” A great deal of different form dynamics can be related to this subject and can be studied and archived by students. Therefore, what is taught in this stage is how form can accompany and follow a conceptual structure. Meanwhile, these letters can be transformed into each other with very little changes. Thus, unfinished approaches are at hands with great potential for evolution and development of new forms.

On the other hand, there will be a notable similarity between advanced samples of these forms and architectural samples, which gives the conclusion that the way of figure out these relations between ingredients of letters form in real architecture .

At this point, the students do not see architectural forms as a single whole, which has been created by an architect all at once, with all its components. On the contrary, now the students will understand that form is a result of various treat and complicated relations between different components, which have been thoughtfully organized and created in harmony with each other.

Here, is a good point to mention a quote from Pallasmaa:

“Creative insight in architecture is seldom made of sudden discovery which can suddenly uncover a complicated entity with complete perfection”.

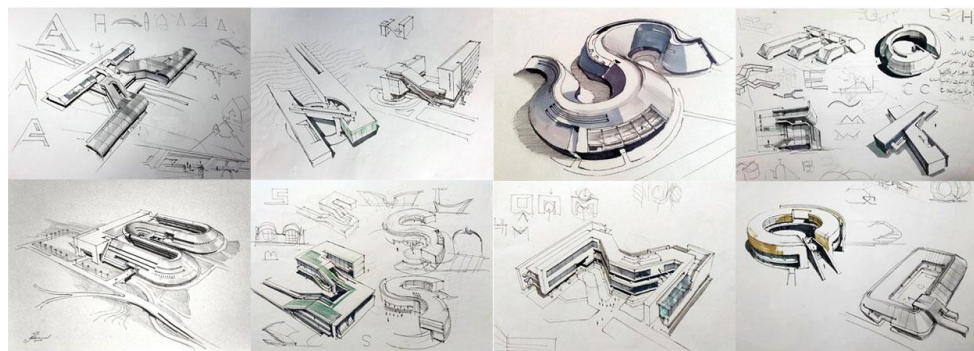


Figure 144 Part of the process taught in form making based on alphabet.

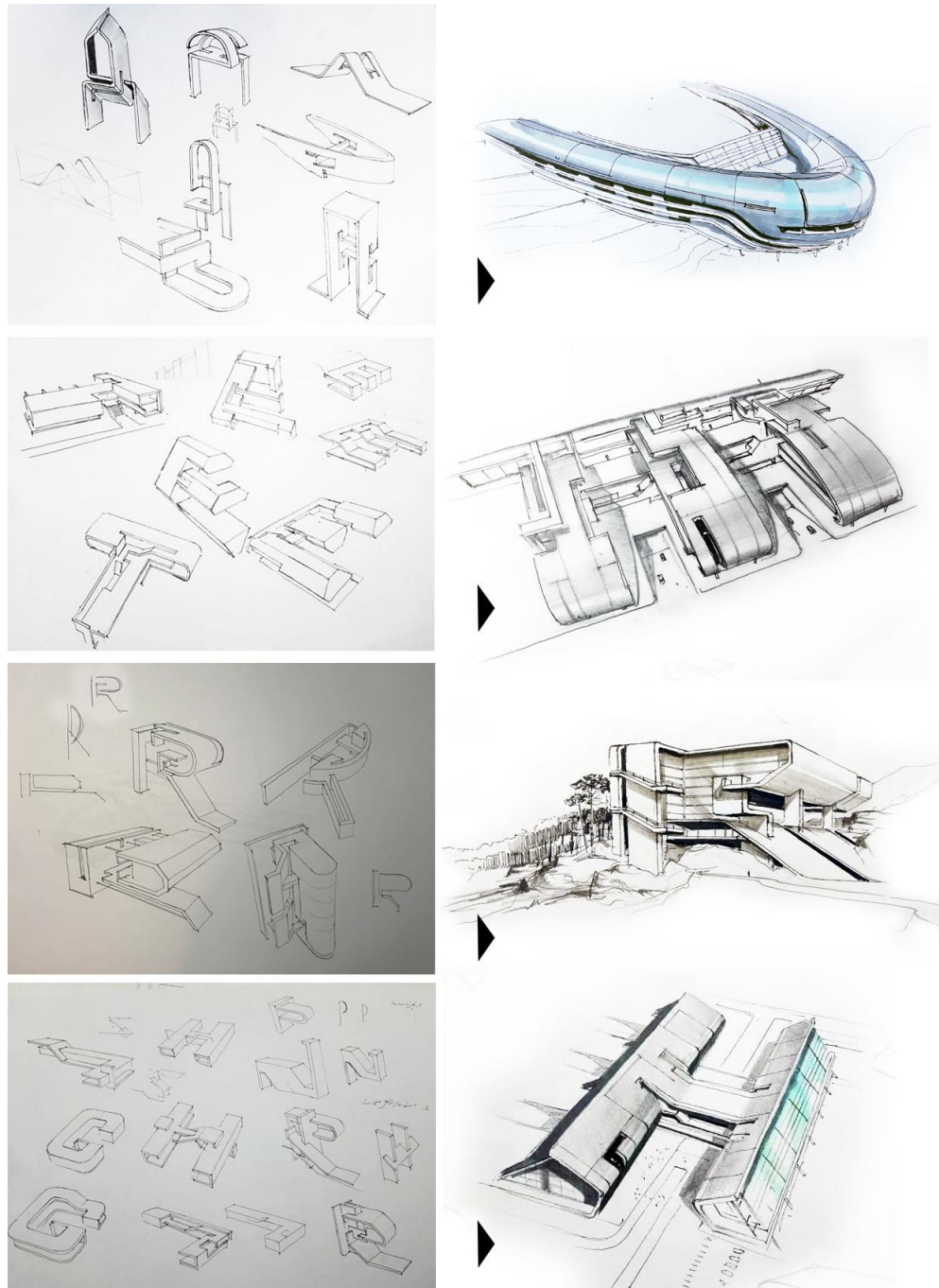


Figure 145 Part of the process taught in form making based on alphabet.

The fourth part is the final and the most professional part of the form design process in this research. In this section, more complicated attitudes are introduced to students. The general approach of the practices is in such a way that new aspects of form as a dynamic, alive system are studied via three main technics. Everything a student has learned in three previous levels is used as a skill beside these three technics. These technics are as follows:

1- The anatomy of growth: in this technic, the initial core of any formal structure which is created using the previous methods, are considered as an unfinished mechanism, which can grow and get more developed. But the place of this growth and development is no longer in the hands of the designer, but it will follow certain rules, which are dictated due to the basic form. Thus, in this system, form is like a live creature which is subject to change, and the designer is the one who carries out these changes. The cause of these changes can be anything. In this system, the upcoming stages are unpredictable, and the design can only be controlled in each stage.

2- Development using spatial format: The second technic of the fourth stage is an approach for development of the form under a certain spatial format. In this system, a spatial format is considered for the basic form or for forms which were created in previous stages. This way, the continuity of design can be under control in order to reach more varieties of form creation. Actually, the spatial format is the controlling structure and the basic form is a variable structure. Albeit, in each stage, depending on the designer's taste and aesthetic matters, the formal composition of the spatial format can be subject to change.

3-The third method includes technics for making a form compatible with a certain place: In this method, the design concentrates on special technics with which form can adapt to the field. This adaptation is studied using certain definitions like harmony, contradiction, merger, fusion, drowning, etc. Therefore, using previous technics for creating these changes is very effective.

In this phase, the students implement the methods in the form of experimental practices and use each technique individually. In this stage, the target is to produce abstract compositions through freehand sketching without considering the architectural subject matter yet paying attention to the proportions, equilibrium, corresponding, and aesthetic terms. The apprentices utilize the advice and suggestions from their instructors to avoid any detour or error. Meanwhile, all their design process will be improvised, and no logical reasoning will be prescribed. Creative attitude and novel expression in terms of decoding the hidden correlation among the components of their design will shed light on this trajectory. Thus, the mentors should provide sufficient guidelines and cases in point so that students fully understand the assigned tasks.

The transcriptions and the sketches made by the participants comprise the protocols that served as data for the present studies. In the first round of exercises, seven experienced architects and three groups of students of architecture worked on the design of some form concepts. They were asked to work on using some sort of techniques on the masses and then provide consequences for architectonic. Each session lasted between one and two hours, with the designers talking to an investigator, who only answered technical questions and prompted speech when silence lasted over several seconds. The objective of the present study was to isolate the activity of form designing and use visual thinking and imagery as a conceptual framework for investigation. The entire process of designing and its front edge especially is not necessarily seen as a case of problem solving or answering the specific architectural task but mostly focuses on how interpreting each student's relation between form and architecture. (A discussion of the difference between problem solving and other models of architectural designing is, however, beyond the scope of the present discourse.)

Part 2: Reflecting on how students perceive techniques and the way of utilizing them in form creation

In this phase, the students implement the methods in the form of experimental practices and use each technique individually. In this stage, the target is to produce abstract compositions through freehand sketching without considering the architectural subject matter yet paying attention to the proportions, equilibrium, corresponding, and aesthetic terms. The apprentices utilize the advice and suggestions from their instructors to avoid any detour or error. Meanwhile, all their design process will be improvised, and no logical reasoning will be prescribed. Creative attitude and novel expression in terms of decoding the hidden correlation among the components of their design will shed light on this trajectory. Thus, the mentors should provide sufficient guidelines and cases in point so that students fully understand the assigned tasks.

The study involved seven experienced architects and three groups of architecture students engaging in design exercises to explore form concepts. The protocols, consisting of transcriptions and sketches, served as the study's data. Participants utilized various techniques on masses, linking them to architectural consequences. Sessions, lasting one to two hours, involved designers interacting with an investigator who provided technical answers and encouraged speech during silences. The study aimed to isolate form designing activity, employing visual thinking and imagery as a

conceptual framework. Unlike conventional problem-solving approaches, the focus was on interpreting each student's relationship between form and architecture. The discussion acknowledged the distinction between problem-solving and alternative architectural design models but did not delve into it extensively within the study's scope. **For the analysis of sketching, moves were classified as follows:**

- Moves made while actively sketching
- Moves made while contemplating sketches and reading off them
- Moves with the aid of T.A. suggestions and their comments

The selective result of how students reflect to the method

In this process the students are taught how to use different techniques and create various form-based structures and developing them. This process is done both independently and in some cases with the supervision of the instructors. In the independent moves the practice was centered on sculptural approaches and with the assistance of the instructors they tried providing some architectural expressions.³⁴⁷ This process has examined the works of 300 students attending to the course. The samples which are directed as follows has been selected randomly among of 15 participants and these works are considered as the basis for further analysis.

Table 19 Grades of different students on the course

	Evaluation	T1	T2	T3	T4	T5	T6	T7	Assessment1	T8	T9	T10	T11	T12	T13	T14	Assessment2
	S1	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16
Student 1	6	B	C	A	A	A	B+	C	9	A	B+	A	-	C	A	A	9
Student 2	8	B+	B	A	A+	A	B+	C+	10	A+	A	A+	A	B	A+	A+	10
Student 3	5	C	C-	B	B+	B	B+	C	8	A	A	A-	B	C	A	B+	9
Student 4	7	B	B-	B+	A	A+	B	C+	10	A	B+	A	A	B	A+	A	10
Student 5	4	C	C-	B	B	A	C	C	7	B	A	B+	A	B	-	B+	9
Student 6	4	B-	C	B	B	-	C	D	7	B	B	B+	-	C-	B	B	8
Student 7	5	D	D	C	C+	B	B	C	8	-	C+	B	B	C-	B	B+	8
Student 8	5	D	E	D+	C	-	C+	C	8	C+	B	C+	B	C	C+	B	7
Student 9	6	B	C	-	B	B	B+	B	9	A	A	B+	A	B	A	A	10
Student 10	6	C+	B	B+	A	B+	B	C	9	A	-	A	A	B+	A+	A	10
Student 11	8	B	B	A	A+	A	A	B	10	A+	A+	A	A+	B+	A+	A+	10
Student 12	3	D	E	C-	D	-	C	-	6	B	C	B+	A	B	B+	B	9
Student 13	5	E	D	C	B	B	B+	B-	8	-	B+	B+	A	C	-	C+	7
Student 14	8	B-	B	A	A	A	A	B	10	A+	A+	A+	A+	A	A+	A+	10
Student 15	4	C	C	B	B+	C+	A	-	9	A	B+	A	A	B+	A	A	10

³⁴⁷ Surveying the feasibility and capacity of the produced forms with architectural perception.

The scores have been given based on the following criteria with the lens of creativity:

Architectural capacity: According to the Mentor, what are the architectural capacities of the produced form and how much it can be used for an architectural idea?

Sculptural expression: The development of the idea of a form based on the sculptural nature of the form and the dimensions of the beauty of sand Ace of it.

Simplicity and explicitly: Creativity in creating form through minimalistic approaches and removing excesses.

Complexity: The ability of producing complex and multi-natured spaces using form

Cohesion: Achieving formal coherence and maintaining the visual balance of the design after the transformation stage

Statical Approach: Students' vision at the way of establishing the design in the defined context and paying attention to its gravity forces.

Array: The ability to logically arrange congruent elements and achieve harmony

Proportions and Harmony: Recognizing and choosing the right proportions for the optimal combination of the components of the composition next to each other.

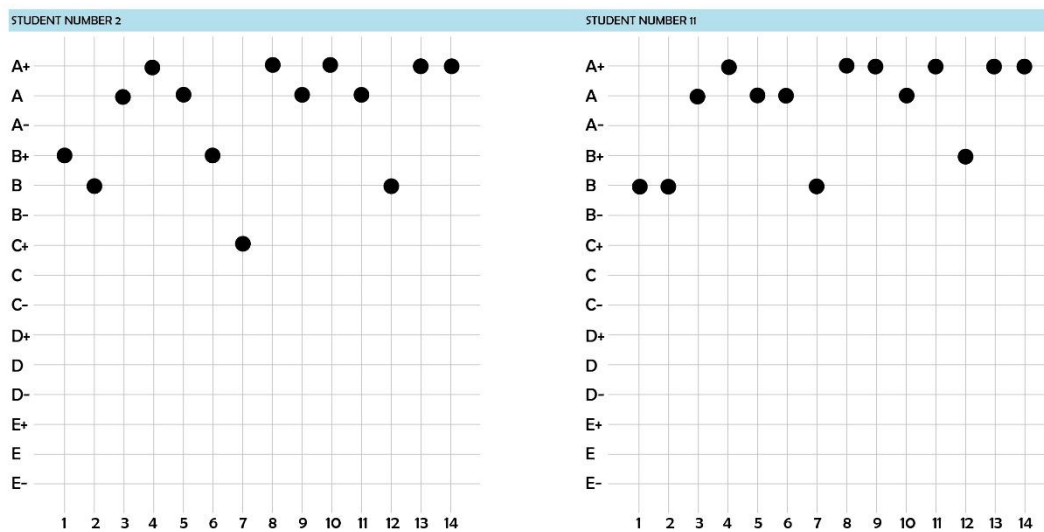


Figure 146 Diagram depicting students` performances.

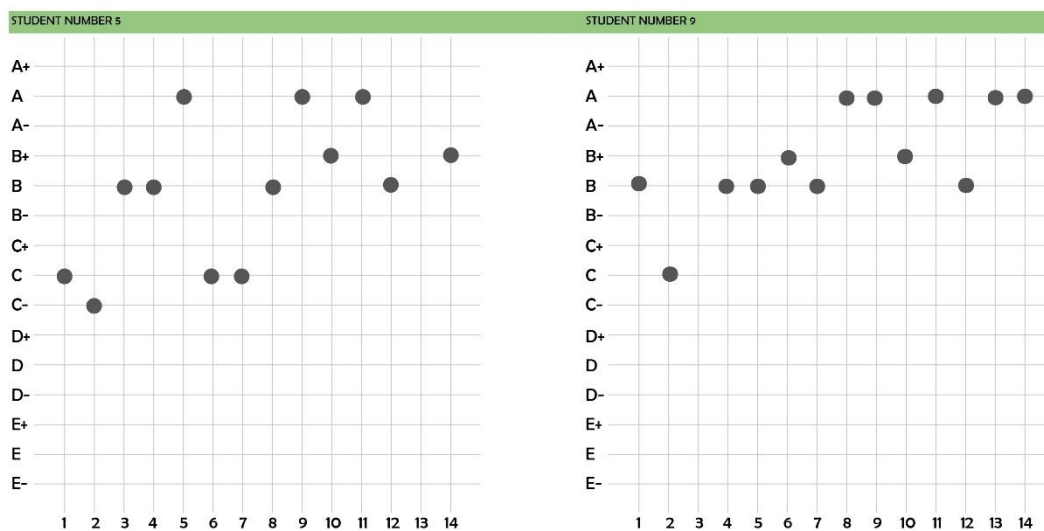


Figure 147 Diagram depicting students` performances.

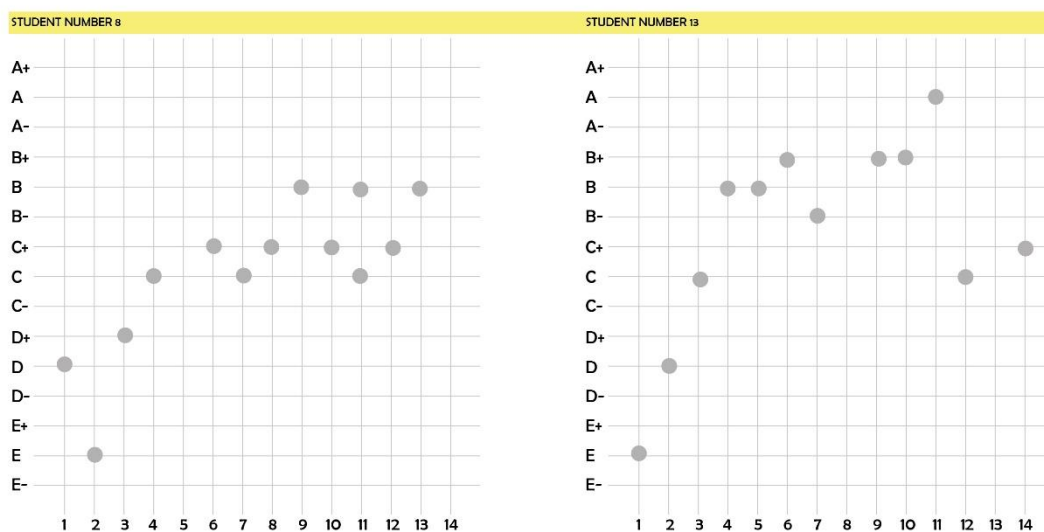
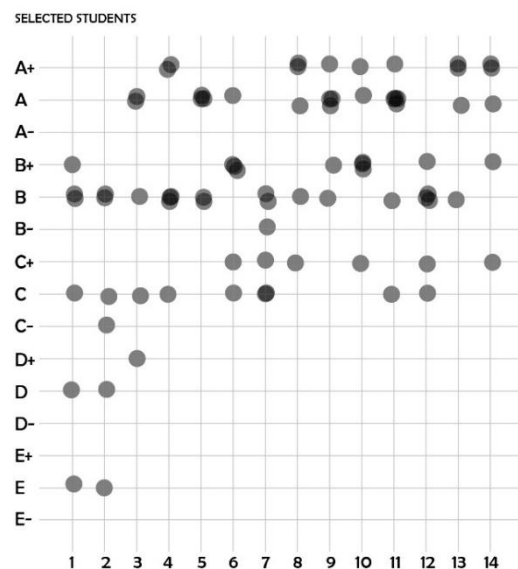


Figure 148 Diagram depicting students` performances.

In the above graphs, six students were selected in such a way that two students with excellent performance, two students with average performance and two students with insufficient performance. According to the table and according to the criteria defined in 16 sessions, their grades are placed on the graph and as the graphs show the performance process of the students, they had an upward trend in the educational process. It should be noted that in some exercises, the difficulty of the exercise itself sometimes caused the student to perform weaker than the previous exercise. This means that a student who got a good grade in the previous practice session but showed a weaker performance in the face of a more difficult practice, but still had a significant advantage in comparison to the rest of the students.

Figure 149- In the graph in front, the collection of all data is also shown in aggregate form. These data indicate 25% excellent performance, 60% good and average performance, and 15% poor performance, which has almost disappeared since the fourth session. In fact, the growing process and reflection of the students from session five onward have been at a good and excellent level, which is accompanied by a better understanding and identification of creative approaches and methods in reflecting on the exercises.



In the following pages, examples of exercises presented by students are displayed. The exercises are a selection of the works of various students who participated in the research experiment of 2020 and 2021. Most of these students were in the second and third semesters of architecture, and their familiarity with the theoretical foundations of architecture and their knowledge of the historical field was very basic. It should be mentioned that during the research process, the students were advised to avoid seeing architectural images and reviewing and searching photos related to architecture. Also, as much as possible, avoid any kind of architectural conclusions at the end of the practice process of each section and focus on developing the form based on the principles and techniques taught, and as mentioned before, try to find creative approaches in the interpretation of each technique for Achieving more advanced and diverse prototypes.

Students' practices on "Vertical and Horizontal cuts" technique

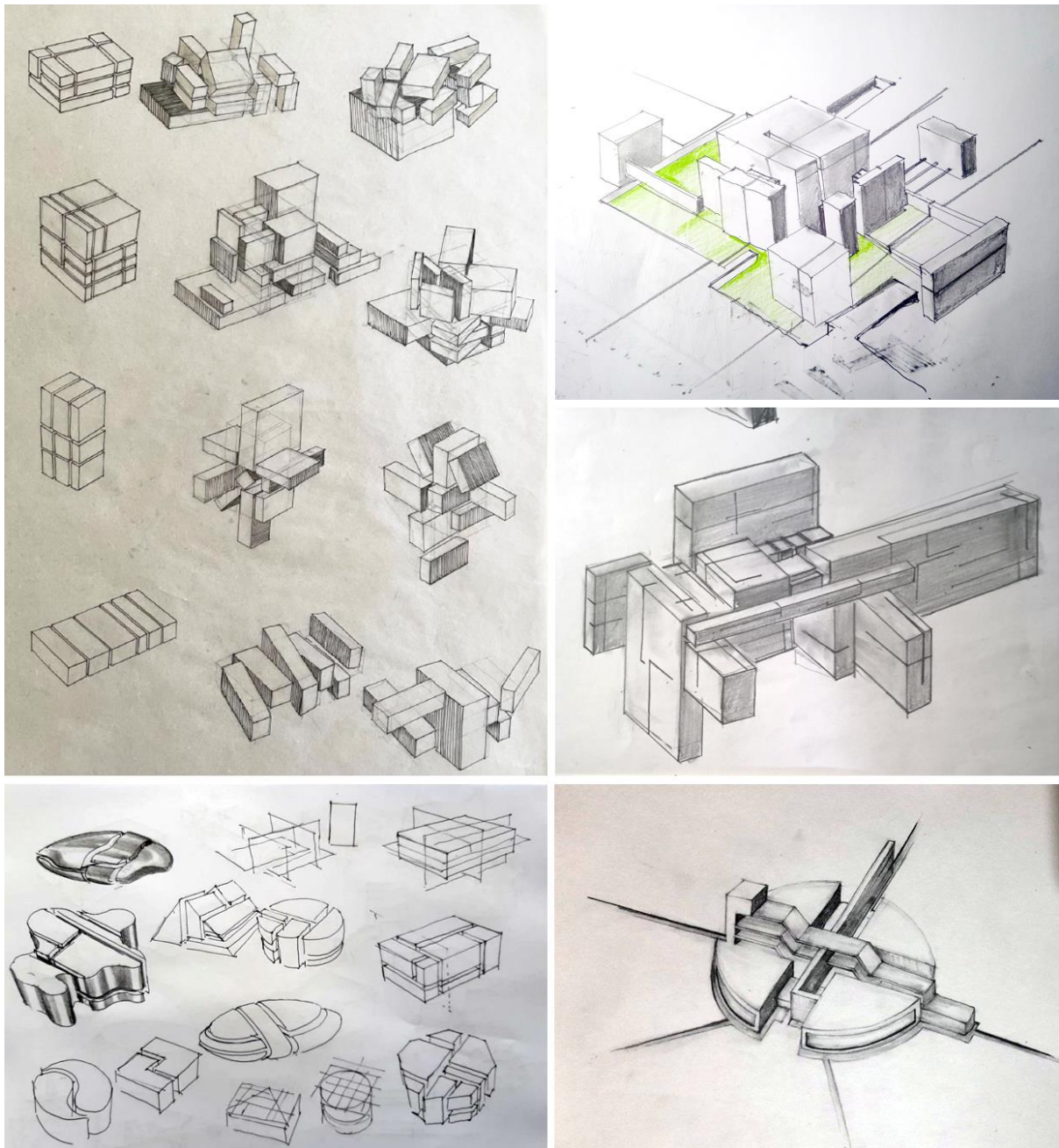


Figure 150 students' practices on Vertical and Horizontal cuts

Students in this technique become familiar with orthogonal structures, and their spatial exploration is conducted through the relationships of parallel and perpendicular components formed as a result of horizontal and vertical cuts. The volumetric mass utilized in this training can take any form, but through entirely direct cuts, it is divided into finer components. As observed in the above examples, a wide range of responses is generated through this process. Despite artists using a specific technique, the created products are entirely variable and divergent, avoiding uniform conclusions.

Students` practices on “Diagonal cut” technique

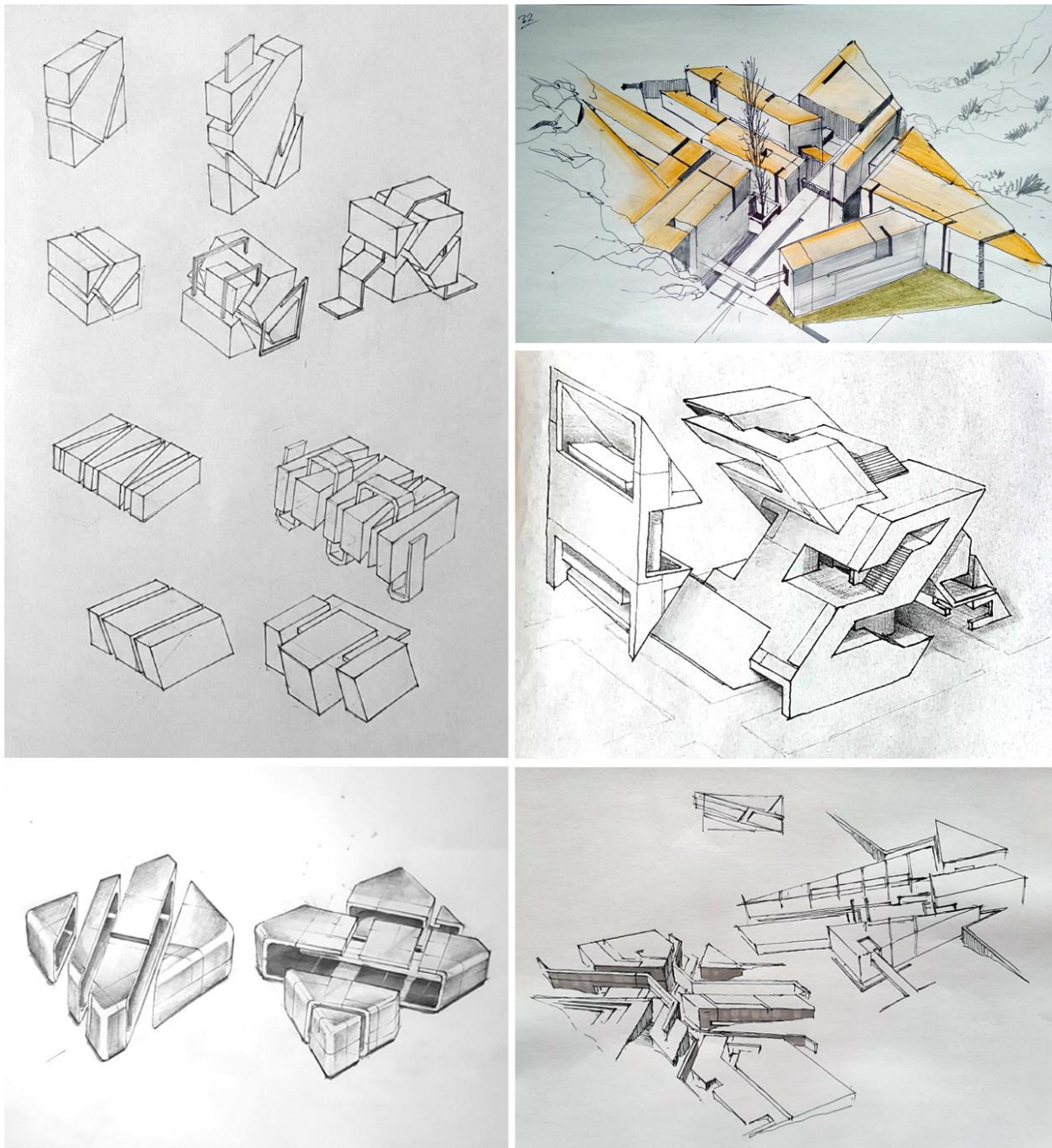


Figure 151 students' practices on Diagonal cuts

The technique of diagonal cuts is distinct from the technique of horizontal and vertical cuts in another exercise. The reason for the final product lies in two processes that, in terms of formal character, are entirely different, although at advanced levels, students can combine these techniques. However, it is recommended to initially perform these processes separately.

Students` practices on “Chamfer and Bevel” technique

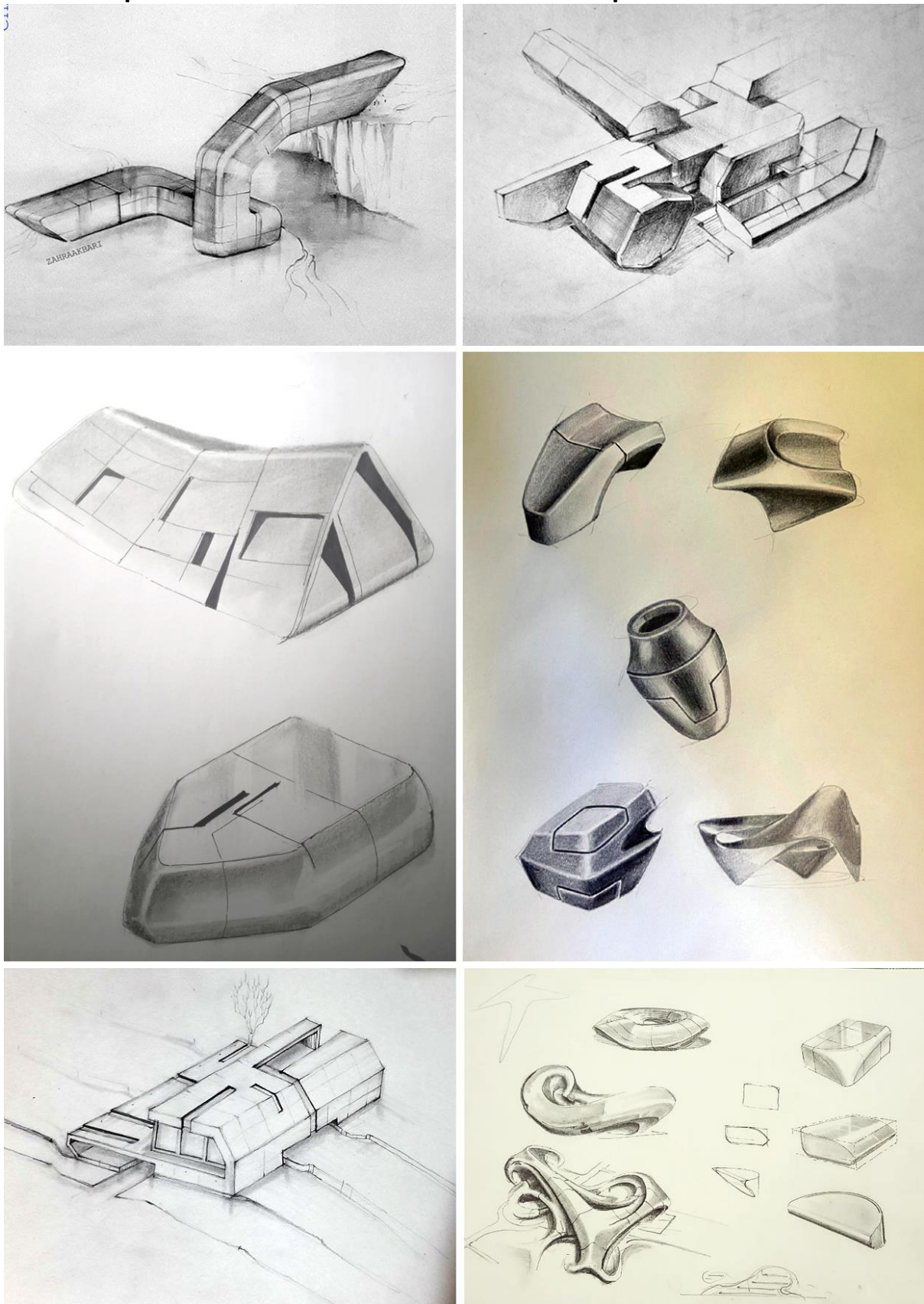


Figure 152 Students` practices on “Chamfer and Bevel” technique

Students` practices on “Subtract and making hollow” technique

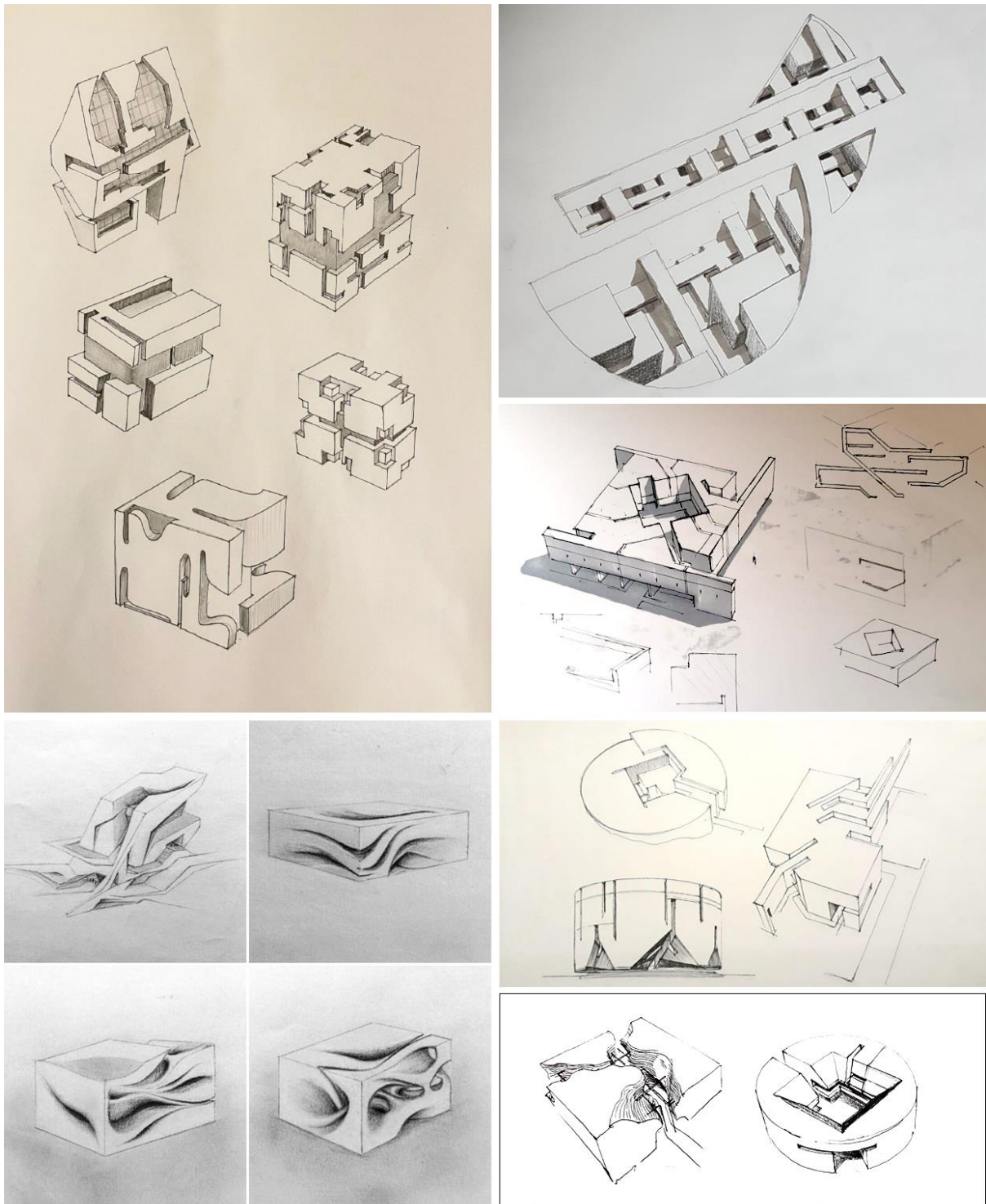


Figure 153 Students` practices on “Subtract and making hollow” technique

A variety of examples illustrate the application of the subtract technique, a highly prevalent method employed to emphasize the nature of empty space in contrast to mass.

Students` practices on “Extrude Path” technique

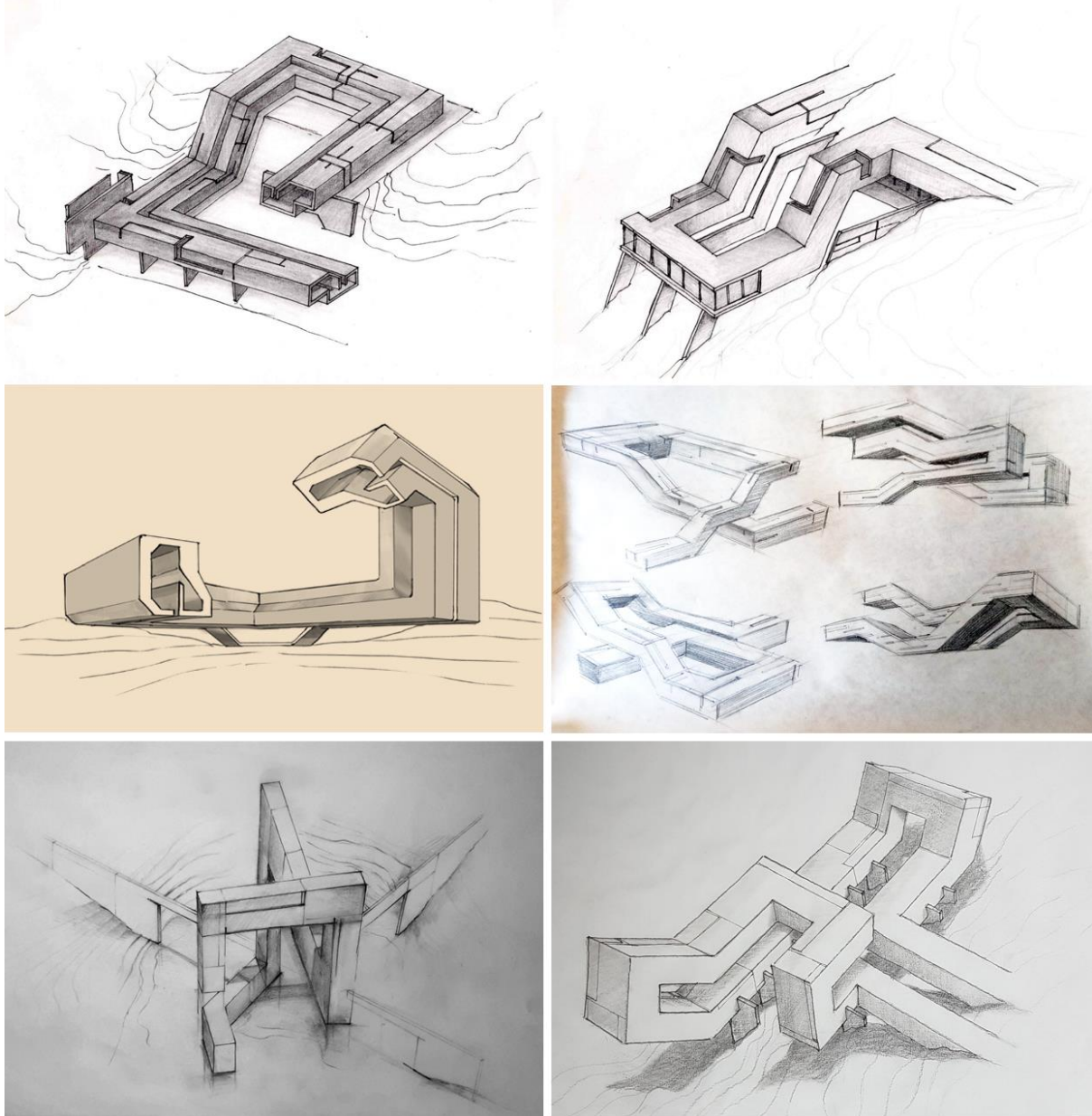


Figure 154 Students` practices on “Extrude Path” technique

As previously explained, the extruded path is one of the linear spatial development methods. Creativity in defining the path and selecting the transferable surface characteristics can generate a vast array of forms. The diverse works of the students reflect the capabilities and flexibility of the forms produced through this method.

Students` practices on “Layering” technique

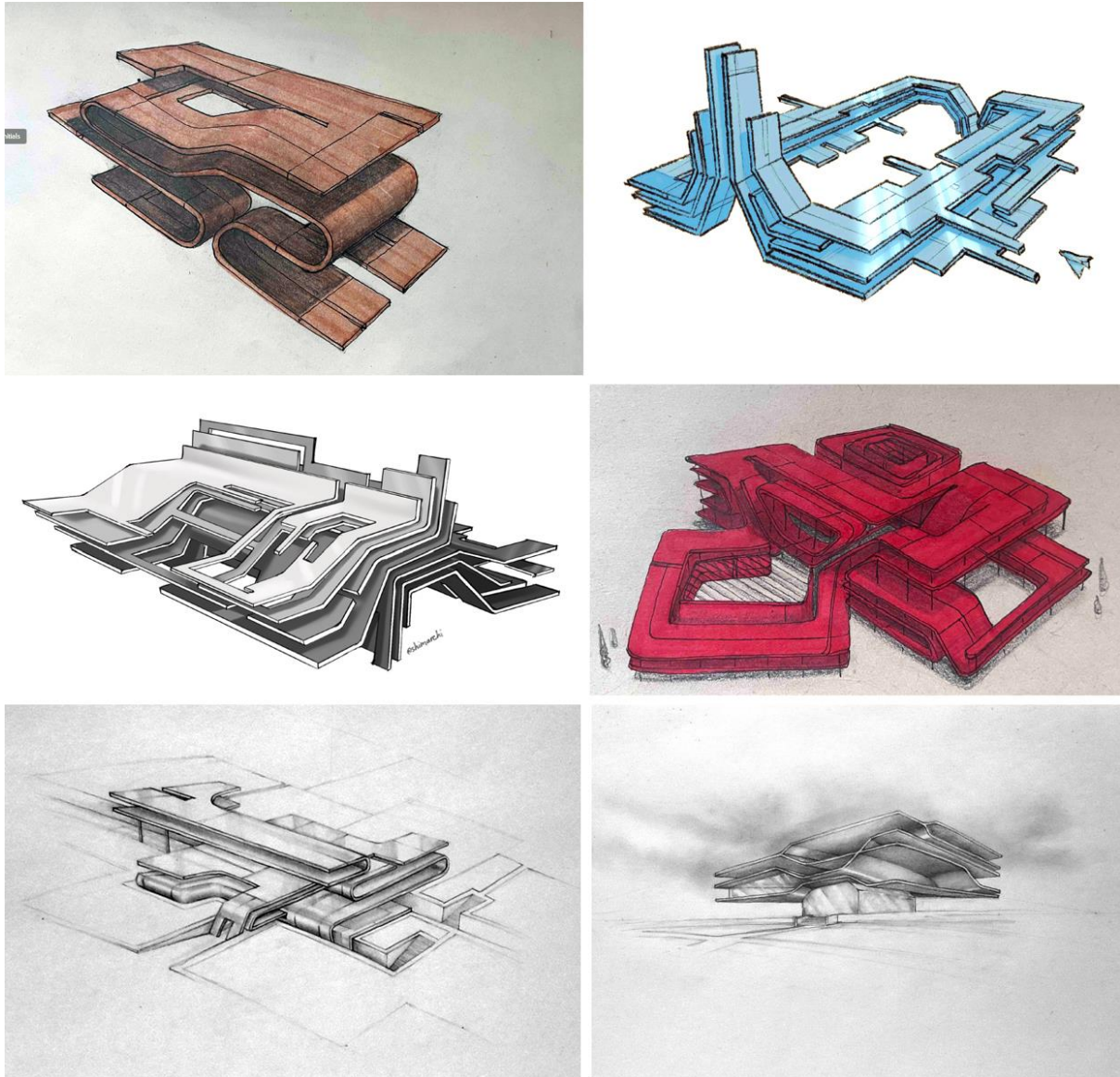


Figure 155 Students` practices on “Layering” technique

Examples of students' studies using the Layering technique showcase the creation of space by defining multiple layers of sheets arranged in various compositions. The form of the sheets, their arrangement, and how they interact with folding, cutting, and curving can enhance the diversity of the generated forms. Additionally, the density of the sheets can play a significant role in defining the desired space. In this exercise, the student identifies the nature of space by recognizing how it is confined through the form of the sheets.

Students` practices on “Intersecting planes” technique

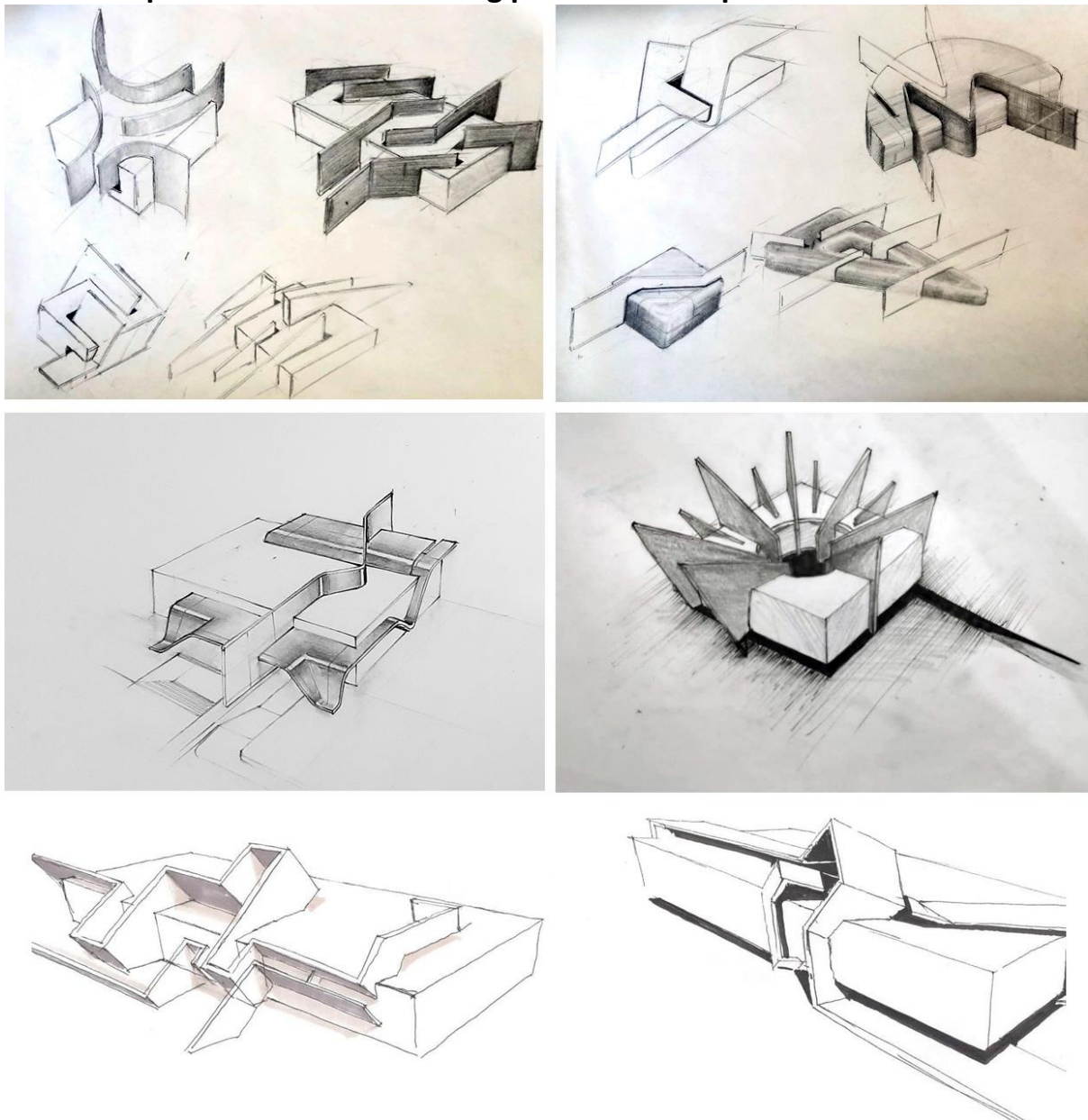


Figure 156 Students` practices on “Intersecting planes” technique

Many architecture students tend to view buildings as volumetric structures rather than shell or plate-like structures. Nevertheless, it's important to recognize that architecture is not solely defined by mass but by the interplay of empty spaces. Shifting this perception in students' mindset involves transitioning from a volume-oriented perspective. This transformation can be achieved by incorporating exercises specifically designed to focus on surfaces or by integrating this foundational space-making element with volumetric structures. Another key consideration is the expression of concepts through surfaces, serving as a foundation for generating and materializing innovative spatial ideas.

Students` practices on “Hollow box” technique

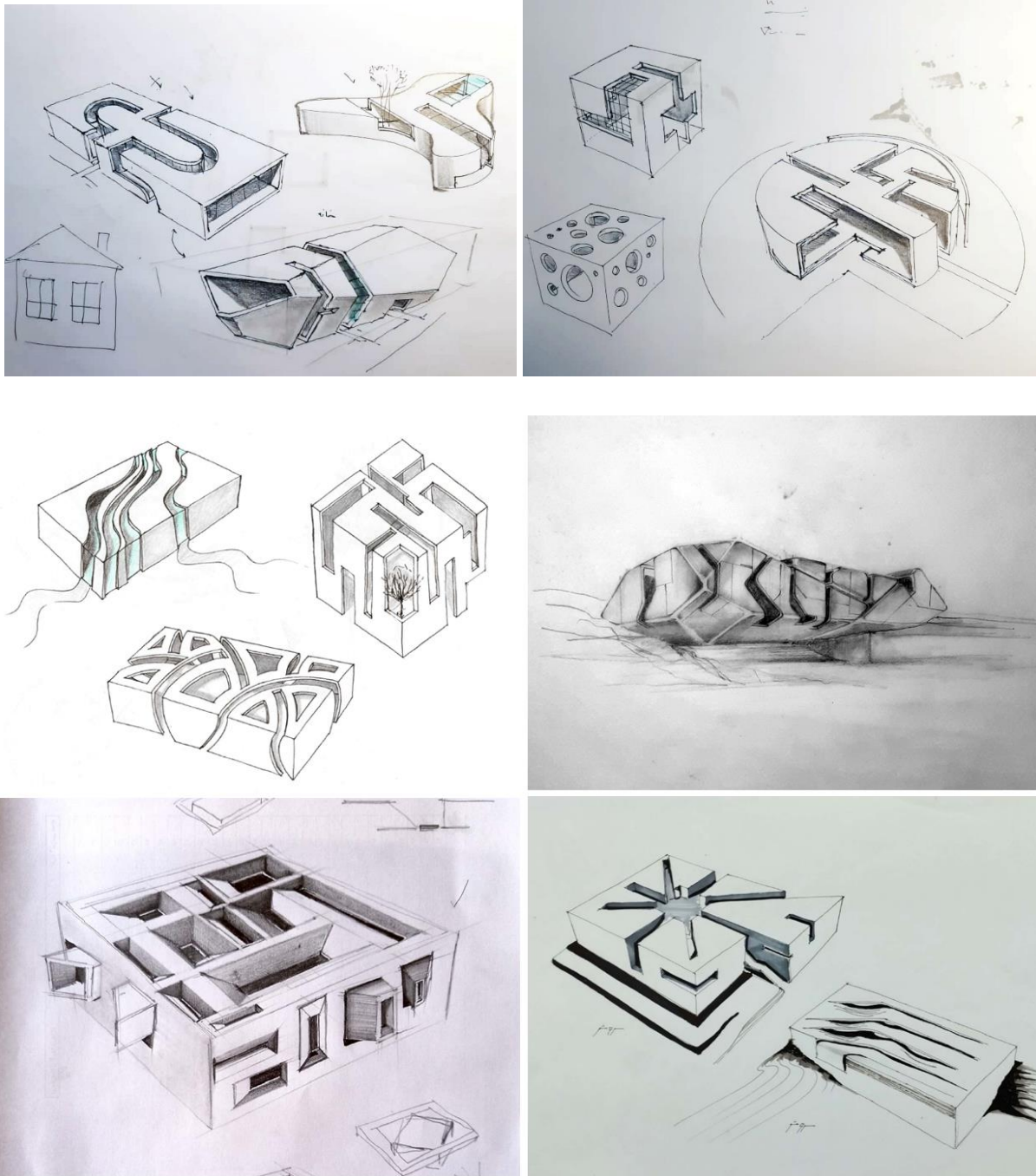


Figure 157 Students` practices on “Hollow box” technique

By introducing openings or cavities on the surface of the form, a direct linkage is established between the internal and external environments, manifesting as an open, semi-open, or transparent space. This technique not only enriches the spatial experience but also contributes to the creation of intricate and varied designs on the facade surface. The manipulation of these voids within the architectural form becomes a powerful tool for architects to craft compelling and innovative designs that transcend traditional boundaries.

Students` practices on “Planar ribbons” technique

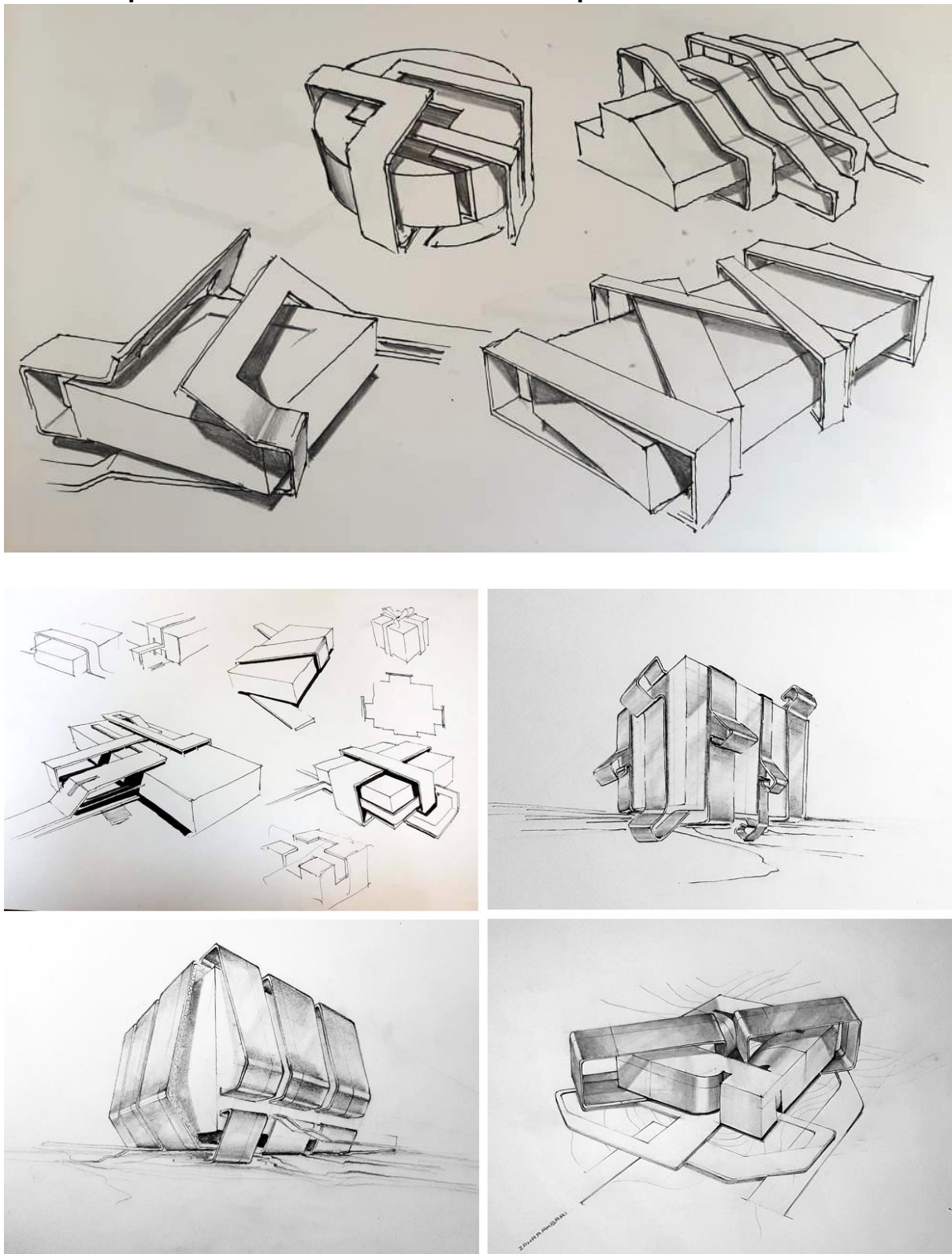


Figure 158 Students` practices on “Planar ribbons” technique

Students` practices on “Shell” technique

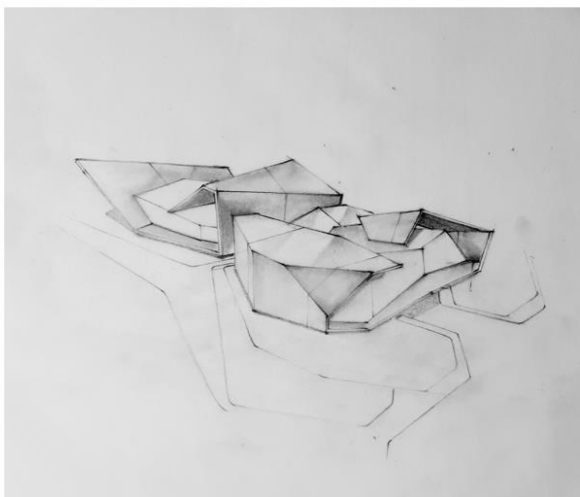
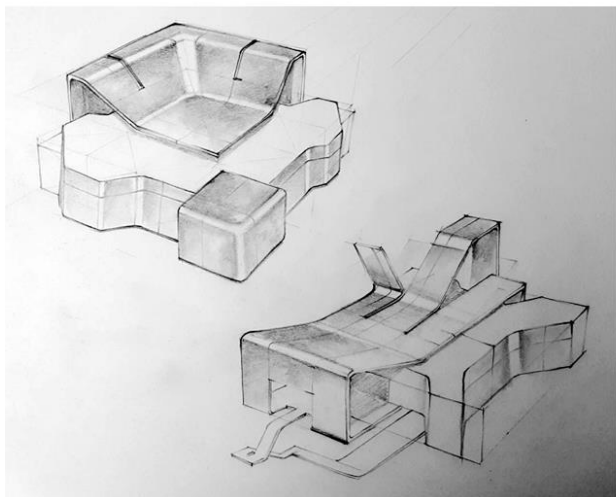
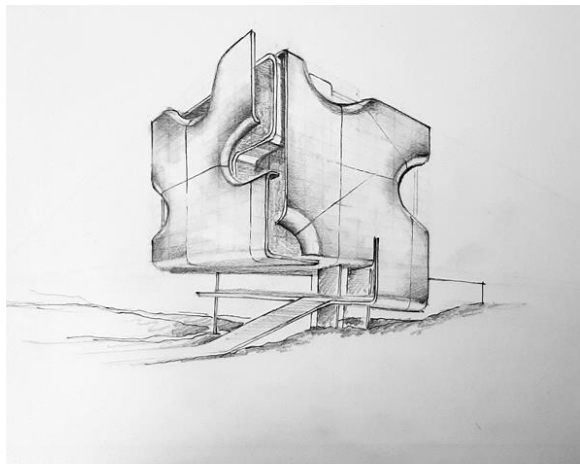
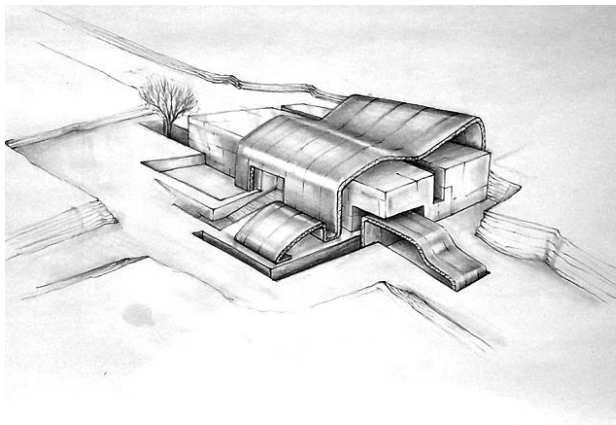
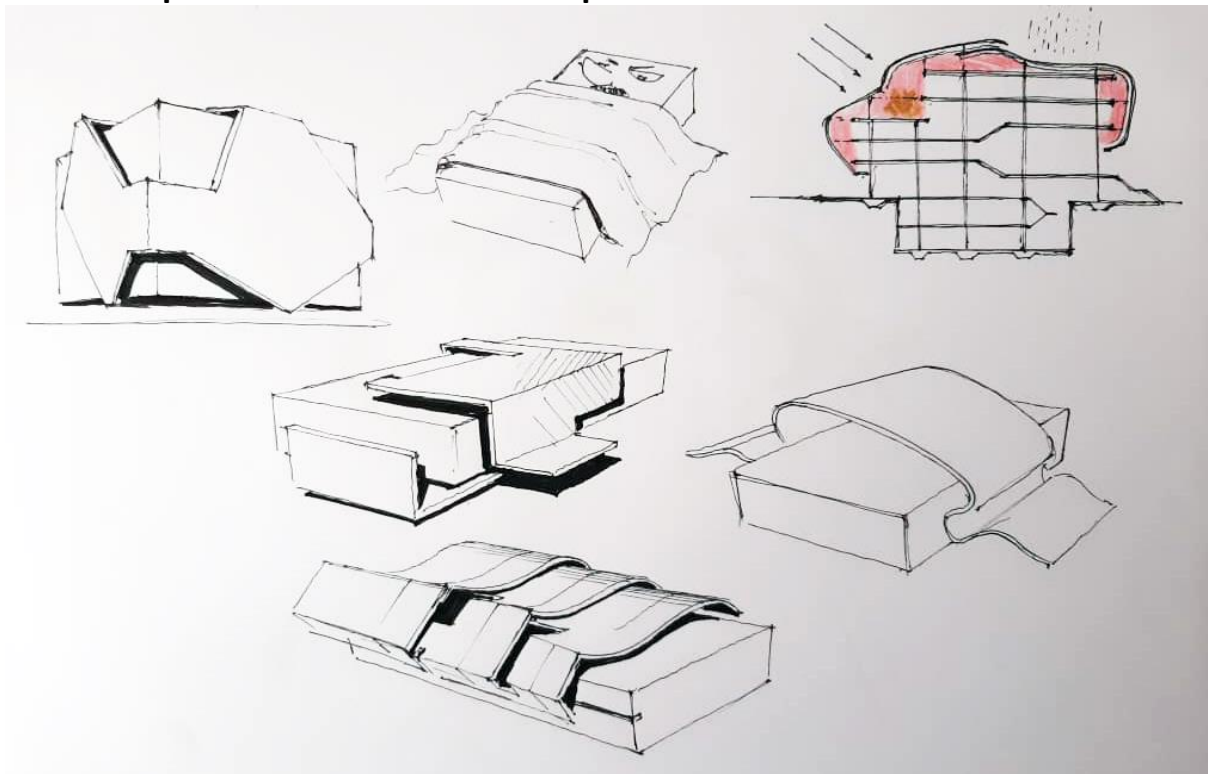


Figure 159 Students` practices on “Shell” technique

Students` practices on “Folded planes” technique

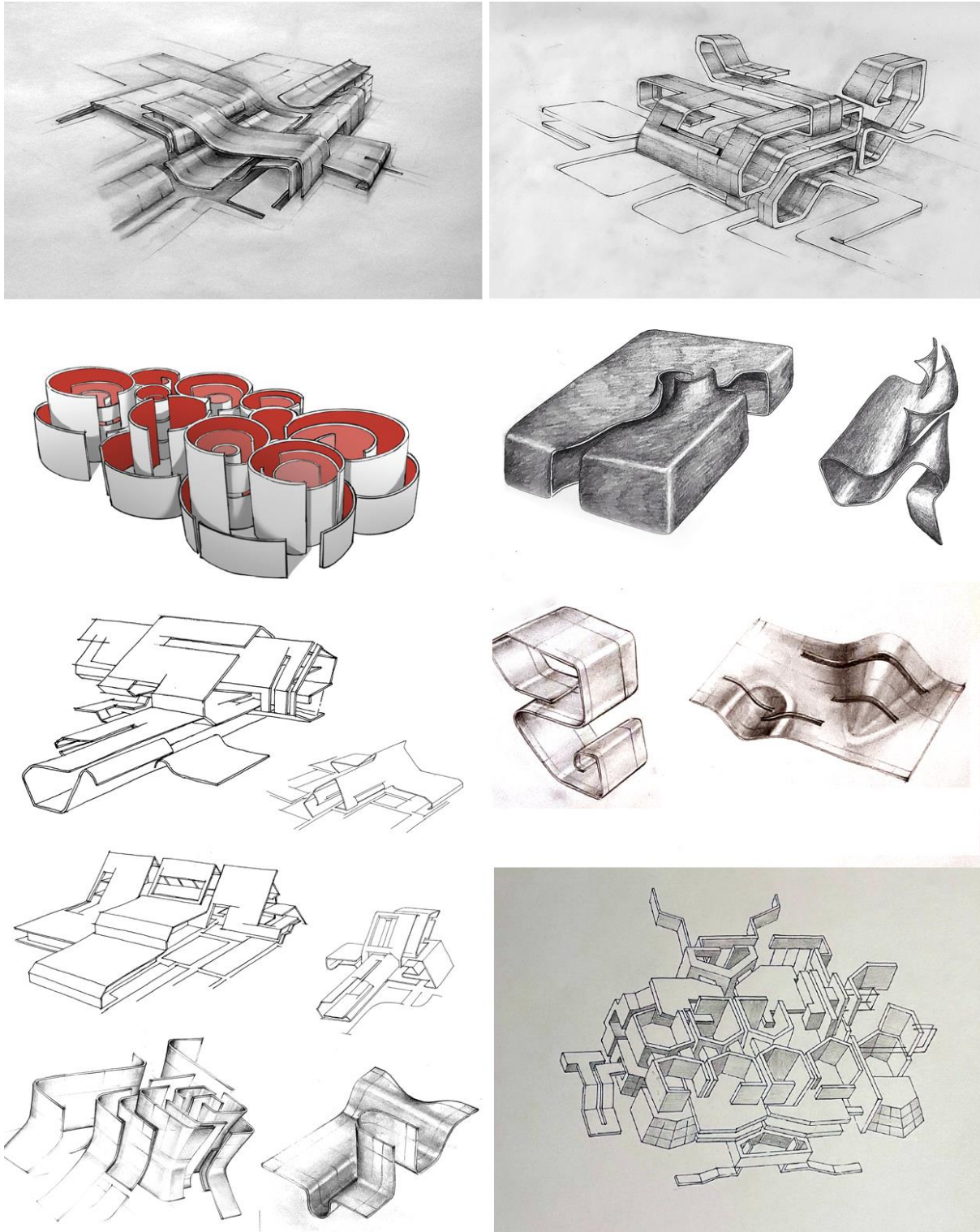


Figure 160 Students` practices on “Folded planes” technique

Students` practices on “Using the English alphabet as a template for designing new forms” technique

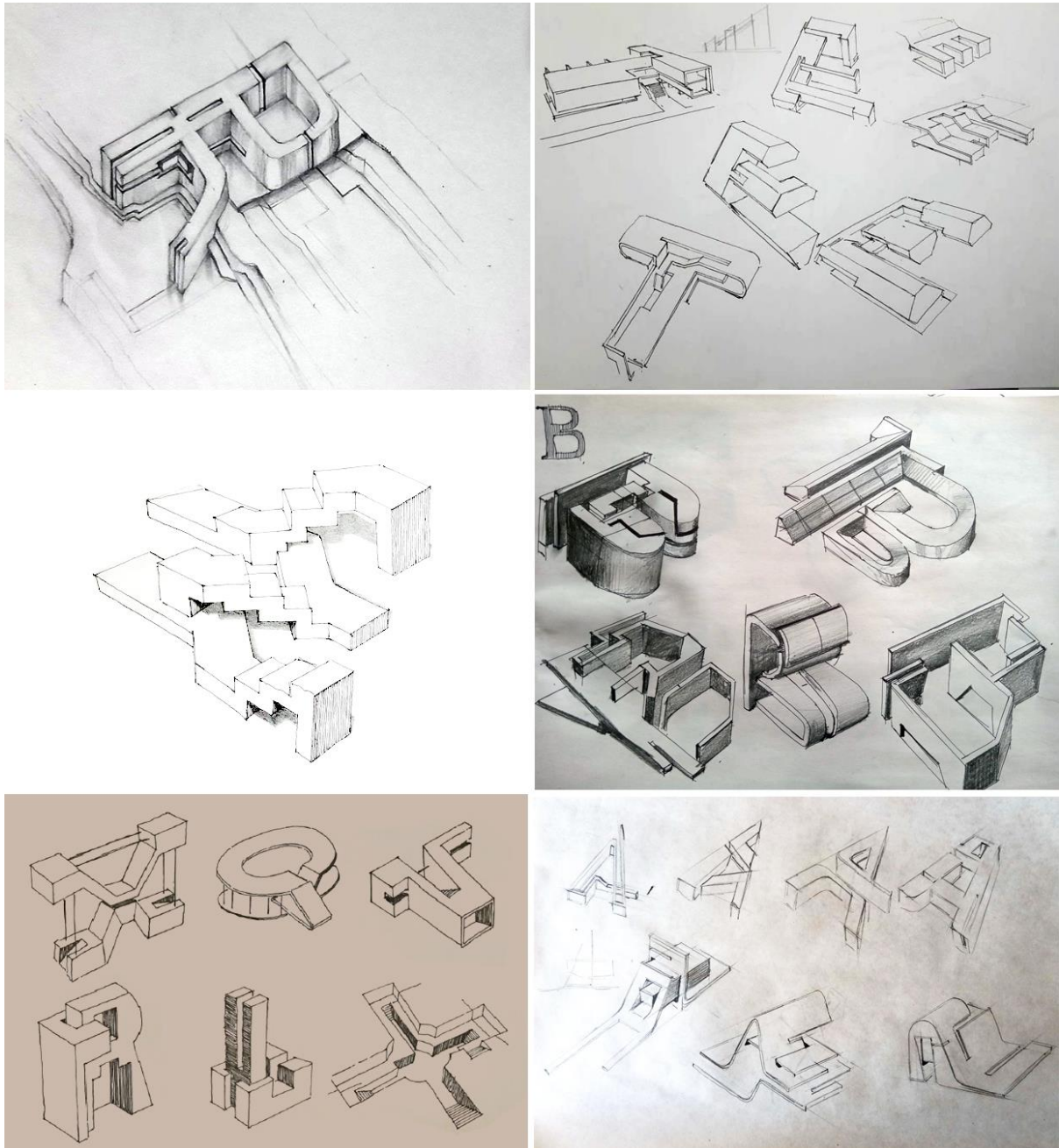


Figure 161 Students` practices on “Using the English alphabet as a template for designing new forms” technique

This practice creates a way for student to start their design with making alterations on a non-platonic volume, which can be start for a change in their interpretation of the perceived world. Visual inertia is the degree of concentration and stability of a form. The visual inertia of a form depends on its geometry as well as its orientation relative to the ground plane, the pull of gravity, and the viewer’s line of sight.

Part 3: The experiential procedure of the form creation without considering the architecture subject matter

In the third stage, instructors give verbal analyses of the prototypes created in the previous step. Acting on this curiosity, a set of semantical expressions is being propounded, and the students will reinterpret their works based on these terms. Terms such as juncture and segregation, consistency and configuration, correspondent and contrast, fluidity and rigidity. Expectation impacts of this stage, lead students being more acquainted with a series of capabilities that are presented in the result chapter.

Part 4: Evaluating the students' strategies for creating design solutions and embodying architectural concepts and spatial structures into form.

Part5: Experiencing the reverse motion process, from form towards architecture.

This stage is simulated and conducted by the instructors. Selecting the students' works with the potentiality of adapting to architectural characteristics and developing them within the framework of an architectural idea. As mentioned, this is a reverse process of conventional architectural design that only an experienced designer can conduct. The idea shows students how the design expertise can perform a higher level of interpretation of the relation between form and space.

6-3. Phase 2: Impact

Part 1: Introduction

Architecture design is a multidimensional problem-solving task that leans on the designation of numerous factors relating to the items, such as site response, project necessity, function, structure, etc. Therefore, Multicriteria decision-making is needed to be done, considering the different aspects of the project which lead to the architectural solution. Providing an appropriate response to the architecture question most of the time results in an alteration in the architectural form of the project. Therefore, it is necessary for architects to have flexibility in design and the necessary training in form-finding methods so that they can have higher initiative in each stage of the design process.

In this research, the three following questions are going to be examined and answered:

- 1- Does form giving practice in the absence of architecture question effect on students 'ability to find a better architecture solution?

2- Does form finding practices impact on the creativity of students in the architecture design studio?

3- Does form finding aligned with the freehand drawing sketches result in student's higher performance in architecture design studio?

To answer the following questions a series of practices has been designed and examined with more than 300 students with different architectural backgrounds. A series of competitions has been held and more than 100 works are represented in assorted topics. The results then are evaluated by the experts and professional architects ranking the works based on creativity and form finding ability. Based on the analysis of the obtained works and comparing them with the level of students' exercises in form-processing, the results have been attained, showing their considerable skill in decision-making through the design process and spontaneous thinking. By noticing the multicriteria decision-making mechanism and examining the connection of the form-finding process in architecture through this mechanism, a hypothesis can be raised regarding the effect of form-processing exercises in optimal performance using the multicriteria decision-making mechanism.

Multicriteria decision making

As Song, Ghaboussi, and Kwon have indicated, architecture differs from other arts in that its products are required to be simultaneously aesthetically pleasing, structurally stable, and functional.³⁴⁸ In general, the design of an engineering device is governed by numerous objective criteria that conflict, in the sense that improvement in any of the criteria occurs at the expense of one or more of the other criteria. This suggests the need to seek conceptual designs that represent the best balance between objective criteria in competition. The relative importance of competing criteria is often unknown, which further suggests the use of optimization to identify a field of conceptual design solutions that can be equally optimal—in the sense that no design is dominated by another feasible design solution for all objective criteria in the solution sector³⁴⁹.

Architecture form is the component which reflects all aforementioned criteria and evolve in the design continuation. Therefore, it is vitally important for architecture students to have higher performance in making reactions accordingly. It is supposed that Form design practice enables the

³⁴⁸ Castro Pena, M. L., Carballal, A., Rodríguez-Fernández, N., Santos, I., & Romero, J. (2021). Artificial intelligence applied to conceptual design: A review of its use in architecture. *Automation in Construction*, 1-30.

³⁴⁹ *ibid*

students to improvise better architecture design solutions, which is done by considering each architecture related dimension in design and making frequent changes where necessary.

The most well-known “critique” of the rational problem solver was brought up by Simon, who introduced the notion of “bounded rationality,” and within that concept, the claim that humans make satisficing rather than optimizing decisions due to limitations associated with unreliable information about alternatives and their consequences, human memory, and resources.³⁵⁰ According to the International Society on Multiple Criteria Decision Making (MCDM), ‘MCDM is the study of methods and procedures by which concerns about multiple conflicting criteria can be formally incorporated into the management planning processes. According to Cesare et al., an MCDM helps the decision makers in understanding his preferences (using criteria) to choose an adequate alternative or priorities and ranking a set or alternatives. During the formation of the decision-making process, it is essential to understand the type of problems in which the decision is inserted. The type of problem will guide the choice of the multi-criteria method to be used. With that said, two methods were appointed as the most suitable for this research context.³⁵¹

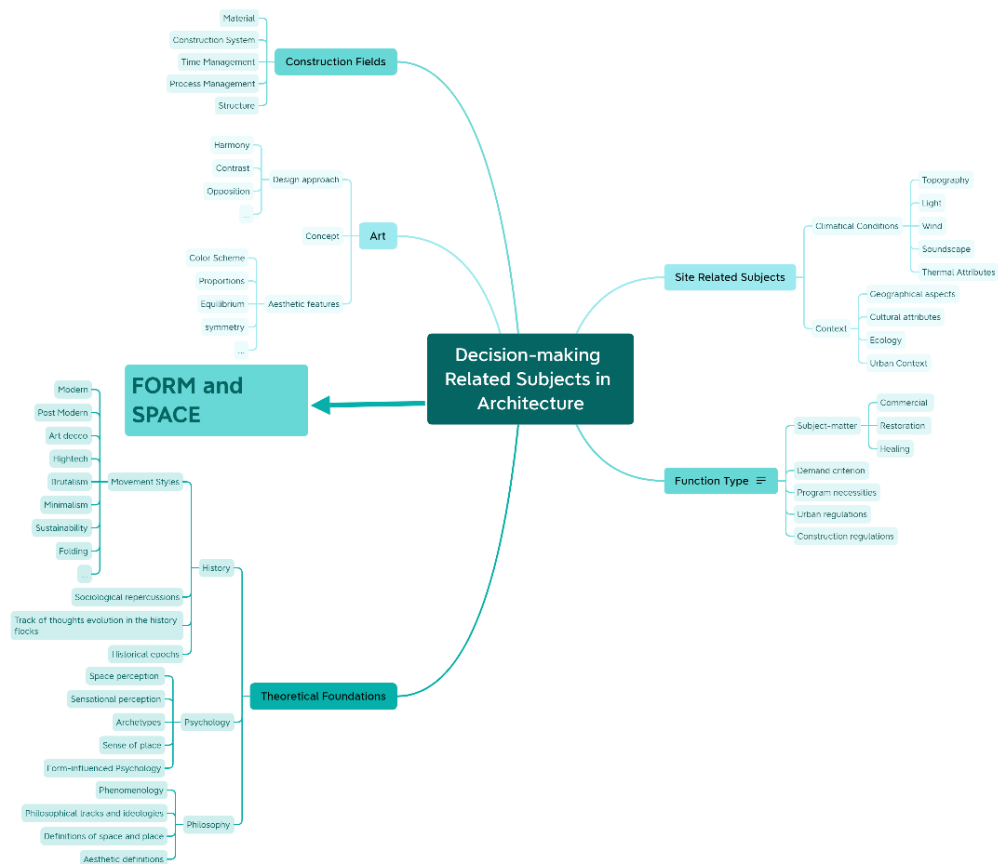


Figure 162 Decision- making related subjects in architecture.

³⁵⁰ Kahneman, D. (2003). A perspective on judgment and choice. *American Psychologist*, 58, 697–720.

³⁵¹ Hannemann, I., Rodrigues, S., Loures, E., Deschamps, F., & Cestari, J. (2021). Applying a decision model based on multiple criteria decision-making methods to evaluate the influence of digital transformation technologies on enterprise architecture principles. *IET Collaborative Intelligent Manufacturing*.

Intuitive decision making

During the design process there will be various situations in which the designer has to make a decision and choose among different alternatives. This process can be done intuitively among the expert designers. Intuition is what we consider as behavior we cannot observe; in research terms, intuition is a hypothetical construct. A hypothetical construct can be defined as “an abstract concept used in a particular theoretical manner to relate different behaviors according to their underlying features or causes.”

Intuition is seen as synthetic as opposed to an analytical function that apprehends the totality of a situation. This aspect is often addressed within the notion of a holistic approach.³⁵²

A connection between intuition, creativity, and innovation is implied in the dimensions outlined above. Albert Einstein refers to the outstanding impact of intuition on creativity: ‘(empirical) knowledge is necessary, too. An intuitive child couldn’t accomplish anything without some knowledge. There will come a point in everyone’s life, however, where only intuition can make the leap ahead, without ever knowing precisely how. One can never know why, but one must accept intuition as fact’³⁵³

Form-Finding notions

It is common for architects to start a design with a disembodied concept and a vague image of its shape which form the basis for proposing a broad set of solutions. The initial form will affect both performance and cost of construction, daylight use, energy consumption, layout configuration, shadow performance, acoustics, functional accessibility, and solar gain, among other features.

Decisions regarding the shape of a building influence its architectural, aesthetic, and structural features as well as its sustainability. Shape affects brightness and heat loss, but also cost and usable area, to name just a few examples.³⁵⁴

Maher and Poon stressed that the exploratory aspect of design has not been fully addressed, especially during conceptual design, since the assumption that designers have a clear idea of the problem, and that the solution is not legitimate. Before starting design synthesis, designers often do not have a complete description of the problem. During conceptual design, they play with ideas to better understand the problem, rather than focusing on

³⁵² Eris, P., & Badke-Schaub, O. (Year). A theoretical approach to intuition in design: Does design methodology need to account for unconscious processes? In [Book Title] (pp. 354-370). [Publisher if available]. (Chapter 17)

³⁵³ *ibid*

³⁵⁴ Hannemann, I., Rodrigues, S., Loures, E., Deschamps, F., & Cestari, J. (2021). Applying a decision model based on multiple criteria decision-making methods to evaluate the influence of digital transformation technologies on enterprise architecture principles. IET Collaborative Intelligent Manufacturing

finding a solution. Therefore, the authors argued, design is an iterative process of searching for the space of the problem of the design as well as the space of the solution. The ability to change objectives, as well as the solution space, over time can be modeled as a co-evolutionary system, suggesting a formal exploration model, such as the interaction between problem space/functional requirements (P), and solution space (S)³⁵⁵

Lateral thinking is a key to creativity

Albert Einstein's position values intuition as a road to new knowledge and emphasizes its impact on the creative sense-making process. Most creativity exercises have specific goals: to increase fluidity or fluency in idea production.³⁵⁶ "There is no convincing evidence that courses in problem solving can increase one's ability to make the imaginative leaps that are often crucial in problem solving."³⁵⁷ Learning to draw would enhance creativity and increase artistic confidence. The process of drawing was, in many ways, a replication of the creative process itself. Lateral and vertical thinking are complementary. Skill in both is necessary. Yet the emphasis in education has always been exclusively on vertical thinking.

Lateral thinking does not select but seeks to open up other pathways.³⁵⁸

The first type of problem requires for its solution more information or better techniques for handling information. The second type of problem requires no new information but a rearrangement of information already available: an insight restructuring. The third type of problem is the problem of no problem. One is blocked by the adequacy of the present arrangement from moving to a much better one there is no point at which one can focus one's efforts to reach the better arrangement because one is not even aware that there is a better arrangement. The problem is to realize that there is a problem. To realize that things can be improved and to define this realization as a problem.³⁵⁹

Part 2: METHODOLOGY

To assess the result of the student's performance, after form-finding practices, a series of criteria were defined to evaluate creativity and form creation quality, which is the aim of this research. Several architectural subjects were given to the students, and they were asked to represent their ideas on B2-size paper by means of freehand sketching. Attending students

³⁵⁵ Castro Pena, M. L., Carballal, A., Rodríguez-Fernández, N., Santos, I., & Romero, J. (2021). Artificial intelligence applied to conceptual design: A review of its use in architecture. *Automation in Construction*, 1-30.

³⁵⁶ Edwards, B. *Drawing on the artist within*. New York: Simon & Schuster, 1987.

³⁵⁷ Hunt, M. *The Universe Within*. New York: Simon and Schuster, 1982.

³⁵⁸ De Bono, E.. *Lateral Thinking: A Textbook of Creativity*. Penguin Books.

³⁵⁹ *ibid*

are categorized in 3 groups. Students from group A, with more than two years of form design practice, group B, with less than two years of form design practice and group C, basic form design practice. Students have the same deadline to submit their sketch. In order to reduce the error coefficient relating to the type of subjects and students' skills, 30 subjects were chosen for 300 attendees, and finally, 60 students were selected as a statistical society. Afterwards, their artworks are analyzed meticulously by a group of expert architects and professionals to evaluate their form, creating quality and creativity based on the defined criterion.

The architectural design sheets were ranked by the jury based on the architecture quality. The judging committee was either asked to score each work based on form creating quality and creativity. They defined some sub parameter in each item and the works were scored accordingly.

The detailed analysis of the scores is the basis of the following research document.

Part 3: Assessment of the works

Form finding practices, in the absence of an architecture question, helps student become more able to create innovative forms and perform better in form finding. The Tables below, compares the three groups of students based on their performance in form finding and creativity based on their performance in the architecture competitions with different types of questions. In group A and B students some other results are seen as well: It is worth mentioning the score which is assigned to each parameter is the average of each group's scores in that item.

Table 20 Form finding evaluation criteria for different groups of students.

Form Finding Evaluation criteria	Group A			Group B			Group C		
	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min
spatial integrity	9	10	8	8	10	7	3.25	3.5	1
Aesthetic quality	9	10	7	7.25	8	5.5	2	3	0.5
Juxtaposition and proportion	7.25	8	6	5.5	7	3	2.5	3	0.0
Cohesion and configuration	8	10	6	6	7	3	1.25	2.5	0.0
Proportion and scale	8.5	10	8	8	9	7	0.75	1	0
Visual Inertia	8.5	9	7.5	8.25	9	7	0.5	1	0

Table 21 Creativity Evaluation Criteria

Creativity Evaluation criteria	Group A			Group B			Group C		
	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min
Redefinition of design problem	9	10	8	8	10	7	3.25	3.5	1

Novel perspective to design	9	10	7	7.25	8	5.5	2	3	0.5
Anomaly (Positive manner)	7.25	8	6	5.5	7	3	2.5	3	0.0

Influential parameters which were involved in the evaluation

1-Expression and Visualisation

Assessing the architecture quality in the evaluation of these artworks is focused on the designing and drawing the students' artworks and in the design process, Expression and Visualisation is extremely important for an architecture student. Narration is extremely important, and the design sheets are helping the students express their idea through their artworks. All the sheet's documents are helping to express a united concept.

2-Compatibility of Idea and the subject

The students who had more form practice drawings are more able to find the compatibility of the idea and the subject and they could present an audacious idea.

3-Spatial dimension

The dimensions of interior space, like spatial form, are directly related to the nature of a building's structural system—the strength of its materials and the size and spacing of its members. The dimensions of a space, in turn, determine a room's proportion and scale and influence how it is used. One horizontal dimension of space, its width, has traditionally been limited by the materials and techniques used to span it. Today, given the necessary economic resources, almost any architectural structure is technically possible. Wood or steel beams and concrete slabs can span up to 30 feet (9 m). Wood or steel trusses can span even farther, up to 100 feet (30 m) or more. Longer roof spans are possible with space frames and a variety of curved structures, such as domes, suspension systems, and membranes supported by air pressure. While the width of an interior space may be limited by structural necessity, it should be established by the requirements of those who use the space and their need to set boundaries for themselves and their activities. Building designers have traditionally developed spatial relationships by sketching and modeling. Computer-aided design and drafting (CADD) and building information management (BIM) software systems are changing the way that building designers work. These computer technologies allow designers to build interactive three-dimensional computer models of buildings and to coordinate building systems as they design.³⁶⁰

³⁶⁰ Ching, F. D. K., & Eckler, J. F. (2012). Introduction to Architecture. John Wiley & Sons, Inc.

4-Form-Finding

A schema holds both declarative knowledge and procedural knowledge. Other characteristics of schemata include schemata have variables and associated knowledge about the variables and their interrelationships. Schemata can be embedded, one within another; a schema is a network of subschemata. Schemata represents knowledge at all levels of abstraction. Schemata represent knowledge rather than definitions.³⁶¹

5-Spatial integrity

Spatial integrity is the quality of an architectural composition where all the spaces and their relationships with each other are applied in a consistent way throughout the form. According to this definition, the correlation and sequence of spaces in architectural composition, with any degree of dispersion of micro-spaces and distances of functional zoning, can display a unified aggregate. This is only possible through formal interactions, both in terms of style and geometry and in terms of the structure of the space template.

6-Aesthetic qualities

Desired relationship of building to its site, adjacent properties, and neighbourhood. Preferred qualities of form, massing, colour, pattern, texture and detail.³⁶²

7-Juxtaposition and proportion

To associate is to join or group. Association is a relationship established through joining or grouping. To evaluate association, you can ask are their similarities of form or space better expressed through an implied association such as aesthetic similarity or a physical association, such as spatial joint creating an intersection between elements.

To place two or more elements near one another for the purpose of comparison. To arrange elements in a way that relates them through comparison.³⁶³

8-Cohesion and configuration

A ranking of elements. Any system by which the importance of elements is represented graphically.³⁶⁴ This criterion is meant to evaluate whether if there is any special form in the design composition which is the focal point? Has the designer thought about the main part of the form in the architecture

³⁶¹ Chan, C.-S. (1990). Cognitive processes in architectural design problem solving. *Design Studies*, 11, 60-80.

³⁶² Ching, F. D. K., & Eckler, J. F. (2012). *Introduction to Architecture*. John Wiley & Sons, Inc.

³⁶³ Chan, C.-S. (1990). Cognitive processes in architectural design problem solving. *Design Studies*, 11, 60-80.

³⁶⁴ *ibid*

and the rest of it? Was He/she able to prioritize the architectural elements in the composition?

Does the designer create an integrated form making difference among the forms?

9-Proportion and scale

While scale alludes to the size of something compared to a reference standard or to the size of something else, proportion refers to the proper of harmonious relation of one part to another or to the whole. This relationship may not only be one of the magnitudes, but also of quantity or degree. While the designer usually has a range of choices when determining the proportions of something, some are given to us by the nature of materials, by how building elements respond to forces, and by how things are made. (8) Choosing this criterion evaluates whether if the form's scale and dimension are compatible with the project's requirements or not.

10-Visual Inertia

Visual inertia is the degree of concentration and stability of a form. The visual inertia of a form depends on its geometry as well as its orientation relative to the ground plane, the pull of gravity, and the viewer's line of sight.

All of these properties of form are in reality affected by the conditions under which we view them. • A changing perspective or angle of view presents different shapes or aspects of a form to our eyes. • Our distance from a form determines its apparent size. • The lighting conditions under which we view a form affects the clarity of its shape and structure. • The visual field surrounding a form influences our ability to read and identify it.³⁶⁵

11-Creativity

Creativity constitutes an important topic related to design problem-solving. Most design problems are ill-defined and, therefore, cannot be completely solved using routine problem-solving processes, either manually or computationally. A characteristic of design problems is that they are complex, ambiguous, and unique. Because of the nonroutine and ambiguous nature of design problems, it is not possible to foresee what type of information will lead to what kind of solutions. Hence, tackling design problems implies the generation of many different and potentially creative ideas and unpredictable solutions.³⁶⁶

12-Redefinition of the design problem

³⁶⁵ Ching, F. D. K., & Eckler, J. F. (2012). Introduction to Architecture. John Wiley & Sons, Inc.

³⁶⁶ *ibid*

One of the characteristics of an ill-defined problem is its huge problem space. In order to save the searching effort in the large problem space, a designer would introduce a design constraint to reduce the problem space for solution generation. To free an optimal solution, the designer would also introduce other constraints, which have been described as criteria by Akin et al.³⁶⁷ To test the generated solution. For these reasons, design constraints are crucial in design problem solving.³⁶⁸

Design is not a procedural or systematic activity as design methodologists have expressed (Alexander,1964, Jones, 1984, Archer, 1984) in which designer must carry out sequential activities such as problem definition, analysis, synthesis, decision making and evaluation, in a definite order in order to attain a final solution. Design is a process in which problem and solution emerge together.³⁶⁹

13-Novel perspective to design

When designers encounter a new architectural problem which they have not solved before, a new method (plan) is needed• Heath indicates that such a method might be individual and personal. It is possible that each new architectural problem requires a new and different method, and that methods might be specific to building types 25.³⁷⁰

14-Anomaly

An abnormality or inconsistency. Something that deviates from the rule, or something that is different from, interrupts or disrupts a pattern.³⁷¹

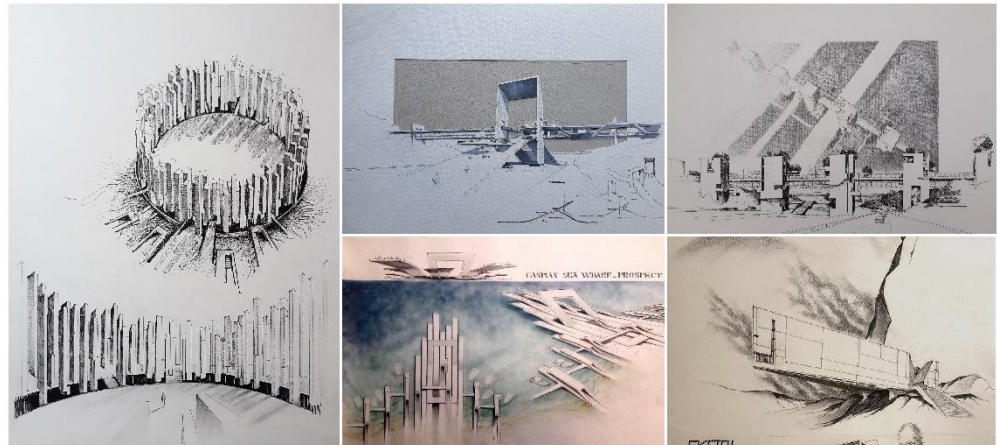


Figure 163 Sample of group A sheet

³⁶⁷ Akin, O., et al. (1984). Problem structuring in architectural design.

³⁶⁸ Chan, C.-S. (1990). Cognitive processes in architectural design problem solving. *Design Studies*, 11, 60-80.

³⁶⁹ Casakin, H., & Wodehouse, A. (2021). A Systematic Review of Design Creativity in the Architectural. *Building*.

³⁷⁰ Chan, C.-S. (1990). Cognitive processes in architectural design problem solving. *Design Studies*, 11, 60-80.

³⁷¹ Eckler, J. F. (2012). *Language of Space and Form: Generative Terms for Architecture*. Wiley.

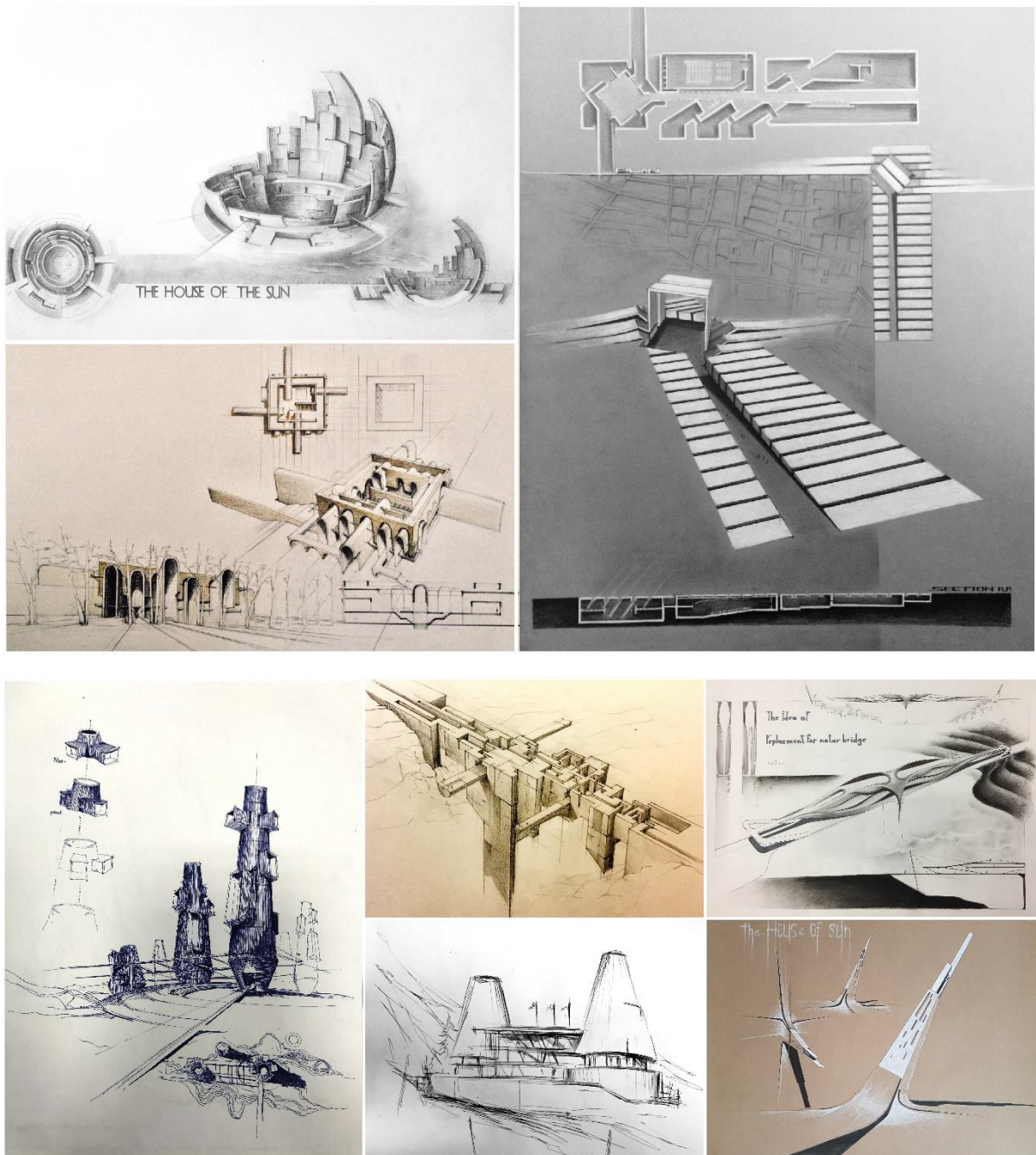


Figure 164 ample of group B sheet

These designs were presented to students from various groups in different competitions, and only a few examples are showcased here. Over time, as each group underwent more exercises, their responses became more refined, and expressions became more robust. Additionally, the creative approach to defining space and the interpretation derived from the fusion of form and space in the showcased examples varied based on the duration of each group's experience and practice. The more experience the groups had in practicing these techniques, the more nuanced and specialized their responses became

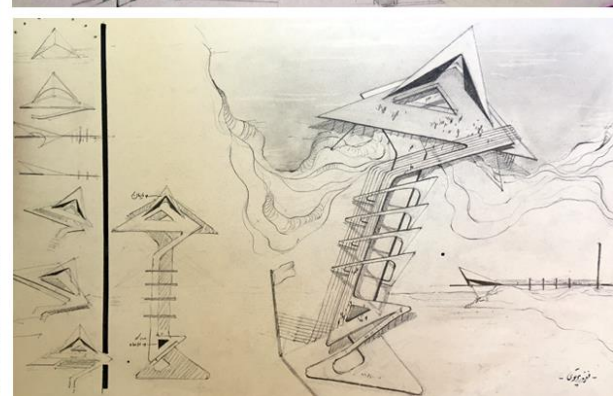
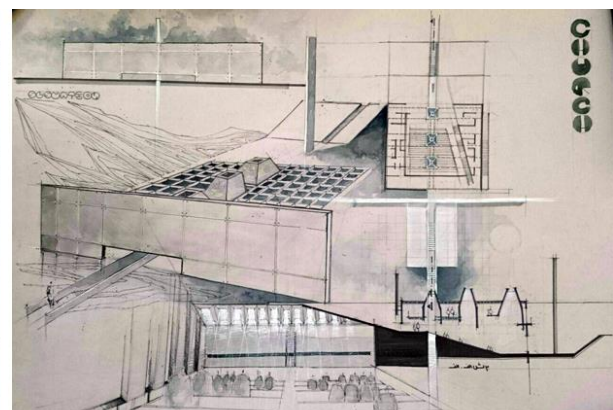
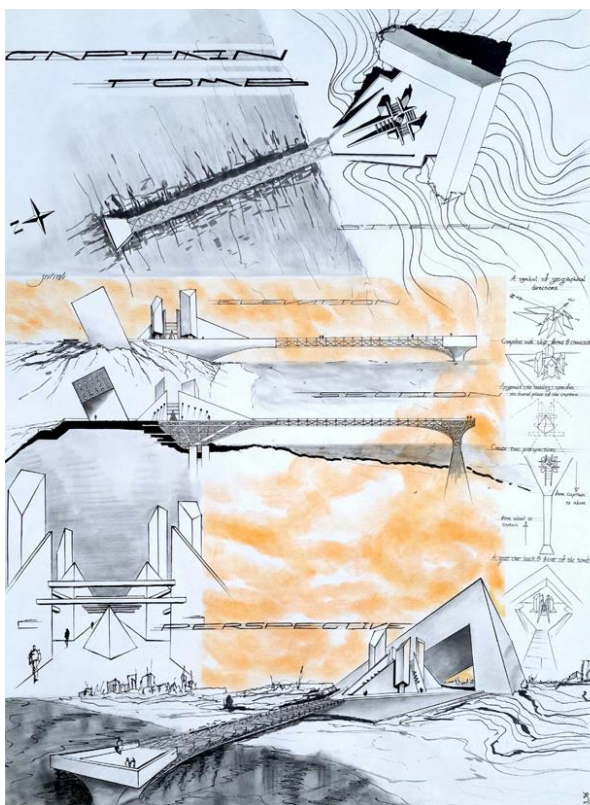
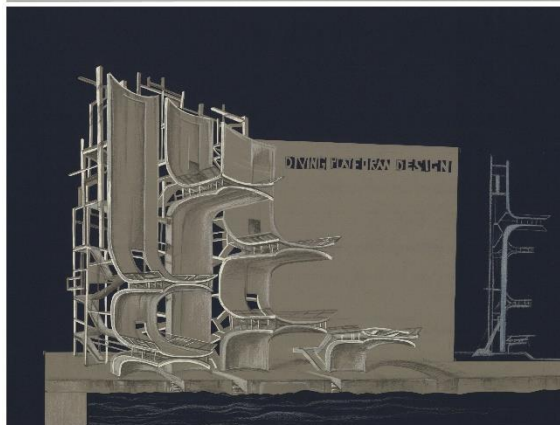
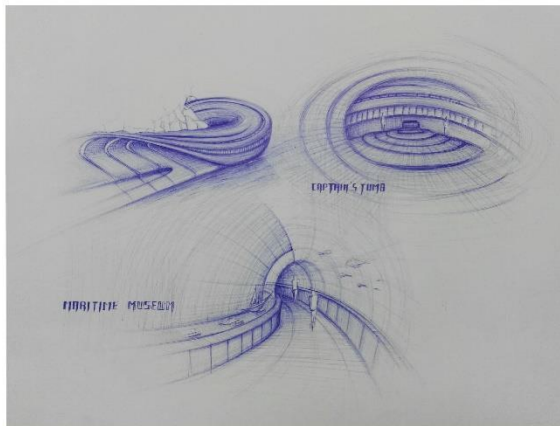


Figure 165 ample of group B sheet

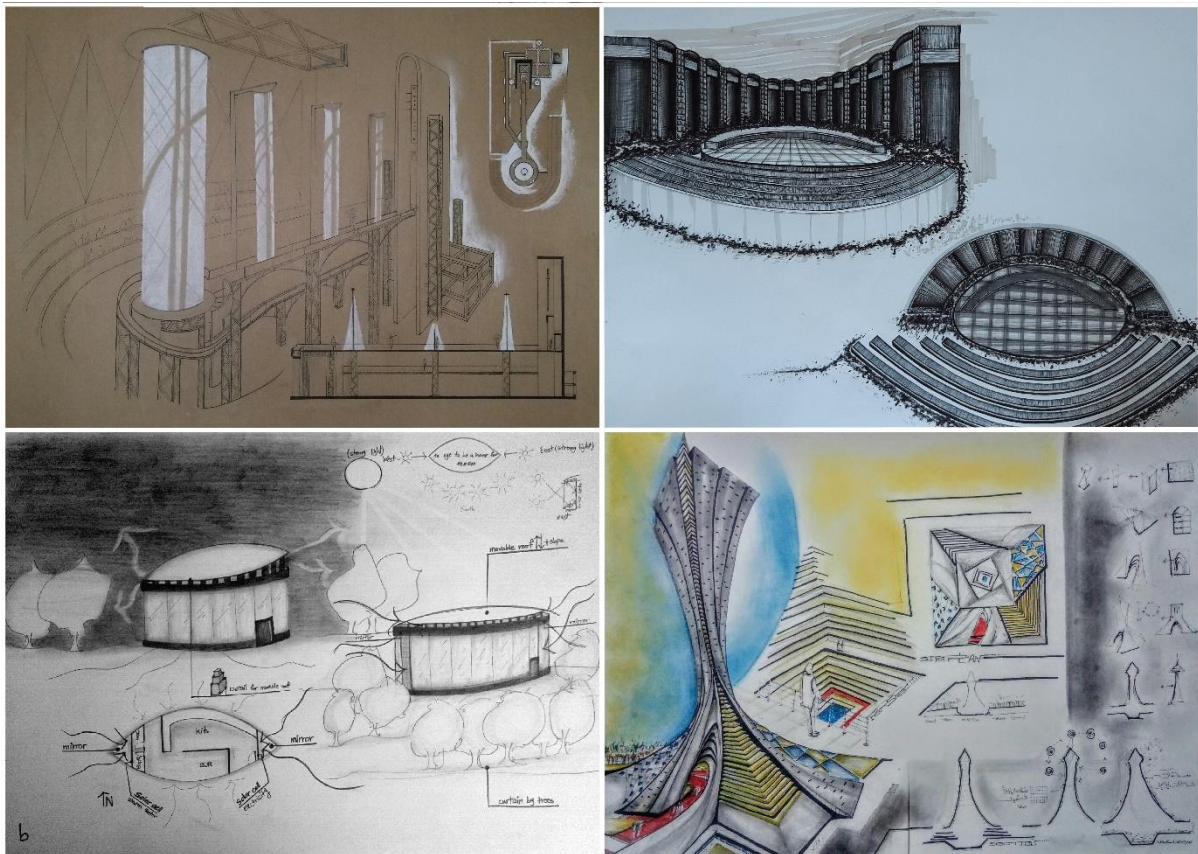


Figure 166 Sample of group C sheet

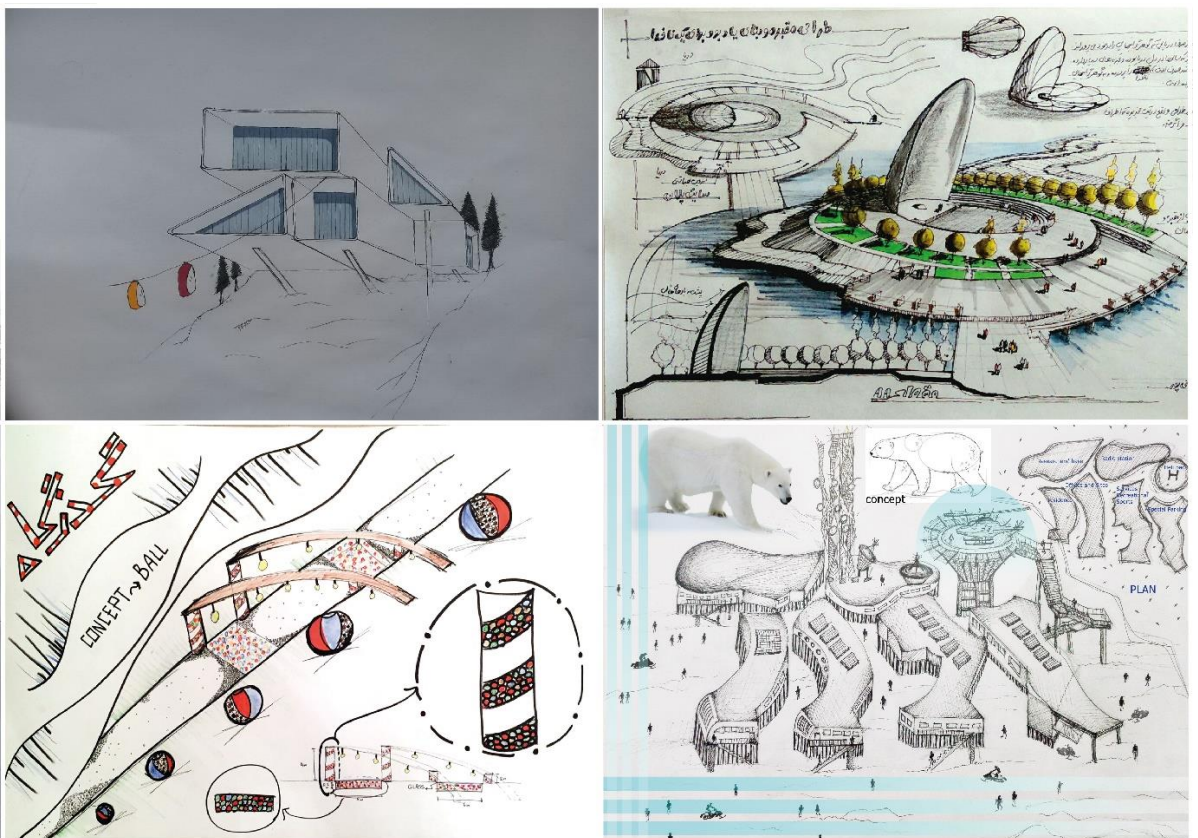


Figure 167 Sample of group C sheet

Part 4: Evaluation and Refinement of the results

Analysis of the facts and figures relating to the sub factors in each category of the research, form finding, and creativity is illustrated in diagram 4 to 12. A detailed explanation is presented below:

In spatial integrity factor, group A has the highest level and group B could not hit the top level and most of group B are in a lower level compared to A. In Aesthetic qualities group A and B are mixed, but many of group B are below group A. Cohesion and configuration has the least difference among B and C, and A is the highest. This shows that this factor is advanced, and each group has achieved based on their practice time. Proportion and scale and Inertia shows a considerable division between group C and the average of A and B. This shows that by starting the practice, these two items grow very fast.

It can be said that in the first level, proportion and scale and Inertia are attained by the students and reaches to an acceptable level. Students understand the importance of scale and they find a new approach towards making form composition which is different from their previous base forms. In the second phase, students achieve an acceptable level in terms of Aesthetic qualities and juxtapose and proportion. These items are integrated and relate to the art and artistic senses. Spatial integrity is related to architecture understanding and it is not attainable by just attending the form classes. Students have to pay attention to the space and their relation to form. This level needs understanding, practice and time, which as illustrated in the diagram is attained most by the students from group A and afterward, group B and group C has the minimum achievement in this regard. It is also noticeable that cohesion and configuration needs a great amount of time and practice for the designer to achieve. This shows that the designer can design perfectly well and can make integrated designs.

Figure 168 Spatial integrity

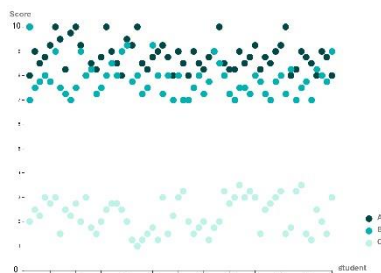


Figure 169 Aesthetic qualities

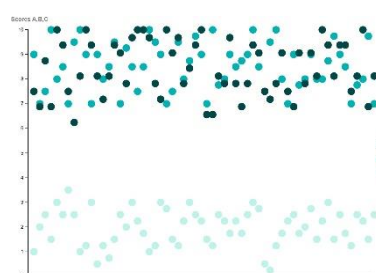


Figure 170 Juxtapose and proportion

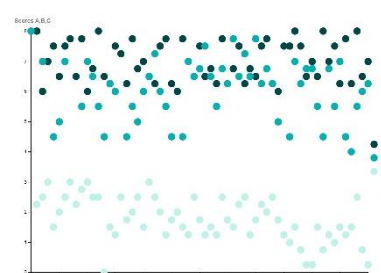


Figure 171 Cohesion and configuration

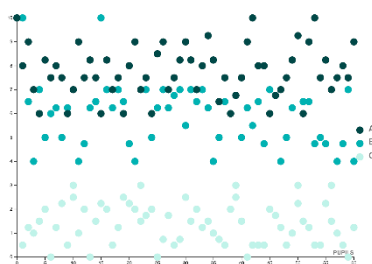


Figure 172 proportion and scale

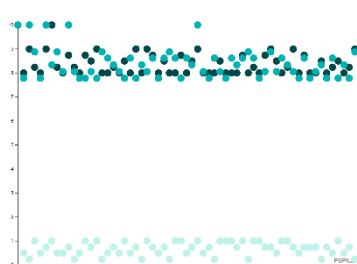
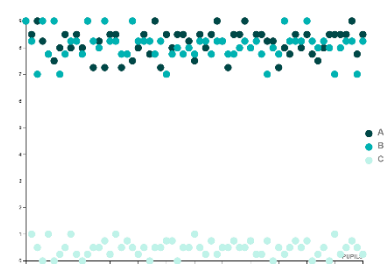


Figure 173 Inertia



Anomaly is the first item in creativity which the student obtains after attending the classes. This is maybe because they pay attention to many architecture samples which are unique and the variety of them make them think out of box. To find a novel perspective and redefining the design problem, student should have more practice and the diagram shows that group c has the least scores, group B students are in the middle and group A, could achieve higher marks in this regard.

Figure 174 *Redefinition of design problem*

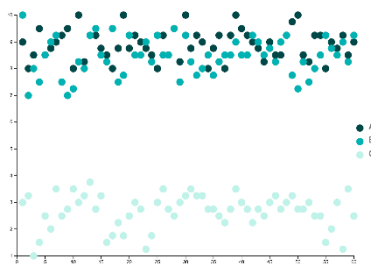


Figure 175 *Novel perspective to design*

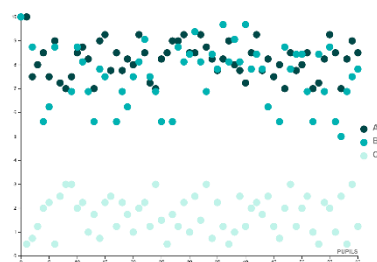
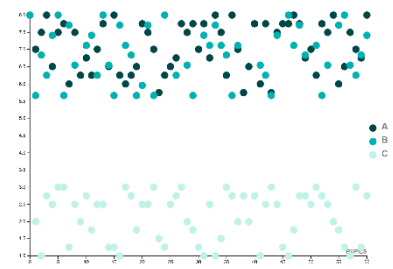


Figure 176 *Anomaly*



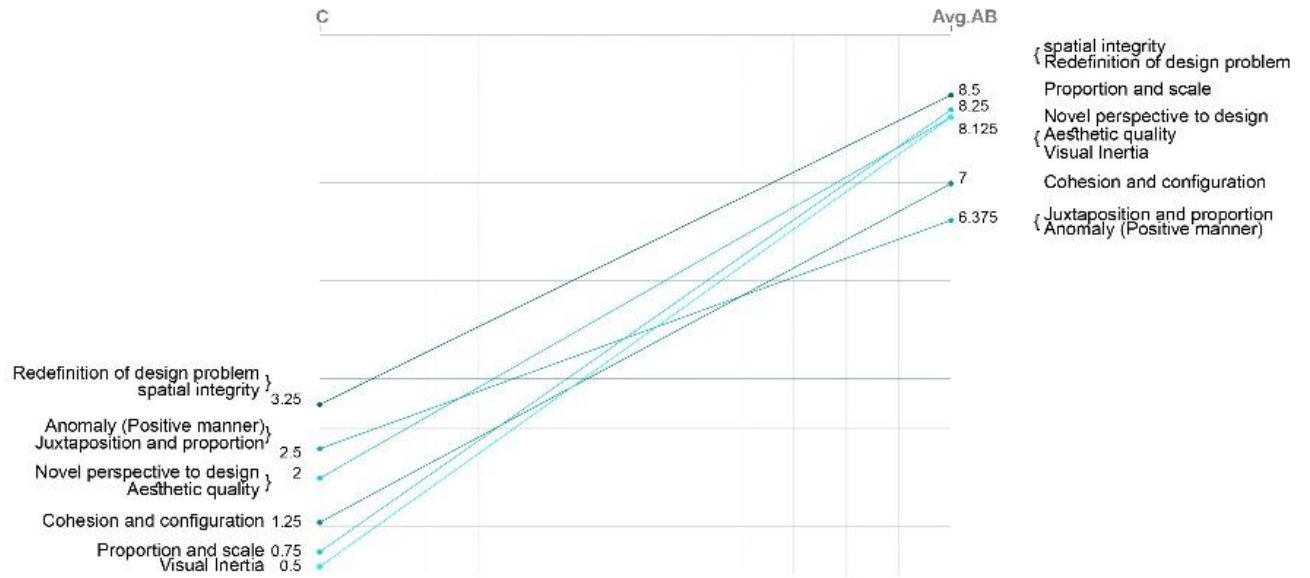
6-4.1. The impact of form design practice on students' design quality

In conclusion, to have the most direct answer to the questions of the project, which is focused on comparing group C and group B and A, together, which are the people with spending more practice on form creation. The following diagram shows a comparison relating to the average marks of group A and B, with group C. both items, form finding, and creativity has progressed, and the students have achieved higher rank, which results in a higher architecture quality in their works.

We can conclude as it is illustrated in diagram below that both items relating to the students' works have improved and form-based practices has changed their architecture quality to a great extent.

Based on the result of this research, form-based practice in the absence of architecture question has made significant improvements in students' art works and has resulted in attaining a higher architecture quality. This idea should be considered by the architecture school decision makers to import such courses among the main courses of architecture. This research can be extended and examined in other disciplines and the result would benefit all art-based disciplines.

Figure 177 *Creativity comparison of group C and the average of A and B*



CHAPTER 7.

Sketch as a means of Creative Externalization

Sketches function as a medium through which the architect can give life to their imaginative visions, transforming them from intangible concepts into tangible design proposals. Álvaro Siza

Jodidio, P. (1999). Alvaro Siza. Taschen.

This chapter encompasses the topics as follows:

- 7-1. Sketching and free-hand drawing as externalization mechanism
- 7-2. Embodiment of thoughts
- 7-3. Importance of sketch
- 7-4. Sketch Typology
- 7-5. Sketching and graphic thinking as a design method
- 7-6. Sketch a creative tool to Unlock imagination
- 7-7. Sketch as a means for achieving Intuition

7-1. Sketching and free-hand drawing as externalization mechanism

In reality, there will be no measurement or quantification of manifestations of creativity that can be defined as specific criteria. The intent of the laboratory research that was described in the previous chapter is to point out what the inherent reasoning patterns are in a domain-specific activity, namely, the practice of sketching at the front edge of architectural design. Sketches as products have received exposure as steps leading to finished works of art or design. However, the process of sketching has commanded little attention as a design methodology, and the architecture students consider it as a lateral skill that architects should be equipped with. An exception is Fish and Scrivener's (1990) theoretical treatment of the cognitive mechanisms that are believed to **enable sketching to induce artistic inventiveness**. The present study of sketching was a practice, in which students participated in "thinking aloud" sessions. The research activity were recorded and then transcribed in the form of visual compositions. The form-based structure, along with the sketches made by the participants (cross referenced with the verbalizations) comprise the protocols which served as data for the present studies. In the first round of exercises, seven experienced architects and a group of students worked on the design form composition based on each techniques. Every possible entry positions was presented by students, and they were asked to develop their ideas on the entries and their consequences for the finding the more creative objects. Each individual session lasted between one and two hours, with the designers talking to an investigator, who only answered technical questions and prompted speech when silence lasted over several seconds. The data present a true challenge as protocols are usually and essentially verbal, whereas in this case, they are densely sprinkled with visual sketches.

In his book "Imagining the Evident" Álvaro Siza explores the intrinsic relationship between imagination and sketching in the realm of architectural design. Siza, known for his sketches that are as much a part of his design process as the buildings themselves, uses sketching as a tool to bridge the gap between the intangible realm of imagination and the tangible world of architectural form. Through sketching, Siza navigates his creative process, allowing his imagination to take form. Sketches are the first instance where a fleeting thought begins to take on dimensions, where the abstract qualities of light, space, and material are translated into concrete elements of design. They are the visual language through which Siza communicates with the world and himself, an essential step in testing and refining ideas.

As pure speculation of ideas of architecture, ambiances and spatial forms, untied from any possible realization, fantasy does not seem to be

considered either as a reference for invention in his works or as an object of his drawings. However, many of the unique features that run through his oeuvre could be said to reveal the presence of fantasy. Alongside individuality and the unprecedented, Costa (2008, p. 35), indeed identifies fantasy as something Siza Vieira aspires to right at the beginning of his career. In Siza Vieira, fantasy is not an instance that is parallel to reality, and much less is it the antithesis thereof. On the contrary, fantasy is rooted in reality, and it is as reality that fantasy is desired and its realization is advanced. Fantasy is realized in reality; it exists as a built thing. It contributes by giving meaning to architecture; it confers exceptionality upon it.³⁷²

The relationship between imagination and sketching is thus cyclical and iterative in Siza's work. Imagination fuels the creation of sketches, and the act of sketching, in turn, informs and expands the imagination. It's a dialogue where each sketch evolves the concept a little further, clarifying and challenging the initial imaginative impulse. Siza's projects, as detailed in the book, are testimonies to how this process comes to fruition, illustrating that imagination and sketching are not sequential but rather concurrent and symbiotic aspects of his architectural storytelling.

Given the discussed concepts and the results obtained from laboratory observations in the two previous chapters, it is possible to incorporate significant dimensions of the design process resulting from the integration of form design processes and creative development of visual choices through methods based on freehand drawing and graphic thinking within the framework of key conceptual considerations.

Freehand sketching is a common human activity, almost like writing. In everyday life, most adults and certainly almost all children are at least occasionally involved in the production of various kinds of sketches such as road-maps and plans, diagrams and abstract patterns as well as depictions of people, animals, and objects, real or imaginary. Most such sketches should be classified as 'drawings' which are representations of either direct percepts, or ideas and images held in the mind. Artists and designers are among the most ardent makers of drawings: In their professional capacity, they execute a great number of drawings as a matter of standard practice. Among these drawings, there is a special category of study sketches which architects have the habit of making in the very early stages of the handling of a task. These sketches are often scribbled on, transparent tracing paper, are usually made very fast and are sometimes so idiosyncratic that they are only comprehensible to their maker. The purpose of the study provides in

³⁷² Duarte, J. M. C. (2019, September). The fantasy of reality: On the design drawings of Álvaro Siza Vieira. In *Intelligence, Creativity and Fantasy: Proceedings of the 5th International Multidisciplinary Congress (PHI 2019)*, October 7-9, 2019, Paris, France (p. 137). CRC Press.

this research is to explore the process of making such study sketches. The practice of sketching is universal and dates back hundreds of years (ever since paper became a readily available commodity toward the end of the 15th century). If architects use the sketching tool so persistently, it must be very helpful to their thinking. The questions this study tries to answer are, what kind of reasoning does sketching represent? Why is it as indispensable as a design thinking aid? In the context of a design research, sketching is taken to be a priori, inherently creative process, in that through its new artifacts are brought into being. To use common classifications of approaches to creativity research, it is the creative process that is here under scrutiny, not the creative product or the creative person³⁷³

Although this raises certain methodological difficulties in the submission of the protocols to informal analysis (Ericsson & Simon, 1984),³⁷⁴ it is a worthwhile struggle, as it permits us to deal with "a real rather than a toy task," to quote Hayes (1989, p. 209), in his examination of another creative activity, that of writing. Informal analyses of creative endeavors have been carried out in other fields, such as poetry editing (Perkins, 1977).³⁷⁵ In architectural research there has been an effort to apply formal protocol analysis to the process of designing as a whole (Akin, 1986).³⁷⁶ That work is guided by Newell and Simon's (1972) information processing theory and looks at designing from a problem-solving perspective. The objective of the present study was to isolate the activity of sketching and use visual thinking and imagery as a conceptual framework for investigation. The entire process of designing, and its front edge especially, is not necessarily seen as a case of problem solving. A discussion of the difference between problem solving and other models of designing is, however, beyond the scope of the present discourse.³⁷⁷

Sketching is used to refer to a subset of drawing, including observational drawing, idea generation, diagramming, design working drawing and doodling. Sketching does not here imply that work is necessarily incomplete or ill formed, though it may be both.

In effect the process of developing pictorial and diagrammatic representations has traditionally been treated as a **skill** rather than an essential part of the **process of thinking** about a design problem and developing a design solution Purcell & Gero (1998).³⁷⁸

³⁷³ Gardner, H. (1988). Creativity: An interdisciplinary perspective. *Creativity Research Journal*, 1(1), 8-26.

³⁷⁴ Ericsson, K. A., & Simon, H. A. (1984). *Protocol Analysis: Verbal Reports as Data*. MIT Press.

³⁷⁵ Perkins, D. (1977). A better word. In D. Perkins & B. Leonard (Eds.), *The Arts and Cognition* (pp. 246-283). Johns Hopkins University Press..

³⁷⁶ Akin, Ö. (1986). *Psychology of Architectural Design*. Pion Limited.

³⁷⁷ Goldschmidt, G. (Year). *Dialectics of Sketching*. *Creativity Research Journal*, 124-125.

³⁷⁸ Purcell, A. T., & Gero, J. S. (1998). Drawings and the Design Process. *Design Studies*, 19(4), 389-430.

Sketching is still commonly regarded simply as a skill. Kimbell, Saxton and Miller, have created a model of design that puts drawing firmly in a functional skills domain for their 'Distinctive Skills and Implicit Practices,' a review of their investigation 'Design Skills for Work' carried out for the Design Council (Eggleston, ed., 2000).³⁷⁹ They say 'we do not believe that the functional skills domain best captures the essence of design because this domain essentially comprises the tools that give external form to our thoughts, and all disciplines use such modes of expression.' They conclude that design is special because of the operational strategies designers use.³⁸⁰

Freehand sketches are essential for capturing ideas in the early stages of design. Through the act of putting ideas down on paper and inspecting them, designers see new relations and features that suggest ways to refine and revise their ideas. We claim that seeing different types of information in sketches is the driving force in revising design ideas. Our retrospective protocol analysis revealed that sketches make apparent to designers not only perceptual features but also inherently non-visual functional relations, allowing them to extract function from perception in sketches. This has implications for ways that future **sketching tools** can stimulate designers to come up with **creative ideas**.

A designer usually begins with freehand sketches in order to come up with promising ideas / concepts / themes, and later turns to using drafting /CAD modelling tools and/or to building mockups in order to visualize, compare, and implement them [3],³⁸¹

Sketching is a highly valued tool of thinking for architects particularly during the **initial conceptual stages** of the design process. Developing an effective design process is one of the key learning objectives facing an undergraduate architecture student. If we can improve the ways, we teach students how to use early design sketching as a tool of thinking then we will better assist them in their aim to become competent practicing architects. The question is how to make these improvements?³⁸²

Psychology of sketching

Over recent years design as a process has begun to attract the attention of psychologists, intent on unlocking the secret workings of the creative minds of designers, and inevitably sketching has been a key puzzle to them. A number of experiments have begun to inform fledgling literature on the subject with some of the wild swings of prognosis consequent on a small

³⁷⁹ Eggleston, J. (Ed.). (2000). Teaching and Learning Design and Technology. Continuum.

³⁸⁰ Suwa, M., & Tversky, B. (1996, April). What Architects See in Their Sketches: Implications for Design Tools. In Short Papers

³⁸¹ What Architects See in Their Sketches: Implications for Design Tools, Masaki Suwa, Barbara Tversky, short papers, April 1996

³⁸² Rice, S. Teaching and learning about early design sketching in architectural education: Towards a phenomenographic viewpoint. In HERDSA2005 [Conference/Event Details if available], 430

potential sample of studies. There is, however, evidence from Verstijnen and Hennessey (1998), and others, to support the thesis that **sketching is a means by which tasks can be undertaken that are beyond our capabilities of mental imaging**. This mental imaging is done within what has been called the **visuo-spatial sketch pad**, a facility of cognition within short-term memory. When our short-term memory is faced with a complex task it cannot cope and, so the argument goes, we need to externalize some of this. Design tasks have been dubbed ‘wicked’ tasks because of their complex, multi-faceted and unfolding nature, and it is precisely this sort of complexity which seems to be beyond us without externalization. Here, it is important to stress the representational aspect of sketching: it is for a large part about projecting **visual information** in a visual form and designers generally appear to prefer **visual communication** to written forms. Sketching is often a **means to engage with the un-sayable, in an un-sayable way, not a shorthand for words but a different realm altogether**.

Another key aspect of sketching in design is expressed by Purcell and Gero (1998) through their explanation of the work of Geol: He argued that sketching constituted a particular form of symbol system, which is characterized by **syntactic and semantic, denseness and ambiguity** and it is these aspects of sketching which allow **lateral transformation** to occur. Purcell and Gero (1998) Geol’s lateral transformations are those in which an idea **develops tangentially** while vertical transformations are those which are linear modifications to an idea. It could be seen that making our rectangular building a little longer in one axis is a form of vertical transformation while making it circular is a form of lateral transformation. This complex aspect of sketches and their potential for simultaneously **divergent meanings** makes sketching a useful working method for the designer and a problematical one for researchers and particularly those engaged in developing IT means of replacing or even just augmenting sketching in design. As Purcell and Gero (1998) go on to say, ‘In contrast to sketching, the computer-based drawing system is **non-dense** and **unambiguous** and should consequently make lateral transformation difficult.’

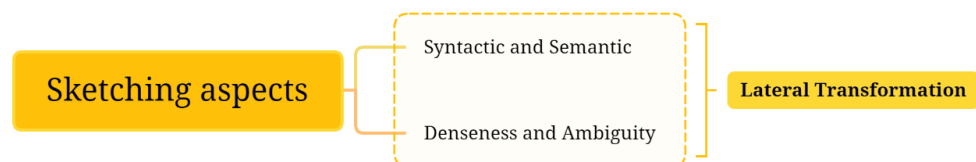


Figure 178 sketch aspects

Obviously, this lateral transformation is the key move in a well-developed design process. It could be seen that ‘non-dense and unambiguous’ sketching on paper also inhibits the design process, the familiar problem of

‘tight’ drawing. As will be discussed later, however, computer software and hardware exist that allows extremely dense and ambiguous work to be undertaken it’s just that it isn’t CAD. So, sketching appears to offer a pretty good working method in the design process. In *How Designers Think*, Lawson (1997) is a little cautious, however: The disadvantage of designing by drawing is that problems, which are not visually apparent ³⁸³

7-2. Embodiment of thoughts

When words leave off, music (Art) begins.

Heinrich Heine

Art and beauty begins where language stops. Artistic aspects of architecture are no exception as well. These features are not easy to be expressed by words and vocabularies. Therefore, we have to look for ways that are expressing the concept in the mind of the artist indirectly. Drawing and illustrations can be the medium which strengthens the artist to present his/her ideas and thoughts. This is why it is essential for an architect to use his/her hands to express the ideas through sketches artistically. The design process includes the artistic aspects which is extremely essential to be expressed via the sketches or other forms of art. The way which ideation is expressed is going to be a place of debate among theorist and a place for metalogue.

There are two types of memory.

Short term memory

Long term memory

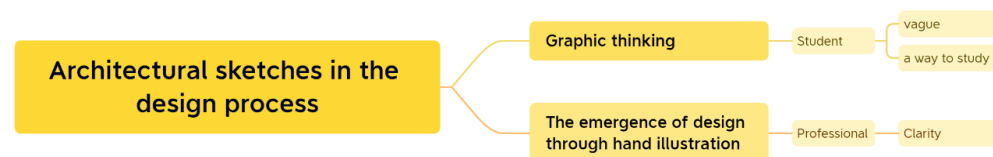


Figure 179 Architectural sketches in the design process

Short-term memory is revolving around events, and the long-term memory is about experiences. The short-term memory is about theories and meanings while the long-term memory is about experiences.

During our architectural education we see a vast number of architectural artworks. This includes a great number of images of the details or different perspectives of the projects that depict their architectural qualities and features.

³⁸³ Hare, R. The act of sketching in learning and teaching the design of environments: A total skill for complex expression. 239.

Unfortunately, there is no scientific method to categorize and order this data. This can be clarified through a comparison of this data with the vocabulary learned in a language. There are numerous methods to memorize the vocabulary of a language or memorizing poems, but it seems there is no method to memorize and categorize architectural spaces. The reason may lie on the complicated processes of our mind and brains.

One of the most important differences between amateur architects and professionals is about remembering artworks and details while designing. Making use of whatever he/ she remembers of the architectural qualities seen. He could transcend the images to the long-term memory and those who cannot use them, have had the architectural images on the short-term memory.

We can remark that one of the most important attributes of the creative designers in the design process is the way of remembering those artworks. This visual knowledge has been gained through visual data gathering.

In fact, it is considered as one of the 14 types of intelligence, such as language, movement ... which humankind has gained.³⁸⁴ According to Ocarloo every newborn baby has 5 types of intelligence activated.

The data saved in the eventual memory type are the types which we save on our long-term memory. Recalling these data is extremely dependent on the type of memory we have saved the visual data on.

With reliance on the laboratory process and the conducted observations, we can assert that **practicing graphic thinking and sketching can help architects recall architectural works when designing.** One part of this process is observatory sketching and one other part is imaginative creation which makes the mind memorize and save these visuals when imagination and drawing.

There is a big difference between a verbal memory and visual memory. When we teach the theories data are saved totally different from the time when we are teaching graphics and visual knowledge.

Having that in mind it is important to make students save architectural visual knowledge in the long-term memory. Sketching is a means for recalling this knowledge and making this type of memory stronger.

Considering these types of memory and the way we save data on, is considered as one of the most important items to pay attention to, for architecture students. They want to learn design by reading books and theories. This is not possible in fact. Because as mentioned above, the type

³⁸⁴ Johnson O'Connor has mentioned 14 types of intelligence. These are: spatial visualization, extrapolation, Idea manufacturing, fast reading, logic and analysis, working with numbers, syllogram and graphoria, design memory, color recognition, work with hands, music and voice recognizing.

of memory which saves data on is totally different from the memory which saves the visual data that can be recalled in designedly imaginations. It seems that we should be able to design by reading a design book, which in fact it is not really possible because design is completely different from cooking based on a recipe. There is no prescriptive recipe for design.

When it comes to the topic of freehand drawing in architectural design, we have two main phenomena. First of all, what exactly do we mean when we talk about handwork in architectural design? One is the educational context of the architectural design process through visual thinking. In fact, look at the hand as a window to the mind³⁸⁵ and a tool for thinking. Contemplating by drawing, which can be used as a skill in the professional design process at advanced levels, is still used as a method. Second, the emergence of design through hand-drawn demonstration. Here we call the sketches under the term "Architectural manuscript." In this case, we are facing a professional and special way of creating mental thought, which is implemented by professional designers and architects. In this sense, sketches are a tool in the hands of professional architects to embody their ideas and imaginations. In fact, architecture students and amateur designers can enter the special and intuitive dimension of using this skill in improvisation and space created by using drawing thinking in the long term. This design behavior in professional architects and the way it occurs is largely different from the way of using this design technique among less experienced architects and students.

The reason is laying on that professional architects try to discover the answer in a sensory and intuitive way by using this skill, and their intuitive knowledge and experience in design allow them to create a relatively accurate guess of what the building is to be designed with vague lines of sketches. This process is influenced by the architect's experience, perceptions, and momentary perceptions, which naturally emerge when facing a design project or problem, while amateur designers and architecture students need to think on paper and through reinterpretation and comparison of designs and creating the series of visual choices from the basic visual structure of their design. This structure is more abstract and diagrammatic in nature. It is easier to read these types of lines compared to the sketches of more professional architects and it is more possible to trace their line of thought compared to the sketches of professional architects.

The reason for the ambiguity of this type of thinking is that professional architects penetrate deeper into the design and evaluate much broader criteria, and the complexities of this type of sketches are sometimes in conflict with ideas or in correspondence with parallel and uncertain currents

³⁸⁵ "The hand is the window to the mind," said German philosopher Immanuel Kant"

of thought. It is that they are monitoring the determination of other dimensions so that they can reach their final form. This process is a reverse process from an answer to a solution. While in the early drawings, using graphic thinking, we see the evolution of the formation of space from simple and abstract forms that become complicated over time.

Teaching the design process through graphic thinking is a process that has been used in different ways during different years of architecture education history. The problematic issue we are confronting is how we can find the essential and valuable dimensions of this process in accordance with the new advent of the digital, virtual world of architectural software includes without being accused of creating a reactionary and non-functional movement. On top of that, this method shouldn't be in conflict with today's technological and digital world and is culturally used by new generations not as a side skill but as a way of thinking and solving problems.

Confidently, the goal of embedding the drawing process in the architectural education system is not to give a pencil to the student's hand and be relieved that he can solve the design problem by using drawings and creating perspective compositions. Architectural demonstration of geometric volumes that were mixed together and drawn by students cannot be the goal of a design process using visual thinking. Here it is appropriate to separate examples of different types of drawings of architects who use different types of lines with different content in different situations in a picture category.

Assortment of sketching by situation of applied

Obviously, there are principal distinctions between Drawing and Sketching. As mentioned before, most of drawings may not be affiliated to hand but what we expected from an architectural sketch is an act which a designer or an architect depicted, realization and embodied to his/her thought from objective observation or mental imagination which run by hand. Actually, sketches are particular type of free hand drawing which can be identified in three category of drawing, introduced by Lawson. Experiential, Diagrams and Fabulous Drawings.

But Lawson assortment seem not to be so comprehensive, regarding to diversity of architects drawing because essentially sketch is a language of thought more than a skill or ability to draw which serve architects to providing a way to answer the architecture tasks. Also, in general, the situations that architects use sketching for designing and thinking, are so varied and in addition to these sketches are so variable from the beginning point of design process to the end from the aspect of the nature of the lines, the range of abstraction, the subject of design from a conceptual objective to a simple detail! **Thus, based on what was observed in laboratory tests,**

it is indispensable that each student be able to use their own sketching language to depict his/her thoughts while tackling the design process. Perhaps these architectural sketches can be defined in a distinctive category which are explained in detail as follows.

7-3. Sketch Typology

In early design, designers draw diagrams and sketches to explore ideas and solutions. Drawing on paper involves **recording ideas**, **recognizing functions** and **meaning** from the drawings, and **finding** and **adapting new forms** into design. Several books have described drawing as a means for design development. For example, *Graphic Thinking* (Laseau 1980) guides designers to make drawings for **working out problems and communicating** with others. *Envisioning Architecture* (Fraser and Henmi 1994) looks at how techniques used to make different drawing types influence the making of architecture. *Why Architects Draw* (Robbins 1994) examines the work of well-known professional architects, focusing on the role of drawings in architectural practice. *Architectural Study Drawings* (Herbert 1993) examines the graphical media and design processes of six practicing architects. It argues that drawings are more than just a convenient strategy for solving design problems and that in fact they are **“the designer’s principal means of thinking”** (p. 1).³⁸⁶

Variation in sketching Through practice architects have come to develop their own ways of sketching and their own associated ways of using sketching to progress their thinking. There is no commonly held approach or agreed method, rather there is considerable variation in how architects sketch. This variation is illustrated in the compilation of conceptual sketches by a group of eminent architects ranging across some fifty years. This variation presents interesting opportunities for investigating teaching and learning from a **phenomenographic** viewpoint. How might such a variation best be observed and how might it be analyzed? Clearly students and teachers would benefit if the nature of the variation in sketching could be made apparent. This would enable access to and reflection on the different ways architects use their sketching. Students can at present turn to books to look at examples of early sketches, but these sources don’t access the thinking process connected with the drawing.

If the variation in sketching could be documented, analysis could focus on identifying characteristic approaches to sketching and attempt to see if there is an association between certain approaches and usefulness and or level of skill. If the documentation were extended to include experiences of

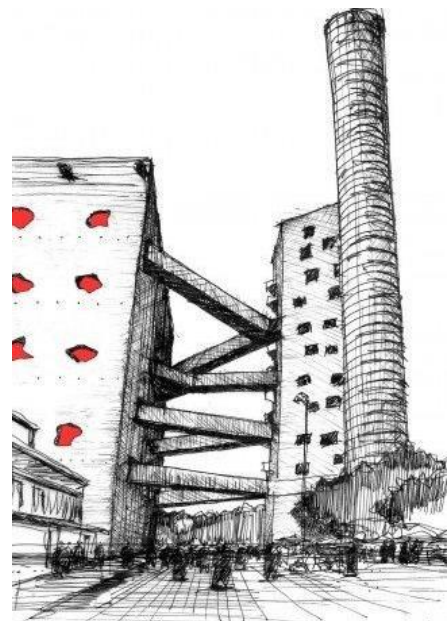
³⁸⁶ Do, E. Y.-L. (1996). The Right Tool at the Right Time -- drawing as an interface to knowledge based design aids. In F. Ozel & P. McIntosh (Eds.), *Proceedings of the 1996 National Conference, Association for Computer Aided Design in Architecture (ACADIA 96)* (pp. 191-199). University of Arizona, Tucson.

learning about sketching, then the outcomes might offer insights as to how to set up better learning situations. In summary it has been suggested that:

- learning to sketch is associated with **learning to think**
- sketching is a skill, an ability developed through **practice**
- There is considerable **variation** in the way architectural practitioners, teachers and students understand and use early sketching
- Experienced practitioners are likely to have a more thorough command of early sketching
- Some sketching is **more useful** than others
- It would be beneficial to **map out** the nature of the sketching variation.

1. Sketch for studding & understanding

Utilizing sketches as a fundamental tool, architects delve into the intricate realm of architecture, meticulously observing and comprehending its nuances. These sketches serve as a visual diary, capturing the essence of captivating architectural structures. The subjects encapsulated within these drawings often span a spectrum of awe-inspiring buildings, each stroke on paper translating into a profound understanding of spatial design, aesthetics, and functionality. Through this artistic exploration, architects not only document their insights but also forge a profound connection with the built environment, fostering a dynamic dialogue between creativity and the tangible expression of architectural marvels.



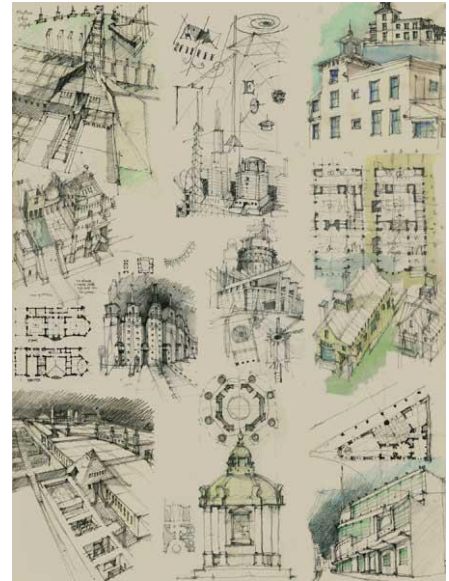


Figure 180-183: Images of how the architect learning through their sketches. This type of sketches mostly known as Croquis

2. Sketch for analyzing & observation (Imaging the evident)

During our architectural tasks, sometimes, we are asked to design a project within the borders of a plot, due to which we decide to conduct environmental studies. Or an architect decides to design in an urban space. These are studies of the city, neighborhoods, land's conditions, views, and perspectives towards the plot and from the plot towards the side. In other words, we intend to create architecture somewhere, so, we set foot in the mentioned space, observe it and carry environmental studies out. Not to mention, qualities are different, and this is the architect's own language. Differs from one architect to the other. Santiago Calatrava makes use of watercolor; the other uses Charcoal and one utilizes pencil.



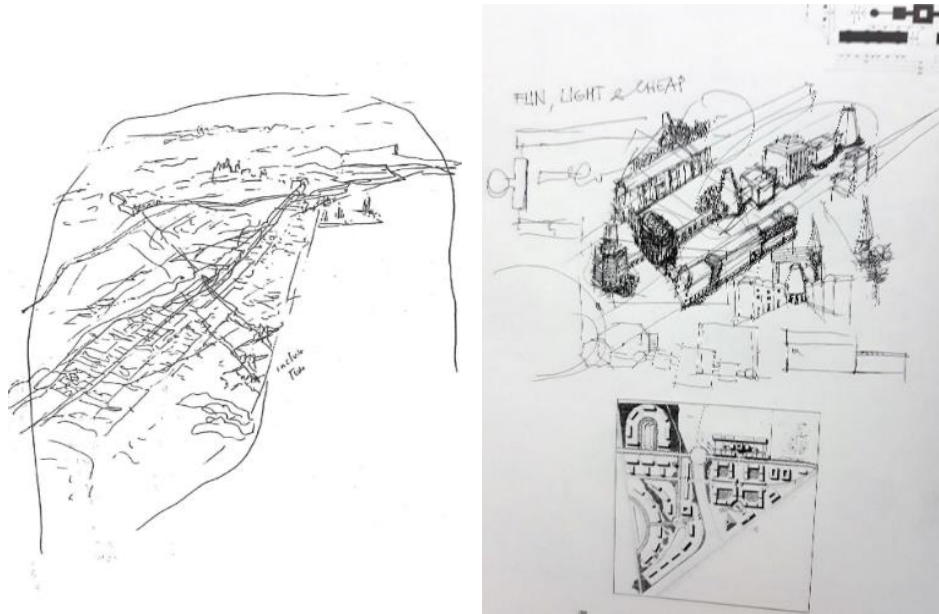


Figure 184-185-186: Alvaro Siza Vieira sketches 187 Nadir Afonso Rodrigue

3. Sketch for Interaction and Review

Another type of sketch is that which we make use of when talking about our projects and mental ideas with another architect; whether our colleague, our boss, our employee, our teacher, our student or a friend who is also an architect. In other words, we intend to explain our ideas through sketches. At this stage, the architect starts designing which may feature different domains. It may be a plan, section, form or a series of climatic diagrams concerning the sun's radiation angle; or it may be an occurrence through the urban fabric; and states like what we mentioned above.

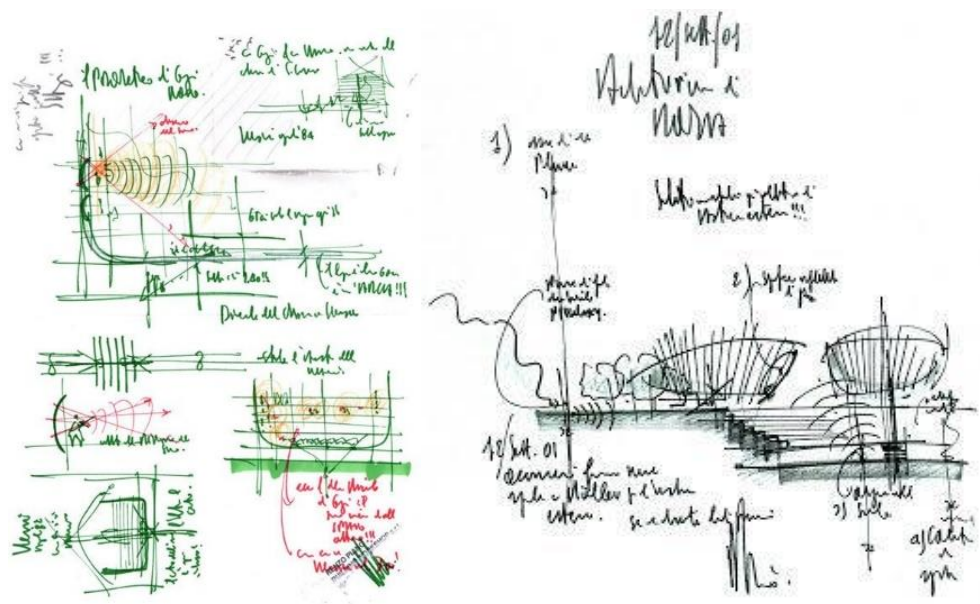


Figure 188 Sketches from Renzo Piano

4. Sketch as an Inner investigation

Sometimes, we do not intend to design a project, that is, the architect's mind which is busy with mental questions concerning some architectural issues, which means the architect's self-knowledge. That is to say, architect is processing issues like: a mental concerning an architectural issue, his/her own style, an occurrence analysis and its effect upon his/her works -like light's effect-; or he/she is researching architecture within him/herself, like someone who enter his/her private library, looking the books and read some of them and try to find something. As mentioned before, here, neither a project is raised nor is an architect collecting information from the environment. There is just the architect; him/herself only. Architects are busy with inner exploration. Here, he/she designs some sketches. For example, he/she decides to think about "home" more thoroughly; or wants to achieve a newer spatial occurrence through studying the light's effect in his/her designs. May be ask him/herself "is it possible to achieve a special quality in a project, through light and space?" And the architect aims to make use of the study results in his/her future projects, which means an inner search and exploration.

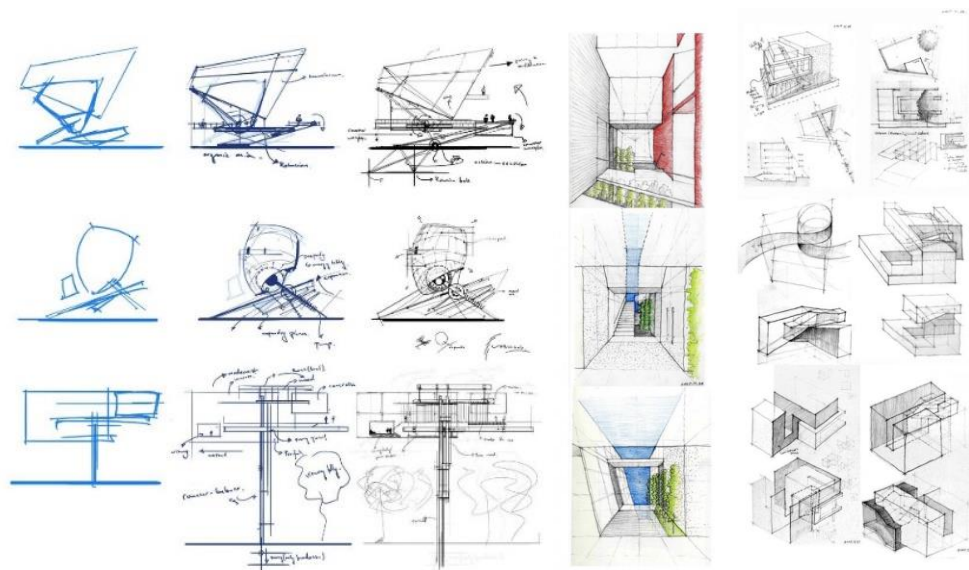


Figure 189 Sketch from Alex Kaiser(Left), HAHN design (Right)

5. Sketch for Disambiguation and delineation

Another type of sketch is that which we make use of in the case of talking to a client who is not an architect. Imagine, a client has sat in front of you while talking about his/her demands, so, we make use of sketch in order to perceive his/her demands, offer him/her our solutions and explain to him/her that we have perceived from his/her demands. In fact, the architect tries to convert the client's imaginations, words and descriptions into a visual and tangible quiddity meanwhile offering him/her more solutions.

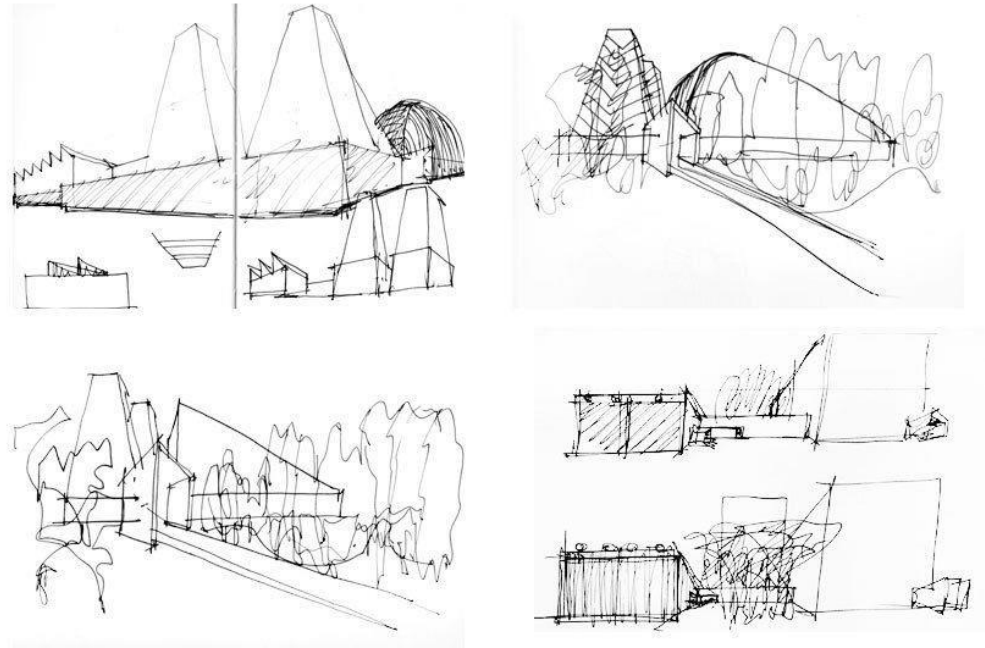
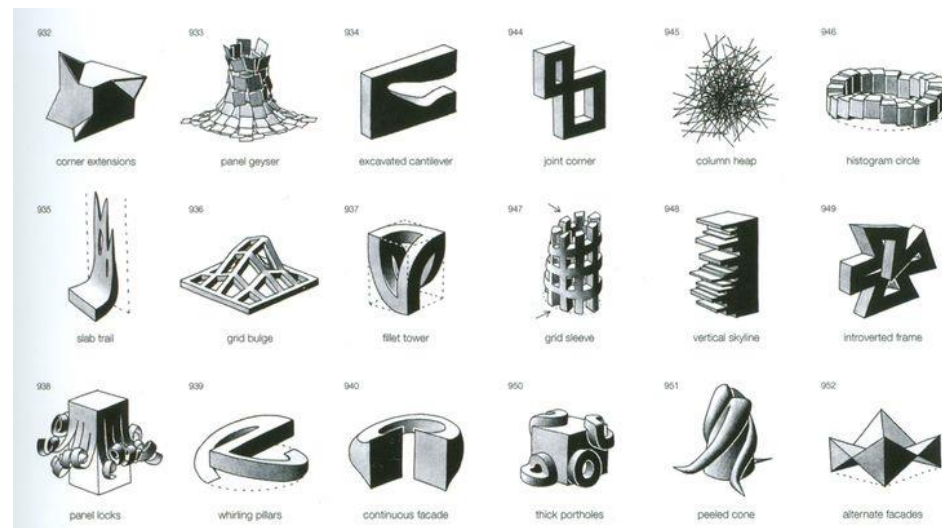


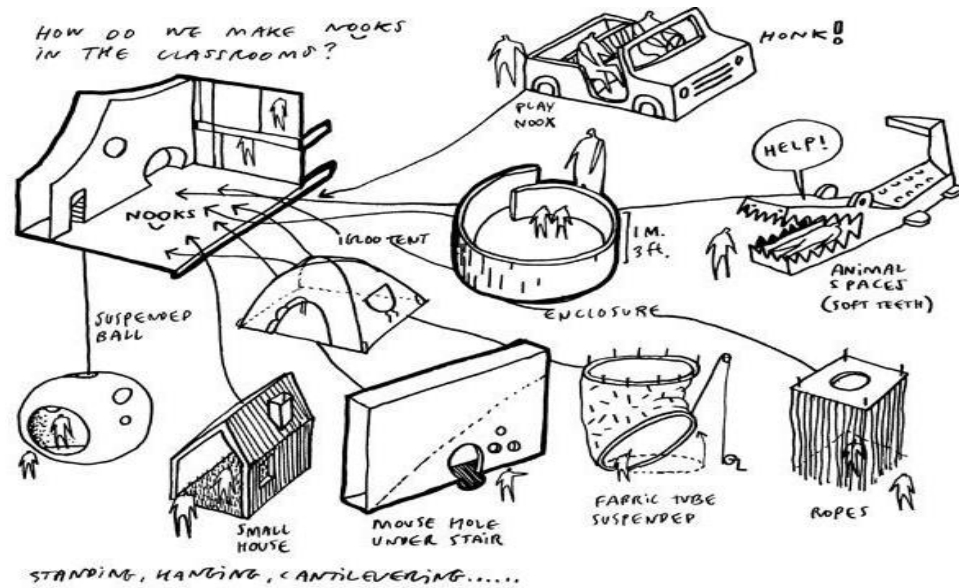
Figure 190 Sketch from Eduardo Souto de Moura

6. Sketch for teaching and instruction

Another type of sketch is used when neither the subject of architecture is raised, nor we want to talk to a client and nor we are to explain our or another individual's idea. In other words, we are intended to teach a student how to think using drawing. At this stage, not only should we teach him/her all kinds of sketching, but we should teach them and tell them what they should think about and how to draw it. Further, we should teach him/her what he/she could produce and what an architect should draw in the case of a project. This kind of sketch comprises two different branches.

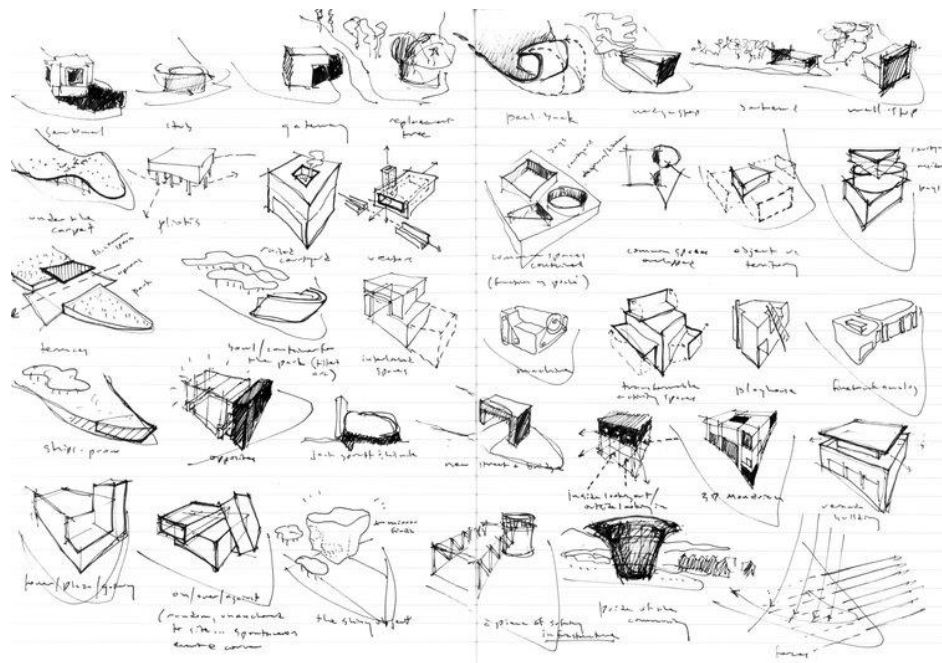
6.1. Diagrammatic thinking issue: there are some input data and we want to convert them into diagram. "Difference between sketch and diagram, based on Susan Rice's book".





6.2. Generating and developing ideas

Here, there is no input data. In other words, we are intended to freely produce data. In fact, we want to produce examples before knowing the issues.



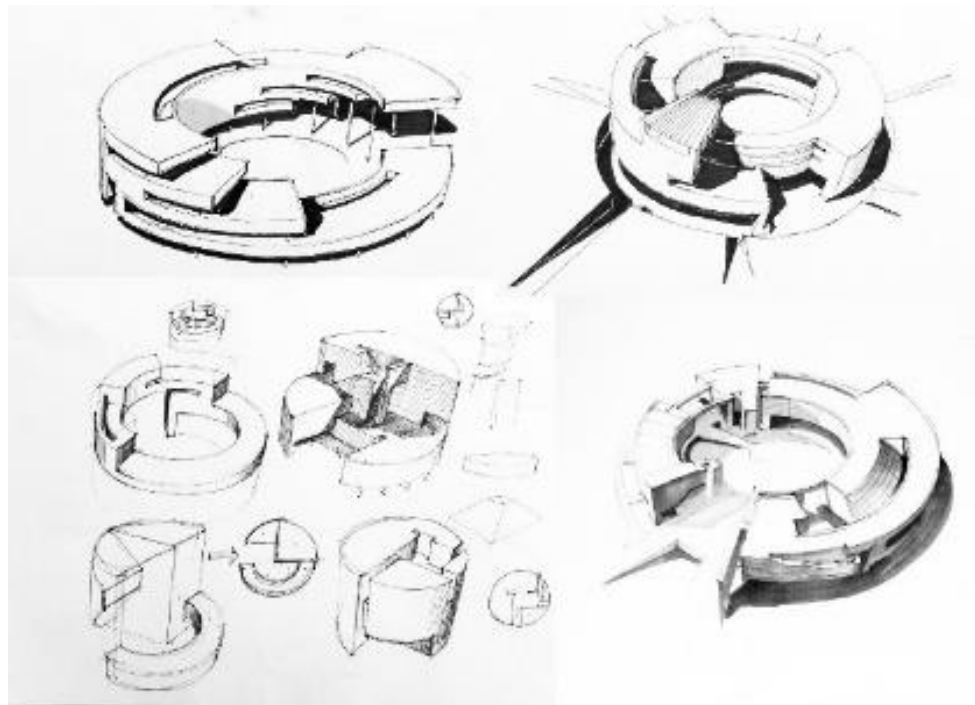
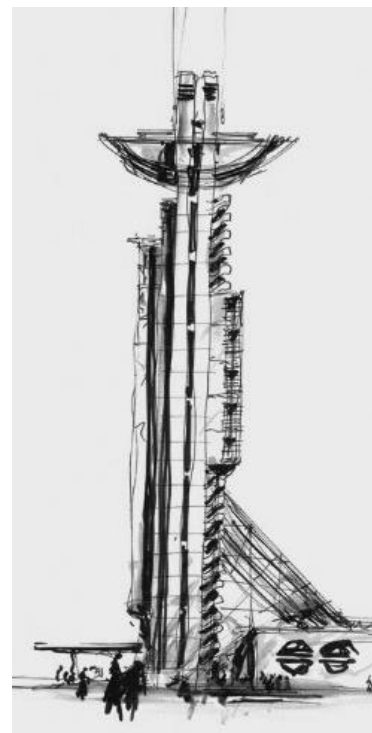
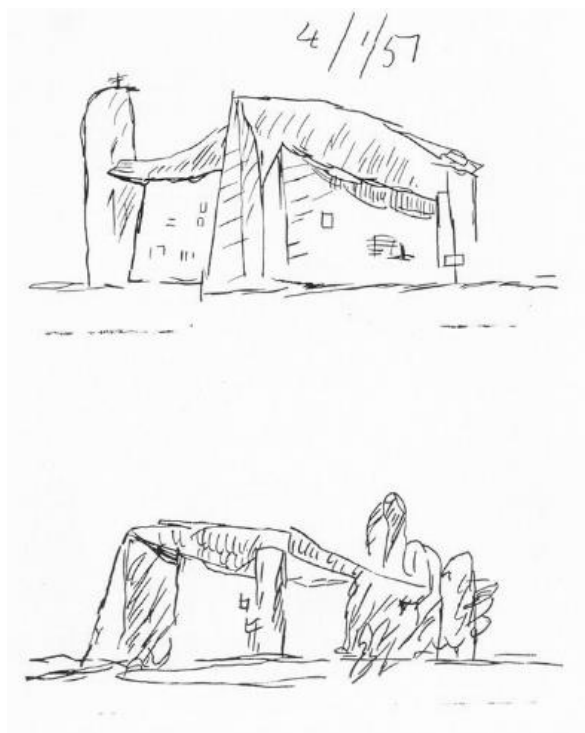


Figure 194-195 Sketch from Ross Drulis (top) Mohammad Pirdavari (bottom)

7. Sketch for realization a concept

This kind of sketches are the outcome of pervious procedure. At this stage an architect tries to find a best form structure as a consensus of his/her drawing and studies. Many of ambiguity and skepticism are rectified and the architect has gotten one step closer to universalization of space.



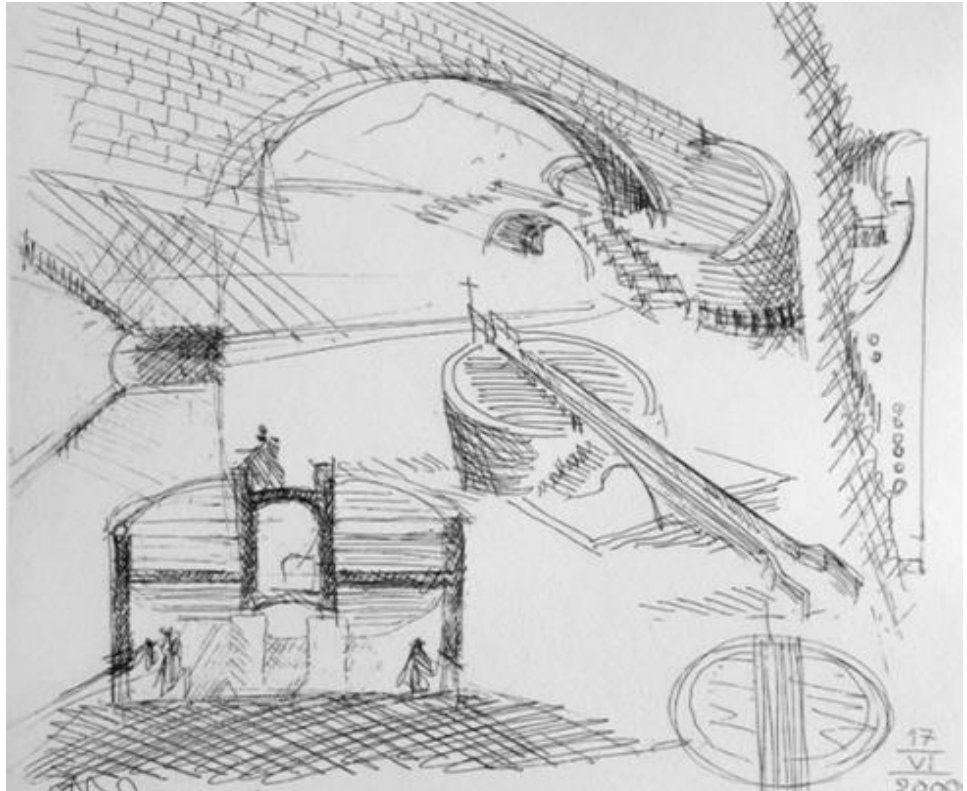
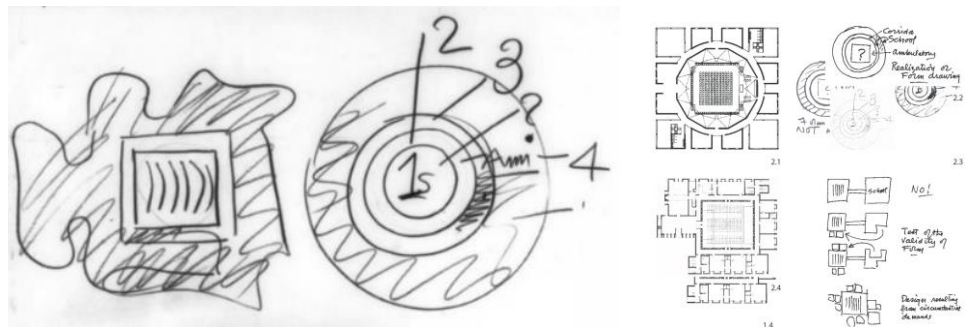


Figure 4 sketch from Mario Botta, Le Corbusier, and Richard Rogers

8. Conceptual Sketches

This group of sketches refers to the simple meaningful of a notion which an architect intends to realize through his/her project. Mostly many of these sketches are only recognizable for the architect him/herself and perhaps even for the trained eye. They are not tangible and the relation between these sketches and the final projects are not so explicit. It can be inferred that this simplicity of line, helps architects to take the first steps toward the goal and embodied his/her sense to visual graphical essence.



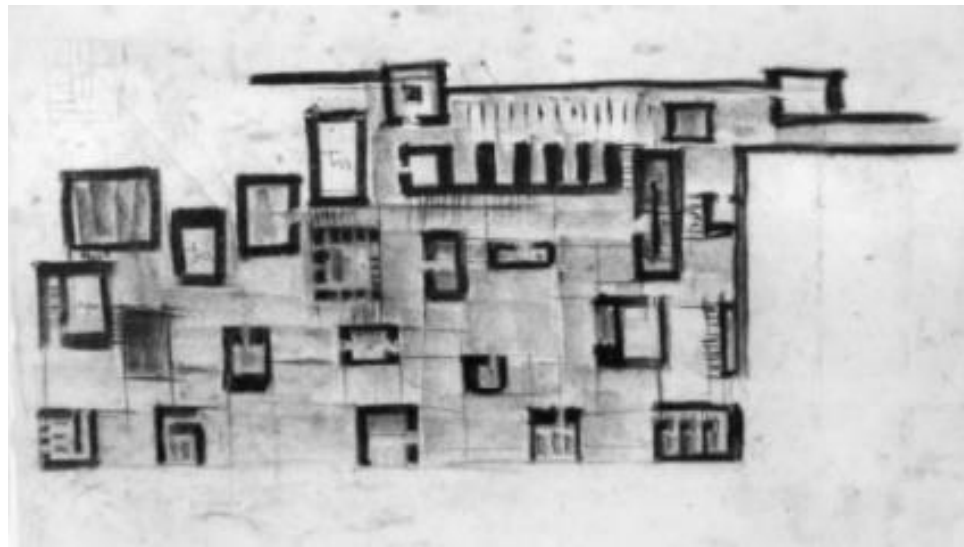
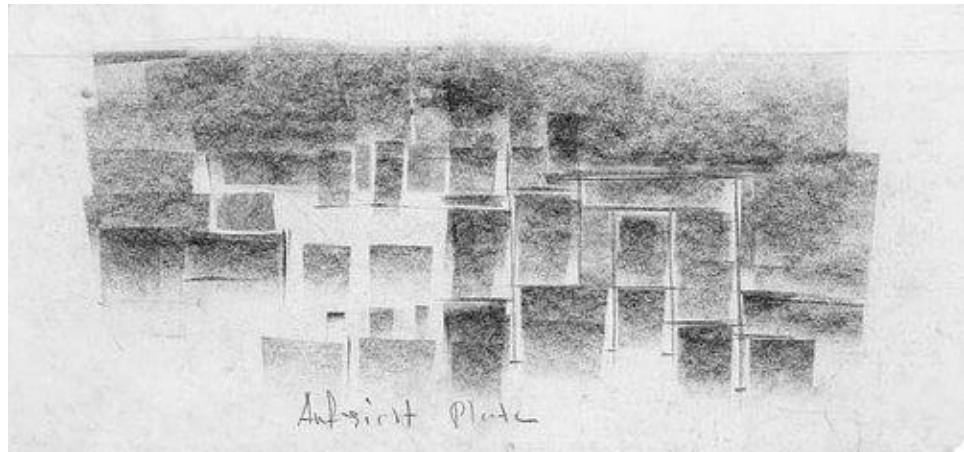


Figure 199- 201 Sketch from Louis Kahn (top) Peter Zumthor (bottom)

9. Imaginative Sketches in search of spatial quidditys

Within the cognitive realm of an architect, contemplation may be spurred by an architectural quandary, an ongoing project, or even unfettered musings. Suddenly, an image materializes, akin to a reverie. This imaginative process unveils a spatial conception, akin to an epiphany, wherein the architect unlocks the key to an enigma. In this instance, a comprehensive mental portrayal of the envisioned space emerges, encapsulating myriad facets and dimensions. The intent is to articulate and manifest these conceptualized elements. This conceptual sketch serves as a medium to document both the ideation and design, capturing the nuanced interplay of ideas and spatial configurations. It stands as a testament to the architect's cognitive journey, wherein the abstract transforms into a tangible record of creative exploration and problem-solving.

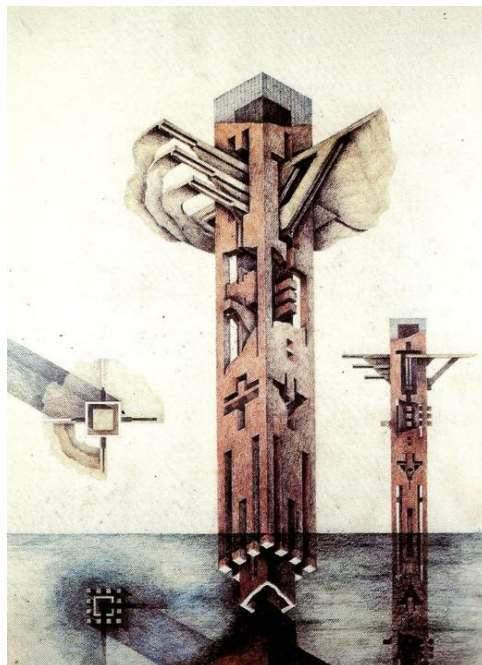
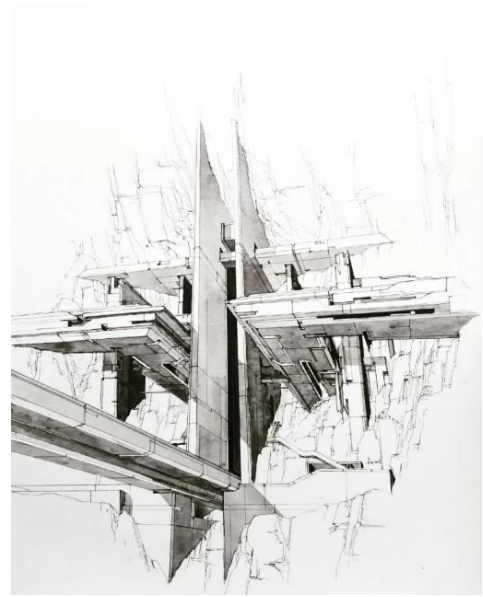
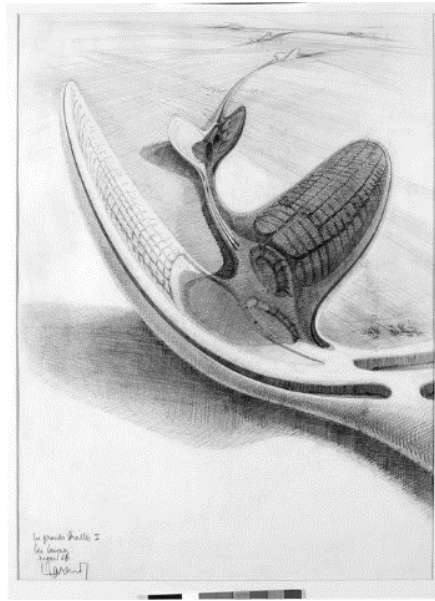


Figure 202- 205 Sketch from Claude Parent, Mohammad Pirdavari, Raymond Abraham, Lebbeus Woods (Top left to bottom)

10. Professional Rendering

This type of sketch is more of a luxurious presentation, which is specifically used for exhibiting the final architectural project, and looks real and it is non-abstract. All materials and final specifications of the project are clear. In many cases, it is probable that the sketch is drawn by a person other than the designer or the architect.

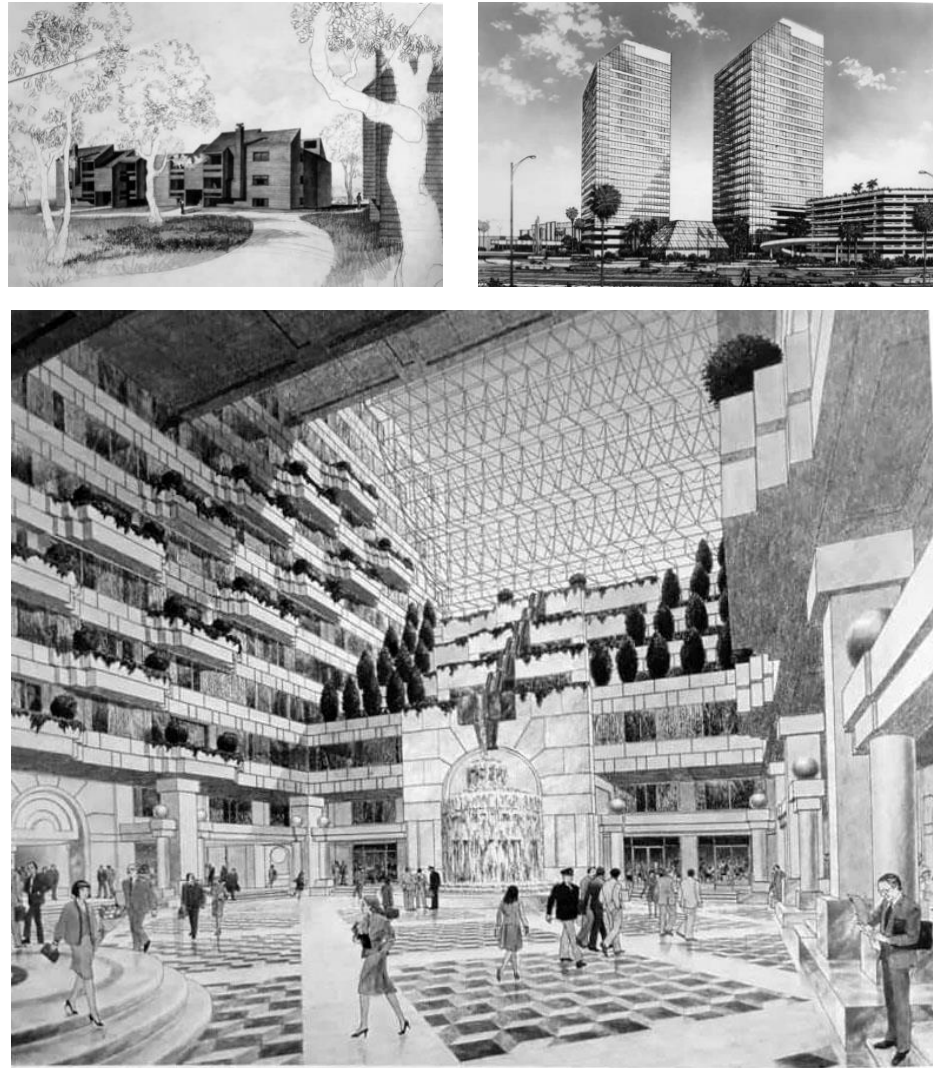


Figure 206-208 sketches from Mike W.Lin

What a student should do through the process of Sketching are:

- Understanding the problem
- Objectifying mental images
- Graphic expression
- Converting obscure mental images into formal and physical patterns
- Checking and summarizing scattered thoughts that can be pieces of the final architectural puzzle. (Sometimes in design, instead of thinking about the integrated whole, we can think of several components that do not yet have a fixed location in the design, but we have images of them in our mind that can play a role in the mentioned project, they are subjects that in graphic thinking, are drawn.)
- Converting concepts into simple diagrams in such a way that it gives us a clear reading of the awesomeness of an architectural building.

Sketch, or in French *esquisse*, includes a wide range of drawing applications in design and "Architectural manuscript." By delving more into its meaning without wanting to interpret it in the context of texts and language, it is necessary to specify the type of such activity more precisely. Should we look at it in the sense of drawing, thinking, and designing? Or is it a word that can have all these meanings at the same time?

Obviously, sketches in themselves are neither drawing nor designing or painting! If we tend to explain it somehow, we may need a long sentence like this:

"Fast drafts lines that are spontaneously drawn with uncertainty and ambiguity during the design and thinking process!!!"

If we look at the subject from another angle and define the sketch with a combination of two words that can have a semantic affinity with the result of a sketching process, then our view of this skill will rise from the form of mere drawing to sublime levels of meaning. Pay attention to the following words.

-Visual exploration: Sketching is not a direct process to achieve an idea but rather an exploration. Not every sketching process is supposed to end in an architectural design, but rather provides the preparations for achieving the final concept.

(Showing works by Louis Kahn and Zumthor)

-Spatial Concepts: Part of sketching is a visualization process. What we seek to create in architecture is space, and this space is explained and understood through the form, and through it we get to know and understand the content of the semantic aspect of the work. What is beyond the external and physical dimensions of the work can be identified.

- Kinesthetic and spatial activity: Juhani Pallasmaa's interpretation of sketches can be understood with this word:

-Perceptual manuscripts: what we perceive and reinterpret through lines

-Dialectics of external and internal reality: Donald Schon's view and interpretation of sketches. The inner reality is the reality that we imagine something, and external reality is that which has displayed our imagination in the form of truth. When these two thoughts meet, the moment a mental image enters the material realm through drawing, the brain re-reads it or makes a new interpretation of it, which is a kind of dialogue between the observed subject and the previous idea of it.

Looking at sketching from this perspective separates it from mere drawing and compositing volumetric demonstration and turns it into a goal that we reach through Sketching tools. Sketch is a medium in design activity, and in

a way, it is a metaphor for a mental concept. If we pay attention to the concept of metaphor, we use it when we want to use something to explain and express something else that does not exist. It helps us to enter the unknown world. Our intelligence and range of knowledge is not enough to understand and recognize something to the extent that we can describe it, because maybe that thing does not exist or if it exists, it is unknown to us, so we use metaphor as a medium to be able to show a manifestation of that unknown truth.

Sketches, as a metaphor in architecture, help us to imagine what does not exist yet with abstract effects. The space that we intend to design but does not exist yet, is not visible and has not been discovered. In the design of an architectural project, although the specifications and physical plan of the space are very well defined and identified, it still does not exist until we design it. At this stage, we come across the word imagination again. Imagination that we saw in the design process and in the ideation and formulating stage, its relationship in the diagram (x) with sketches and intuition. The concept of embodiment, in the fact of giving physicality to imaginations, is the same as the title of this research, which is related to embodiment. But the envision of that which is still in the mind and the embodiment of that which has gone out of the mind and become physical and imagination is the source of these two.

7-4. Sketching and graphic thinking as a design method

It has been often suggested that graphics, especially pictures, "resemble" what they represent. For example, Sloman at one-point claims that in the case of analogical representations, there must be "some correspondence" between the structures of the representation and its target, whereas in the case of Fregeau representations there need be no correspondence (Sloman 1975, p. 433).³⁸⁷ In a similar vein, Barwise and Etchemendy write (1990, p. 22):

Another advantage of diagrams is that a good diagram is isomorphic, or at least homomorphic, to the situation it represents, at least along certain crucial dimensions... By contrast, the relationship between the linguistic structure of a sentence and that of its content is far more complex. It is certainly nothing like a homomorphism in any obvious way.⁴³⁸⁸

Mental concepts to be conveyed or must be described through language or the need to create an image and a scene to convey its' concept. However, since in architecture, significant dimensions of space need a material form

³⁸⁷ Sloman, A. (1975). Afterthoughts on Analogical Representations. In R. J. Brachman & H. J. Levesque (Eds.), *Readings in Knowledge Representation* (pp. 432–439). Morgan Kaufmann Publishers, Inc.

³⁸⁸ Shoja, A. (2001). The Graphic-Linguistic Distinction. *Artificial Intelligence Review*, 15, 5-27.

for complete perception, verbal descriptions cannot determine its certainty because basically linguistic concepts are uncertain and conventional concepts.

Architects' drawings are called simultaneous sketches during the design process of graphic thinking—a kind of visual description combined with thinking and analysis. In graphic thinking, mental concepts that are basically qualitative become quantitative through drawing and are so-called "converted" into something like an image. This type of visual discourse is a communication channel and, as mentioned earlier, a type of research tool for better understanding and development of architectural thoughts.

Graphic thinking in the context of design studio

Architects specialize in building design, and it's understandable that students look to their architecture degree as a place where they learn how to design. Design learning can be seen as having two aspects. First, learning about what is being designed, which is a range of issues related to the building: what it is made of, how it keeps the weather out, the character of the spaces, etc. A significant emphasis has been placed on teaching and learning to cover these types of issues. Second, learning how to design. It is the process or way in which a designer moves his architectural thinking towards design, it is the process or way in which a designer moves his architectural thoughts from one to another. Teaching and learning in this area is much less clear and at the same time no less important.

An observed need for improvement in teaching and learning about how to progress a design is the motivation behind this research. More particularly, the researcher's experience in teaching design and drawing has led to the finding that teaching students how to use early design sketching as a tool of thinking is helpful in their development of an effective design process, a key educational objective facing each undergraduate architectural student. This suggests that a useful question to ask is how can we assist students to improve their learning about sketching as a tool of thinking to progress the early stages of a design? ³⁸⁹

Developing a characteristic design process as it has said earlier, is one of the most important learning objectives facing an architecture student to develop their own characteristic design process or approach to design. As part of their ongoing development students are expected to shape and refine their approach informed by the understandings, they have gained through the completion of individual design projects. This development is often perceived by students as being difficult, yet they are aware that students who appear to have a more effective design process repeatedly

³⁸⁹ Rice, S. (2005). Teaching and learning about early design sketching in architectural education: Towards a phenomenographic viewpoint. In HERDSA2005 ,431.

produce designs of higher quality. Teachers need to keep this learning objective of the student in mind because it is too easy when teaching in the studio to focus on the architectural content of the design and overlook the need to assist the student in ways that they might progress the design, an indication that the teacher is not placing themselves in the situation of the student.

Student centered learning If a teacher is to assist a student in developing their design process, that is focusing on both the content (what) of the design project and the way to move ahead () of the design project and the way to move ahead (how), they need to work closely with the student placing them at the center of the learning experience and be mindful of the reality that different students will think in different ways and that different students will need to be guided in different ways. To be effective in this guidance the design teachers need to be able to access what and how the student is thinking and reasoning throughout the unfolding design process. Accessing students' thinking is difficult and students are understandably unfamiliar with discussing their thought processes. This is where sketching is invaluable. If the teacher sees and works with the students' sketches as windows into their creative thinking, they can then work with the student to devise ways to specifically assist them to progress through the design. Students are acutely aware as to if a design teacher has been helpful, as evidenced by a second-year student commenting on their design teacher, "...helps me learn about the process of design, invaluable. She is good at explaining things graphically which prompts me to draw more, which I think is good. She helps draw out key elements and clarifies them so that I can progress in my work with a more solid understanding." (Anon. 2002)³⁹⁰

A shift away from word-based thinking Generally speaking students do not begin their architectural studies with the ability to think through drawing. It is not a skill that is given significance in school. As high achieving school graduates they begin their design studio learning with a keenness to talk about their ideas with seldom a shortage of words. In order to begin to use sketching as a way of thinking, students have to shift away from word-based thinking and start by reaching out for a pencil to express their ideas. Experience and student feedback suggest that the teachers who draw alongside students, consciously or unconsciously modelling this sketching-based way of thinking are an important and appreciated learning source for students. One thoughtful second year student when asked to reflect upon a design studio he had just finished where the teacher placed deliberate emphasis on thinking through sketching commented, "This studio has seen me realize more about the way that I design and the points about this

³⁹⁰ Anon. (2002). Student feedback (anonymous) on design teachers' teaching in Design Practice, Year 2, Semester 2, 2002. Faculty of Architecture, Sydney University.

method that can be improved in order to be a better designer and start to think through my drawings and draw through my thinking” (Stephen 2002)³⁹¹

In summary, it has been suggested that: -

- Students need help to develop an effective design process
- learning how to design necessitates the student to be at the center of learning
- Students need help to learn how to use drawing as a tool of thinking.

Approaching teaching and learning improvements

Bringing together the issues raised about sketching and its associated teaching and learning with the methodologies offered by a phenomenographic research viewpoint we can identify a study which has as its focus the identification and description of the variation in approaches to early sketching, the outcomes of which might assist students to develop a deeper understanding of sketching and its usefulness. As the basis to this study, approaches to early sketching become the phenomenon under investigation and the variation in approaches to early sketching, the object.³⁹²

It is highly accepted that proficiency in early sketching greatly aids in the advancement of an efficient design process and that sketching serves as a crucial cognitive tool for architects. It might be beneficial at this juncture to delve deeper into the interplay between thought and sketching, or, using the broader phrase, the connection between thought and drawing.

Sketching and drawing are essential tools for architects to manifest their conceptual ideas visually. They represent a mode of visual thought, serving as a pivotal vehicle for evolving the intricacies of a design. The processes of drawing and thinking are inherently intertwined. If this is the case, then the mastery of drawing is intricately linked to the refinement of thinking. Glenn Murcutt illustrates this interconnectedness in an interview just after he was awarded the Pritzker Prize three years ago. When asked about the importance of drawing he replied, “...when we lose the ability to draw, we lose a part of our ability to think.” (Glen Murcutt 2002)³⁹³ In Figure 209 Joern Utzon may well be expressing a similar sentiment as he depicts himself with pen in hand dipping into his inkwell-like brain.³⁹⁴

³⁹¹ Steven. (2002). Reflective design review for Design Practice, Year 2, Semester 2, 2002. Architecture Faculty, University of Sydney.

³⁹² Rice, S. (2005). Teaching and learning about early design sketching in architectural education: Towards a phenomenographic viewpoint. In HERDSA 2005

³⁹³ Murcutt, G. (2002). Pritzker Architecture Prize 2002, accounts and interviews. Architecture Australia, 91(3).

³⁹⁴ Rice, S. (2005). Teaching and learning about early design sketching in architectural education: Towards a phenomenographic viewpoint. In HERDSA 2005 ,431.

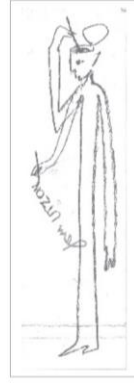


Figure 209 sketch by Joearn Utzon

One of the central emphases of this research is the practice of early freehand design sketching, a distinctive form of drawing. These sketches, characterized by their inherently creative and exploratory essence, find their ideal application in the initial conceptual phases of the design process. The act of sketching serves as a conduit through which individuals can manifest their ideas, concepts, intentions, analogies, qualities, and inspirations. Moreover, it functions as a versatile instrument for scrutinizing, challenging, evolving, and honing each of these thoughts.

The boundary separating the sketch itself and the cognitive processes it initiates is often indistinct. Within the scope of this research, we will employ the term "sketching" to encompass not only the physical act of drawing but also the cognitive deliberations it triggers.

Alvar Aalto offers us insight into his use of early sketching when he describes his process for designing the city library at Viipuri, "...for long periods of time I pursued the solution with the help of primitive sketches. From some kind of fantastic mountain landscape with cliffs lit up by suns in different positions I gradually arrived at the concept for the library building...The childish sketches have only an indirect connection with the architectural conception, but they tied together the section and the plan with each other and created a kind of unity of horizontal and vertical structures." (Alvar Aalto 1947) The early conceptual stage of the design process, the stage Aalto is referring to, is both critical to the design process and hard for students to grasp – critical because it is where the seminal ideas and intentions that guide the design are laid down and tested and hard to grasp because students are trying to give expression to emerging thoughts and concepts in an attempt to give them a physical form. Most architects would agree that being creative is by no means easy and it follows that teaching students how to approach their design work in a creative way is similarly difficult.³⁹⁵

³⁹⁵ Ibid

Visual literacy and visual communication

What is deduced from the following text: Verbal literacy is considered an essential skill in an industrialized, technological-based society. Most of us have learned how to take verbal or written notes. We learn to understand others and express ourselves in written language usually by the completion of high school. However, understanding and expressing visual messages is a skill that remains poorly developed. Visual literacy includes two skills: visual acuity and visual expression. Visual acuity is an intense ability to see information or multiple messages in one's environment with clarity and accuracy. Visual expression encompasses the capacity to initiate visual communication. This ability is prominently showcased by individuals such as artists, designers, choreographers, photographers, and architects, but it holds significance for everyone. While visual acuity pertains to the reception of visual messages, visual expression revolves around the transmission of such messages. Much like listening and speaking are interconnected yet distinct skills, the act of seeing and the act of expressing are interdependent but inherently separate. Seeing serves as an essential precursor to visual expression, and achieving visual literacy necessitates a deliberate development of both. Given that most individuals may not initially possess these proficiencies, they stand as both an objective and a valuable outcome of engaging in visual notetaking.

This procedure, on the other hand, leads to the development of spatial visualization and imagination in such a way that observing and expressing the mind at the same time enables long-term memory to be involved, and in this way, the observations become mental identifiers that were previously mentioned at the beginning of this chapter.

In *A Primer of Visual Literacy*, D. A. Dondis identifies three levels of visual messages. They are representation, abstraction, and symbolism. Representation seeks to accurately record what we can actually see or experience. Representative sketches function much as do photographs, but they are, of necessity, more selective. The photograph accurately duplicates all that can be seen from a specific vantage point; the representative sketch describes those parts of a view which are of special interest to the person sketching. While a photograph is a reproduction of what is visible, the sketch is a record of how one sees that which is visible. Producing sketches and "reading" other people's sketches provide both a view of the subject and an education about a variety of ways of seeing. In visual communication, abstraction can be seen as a "simplification toward a more intense and distilled meaning."

We are literally bombarded with visual information at any given moment; in order to function in the world, we must create some order and meaning out of what we see. This is basically the process of abstraction called

perception. If we visit someone's house, the whole facade may be visible, but we notice the front walk and front door because they are important to our intention to enter the house. While perception usually operates on a subconscious, reflex level, abstraction can be brought to a conscious, purposeful level when incorporated into a visual message. Abstractions may place emphasis on certain parts of a representational sketch, such as the pattern of windows in a house, or they may be illustrations of that which cannot be seen, such as the probable structural system of the house. Symbolism is also a form of simplification of visual messages, but it employs a surrogate or substitute image for what can actually be seen. In place of a representational drawing of a specific house, we can use a symbol that most people accept as standing for the general concept of "house." The advantage of using such a symbol is that it can be quickly drawn and miniaturized so that many symbols can be shown in the same space it takes to draw one house. These symbols can be arranged in an abstract "environment" in which the sequence, position, or grouping of the symbols conveys additional information. A variety of examples of representational, abstract, and symbolic drawings can be found in other books. A partial list of sources is included in the Bibliography for this book, and specific examples of drawing techniques are included in the Appendix. Here are some tips and critical points that can be applied as educational material in the primary courses.

Visual Notetaking as a Cognitive Tool:

Use visual notetaking as a method for engaging with and processing information. Translate verbal or written content into visual representations to enhance comprehension.

Experiment with representing concepts through sketches, diagrams, and symbols, fostering a deeper understanding of the subject matter.

Spatial Visualization for Creative Thinking:

Develop spatial visualization skills by observing and expressing ideas simultaneously. This can stimulate creative thinking and problem-solving.

Practice mental imagery to envision spatial relationships and explore possibilities before implementing ideas in a tangible form.

Abstraction for Simplification:

Embrace abstraction as a thinking tool to simplify complex information. Identify key elements or patterns in a concept and represent them in a distilled form.

Apply abstraction consciously to organize thoughts, break down information, and focus on essential aspects, promoting clarity in thinking.

Symbolic Thinking for Conceptualization:

Incorporate symbolic representations when conceptualizing ideas. Use symbols to represent overarching concepts, making it easier to convey and remember information.

Experiment with creating and interpreting symbolic representations to explore various perspectives and enhance symbolic thinking.

Enhancing Memory through Visualization:

Leverage the connection between observation, expression, and memory. Engage in activities that involve simultaneous observation and expression to enhance long-term memory involvement.

Use visual identifiers, such as sketches or symbols, to anchor observations in memory, creating mental cues for recalling information.

Strategic Use of Visual Communication:

Integrate visual communication techniques consciously in conveying messages. Consider the interplay between representation, abstraction, and symbolism to enhance the effectiveness of visual messages.

Explore how the sequence, position, or grouping of visual elements can convey additional information and meaning in a structured manner.

Iterative Sketching for Ideation:

Adopt sketching as an iterative thinking process. Generate and refine ideas through successive sketches, allowing visual representations to evolve and adapt during the ideation phase.

Flexible Thinking

Based on James Adams³⁹⁶ written, entitled *Conceptual Blockbusting* in which he pointed out that often our creativity is hampered by mental blocks. Five Habit or training in just one mode of thinking can cause us to ignore the many other ways to look at a problem. To fully harness the potential of our minds, it's essential to understand different approaches to thinking and methods for changing how we perceive things. One effective technique for promoting flexible thinking is taking obscure sketches, which can offer visual cues or triggers that alter our perspective and lead us to explore new ideas.

For example, consider the act of transforming a conventional plan drawing into an abstract geometric pattern. This shift in representation can reveal previously unnoticed connections between different components and

³⁹⁶ Adams, J. L. (2019). *Conceptual Blockbusting: A Guide to Better Ideas* (5th ed.).

potentially unveil entirely novel functionalities. On the other hand, a loosely drawn diagrammatic form concept might reveal multiple alternative ways to interpret spatial enclosures. It's important to actively pursue these new insights and explore their consequences in order to make the most of these changes in our thought processes. Fast sketching can serve as a tool for expanding our thinking and exploring fresh, innovative perspectives.

Students' perceptions

To begin to understand something of student conceptions of, and their relationships with drawing, a pilot questionnaire has been put to groups of students at LMU on design of environments courses Architecture, BAHons (Arch.), Landscape Architecture, BAHons (BALA) and Garden Art and Design, BAHons (GAD) at levels 1 and 2 full time. Initial findings based on a sample of 90 students (self-selecting by virtue of the fact that they were the ones who turned up to scheduled teaching on given days) suggest that drawing is certainly on the students' agenda. It must be stressed that this questionnaire is intended as a pilot to suggest possible areas of further study and these results are regarded as no more than indicative³⁹⁷

Although many students enjoy free-hand drawing and consider it a type of artistic skill, they simultaneously think that computer software obviates the need to develop drawing skills. Due to the fact that architectural designing is actually not possible without "Thinking Hand," most students don't realize that learning free-hand drawing in their current course makes them feel more creative.

Having a statistical questionnaire obviously gives us no idea of the practical aspect or effect of free-hand drawing abilities of students in their design progress. Still, we can begin to see whether sketching is viewed as important by these students or not. In fact their conception of design could be being severely restricted by the primacy they give to drawing. Exploring effective curricula practices based on My own experience with students from several institutions on design of environments courses across the globe is that there is often a hunger for Free-hand drawing instruction, particularly for sketching. Students appear to consider there are good reasons to be able sketch well, whether they don't know what those reasons behind, and after teaching sketching for fifteen years and using drawing as the medium of architectural design, I still feel there is a lot more to it than there seems.

Graphic thinking in the design process

As we mentioned in the second chapter, Design involves many different activities. However, most current Computer Aided Design tools assume a single task – tool approach. We propose that a useful design environment

³⁹⁷ Hare, R. The act of sketching in learning and teaching the design of environments: A total skill for complex expression, 236.

should provide a variety of tools to support various design activities. Design studies researchers identify different phases of design during which different kinds of activities take place. For example, Sanoff describes design as transforming information through stages of analysis, synthesis and evaluation (Sanoff 1977).³⁹⁸ Markus describes design as decision making through problem identification, finding relationships between issues, model buildings and optimization (Markus 1969).³⁹⁹ This notion of design involving many different activities is shared among researchers and designers. In interviews with four professional architects (Do and Zacherl 1993), they found that though personal styles vary, designers use diagrams and drawings to develop ideas, employ different tools, conduct case studies, and perform various analyses. Based on design studies (Akin 1984) and interviews (Do 1993b), he observed that the early design process involves three major activities, which we call Organization, Ideation and Fabrication.

-First, Organization: deals with abstract manipulation of spatial requirements as derived from the program brief or problem analysis. During Organization, designers use cut-out paper cards or bubble diagrams to explore functional arrangements. They trace over bubbles or move them around to find design alternatives. Designers explore adjacency, circulation, and approximate construction costs. The drawings of this activity deal mostly with “function.”

-Second, Ideation: in Ideation designers sketch to express and explore formal or analogical thoughts. For example, in the interviews designers mentioned that at certain times they would find ideas and visual references to incorporate into their design. They are open to ideas that lead to physical forms, and concerned with form configurations and shape manipulations. In Ideation, they use sketches to explore and understand formal aspects. Drawings in this activity deal mostly with form.

-The third activity is Fabrication. When designers refine design solutions, they make more structured drawings. For example, grids are used to guide column or wall locations in the floor plan and isometric sketches are used to depict three-dimensional massing. In this activity, design drawings are not as diagrammatic or sketchy as in the first two phases, and can easily be hard lined. In Fabrication activities, designers make harder line drawings in this stage to help prepare for constructing the future working drawing.⁴⁰⁰

In the couple of decades since the first publication of his book, Paul Laseo has been an extraordinary expansion in the use of visual thinking. This is

³⁹⁸ Sanoff, H. (1977). *Methods of Architectural Programming*. Dowden, Hutchinson & Ross, Inc.

³⁹⁹ Markus, T. A. (1969). The Role of Building Performance Measurement and Appraisal in Design Method.

⁴⁰⁰ Do, E. Y.-L. (1996). The Right Tool at the Right Time -- drawing as an interface to knowledge based design aids. In F. Ozel & P. McIntosh (Eds.), *Proceedings of the 1996 National Conference, Association for Computer Aided Design in Architecture (ACADIA 96)* (pp. 191-199). University of Arizona, Tucson.

partly due to a growing interest in visual thinking in a number of fields other than design, including business, medical, legal, and literature. In this chapter we turn to the use of visual thinking for recording information from a diverse range of investigations including research and design. It is largely believe to demonstrate through examples the extended usefulness of sketching and free-hand skills gained through certain practices, and to show how the practice of visual thinking encourages a dialectical interaction between sketching and thinking, a process that is important to many other tasks.

Visual thinking and the design process clearly have bonded to each other in a way that the practice of visual thinking helps designers to form relationships between images and the embodiment surrounding around them. Additionally, Visual Thinking records represent observations in the form of a visual archive and students use this archive to move from speculation to physical concept proposals for future tasks. Moreover, the regular practice of visual thinking creates a lexicon of ideas about design and its relationship to form and space. These imaginary activities form a basis for the retrieval of inner design notions and concepts.

Interviews with designers reveal a capacity to recall many details of activities from the time a sketch was first made. It is not unusual for designers to start a project by making sketches of fairly simple patterns as a way to prod their memories, then build upon those sketches with additional drawings, thereby exploring the possibilities inherent in the project. It is this cyclical process of sketching, observation, and rethinking that form the basis of creative thinking for a designer.⁴⁰¹

One of the central insights offered to cognitive science by artificial intelligence research is the importance of problem representation when creating effective implementations of intelligent behavior. This is mirrored in experimental psychology by studies demonstrating that the form in which a problem is presented can make structurally identical problems either very easy or very difficult to solve (Hayes and Simon 1977). Diagrams are an interesting artefact for this reason - their purpose is purely to modify the representation of problem situations. Furthermore, diagrams are not easily amenable to the methods that have been used to investigate other varieties of human markings. They are not linguistic in the way that speech and written text tend to be. Neither are they pictorial representations. This means that neither linguistic nor perceptual theories are sufficient to completely explain their advantages and applications.⁴⁰²

⁴⁰¹ Laseo, P. Visual notes.page 141

⁴⁰² Blackwell, A. F. (2001). Thinking with Diagrams. Artificial Intelligence Review, 15(1-3). © 2001 Kluwer Academic Publishers

7-5. Sketch a creative tool to Unlock imagination

During the laboratory exercise, some important questions were sequentially asked by participants. **What exactly is creativity?** How can we achieve creativity? How can we recognize that our design or production is creative? How can a concept that holds such immense importance in human thinking, plays a pivotal role in human history, and is cherished by almost everyone, remain so elusive? Creativity has been meticulously examined, analyzed, and scrutinized. Educators treat it as if it were a tangible entity, an achievement to strive for, much like mastering mathematical divisions or mastering a musical instrument. Cognitive scientists, captivated by the enigma of creativity, have generated a plethora of insights and fragments, offering tantalizing glimpses and clues. Yet, they have not managed to assemble these pieces coherently. Up to this point, there is still no universally accepted definition of creativity, no consensus on what it truly represents, how it can be acquired, how it can be taught, or whether it can, in fact, be cultivated or instructed. Even the dictionary deals with this complexity by offering a solitary cryptic phrase: "creativity: the ability to create," while many encyclopedias evade the matter altogether, although they devote an extensive column of small print to another admittedly elusive concept, "intelligence." Nonetheless, the subject of creativity has given rise to a multitude of books as enthusiasts persistently pursue a notion that paradoxically seems to recede as they advance.

Based on Betty Edwards⁴⁰³ thankfully, this path is, at the very least, adorned with signposts to lead the way. Letters and personal records, journals, eyewitness accounts, descriptions, and biographies are in abundance, gathered from creative individuals and their biographers over past centuries. Like clues in a treasure hunt, these notations spur the quest, even though (as in any good treasure hunt) they often seem illogical and indeed frequently contradict each other to confuse the searcher. Recurring themes and ideas in the notes, however, do reveal some hazy outlines of the creative process. The picture looks like this: the creative individual, whose mind is stored with impressions, is caught up with an idea or a problem that defies solution despite prolonged study. A period of uneasiness or distress often ensues. Suddenly, without conscious volition, the mind is focused and a moment of insight occurs, often reported to be a profoundly moving experience. The individual is subsequently thrown into a period of concentrated thought (or work) during which the insight is fixed into some tangible form, unfolding, as it were, into the form it was intended to possess from the moment of conception. This basic description of the nature of the creative process has been around since antiquity. The story of Archimedes' sudden insight, while he was sitting in the bathtub mulling over the problem

⁴⁰³ Edwards, B. (1987). *Drawing on the Artist Within.*, 17.

of how to determine the relative quantities of gold and silver in the king's crown, has put his exclamation "Eureka!" (I have found it!) Permanently into the language as the "Ah-Ha!" of creativity.⁴⁰⁴

When working with groups of students without prior artistic training, who have transitioned from mathematics courses to architecture, I've observed that anyone with a rational mind can acquire the ability to use freehand sketching as a means to convey ideas and thoughts. The likelihood of achieving this skill is akin to learning how to drive; it primarily involves acquiring fundamental perceptual abilities—those unique ways of observing essential for driving. I assert that anyone can develop adequate perceptual skills to create an accurate representation of something they observe in the real world. Once these fundamental perceptual skills are acquired, their application can be as diverse as the subsequent use of fundamental language and arithmetic skills. A few individuals may choose to pursue art and eventually become artists, much like some choose to specialize in science or sport, eventually becoming scientists or athletes. Nevertheless, nearly everyone can harness perceptual skills, similar to science and sports skills, to enhance their thinking abilities.

A paradox: Teachers fear that teaching drawing skills will harm or hinder a child's "creativity in art"—yet the criterion for selecting children who are "gifted in art" is usually ability to draw realistically. A further paradox: Picasso, the most prolifically creative artist of our century, was systematically trained in classical drawing skills to the point that, as has been said, he "could draw like an angel." And even a further paradox: all the major artists in the history of art had learned how to draw without, apparently, any damage to their creativity. Only in this century—specifically, post-Dewey and post-Gestalt psychology—have fears of "damage to creativity" prevented instruction in drawing.

Educator Victor Lowenfeld shared a belief with many scholars that creativity itself is a common human trait, often existing as a potential ability awaiting release into outward expressions of latent talents. Lowenfeld cautioned educators: "We have to regard it as our sacred responsibility to unfold and develop each individual's creative ability as dim as the spark may be and kindle it to whatever flame it may conceivably develop."⁴⁰⁵

To go a step further, Edwards propose that perceptual skills are deeply involved in the five stages of the creative process. I also propose that visual, perceptual skills are enhanced by training, just as the verbal, analytic skills benefit by education. And finally, I propose that learning to see and draw is a very efficient way to train the visual system, just as learning to read and

⁴⁰⁴ Edwards, B. (1987). *Drawing on the Artist Within*, 17.

⁴⁰⁵ Edwards, B. (1987). *Drawing on the Artist Within*. [Publisher if available]. (Quotation from: Lowenfeld, V. (1961). *Basic Aspects of Creative Thinking*.)

write can efficiently train the verbal system. That is not to say that the visual system is better, morally or otherwise, than the verbal system. But the two systems are different. And when trained as equal partners, one mode of thinking enhances the other, and together the two modes can release human creativity.⁴⁰⁶

Drawing, Creativity, and Visual Thinking

An important aspect of teaching creativity in architecture is the development of a creative view towards things, and this is not only about architecture and design but also about many issues of human life. The specialized view of creative education and creative thinking is a psychological view and is outside the area of expertise of architects and architecture professors. It seems that there is a need for workshops to foster creativity or to implement a group collaboration of architects and some psychology experts in developing a series of creative exercises can be effective for improving the creative thinking of architecture students, especially students who were more involved with analytical thinking than intuition. . Students who have come to architecture from math majors. **Edward do Bono**,⁴⁰⁷ the author of the book "*The Use of Lateral Thinking* (1967) " and the creator of "Lateral Thinking" has done a lot of research in this field, the results of which can be helpful in creating creative approaches of architecture students towards creative problem solving methods. Sketching and designing the use of visual thinking tools is one of these capabilities, as Betty Edward has done such an experiment in a similar educational process. In his own words, in the process, she has produced significant data.

She has been a professor of education and psychology for over 20 years. At the start of her class, they would discuss assignments in the course syllabus—one of which was to keep a sketchbook of creative ideas throughout the semester. She continued: Inevitably, some of the students would say, "But I can't draw." I would reply, "But everyone can doodle!" And the sketchbooks were to be used for simple sketching—or doodling—and writing about creative ideas and imaginings.

Drawing from imagination is the process of creating an image in your mind and then drawing it on paper. Here are some key points that can be deduct about the relationship between sketch and imagination:

⁴⁰⁶ Edwards, B. (1987). *Drawing on the Artist Within*, 17

⁴⁰⁷ **Edward Charles Francis Publius de Bono** (19 May 1933 – 9 June 2021) was a Maltese physician, psychologist, author, inventor and broadcaster. He originated the term lateral thinking, wrote many books on thinking including *Six Thinking Hats*, and was a proponent of the teaching of thinking as a subject in schools

Imagination is essential for sketching: Imagination is the ability to create images in your mind, and it is essential for sketching because it allows you to visualize what you want to draw before you put pencil to paper.

Drawing from imagination is different from drawing from life: Drawing from imagination is different from drawing from life because you are not looking at a reference image. Instead, you are creating an image in your mind and then drawing it on paper.

Drawing from imagination requires practice: Drawing from imagination can be challenging because the image you are trying to create is not in front of you. However, with practice, you can improve your ability to visualize images in your mind and then draw them on paper.

Drawing from imagination involves mixing elements of reality: Imagination is the ability to mix elements of reality to create new versions of it. When drawing from imagination, you are using your knowledge of the world around you to create something new.

Drawing from imagination requires knowledge of basic shapes and perspective: To draw from imagination, you need to have a good understanding of basic shapes and perspective. This knowledge allows you to create images in your mind that are accurate and realistic.

Drawing from imagination can be combined with drawing from observation: For example, you can use a reference image as a starting point and then add your own creative elements to create something new.

Imagination is essential for sketching, and drawing from imagination requires practice, knowledge of basic shapes and perspective, and the ability to mix elements of reality to create something new.

Providing a direct answer that how can sketching help develop imagination it is worth mentioning that Sketching can help develop imagination in several ways as follows:

Stretching creativity: Drawing from imagination gives you a chance to stretch your creativity and come up with new ideas. It allows you to go beyond what is and imagine what might be.

Boosting visual thinking skills: Sketching from imagination can help boost your visual thinking skills. It allows you to visualize images in your mind and then put them on paper, which can help improve your ability to think visually.

Training observation skills: Observation skills play a big role in imagination drawing and becoming a better artist. By carefully observing the world around you, you can build a library of visual references in your mind that you can use when sketching from imagination.

Layering information: When sketching from imagination, it can be helpful to use the principle of layering new information on top of each other. This can help you refine your drawing and optimize it as you go

Drawing designs: Drawing designs for what you want to build can help develop your imagination. It allows you to imagine what something could look like and then put it on paper.

In summary, sketching can help develop imagination by stretching creativity, boosting visual thinking skills, training observation skills, layering information, and drawing designs.

Imagination is traditionally understood as a universal creative ability that allows the production of new images, combinations, and conjunctions.⁴⁰⁸ However, its cognitive function is mentioned in research and works less frequently.⁴⁰⁹ Nevertheless, the role of imagination in cognitive activity is of high significance, as by its virtue, we can see the connections and laws of the world around us through images.⁴¹⁰

In the scope of various approaches, different functions and definitions of imagination were developed.⁴¹¹ For example, Gestalt psychology regards imagination as a confrontation of an innate ability to perceive the structures of the phenomenal field with the real objects.⁴¹² This confrontation provides the work of such functions of imagination as the solution of cognitive problems, the visualization of ideas, and the search for (and finding) creative answers. Psychoanalysis considers imagination as a tool for building imaginary constructs that release internal tension, which performs mainly a passive protective function (transfiguration or substitution of painful memories, for example).⁴¹³ In the earliest stages of his work on the theory of cognitive development, Piaget understood imagination to represent our reality, associated with subjectivism and distortion of the image of the objective world.⁴¹⁴ Later, this approach switched to the function of imagination as using an idea for anticipating and forecasting the situation dynamics or the behavior of objects.⁴¹⁵ In its turn, cultural-historical psychology understands imagination differently.⁴¹⁶ Vygotsky emphasized that the imaginary images come from the world of adults [15]. Therefore, the development of imagination is related to speech and is taking

⁴⁰⁸ Harris, P. L. (2000). *The Work of the Imagination*. Blackwell Publishing..

⁴⁰⁹ Beck, S. R., & Riggs, K. J. (2014). Developing thoughts about what might have been. *Child Development Perspectives*, 8, 175–179.

⁴¹⁰ Harris, P. L. (2021). Early Constraints on the Imagination: The Realism of Young Children. *Child Development*, 92, 466–483.

⁴¹¹ Dyachenko, O. M. (2008). Development of the Preschooler's Imagination: Method. A Guide for Educators and Parents. *Mosaic-Synthesis*. (In Russian).

⁴¹² Arnheim, R. (1974). *Art and Visual Perception: A Psychology of the Creative Eye*. University of California Press.

⁴¹³ Freud, A. (2018). *The Ego and the Mechanisms of Defence*. Routledge.

⁴¹⁴ Piaget, J. (2013). *Mental Imagery in the Child: Selected Works (Vol. 6)*. Routledge.

⁴¹⁵ Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. *Human Development*, 15, 1–12.

⁴¹⁶ Archambault, A., & Venet, M. (2007). Le développement de l'imagination selon Piaget et Vygotsky: D'un acte spontané à une activité consciente. *Revue Des Sciences De L'éducation*, 33, 5–24..

place within the process of communication with others. From this perspective, the most outstanding function of imagination is the symbolic one. It allows the reflection of reality through sign activity and symbolic forms (i.e., speech, writing, playing, and drawing).⁴¹⁷ The communicative aspect of imagination is no less important because, in this case, imagination is connected with creativity and is directed towards people. Last but not least is the anticipating function: imagination contains the idea and the representation of the goal of one's actions. In his works on the psychology of art, Vygotsky concluded that our imagination works the most productively under the condition of "unity of affect and intelligence."⁴¹⁸ This means that including all personal experiences is required (intellectual, emotional, and behavioral)⁴¹⁹

Two types of imagination can be distinguished: passive (daydreaming, dreams) and active (creative production of images).⁴²⁰ The latter is related to a person's productive, creative activity and implies the novelty and originality of the new images. This type of imagination is highly required under uncertainty and for the solution of open-ended tasks.⁴²¹ As may be supposed from their name, these tasks usually do not have ready solutions and allow a person to respond creatively.⁴²² Nowadays, an extensive range of personal and professional challenges can be categorized as open-ended.⁴²³ Uncertainty and openness related to their solving require imagination's active involvement.⁴²⁴ However, in many countries, the development of imagination and creativity is not set as a separate goal within the general education system⁴²⁵⁴²⁶

Imagination is the quintessential core of learning, a force that propels education into uncharted realms of possibility. It serves as the wellspring of creativity and innovation, igniting curiosity and pushing the boundaries of knowledge. Imagination empowers us to visualize, conceptualize, and dream, encouraging us to envision a world not as it is but as it could be. Throughout history, transformative discoveries and inventions have sprung

⁴¹⁷ Fleer, M. (2011). 'Conceptual Play': Foregrounding imagination and cognition during concept formation in early years education. *Contemporary Issues in Early Childhood*, 12, 224–240.

⁴¹⁸ Vygotsky, L. S. (1972). The psychology of art. *Journal of Aesthetic and Art Criticism*, 30, 564–566

⁴¹⁹ Vygotsky, L. S. (1987). The problem of mental retardation (a tentative working hypothesis). *Soviet Psychology*, 26, 78–85.

⁴²⁰ D'yachenko, O. M., & Kirillova, A. I. (1980). Some features of the development of imagination in preschool children. *Voprosy Psichologii*, 2, 107–114.

⁴²¹ Davies, J., Atance, C., & Martin-Ordas, G. (2011). A Framework and Open Questions on Imagination in Adults and Children. *Imagination, Cognition and Personality*, 31, 143–157.

⁴²² Ward, T. B., Patterson, M. J., & Sifonis, C. M. (2004). The role of specificity and abstraction in creative idea generation. *Creativity Research Journal*, 16, 1–9.

⁴²³ Suarta, I. M., Suwintana, I. K., Sudhana, I. F. P., & Hariyanti, N. K. D. (2017). Employability skills required by the 21st-century workplace: A literature review of labour market demand. *Advances in Social Science, Education and Humanities Research*, 102, 337–342.

⁴²⁴ Purcell, A. T., & Gero, J. S. (1996). Design and other types of fixation. *Design Studies*, 17, 363–383.

⁴²⁵ Barbot, B. (2016). Perspectives on creativity development. *New Directions for Child and Adolescent Development*, 151, 27–39.

⁴²⁶ Veraksa, N., Gavirola, M., & Veraksa, A. (Year). "Complete the Drawing!": The Relationship between Imagination and Executive Functions in Children.

from the fertile soil of imagination, from scientific breakthroughs to artistic masterpieces.

Teaching how to use the ability of imagination inspires students to explore, think critically, and seek understanding. It is the driving force behind the desire to learn, compelling us to turn our imaginative visions into reality. Imagination is not merely a facet of learning; it is the nucleus around which knowledge orbits, the compass guiding the learning process, and the key to unlocking human potential.

Lev Vygotsky—an early and eminent 20th-century developmental psychologist—considered imagination as essential for all learning and development. He described two kinds of cognitive behaviors: those that are reproductive of our past experiences, which lack a creative quality, and those that he called imaginative. According to Vygotsky, imaginative behavior is based on the brain's ability to draw from, combine, and recombine elements from our previous experiences, generating ideas for something new. He said:

"The brain is not only the organ that stores and retrieves our previous experience; it is also the organ that combines and creatively reworks elements of this past experience and uses them to generate new propositions and new behavior. . . . This creative activity, based on the ability of our brain to combine elements, is called imagination or fantasy in psychology."

Imagination realm—Where Creativity and Visual Thinking Meet

The "Imagination Realm" is a mystical domain where creativity and visual thinking converge to shape the world of an artist's ingenuity. This enchanting space within the minds is where the most remarkable innovations and artistic expressions are born.

Álvaro Siza, a distinguished Portuguese architect, places great importance on the intricate relationship between sketches and imagination within the architectural design process. His ideas reflect a profound understanding of how sketches serve as a vital conduit for creative expression and innovation in architecture. Siza asserts that sketches are not merely tools for representation but extensions of the architect's imagination (Siza, 1999).⁴²⁷ They provide a tangible means to translate abstract ideas into concrete, visual forms. In this sense, sketches function as a medium through which the architect can give life to their imaginative visions, transforming them from intangible concepts into tangible design proposals.

⁴²⁷ Jodidio, P. (1999). Álvaro Siza. Taschen.

In the early design stages, sketches allow architects to explore various possibilities and solutions. Sketching allows for a dynamic and spontaneous interaction with the design process, enabling architects to test and refine their concepts. It is in these initial sketches that the seeds of innovative design solutions are sown. Siza perceives sketches as a narrative of the design process, documenting its evolution over time (Siza, 1999). Each sketch becomes a chapter in the story of a project, reflecting the architect's evolving ideas, decisions, and refinements. These sketches serve as a record of the architect's creative journey and provide valuable insights into the design's development. In the interview with Dawne McCance⁴²⁸ he asserted that: *there are moments when I have to be alone to consider some things*

*I have to be able to walk through the whole building mentally without looking at the drawings, you know? I have to be able to sit and imagine walking through the building, going down each hall, entering the bathroom, washing my hands, going to the kitchen if it is a house. And if it is a public building, this can indeed be difficult. But I make every effort to study the project as it develops. Only when you can walk mentally through the building can you design the final details and can you feel the atmosphere of that building and what it really means. For this, I need moments to concentrate by myself, alone.*⁴²⁹

A key feature of sketching in Siza's approach is its flexibility (Siza, 1999).⁴³⁰ Sketches can be easily modified, erased, or expanded upon, reflecting the fluid and adaptive nature of architectural design. This adaptability allows architects to respond to changing project requirements and evolving design insights. In Siza's view, sketches serve as a means to bridge the gap between conceptual thinking and practical realization in architecture (Siza, 1999).⁴³¹ Sketches become a shared language that fosters a common understanding of the design's core concepts. Siza places special significance on hand drawing as a form of craftsmanship in architectural design (Siza, 1999).⁴³² Hand-drawn sketches offer a personal and tactile connection between the architect and the design. This artisanal approach enriches the creative process and infuses it with a sense of the architect's presence.

Álvaro Siza's insights into the interplay between sketches and imagination in the design process underscore the pivotal role of sketches and illuminate

⁴²⁸ Interview with Alvaro Siza. (2002, December). Mosaic: An Interdisciplinary Critical Journal, 35(4), 1-16. Special issue: Literature & Architecture. University of Manitoba.

⁴²⁹ Ibid

⁴³⁰ Jodidio, P. (1999). Alvaro Siza. Taschen.

⁴³¹ Ibid

⁴³² Jodidio, P. (1999). Álvaro Siza. Taschen.

the profound value of sketching as a fundamental element in the architect's creative toolkit.

Creativity is the lifeblood of the imagination realm, infusing it with endless possibilities. It's the ability to connect seemingly unrelated ideas, to recombine elements in novel ways, and to envision something that has never existed before. In this realm, the mundane is transformed into the extraordinary, and the impossible becomes achievable. Creativity thrives in an atmosphere where it is free to roam, unrestricted by the confines of convention. Visual thinking is the language of the imagination realm. It's the art of using mental imagery to solve problems, conceptualize complex ideas, and communicate in ways that transcend words. Through visual thinking, we can sketch the blueprint of a groundbreaking invention, chart the course of a compelling story, or design a breathtaking piece of art. It bridges the gap between the abstract and the concrete, enabling us to give form to the intangible.

The imagination realm is the meeting point of these forces, where creative ideas take shape through visual representation. It's where inventors design their innovations, writers craft vivid worlds, and artists bring their visions to life. The imagination realm is a boundless playground where imagination and creativity intersect to generate the remarkable.

In education, cultivating the imagination realm is paramount. Encouraging students to explore this realm fosters critical thinking, problem-solving skills, and the ability to see connections where others might not. It stimulates a passion for learning and a desire to transform imaginative ideas into tangible realities. Nurturing the imagination realm is key to unleashing the full potential of human creativity and visual thinking, opening doors to innovation and beauty that enrich our world.

7-7. Sketch as a means for achieving Intuition

Another research outcome is the relevancy of sketching and free-hand drawing with intuition. Sketching, an age-old practice, is a paramount instrument that has transcended time, employed by artists and architects to cultivate and convey their intuitive insights. It operates as a conduit between the ethereal realms of creative imagination and the corporeal world, serving as an indispensable tool for ideation, a deeper comprehension of form and space, and the crystallization of abstract concepts.

In the realm of art, sketching embodies a timeless tradition that has its roots in the artistic genius of luminaries such as Leonardo da Vinci and Michelangelo. These luminaries utilized sketches as a means to externalize

their innermost creative visions (Dorner, 2019).⁴³³ It is a practice that provides artists with a direct and unfiltered connection between their cognitive processes and the canvas, enabling the spontaneous flow of ideas. The act of sketching encourages experimentation with a plethora of compositions, shapes, and lines, thereby birthing unexpected, innovative, and emotionally charged masterpieces. These preliminary sketches function as a visual diary of an artist's intellectual odyssey, unveiling the raw, unpolished, and genuine nature of their artistic voyage (Sullivan, 2005).⁴³⁴

Likewise, within the sphere of architecture, sketching plays an indispensable role in nurturing intuition and design innovation. Architects, from Frank Lloyd Wright to Zaha Hadid, have historically employed sketches to transform conceptual abstractions into tangible blueprints (Pallasmaa, 2009).⁴³⁵ Sketching is the medium through which architects explore a multitude of spatial arrangements, building forms, and contextual relationships. Through this tactile exploration, architects can tap into their innate intuition, allowing them to make informed design decisions that transcend mere mathematical computations or technical constraints. The outcome is a synthesis of function and aesthetics, ensuring that architectural designs resonate with the human experience (Schön, 1983).⁴³⁶

Furthermore, sketching accentuates the intrinsic relationship between art and architecture by fostering an appreciation of the built and natural environment. The act of sketching compels artists and architects to actively engage with their surroundings, capturing the sensory nuances of the environment beyond the visual realm. The resultant sketches encompass auditory, tactile, and even olfactory dimensions of a space, further enriching the design process (Groat & Wang, 2002).⁴³⁷

Sketching stands as an indispensable and enduring means of achieving intuition in both the domains of art and architecture. It serves as a vehicle for the unbridled expression of creative concepts, enabling artists and architects to tap into their innermost musings and transmute them into tangible forms. This cherished practice is imbued with the legacy of countless visionaries who have relied on it to breathe life into their intuitive visions (Davies, 2015).⁴³⁸ Consequently, sketching continues to occupy a pivotal role in the repertoire of artists and architects, manifesting as a testament to its enduring relevance and timeless significance.⁴³⁹

⁴³³ Dorner, J. (2019). *Drawing the Line: The Early Work of Agnes Martin*. MIT Press.

⁴³⁴ Sullivan, G. (2005). *Art Practice as Research: Inquiry in Visual Arts*. Sage Publications.

⁴³⁵ Pallasmaa, J. (2009). *The Thinking Hand: Existential and Embodied Wisdom in Architecture*. John Wiley & Sons.

⁴³⁶ Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Basic Books.

⁴³⁷ Groat, L. N., & Wang, D. (2002). *Architectural Research Methods*. John Wiley & Sons.

⁴³⁸ Davies, D. (2015). *Art as Performance*. John Wiley & Sons.

⁴³⁹ *ibid*

Robert S. Ryf believe that the use of the parallel visual language in thinking—particularly the kind of thinking that results in First Insight, the initial stage of the creative process. The analog drawings demonstrate that this visual language is there in the brain, accessible under certain conditions, and ready to be used right at this moment. Since creativity depends on the ability to perceive new solutions to old problems, or on new combinations of things or ideas already existing, or on seeing things in new ways, the first step in the process is to ponder a problem—to ask a question, to present an insight to the brain in a form that makes thought visible, for the eyes to see.⁴⁴⁰

The American psychologist J. W. Getzels said in a footnote to an address on “The Psychology of Creativity” that he had found the sentences below “... under the name Gertrude Stein in a notebook I kept years ago; I no longer know where the sentences are from, but they must have pleased me, as they still do. “ ‘The whole question of questions and not answers is very interesting. Suppose no one asked a question. What would the answer be?’ ”⁴⁴¹

Illustrating the nature of a subject that is not yet clear and uncertain for the architect is a complicated task. But drawings can also not refer directly to anything and be as vague and uncertain as thoughts. Since while drawing, an image is produced that corresponds to our momentary feelings, rereading it can help clarify part of our vague thoughts and facilitate the formation of a formal structure of what might exist. Here, imagination is the power to visualize realities or unrealities, to reach the inner interpretive apparatus and the source of mental inspiration. The source of imagination is definitely the human mind, and its main data comes from the assumptions that have arisen in life experiences; it is free from the constraints of logic and rational arguments and can imagine the impossible. This internal human force produces data from the visual and image mind. He portrays reality in his own way and approves it. Its descriptive tool is drawing. Thus, drawing enables architects to have direct access to their imaginative information and thus tap into their intuitive origins.

Additionally, as Betty Edwards’s remarked, in the creative process, beauty, and the esthetic response to beauty, are deeply involved. Saint Thomas Aquinas, the Italian philosopher of the thirteenth century, said that three things are needed if beauty is to be achieved: wholeness, harmony, and radiance. Aquinas linked beauty with truth, and held that faith and reason constitute two harmonious realms in which the truths of the heart (faith) complement those of the mind (reason). The drawing you are about to do can be thought of, then, as having an esthetic goal: to be a work, no matter

⁴⁴⁰ Ryf, R. S. (1962). *A New Approach to Joyce*.

⁴⁴¹ Edwards, B. (Year). *Drawing on the Artist Within*. Simon and Schuster. (Quotation from the Carnegie Symposium on Creativity, 1980).

how slight, that comes from the heart and therefore presents a beautiful truth which can later be comprehended in the realm of reason.⁴⁴²

Vinod Goel's definition of basic intuition is that there is a close relationship between the structure of our thoughts and the structure of our symbol systems. If there is a system of internal representation a language of thought then thoughts with certain properties will require symbol systems with certain properties, and, more strongly, the properties of symbol systems will affect the properties of thoughts. As the structure of our thoughts changes, the structure of our symbol systems will need to change. Conversely, as the structure of our symbol systems change, the structure of our thoughts will change. Symbol systems are not passive/transparent structures on which to hang arbitrary concepts. They can vary quite radically in their structural properties. These properties, in turn, constrain and filter the character of our thoughts and concepts. There are no reasons to believe that there could be a privileged symbol system capable of expressing every possible human thought content, and many reasons to doubt it. The most obvious refutation of the prevailing claim that a discursive symbol system with the CTM-properties is both necessary and sufficient to encode all human thought contents is to assume that it is true and examine the absurd conclusions that follow. For example, if it were true, then we should, for example, be able to substitute a music critic's discursive description of Beethoven's Ninth Symphony, for the symphony itself, without loss of cognitive significance. The two should be interchangeable in the sense that after reading a complete, accurate description of the work one would know all there was to know about the symphony. We would not gain any additional knowledge by listening to the actual symphony. This is clearly absurd. A similar point can be made with a less fanciful mathematical example. For two thousand years it seemed that Euclid was the final word in geometry. One of the great intellectual upheavals of the nineteenth century was the discovery that this was not the case.⁴⁴³

There was limited direct neuroscience research specifically addressing the relationship between sketching and intuition. Neuroscience studies tend to focus on broader cognitive and creative processes, making it challenging to find studies that directly investigate the neural mechanisms involved in sketching and its connection to intuition. However, there is some relevant research in the fields of creativity, artistic expression, and cognition that indirectly touch upon the subject.

Studies on creativity often examine the neural processes underlying creative thinking, which is a component of sketching and intuition. For instance, research on divergent thinking, a key aspect of creativity, has

⁴⁴² Edwards, B. (Year). *Drawing on the Artist Within* (p. 154). Simon and Schuster.

⁴⁴³ Goel, V. (1995). *Sketches of thought*. MIT press.

explored brain activation patterns associated with idea generation and problem-solving. Some researchers have used neuroimaging techniques like functional magnetic resonance imaging (fMRI) to study brain activity during creative tasks (e.g., drawing, brainstorming), providing insights into the cognitive processes involved.⁴⁴⁴

Based on the research that are mentioned in the footnote the intersection of creativity, neuroscience, and artistic expression is a captivating realm where the human mind's innate ability to innovate and intuitively navigate complex terrains is explored. Within this context, the act of sketching emerges as a dynamic conduit through which cognition meets creativity and intuition finds its visual voice. While direct neuroscience studies delving into the intricate relationship between sketching and intuition may be scarce, a broader body of research scrutinizes the neural underpinnings of creativity and cognitive processes that are intimately linked with the act of sketching.

As we mentioned in the second chapter, Divergent thinking, a critical facet of creativity, has been a focal point of investigation in neuroscience, with researchers employing neuroimaging techniques like functional magnetic resonance imaging (fMRI) to unveil the intricate patterns of brain activation during tasks such as drawing and brainstorming. These studies offer glimpses into the cognitive mechanisms underlying the creative process, shedding light on how the mind navigates the intricate journey from ideation to realization. In this discourse, we embark on a journey through the multifaceted landscape of art, architecture, and creative cognition, exploring how the act of sketching is intrinsically tied to the profound realms of intuition, inspiration, and innovation.

⁴⁴⁴ Here is provided some relevant research that can be profound on this topic, but since it is out of the scope of this research, we only mention the references.

Divergent Thinking and Creativity:

Guilford, J. P. (1967). The Nature of Human Intelligence.

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal*, 24(1), 92-96.

Neuroimaging Studies on Creativity:

Arden, R., Chavez, R. S., Grazioplene, R., & Jung, R. E. (2010). Neuroimaging creativity: A psychometric view. *Behavioural Brain Research*, 214(2), 143-156.

Jung, R. E., & Vartanian, O. (2018). *The Cambridge Handbook of the Neuroscience of Creativity*. Cambridge University Press.

Artistic Expression and Brain Activity:

Dietrich, A., & Kanso, R. (2010). A review of EEG, ERP, and neuroimaging studies of creativity and insight. *Psychological Bulletin*, 136(5), 822-848.

Saggar, M., Quintin, E. M., Bott, N. T., Kienitz, E., Chien, H., Hong, D. W. ... & Reiss, A. L. (2015). Changes in brain activation during the acquisition of a new bimanual coordination task. *Neuropsychologia*, 67, 54-66.

Concluding Insights in Embodiment of Architectural Thoughts

Simultaneous engagement in design and form-making, combined with sketching and freehand drawing, constitutes a form of creative and prolific activity. This practice not only nurtures and prepares the minds of students for engagement in an artistic and design-oriented context but also readies them for involvement in established design studios and participation in tested design projects. Attention to the conceptualization and alignment of ideas with design objectives within the framework of a cohesive physical structure necessitates a broad vocabulary of formal terms. Furthermore, it requires creative and intuitive responses for selection and decision-making, transcending analytical arguments.

This capability, prior to students' familiarity with architectural theories, can prevent them from preconceived notions in design and establish a creative mental world for them. The role of sketching and freehand drawing in this regard is crucial and significant. Merely possessing the ability to draw in line with the design goals presented in studios and the architectural profession cannot be a reliable foundation. Instead, the correct utilization of these skills as a research tool and in unlocking students' imagination and problem-solving approaches can be constructive.

Based on observations conducted in the experimental process in chapters 5 and 6, noteworthy solutions are proposed for developing an instructional method centered around sketching. These suggestions are succinctly presented under specific headings for architectural schools.

Suggestions for architecture schools

1. Sketching as a Creative Process:

- Emphasizes sketching as an inherently creative process, surpassing a mere skill.
- Highlights the generation of new artifacts and the creative potential embedded in sketching.

2. Imagination and Architectural Design:

- Explores the symbiotic relationship between imagination and sketching in architectural design.
- Cites examples, such as Álvaro Siza, to illustrate how sketching bridges the gap between imagination and tangible architectural forms.

3. Cyclical and Iterative Nature:

- Describes the cyclical nature of sketching within architects' work, where imagination fuels sketches and vice versa.
- Positions this iterative process as essential in the narrative and development of architectural ideas.

4. Function of Freehand Sketches:

- Highlights the pivotal role of freehand sketches in crystallizing ideas during the early design stages.
- Stresses the significance of putting ideas on paper to facilitate the inspection, refinement, and revision of design concepts.

5. Universality of Sketching:

- Notes sketching as a common human activity, akin to writing, with universal relevance.
- Emphasizes the cross-cultural and contextual applicability of sketching as a fundamental practice.

6. Sketching in Design Thinking:

- Positions sketching as a valuable thinking tool for architects, particularly in the conceptual stages of design thinking.
- Advocates for the integration of freehand sketching into the broader design thinking process.

7. Challenges and Opportunities:

- Acknowledges the challenges in analyzing and understanding the dense and ambiguous nature of sketching.
- Identifies the complexity of sketching as a challenge for researchers but also as a source of opportunities for designers.

8. Psychological Aspects:

- Briefly touches upon the psychology of sketching, linking it to experiments exploring the creative minds of designers.
- Introduces the idea that sketching involves externalizing tasks beyond the capabilities of mental imaging.

9. Lateral Transformation:

- Introduces the concept of lateral transformation in sketching, contributing to its complexity.
- Emphasizes how lateral transformations enrich the sketching process, fostering innovation and richness in ideas.

10. Importance of Teaching Early Design Sketching:

- Stresses the educational importance of teaching early design sketching as a thinking tool.
- Aims to enhance teaching methodologies to empower students to become proficient architects.

11. Expressing the Inexpressible:

- Highlights the role of drawing and illustrations in articulating architectural ideas that go beyond the limitations of language.
- Emphasizes drawing as an essential medium for expressing the ineffable aspects of art and beauty in architecture.

12. Memory and Architecture:

- Distinguishes between short-term and long-term memory in the context of architectural education.
- Underlines the importance of memory in recalling vast architectural artworks and experiences.

13. Visual Memory and Design Process:

- Introduces visual knowledge gained through architectural works as a form of intelligence.
- Explores how the type of memory influences the recall of architectural visual knowledge during the design process.

14. Role of Sketching in Memory Recall:

- Asserts that graphic thinking and sketching aid architects in recalling architectural works during the design process.

- Emphasizes the role of sketching in strengthening visual memory and facilitating the recall of architectural visual knowledge.

15. Differences Between Professionals and Amateurs:

- Highlights a key difference between professional architects and amateurs in their approach to architectural images.
- Stresses the importance of transcending images to long-term memory for accurate and proficient design.

16. Ambiguity in Design Thinking:

- Acknowledges the complexity and ambiguity present in the design thinking process.
- Describes professional architects' sketches as reflections of uncertain currents of thought, adding depth to the design process.

17. Teaching Design Process through Graphic Thinking:

- Addresses the challenge of teaching the design process through graphic thinking, especially in the digital age.
- Calls for finding a balance that aligns with contemporary technological advancements and cultural shifts.

18. Purpose of Embedding Drawing Process:

- Stresses that embedding the drawing process in architectural education is not solely for problem-solving but to encourage visual thinking.
- Aims to develop a unique way of thinking among students, moving beyond the pragmatic aspects of design problem-solving.

19. Distinguishing Between Drawing and Sketching:

- Highlights the distinction between drawing and sketching, focusing on sketches as a language of thought for architects.
- Introduces three categories of architectural sketches: experiential, diagrams, and fabulous drawings.

20. Early Design Exploration through Drawing:

- Emphasizes the role of drawing, particularly sketches, in the early stages of design exploration.
- Describes drawing as a tool for recording ideas, recognizing functions, and adapting new forms into the design process.

These condensed points encompass the diverse facets of sketching in architecture, ranging from its creative essence and universality to its cognitive and psychological dimensions. Teachers can leverage these insights to structure comprehensive lessons on the role of sketching in architectural education.

“Embodiment of Architectural Thoughts”

In conclusion, the integration of form design procedure and creative development through freehand drawing and graphic thinking is a cornerstone in architectural education, transcending the allure of modern digital tools. Despite the technological advancements, sketching remains a pivotal language and research tool, offering students a gateway to the imaginative realm and cultivating intuitive design capabilities.

Considering the results obtained in the laboratory test, the design process through graphic thinking assumes paramount importance in navigating the complexities of the digital age without succumbing to a reactionary stance. This pedagogical approach aspires to seamlessly integrate traditional graphic methods with contemporary digital tools. The goal is to foster a characteristic design process that harmonizes with the technological landscape while preserving the fundamental essence of architectural education. By bridging the traditional and the modern, this approach equips students with a versatile skill set, allowing them to navigate the evolving demands of the profession.

As reflected in the students' works and exercises, this integration aims to bridge the gap identified in design studio challenges, where students often struggle to translate theoretical foundations into tangible spatial structures. The lack of operational strategies and an inability to embody mental concepts result in inconsistent outcomes, emphasizing the need for a more detailed comprehension of design principles based on graphic thinking before embarking on design studios.

Advocating for a unified approach to design education, this concept proposes a broader introduction to design basics according to developing imagination and the ability to recruit form-based concepts through developing the **Form lexicon** which can be operate through free-hand drawing. It calls for an inclusive curriculum that encompasses not only architecture but also diverse design disciplines like industrial design, product design, and environment design. The goal is to nurture a versatile and adaptable design mindset among students, enriching their creative thinking beyond technical confines. Moreover, this concept delves into the often-overlooked realm of intuitive thinking in the architecture education system. Recognizing the indispensable role of intuition alongside analytical categories, it advocates for a more balanced and comprehensive design process. The juxtaposition of systematic form development and form-finding processes with the free-flowing nature of sketching becomes a catalyst for creative problem-solving.

By reducing the possibility of analytical thinking ground in the educational process in the **first part of the laboratory test**, the results obtained in the **impact section** clearly showed that the relevance of intuition and imagination takes center stage in reshaping the creative mindset in design process. Many traditional approaches to architecture pedagogies have, at times, neglected or struggled to teach and practice intuitive thinking in new systematic education. This research urges a shift toward more intuitive and imaginative design practices compared to analytic and systematic approaches, which rely on digital representation in architecture design studios. The results of observations conducted in the laboratory setting

clearly indicate that the freedom of expression and mental overflows of students, facilitated by hand-drawings, give rise to a communicative language. Alternatively, as articulated by Gabriela Goldschmidt, it can be viewed as a form of dialectic interaction between the designer and architecture through drawing and sketching. This intrinsic energy serves as a generative force for vitality and the attainment of intuitive insights.

It acknowledges that intuition is not an unteachable or impracticable aspect but a consequence of vast experiences and knowledge in a particular field. Through this research it was determined that by investigating and fostering intuition and imagination, the architectural design studio can become a space where half-shaped ideas are articulated, reflected upon, developed, and revised according to creative attitudes.

In essence, this integrated concept that developed in this research envisions design education as an evolutionary process. It was recognized that an architectural idea, starting with vague and unclear lines, has better potential to develop with flexible characteristics and later can evolve into a thoroughly technical document. As the design progresses, scales, measures, organizations, and regulations become more pronounced, emphasizing the crucial role of ideas, imaginations, and mental pictures in the initial phases. By seamlessly blending form design processes lean on graphical externalization, this concept advocates for a transformative approach to architectural education—one that fosters creativity, embraces diversity, and prepares students for the dynamic challenges of the design world. This procedure forms an active learning ambiance that helps both convergent thinkers and divergent thinkers to engage in the initial phase of design through the creation of vast sets of visual choices. Hence, the rich lexicon of form-based structures will help them recruit and tailor suitable physical ideas for their architectural thoughts.

On the other hand, we were witnessing in the testing ground, the dichotomy of architectural manuscript sketches stands as a testament to the multifaceted nature of freehand drawing within the field of architectural design that operates both in educational contexts, where it facilitates visual thinking, and as tools for seasoned professional architects, this process transcends mere skill, becoming a nuanced means of embodying ideas and imaginations. In this symbiotic relationship, freehand drawing becomes a bridge connecting novices and seasoned architects, facilitating a continuum of creative expression.

Within the pedagogy of imagination and creativity, sketching emerges as an enduring and transformative means of achieving intuition. Beyond its role as a mere skill, sketching evolves into a powerful vehicle for unbridled expression, enabling artists and architects to translate abstract musings into tangible forms. This transformative process encompasses a spectrum of

activities, from observation to visualization, and culminates in the layered refinement of ideas. Thus, sketching becomes an integral component of a comprehensive approach to design education, acting as a catalyst that stretches creativity and hones essential visual thinking skills.

Elicited from the obtained results, it can be generally said that the fusion of form design and sketching emerges as a pedagogical powerhouse, ushering students into the imaginative realm and nurturing intuitive design capabilities. Traditional methods of teaching design have long leaned on sketching as a communicative language and a research tool, and despite the digital age's influx of tools, sketching persists as a vital conduit to harness creativity. In this integrated concept, the symbiotic relationship between form design, sketching, and the cultivation of creativity provides a roadmap for students to traverse the complex terrain of architectural imagination and design thinking. It emphasizes not only the technical proficiency but also the artistic intuition required in the ever-evolving field of architectural design. This holistic approach ensures that students are not only equipped with the necessary tools but are also instilled with a creative mindset to navigate the challenges of the dynamic architectural landscape.

At long last in considering the global landscape of design education, achieving the consensus of an introductory pre-studio pedagogy can propose a more balanced, multicultural system of thinking. Strengthening the global design conversation becomes imperative. Learning from users and designers worldwide can significantly enrich students' perspectives and contribute to a more holistic understanding of design principles.

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Figure Index

Figure 1 samples of imaginative architectural spaces: These images have been designed with digital devices or AI, and most of them are just considered as concept art that introduced a futuristic spaces which can use in video games and animated movies purposes. Many of these worked are not designed by architects and vastly available in virtual space and social media.

Figure 2 samples of eVolo winner project: As seen in this image, many architectural competitions encourage students to design large-scale projects with imaginative approaches. The form of most of these projects is influenced by mega-structures that sometimes seem impossible to build in current conditions, and the designer has only tried to present a mind-boggling representation of an architectural design.

Figure 3 samples of eVolo winner project: Another example of a project presented in the eVolo contest. This strange structure is a display of a residential complex in the future! Dichotomy and ambiguity created for architecture students from seeing projects like this is considered a disruption in the education system. In this research, without the intention of directly criticizing ideas for the future, the question is raised that the contradiction of the educational system in architecture schools with what happens in the atmosphere of architectural competitions has consequences for the formation of the correct understanding of design thinking among architecture students.

Figure 4 Work of Courtney Roose, MArch, Victoria University of New Zealand

Figure 5Michael Hollander, Drawing excellence Award, Pratt Institute of Architecture

Figure 6 Yazeed Almasi, Pipe 942, Pratt Institute of Architecture

Figure 7 Franklin Mwanza, M.Arch Thesis Victoria University of Wellington, New Zealand

Figure 8Marc Honore, MArch Thesis, Victoria University of Wellington, New Zealand

Figure 9 University of Los Angeles, Thesis Project of student

Figure 10 Callum Brookland, "The Valley of Abandoned Dreams", MArch Thesis, Victoria University of Wellington, New Zealand

Figure 11Project of Aleksa Milojevic and Adam Rostek Advanced studio with Peter Eisenman, Frank Gehry, and Daisy Ames, Yale University

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Figure 17 Design Process Stages Analysis

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Figure 47 developed Vertical and Horizontal form samples by the Author

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Figure 145 Part of the process taught in form making based on alphabet.

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Figure 147 Diagram depicting students' performances.

Figure 148 Diagram depicting students' performances.

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Figure 150 students' practices on Vertical and Horizontal cuts

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