U.PORTO
FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO

Interactive Mediascape
Designed for Collaborative Creativity

Irina Petrova

Master Degree in Multimedia

Supervisors: Prof. Luis Leite
Prof. Gilberto Bernardes

October 2023

This work was created using LaTeX typesetting language
in the Overleaf environment (www.overleaf.com).

Declaration

I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade do Porto.

Abstract

We live in the world where ”together alone” has become a common phenomenon, where personal devices providing the wealth of information and entertainment, yet drawing attention away from our physical reality and people surrounding us, create a reality disconnect. Technology propagators need to focus more on developing systems which would allow people to connect in physical space. The implementation challenge still exists as there is a scarcity of frameworks facilitating the development of such systems. Although the state of technology today makes interaction embedded in physical space plausible across multiple domains and interactive installations and immersive experiences are not a new topic, there have been few attempts to describe such experiences in a systematic way, to find common threads, structures, parameters and general approach to designing interactive multi-modal experiences in physical space. I propose to design such systems by engaging concepts from various research fields with the focus on the problem at hand. Following the premise of concept-driven interactive research, I define an Interactive Mediascape Ecosystem, contextualize it within a broader scope of HCI knowledge-base. I then use the Ecosystem elements to address the question of: How can co-located interactive experiences be designed to foster collaborative creativity among a group of participants? Drawing on the results of research, I formulate a systematic process for developing Interactive Mediascape experiences rooted in multidisciplinary theory and practice. This approach opens opportunities for research continuity, comparability of results and serves as a starting point towards ”integrative discipline” for knowledge creation centered around co-located TMEs.

Keywords

interactive mediascape, technology-mediated experience, interactive design, concept-driven research, integrative discipline, collaborative creativity

Contents

List of Figures

Acronyms

IM	Interactive Mediascape
TME	Technology-Mediated Experience
SUI	Spatial User Interface
CTS	Csikszentmihalyi Time Slice
CSI	Creativity Support Index
CSCW	Computer Supporting Cooperative Work
MR	Mixed Reality
3Cs	Collaboration, Communication, Cooperation

1

Introduction

Contents

1.1 Motivation

Any conversation about modern day technology inevitably comes around at some point to find everyone in a consensus, discussing humans' over-attachment to their phones. Overstimulated, constantly on the phone, disconnected from our physical environment and its context, we use the phone as an extension of reality, our individual preferences and habits expanded and/or are warped over time by algorithms from the apps we choose to use. The loneliness epidemic, which has been well documented in the media and scientific literature, is the byproduct of this lifestyle, if one can entertain oneself, fulfill basic needs by having everything delivered to the door by a faceless delivery person, and, in the near future, very likely be denied a possibility of customer service offered by another human, why would one need anyone at all?

In the last two decades millions of applications have been developed for the virtual space of personal devices, thus socio-cultural tendencies are defined by the diminishing consideration for the physical environment while attention is focused on virtual environments facilitated by personal devices. Today provides for a great opportunity to begin softening the imbalance between the number of opportunities which exist for socio-cultural interaction in physical space with that of virtual personal devices. More experiences in physical space designed to connect people in real time can create such opportunities. IoT and network capabilities have become sufficient in recent years to develop systems which can ensure quality of experience and developing prototypes of such systems is now more feasible than ever before. My interest is in creating experiences in physical space in real time for a group of people connected through a narrative and enabled by interactive technology. I think such experiences can be part of the solution in tackling the loneliness epidemic. The focus of this thesis lies in the question of how to develop such experience intelligently.

"The issue of symbiosis of humans with smart ecosystems is complex and multi-faceted, extending beyond technical boundaries to a multi-disciplinary approach..." (Stephanidis et al., 2019) In product design, we need to move from the I - paradigm into the We - paradigm, we need to create interactive systems which are truly unobtrusive for tapping into and foster creative abilities of the user, and we need to use interdisciplinary approach to address the questions arching over multiple research domains while developing a product. These points, among others, were made by the authors of paper "7 Grand Challenged of HCI" and presented at a recent HCI conference in California, the publication stressed the urgency to move in the direction of *collaborative approach connecting established fields of knowledge, while noting the limitations of a strictly vertical HCI perspective in creating complex systems.*

This calling for a discourse and collaboration between research fields is also echoed in recent theory of design by Neri Oxman. Oxman's framework called "The Krebs Cycle of Creativity" (Oxman, 2016), reminiscent of the Bauhaus wheel model of education (Gropius, 1922), which draws connections between research fields and illustrates an integrated view of interdisciplinary approach. In Oxman's frame-

work Art, Science, Design and Engineering are all linked within one circumference of the design circle, they are relating to each other through intersections of conceptual Physical, Biological, Metaphysical and Digital spaces.

Why haven't there been more Technology-Mediated Experience (TME) systems designed for physical space and for group interaction? This is in part due to the fact that much of interactive technology of recent years has been developed for the virtual domain experiences. Integration of these technologies with physical reality has been slow due to the "engineering hurdles" posed by latency, reliability of hardware, connectivity, etc (Ens et al., 2019).

Besides technical challenges, another side of the problem is that communication between research domains has been inhibited by lack of interdisciplinary exposure to and/or awareness of relevant knowledge. Recent publications note some of these gaps in the knowledge base: the concept of agency not being understood (Gondomar and Mor, 2021) and semiotics of product design not being well received by the HCI community (Steffen, 2021) On the other hand, in a recent engineering design article the authors note the need for interdisciplinary dialog: "research in engineering design would benefit from works analysing the many methodologies proposed from a meta level that permits obtaining general concepts that are domain-independent and universally applicable." (Escudero-Mancebo et al., 2023)

The need for novel interdisciplinary frameworks is apparent. With fast advancement of technology, especially in the Artificial Intelligence (AI) and Machine Learning (ML) research fields, we may speculate that intelligent agents will be operating side by side with researchers and practitioners in every domain of inquiry. This will expand the possibilities of tackling problems more complex than ever before. Understanding complex systems and defining connections between the bodies of knowledge can provide an easy starting point for rapid prototyping and experimentation.

As networks get better, today, there is a great opportunity to begin expanding the knowledge gathered over the years in the domain of virtual communications into the mixed reality domain, and, bringing the physical aspect back as an integral part of the experience. How can we design TME in physical space? What are the elements involved in the process comprising the experience? What is the ideal configuration of elements leading to an intuitive and comfortable interaction with the system while fostering a co-creative spirit?

1.2 Past Projects Overview

Driven by the curiosity of creating interactive experiences in physical space for group participation, over the course of two years I have developed 8 public experiences using proximity sensors as interactive device. Throughout the course of these experiments proximity sensors were the "sensor of choice" for me as researcher, with each project I proposed an interaction context possibility slightly varying from the

previous. The full description and takeaways of projects are available in the Appendix of this document. Here I will briefly summarize each project in a sentence to provide an overview of experiments.

Figure 1.1: Participants Interacting during ”IamBITus” Interactive Mediascape (IM) experience

Beginning with a project which consisted of proximity sensors attached to the wall and coupled with audio samples was the first attempt on my part to use proximity sensor set up in a context-specific interactive project (project 1 “Abel Salazar Might Have Heard”); this project was presented at a museum. In the next experiment I moved on to placing the sensors on the table and positioning participants around the table while developing a playful performer/audience dynamic (project 2 “Interactive Happening 2”); this project was presented in a classroom. In the next project I placed proximity sensors inside food carton packaging and had participants record their voices which then were used as part of the soundscape produced by sensor triggering (project 3 “The Talking Vessels”) and in the next project metro tickets were attached to proximity sensors to contextualize the theme of the experience, while visuals and sound were triggered through interaction (project 4 “From Lucio Sestio to Pigneto”); projects 3 and 4 were presented at a co-working space. By that point I felt confident enough with creating non-complex interaction scenarios and posed a challenge for myself to make a project with multiple levels of interaction, with a longer timeline which was structured in parts, I will come back to this project in the next paragraph in more detail served as an eye-opening moment (project 5 “stairwellbeing”); it was presented in the staircase of the university building. The following project was a step forward because I began to use wireless technology to enable interaction, using ESP32 microprocessor I was able to detach the interaction modules containing the sensor from the computer and place these modules anywhere in the

space (project 6 “Azulejos of the Sea” ((Figure 1.2)); it was presented in a black box theater. In the next project I utilized the same interactive engineering using ESP32, however, I increased the number of modules to 7, each of them had 2 proximity sensors, thus I increased the number of interactive couplings which could take place at the same time to 14, this project was scripted in 3 parts (project 7 “IamBITus” (Figure 1.1)); this was presented in a small auditorium of municipal theater. Finally the last project to date which I presented publicly was a demonstration of proximity sensors integration with Touchdesigner software, this was the first time when I used direct metaphor to connect the interaction device with the visual and observe the dynamic of public interaction with the system while providing minimal instruction (project 8 Touchdesigner Roundtable); presented at Monopol, Berlin, an open art space.

Figure 1.2: Participants interacting during ”Azulejos of the Sea” IM experience

I will now come back to project number 5. What was so notable about it is the fact that it presented a problem of scripting. While I was able to conceptually sketch the script (Figure 1.3), when it came to actually implementing the code and coupling interaction with media the orderly method I used in simpler projects did not work. Or rather, I could set the media coupling but I could not establish a logic of why I was setting it one way or another, my choices were arbitrary, based on intuition. There was no systematic guideline and all I could do is make the experience based on hunch and observe how it is received by the participants. Although I was aware of this problem, in the following projects my approach was still

intuitive and although some issues were improved from one project to the next, the body of knowledge I was building was case-based and results were not part of any comparability metric. With this problem I went into the current thesis.

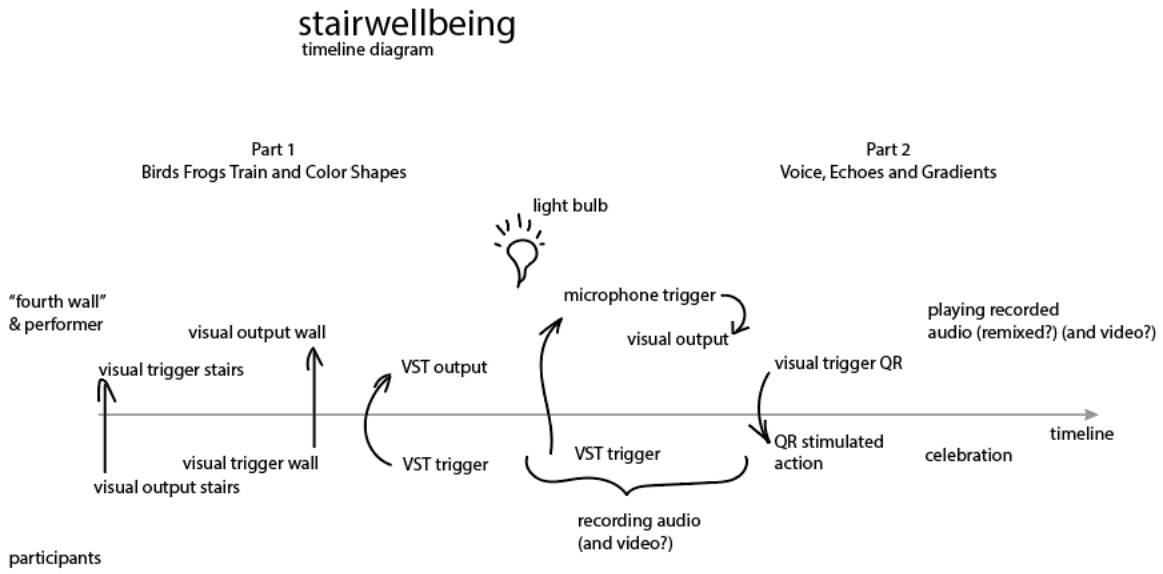

Figure 1.3: Sketch of interacive events for the script of ”Stairwellbeing”

Although I am motivated by developing an experience for collaborative creativity, it is clear that the first objective is to formulate how to create such experience in an intelligent and systematic way regardless of the application domain.

1.3 State of the Art

1.3.1 History of TME in art

TME is not a new idea and many artists have embarked on exploring this topic. We can go as far as the DaDa. With ave-cadaver, where a piece of paper was used as a technological instrument and, when folded a certain way and passed around from participant to participant each of whom would add something, would produce a textual work of art or a drawing. Or even earlier, Mozart, who made notation passages and then “shuffled” them around according to how the dice would land and centuries later John Cage rediscovering this concept and pioneering the movement of randomness and algorithmic composition along with Xanakis, whose graphic scores gave rise to the “interpretive” style of composing, where the score would only suggest but the performer was free to interpret it. These are examples of pre-information Age generative art. And Generative systems are at the root of IM because it’s a score

filled with algorithms allowing for variability of result depending on who is acting upon it. We can consider such works of the past as a guiding aid when creating a score.

Another aspect of IM appearing in history is spacial exploration and the placement of human body in space. These ideas can be noted in the works of Richard Wagner, Ianis Xanakis, Myron Krueger and Kusama Tokion to name a few. These artists explore how perception can be informed by the location of the body in a specific environment. We may say that today's immersive experience exhibits take their roots in such works as Xanakis' Poem Electonique or Kusama's Infinity Mirrors and interactive installations can be traced back to Myron Krueger's Metaplay experiments. While Richard Wagner's idea of Gesamkunstwerk points to the notion that when thought is given to the location, architecture and the immediate environment where the experience of art takes place, the audience experience the performance in a difference, more wholesome way. It's not just what is presented to the audience, but how and under what circumstances. All of these artists, however different in their historic and art context, pay attention to the human body and the environment where it exists during the art seance. Recent science data and various branches of the embodiment theories validate these artists' quest for trying to understand the relationship between perception of reality and physical self/environment awareness.

Much has emerged in the recent years in the area of immersive experience produced in physical spaces using the most powerful projectors and audio technology. Notably such shows as The Van Gogh or Frida Kahlo propose immersive environments based on well known artworks, teamLab makes fantastic environments based on generative graphics resembling nature, while the Berlin show Dark Matter chooses a different approach by curating a number of immersive installations which constitute a "tour" through sensorial experiences, and a recently opened media art center Khroma Berlin experience expands the idea by providing a walk through interactive installations.

Some of these experiences are passive, where a participant walks through without interfering with the content of installation. Other times we see experiences designed with an extent of interaction, where a participant can move a hand, for example, to trigger an event or where one's physical presence informs the configuration of presented content in some manner. Our understanding of the balance, even between such closely related modalities as audio/visual is still in its infancy. Scientific knowledge in this niche is scarce, especially when it comes to physical spaces. Much of design decisions in these projects are based on personal taste, intuition and sensibility with the varying degree of success, while these projects aim for commercial viability.

When we examine these recent works from the perspective of interaction complexity, one factor is apparent - the user journey is comprised of stand alone individual tasks, these tasks are not meant to have a complexity dynamic development over time, nor are they part of a larger collaborative narrative emerging from participants' engagement. Each installation, each immersive experience are a few minutes worth of contemplation, they don't offer a trajectory of action progression, although they consist

of dynamic media, they are contextually static. Thinking in terms of possibilities, one may say these installations and immersive experiences are an animated gif of TMEs. In other words, these art projects do not tap into the full potential of TMEs as an emerging content presentation form.

1.3.2 Interactive Mediascape Definition

What is a technology-mediated experience in the context of a group participatory event? Think of a ball and a game invented using a ball, like football, for example. Here the ball is the technology and the game itself is a technology-mediated experience. It's that simple. Depending on the game the ball is designed differently and has to be adjusted in size and other properties to make the best fit for the activity. Now, draw a parallel with interactive technologies and tangible user interfaces, it's in the same manner that we can think about ways to adapt them for real world environments where groups of people can emotionally benefit from engaging in activities facilitated by such technology. Same as any ball game - it can make the participants happy or relaxed or creative (depending on the initial purpose of the designed experience) while offering a chance to be in the environment with the others and actively engage with them.

Similarly to designing the right type of ball for a given game, to intelligently design an IM, we need to understand the nature of interaction among the participants, the physical space where that interaction takes place, and technical possibilities of the system in the context of the experience (what are the properties or features of the ball which would best suit the given situation?).

Of course, we are not designing a ball game. TME and Interactive Mediascape in particular can be a narrative, a quest riddle, an immersion into various environments, an educational aide, an entertainment piece or even a team-building activity; this event can exist in the context of a school, a theater, an office to name a few. The full potential of this content expression paradigm has not yet been tapped.

How can we approach the construction of a systematic view of Interactive Mediascape, considering its technical complexity and diversity of application purposes?

What would happen, if we were to say, that Interactive Mediascape is a form of expression such as a book, a sonata or a play? Each of these entities are familiar concepts and following certain guidelines in each of these areas infinite number of results can emerge. What do these guidelines consist of? What elements are woven into the tapestry of these forms? In a book, the author has such expressive tools as words, linguistic style, rhythm; in a musical composition, as defined by Laurie Spiegel, the creator can use transposition, reversal, rotation, extrapolation and fragmentation, among other techniques (Spiegel, 1981), while in a play, as proposed by Vsevolod Meyerhold, the director brings together elements such as: the language, musical composition, set design, space, gesture, mise en scène and lighting (Braun, 1998, Nikulin and Pichihadze, 2008). All of these elements are tools at the disposal of the creator to convey an idea, a mood, a feeling, etc.

In a similar way, Interactive Mediascape is a form which contains multiple elements - tools of expression. For the sake of cohesion, in this thesis the question of expressive style is dropped, while leaving the question of what tools can be used to achieve style and form.

Because TME is a broad term which is widely used to describe experiences in both physical and virtual domains, to avoid ambiguity, I will be using the term Interactive Mediascape throughout the paper. Interactive Mediacape is a technology-mediated experience presented in physical space and it presumes an event timeline and a narrative.

1.3.3 Interdisciplinary Approach

Coming back to the words of Vsevolod Meyerhold, a director must know and be familiar with the elements which comprise the art of theater. This thought is being echoed a hundred years later by HCI researchers Frankjaer and Dalsgaard arguing that the designer must have equal understanding of qualities and potential of digital and analog materials (Frankjaer and Dalsgaard, 2018). According to Meyerhold, a director has to understand the difference between static and dynamic art. A painting or a statue are forms of static art while theater and music are dynamic - their expression exists in time, this is an important and fundamental factor to consider while conceptually thinking about Interactive Mediascape as well. Arranging events on a timeline is the core element. What are the events? In what order should they appear? What is the rhythm and impression amplitude? The scope of these questions becomes increasingly more complex as we add the possibility of interaction to scripted multi-media events, make the script itself dynamic and media - generative, etc.

Going further, Meyerhold points out that the art of painting exists in space while music exists in time but the elements of theater are perceived in space and time. Interactive mediascape is a form of expression which equally exists in these dimensions, thus not only scripting but also the questions of mise-en-scène and choreography are important. Additionally, because IM goes a step further than traditional theater by providing a possibility for erasing the 4th wall which in theater art traditionally implies the audience looking through a rectangle opening of the stage, the architecture of physical space where IM is presented can play a significant role.

Thus, we must understand the elements in play to map a timeline and define a spacial configuration in physical reality. Looking for a framework which addresses the full scope of tools and techniques for this purpose has proven to be a challenging task.

While reviewing current frameworks in attempt to find one which could serve as a guiding path in developing an Interactive Mediascape, several concepts were relevant. I begin by knowing that an experience I am trying to develop encompasses such fields of research as IoT, HCI and interactive design, dramaturgy, thus I am looking for an approach which integrates elements from these domains. I am trying to develop an interactive experience in physical space for a group of people and construct a

narrative for such experience. Although I did not find one specific framework which covers all domains involved in IM design, some frameworks and concepts provide insight into the complexity of the inquiry and shine light on specific aspects of it.

Internet of Musical Things (Turchet et al., 2018) gives insight into the engineering approach to IoT based musical events. The paper states: "ecosystems associated with the IoMusT include interoperable devices and services that connect musicians and audiences to support musician–musician, audience–musicians, and audience–audience interactions." Interactive mediascape is comprised of various media, not only sound, but the principles of IoMusT are useful in thinking about the data flow and user interaction from a computer science perspective.

Another technical insight can be found in the Frogger interaction design system (Wensveen et al., 2004). This is especially relevant because IM employs UI elements in physical reality. Frogger interaction design framework, is a clear engineering approach to coupling specific tangible user interface devices with media content. It gives insight into creating intuitive tangible user interfaces in a given scenario and it can be helpful while the TUI is being developed for the IM experience. Stephan Wensveen developed Frogger in 2004 specifically to address the absence of a unifying approach Tangible User Interface development in the designer's domain. He proposes 7 variables which can be coupled to each other in a weak or strong way, depending on the needs of the system. He leaves great flexibility for the designer to decide how the coupling will be established, yet he provides a structured and complete approach to guide the designer in doing so. In this framework he is also introducing such concepts as feedforward and feedback which are directly applicable in the development of Interactive Mediascape and can be used when we think about user interface system and how it functions within Interactive Mediascape environment.

On a more conceptual level, we find Forlizzi, Zimmerman and Evans' framework for interactive design (Forlizzi et al., 2008) aiming at bridging the gap between disciplines of HCI, biology and anthropology. At the time in 2008 they proposed the framework, Fozilli, Zimmerman and Evans said "Through our inquiry, we learned that many HCI researchers' commonly held view of design is focusing on the surface structure of products." The new model of interaction design in HCI they proposed intended to give designers a chance to participate more evenly. They stress the misalignment of goals in traditional design and HCI design, the first being focused on commercial value while the latter focuses on acquisition of knowledge and how to improve certain function in the process of developing interactive products. Fozilli, Zimmerman and Evans propose an epistemological framework for interaction designers to integrate "true" knowledge from behavioral scientists, anthropologists and engineers. The authors then separate the process of research from that of practice, proposing that research arficats can be passed onto practitioners. Considering this model within IM context, it is difficult to say where a dramaturg's role would be present. Would it be on the par with the role of Interaction Designer or would it be more/less

significant? Perhaps it would depend on the initial set of requirements for the researched problem? The more fundamental question is, can the line between researchers and practitioners be erased? The paper was written 15 years ago, since then the idea-to-prototype cycle has become shorted, enabled by fast technological advances. Does it make sense to separate research from practice while developing a system to support IM experience design?

In “Strategies of Interactive Art” (Kluszczynski, 2010) Ryszard W. Kluszczynski by analyzing existing interactive art synthesizes a list of possible “strategies” or scenarios which describe the “mes-en-scene” and the interaction sensibility of the installation. His conclusions are definitive and specific, the main modes of content presentation he found during his analysis of interactive artworks are: strategy of game, strategy of archives, strategy of labyrinth, strategy of rhizome, strategy of system and strategy of spectacle. These strategies by themselves do not hold enough knowledge about the nature of interaction, space, dramaturgy and interactive technology, rather, they crystallize the overall experience into a familiar abstraction, something that can be instantly meaningful in describing the event. Such thematic abstractions are useful in terms of IM design, they make ideas easy to describe and they carry certain principles of space choreography and interactive activities.

A 2012 framework developed for service spaces provides a fresh insight into seeing space as consisting of levels: space level, installation level, and interface level. In a framework for designing interactive service spaces (Chen and Lu, 2012) Chen and Lu were “exploring the concept of interactive service space to address the following questions: Is it possible to create service opportunities using an interactive space approach? What is the best approach to designing an interactive service space? How can one incorporate, design, and implement a spatial-interactive service experience?” The authors developed a precise way of identifying design elements for each level and then arranging them on a timeline indicating a user journey. A 2021 PhD thesis of Yu Kao (Kao, 2021) proposed a framework for designing interactive installations for public spaces, Kao’s approach is similar to Chen’s. Both frameworks heavily rely on a situational view, that is to say, the frameworks are developed to be used in a specific space and the initial ideation spans from a place where the installation would be presented. In Chen’s case it’s a place of service, in Kao’s it’s a public area. There are a number of other publications suggesting frameworks which address the topic of designing interactive experiences for public space.

The aforementioned research and frameworks are closely related to developing an Interactive Mediascape, however, none of them singlehandedly cover the scope of knowledge comprising IM design.

Although IM experience is not virtual but hybrid system, it could help also to examine the presence of online apps which claim to ”improve” user’s creativity skills, to see if these can shine some light on how to approach this design challenge in a systematic way.

There are currently thousands of apps which claim to enhance creative abilities. For the most part, however, they are developed based on assumptions, hunch and reverse engineering based on case

studies Because no unified concept of creativity within the online application domain exists, comparing evaluation results across studies is also problematic. Considering examples of apps designed for creativity as models for designing IM experience is unsubstantiated since there is no clear development or evaluation method.

For example a 2023 study looking at children creativity (and also learning) apps concluded that ”evidence from research on apps and creativity suggests that we have limited knowledge on the aspects of creativity apps that may be used to cultivate child creativity” (Booton et al., 2023), the authors Booton et al then examined 152 apps to compare provider's promise of the app to enhance creative skills with the actual product. They found that creative quality ”was overall low according to our criteria. ...creativity apps are not strongly evidence-based...”(Booton et al., 2023)

There is a sentiment that because the apps domain is being flooded with new apps without any criteria for monitoring the quality, it will become increasingly difficult to pin point more successful ones according to science (Papadakis and Kalogiannakis, 2017). Commercial success is often a result of good marketing and not that of good scientific research. Grounding IM design in the knowledge from the online apps domain can be insufficient and, arguably, unreliable. Although frameworks emerging for development of creativity apps are emerging, for example, Design and Implementation of the Mobile Learning App for Creative Problem Solving Activities (Bae and Lee, 2017), they are domain specific and cannot be utilized in IM design.

1.3.4 State of the Art Conclusion

While not finding a specific framework to follow, the options for my research method are to use empirical approach and develop another project to be evaluated and produce a case study; or to try and tackle the problem on a more fundamental level and try to formulate an underlying theory for developing IM experiences.

After developing interactive experiences for 2 years on project-based criteria and requirements, I have to acknowledge the lack of system which could take these individual projects further in research to improve and expand on the knowledge.

To enable continuity, comparability of results and collaboration on the topic by various researchers a system needs to be set forth. Therefore, I reject the idea of making another prototype (”a manifestation of a specific idea for a specific design solution” (Stolterman and Wiberg, 2010)) and instead turn to the idea of Concept-Driven interaction design research, the idea which was proposed by E Stolterman and M Wiberg in 2010.

While “situation-driven research has a client and a problem to solve, concept-driven research is *an exploratory investigation of established theories with the overall aim of improving and widening the range of* ***theory and knowledge.***” (Stolterman and Wiberg, 2010)

Attempting to establish a systematic approach to designing IM experiences would yield a greater potential contribution to the field of interactive design than presentation of another prototype, because, as Stolterman and Wiberg note, concept in itself has the “capacity of carrying knowledge [and] is highly desirable from a research perspective”.

How do I begin developing a framework? The common sense is to somehow bring everyone to the same page, a starting point of understanding of where the artifact stands in relation to the world and where we (designers/developers) are in relation to the artifact. IM experience is developed by engineers, artists, interaction designers, thus the structure of this framework cannot be tilted from the beginning towards technicalities. An approach has to be more universal, providing a clear picture for everyone involved in the design/development.

“When crafting with digital and physical materials this means identifying when and how particular digital technologies can form a significant focal point in the creative process, which in turn requires a deep understanding of the qualities and potentials of these technologies, as well as of the analog materials in use.” (Frankjaer and Dalsgaard, 2018) For a moment, equating IM experience to a crafted artifact, the first challenge, as we see from the paper by Frankjaer and Deslgaard, the designer must know the material. IM experience is an ”artifact” resulting from interdisciplinary collaboration. A group of collaborating practitioners must understand not only each other’s roles in the design process but also how their mediums of craft will morph together. How they will complement each other’s input? What criteria will they take into account as they design an IM and on what basis will they align each their perspectives?

A step towards such understanding can be made through drawing the ontology of IM experience. By grounding the proposed framework in theory gathered from previously reviewed concepts as well as adjacent topics, the aim in the next chapter is to establish an IM ontology and a collaborative system life-cycle for designing IM experiences. ”...most scientists (...) acknowledge that it is a difficult but admirable goal to begin as descriptively as possible before proceeding prescriptively.” (Rohrer, 2008) The stakes are high but we must try!

1.4 Organization of the Document

In **chapter 2** I propose the Interactive Mediascape Ecosystem which consists of: Interactive Mediascape Semantic Model, Taxonomy of Elements and Project Implementation Life-cycle Tools. These structures are part of the Interactive Mediascape design ecosystem and can be utilized in developing IM experiences across variety of domains and purposes.

In **chapter 3** collaboration and creativity research is presented to inform the design process of IM experience. Because the goal of my inquiry is to understand how to design for collaborative creativity,

I tackle fundamental questions such as: what is creativity? how can we design technology-mediated systems for collaboration? Topics such as creativity definitions, dynamic creativity, groupware, social interaction, space and place, spatial user interface (and TUI) are covered. From this research I synthesize ”design sensitivities” to be employed in practical implementation. General collaboration/creativity evaluation methods, pertaining to IM experience, are also proposed in this chapter.

Chapter 4 is a practical exercise to combine the IM ecosystem (chapter 2) with design sensitivities from previous research (chapter3). Here ideas of scripting, writing a score and proposing particular evaluation methods of the final project are explored.

Chapter 5 contains results, discussion and conclusion.

2

Interactive Mediascape Ecosystem

Contents

2.1 Technology as a discipline of systematic thinking

In a famous paper called “Wicked Problems in Design Thinking“, Richard Buchanan wrote “Most people continue to think of technology in terms of its product rather than its form as a discipline of systematic thinking.” (Buchanan, 1992) Luckily, this is no longer true, in recent years a number of researchers tackled the question of broader epistemology and knowledge generation in the field of HCI. (Frankjaer and Dalsgaard, 2018, Dalsgaard and Dindler, 2014, Stolterman and Wiberg, 2010, Höök and Löwgren, 2012, Forlizzi et al., 2008)

> “Concept designs have one obvious and valued quality - anyone can almost instantly get an overall understanding of the character of the concept without any expertise or special training. The character of a concept design is the overall *organizing principle* that makes up the composition of the *design as a whole* (Nelson and Stolterman, 2003). This idea is based on the assumption that the whole reveals emergent qualities that cannot be made visible or measured as the sum of the part’s qualities. This is a core quality of any concept design and is the major reason for why concept designs have a value different from text statements or other traditional theoretical formats. The concept as a whole brings forward aspects difficult to extract as abstract externalized statements. The degree to which it is possible or not to combine theoretical aspects into a design becomes a sign of how well the theoretical aspects are commensurable.” Stolterman & Wiberg (2010) (Stolterman and Wiberg, 2010)

Stolterman and Wiberg propose that ideas which can be described by concept design are those which could be easily formulated in a single word or a sentence, these ideas usually combine “expected qualities from . . . opposing desires and the design challenge is to combine all of these aspects into one single design”(Stolterman and Wiberg, 2010). In Interactive Mediascape theory the aspects of interactivity, digital and physical space, dramaturgy and user interface are combined in a way to integrate them into a single structure.

To contextualize IM theory within a greater scope of knowledge we can refer to Delsgaard & Dindler (2014) (Figure 2.1) . In his research career spanning more than 15 years he examines interactive design and HCI concepts in relation to building experiences in physical space. Delsgaard characterizes artifacts produced by concept-driven interaction design research as “conceptual constructs” giving them “a wider definition of forms of knowledge that occupy this middle ground between theory and practice”. (Dalsgaard and Dindler, 2014) He also notes that the uniqueness of “conceptual constructs” is that they arise from theoretical basis rather than from practice. Whereas, he attributes artifacts produced by empirical process to “strong concepts” (Höök and Löwgren, 2012, Dalsgaard and Dindler, 2014). Delsgaard and Dindler specify that “strong concepts are primarily developed bottom-up or inductively with the main purpose of generating knowledge that can be employed in design practice, whereas conceptual constructs

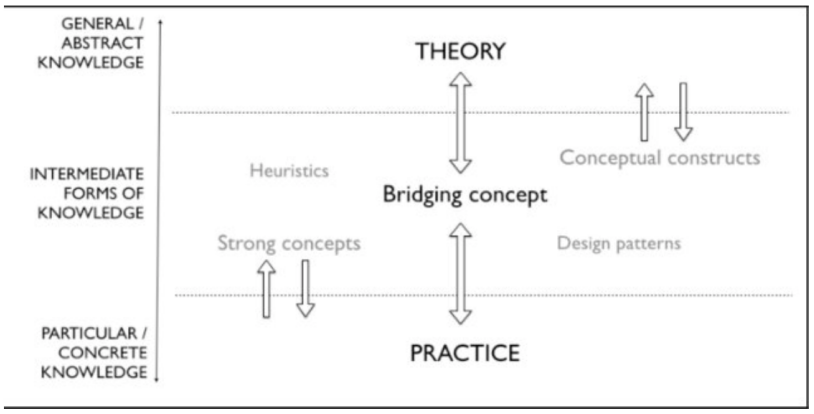

Figure 2.1: Knowledge Structure in HCI according to Dalsgaard and Dindler 2014

are primarily developed top-down with the main purpose of enriching the theoretical foundations of HCI."

In this epistemological system, IM theory is a Conceptual Construct, it aims to link elements from related fields and, by doing so, provide a conceptual structure which supports the development of IM experiences. It establishes a niche of knowledge for relating interdisciplinary theories with IM design implementation. Thus, the goal in developing IM concept is *theoretical advancement* (Figure 2.2).

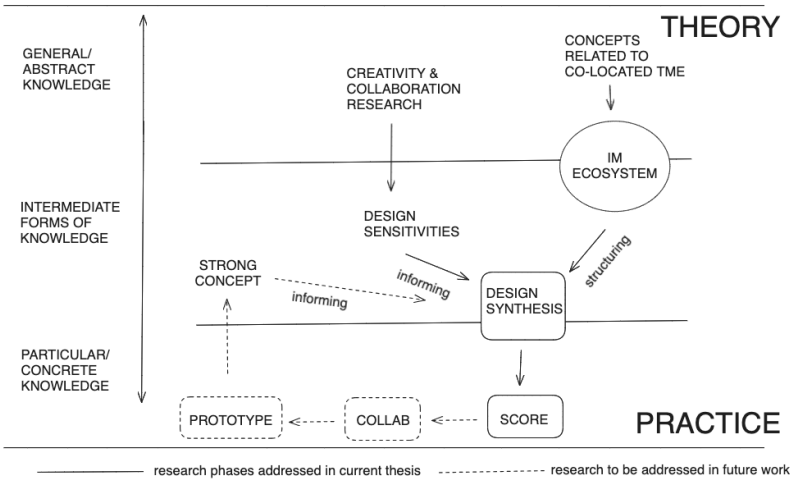

Figure 2.2: Current Thesis within Delsgaard & Dindler 2014 HCI Epistemological model

Now that we have defined epistemological space for IM theory within a broader research ontology , we will explore an approach to tackle the problem at hand: How to systematize the complex development process of and the multitude of elements comprising IM experience? We'll begin by recalling a now classic definition of Buchanan's idea of Wicked Problems.

2.2 Wicked Problems

What are wicked problems and why are they wicked?

Wicked problems are the ones with too many variables. “The wicked-problems approach suggests that there is a fundamental interdeterminacy in all but the most trivial problems - problems where, as Rittel suggests, the “wickedness” has already been taken out to yield determinate or analytic problems.” (Buchanan, 1992) Buchanan’s views will be addresses and cross-referenced in further discussion.

In a few words here, we draw the distinction between ill-defined / well-defined problems (Schubert, 2021) and wicked problems (Buchanan, 1992). This terminology is essential because the research methodology will greatly depend on these definitions. An ill-defined problem is simply the one that is open-ended: such as ”write a sad piece of music”, for example. Here the practitioner may find one specific approach and the problem is then dependent on one variable, for instance, the practitioner would use minor scale which is known as the ”sad” tonality. Both, ill-defined and well-defined problems, however, can still be ”wicked” if they are founded on ”interdeterminancy” of variables which cannot be studied independently of each other.

It is necessary to admit that IM design presents one of such ”wicked problems” with elements in flux the resulting experience can hardly be quantified in terms of numbers, or can it? Before we can answer this question, we need to make the first step towards understanding the elements of the system. Because we are not able to ”take out the wickedness” to yield IM design deterministic, by formulating the elemental structure we can set the foundation for establishing connections and relationships between them. Until such base is established, no further progress can be made.

In order to find the best approach in designing an Interactive Mediascape, we need to synthesize a description of its ecosystem. We need to define a conceptual space, to have a foundation. Thus, as the first step, I am proposing to draw a semantic model - The Interactive Mediascape Wheel Figure 2.3, which can help with an overview of the system at a glance.

2.3 IM Semantic Model

> *“The work of art is complete only as it works in the experience of others than the one who created it. ...There is the speaker, the thing said, and the one spoken to...”* (Dewey, 1934)

Similar to Neri Oxman’s Krebs Cicle of Creativity (Oxman, 2016) and the Bauhaus Wheel (Gropius, 1922), in describing the phenomenon through a simple representation, IM Semantic model (Figure 2.3) illustrates the disciplines, actions (designer/participant) and (digital/-physical) application domains comprising the experience.

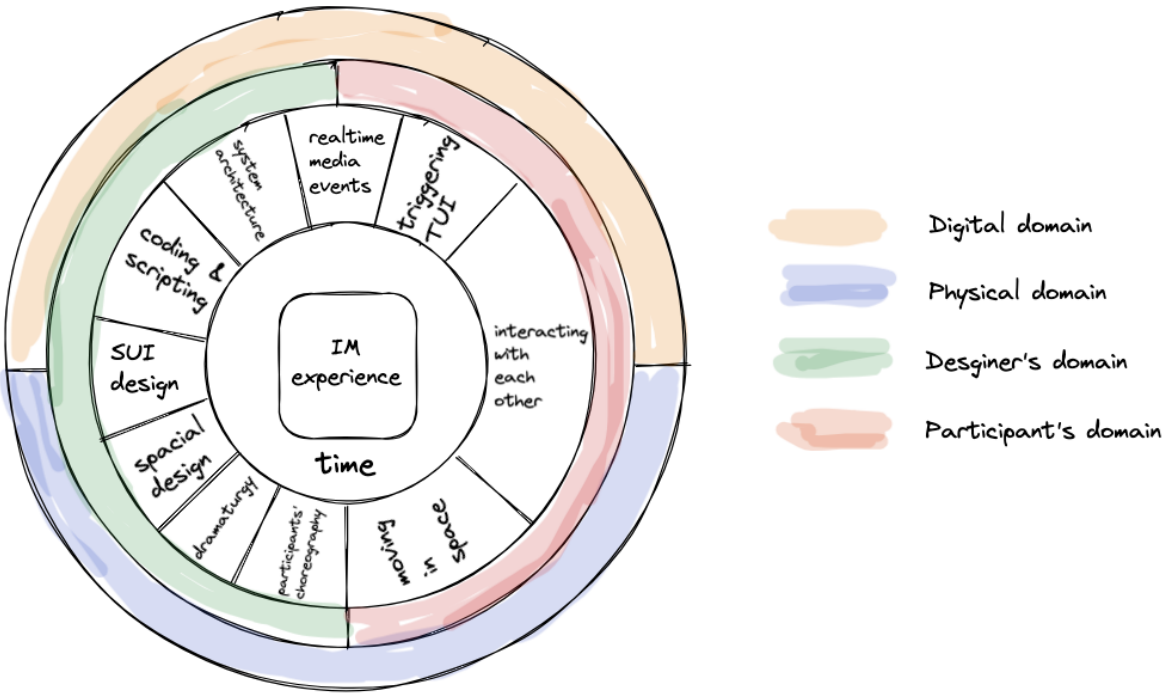

Figure 2.3: IM Wheel (Semantic Model)

By outlining the Interactive Mediascape semantic wheel a complex concept can be easily comprehended and prepare the ground for merging elements and applying existing design techniques. This simple model will also serve as a gateway into the Interactive Mediascape paradigm for novice practitioners and/or someone not familiar with interactive technologies, opening opportunities for academic and extramural collaborations. To reiterate the words of Stoltertman & Wiberg ”anyone can almost instantly get an overall understanding of the character of the concept without any expertise or special training” (Stolterman and Wiberg, 2010). Although the intention is to provide a framework as a starting point for multimedia & interaction designers; bringing specialists from various fields such as art, literature, media, psychology, etc can enrich the design process and this semantic model can introduce them to the idea without too much technicality.

The diagram shows Physical and Digital as well as Designer's and Participant's domains. Various craft and action elements existing in each domain are defined as slices of the experience wheel. The elements exist in time. The slice size can be adjusted in proportion to the importance the element will play in the designed experience. For more expanded experiences of longer duration, these ratios can change over time.

In the proposed configuration, Spatial User Interface (SUI) slice is positioned at the intersection of physical and digital domains, this is because SUI is comprised of a physical object

coupled with digital output. While real-time media events slice appears at the intersection of designer and participant domains, illustrating the fact that, while events are scripted by the designer, they are triggered by the participant.

2.4 IM Taxonomy

2.4.1 IM Taxonomy of Elements

In the proposed taxonomy the experience of interactive mediascape is composed of 5 primary elements, their primary and secondary attributes and descriptors, plus the mediating elements through which the main elements are connected to the experience. Departing from the borader view of the Semantic Model, the purpose of the Taxonomy is to enable developers to describe the whole experience in great detail. This is important to ensure comparability of results and also to illustrate the vast spectrum of tools available to the designer, through which the experience can be expressed. Establishing this relational model of elements could help in the future to understand certain correlations between the elements and their functions in facilitating the Interactive Mediascape experience.

The 5 *primary elements* are: SUI, Media, Content, Motivation and User (Figure 2.4). These 5 elements are at the root of the experience formation. They are connected to the experience itself through the essential *mediating elements*: Perception Modality, Spacial Configuration, Coupling State, and Temporal Dynamics.

Mediais a primary element. It refers to the type of media used in the project. There are two main attributes Modality Type and MR Component. The former refers to the type of modality the media represents, the latter - whether the project contains a mixed reality component such as VR, AR, etc.

User is a primary element. It refers to the participant as interactor and has one main attribute called Collaboration Type, which further is divided into 3 secondary attributes - group, individual, 4th wall. These secondary attributes describe the experience design scenario, it can be for a group of people, for one individual or for a performer/audience (insights regarding this can be found in Delsgaard's work (Dalsgaard and Hansen, 2008)),

SUI is a primary element. It refers to the spatial user interface which is comprised of interaction devices embedded within physical vicinity of the experience. This element has a number of attributes: Sensor Name, Interaction Type, Sensor Type, Feedback and Feedforward(Wensveen et al., 2004). Feedback and Feedforward are definitions borrowed from

the Frogger coupling system mentioned in the state of the art in Chapter 1. Further, some attributes have specific descriptors.

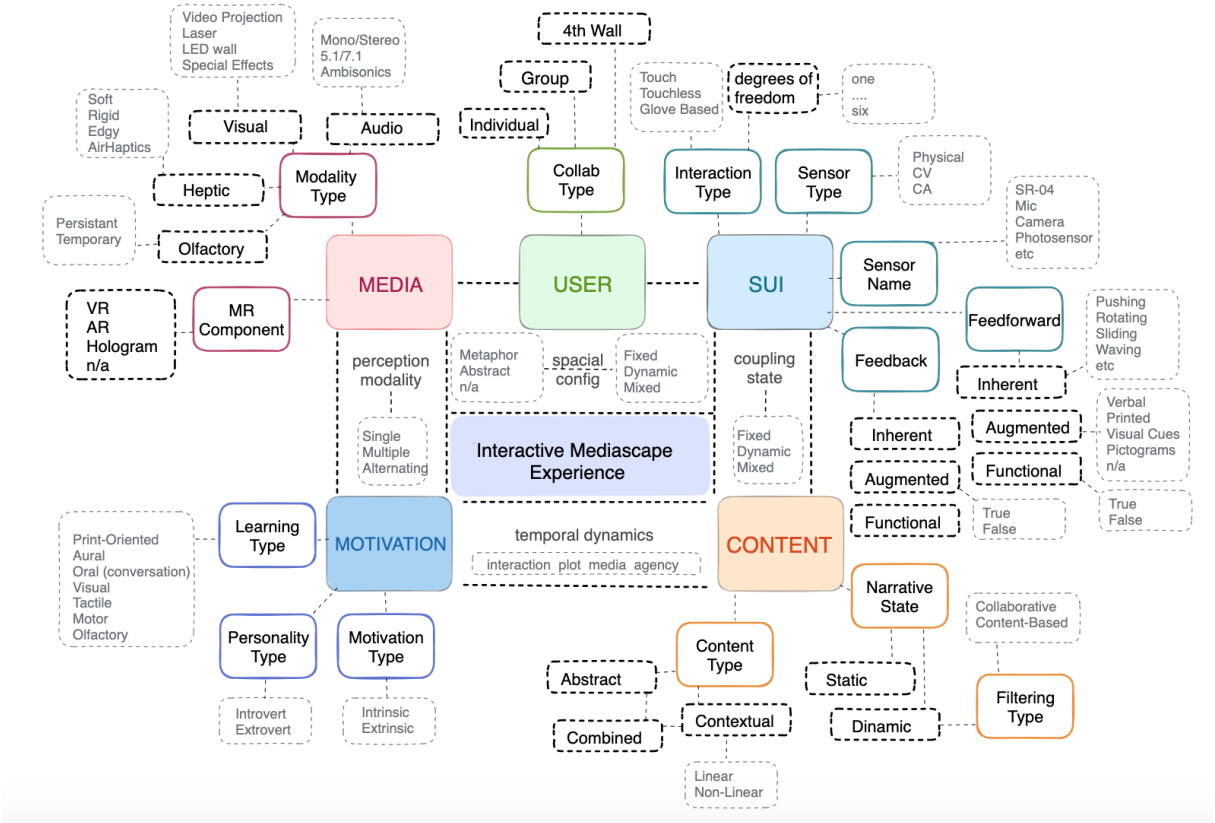

Figure 2.4: IM Taxonomy of Elements

Content is a primary element. It refers to the type of content presented in the project. This element has 3 primary attributes: Content type which describes the story-line, Narrative State which refers to whether the story-line is hard-coded (static) or dynamic (user/system enabled), and, in case it is dynamic, Filtering Type - an attribute borrowed from recommendation systems jargon, an idea explored in experiential computing concept by Ramesh Jain (Jain, 2003). Here it specifies the nature of generative algorithm in dynamic content creation. Considering advancements of ML, it's possible to speculate that a novel approach to dynamic narrative will emerge in the future.

Motivation is a primary element. It refers to the foundation for selecting the participant motivation strategy. It's attributes are Learning Type (Eberts, 1994) or Personality (Jung, 1923), and Motivation Type (Ryan and Deci, 2000).

Primary elements are connected through the mediating elements:

Motivation and Media are mediated by and connected with IM experience through the pa-

rameter **perception modality** which is part of the experience's Affective Loop (Ståhl, 2015) . Participants receive feedback through a single, multiple, or alternating modalities throughout the experience.

Media, User and SUI are mediated by and connected with IM experience through the parameter **spatial configuration**. This refers to the overall spatial configuration of the experience. Each of the primary elements Media, User and SUI can have a specific place in spatial configuration of the experience. The properties can be described as fixed - positioned in the same place for the duration of the experience, dynamic - being movable or mixed (for example, the projections may remain fixed (Media element), while the users can move around (User element) the space and move interactive triggering devices (SUI element) with them in space). The other property discussed under spatial configuration is form - Abstract or Metaphor placement (Gibbs et al., 2004), referring to metaphorical representations present in media, interior (Rai et al., 2019), mise en scène (Braun, 1998) and/or TUI (Eberts, 1994, Hornecker and Buur, 2006, Fishkin, 2004, Ishii and Ullmer, 1998) placement.

Media and SUI are mediated by and connected with IM experience through the parameter of **coupling (mapping)** of media content to the user interface devices (triggering devices). The Coupling state can be Fixed - when one media event can be triggered by the same device throughout to the experience, Dynamic - when the same triggering device can be coupled with various media events over a period of time, or Mixed - when the experience is designed with some triggering devices being Fixed and some being Dynamic.

Motivation and Content are mediated by and connected with IM experience through the parameter **temporal dynamics** which describes the changes or variations over time. This is where event scripting and timing is noted, where the rhythm of the experience and multimodal orchestration takes place. This is where the designer addresses scenario-related questions related to making the temporal arrangement of media events on a timeline and also planning for event density and user task complexity dynamics.

2.4.2 IM Taxonomy and Buchanan's Four Order System

A few decades ago in 1992 a now highly-regarded concept in design thinking methodology was formulated by Richard Buchanan (Buchanan, 1992). Buchanan specifically addressed the question of complex problems in design with multiple variables at hand, problems, which do not allow for a single-handed solution. He approached it from the "liberal arts" point of view supported by Dewey's definitions of art, science and technology. "Instead of treating science as primary and art as secondary, Dewey pointed toward science as art" (Buchanan,

1992).

Moving further in this train of thought, Buchanan is concerned with the idea of ”segmentation” of knowledge, specifically but not limited to design domain. He talks about the importance to understanding the categories, yet remembering that these categories, in actuality, are connected. He notes that at ”as a vision of an encyclopedic education of beaux arts, belles lettras, history, various natural sciences and mathematics, philosophy, and the fledgling social sciences... their pick as liberal arts, these subjects matters provided an integrated understanding of human experience and the array of available knowledge.”

He then makes an analogy with the current development of design, as he notes there are four main directions of practice in design (today referred to as The Four Order system): *symbolic and visual communications, objects, activities and organized services, and complex systems or environments for living, working, playing, and learning*. While symbols, objects, and activities can be defined as such, the complex systems also ”express the unity of any balance and functioning whole” and designers are increasingly concerned with ”exploring the role of design in sustaining, developing,... [and] shaping these environments...” while integrating human beings within such designed spaces.

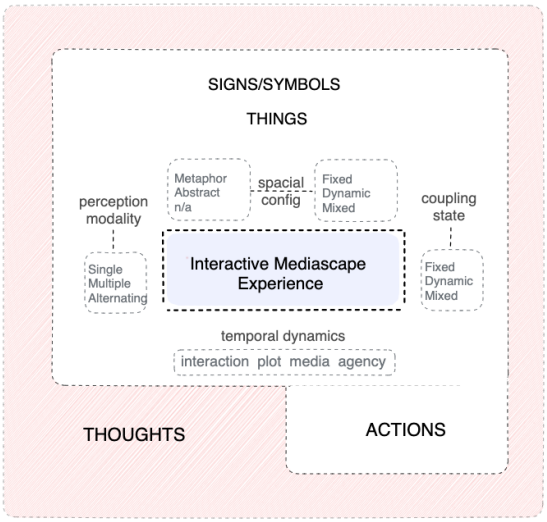

Figure 2.5: IM Taxonomy within Buchanan’s Four Order System

Although, Buchanan proposes the four directions of design, he also cautions, ”the areas are also interconnected, with no priority given to any single one. For example, the sequence of signs, things, actions, and thought could be regarded as an ascent from confusing parts to orderly wholes...But there is no reason to believe that parts and wholes must be treated as ascending rather than descending order.”

In other words, if we consider this idea within IM Taxonomy of elements, we cannot name the one and only most important element. Such description remains fluid and can be different for every project. However, it is useful to have the categories/attributes/parameter, just as it is helpful to distinguish between the four orders of design. This helps in organization of work, in analysis, and in making intelligent decisions about a specific aspect of the system. But in no way should it be considered as a hierarchical type of relations between the elements (unless such relation has been established through theory and practice, although even then, a change in a single parameter may cause a disruption to the hierarchy). Buchanan always stresses to examine a ”particular” problem, rather than general.

In its particularity of approach design greatly differs from science. In design *indeterminacy* is addressed qualitatively through practice, whereas in science problems are, in fact, *undetermined* and can be approached quantitatively while studying principles, laws, rules, or structures that are necessarily embodied in existing subject matter. This idea is very well illustrated in a PhD work of Anna Ståhl (2015) (Ståhl, 2015), where she points to the difference in HCI and design research methodologies at large. She shows HCI ”single-tracked” iterative approach (adapted from Buxton 2007) and Design ”exploratory” approach.

These illustrations correspond in principle with Buchanan's definitions of indeterminacy within wicked problems which are often the subject matter in design research and undetermined in defined problems, which are usually the focus in such fields as HCI, IoT and Engineering.

However, let's hold a hypothesis in line with Buchanan's observations: a possibility of successful interdisciplinary dialogue exists: “the participants, who increasingly come from diverse professions and academic disciplines ... are drawn together because they share a mutual interest in a common theme: *the conception and planning of the artificial* ... Communication is possible at such meetings because the results of research and discussion, despite wide differences in intellectual and practical perspectives, are always connected by this theme, and, therefore, *supplemental*.” (Buchanan, 1992)

Buchanan calls for creating ”integrative disciplines” to move away from the ”patchwork quilt of specializations” towards a more integrated view on the design process. He recognizes the fact that scientific knowledge is important in the basis of design, but he underlines that its main function is to ”to connect and integrate useful knowledge from the arts and sciences alike... in ways that are suited to the problems and purposes of the present.”

By integrating Buchanan's Four Order System of design with IM Taxonomy, we lay a foundation for combining ”single-tracked” and ”exploratory” approaches to enable interdisciplinary collaboration in designing IM experience, where practitioners of a given research field can remain true to their methods, while maintaining awareness of each other's perspective.

The diagram in Figure 2.5 takes the core of IM Taxonomy and references it against Buchanan's Four Order Design classification. It identifies conceptual space where the majority of each design order exists. Signs and Things correspond to the SUI interactive modules and other objects located within the space - the overall spatial configuration, while Actions correspond to dynamic (temporal) properties - the script, as well as motivation, and the mode of interaction. Thoughts order encompasses all aspects of the experience; with symbols, things and actions contributing. One may argue that there is a cross over between Signs and Media (if the media content is filled with metaphor, for example) or Actions and Spacial Configuration (if persons move in space for example). These can certainly act as supplements in the design process.

2.4.3 Embodiment & Metaphor within IM Taxonomy

"Linguists have documented a number of Mayan languages such as Mixtec, Tzeltal and Zapotec whose prepositional structure is entirely composed of body-part morphemes. For example, saying the stone is under the table requires saying the stone is proximal to the table's belly (yuu wa hiyaa cii-mesa / stone the be-located table-belly) (Lakoff 1987: 313)." (Rohrer, 2008)

Could it be that metaphorical perception arises from within our body? Gibbs et al pose hypothesize that poetics and expressiveness of metaphoric language originate within "ordinary, felt sensations of their [people's] bodies in action" (Gibbs et al., 2004) They conclude that metaphors are deeply embodied in our experience "metaphorical thought and language arises from, and is grounded in, embodiment" (Gibbs et al., 2004).

Ishii & Ullmer (1999), discuss metaphor in their early paper on tangible user interfaces, saying "we realized that metaphors which bridge physical and digital worlds are particularly interesting" (Ishii and Ullmer, 1998). The idea of metaphor was already present in Graphic User Interfaces (GUI), for example "windows", "files", "folders", later "cloud", etc. For the last 20 years metaphor has also been widely discussed as a vehicle for expanding tangible user interface efficacy. With TUIs came tangibility, thus the idea of "embodying" a metaphor. The question of *embodiment* has been a long standing inquiry by philosophers paragmatists (Rohrer, 2008) and phenomenologists (Dourish, 2001a, Ciolfi, 2004), who investigated the mind/space duality, or rather its absence (Damasio, 1994). For the last two decades, with growing research on TUIs, the concept of embodiment has also been examined in interaction design.

In this section I will present one specific idea, accepted by the research community, which

encompasses TUIs, metaphor and embodiment and will propose a format of adapting it to IM ecosystem.

The idea belongs to Kenneth P Fishkin (2004) (Fishkin, 2004), he establishes a two-dimentional taxonomy of metaphor and embodiment for design and analysis of TUIs. Fishkin proposes to classify embodiment in terms of proximity: full (output device *is* the input device), nearby (near), environment (around), distant (over there). Consequently, he suggests, that metaphor can be classified based on cognitive psychology theory which show inherent intuitive distinctions people make between verbs and nouns as follows: none (no metaphor), noun (an object), verb (an action), noun and verb (i.e. ”drag-and-drop”), full (virtual system is equivalent to physical system) (Fishkin, 2004). He adapts the ideas of ”object as noun” and ”object as verb” from Underkoffler & Ishii (1999) (Underkoffler and Ishii, 1999).

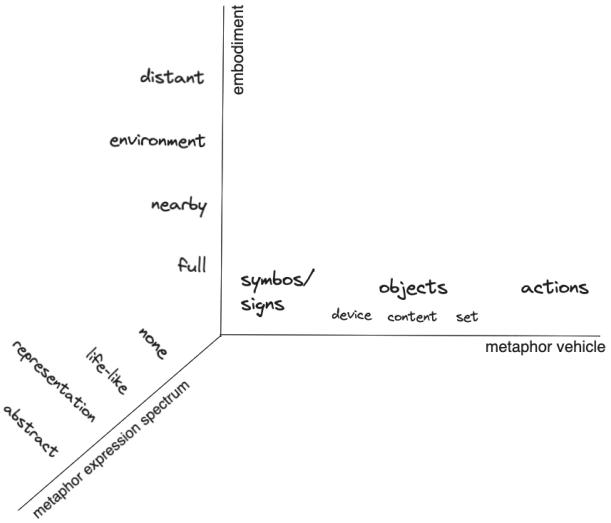

Figure 2.6: Integrated Embodiment/Metaphor Chart for IM

I would like to propose a similar approach to metaphor but adapt it further. While Fishkin is describing Metaphor as an attribute of interaction quality, I would like consider metaphor as an attribute of environment, in order to better reflect the nature of the object through which the metaphor is being expressed. This adjustment shifts the principle focus from purely HCI perspective towards the design domain. The reason it is practical to do so is because, developing IM experience is an interdisciplinary endeavor, the tools we use in the process should be easily graspable, not only by technically savvy, but also by ”aesthetically” savvy specialists. Fishkin’s model can still be used for evaluation, and/or for a more technical dive into the metaphor/embodiment duality within HCI domain, but for design purpose, it is necessary to have a better understanding of the modes of metaphor expression throughout the experience.

It is pragmatic from the design perspective to adapt the metaphor/embodiment relational schema to Buchanan's design concept outlined above, to base embodiment on symbols/signs, things, actions, thoughts(environment) and to further add a dimension of metaphor based the scale of resembling reality: none, life-like, representative, abstract (Figure 2.6). I have to note that "none" in this case is a little counter intuitive, this is as defined by Fishkin - if the object is actually representing itself, so there is no metaphor, per se.

Of course, Fishkin aims to encompass all possible TUIs with his taxonomy, and offers examples of how it can be applies to various systems. Here, the goal is slightly different. We know that IM experience is a co-located TME, so we seek the best systematic approach in describing metaphor/embodiment integration into this specific system. This structure may help designers identify the best attributes of IM taxonomy to "channel" the metaphor into the experience. In chapter 4 I will illustrate the use of this tool in practical terms.

Metaphor is an important aspect of system design to pay attention to, specifically because it's such a powerful tool. It can enhance inherent efficacy of the system, but can also inhibit them (Fishkin, 2004), metaphor serves as a semantic limitation in a given context and sometimes it can be misunderstood by the participants. Users may "not always correctly decipher metaphors, and incongruences between analogue and digital properties may cause metaphors to break down, potentially ruining the user experience" (Dalsgaard and Dindler, 2014).

2.5 IM Design Ideas Evaluation Cycle

Taking the lead from a well known idea of lateral thinking by Edward de Bono and his 6 hats approach (Gonzalez, 2001) to problem solving, I propose a method for thinking about IM design. I summarize de Bono's concept into three main components which are the leading principles behind the 6 hats approach. Intuition (personal feeling), possibility (opportunity), intelligence (research) provide different perspectives for looking at the same problem.

How to explore and evaluate ideas for IM design? There are a number of models of the design process: A simple four stage model of the design process (Cross and Roy 1989), The Double Diamond Model (Design Council 2006), and The Design Thinking Process (Gibbons 2016) (Inie and Dalsgaard, 2020). For example, in the popular double diamond model, in the first diamond divergent ideas are generated through brainstorming and then in the convergent stage, they are narrowed down by evaluation of relevancy, plausibility, etc. I propose to use Intuition. Possibility. Intelligence.(IPI) method as a specific approach in brainstorming IM

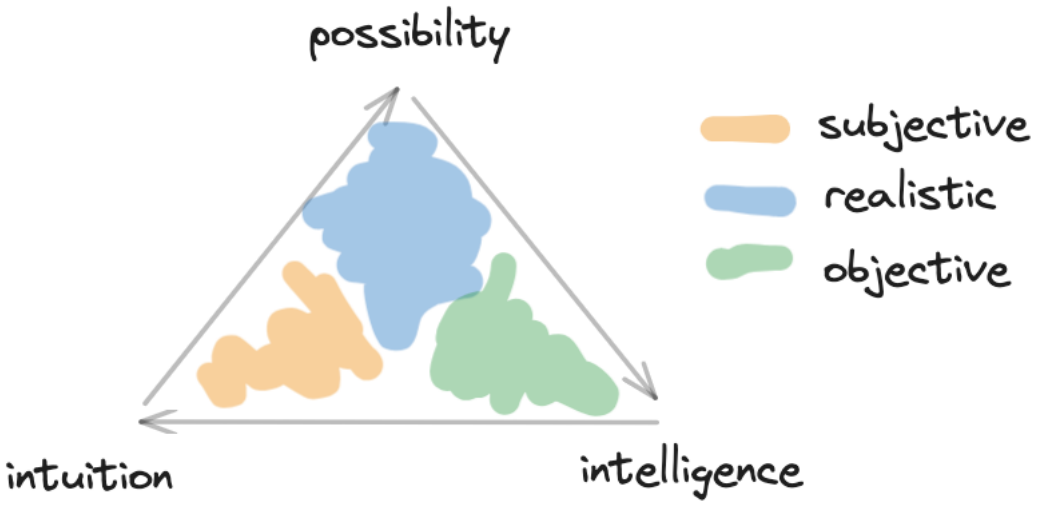

Figure 2.7: IM Intuition. Possibility. Intelligence. idea evaluation model

design ideas.

Inspired by Edward de Bono's lateral thinking and the 6 hats approach to ideas development (Gonzalez, 2001), the IPI is a cycle of reasoning which considers a particular idea from various angles - intuition (subjective - as in does this feel right?), possibility (realistic - such as in what resources are available?), and intelligence (objective - meaning, what does current research tell us?) Once an idea passes through these points, it can be integrated into the design of the Interactive Mediascape experience. The starting point can be at either corner.

By applying the intuition - possibility - intelligence model, collaborators can brainstorm ideas and also work in iterations to improve the idea and design. This method provides a self-regulating structure for idea analysis, it also allows for ideas to enter from various points in the model. It is best if the idea passes through all of these three angles of reference. However, in some cases the intelligence angle may be absent because the phenomenology of TMEs has not been vastly researched yet, not much concrete data is available, and thus, ideas might be based on intuition and possibility only.

A word of caution about using only one of the qualifications, specifically Possibility. Just because something is technically achievable doesn't mean it has value, all too often I have observed in group work that ideas are borrowed and adapted from someone's previous project because it is "cool" and because "we know how to make it happen". Falling into this design-by-analogy trap may leave the main questions of why certain choices are made and how these choices impact the success of the final artifact unanswered. Even if the idea is bor-

rowed, to qualify as useful in IM design it needs to pass through the prism of Intelligence in relation to interaction design.

2.6 Design Sensitivities

Design Sensitivities (Ciolfi, 2004, Hornecker, 2006a, Dalsgaard, 2008) “suggest relevant issues and inspire creative design, rather than imposing rigid rules on the design.” (Dalsgaard, 2008)

Luigina Ciolfi coined the term, she calls the technique of using knowledge to inform the design process rather than dictate the steps - “design sensitivities”. This is a similar idea to “placements” defined by Buchanan (Buchanan, 1992), both of these qualitative criteria set the limitations, boundaries during the design process. Design sensitivities come from induction of what is known theoretically, while “placements” are circumstances defined by the designer (or any other stakeholder) based on heuristics, both of these inform the process. Ciolfi proposes to draw design sensitivities from data gathered during contextual inquiry research. Contextual inquiry data comes from analysis of a specific space where the project is to take place. In the particular case examined in this thesis, however, we’ll be drawing on other type of research to gather data and propose design sensitivities relative to our particular goal. More will be said about this in Chapter 3 and 4. Design sensitivities is a universal bridging concept (Dalsgaard and Dindler, 2014), which can be used in multiple contexts of research practice.

As noted by Peter Delsgaard: ”design sensitivities can be construed as syntheses of given concepts related to the specific concerns of designers of interactive systems.” (Dalsgaard, 2008)

Depending on the goal set by the designer and the stakeholders, research areas can be identified. The research can then be summarized in these practical ”recommendations” to follow / keep in mind throughout the design and implementation process. Understanding scientifically based principles which guide the project would be equally helpful to main designer(s) and other collaborators working on the project. It’s a theoretical ”mood-board” which informs design decisions and helps everyone on the development team to have a grounded vision, while developing solutions based on system’s requirements.

2.7 IM Interdisciplinary Collaboration matrix

Designing an Interactive Mediascape experience is not a trivial task. It combines elements from theater, design, media and engineering, it calls for interdisciplinary collaboration. IM theory aims to provide a structure which can be utilized by researchers and practitioners in a systematic manner. It proposes to erase the separation between researchers and practitioners, specifically projecting design-based and practice-based research methods as the most suitable areas of application for the proposed framework. To move towards interdisciplinary

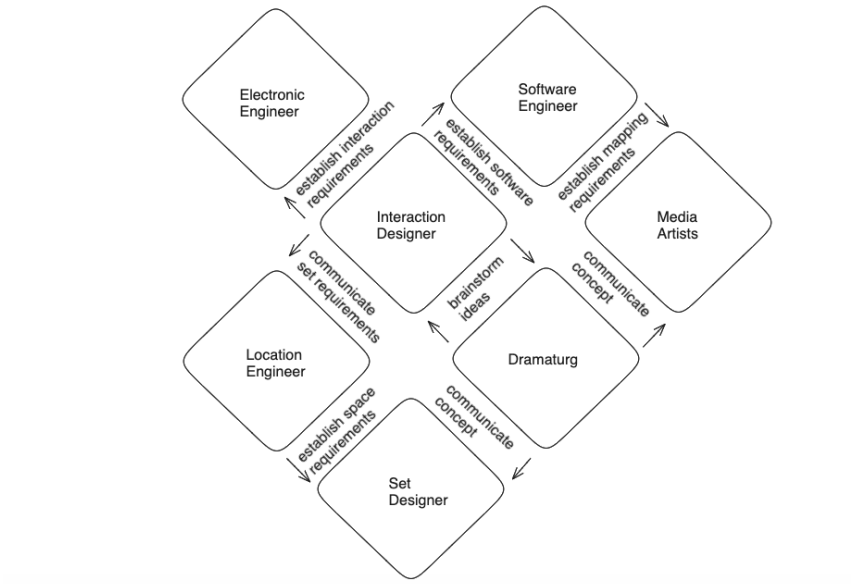

Figure 2.8: IM Interdisciplinary Collaboration matrix

collaboration in design, novel frameworks are needed to integrate research from relevant fields into an interdependent system. Instead of approaching formulation of such framework from a standpoint of a single field, IM theory is defined by understanding how various concepts from across the scientific spectrum are interrelated within a given system. By placing TME in physical space, i.e. Interactive Mediascape Experience, at the center of the framework, we are able to provide multiple entry points for collaborations between specialists from different research domains.

IM semantic model describes a common conceptual base for interdisciplinary collaboration, while taxonomy elements open the multidisciplinary knowledge toolbox to be utilized in addressing specific design challenges. Thus, the semantic model and the taxonomy define the scope of possibilities, however, to understand how to implement these possibilities within the design process, intelligence, i.e. research must take place.

Depending on the objective of the experience which is being developed, a specific knowledge base must be obtained by the developer to establish scientific ground for choosing and calibrating the taxonomy criteria. The resulting ideas from research can then be integrated with the elements of the taxonomy and the designer's vision.

This vision can be then communicated to specialists supporting the implementation process. Thus, from brainstorming which combines designer's intuition with scientific base, the idea can then be communicated to collaborators from other fields (Figure 2.8). This collaboration matrix can be further utilized in design iteration process to make improvements in particular areas of the system.

Number 1 - always begin with a clear goal. Number 2 - know the space where the experience is going to take place. From these data points one can develop the research. From research we develop design sensitivities. Once we know the design sensitivities, we develop the script, the score, draft interaction mappings. Once these items are in place, then we can brainstorm and collaborate with other experts. The diagram outlined in this section only shows a few connections between specialists. This is only an example, these connections will vary with each project. Some projects will require more technical support, others - more artistic. However, the structure outlining the interdisciplinary collaboration is there to remind and guide interactive designers in the process of articulating the final concept. There are opportunities for divergence and convergence of ideas through formulating an iterative collaboration system life-cycle, while using these matrix as a starting point.

2.8 Interactive Mediascape Ecosystem Conclusion

Ideas presented in this chapter are interrelated, however, each one of them can be used independently on a need basis, depending on the challenge one faces. Whether it is explaining the overall idea about the experience to other practitioners, trying to manage the configuration of available elements, making design decisions, creating a collaboration production cycle which involves colleagues from adjacent fields - concepts outlined in this chapter can help in centering the thinking process and giving theoretical foundation for practical work.

3

Collaboration and Creativity Research

Contents

Because I have set the goal of designing IM experience for collaborative creativity, collaboration and creativity research needs to be conducted in order to identify design sensitivities specifically aligned with this goal.

These topics are addressed:

1. Definition of “creativity” in the context of current research goal 3.1.1
2. How can creativity and collaboration be facilitated in IM experience through existing frameworks in groupware 3.3, spatial, and user interface design
3. How to evaluate the success rate of a prototype pertaining to creativity and collaboration 3.6

Once these topics have been explored, in the following chapter an example of project implementation will be presented.

3.1 Creativity Research

Creativity has been noted in recent literature as a survival and mating mechanism (Bonetto et al., 2020), as a human dignity and meaning-making necessity (Corazza, 2016), a catalyst for pleasure (Schubert, 2021),as a gateway to happiness (Csikszentmihalyi, 1996, Csikszentmihalyi, 2008), and indication of well-being (Bateson and Martin, 2011) as the one of the four most important abilities of the 21st century (Qian et al., 2019, Bonetto et al., 2020). Creativity is clearly, although still not well understood, remains one of the most fascinating human abilities. World Economic Forum 2023 report (Masterson, 2023) listed Creative Thinking as second out of 10 most important skills in the future workforce - it is up from position number 5 just three years ago (Whitinga, 2020).

As a product designer, why would I want to design a system (i.e. product/artifact) for collaborative creativity? One obvious answer would be - to enable a creation of innovative and useful ideas, as would be in line with the widely accepted traditional definition of creativity (Runco and Jaeger, 2012), to provide a structure for a group activity so that several people may engage in the creative process and achieve a specific goal.

However, I would like to shift the focus in a different direction and ask: What would such a system have as an intended goal? What if it is NOT concerned with the final output? What if it has at its core the idea of bring people together through a collaborative creative activity, while NOT expecting them to produce any significant result? Going canyoning in the mountains

near Porto carries the goal of being with friends and doing something thrilling, while enjoying nature and each other's company, even though nothing is "produced" at the end.

"A core feature of play is its intrinsic motivation which is powerful while it lasts. No additional external reward is required. Playful play is associated with a positive mood and when it occurs is taken as an indicator of well-being."(Bateson and Martin, 2011)

I would like to examine this position and find a way to bring "playful" creativity into the tapestry of social life. IM experiences can be one of the ways groups of people may enjoy their time and become connected through an experience, while leaving their phones in their pockets and giving their virtual existence a rest. By using technology-mediated systems such environments can be designed where these playful activities can take place.

In this subsection the following ideas will be introduced and discussed to contextualize "creativity" in relation to IM experience design.

- The classic definition and questions of creativity research 3.1.2
- Dynamic creativity definitions 3.1.3
- Dynamic creativity framework & the state of flow 3.1.4

3.1.1 Creativity in the context of IM experience

The following section outlines what is meant by creativity, creative process and a creative state of mind in the context of the current thesis. If any quantitative/comparative analysis is to be assessed upon project completion, a consistency of definitions throughout inception, development, evaluation and analysis stages of research must be maintained.

There appear to be two major fundamental arguments in the domain of creativity research; one is identifying the structure of creativity elements in a systematic way and two - is the definition of creativity itself.

The creativity research domain is immense, I focus specifically on concepts which could be useful in understanding how to design a dynamic experience for a group of people aiming at fostering creativity. The frameworks discussed in this section establish etymological foundation for creativity definition within IM ecosystem.

3.1.2 Standard Definition of Creativity

What is the definition of creativity? Creativity research takes its roots from empirical research at the beginning of last century, when Wallas (1926) identified the four stages of creative pro-

cess as preparation, incubation, illumination and verification (Runco, 2007, Glăveanu, 2013) In 1950s Stein was the first researcher to define creativity in concrete terms as something which is a) deemed useful by others b) reintegrates existing material into something new, and also pointing to the importance of separating personal creativity from historic (Runco and Jaeger, 2012). Since then the standard definition of creativity has been widely used by the scientific cohort with variations in terminology, yet relying on two fundamental criteria "effectiveness and novelty". Effectiveness has been referred to as usefulness, fit, appropriateness and even utility; while novelty has been referred to as originality, inventiveness[1], new. In the multitude of deviations from the core definition, most researchers agree that creativity is to be "judged" by someone other than the person producing the artifact, meaning that the usefulness or effectiveness of the artifact is to be measured against the existing conditions and the creative success of such artifact would depend equally on its usefulness as on its originality.

However, in recent years this position has been challenges. One prominent figure in this debate is Robert W. Weisberg who proposes that the definition of what is creative ought to drop the "usefulness" criterion (Weisberg, 2015). His main concern is that the notion of "usefulness" puts certain barriers on the path of creativity research continuity. He argues number one, usefulness is always a subjective measure, guided by the historic settings and sociocultural circumstances present at the time an artifact is created. And number two, he argues that there is a logical flaw in defining creativity by usefulness, his view is that as time passes certain artifacts may become useful although they were not useful at the time of creation and does this change the status of the person who came up with the artifact from not creative to creative simply because someone decided that now the artifact is useful. There is a third point, but I will come back to it in further discussion.

Weisberg makes an example of Van Gogh (also in Csikszentmihalyi (Csikszentmihalyi, 1996)) who's paintings were not recognized until after his death, does this make Van Gogh creative after he died? But he painted the artworks before he died, does this mean he was not creative before he died because the paintings were not recognized as noteworthy in sociocultural circumstances? In parallel, to bring it closer to home in Portugal, the history of Fernando Pessoa is similar. Can Pessoa be identified as a creative while composing his poems which he hid away and showed to no-one? Was he being creative during his lifetime even if there was no sociocultural validation of his artistic merit?

Usefulness is usually measured against the backdrop of the current knowledge which exists

[1] a debate whether originality and inventiveness are the same has been highlighted in "The creativity paradox" (Bonetto et al., 2020)

in the domain where the artifact is being made. It is assessed by experts in the field, by designated seasoned "gatekeepers" of the domain who decide whether an artifact is effective in providing a better solution than anything that came before. This works in fields of research where a specific problem requires a new approach. But what about the novelty which is driven merely by intrinsic conditions and curiosity? Why did Pessoa feel the need to express himself through words? What about art therapy? What about playful play? Maybe usefulness also can be a trait of intrinsic nature? Can novel artifacts resulting from activity motivated by the intrinsic state and not intended to be useful be considered creative? In Weisberg's definition - yes. He proposes a second criterion for defining creativity "intentionality". Hence his definition reads "A product is creative if it is *novel* and if it was produced *intentionally*".

To take this definition a step further and considering recent research in biology and neuroscience research (Schubert, 2021, Bonetto et al., 2020, Bateson and Martin, 2011) can we speculate that, if the creative act takes place intentionally, intrinsic "usefulness" is equally important as the "usefulness" identified by sociocultural judgements of value? Was the poetry Pessoa was writing at the time valuable to him, to his being? If so, why should this value be of lesser stature than the value "set" on his work by the public after his death? It's a question of intrinsic value vs. extrinsic.

Another aspect of creativity definition worth examining is the question of "scale" personal creativity vs historic of Stein's concepts (Runco and Jaeger, 2012) was extensively further developed by Margaret Boden, identifying P-creativity and H-creativity (Boden, 2007). Spanning from Boden, I-creativity and G-creativity where "I" stands for individual and "G" stands from group were defined in participatory design (Warr and O'Neill, 2004), while Beghetto & Kaufman's 4C framework mainly for application in education domain, proposed to consider creativity on the scale from c-mini to c-BIG (Beghetto and Kaufman, 2007). The diversity of this research is a testament to the fact that there is an underlying difference in creativity qualities which resonate on the personal scale rather than historic (sociocultural).

In defining creativity, thus, the scientific world assigns a function to the creative act. Creative act is to result in something "novel and useful" or creative act is to "find the most optimal solution to the problem" and, it follows that, the research in the creativity domain spans from the initially established function assigned through creativity definition. Thus the function traditionally "assigned" to creativity starting from 1950s has been, as quoted in the words of MacKinnon (1978) in a recent publication by Pichot et al: "the starting point, indeed the bedrock of all studies of creativity, is an analysis of creative products, a determination of what it is that makes them different from more mundane products" (Pichot et al., 2021). However, this "bedrock" lies in a specific zone of creativity research epistemology, it does not

provide a good anchor when we address creativity as a phenomenon which is *not* concerned with the resulting artifact as much as it *is* concerned with exploratory action, curiosity, and experimentation. Judging creativity merit by resulting outcome does not suffice when the starting point of creative action is intrinsic in nature.

One may argue that such "intrinsically motivated" creativity is not useful in sociocultural sense, therefore there is no need to examine it, to understand its function or find structures which may support it. However, this argument hardly stands the ground. Coming back to Van Gogh and Pessoa, these are vivid examples of such creativity which "went unnoticed" but once discovered with time passing became an undivided part of the knowledge domains or art and literature, and in that sense became "useful". This brings me to the third point Weisberg made in his article, it talks precisely about this phenomenon of *"usefulness" mediated by time* but in the scientific domain rather than the arts, he concludes "that there seems to be no principled reason to reject nonvalued products as being noncreative." He refers to an example of two scientists who failed on the first attempt in solving a problem but succeeded on the second some time later due to having more data and better instruments. Weisberg argues that both attempts can be considered creative, albeit judging by the outcome the former one is not successful, because both attempts were intentional and resulted in something novel, they are creative.

The 4Ps - the four directions in creative epistemology first set by Rhodes in a 1961 assay which reviewed techniques in creativity study up to that time (Rhodes, 1961). Based on research literature review, he singled out these four main strands in creativity research: person, process, product, press. Creativity study of the person is mostly psychological, personality traits related research, also summarized as ability (Schubert, 2021). Process is usually referred to cognitive processes involved in creativity, also associated with intentionality (Schubert, 2021). Product is perhaps the most straightforward block of creativity studies concerned with artifacts, the outcome of the creative process. Press is often referred to a place (Runco, 2007) or environmental influence (Glăveanu, 2013), also context in which the creativity occurs (Schubert, 2021)[1]. Overlapping at times, the 4Ps provided the backbone of the creativity research field for decades (Glăveanu, 2013, Runco and Jaeger, 2012).

According to a 2010 publication (Walia, 2019, Kampylis and Valtanen, 2010), a literature review of 42 explicit definitions of creativity was presented. The review included 42 well-established creativity theorists such as Stein, Amabile, Runco, Beghetto, Boden, Csikszentmihalyi and others over the period since 1950s. They concluded the following to be the

[1] However, it is interesting to note Press was a concept used by Murray (1938) and others, the key idea being that there are pressures (or influences) on our behavior. . . Murray (1938) distinguished between alpha and beta presses. The former are entirely environmental or extrinsic; the latter, in contrast, depend on the individual's interpretation.(Runco, 2007)

essence of the review

1. Creativity is a key ability of individual(s).
2. Creativity presumes an intentional activity (process).
3. The creative process occurs in a specific context (environment).
4. The creative process entails the generation of product(s) (tangible or intangible). Creative product(s) must be novel (original, unconventional) and appropriate (valuable, useful) to some extent, at least for the creative individual(s). (Kampylis and Valtanen, 2010)

It is apparent that Rhodes' 4Ps framework could be used to summarize the generally agreed upon components of creativity.

3.1.3 Dynamic Creativity Definitions

However, in recent years there has been much debate about the place of the 4Ps in the field of creativity research, being considered as the "metatheory" of the research domain (Glăveanu, 2013) and still the most referenced, Rhodes' concept is questioned and expanded by a number of researchers. The context of this thesis does not provide the time to look closely at all deviations from the main creativity concept, however, driven by the Interactive Mediascape ontology, it is interesting to find concepts which are closely related to the idea of creativity within IM ecosystem. The theoretical works discussed in this section are:

- Glăveanu (2013) (Glăveanu, 2013) 3.1.3
- Corazza (2016) (Corazza, 2016) 3.1.3
- Walia (2019) (Walia, 2019) 3.1.3
- Glăveanu & Beghetto (2020) (Glăveanu and Beghetto, 2020) 3.1.3

Glăveanu and other authors are interested in viewing creativity as a dynamic process which is to be evaluated not by the merit of outcome but also by the creative activity itself marked by time. They each have a different view but their theories are related in the premise that the creativity research has to move beyond evaluating results and towards establishing methodologies to address the evolution of the creative process overtime.

> *"The language of creativity or, better said, the language of creativity theory and research in psychology is a language written largely from the perspective of the individual and, within individuals, from the perspective of cognitive functioning. Key terms that help us, to this day, organize the growing literature in the field reflect not only an inherent individualism and cognitivism . . . but also a rather static, disjointed, and acontextual approach to creativity. There is however a pressing need to expand our language and consequently our thinking about this phenomenon, to do justice to its true complexity and relational nature and be able, ultimately, to understand and cultivate creativity in a variety of domains."* (Glăveanu, 2013)

One of the key goals of IM design is to create an environment which fosters creativity, the other is to bring the experience from the individualistic perspective into the WE-paradigm. Glăveanu is driven by the same motif in the study of creativity as we are in experience design, he emphasizes the need to integrate the elements of creativity and find a unifying set of relationships between the 4 Ps, to consider the environment and socio-cultural context. Glăveanu mentions the work of Moran (2009) who proposes a system of interconnectedness between the 4 Ps, however, in Glăveanu's view this inquiry doesn't go far enough in providing a proper place for the dynamic, circumstantial nature of creativity. In his view the question posed by Moran "How can these dimensions be studied interactively? That is, what lens might support scholars to focus not on the elements themselves but on the dynamics among elements?" still remains open. "By focusing on the individual, any background element became secondary and so did the many ties connecting people with their specific situations and ways of living." (Glăveanu, 2013) Glăveanu proposes to embed the creative process within a broader concept of action in order to acknowledge "the double nature of creativity: an internal, psychological dimension and an external, behavioral one" and to view these actions in context "to pay increased attention to the domain of the creation, the characteristics of the creator, and features of the situation." Glăveanu proposes a new schematic basis for research, making relationships between elements one of the objectives, rather than evaluating each element on its own. He defines a 5As system of creativity where the five As are: actor, audience, artifact, action and affordances (Figure 3.1).

While keeping the 4Ps concept, Glăveanu proposes to rename the elements and, instead of addressing "press" as a single element of place or environmental context, split it into audience and affordances. He proposes the idea that in the environment people other than the creator can equally influence the creative process through their judgements etc, while affordances of the place may provide opportunities or challenges. Quoting Rhodes himself, Glăveanu suggests that the 4Ps elements of the creative process were never meant to be

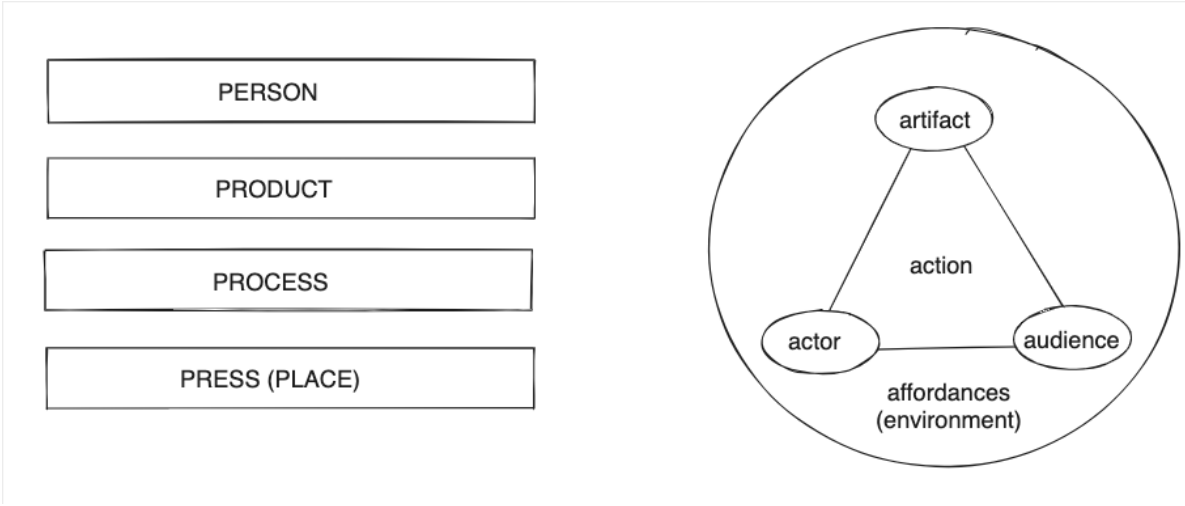

Figure 3.1: Creativity Models Rhodes 1961 (left), Glăveanu 2013 (right)

studied as independent entities but rather needed to be integrated within a relational ecosystem. He, thus, draws the elements in a schematic way where the creative action is in the middle, surrounded by a triangle composed of actor, audience, and artifact while the whole system exists within a circle representing environmental affordances.

This definition is a wholesome way to look at the creative process and to envision it not as the evaluation of the outcome but rather an action which carries the influences of the other 4As and may in return interact with the other elements as well.

As a side-note observation, remembering earlier mentioned Wicked problems in Design, it is easy to see a similarity in how Buchanan suggests approaching such problems - to view the possible solution as a set of interconnected elements none of which can be separately determined, but rather characterized by indeterminacy in absence of a specific context. This is very interesting because this likeness in thinking leads us to hypothesize that the method in designing for creativity needs to be substantially grounded in practice-based inquiry. Drawing feedback from prototype demonstration is necessary, because the act of creativity is related to the affordances of the environment as much as it's related to other factors.

> *"... creativity will not only be accessible to everyone, but it will essentially be the prime skill and talent for all human beings... in today's society, where technologies are transforming information into a mere commodity at the disposal of anyone who can access networked resources, the dignity and self-esteem of human beings cannot be related any longer to the mere possession of knowledge and know-how, but rather to the transformation of that knowledge for the generation of new ideas, concepts, and artefacts starting from the shared layer of extant*

> *information. . . . In the lifespan of but a few generations, creativity will therefore pass from a sort of scientific singularity reserved to a few talented individuals to an essential ability for the entire human species. "* (Corazza, 2016)

Corazza explores the idea of subjective judgement in the creative process, instead of setting this characteristic as as negative, he regards it as "a degree of freedom which allows interpretation, imagination, discovery of value in a novel outcome by a specific observer, where perhaps others cannot see any". (Corazza, 2016) He argues against Weisberg's idea of intentional novelty, saying that without "value judgment it becomes impossible for the creator to advance and conclude his/her creative activity". Instead of criticizing the idea of evaluation in effectiveness/value itself, his critical focus falls on the subject of evaluation. Corazza argues that evaluating "static" creative achievement is impossible to accomplish due to subjectivity of judgement coming from any given expert involved in measuring this achievement. He talks about creative "inconclusiveness", as an outcome which implies insufficient originality or effectiveness, inconclusive outcomes may, however, eventually lead to a highly valued creative artifact, it should be considered as part of a greater creative cycle. Thus, Corazza proposes to consider the "potentiality" of creative activity and redefines the traditional definition of creativity by stating "creativity requires potential originality and effectiveness".

Although no clear relational diagram is drawn or evaluation method provided, Potential Originality and Effectiveness: The Dynamic Definition of Creativity, raises important questions and they are in line with the general sentiment in the creativity research field. Evaluating creativity by analysis of the outcome is a limited view of the subject matter. Corazza expands this idea by proposing to connect subjectivity of judgement of outcome to a time-dependent and context-dependent metric in order to trace results overtime. He argues for creativity as an overarching phenomenon and vouches for general education in creative thinking.

> *"Herein lies the problem in studying creativity as synonymous with creation, because creation can be judged only when it has concluded, whereas creativity is active throughout the process and may not even end after having led to creation."* (Walia, 2019)

The idea of potentiality was integrated into the description of creativity as early as 2007 by Runco, he proposed to arrange the traditional 4Ps in hierarchy of elements (Runco, 2007). Runco separated creative potential and creative performance and stated that potential does not predict performance because of its dependence on opportunities. He thus added "persuasion and interaction" as part of the creative performance, interaction being the multiple of

personal ability x environment. Further in 2018 this model was finessed by Runco & Kim and introduced as six Ps: person, process, place (or press), product, persuasion, and potential (Walia, 2019).

Walia further developed these ideas into a dynamic framework. By differentiating between the act of creativity and the creation, he was able to define a conceptual space where the two are treated as separate entities. He notes that in most instances modern literature "equates creativity to creation". However, "an act may be creative and yet the creation might be disregarded by the field or the domain", and this echoes Weisberg's point. He argues that much of the debate about the definitions arises from merging creativity (as an act) with creation. To resolve this logical inconsistency Walia sets "[t]he objective (. . .) to examine the elements of creativity separately from the elements of creation and use these elements to define creativity and creation." (Walia, 2019)

Walia then draws a dynamic framework integrating Runco & Kim's elemental creativity construct with that of Rhodes' 4Ps. He proposes that *creativity is an act and thus a dynamic process, while a creation is something tangible or observable*. In his view, creative acts require "deliberate practice and time, (Weisberg, 1999), emotional (Schuldberg, 1994; Vygotsky, 2004) and cognitive engagement (Ward & Kolomyts, 2010), and sometimes a total absorption or immersion in the task (Csikszentmihalyi, 1996)." Creative acts are prompted by a certain "acknowledged disequilibrium" which exists in a given context and aim to resolve it, thus productive [1] activity is triggered.

In Walia's schematic representation we see the "social environment" as a separate entity from that of "press". He places "knowledge & past experience" and the onset of creative activity, i.e. "triggering product activity", under "press", while placing "perceiving environment" under "process". The only link he proposes to "perceiving environment" is through person's "cognitive ability". However, a question then arises about perceptions which are not processed on the level of cognition - sensorial and emotional events. Placing the load of environmental perception purely on cognition, creates a limitation of the human condition as a whole which is behavior is a result of entanglement of emotions and reason (Damasio, 1994). Considering this circumstance, it's possible to say that Walia's schema is incomplete. Although it is a major step forward in thinking about the dynamic representation of creative potential, it is a

[1] "Creativity is a production and not a reproduction - "Productive activity occurs when new experiences interact with existing knowledge and experiences to create new images for the future (Vygotsky, 2004)" (Walia, 2019) It is to be noted that the distinction between reproductive and productive activity was made by Vygortsky. He was actively writing during 1920-30s, and the term reproduction at that time, arguably had a narrower meaning, closer to "copying". While "reproduction" is still equated in Merriam-webster dictionary with "copy" https://www.merriam-webster.com/dictionary/reproduction, considering the age of re-mix we live in, reproduction, if not treated in absolute terms, may have a broader scope of definition in practice. For example, reproduction can be carried out in a style different from original or in another application domain. Thus, reproduction may provide less of a dichotomy with production and, perhaps, for the clarity of differentiation we may consider production vs copying.

representation which does not reflect the complexity of human perception.

For that matter, as we see in the next publication, a hypothesis exists, that a person may be creative even without realizing it. Such hypothesis has to be rejected according to Walia's view, however, the authors Glăveanu & Beghetto (Glăveanu and Beghetto, 2020) make a good case for it, as will be outlined in the following discussion, and perhaps it's Walia's representation which needs further analysis and adjustment.

> *"What we question is the "standardness" of considering creativity almost exclusively in terms of products and product-directed processes.(. . .) Our issue is (. . .) the fact that this definition directs our attention toward the outcome (i.e., ideas and products) with little consideration for any other dimension of creativity . . . If originality and effectiveness were studied in more contextual terms, as Stein (1953) actually recommended, then the processes that become apparent are those of meaning-making, within and between different groups, about what makes an outcome novel, original, useful or appropriate . . . we want to focus on creativity as an experience, a line of thought that has just as old if not older historical roots (see Dewey, 1934; May, 1975; Schachtel, 1971)"* (Glăveanu and Beghetto, 2020)

Glăveanu & Beghetto move even further than Walia in differentiating between a *creative act* and *creation*, towards establishing a new approach in defining a *creative experience*. They argue that creativity is a property emerging from the person interacting with the world. Thus, the product-oriented evaluations or processes defined by a linear trajectory towards achieving specific goals describe only a portion of the phenomena which can be attributed to creativity.

They name one of the main pitfalls of outcome based evaluations: the fact that processes cannot be easily backtracked from the analysis of outcomes. Creativity, in their view, also may have no acknowledgeable result. "Our perspective asserts that creativity represents dynamic and indefinite encounters with a wide variety of lived experiences, including artifacts and outcomes, situations and contexts, and the full spectrum of lived events, which may have no clear trajectory, finalized endpoint, or tangible result".

It is evident that evaluating creativity result can not be done on an absolute scale, it requires judgement based on available knowledge in specific circumstantial socio-cultural reality and, therefore, subjective. So then, how can we foster creativity which appears to be an elusive phenomenon? From previously discussed literature, we draw a distinction between *creative experience*, *creative act* and the *creation*. In the following discussion we'll focus on the **creative act** and **creative experience** rather than creation and the questions of how a creative

act can be nurtured and evaluated, to quote Csikszentmihalyi: ”the first question I ask of creativity is not *what* is it but *where* is it?” (Csikszentmihalyi, 2014). So where does creative act or creative experience take place?

3.1.4 Csikszentmihalyi's Concept of Flow

After reviewing the aforementioned literature, it is plausible to say that *creativity is an emergent phenomenon and, while favorable intrinsic (within person) and extrinsic (within environment) conditions exist, it manifests itself*. Spanning from this conclusion it follows that in order to foster a creative experience, certain conditions need to be provided. What could these conditions be from a practical point of view? Here is Csikszentmihalyi describing the state of flow:

> *“It is the state in which a person becomes engaged in what he or she is doing to such an extent that all his attention becomes focused on the task and the rest of the world—with all of its problems and possibilities—no longer attracts attention.(. . .) This feeling is what we called the autotelic experience, or flow; and it appeared that this was such a great feeling that people would seek it out even when no other rewards or goals motivated them (Csikszentmihalyi, 1990, 1975/2000).”* (Csikszentmihalyi and Asakawa, 2016)

IM designed for collaborative creativity aims to expand individual's inclination of being creative, divergent thinking and exploration - it promotes openness of definitions and provides an environment where individuals are not afraid to act playfully, interact, think outside of the box and experiment. IM experience, if it is to foster creativity, has to gravitate towards conditions in its environment which allow for an activity leading to a creative state of mind, a state of mind which can be identified as “being in the flow”.

Mihaly Csikszentmihalyi's works on creativity have been quoted over 100,000 times according to researchgate (res,). All of the creativity researchers mentioned above have referenced his work. It is a natural development to understand whether his findings can shine some light on how to approach the question of creativity, or rather, how to design for it, in the context of Interactive Mediascape environment.

Mihaly Csikszentmihalyi draws a diagram of psychological states on the skill/challenge axis (Figure 3.2) (Csikszentmihalyi, 2008). He shows that the optimal conditions for the “flow” state, which according to Csikszentmihalyi theory[1] is the most favorable for creativity, is be-

[1] there has been criticism of Csikszentmihalyi theory when considered in the context of educational or work environments, however, Interactive Mediascape exists outside of these contexts mostly as a leisure activity which is meant to be enjoyed

tween arousal (we'll call it excitement) and control. He argues that a person can enter the flow through the latter of the former. Before we can discuss the conditions of Interactive Mediascape experience which can cultivate either of these states, we need to spend a few minutes understanding what is the relationship between challenge and skill in the context of Interactive Mediascape Experience.

"This feeling is what we called the autotelic experience, or flow; and it appeared that this was such a great feeling that people would seek it out even when no other rewards or goals motivated them (Csikszentmihalyi, 1990, 1975/2000)... conditions where the challenges were slightly higher than the person's skills—were the most favorable for allowing flow to emerge (Abuhamdeh & Csikszentmihalyi, 2012; Moneta & Csikszentmihalyi, 1999)." (Csikszentmihalyi and Asakawa, 2016)

Skill is related to learning and to knowledge however, skill implies a practical application of learning or knowledge - hence it requires action, active participation. A person cannot gain a swimming skill unless a person goes in the water. In a similar way, no matter how much explanation one gets about the interactive system, until one tries to interact with it no skill is developed. Further, to develop higher level of skill a person's user journey must involve a complexity curve over the time of experience with interactions becoming more sophisticated in nature. Thus, providing an adequate action opportunity for the skill level to advance is key.

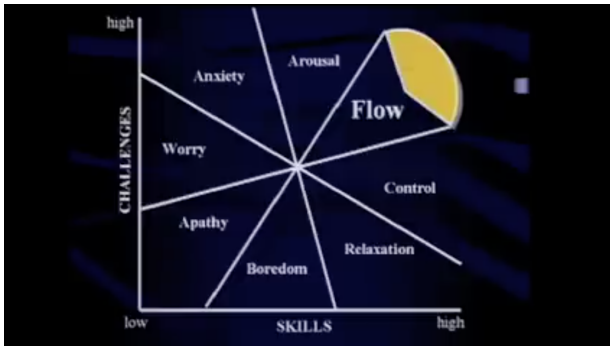

Figure 3.2: Csikszentmihalyi's chart of emotional states

Challenge is related to external and internal motivation, however, meeting the challenge is enabled by available tools plus opportunities for action. An evaluation method based on this model will be presented at the end of this chapter.

The concept of flow is consistent with the findings of a recent study of creativity apps for children (Marsh et al., 2018), which also also echoes Glaveanu & Bengetto's conclusions (Glăveanu and Beghetto, 2020). The study discovered key features in children's apps which promote or inhibit play and creativity. Marsh et al outline these key factors as inhibitors: no

clear aims, or too many aims; being too narrowly focused, with tasks that contain few challenges; contain few scaffolding techniques [enabling to gain skills/understanding]. Whereas the positive play and creativity effect is supported by features such as: a great deal of appropriate scaffolding that is both visual and aural (ie, not over-reliant on text); inclusion of open-ended activities, which enable children to experiment for themselves and focus on the process rather than an end product; embedded activities that foster co-production of content (with peers or adults). Although the research domain of this study, online apps for young children, is not perfectly aligned with that of the current thesis, the findings of Marsh et al, nevertheless, inform the current inquiry. Key factors outlined in the paper are in line with the concept of flow and provide concrete examples of design scenarios which can effect skill/challenge balance.

Csikszentmihalyi's idea is also at the center of Creativity Support Index (Cherry and Latulipe, 2009) - a product evaluation tool which will be discussed below. The authors of CSI quote Csikszentmihalyi directly and name the main factors for sustaining the state of "flow": 1. There are clear goals every step of the way. 2. There is immediate feedback to one's actions. 3. There is a balance between challenges and skills. 4. Action and awareness are merged. 5. Distractions are excluded from consciousness. 6. There is no worry of failure. 7. Self-consciousness disappears. 8. The sense of time becomes distorted 9. The activity becomes autotelic, [the meaning of the activity is within itself]. (Csikszentmihalyi, 1996, Csikszentmihalyi, 2008, Cherry and Latulipe, 2009)

The flow theory is also referenced in "Designing for Inquisitive Use" by Delsgaard "flow can be understood as convergence of conflict and inquiry" (Dalsgaard, 2008). I will further discuss his idea in the following section.

3.2 Motivation through Curiosity

Now, let's examine possible motivation mechanisms which go hand in hand with creativity. Peter Delsgaard proposes to view participants as "resourceful co-creators of experience in the use [of] interactive systems, capable of finding ways of making sense of installations that are not self-evident in their structure, presentation, or operation." (Dalsgaard, 2008) As interactive mediascape experience is not strictly speaking an installation but rather an interactive spatiotemporal narrative, we can look at Delsgaard's ideas from this particular perspective. In his paper "Designing for Inquisitive Use", he defines 9 design sensitivities which could be useful to designers at the start of their project planning. These ideas are grounded in terms of Deweyan definitions of *experience, inquiry and conflict*. Some of the

key points to consider are: the notion of ”problematic” and ”aesthetic” experience and that they are interrelated, with problematic often resulting in aesthetic; that there is a possibility of ”a transactional” situation - where the situation is changing by the means of interaction loop between the participant and the system; and the idea of conflict as elements which ”can exist on multiple levels, eg. it may appear in the interface, in the selection and structuring of content, in the temporal unfolding of interaction etc.” (Dalsgaard, 2008)

Deslgaard divides experience, inquiry and conflict into three subcategories and provides design considerations for each specific use case. He establishes a systematic way to think about user journey in terms of these dimensions. I will briefly outline them here.

Experience: 1. Experience as practice 2. Continuous experience 3. Distinct experience

Inquiry: 1. Situated intentionality 2. Concurrent action-reflection 3. Reciprocal change

Conflict: 1. Challenge 2. Risk 3. Resolution

I cannot go into details of each one but will describe a few, especially related to inquiry. *Situated intentionality* has to do with user's past conceptualizations and translation of these into the designed experience. User may expect a certain outcome based on preconceived notions, these expectations could be evoked in order to arouse interest, curiosity and thus, motivate engagement. ”users' pre-existing desires to have specific experiences in the setting and by bringing into play elements that pique the interest of users by tapping into their past experiences so that these intentions arise.” *Concurrent action reflection* describes the idea that in user experience there should be a balance between familiar and unfamiliar, stable elements and uncertainty. Delsgaard writes that the ”experiencer needs the stable semantic elements as scaffolding for exploring the unfamiliar, lest everything appears in flux.” Thus participant's action, driven by curiosity, can lean on semantic anchors for reflecting before and while acting. The third inquiry subcategory is *reciprocal change*. Here the idea of ”trans-action” is addressed, which also resonates with the concept of ”agency” (Murray, 1997). It's the degree to which the user, when acting upon the system can, in turn, change the system's state to enable further action. ”Strategies for reciprocal change range from expressive systems that allow for short-term alterations (eg. installations such as Laser Tag) over progressively unfolding systems (eg. computer games with advancing levels and narratives) to adaptive, collaborative systems that are deliberately unfinalized by designers and made valuable by users' interaction and input over the course of time”.

As the last category, conflict, which consists of challenge (in part adapted from Csikszentmihalyi's concept), risk and resolution, is an essential element of user journey in sustaining inquisitive motivation. As mentioned earlier, conflict can be expressed through various ele-

ments of the experience, content narrative, interaction method, physical movement.

3.3 Groupware

3.3.1 CSCW Concept Overview

IM Experience in the context of this thesis is defined as a technology-mediated experience for a group of people, it's co-located (happening in the same location, as opposed to teleconferencing, for example, where people communicating from different geo locations) and synchronous (happening at the same time, as opposed to social media, for example, where the content can be consumed any time after it has been produced) .

The term Computer Supporting Cooperative Work (CSCW) systems has been around since the end of last century. It specifically refers to systems designed for cooperation between individuals and/or groups in working towards a common goal, the research in this scientific domain examines the best scenarios for enabling cooperation through software/virtual, hybrid/combination of virtual and physical systems. Because IM experience is technology-mediated, the focus is indeed on CSCW systems as the primary source of understanding how the development of technological systems in IM design can be approached. What questions should be asked and what important points should be addressed?

In this section a concept of 3C will be explained and two literature review papers will be referenced in order to establish essential technicalities in adapting CSCW research to IM experience design. Most of literature covering CSCW systems topic exists in work and learning application domains (as opposed to leisure and entertainment). However, because the principles refer to best practices associated with designing for collaboration, we can examine what has been proposed and how it can be integrated into IM experience design thinking.

Before going into the specifics about design practices, a few words should be mentioned about Interactive Mediascape in the context of CSCW. Interactive Mediascape experience is a group experience, therefore it is related to the field of groupware design.

In a 2019 literature review Ens et al (Ens et al., 2019) 110 papers that employed Mixed Reality Mixed Reality (MR) technology enabling collaborative scenarios involving two or more people were examined. The authors of the review concluded that the current state of research does not provide a clear understanding of how to approach the design of application in this domain, noting that this, being a new medium requires further exploration. "This overview reveals that existing frameworks for describing groupware and MR systems are not sufficient

to characterize how collaboration occurs through this new medium.“ The authors point to two major veins of research which have emerged in groupware applications “First, understanding how to enable *awareness* for collaborators (e.g., Dourish and Bellotti, 1992; Gutwin and Greenberg, 2002) — knowledge of who is in the workspace, and what they are doing. Second, articulating an understanding of how *visual* information supports collaboration (e.g., Fussell et al., 2004; Gergle et al., 2013; Kraut et al., 2002).” (Ens et al., 2019)

Ens et al proposed five dimensions to evaluate the publications: time & space (synchronous/asinchronous, colocated/remote); symmetry - whether participants have the same same basic roles or not (echoing Hornecker's idea 3.4.1 discussed in the following subsection); artificiality - whether the system is physical, digital or hybrid; focus - environment, workplace, person, object; scenarios - remote expert, shared workplace, shared experience, telepresence, coannotation.

So then, if we describe IM experience from the perspective of Ens et al, we may conclude that Interactive Mediascape IM is a *shared hybrid experience which is synchronous and symmetric with focus on the environment/person*.

Further, looking at the list of papers examined by Ens et al, I tried to find the examples which matched the description of IM. Out of 110 publications the majority was focused on the workplace and a lot fewer on object, person, environment. While, when the criteria of IM experience was applied, only 2 articles were a match, one is a proof-of-concept for specific application (RoomAlive: Magical Experiences Enabled by Scalable, Adaptive Projector-Camera Units) and another is a framework for an augmented reality game (Visuo-haptic collaborative augmented reality ping-pong), these are rather specific inquiries with a particular field of application. The first one deals with one specific interactive device and output, the other deals with a specific mode of interaction and output as well. Both of these studies do not address the importance of place, metaphor, various interaction opportunities between participants, scripting of events making a narrative, etc. They focus mostly on the technical side to enable the experience. The technical side is important, but, as was discussed in previous sections, to design for an experience means to consider a broader range of criteria.

The review presented some of the most telling publications in the mixed reality research domain, yet out of 110 only 2 specifically matched the IM experience parameters (a shared hybrid experience which is synchronous and symmetric with focus on the environment/person), however, neither of those 2 provided a usable guideline which can be translated into IM experience design. It's an untapped territory and it could be helpful to look into concepts which have been used in other settings, beyond co-located environments, i.e. remote collaboration to see what essential ideas can be taken and adapted to IM experience design.

To take a step back to 1996 the authors of article title “Physical Spaces, Virtual Places and Social Worlds: A study of work in the virtual” (Fitzpatrick et al., 1996) point to the notion that “space” in virtual collaborative systems is considered as “metaphor” - this is a parallel to the idea which was established in the previous section about physical space as metaphor - necessary to create a unified perception of situatedness for all participants. The authors here propose a similar idea - to “re-think an interpretation of spatial metaphors as the foundation for system building”. Here, as well as in most research conducted in the domain of virtual application, the questions of physical reality are omitted, however, principles of environments enabling collaboration could be similar to what we are looking for in IM experience design, because it is a hybrid system. In a hybrid system concepts of virtual domain could prove equally useful and applicable.

In the article the authors examine a work flow in an organization where collaboration happens through a hybrid communication online and in person. Considering the article is 30 years old, the details may not be in line with today’s realities, however, the authors research is centered around understanding “how the individuals themselves *make sense* of this complex virtual work domain to get their work done?” (Fitzpatrick et al., 1996)

This question is interesting in the context of current research because it may point to a direction of how the meaning about the experience/the designed system can emerge in participant’s view. Perhaps this can be in part achieved by drawing on the concept of “social worlds”. ”Social world is a concept from the interactionist school of sociology. It has been developed by Anselm Strauss to define a group of people who share some commitment to collective action. . . Social worlds do not necessarily conform to geography or organizational boundaries, being constrained instead by the limits of effective communication.”(Fitzpatrick et al., 1996) Fitzpatrick et al propose the following - a particular social world uses various “locales” to enable communication, they explain that a “locale” is like a meeting room for discussing issues of the department which is a social world itself and communication during the meeting is enabled by the locale of the meeting room.

Fizpatrick et al use the notion of social worlds and a person’s engagement within them “as a key to understanding the way in which these people make sense of their environment.” Although this idea has not gained traction in the research that followed, it is useful as a reference for categorizing and describing spatial configuration elements and the surrounding context, which emerges around them through participants perception. Thus, it could be said that, social worlds in IM experience would be formed through a combination of the system/content provided by the designer and the interpretation of events by participants.

3.3.2 3C and Awareness Theory

Another idea which has been around for a few decades is the Collaboration, Communication, Cooperation (3Cs) approach to groupware design in setting requirements for a successful groupware system implementation. The concept first proposed by Ellis, Gibbs and Rein (1991) was adapted by Fuks et al 2007 to "explore the 3C model as a means to analyze and represent a groupware application domain and also to serve as a basis for groupware development." (Fuks et al., 2005)

3Cs are Collaboration, Communication, Cooperation and Fuks et al are proposing that the central enabler of these elements is awareness. "The participants obtain feedback from their actions and feedthrough from the actions of their companions by means of awareness information related to the interaction among participants (Gerosa, Fuks, & Lucena, 2003)." (Fuks et al., 2005) In other words, presence of awareness mediates the cycle of communication, collaboration, coordination; for the action process to continue members of the group must be aware of what is taking place. Starting from this premise, there has been a number of studies dedicated to the question of awareness in CSCW systems context, however, this is still a very young field of inquiry with multiple variables and so far no particular method has been established as a "one size fits all" solution. Igor Steinmacher et al 2012 (Steinmacher et al., 2013) specifically looked at literature related to awareness support in Distributed Software Development (DSD) and after considering nearly 2000 articles concluded that although many studies analyze means to support communication they "do not present any awareness element to improve the communication in DSD scenario", the authors have not found papers dealing with awareness to overcome cultural issues or papers linking awareness in DSD with ubiquitous and mobile computing. (Steinmacher et al., 2013)

In another literature review which came out 10 years after the one discussed in the previous paragraph titled "Awareness Support in Collaborative System: Reviewing Last 10 Years of CSCW Research" (Mantau and Benitti, 2022), the authors began by considering close to 4 thousand articles from the last ten years. "...a fundamental element of a collaborative system: the awareness. Awareness has been a significant concept in Collaborative Systems since its formation and it is an essential part of it. We consider awareness as the backbone of a collaborative environment and, through it, all collaborative concepts are archived. In this sense, we define awareness as a process that occurs at three basic levels of abstraction: representation, understanding, and projection." (Mantau and Benitti, 2022)

The authors argue that representation awareness is the mechanisms/elements by means of which a participant gets the cues about *"what's going on"*; understanding awareness is

how well the participant understands his/her own actions in the context formed by actions of others in the group and by the environment settings, this is a cognitive quality described by how well the participant can extract meaning; and projection awareness is a product of representation and understanding resulting in a better projection of one's own future action possibilities within a given setting.

This approach is interesting for two reasons, one because in a complex system such as IM experience communication breakdown can happen on many levels, from technical to social and thinking about awareness as one of the elements which is necessary to pay attention to could help in "troubleshooting" the system. While looking to reasons why a certain set up doesn't live up to its potential affordance, examining the representation awareness vs understanding awareness and any gaps between the two may hold some answers. The second reason Mantau & Benitti's approach is interesting is because it provides a starting point in thinking about awareness - designing for representation awareness, *considering the best scenarios which can illuminate the question of "what's going on?"* to the participant may result in improving understanding awareness and consecutively projection awareness. This can lead participants to exercising a greater degree of agency during the experience as a whole.

The authors further establish a typology of awareness divided into contextual, collaboration, situationalist and workplace. These concepts are outside of the scope of this thesis, however, they can be helpful in future investigation of the question of awareness within IM ecosystem of elements. As Mantau et al point out "it is still very difficult, or even impossible, to achieve an accurate and clear-cut definition of awareness" (Mantau and Benitti, 2022).

In continuing the inquiry into how to raise *representational awareness*, we can look at an earlier paper from 2003 "A Framework for Awareness support in Groupware Systems" (Kirsch Pinheiro et al., 2003) the authors propose a systematic view. Their view may shine some light on what questions to ask during the design process to address the question of "what's going on?" and achieve the most aligned representation between what is offered by the system and what is perceived by the participant. "To help groupware designers... Kirsch-Pinheiro et al. (2001) identified some important characteristics needed to provide such support. These characteristics are organized into 6 questions *(what, when, where, who, how, how much)*, each one identifying crucial aspects of awareness support in cooperative systems: what information to present, when this information is produced/presented, where it is produced/presented and how, who is working and how much information about all this should be presented to the user." (Kirsch Pinheiro et al., 2003)

Kirsch-Pinheiro et al are concerned with establishing a framework for work-related group-

ware, their findings are domain specific and focused on a task/goal oriented setting of a work place, therefore cannot be applied in the context of a creative collaborative environment such as IM experience. That said, their conclusions are important and resonate with the concepts put forth by Mantau & Benitti (Mantau and Benitti, 2022). ”What's going on?” can be further subdivided into what, when, where, who, how, how much and each of these questions then can be addressed in relation to the overall experience. These questions can serve as a tool for guiding the software engineering choices as well as scripting of the experience.

> Practical idea: Awareness evaluation. While designing the system and scripting the experience think about the following questions from a participant's perspective. Would the participant be able to understand (make meaning from) what's going on? what is everyone doing, when are they doing it, where is the action taking place, who is acting at any given moment, how are other participants interacting with the system, how much control / impact does each participant have in overall experience? After collecting primary feedback from participants at the end of IM experience and if, according to gathered data, the state of creativity has not been reached, use these questions to “troubleshoot” and further understand the nature of the problem. These questions could be asked in a follow up discussion. Think about how to improve awareness within a given range of possibilities of script/software/hardware etc.

What is “awareness” in communication in practical terms? We've all been part of that group chat situation where you end up reading the same message 5 times or miss a message because after a period of time away from chat, you look and cannot find that important piece of information in all of the chatter that came before and after. While designing an IM experience it's important to think about what information is crucial in terms of group communication and how to draw everyone's attention to it.

Let's go back for a moment to Fuks et al and their definitions of the 3Cs. The authors propose the three elements: communication, coordination, collaboration as the three cornerstones for a collaborative environment. These elements are connected with each other by correlational means of effect, such as communication generates commitments that are managed by coordination which arranges tasks for cooperation which, in turn, demands communication. Thus, these three elements continue in iterations until the goal is reached. All three elements foster awareness, while awareness mediates these elements. (Discussing the full scope of the article is too lengthy for this work and it is unnecessary as well.) The authors provide a metric for synchronous/asynchronous x co-located/remote systems and because IM experience is synchronous and co-located, it is possible to focus on the findings for this specific parametric set.

Practical idea: Considering the group chat analogy, where you can ”tag” people or yourself. In the same manner, what type of mechanism can be employed in a system facilitating IM experience? What if the participants had a button saying “I’m on pause and I’m just going to observe” or on the contrary “I’m in the flow, let me lead for a while” and what if these states were indicated by a light pause by - yellow, flow by green. A setting like this would one one hand provide an option for available action, on the other hand a possibility participant to agency and also signal the whole group about the change in a group dynamic. One can also speculate that the first one would get pushed more often than the latter one, however, giving this type of control as well as communication channel, facilitating a dialogue and ensuring that all participants are aware of its progress could improve communication and coordination among the participants and thus cultivate greater potential of cooperation, also affecting the overall scale of affordance of the system.

Coordination Fuks et al point to so-called *loosely integrated* and *tightly integrated* collaborative activities. The former being “deeply associated with social relations. . . [and] characterized by the absence of any computer-supported coordination mechanism” (Fuks et al., 2005); while the latter is a set of highly interdependent activities and “require sophisticated coordination mechanisms”. They further state that the “great challenge of the designer in designing coordination mechanisms in groupware is to achieve flexibility without losing the regulation”. How can these findings be applied in IM experience design? While knowing that IM experience has a temporal dimension, it is possible to say that a user journey may be used as a way of creating those “social relations” and as a result provide an opportunity for loosely integrated coordination scenario, however, to achieve acquisition of tacit knowledge about the environment and make the meaning of interactions, the experience could begin with a tightly integrated activity. Fuks et al suggest: “The system should . . . offer the user the possibility to use, alter, or simply ignore them [communication protocols].” Here the argument needs to be made that because IM experience is where a “social world” emergence happens, clear directions need to be given from the start and followed by the participants to gain an understanding of the nature of interaction and resulting environment. A user journey has to begin with a clear set of coordination mechanisms. A tightly integrated simple activity can serve as an entry point into the interactive paradigm of IM experience, participants can gain the perception of how coordination between them happens. Once this point has been achieved, a more complex and loosely coordinated activities may be added to the user journey.

Practical idea about coordination: These points have a lot of resemblance with Csikszentmihalyi’s concept of challenge correlation to appropriate skill level during the experience. Introducing simple activities and providing a palpable structure of interdependencies in participants’ actions can establish a foundation for introducing activity which is more complex in interaction and less structured in its form. Thus, structuring with a simple activity may provide for an organic learning curve with fewer activities where coordination is supported by the system, while starting with a complex activity may require a lot of coordination support by the system.

3.4 Spatial User Interface

“Many researchers agree that TUIs are especially suited for collocated collaboration” (Hornecker and Buur, 2006). Post-WIMP[1] interfaces draw on human inherent abilities to situate themselves in space in relation to other objects and people. These abilities can be considered as base-level skills (Jacob et al., 2008) in conceptualizing a spatial user interface. From common physics to body, environment and social awareness, humans are able to navigate through space (Jacob et al., 2008) and in addition make meaning from the surrounding environment. “Our body is the central reference point for perception. Movement and perception are tightly coupled and we interpret spatial qualities (or positioning of other objects) in relation to our own body. Spatial qualities therefore have psychological meaning” (Hornecker, 2005)

3.4.1 Tangible User Interface (TUI)

TUI stands for tangible use interface, the term has been used narrowly to describe interfaces enabled by tangible objects, and recently, more loosely, to describe interaction embedded in physical space. There have been further definitions such as “graspable user interface” (Hornecker, 2006b, Hornecker and Buur, 2006), “physical-digital interactions and digitally-augmented physical spaces” (Hornecker and Buur, 2006), reality based interaction (Jacob et al., 2008), while “tangible interaction” was used as an umbrella term to cover approaches from HCI, computing, product design and interactive arts (Hornecker, 2006b, Hornecker and Buur, 2006) Interactive devices have been called: ”passive real-world props”, ”graspable”, ”manipulative” and ”embodied” and the term ”tangibility as a multi-valued attribute” (Fishkin, 2004)

TUIs as a concept was proposed by Hiroshi and Ullmer (1997): ”Tangible Bits” is an attempt to bridge the gap between cyberspace and the physical environment by making digital information (bits) tangible. . . .Ultimately, we are seeking ways to turn each state of physical matter – not only solid matter, but also liquids and gases – within everyday architectural spaces into ”interfaces” between people and digital information.” (Ishii and Ullmer, 1998). Today their ambition has not been fully materialized yet, however, haptic interfaces and touchless interaction has been researched and implemented throughout various domains of application. (Frish et al., 2019, Marzo et al., 2018, Krestanova et al., 2021) Ullmer and Hiroshi coined a definition of TUIs as systems which ”augment the real physical world by coupling digital information to everyday physical objects and environments.” (Ishii and Ullmer, 1998)

[1] window, icon, menu, pointing device

In the context of this work, I opted to use Spatial User Interface as opposed to TUI to underline the versatility of use and configuration and to avoid a potential misinterpretation of TUI due to its multiple definitions and its inherent attachment to a linguistic ”tangible” property, as such haptic quality may not always be present in a UI built based on IoT network. Spatial user interface encompasses variations of TUIs and WIMP interfaces. Similar to the definition of “tangible interaction” proposed by Eva Hornecker (Hornecker, 2006b), *SUI is a system based on co-located embodied interaction, utilizing user interface devices embedded within physical environment and resulting in a reality-virtuality continuum.*

What are the main questions that need to be addressed in this research pertaining to interaction design of SUI:

1. What interactive design strategies can optimally fit within a collaborative scenario?
2. How to balance skill/challenge levels to develop a mode of interaction which can be easily adapted by participants throughout experience?

In an early position paper from 2005, Eva Hornecker (Hornecker, 2005) proposed that structural relations are important in interaction design[1], she began to examine interaction from the geometric perspective, trying to understand how “structural qualities predetermine, limit and guide interaction”. She argued that through these parameters set in a certain way the interactive physical space is “appropriated” by participants. By establishing the fact that in spatial interaction not only the objects but also the user may move in space, she stressed the necessity to address the question of relation of interactive devices in space to the human body. As result of her research two main themes emerged: spatial interaction, which focuses on configurability, and embodied facilitation, which is focused on embodied constraints, access points and representations, i.e. techniques which designer uses to gently “nudge” participants into the intended scenario of system’s use. Here, I would like to mention a few valuable insights about facilitating collaboration through spatial interaction design, which also echo the work of Kirsch-Pinheiro et al on awareness presented earlier. Hornecker’s research related to embodied facilitation resulted in design sensitivities, which she outlines as following:

- Give multiple points of interaction
- Allow for simultaneous action
- Give equal access - no privileges

[1] this work later resulted in a broader framework for physical space and social interaction (Getting a Grip on Tangible Interaction: A Framework on Physical Space and Social Interaction (Hornecker and Buur, 2006))

In the article “A Design Theme for Tangible Interaction: Embodied Facilitation” (Hornecker, 2006a), she points to the following observations, which I quote here directly to ensure that these valuable considerations are well-noted and appreciated by the reader in full detail.

- Multiple interaction objects distribute control in a group, make it difficult for individuals to take over control, and lower thresholds for shy or timid persons to become active.
- Simultaneous interaction supports multiple points of interaction.
- Multiple points of interaction ease simultaneous interaction, but do not necessarily permit it. Often systems provide several input devices, but require sequential input, ignoring parallel events or reacting delayed.
- Physical constraints that sequentialize actions can serve to give necessary order to an interaction process or to ensure equal rights (e.g. a waiting queue)
- Equal access refers to giving everybody equal options; it does not mean everybody should have one of every tool or that all interaction devices should provide the same functionality. (Hornecker, 2006a)

Hornecker further talks about “syntax of interaction” in the context of tailored representations. Firstly, so the definitions are clear, we can point to the fact that “tailored representations” (Hornecker, 2006a), of Hornecker are similar ideas to “augmented feedforward” of Wensveen (Wensveen et al., 2004). It is a characteristic of interactive device which communicates its potential affordance through the means which are not inherent in the device itself, like a textual instruction or a sign, for example. However in Hornecker’s case such feedforward is described as elements rooted in user’s knowledge/past experience, something relatable cognitively or emotionally. “Does it connect with their [user’s] experience and skills and invite them into interaction?” (Hornecker, 2005)

These are the observations Hornecker makes about tailored representations, which can be also applied to a wider understanding of feedforwarding concept, and its function of mediating skills and challenge to achieve the state of “flow”:

- Focusing only on intuitiveness neglects the skills and knowledge of people (cp. Buur, Jensen and Djajadiningrat, 2004) and may result in systems that don’t scale up to experienced users and complex domains
- it is important to ease initial access on the basic level of manipulating relevant objects. If we cannot figure out how to interact with a system, it is of no help if the representation is legible.

- Users should be able to quickly explore the basic syntax of interaction. Over time they might acquire the more complex syntax of advanced interaction (learnability).

Let's further address the topics of interaction syntax (interaction vocabulary) and "learnability" potential afforded by device characteristics based on users skills and knowledge.

Syntax of interaction, which I have also defined in my past projects as *interaction vocabulary*, pertains to the mode, the nature of interaction within a given system. Because this thesis doesn't provide the time to explore the linguistic accuracy in analogous way these definitions are used and propose which one is more suitable, and to avoid multiple definitions of the same phenomenon, I will use interaction vocabulary throughout the remaining text.

In a recent paper Renom et al (Renom et al., 2023) the question of interaction vocabulary (although they don't call it by this term) and its usability across multiple applications hypothesized that by building on user's past knowledge, types of interactions may be "transferrable" from user interfaces in one application domain to another. They found that users are able to extract interaction principles and then apply them in different context. In describing the results of their experiment they note: "computer users have acquired a series of principles about user interfaces that they transfer to other interfaces, resembling the transfer of mechanical knowledge" (Renom et al., 2023). Similarly to the way people learn about the principles of physical world, they can learn about a digital environment by obtaining the essential rules of interaction. "For example, users can copy and paste across a multiplicity of contexts where selection is possible".

There is an interesting parallel which can be drawn from this paper to an earlier publication applying the same logic of using the skills humans inherently possess as basis for interaction design in physical space. In Reality-Based Interaction: A Framework for Post-WIMP Interfaces (Jacob et al., 2008), Jacob et al propose to use humans' inherent understanding and knowledge of physical space as a starting point for interaction design. While Renom et al propose to use inherent cognitive abilities such as signifiers and cultural conventions, past experiences, technical reasoning and analogical reasoning which can lead towards *interaction knowledge*. Jacob et al discuss specific possibilities and trade-offs in design considerations, and Renom et al discuss broader opportunities in conceptualizing interaction design by employing similarity of principles; Jacob et al examine user interface as applied to physical reality, while Renom et al explore it in relation to digital environment. If we consider these two papers in a complementary manner, we find that these ideas can be employed in design of systems on the reality-virtuality continuum, such as Interactive Mediascape experience. Considering the limitation of space, I will make a brief summary of both concepts.

Jacob et al (Jacob et al., 2008) propose to consider the following attributes of human abilities: naive physics (common-sense knowledge), body awareness, environment awareness and social awareness. They propose to design interaction which "gives up" on physical qualities only in return for such design functions as: expressive power, efficiency, versatility, ergonomics, accessibility, practicality. Then they propose to evaluate design considerations based on trade-offs such as, for example, "In some cases it is better to privilege the expressive power of a system; in other cases it is better to limit functionality in favor of realism." (reality vs expressivity) or "cost, technological limitations, space, size, durability, power consumption, and environmental impact ... may be traded off against realism." (reality vs practicality). Thus, in making design decisions, these trade-offs are to be considered as criteria for deliberation.

Renom et al (Renom et al., 2023) argue that the knowledge and analogy to physical world is not enough to create intuitive digital interfaces. They provide an example of a blinking cursor, how is that the user understands that this is a place to type, this interaction has no analogy in the physical world? They propose the idea of "interaction knowledge" which comes from human's ability to *extract principles of interaction* and then transfer them to a different application or even use the tools in novel ways. In a physical world, they make an example of a knife, we know that it is made to cut, but we can also use it as a screw driver, if needed. How are we able to make the leap from cutting to tightening a screw using the same tool? Renom et al describe several theories of inherent human abilities in aspects of analogical thinking and technical reasoning. They conclude that "Technical reasoning in particular defines a form of knowledge that enables tool users to discover how to carry out unusual uses of tools, namely, mechanical knowledge." Further, they propose a concept of "interaction knowledge" which aims to shift the concepts of mechanical knowledge, informed by physical reality, into the digital interaction realm.

Renom et al argue that interaction knowledge originates in "the principles that users learn through experience in both physical and digital environments." The users can then apply the principles in different digital interaction contexts. This point of view is extremely important in the design of Spatial User Interface and interactive systems embedded in physical space. Today, such interfaces are still "arbitrary and differ from one environment or one application to the next". By addressing the question of *interaction principle* during the design process, if successful, we may enable users to recognize interaction tools in other contexts and thus create a more intuitive experience in the future.

3.4.2 Proximity Sensors as UI Points of Access

In conclusion of this subsection I would like to say a few words about the interactive devices I have been developing over the past months. These devices are based on ultrasonic proximity sensors. These sensors are currently not represented in wider spatial user interface discussion as a possible element in UI design. In the 2021 review of TUIs implementation across a wide-field area of application Review: Development and Technical Design of Tangible User Interfaces in Wide-Field Areas (Krestanova et al., 2021) of Application the authors noted the following technologies: Optical sensor, Accelerometers, gyroscopes, magnetometers, RFID sensors, Hall sensor, Light-dependent resistor, Tilt sensor. These types of sensing devices were used in TUI applications designed from 2010-2020. Although, according to the findings of the review, proximity sensors have not been utilized by practitioners, I would like to make a few observations about this technology, as I had a chance to work with it on a number of projects.

Pros and cons of ultrasonic proximity sensors in spatial interaction application.

Pros:

Cost - proximity sensors are cheap

Versatility of placement - proximity sensors can be pairs with a wireless microprocessor and can be places anywhere in space

Versatility of metaphor - can be placed within objects representing a familiar reference

Versatility of interaction vocabulary - can be used in three modes: on/off, hover, up/down

Types of data mapping - on/off, on-sustained constant, on-sustained and incremental

Ease of technical implementation - software abstractions integrating electronic device with digital media can be reused multiple times

Susceptibility to environment - can operate in low light situations

Privacy - limited to detecting user presence only, not identity

Power - use only 5v

Output - digital, no need to analog conversion

Range - can be activated in the range from 1 cm to 3 m

Novelty - creates curiosity about the interaction

Cons:

Noise - software adjustments need to be made to minimize data noise

Latency - due to the nature of interaction, it is not instantaneous, 1-2 seconds delay is present most of the time.

Interference - certain types of sound waves may interfere with proximity sensors

Degrees of freedom - interaction only allows 2 degrees of freedom - XY

Novelty - creates challenges of use (which need to be addressed in design process)

3.4.3 SUI summary

In closing this spatial interaction section, here is a brief summary of ideas which were discussed earlier. For fostering collaborative it is important to think about how many points of access are there, how they are used synchronous/non-synchronous, what types of past knowledge can participants draw on in order to understand interaction affordance, how can the participants be gently “nudged” into following a certain navigation pattern through the experience, equal access to interaction devices may promote distributed ownership of the outcome and ease entrance for individuals who are more shy than others. In developing spatial interactive system we need to remember that there are trade-offs between real world qualities and functional qualities and it is the task of a designer to establish the best balance between the two.

Humans possess innate reasoning patterns such as analogical thinking, connecting new things with past knowledge, technical (mechanical) reasoning, guided by intuitive knowledge of how things work in physical reality. Similarly, in engaging with digital interactive systems, people are able to extract the principles of interaction and apply them in a different context. This allows for the use of a particular interaction principle across various application domains and can be especially useful in Spatial User Interface design to establish continuity of similar interaction principles across a spectrum of projects. In order to enable the creation of ”interaction knowledge” we need to think more closely about the *principles of interaction* we are offering to the user. This, together with considerations of practical ease of operation and metaphorical embodiment are equally important considerations during the design process. In designing a user journey we can draw on these considerations in order to balance ”skills and challenge” of the interactive system from basic level of manipulation to more complex.

3.5 Social Interaction, Space & Place

A couple decades ago Paul Dourish introduced the phenomenological point of view for context-aware systems[1], in relation to HCI research field. He argued that in development of such systems researchers are not aught to consider only the motor skills, positioning and cognitive abilities but also socio-cultural context in which interactions take place. His view has gained speed since then and in fact, some of the frameworks considered earlier in the state of the art speak to that (Chen and Lu, 2012, Forlizzi et al., 2008, Kao, 2021).

Researchers are paying increased attention to social factors while designing interactive systems. Dourish points to the fact that such considerations should be integrated in the design process at the start. He states that a fruitful place for starting a relationship between technical design and social understandings lies in weaving social understanding "into the heart of the process and fabric of design." (Dourish, 2001b).

In this section we will address the questions of social interaction in relation to space. We will examine several angles of this question with reference to the work of Luigina Ciolfi, Yi-Fu Tuan, Thoring et al, and Adam Kendon.

Interactive Mediascape is an experience. Experience which exists in time and space. Often when we remember an experience, we remember doing something and where we were. Ex - latin - out; Perir - latin - to parish; Experience - out of what has perished; Experience; also from experiri is usually translated from latin as "to try"

"In CSCW, the interest in the physical space of interaction is motivated by the need to create or to understand the context for collaboration." (Ciolfi, 2004) Luigina Ciolfi made an extensive inquiry into the nature of relationship between the domains of HCI and environment context from the perspective of Interactive Design, she proposes the concept of "place" as "experienced space". While outlining the limitations of HCI in dealing with questions of interactive environments, Ciolfi motivates her work by the scarcity of research on the topic of spaces empowered by ubiquitous computing technologies. She makes a deep analysis of what constitutes a place in the context of interactive environments and how a notion of place can inform an experience within such environments. Her research is extremely relevant to the current thesis because, unlike the majority of HCI inquiries, it addresses physical environment at great scale, probes its relation to the nature of interaction, and produces a method for designing interactive experience for a specific place.

However, her research at large cannot be applied within the context of my current inquiry, Ciolfi's starting point of inquiry is different from ours. She begins with a specific setting, an

[1] In other words, systems which can sense the environment, TUIs fall under this definition

existing place and then through the method of Contextual Inquiry finds the best practice for developing interaction within this specific space. “This work is mainly focused on the physical context of interaction as a “setting”: a locale within which human actions and behaviours occur, characterised by structural and environmental properties that influence its inhabitants in some way.” It is interaction design embedded in a specific environment. Interactive Mediascape experience which is at the center of current thesis, on the other hand, is “from scratch” - there is no given environment, the design needs to be conceptualized and implemented with the tools (elements and attributes) outlined in the IM taxonomy. Thus, having a “blank canvas” of a black box theater as the initial environment, we cannot follow Ciolfi’s methodology.

Much of Ciolfi’s reasoning is based on the concepts articulated by Yi-Fu Tuan, she applies Tuan’s concepts within the interaction design domain. Ciolfi’s theory articulates Tuan’s notion of place as a set of 4 dimensions: physical, personal, social, cultural. These dimensions are not fixed, rather they are dynamic and they are shaped by people’s presence and actions within the space. “Because a sense of place emerges from the patterns of use (Harrison and Dourish, 1996: 70 in Ciolfi), we cannot design a place per se, however we can design a space for a possibility of becoming a place.” (Ciolfi, 2004)

According to Ciolfi, to design for possibilities means not “prescribing what the interaction will be” but rather *providing an opportunity and letting directions and features of experience emerge from people’s interaction with technology* and, in the context of IM, also with each other and physical objects in the space. While Ciolfi’s methodology cannot be applied in IM design at large, her research has significant value because she was able to integrate the complex question of physical setting into an interactive design framework.

> Practical idea: because we begin with a black box theater, we can initially present any type of environment as a starting point for the user journey. For example, if we are designing ”for” the state of ”flow”, when we refer to Csikszentmihalyi’s chart we see that the state of ”relaxation” may lead to the state of ”control” and then to the state of ”flow”. We can then incorporate ideas from biophilic design (Ryan et al., 2014, Asim et al., 2020), which have been associated with a calming effect, into the spatial and content elements of the experience. In biophilic design there are studies which conclude that presence of elements from nature in the designed space may lead to a relaxed state, such as for example, presence of water or indication of a water source through representation, could be visual or sound. Thinking further in the same vein, if at the beginning of IM experience participants perceive the environment as relaxing, they may have a greater inclination to explore (than if they were anxious or confused, for example) and once they become familiar with the system, i.e. feel like they are in control, may move into the state of flow. Thus, in could be speculated that adding elements from the world of nature may enable the user journey towards the state of flow and creative discovery.

It is also interesting to examine the original writing of Tuan, it provides additional insight and intellectual guidance. As Ciolfi notes “for Tuan place can only be grounded in the physi-

cal, material reality of the world as the prime feature of human experience is its sensuousness (This perspective is deeply influenced by the phenomenological notion of embodiment (Merleau-Ponty, 1945)." Tuan, indeed, defines space as "the order of coexisting data" (Tuan, 1979) leaning on positivists and phenomenologists belief that time is more important than space [1]. It is helpful to pause on the definition he proposes especially in the context of IM experience where space can be defined by the designer for a given moment to include a specific set of data. In the context of IM experience, because it's an artificially constructed reality, the space can be filled with information set forth by the designer. This information "the co-existing data", however, still do not shape the space into a place. A place in Tuan's view is a perception which is formed over *time*. He suggests several fundamental elements which can transform a space into a place.

One is the idea of "Latent zone". In Tuan's definition it is the "zone of one's past experience" it acts as a "ballast to activity, freeing activity from complete dependence on the visible space and present time". (Tuan, 1979) Through this method an empty space can transform into a familiar place instantly. The more abstract the metaphor, however, the further the range of association, thus differentiation in perception of place may occur. We can speculate that divergence and convergence of "latent zone" parameter among participants may play a role in the level of bonding through place. Further, such divergence and convergence through the means of metaphor could be used to create variation in engagement. A divergence in "latent zones" among participant would place more emphasis on individual abilities of participants to make connections, while creating conditions for convergence, such as with a clear well-rooted metaphor, may promote similarities in perception of present space and thus a more fruitful ground for collaboration.

> Practical idea: while designing an IM experience, we may think of metaphor as such "ballast" by bringing commonly recognizable forms into the designed space, we create the context for a unifying place to emerge. For example, by placing 4 square meters of artificial grass with some flowers in the middle of the room, we suggest a field, the same can be achieved through media - a projection of a field on the wall and/or sounds one associates with being in the field such as of birds crickets etc (a convergent "latent zone" as all users are in the same metaphorical space). Another example would be if the space is split in two parts where the participating group is also split in half, they are presented with different metaphorical setting, snowy field and a desert, and then invited to rejoin and share what they had seen (that would be an example of a divergent "latent zone" parameter)

The other idea Tuan proposes is "fields of care". "A carnival transform temporarily an abandoned stockyard into a place. . . [it] draws on the capital of sentiments that has accumulated

[1] Although in the following chapter of his work, Tuan also examines the importance of space over time to make a point that for humans it is easier to note the change in space rather than in time

in inconspicuous small worlds elsewhere and in other times". Tuan proposes that while engineers create "localities", time is needed to create place (Lowenthal 1966, Lynch 1972). Tuan calls the emergent perception property of a place "the fields of care" - these are accumulated experiences which build up care about a specific space. Together with visible symbols (metaphors) fields of care add to the strength of connection to a locale, transforming it into a place.

It could be said that "a latent zone" and the "field of care" could be a result of associative thinking in reference to a known symbol/metaphor or a meaningful action. "...the power of the symbols to create place depends ultimately on the human emotions that vibrate in a field of care". (Tuan, 1979) IM experience, examined in this thesis, is a place intended to be a self-contained environment (in Delsgaard's terms it's a "distinct experience" (Dalsgaard, 2008)). Adding metaphors and scripting a user journey which provides opportunities for the creation of fields of care through events that are meaningful may strengthen the perception of place and belonging and foster collaborative behavior.

> Practical idea: in the context of IM experience personal artifacts could be brought into the mix of content, to establish a personal field of care through emotional connection arising from familiar objects/subjects. Or, there could be a particular starting point of the experience, for example if everyone has to walk into a completely dark space - an experience which can serve a bonding function and developing a field of care - overcoming an obstacle together in addition to being curious about what is to come.

In the beginning of the article Tuan states "A comprehensive study of experiential space would require that we examine successively felt, perceived, and conceptual spaces, noting how the more abstract ideas develop out of those given directly to the body, both from the standpoint of individual growth and from the perspective of history". (Tuan, 1979) He goes to say that such an undertaking is beyond his present purpose. Of course, it is also beyond the scope of this thesis but it's invaluable to note the foundation of his thinking process.

It is also interesting to see the similarity of argument Glăveanu articulates in his 5As creativity theory. While Tuan says that abstract ideas emerge out of the perceived environment, so does Glăveanu stating that environment may act as a facilitator in shaping both, creative actions and thoughts. "The existence of a material or physical press was rarely acknowledged by creativity researchers and psychologists at large. This is quite surprising considering the fact that creation is not only a psychological function but also a form of action deeply embedded in the material world.... The assertion above is valid not only for art and design but also for the most seemingly "mental" activities; even poets rely on a physical environment to be stimulated, inspired and capable to write, edit, and publish their work. Material objects both

constrain and allow creative action in ways that deserve further investigation." (Glăveanu, 2013) Here we establish the interdependency of perception of place, action and the resulting experience.

A very practical approach to space design for creativity was developed recently exploring the domain of design education and practice. "We regard a space as 'creative' when it facilitates activities in a design education or design practice environment. This includes but is not limited to the facilitation of creativity. The term 'creative space' spans from a single piece of furniture to the interior design and layout of rooms; and from architectural structures to the location within neighborhood and city" (Thoring et al., 2018). These definitions of creativity and context do not exactly match the ones which are set forth in the previous section, however, they can be applied within the current IM design context. The typology proposed by the authors can "provide concrete, yet adaptable guidelines" in designing a creative environment. One of the essential aspects of the typology, for example, is that it outlines what type of space can enable or reduce social dimension (interaction). It's a detailed knowledge base which can greatly inform the design of spatial configuration in IM experience. The typology defines space type and spatial quality, these can serve as a "design sensitivity" in development of IM experience.

Thoring et al divide spaces into 5 types: personal, collaboration, presentation, making, intermission, these types of space contain a varying degree of 5 spatial qualities: knowledge processor, indicator of culture, process enabler, social dimension and source of stimulation. The authors propose a systematic description between correlations of these elements. Because the typology is created from analyzing design education facilities for the purpose of designing such facilities, the descriptors are not always applicable in the context of IM design, however, this systematic overview can set the base for thinking and planning the spatial configuration of the experience. A particular type of space may not answer to all requirements but the typology provides for easy brainstorming and combining of space types. For example, the space we design for IM experience is a collaboration space but it is also a presentation space and a making space and perhaps it would be useful to provide a personal space and an intermission space in the middle of experience. When we begin with a black box theater, spatial configuration possibilities palette is vast, thinking in terms of the Thoring et al typology may help in organizing and articulating spatial ideas script throughout the experience. It may be equally useful in developing IM experience with the purpose other than collaborative creativity, the design principles outlined by Thoring et al could cross over application domain boundaries.

> Practical idea: design the space in such a manner that there are several “activity zones” - locales, each enabling a different type of interaction/content generation. For example, locale number 1 is a group setting on the floor in a circle to give participants a chance to get acquainted during a period of time while engaging in a simple set of creative challenges. The second locale 2 could be individual pods where each participant is invited to remain by themselves, for example 4 pods can be located in the space, participants enter those pods and are offered a creative collaborative challenge, for example, triggering audio, the concept of a place can be maintained through a sound metaphor while this activity would be a higher level challenge for collaboration, it can offer each participant to experience interaction from a personal space. Locale 3 can invite people to come out of the pods and lie down on the floor while a visual projection associated with the soundtrack they just made is being played. In this example locale 1 is a collaboration space, locale 2 is a personal space and locale 3 is a presentation space and locale 1 and 2 can be described by qualities of process enabler and social dimension while locale 3 can be associated with course of stimulation and indicator of culture qualities.

That said, remembering Tuan’s idea that place emerges from space overtime and the idea of designing for possibilities, the design for creative environments typology and principles cannot guarantee an outcome but can inform the design of objects, their configuration and the flow of movement in a certain way may increase the odds of cultivating creativity and encouraging collaboration.

Above we have discussed idea of space evolving into place through to personal meaning-making and past experiences. These ideas reflect the notion of a place as contextual environment for experience. It brings people together through a unified perception of locale.

Now we can change the focus and examine the idea of body position in space and it’s relation to social interaction. Empirical research was conducted by Adam Kendon (Kendon, 2009) and has been well utilized by the scientific community since. Kendon studied the position of a body in relation to another body to conclude the types of configurations which are most common in social setting and can lead to a collaborative interaction.

Kendon’s inquiry begins with the ”needs of organism” to find a suitable place to carry out actions which the organism wants to engage in. Kandon talks about a cat which will look for a place suitable for sleeping such as solid surface while it will not consider water as suitable. He further notes that this ability of organisms to find an appropriate place is supported by ”selecting spaces in the environment that, because of their physical characteristics, shut out some kinds of stimulation, let in others and, within the space itself, make available what is needed” (Kendon, 2009) In other words, the environment somehow provides for the needs while minimizing unwanted distractions.

In relation to humans Kandon proposes an idea of ”transactional spaces” as areas which people ”designate” to a particular activity - for example, watching tv, a couch becomes such area. He notes: ”Changes in spatial and postural orientation are, for this reason, excellent clues to major junctures in the flow of behaviour.” (Kendon, 2009) A transactional segment becomes a common space when two or more people share a transactional segment. In

other words, when one person approaches another and the other person adjusts themselves as a result, now both are facing each other. A common space is characterized by common activity.

When, for example, people are engaged in a conversation and are facing each other, their interaction becomes ”focused” and the formation of their bodies creates a boundary between the group and the outside world. This distinctive social-orientation arrangement ”is sustained through time and its maintenance requires the cooperation of all the participants”. Kendon calls such arrangement sustained over time through cooperation - a *formation*.

As a result of his research, Kendon proposes a typology of shared transactional space, aka F-formation Figure 3.3. The foundation for this typology is the idea that each person has a p-space aka personal space, that when people come into an F-formation their personal spaces overlap in a certain manner, while the space which is beyond the F-formation is the outer environment and is linked to the F-formation with r-space - a buffer zone. Kendon's work is examined in Hornecker's research, she notes, a shared transactional space may enable a shared focus, and at the same time allow for peripheral awareness: ”A transaction space, by providing exclusive access, also limits communication to those sharing it. There is a natural limit to its size determined by visibility and audibility.” (Hornecker, 2006a)

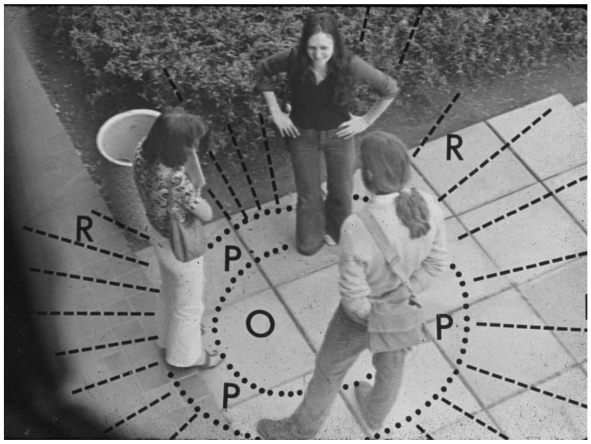

Figure 3.3: Kendon's concept of F-formation, original image

Kandon identifies several types of F-formations which are collaboration-friendly and provide equal distribution of agency. Vis-a-vis, L-shape, side-by-side or horseshoe (resembling a semicircle), and circle (o-shape).

The difference between these formations is the amount of information filtered from environment outside with the o-shape and vis-a-vis being the most effective in filtering out the outside environment, while the other ones share a degree of environmental presence in the trans-

actional space. For example, when two people are examining something side by side, the environmental factors in front of them become part of the transactional space, or if the persons are in L-shape formation which is at about a 90 degree angle, each of them is within the other's personal space but facing in different direction, this allows the environmental factors play a bigger role in the interaction.

It is then possible to hypothesize that Kendon's observations about F-formations of body placements in combination with Thoring et al typology of spaces may serve as tools in guiding design decisions. Understanding the concepts of personal transactional space and the configuration of the environmental space provide a glimpse of insight when we address questions of user choreography, spatial navigation and the shape of environments produced by architectural structures, such as perhaps sets or space dividers and the media output itself. For example, will the experience feel more organic and promote collaboration if the participants stay in a side by side F-formation while the projections are in front of them, or will the same F-formation work with a 360 projection? Will participants adjust themselves according to the projection geometry? And if they do adjust themselves, would these adjustments preserve or inhibit a collaborative spirit? Such observations and analysis can be inferred from noting F-formations which the participants choose to assume.

3.6 Evaluation Techniques

3.6.1 Creativity Support Index (Creativity Support Index (CSI))

Surveying 113 papers on Creativity Support Tools in HCI research Remy et al found that, the "three most commonly used methods were observations (38 occurrences), surveys/questionnaire (37), and interviews (33)." (Remy et al., 2020) The authors note that of all the techniques Creativity Support Index CSI (Cherry and Latulipe, 2009) stands out as it is based on creativity theories and allows for quantifiable and comparative results. Still, they caution, "While we consider the CSI to be an established, useful tool, similar to what has been observed in HCI and creativity research there is need for developing multiple evaluation strategies of which there is an apparent lack." (Remy et al., 2020)

The current lack of creativity evaluation tools is illustrated by "the scarcity of creativity metrics has been called out by Remy et al. (2020)." (Remy et al., 2020, Prasch, 2022). Considering these research findings, I propose an evaluation tool based on the "flow" emotional states by Csikszentmihalyi (Csikszentmihalyi, 2008). After reviewing CSI in HCI, Remy et al. hypothesize "that being more specific about the goal of your CSI can help sharpen the goal of the

evaluation of the CSI as well." (Remy et al., 2020)

3.6.2 CTS - Novel Evaluation Technique based on "flow"

Csikszentmihalyi Time Slice Csikszentmihalyi Time Slice (CTS) is a novel evaluation technique I propose for monitoring experiential perception by participants through in-experience self-reporting, this technique is based on Csikszentmihalyi's "flow" concept (Csikszentmihalyi, 2008, Csikszentmihalyi, 1996, Csikszentmihalyi and Asakawa, 2016). In establishing the Csikszentmihalyi based tool we focus on participants' state during the experience, which can make it possible to identify the patterns of certain emotional states occurring over time, and consequently, adjust the script to yield better results. I will now explain the tool. Csik-

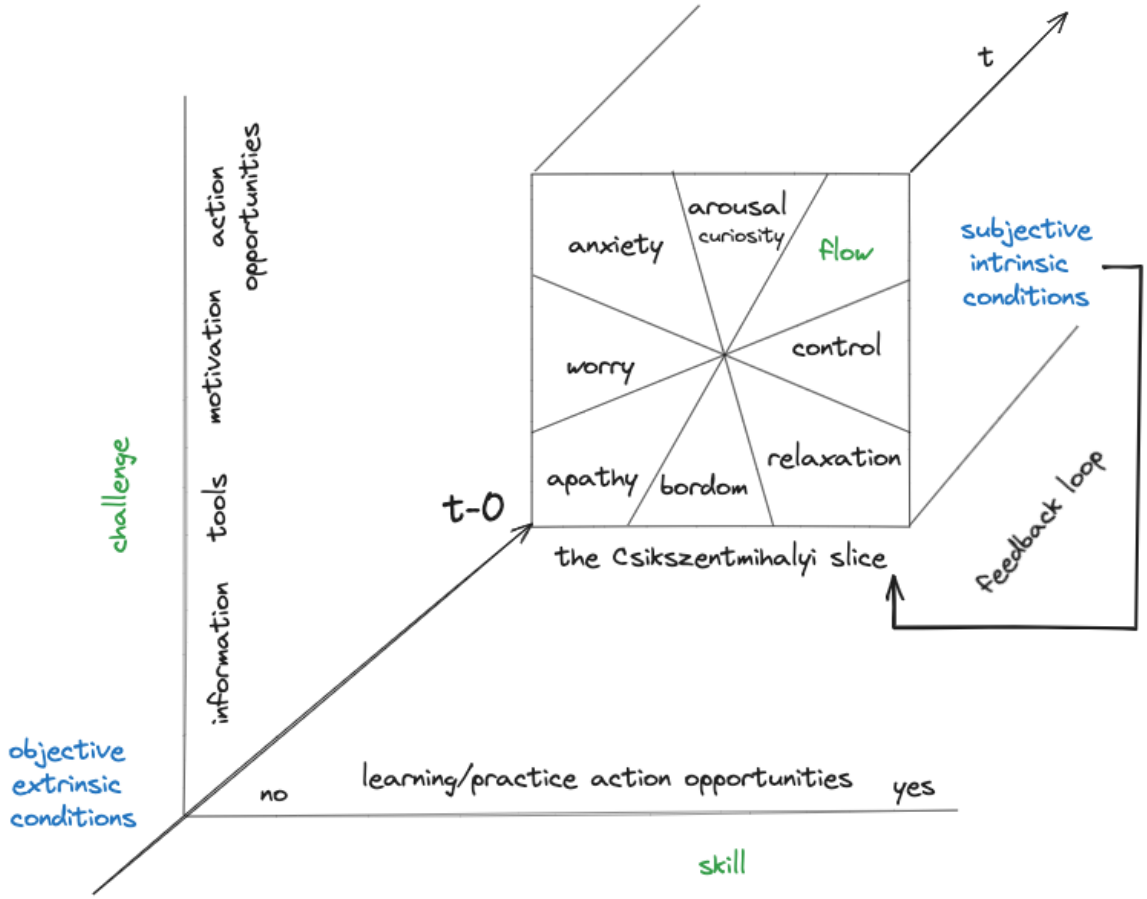

Figure 3.4: Csikszentmihalyi Time Slice (CTS): Novel Evaluation Technique Based on "flow"

szentmihalyi's chart is a static representation of states "in a time slice". Because Interactive Mediascape Experience is a dynamic occurrence, another dimension can be added to the given chart (Figure 3.4). If the CTS exists at t.0 (CTS-t.0), the dynamics of IM are moving

on the Z-axis from positive to negative. Negative values correspond to Intrinsic conditions, while positive values correspond to Extrinsic conditions. While moving through the CTS-t.0, experience itself occurs.

The Csikszentmihalyi time slice mediates the Extrinsic and Intrinsic paradigms, as conditions transition from positive to negative - Extrinsic conditions may affect Intrinsic ones. It is worth mentioning that while we can establish objective qualifications for Extrinsic conditions (as least to the degree established by the designer), once they cross into t.0 and into the ”negative” Intrinsic space of the user's perception, conditions become subjective as they are experienced and internalized by the participant. This is an important point to keep in mind, especially during the evaluation process, although subjectivity of experience is an inevitable circumstance, it may present further challenge in the evaluation and analysis stages of research.

We can see that while all of the elements are balanced, action opportunity could be the best predictor for the state of “flow”. In the context of Interactive Mediascape, action can be related to interaction, content creation, communication with other participants, providing input of personal content into the system, etc. It is only limited by the domain and purpose of application of Interactive Mediascape Experience. Finding the balance between elements in the chart above could serve as the door to understanding how to invoke the state of “flow” through a particular experience.

One of the important questions to ask in the creative process is, what are the factors which can stimulate creative thought, in every day life circumstances it is a difficult task to accomplish due to everchanging factors in individual's behavior and environment. These factors cannot be easily observed or noted during person's daily activity. What makes an Interactive Mediascape a unique opportunity, in this sense, is the fact that the environment of the experience is (although dynamic and allows for a range of configurations), is nevertheless, an artificially designed environment and having the participants self-report their emotional state during the experience, could provide valuable insight into the the correlation of participant's emotional state with extrinsic circumstances. An Interactive Mediascape designer knows the timeline of events, i.e. ”the order of co-existing data” which comprises the experience, received participant's feedback can be matched with the configuration of elements at the time.

I am not proposing the mechanism for self-reporting when ”feeling in control” or ”being excited” as these emotional states may lead to ”flow” and disrupting participant's attention at this moment is not advisable (Cherry and Latulipe, 2009, Csikszentmihalyi, 2008). While the participants do not report boredom or frustration, it can be assumed that they are enjoying

the experience. This assumption can be further supported by observing their interaction with the system, for example, through the history of interaction logs. Interview/discussion after the experience may provide additional clarification as to how they felt in the moments when they were fully absorbed in the experience.

Combining CTS-t.0 tool with CSI survey may also give good insight into the way participants perceive the experience. These methods can supply substantial quantitative data to address specific time points in the experience (through CTS) as well as the overall outcome (through CSI). The two techniques, complemented by participant's interview and discussion would provide the most comprehensive evaluation of IM experience.

4

IM Implementation

Contents

In this chapter the design synthesis takes place combining items from IM ecosystem outlined in chapter 2 with research outlined in chapter 3.

Before poetry is written, the language must be understood; before a play can be directed, professionals from various fields need to have a vision from the director; before a symphony is composed, the composer must understand what each instrument's range is and assign it a function in the overall composition. These are all oversimplified statements but they help to bring the point across - in order to design an interactive mediascape experience, the core of it must be formulated. This core consists not of content details but of interaction dramaturgy. Once this structure is formed, it can begin evolving into a detailed experience. This is when experts from sound, visual arts, dramatic scripting/ storytelling / narrative, set / spatial design specialists come together to create the IM in full detail and color.

The challenge of IM designer is to bring all of these experts to "the same page" during the design process. It is not enough to understand the principles behind IM experience structure, it is equally important to understand how to communicate the requirements to various practitioners. Communicating a task to visual and sound artists requires a different language from communicating with software folks. IM designer must understand these differences and know the most efficient way to pose a task while making sure the expert understands the concept at large.

4.1 IM Scripting Process

Having discovered various elements which can impact IM experience design, it is clear that this is not a one person job. Although it might be possible to make a simple prototype with an effort of one person, to really leverage the wealth of applicable concepts and ideas, a team has to work on developing an IM experience. As mentioned in the beginning, Meyerhold's view of theater as a place where various types of art come together to blend into an organic whole by using expert approach from each art domain, adapting it to the setting of the stage and then shaping into a vision proposed by the director. Similarly Buchanan's ideas in design where practitioners from various domains, although, they may have different opinions at large, join forces in search of creating the artificial. A movie production as opposed to theater adds a layer of complexity to making an experience (a story which the public will enjoy watching), it requires equipment and the knowing of how this equipment will change the perception of what is on the screen, take for example wide angle or zoom lenses, they reproduce reality in a completely different way. Then there is editing which chips away at massive amounts of footage, etc. IoT and interactive systems, on the other hand, take design challenge one step

further by adding a layer of engineering requirements, software, networks which can support the design of a physical object itself.

Designing an Interactive Mediascape experience is not a trivial task. It combines elements from theater, design, media and engineering, it calls for interdisciplinary collaboration. In this section I am proposing a scenario for IM designed for collaborative creativity, however, it has to be apparent that this is only a beginning of the implementation process which is to continue in a future discussion with practitioners and experts in adjacent fields. Perhaps it could be helpful to have a person such as a director in the position to define the vision for the project, but it is evident that creating and developing an IM experience is a team effort.

4.2 Design Sensitivities for Fostering Collaborative Creativity

In this section I summarize concepts reviewed in the previous chapter. This is to define boundaries and points of focus in the design process. As previously noted, these ideas can then be applied as design sensitivities, they don't prescribe a course of action, but inform the design process.

Project Limitations:

1. I considered the limitations of space as a black box theater 2. There are 4 projected walls 3. There is a dome projection available on the ceiling 4. I have to work mostly with SR04 sensors to keep the costs down

Design Sensitivities:

Fitzpatrick et al - locales: It is proposed to design a "social world" with multiple "locales" for action.

Tuan & Ciolfi - place and **Buchanan** - thoughts: Thinking about metaphors of place and embodiment of actions to activate the associative thread to participant's "latent zone" - "zone of one's past experience".

Eberts, Fishkin - HCI and **Buchanan** - signs/things: Thinking about metaphors in signs and things/objects "Using metaphors can be an effective way to communicate an abstract concept", embodiment/metaphor chart.

Thoring et al - creative spaces typology: Considering different types of space: personal, collaboration, presentation, making, transitional.

Kendon - F-Formations: consider vis-a-vis, side by side, circle and semicircle body positions in space as the most favorable for 3Cs.

Csikszentmihalyi - flow: Balance of skills and challenge.

Corazza & Glăveanu, Beghetto - creativity: Creativity as a dynamic process, creative act as a product of favorable intrinsic and extrinsic conditions, creative experience as encounter with a spectrum of lived events which may have no clear trajectory.

Tuan - place: abstract ideas emerge out of the perceived environment over time. Latent Zones, fields of care.

Biophilic design Elements resembling nature may improve conditions for making the environment more relaxing.

Fuks et al - 3Cs by means of awareness: In collaborative systems, it is necessary to think about group process awareness to ensure communication, collaboration and coordination.

Hornecker - embodiment facilitation: Being mindful of how interaction is structured and distributed among the participants, synchronization of action, physical positioning of access points can guide user experience.

Jacob et al plus Renom et al - user interface: build on intuitiveness driven by people's understanding of ”naive physics” and ”interactive knowledge”. Ability of users to extract interaction principles.

Deslgaard - design for inquisitive use: Draw on design sensitivities proposed by Peter Delsgaard in questions which address user experience and motivation.

It should be noted that these *design sensitivity anchors* can be addressed through dramaturgy, set design, user movement through space, user interface design, interaction dynamics, software design and content itself. The next challenge is to find the best “vehicle” for delivering optimal solutions for each of these design sensitivities. The IM taxonomy gives some guidance as to how the metaphor and other place-related ideas could be integrated, or how user interface design can mediate awareness through feedback/feedforward mechanisms, for example. However, the points which have to do with the dynamic process of emergence of flow and creativity are more difficult to tackle in such direct manner.

My thought process / method in creating the dramaturgy

It follows that my initial thoughts and considerations are, I need to create several locales for action, I need to establish a user journey which would be progressive in terms of interactive possibilities, I need to introduce a metaphor which will resonate with people across various cultures and social settings, I need to create a feedback loop from participants perception of events to the environment, I need to establish a pattern of communication, collaboration and cooperation between the participants as clearly in the experience as possible.

I begin by establishing two locales a collaboration type setting in the center of the room and 4 individual cubicles, because it would provide for an opportunity to evaluate how the participants perceive these two environments and how these settings would mediate the collaborative process in the context of IM experience. Then I think about ways to link these settings through a narrative. I think about the ocean and its potentially soothing effect on participants and take the narrative further by exploring the idea of camping on the beach. Once I have established that, the cubicles take shape of tents and the places in the center of the room becomes a gathering around a fire.

Further I establish another scene where participants would lie down and look at the projection inside the dome, the idea of a starry night emerges. From there I think, if the night has fallen, the participants may end up in a dream. A dreamworld would become the ultimate creative space to explore through interactive activities coupled with generative art. Leading up to this 3 previous scenes would create enough context and familiarize the participants with the current interactive paradigm within the mediascape environment. Now I can begin thinking about the details.

As mentioned earlier, designing an IM experience takes more than one person, it requires expertise from various fields. What I am proposing here is an idea for a prototype experience, but by no means a finished product. The script offered below can be implemented in multiple ways depending on the group of practitioners developing it.

"Delphinium Dreams" Interactive Mediascape Experience

SCRIPT

User journey in 4 scenes

Scene 1 (locale 1) At the seashore around the fire

Time is getting close to the sunset, the travelers made a fire and have gathered around it. They see the ocean all around them and hear it's murmuring sounds

Scene 2 (locale 2) In a tent - sunset

There are 4 tents in the space, the travelers go inside. As the sun sets they watch each from her/his own tent through a small window.

The sun has set but the sounds of nature continue together with a soothing tune in the background. An owl wakes up and makes itself known, with its eyes shining in the dark.

Scene 3 (locale 3) Gazing at the stars

As the nightfall closes in, the starry sky comes to live. The travelers come into the center of the room and lie down on sand cushions. A dome above them glows with constellations and particles floating.

Scene 4 (locale 4) Dreaming Delphinium Dreams

All around the travelers observe a strange happening - ocean waves morph into delphinium flowers and into strange geometries and shapes. Travelers are immersed into a wonder land filled with changing patterns and accompanied by the sounds from real and outer worlds. Travelers move through the room and explore the dreamworld.

In the above script we find several design sensitivities reflected such as *biophilic design, Tuan's latent zone, Kendon's F-formations, Deslgaard - distinct experience, situated intentionality, concurrent action reflection, the concept of social locales by Fitzpatrick et al and creative spaces typology by Thoring et al.* These ideas are still touched upon only "on the surface", further, each of these concepts can be examined in more detail in relation to the experience which is being designed. These ideas together comprise a theoretical foundation for design decisions and establish a starting point. While the design process remains exploratory and fluid, having these key points is similar to what they call in art direction "a mood board" - this is a *theoretical mood board* to which practitioners collaborating on the project can refer.

In the next section we will discover:

- an explication of the script
- "full score" of the script
- data-flow implementation schematics
- IM interdisciplinaty collaboration matrix application

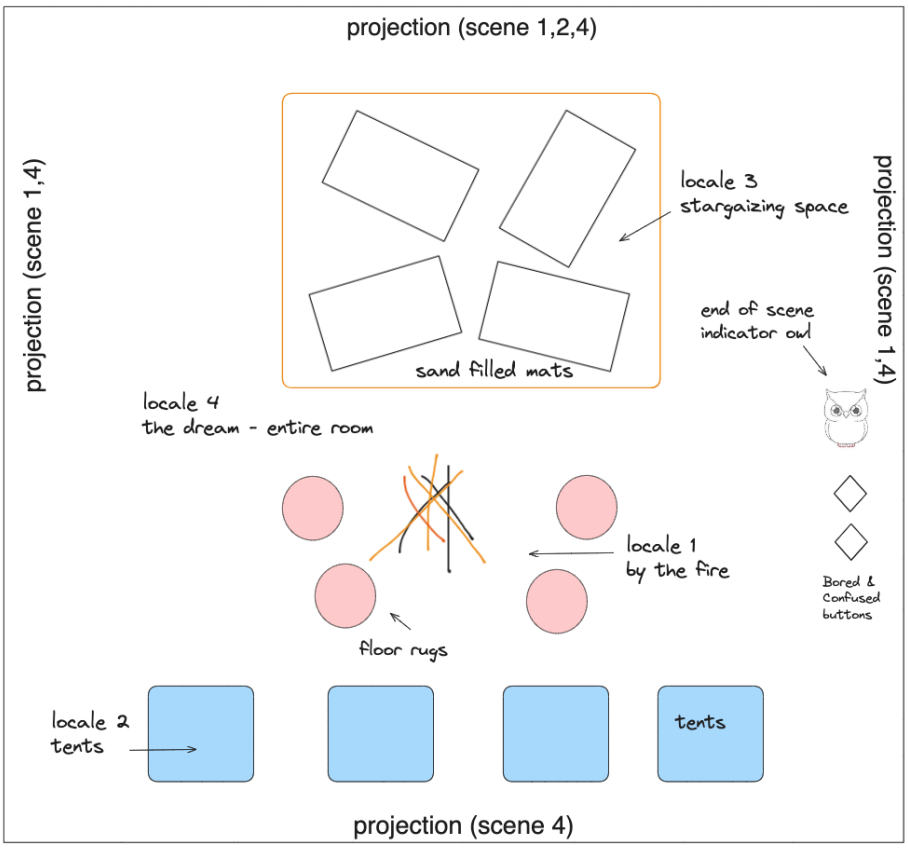

Figure 4.1: Delphinium Dreams Floorplan Sketch

- possible experience evaluation scenarios

4.3 Synthesis - Script Explication

In this section all of the research considerations previously discussed will be integrated into the concrete overall shape of IM experience. Still without too much focus on the content itself, here the main goal is to fill the timeline with events - events are comprised of elements introduced in IM taxonomy (see 2.4). It is an *explication* of interactive patterns throughout the script.

We have to remember that we are designing for possibilities and while the events are being scripted in a certain way based on hypotheses from research findings, the most essential part of analysis will be from observing how the environment is being experienced by the participants, how they choose to move and what types of interactions they choose to engage with.

Because IM is a novel phenomenon, by creating a particular sequence of events we are setting the parameters to a “default” value to see if the feedback from user experience gives any clues about how to calibrate parameters for a more organic and enjoyable user journey.

Global taxonomy elements settings

Collaboration type: small group
Media type: audio stereo, video projections
Interaction type: touchless
Degree of freedom: varying
Sensor type: physical
Sensor name: SR-04
Feedforward: functional - from the start participants are informed about the overall system affordance potential
Narrative type: contextual, linear
Narrative state: static
Learning type: visual, aural, motor
Perception modality: multiple
spatial configuration: metaphor / mixed
Coupling state: mixed
Temporal dynamic: see each locale

There are three interactive devices which remain active throughout the experience: The Owl (triggers the change of scene) and the Boring and Confused buttons (triggers for the Csikszentmihalyi time slice evaluation (see 3.6.2)).

The Owl device resembles an owl - it is a movable device, participants can carry it with them (spatial configuration SUI metaphor: yes, positioning: dynamic)

The Boring and Confused buttons are placed anywhere in the space as long as they can be easy accessed by any participant an any time during the experience. (spatial configuration SUI metaphor: no, positioning: fixed)

The Owl, Boring and Confused buttons constitute continuous events throughout the experience. Meaning, they can be triggered at any time in the duration of the experience.

So we describe, Continuous Events (Ec):

(Ec1) - when the owl is triggered 3 times there is a scene switch

(Ec2) and (Ec3) - The Boring (Ec1) and Confused (Ec2) buttons are on and can be pressed by participants at any time during the experience.

Scene 1

At the seashore around the fire (locale 1)

Time is getting close to the sunset, the travelers made a fire and have gathered around it. They see the ocean all around them and hear it's murmuring sounds.

spatial configuration user: metaphor: yes, center of the room, fixed (people sitting around the fire)

spatial configuration SUI: metaphor: yes, center of the room, fixed (interactive modules in shapes of seashells)

spatial configuration media: video : metaphor: yes, 3 walls, fixed (ocean images); yes, special effect, fixed (fire)

metaphor: yes, center of the room, fixed (this is the object resembling fire)

SUI devices: Pair A - D shaped like shells, each pair slightly varies in color

Temporal configuration: prompted — SUI feedforward type inherent (waving) & augmented (visual LED prompt)

Media type: audio: stereo

Media type: video: projection, special effect

Content: projection of the sea, sand, sounds of the sea, lights resembling fire in the center of the room.

Events

E0 ambient soundtrack - hardcoded

E1 visual stop/go - sensor 1, device pair A

E2 sound ocean sound - sensor 3, device pair B

E3 visual switch ocean/sand - sensor 5, device pair C

E4 visual flip upside down - sensor 7, device pair D

E5 sound fire crackling - sensor 2, device pair A

E6 visual fire flash - sensor 4, device B

E7 visual on left panel a ship passes - sensor 6, device pair C

E8 visual on main panel the sun begins to set - sensor 8, device pair D

The full explication of the entire experience is outside of the scope of this master's thethis, however, presented scene serves as an example of the thinking pattern which can be used during explication process. It is to be noted that E1-8 are only "placements" they are drafted as placeholders for now and can be adjusted later once the project develops in more detail.

In this section we note more of design sensitivities coming into play, such as *Hornecker's idea of distributed interaction to facilitate collaboration, Delsgaard's reciprocal change, the idea of interaction knowledge by Renom et al as we allow participants to get a grasp of interaction principles during the experience, and integrattion evaluation tool based on Csikszentmihalyi's "flow"* We add these sensitivities to the "theoretical mood board" of the project.

4.4 IM Score

The lesson I took from presenting multiple projects is that one person cannot be an expert at all these fields of knowledge but in designing a co-located TME such as Interactive Mediascape it is essential to begin with the basic knowledge of possibilities provided by these fields and a solid knowledge of creating an experience for a group of people in physical space. Each of those fields alone cannot provide the necessary spectrum of information, a sonata written for a piano is not the same as the one written for an orchestra, although composing both is not a trivial task, the latter requires a more sophisticated skill set. A composer doesn't

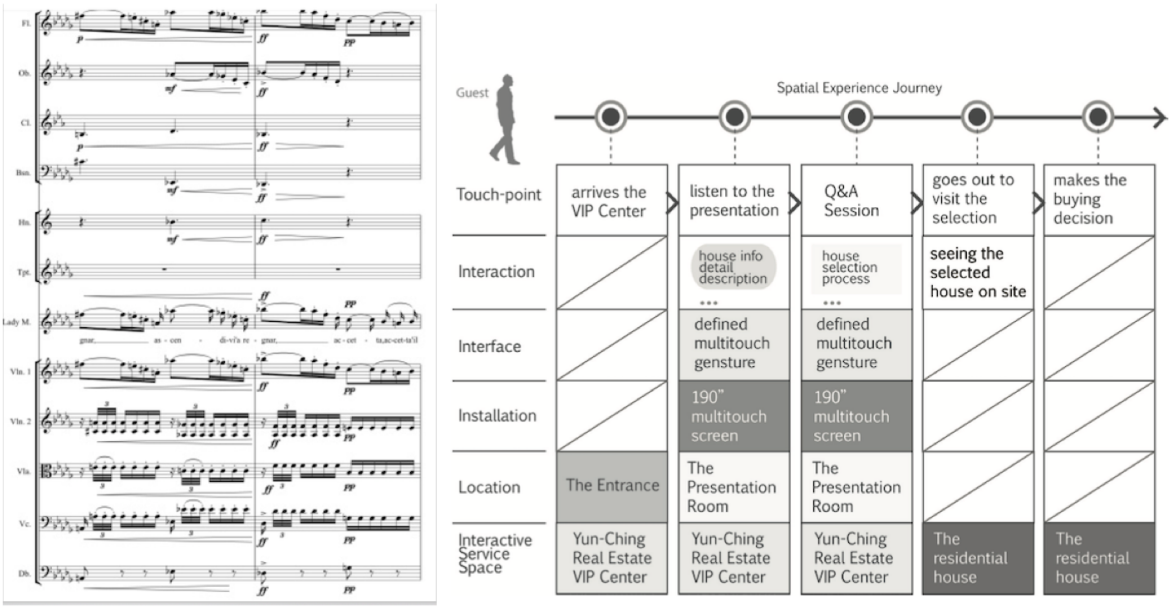

Figure 4.2: Orchestral Score "Macbeth" Verdi (left), Framework for Interactive Service Spaces By Chen & Lu (right)

need to now how to play each instrument at an expert level but must understand the possibilities, and then, the composition itself must have a structure. A composer leaves it to the conductor and the orchestra to perform; so does a playwright rely on the director and actors.

Taking into account the design sensitivities outlined from the research phase and the script explication, we now can write the "full score" of the experience. In approaching this task

I considered references to the framework proposed by Chen and Lu (Chen and Lu, 2012) as well as a typical classical opera orchestral score (Figure 4.2). In both scenarios we see the elements presented on a timeline divided by temporal periods. In the framework for interactive service spaces these periods are defined by the user journey actions, while in the orchestral score they are divided into duration-measured by rhythmic signature.

Examining Chen and Lu's frameworks more closely, we note that the specifications inside each temporal block related to a specific element is rather general. Not much detail is provided, they merely pin point structural abstractions appropriate in the given temporal space. This leaves a lot of room for interpreting these abstractions in various ways, leading to a range of possible outcomes in the final design.

Now, let's consider the orchestral score. We can observe that in the orchestral score the vocal line which carries the language based content is positioned in the middle of the ensemble of instruments, thus visually communicating the idea that it is not a dominant part but rather an equal part of the ensemble in musical terms. It is the ensemble of instruments, including voice, which communicates the overall expression of the narrative. The number of instruments here is greater than the number of elements in Chen and Lu's framework and in orchestral score each instrument is provided with a precise direction to follow on the musical scale. There are also indications of relative speed and dynamics throughout the score, guiding the conductor in shaping the overall shape of expression.

IM design process is not a live performance such as an opera production, and we do not need to provide such fine level of detail. Thus, similarly to Chen and Lu's approach, a certain level of abstraction can be present in the temporal blocks as the score is being compiled. However, the orchestral example contains the insight for addressing the narrative construct which is comprised of all elements - this calls for noting the *dynamics of the expression*. In case of IM design this aspect is especially important because a. We need to avoid unnecessary distractions, ie adding elements which do not support the overall narrative and b. We need to pay attention to the overall sensorial load, ie striving towards balance between motor, cognitive, emotional engagement.

4.5 Integrating Design Sensitivities with IM Taxonomy

4.5.1 Symbols & Things

One of the design sensitivities which came up across research domains was metaphor. Based on this and to begin integrating research with the taxonomy, we first identify "sym-

bols and things", using Buchanan's 4 order design steps. Because the experience is about spending an evening on the beach with a consequent dream, we can brainstorm some elements which are associated with the beach, ocean etc (Figure 4.3). Then we think about "things" which can carry the metaphor of these elements. These "things" will be the anchor points throughout the design process. Let's also keep in mind that metaphor can be carried through actions, it can be embodied through participants movement and positioning in space.

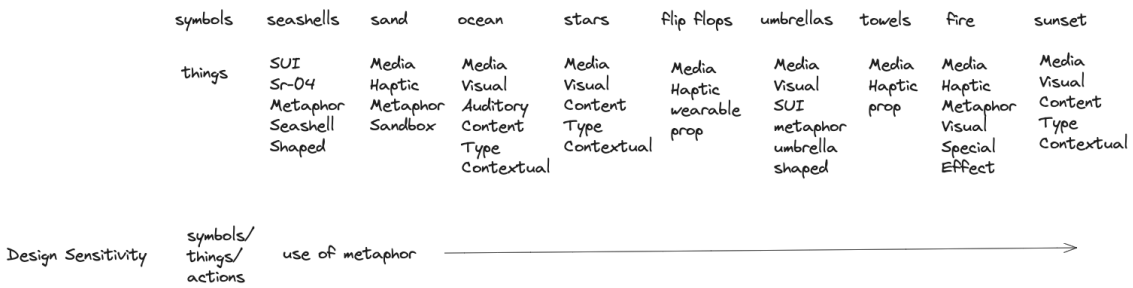

Figure 4.3: Metaphor carried by Symbols, Things, and Actions

4.5.2 Actions

The next step is to describe the action of the narrative in general terms and define design sensitivities which will guide the configuration of elements. In the narrative there are 4 scenes: by the fire, in the tent, star gazing and the dream. These scenes can be summarized in an

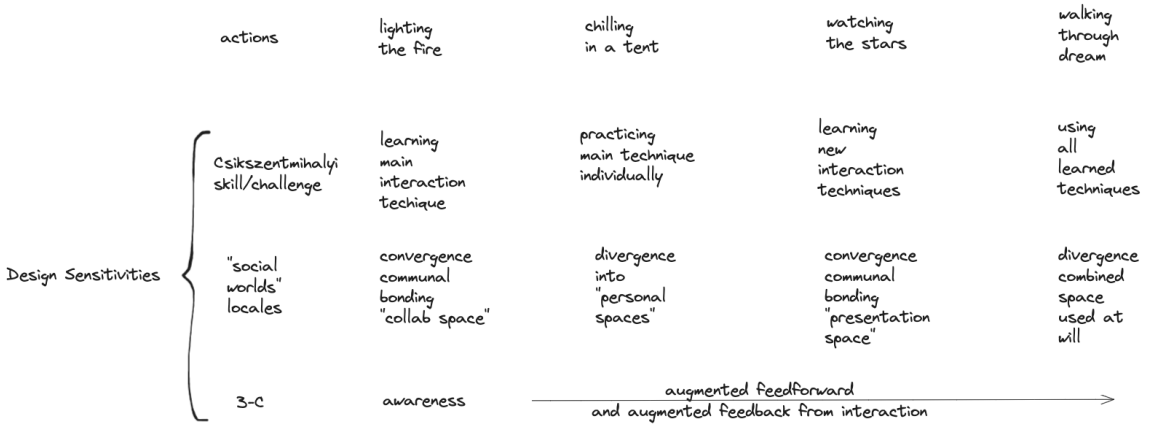

Figure 4.4: User Journey "through" Actions & Design Sensitivities

actions which describe the participants' journey (Figure 4.4). Without too much specifics, these actions express the central focus of what is happening in each scene. Then based

on design sensitivities we construct a user journey aiming at the goal of designing and IM experience for collaborative creativity. Each design sensitivity serves a function in developing a user experience. The properties outlined under design sensitivities will further shape the design of user actions and the overall dynamic of the experience.

4.5.3 Full Elemental Score

Further we bind these sensitivities with the Taxonomy elemental structure. We define each element on a semi-abstract level which implies a connection with the sensitivity, yet remains open-ended in anticipation of a discussion between collaborators working on designing this IM.

This approach creates a boundary for designers' creative process. In other words, the score serves as a design improvisation structure, it established the temporal correlations between specific sets of elements and the dynamics.

The score (Figure 4.5) is based on the original script explication outlined in previous section (4.3).

Let's examine each element in the score.

Spatial Configuration In the spatial configuration the user positions in space are indicated, also the dynamic nature of the positioning is described as either fixed, when the participants remain in a certain place, vs dynamic, when participants navigate from one position to the next. In the first through third scenes participants' positions are fixed because once the participants arrive in a certain position they stay there during the scene. Although they can still move freely in space if they wish to, in scenes 1-3 the design of the experience is focused on providing a fixed "locale" for each scene.

While in the fourth scene participants positioning is dynamic because there is no one specific place where they are encouraged to be by design, rather, they can follow their own curiosity and explore the interactions and reflection points as they please. This establishes a structured spatial journey which is constructed by the designer in the first part of the experience while in the last part the participants, after gaining enough control of interactive modules and understanding of the experience paradigm, can freely choose how to interact with the environment.

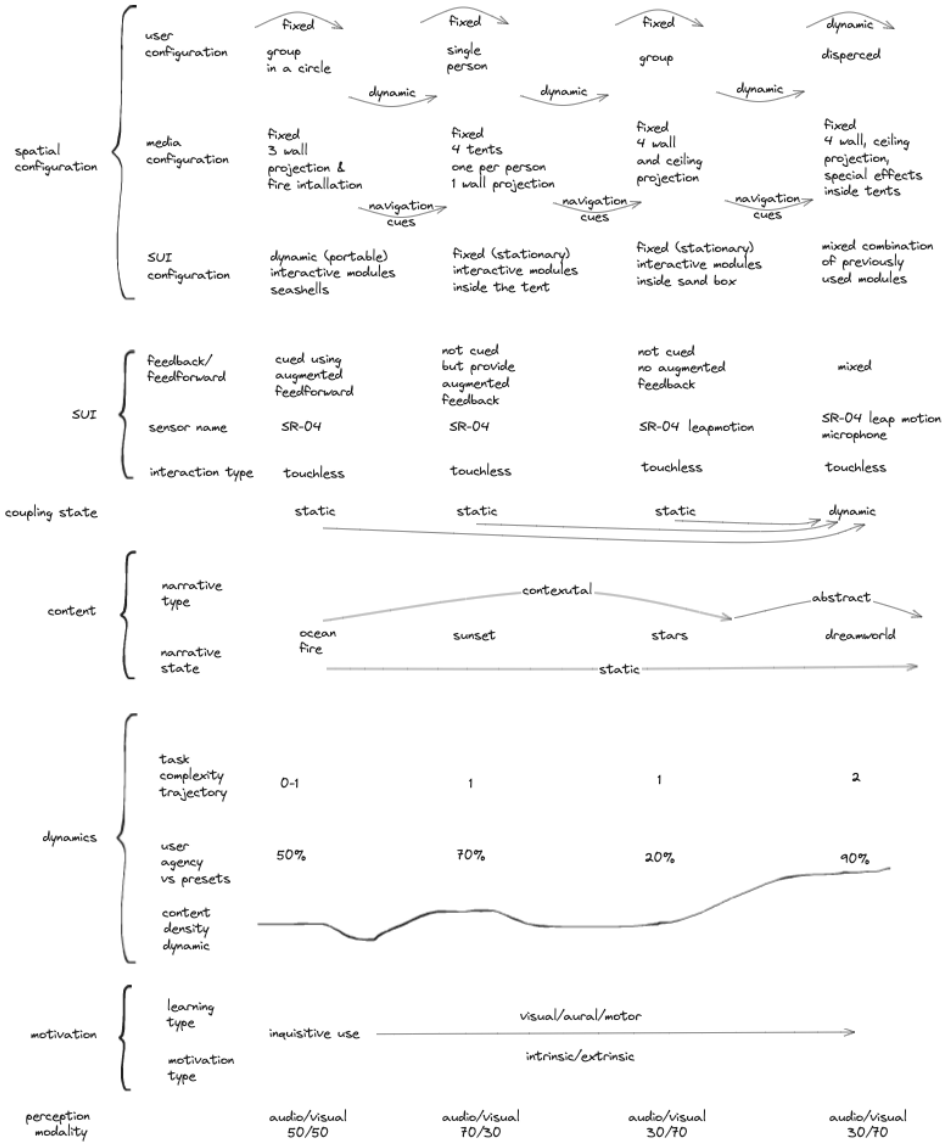

Figure 4.5: Full Elemental Score

Media configuration outlines the layout of media elements in space. "Navigation cues" indicate media-aided cues, such as light, for example, for the users to travel from one scene locale to the next.

SUI configuration indicates the presence of physical objects enabling interaction located in space. This is the Buchanan's "things" order design where interactive modules are described in terms of what shape they take and/or what place they occupy in physical space. Again, we must remember that the score describes elements at a certain level of abstraction so that here we don't go into too much detail, just enough to give the collaborating designer a clue

of the context where interactive modules will appear. In scene number one the interactive module is portable and adding an idea of what it will be shaped as is helpful.

SUI Moving onto describing SUI elements, we begin with feedback/forward type. As noted from design sensitivities these properties of interaction will play an important role in establishing means for awareness to enable participants collaboration, coordination and cooperation. These mechanisms will make it easier for participants to understand "what's going on" and what their individual role is in the co-creative process. Just to refresh the memory on terminology, augmented feedforward means giving cues, such as light, text, sound etc, to prompt user to interact, augmented feedforward is activated before interaction occurs. Augmented feedback means the same type of cues given while the person interacts with the system, these augmented cues are given in addition to "inherent" feedback which is the actual media change prompted by interaction, augmented feedback is activated once/while interaction occurs. Sensor name and sensor type are self-explanatory.

Coupling State We note that in scenes one through three the interactive modules are dedicated per interaction mapping, ie fixed coupling. In the fourth scene the interactive modules from scenes one through three are repurposed and coupled with new media events, ie it is dynamic coupling and the devices from previous scenes are used to create a new interactive experience. This does not, however, rule out a possibility of adding new interactive modules in scene four.

Content Here we come to our "vocal line" in the score. The narrative is described in terms of content type contextual and/or abstract and content state static of dynamic. In this scenario dynamic narrative is not used because the storyline is fixed, it's static and can be described as four consecutive scenes. An example of a dynamic narrative would be if the scenes could change order, in this scenario - they do not and the participant does not have the ability to change the order of the narrative. Narrative type parameter describes contextual cohesiveness of a given content sequence. Because the first three scenes are well defined and the context is clear - ocean/fire, sunset, stars - they are contextual, the dream scene can be made of a media collage which will not necessarily be as well defined by a specific description, it's going to be based mostly on user interactions and will be abstract.

Dynamics This section is perhaps the most intuition-driven part of the score. Similarly to a composer who indicates crescendo and diminuendo, places accents in certain points with fortissimo or a pianissimo, in this part of the score we outline the dynamics of media, agency, interaction and plot density. It helps balancing sensorial load, albeit subjectively, it shapes designer's awareness of elemental amplitudes in temporal space. Initial values are to be established by the designer, the highest and the lowest points in each dynamics category.

What is the highest level of media density, what is the lowest? Same for interaction complexity, what is the easiest and the most difficult interactive techniques being used during the experience? The agency percentage assigned to participants' triggered events vs "hard-coded" events. And finally plot density dynamic - how much is actually happening in terms of narrative, when do the pivotal points of conflict, resolution and contemplation occur? It is known that confusion may set in where there are too many events and boredom may result from too few, this is the place to set the general feeling of the experiential load throughout IM experience. Just as in the orchestral score the conductor pays attention to the assigned dynamic in a particular instrument and brings it out by gently quieting the overall orchestra, so in IM design it is necessary to think in terms of such balance.

Motivation It is proposed to use design sensitivities from Delsgaard's "Design for Inquisitive Use" in order to motivate participants' actions.

Perception Modality Here the balance between various perception modalities prevalent during the experience is noted. This is a subjective estimation in terms of percentage, it's meant to serve as a guiding number for media artists to know when the content the degree to which the narrative will be relying on one or another type of media.

4.6 Interdisciplinary Collaboration Practice

With this information at hand, it would be useful to meet with a dramaturg and introduce a plot into the experience to complement the elements outlined so far and to carry the narrative forward (the "brainstorming" round Figure 4.6). Here the interaction designer serves as a mediator between various specialists and ensures the balanced approach referring to the overall score. The narrative needs a dramaturg to weave in "conflict and resolution" into the storyline. However, considering the complexity of existing interactive system plus spatial configuration and participants' choreography which has emerged from the supporting research, the dramaturg, in order to preserve the balance of the whole, will have a challenge of a "limited work space". What I mean is that she has to keep the dramaturgy to a necessary minimum while adding a plot line. It is the responsibility of the interaction designer to communicate this and to discuss. Alternatively, the dramaturg may propose a complex plot line which may actually become a distraction rather than an aide in perpetuating the overall experience. That said, proposing a simple plot may require great skill on the part of the dramaturg.

Following a discussion with the dramaturg, it could also be beneficial to meet with media

artists, present the script and the score and ask for their input, ideas they can think about overtime and share with both interactive designer and the dramaturg. This initial introduction of media artists to the project may create a fruitful follow up discussion including the interactive designer, the dramaturg and media artists. This is also a good time to communicate initial requirements to software engineer, check with the location engineer/manager and electric engineer to establish what is possible and what might be a challenge. This is illustrated

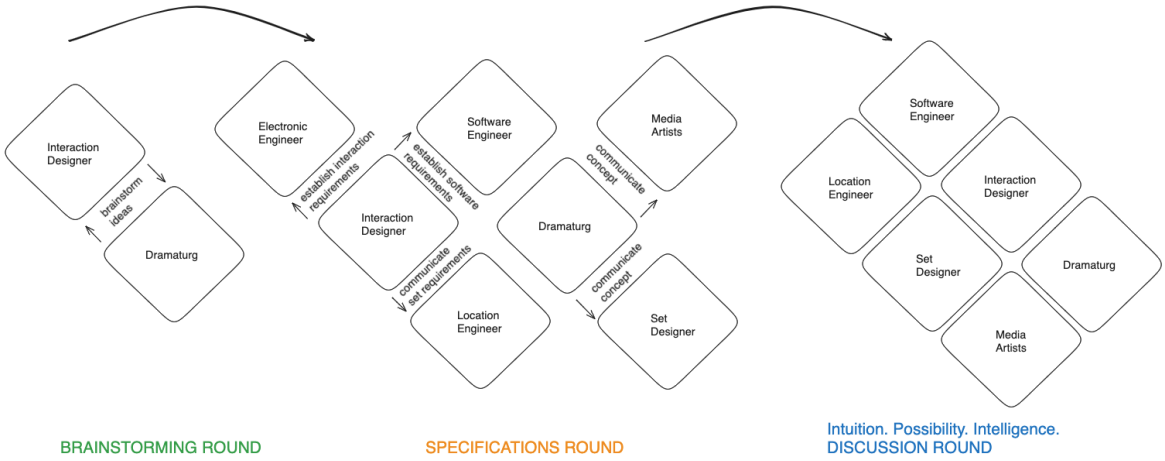

Figure 4.6: Interdisciplinary Collaboration Matrix Example

in ”Specifications Round” in the matrix: Interaction Designer speaks to technicians, while Dramaturg speaks with the creatives. This phase can be followed by ideas evaluation cycle of Intuition. Possibility. Intelligence. This round of discussions is aimed at crystalizing the best, most suitable ideas.

Unfortunately, meeting with a dramaturg is beyond the scope of this work and, while noting the possibility of interdisciplinary collaboration here, I continue describing the design implementation. Next we expand each section with particularities. I am not able to expand further on media or plot related aspects of the experience, nor the set design as these would require collaborators to complete. Thus, technical aspects of the process are the focus of further discussion.

4.7 Data-flow Design Schematics

Interaction design is concerned with interactive devices coupled with media. As was outlined in the script explication already, and now understanding the overall structure of experience from the score, we can begin working on the interaction architecture and implementation

requirements. In the following discussion I present some design principles for addressing hardware/software integration, general design principle employing Augmented Feedforward/Feedback concept, evaluation scenarios and an example of software-implemented timeline.

4.7.1 Media Events Mapping Chart

I will use scene one as the main example also illustrating scene 4 for comparison. Providing integration architecture for the complete experience is not possible within the scope of the timeframe I have for this thesis, nor is it possible due to the fact that further design process requires collaborators to finalize the script.

Here is the mapping proposed earlier in the script explication:

E0 sound greetings and ambient - hardcoded

E1 visual stop/go - sensor 1, device pair A; E2 sound ocean sound - sensor 3, device pair B; E3 visual switch ocean/sand - sensor 5, device pair C; E4 visual flip upside down - sensor 7, device pair D; E5 sound fire crackling - sensor 2, device pair A; E6 visual fire flash - sensor 4, device B; E7 visual on left panel a ship passes - sensor 6, device pair C; E8 visual on main panel the sun begins to set - sensor 8, device pair D;

For the interaction architecture we can first provide a schematic data flow outline. Here, using the concept of Placements (as mentioned earlier), the media is indicated as a generalized form, the actual content can be altered in the discussion during Discussion Round (Figure 4.6). The data flow architecture is functioning as a blueprint for the software and hardware engineers to understand the context of use. It is also a simple way of seeing the scope of work for media artists as it indicates which events are assigned to which media (Figure 4.15). The media artists can then form a better understanding in terms of specific points. For example, for the visual artist the schematics point to the number of places where their visual design or generative art can be altered by participants and the artist has to consider where to “insert” such interactive functions. While for the audio artist it shows the number of alterations which can be triggered by participants, possibly different instruments/tracks and/or effects, sound samples, etc.

In this data flow chart the device pairing with media is shown schematically. It reflects protocols which can be used during integration. This provides the base for technical communication between hardware, software and media art specialists. Hardware specialist can understand what types of data needs to be sent to the server, software specialist can see what type of data is received and then in what format it has to be sent to media artist for

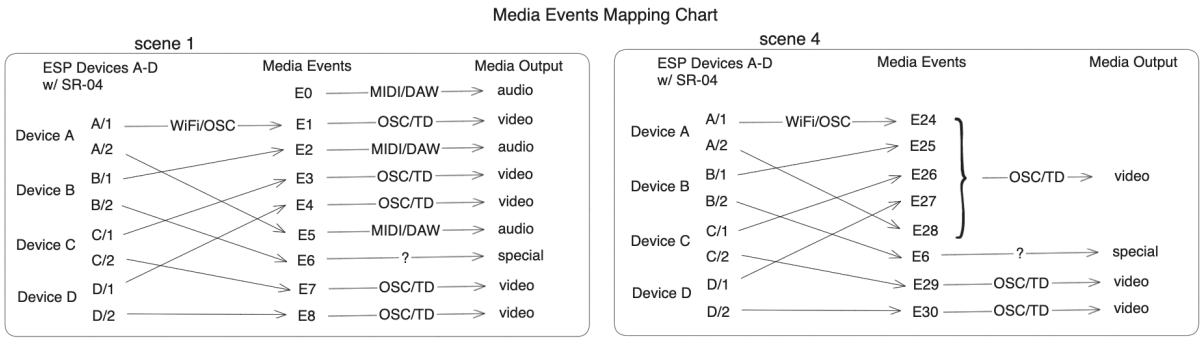

Figure 4.7: Media Events Mapping Chart

integration with end applications. These protocols are not the prescribed solution, they are a solution, depending on situations specific in each design case, these can be discussed and adjusted to whatever methods appropriate. The main idea is to have the understanding that this schematic representation exists to ease integration and communication between different parties working on the project.

It is also useful as noted earlier because it allows for Placements to be inserted, as something that is expected to become specific but during the design process still remains ambiguous. For example, we don't know exactly what type of video or audio is going to be employed in the final version of the design but having these placements allows hardware/software/media artist collaboration to be initiated before the final media art is approved. This approach also allows to clearly identify points of challenge, as, for example, here Event 6 is a special effect and it is not clear "how to make it happen", this creates room for discussion between collaborators and finding a solution. There is also room for "hardcoded" events, such as E0 in this example, which is an audio track, something that is on automatically and plays in the background, without the need for participant's interaction.

In addition to the above, by introducing this diagram for every scene, it is easy to see when the same interactive devices are coupled to a different media. For example, if this schematic is applied to scene number four, the same devices A through D are mapped to new events. This is to illustrate the switch from the interactive content corresponding to the sensors in the first scene to a new set of media. For example here in scene 4 Device C, sensor number 2 is coupled with the same event in scene 1 and scene 4, while all other devices are re-mapped.

4.7.2 Augmented Feedforward and Augmented Feedback

The diagram above only describes the data flow from participant to media, there is also much to be said about the flow in the opposite direction. Because IM experience is scripted, events are timed and this timing is regulated by when and how the interaction happens. There are three possibilities: interaction timing is left completely up to participants, the interaction timing is cued for a specific beginning time, interaction time is cued for beginning and end time. “Inquisitive use situations should contain both semantic elements of stability and recognition as well as elements of change and uncertainty: The experiencer needs the stable semantic elements as scaffolding for exploring the unfamiliar, lest everything appears in flux.” Dels-

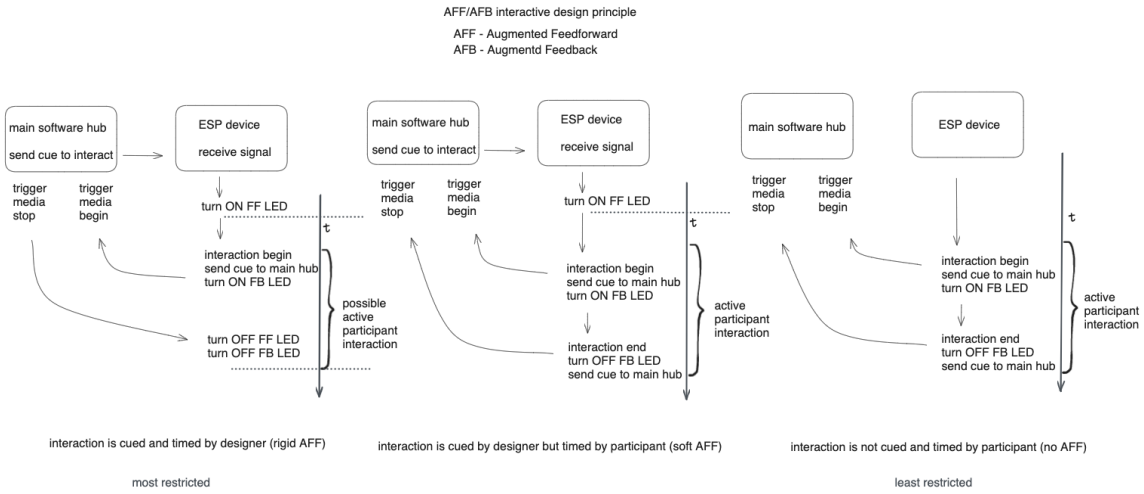

Figure 4.8: Augmented Feedforward/Feedback Interactive Design Principle

gaard points to the necessity of having semantic “anchor points” during the experience so that the participant can appropriate them into the understanding of the experience, if there are no such points, the participants may become confused and loose interest. Providing interactive modules throughout space without any type of guidance for interaction may, in fact, result in such state of confusion. This is because in navigating an interactive experience with a narrative requires a certain skill on the part of the participant, she has to understand the resulting actions from engaging with interactive modules, she needs to gain a greater sense of agency within the IM environment. This idea is outlined in the score, where the skill/challenge element describes a user journey from simple to complex interaction over the course of the experience. Here we need to address this question in technical terms, in relation to interactive modules design. What type of device design would allow for a spectrum of interaction complexity to be expressed in a physical object?

One of the concepts used in IM taxonomy and described earlier in the state of the art is device to media coupling based on the Frogger framework. In applying this idea to create a user journey allowing for interaction complexity dynamic we can use Augmented Feedforward (AFF) and Augmented Feedback (AFB) as helping aides during the interaction. They can serve a scaffolding tool for the participants to learn about affordances of the system and move from a simpler version of interaction patterns towards freer, more complex ones. For this purpose interaction modules are designed with elements enabling AFF and AFB. For example, and I have used it in previous projects, such elements can be LEDs, they can serve to indicate with a light when the module is active and ready for participants' input (AFF) and when the module is in use by the participant indicate with another light that the module is responding to participants' actions (AFB). AFB may seem redundant at first, however, sometimes the participant cannot readily see the results of her interaction with the module reflected in the media content. The light indicating that the interaction is, in fact, in progress helps the user gain the sense of agency and provokes her to further engage in "finding" the result of her actions in the overall mediascape. AFF on the other hand serves as a tool for the designer to prompt cues, time engagement and invite users to interact with the system.

AFF/AFB interactive design principle (Figure 4.8) is therefore outlined in the following diagram. It is a general interaction principle which can be applied by the designer and also learned, "extracted" (Renom et al., 2023) by the user. It may have a positive effect on interaction knowledge acquisition by the participants, to then be further incorporated across different applications and contexts.

4.7.3 Comparison & Evaluation Methods

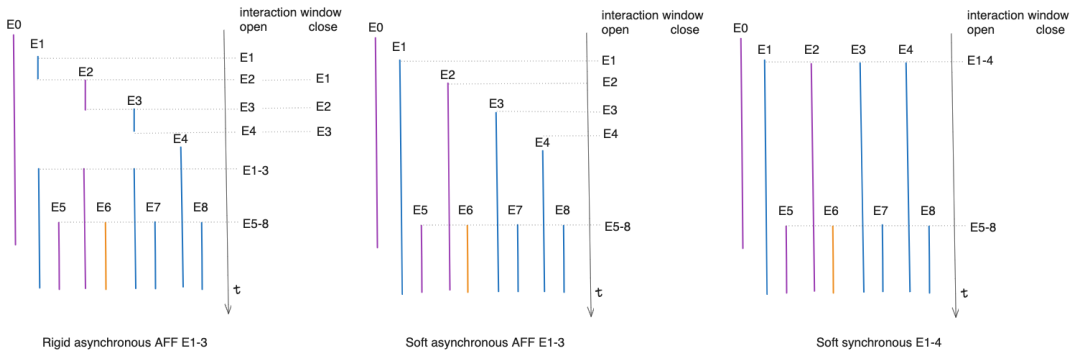

Figure 4.9: Experimental Scenarios: Cuing Type Variations

Now that we have an understanding of what devices are responsible for which events as

well as the type of interactive devices that can be employed during the experience, it is possible to compile a technical timeline. It shows the coupling of sensors with specific media overtime. As noted in the script explication the sensors are numbered and assigned to specific events, in this scenario based outline these events are presented in a sequence. Due to time constraints and thesis format limitations the complete timeline of scenes 1-4 is not presented, however, it is possible to illustrate how such timeline can be drawn and what it can be used for (besides serving as a technical reference).

Here we can indicate different scenarios of events' timing to compare and analyze whether setting any specific type of Augmented Feedback/Feedforward would predict greater participants' agency for the rest of the experience. In other words, whether this type of learning scaffolding is necessary for the participants to gain the skill to interact.

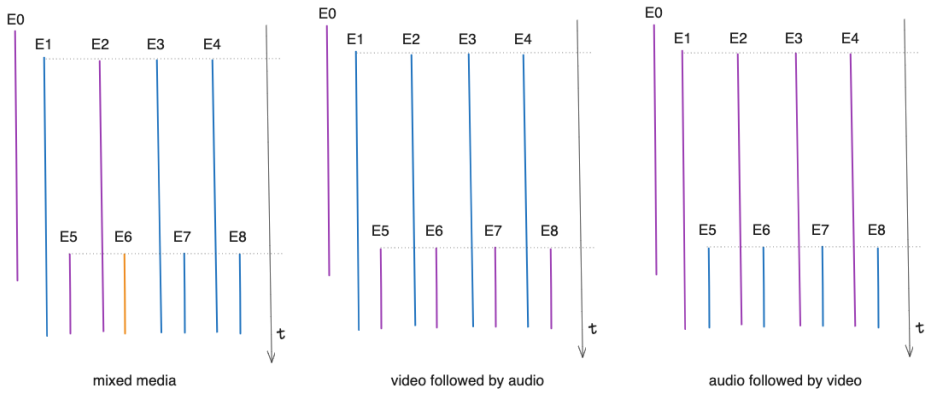

Figure 4.10: Experimental Scenarios: Media Type Variations

Would introducing Augmented Feedforward and Augmented Feedback at the beginning of the experience impact the level of gained agency and predict greater engagement? For example, the question I would like to test the difference between consecutive prompting of sensors 1-4 and synchronous right from the start to understand how this change impacts the 3 Cs and the perception of control/personal agency in a "meeting space setting". Although, this is still part of the IM grounded theory and is a hypothetical question, however, it's possible to outline an idea of what such an experiment would look like.

Consider these three scenarios (Figure 4.9). In the first case events E1-3 are cued and timed, they are distributed over the timeline asynchronously. In the second case these events are cued but not timed, once the interaction cue is ON, soft AFF allows the participants to continue interacting as long as they please, still, the cues are distributed on the timeline, making this an asynchronous soft AFF. In the last example all events E1-4 are cued right from the start and at the same point on the timeline, making this configuration a soft but

synchronous AFF. In making an experiment, as in the question above, it would be interesting to see if there is a difference of outcome when these scenarios are introduced.

In the figure above the colors represent media types. Purple for audio, blue for video, orange for special effect. Similarly to the aforementioned experiment one of these scenarios can be picked and while controlling for the AFF variable (Figure 4.10), media type can be changed and the results can be noted. It has been hypothesized that interaction with visual content is more readily noticed by the user as opposed to audio. It would be interesting to see if this is true within IM environment. Such finding may in guiding for developing a more organic user experience and assist in further scripting techniques, media type placement on the IM timeline, etc.

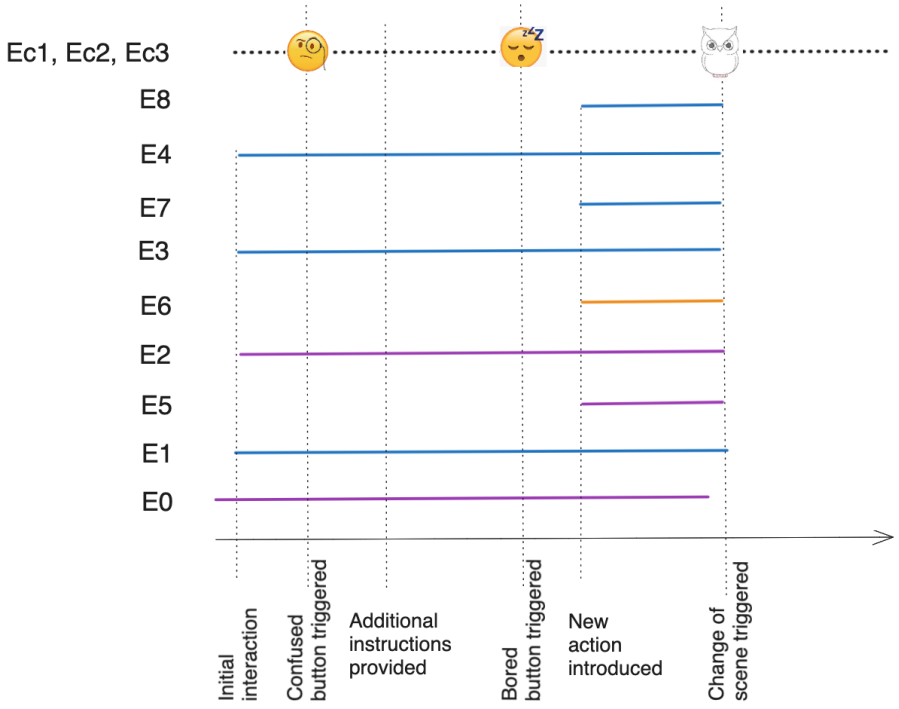

Figure 4.11: Hypothetical Csikszentmihalyi Time Slice Scenario in Practice

I further propose a CTS 3.6.2 method for gathering feedback during the experience and use participants' self assessment reporting to understand what events introduced during IM experience may lead to boredom or distress/frustration. This can further help in fine-tuning the existing script. With the development of technological opportunities, dynamic scripts can be written where IM events are generated based on participants' feedback. Such dynamic scenarios can be informed by the analysis of previously gathered data and by new rapid prototyping of IM designed with dynamic scripts.

Let's take scene one, as examples Figure 4.11. Here is a hypothetical timeline of events

taking place during these scenes and places where a participant triggers Boring or Confused buttons and the Owl - change of scene (continuous events Ec1, Ec2 and Ec3, as described above, see 4.3).

By noting when the buttons were pressed, we can assess the events which were in place and further follow up with an interview to understand why something was boring or confusing. Such analysis can lead to eventual possibility of adding dynamic rules to generative content, so that the content can be adjusted based on user's reported state. For example, additional information can be provided if the participant is confused or a change of pace in the content can be offered if the participant is bored. It is difficult to say with certainty what type of change would need to take place, but studying the IM experience phenomenon in situ will help identify possibilities for positive content adjustments based on user self-reporting.

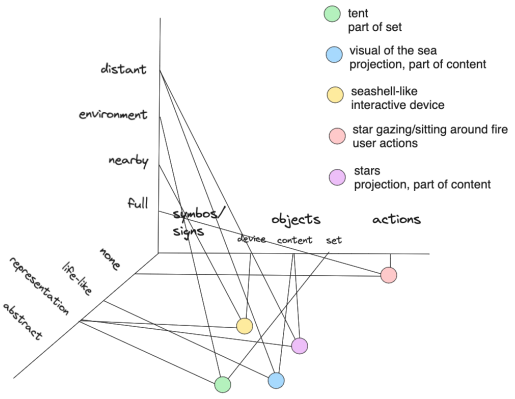

Figure 4.12: Example of Metaphor/Embodiment Chart Data Points

To complement the above with another type of "coexisting data" at any specific moment, in addition to media type, we can include the descriptor according to the Embodiment/Metaphor chart (see 2.4.3). Here is an example chart Figure 4.12 based on the script proposed in this chapter, only a few items are used from the "symbols/things/actions" list described earlier (Figure 4.3 & Figure 4.4), these items are positioned according to the corresponding values identified in the chart.

In a visualization generated in Touchdesigner, we note the number of blocks in 3D space, these blocks correspond to metaphor/embodiment representations in a given project. This approach provides a practical way of seeing metaphor/embodiment distribution and can help with further analysis. This chart (Figure 4.13) is only an example, however, if such data points are filled in for the entire project, perhaps they can provide a different aspect of information and can lead to finding new patterns and correlations with participant's experience. If we, for example, hypothesise that the area of perception space described by *embodiment*, *expres-*

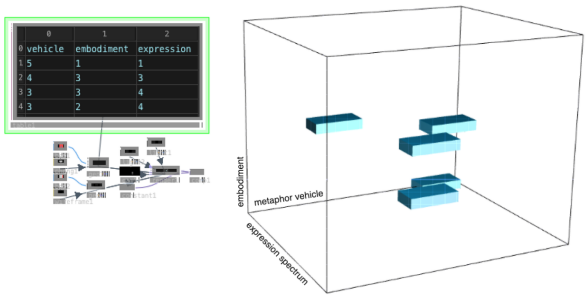

Figure 4.13: Metaphor/Embodiment Chart Visualization

sion and *metaphor vehicle* is correlated with the system's efficacy, we can then experiment with various configurations within this perception space and note the results. Maybe having less metaphor representation in full, nearby and environment embodiment dimension, while heavily relying on distant (as in most immersive experiences produced these days, i.e. replying on projections) would produce the most user friendly result. Or maybe, on the other hand, introducing metaphor representations through full, nearby and environment embodiment dimensions would result in greater participant engagement.

4.8 System Architecture

Here I will speak from past experience and outline the setup I usually use to integrate proximity sensors with media. I understand that practitioners may have a different approach depending on their expertise in certain software, etc. The essential part is that because there is ”input” - usually sensors embedded in physical space, ”intermediary” and ”output” - usually media resulting from interaction, I separate the system's structure into four ”modules”.

1. spatial User Interface - points of access software/hardware
2. Intermediary Software - experience timeline
3. Output Media Software
4. Media Hardware

This separation allows me to work on the interactive devices, plan the experience timeline and couple interactions with media output in an orderly manner. Here is an overview of dataflow during the Interactive Mediascape Experience Figure 4.14. I have indicated various specific devices, software and protocols; all of these can be adapted depending on project's needs and your knowledge of software.

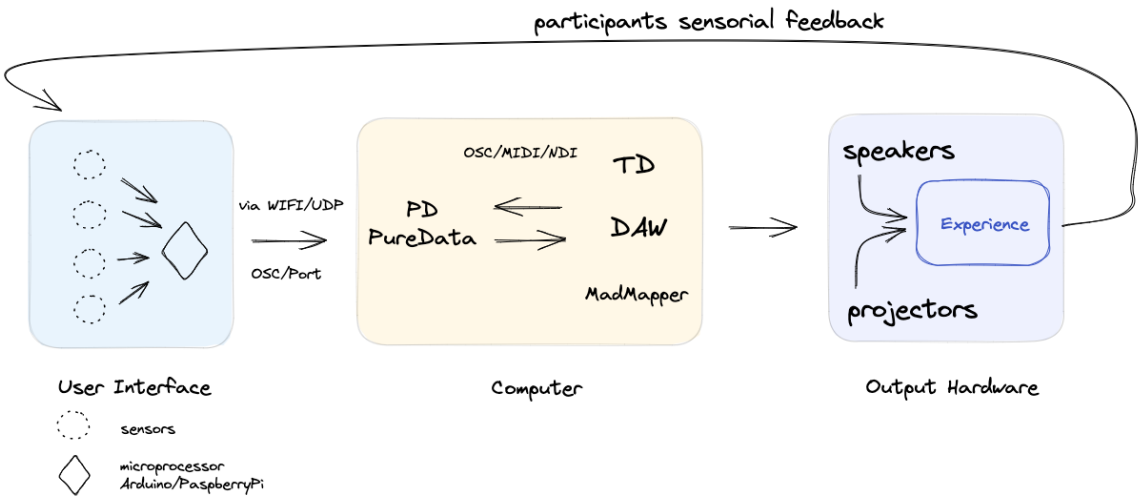

Figure 4.14: Dataflow during IM Experinece

The diagram is self-explanatory, however, I will pause on the distinction between PureData and the applications it communicates with, such as Touchdesigner, Madmapper, Digital Audio Workstation (DAW) etc. I use PureData to receive inputs and send outputs over time - the experience timeline is facilitated by the PureData hub. I have been asked before, why do I prefer to separate the timeline and use PureData. One, it's a personal preference (PureData is simple, free and light in terms of system resources), two, and more importantly, this allows me to see all of the scripted digital events in one place. Why is it helpful? If we look back at the scenario described in the thesis Section 4.7.1 (also referenced below Figure 4.15), we can see that once the need arises for collaboration on the project, it becomes necessary to formulate the interaction structure before the actual media content is added (as described in previous sections, initial media are just ”placements”, they indicate the sequence and format of output of media). If I, for example, work with visual and audio artists, I can set everything up in the ”timeline hub” and the only parameters which need to be communicated with the artists would be the protocols they can use to integrate and the signal type they will be receiving (on/off, continuous) so they can create generative artwork based on these parameters.

Another reason I like using PureData is because it can run on something like RaspberryPi, it's light, so should I need to have parts of the system installed on different smaller units, this can be achieved. For example, some Touchdesigner experts have told me that it's possible to create a timeline and keep everything in Touchdesigner, but TD doesn't run on Raspberry. It could be practical in a specific situation, however, in my practice, I found it useful to keep the ”timeline hub” as an intermediary structure, independent of the media. Of course, the same

goal can probably be achieved with TD or MaxMSP, still, those are heavier applications. I am not a coder and don't know Python, for example, but perhaps this could be achieved with Python as well. For the time being, I prefer PD for it's simple aesthetic and GUI, which make it easy to create a timeline layout.

That said, tools such as Bridgets, which supports a number of different peripherals that can be mapped to any widget within TD as well as TD "native" kinect and leapmotion operators, can be utilized in mapping physical sensor devices to media and be directly connected to these, foregoing the "timeline hub". However, the timeline hub can retain the control over the precise timing when this connection is activated. *Such arrangement allows for "swapping" of outputs while keeping the timeline unchanged; or the opposite, the change in timing, while keeping outputs the same.* It helps to keep the timing data and output data controls in connected but independent structures.

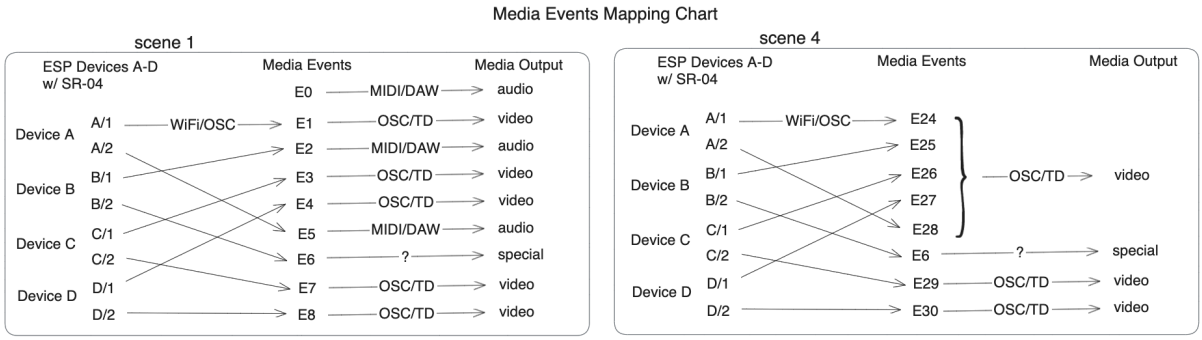

Figure 4.15: Media Events Mapping Chart

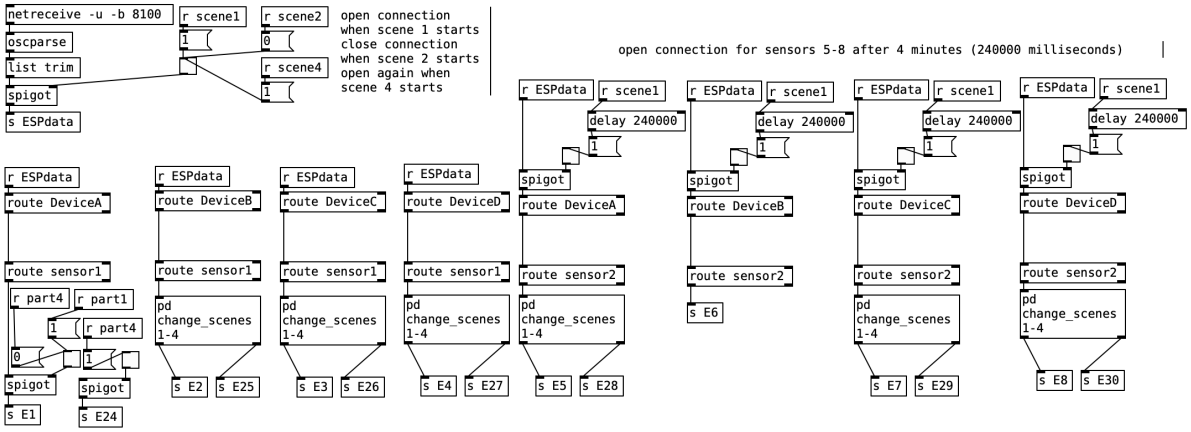

Figure 4.16: PureData Timeline Event Mappings (detail 1)

Here is an example of the timeline (Figure 4.16) for events scripted according to mappings indicated in Media Events Mapping Chart (Figure 4.15) with Soft Synchronous AFF (Fig-

ure 4.9). For those not familiar with PureData it might look a bit overwhelming, however, if you look closely, everything is orderly and you are able to see exactly at what time each event is going to be active. You can also see the sensors which are being used for multiple events, in scene one and scene four, the same signal is used for both but we separate the dataflow by ”spigot” - which is essentially a data gate, with 1 we open it with 0 we close it. This way we save system resources to only process the data when they're needed. In the lower part you can see the layout for the logic in the first string of objects, then I condense the code with an abstraction. As you note, event E6 is the same for scene 1 and scene 4, so no scene change is needed in this case.

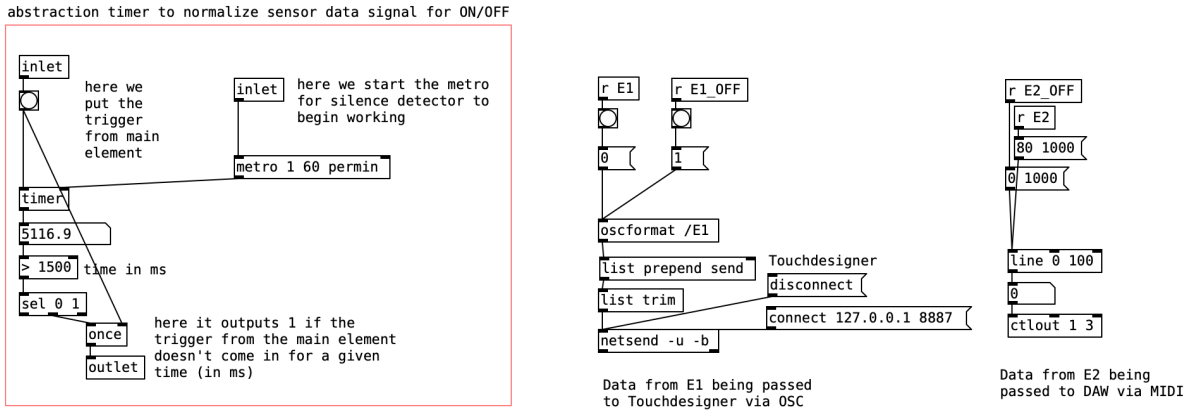

Figure 4.17: PureData Timeline Event Mappings (detail 2)

From this point we can specify the type of data which are going to be passed onto the media applications, depending on the protocol OSC or MIDI, we make an adjustment to convert data format. I will show an example of E1, which is being sent to TD via OSC and E2, which is being sent via MIDI to DAW (Figure 4.17). Here you see that the signal is sent to TD and DAW and the necessary objects to pass the data. Also included in the figure is the timer abstraction I use to normalize the signal coming from the sensor data. It indicates if the sensor has not been activated by the participant for 1.5 seconds and I use this function to send ON/OFF signal to OSC/MIDI by applying additional logic. In a different scenario, where a direct connection from kinect or leapmotion is facilitated by Touchdesigner, the timing of opening/closing this connection still be controlled from the main ”timeline hub” over OSC.

I have also recently given a talk at musichackspace.org where I explained my approach in great detail, the session can be accessed here (MusicHackspace, 2023). I think that it is less important to use the exact software applications I am using, but more important to note *the principle* of separating the part of software containing the timeline from the media for the reasons I have mentioned earlier.

5

Results, Discussion and Conclusion

Contents

5.1 Results

The following contributions have resulted from this thesis:

1. Interactive Mediascape Ecosystem
2. Semantic Model
3. Taxonomy, also integrated with Buchanan's Theory
4. Metaphor/Embodiment Chart adapted from Fishkin
5. IPI Principle inspired by De Bono
6. Collaboration Matrix
7. Novel Evaluation Tool based on Csikszentmihalyi's "flow"
8. Interaction Design Principle based on feedback/feedforward of Wensveen's Frogger system
9. Contextualization of Interactive Mediacape experience within HCI epistemology according to Delsgaard & Dindler
10. A firm distinction between *creative act* and *creation* as essential differentiation for IM design
11. Design Sensitivities informed by collaboration and creativity research to guide IM design process

Based on prior project experience and research, I was able to formulate a semantic model (Figure 2.3) to describe the experience of Interactive Mediascape by analogy to Neri Oxman's Krebs Circle and Bauhaus Wheel. This alone can provide an easy way to a general understanding of the idea of IM. Driven by the idea of "liberal art" as defined by Buchanan, the semantic model encourages the "discipline of thinking that maybe shared to some degree by all men and women in their daily lives and is, in turn, mastered by a few people who practice the discipline with distinctive insight and sometimes advance it." (Buchanan, 1992) Perhaps, here the aim is not to address "all men and women", but those, who would like to approach the subject, yet are completely unfamiliar with it.

Further, I was able to establish the Interactive Mediascape Ecosystem and its context within a wider HCI and interactive design epistemology according to Delsgaard & Dindler (2014) (Figure 2.1). Following the principles of concept-driven interactive design proposed by Stolter-

man & Wiberg (2010), I formulated the theoretical basis for approaching IM design, encompassing the life-cycle of implementation. This figure (Figure 5.1) illustrates how all given concepts fit within the epistemological space. The numbers indicate the corresponding chapter in this thesis, where these topics were addressed. Further, this diagram can be considered as a methodology of developing Interactive Mediascape experiences from theory to practice.

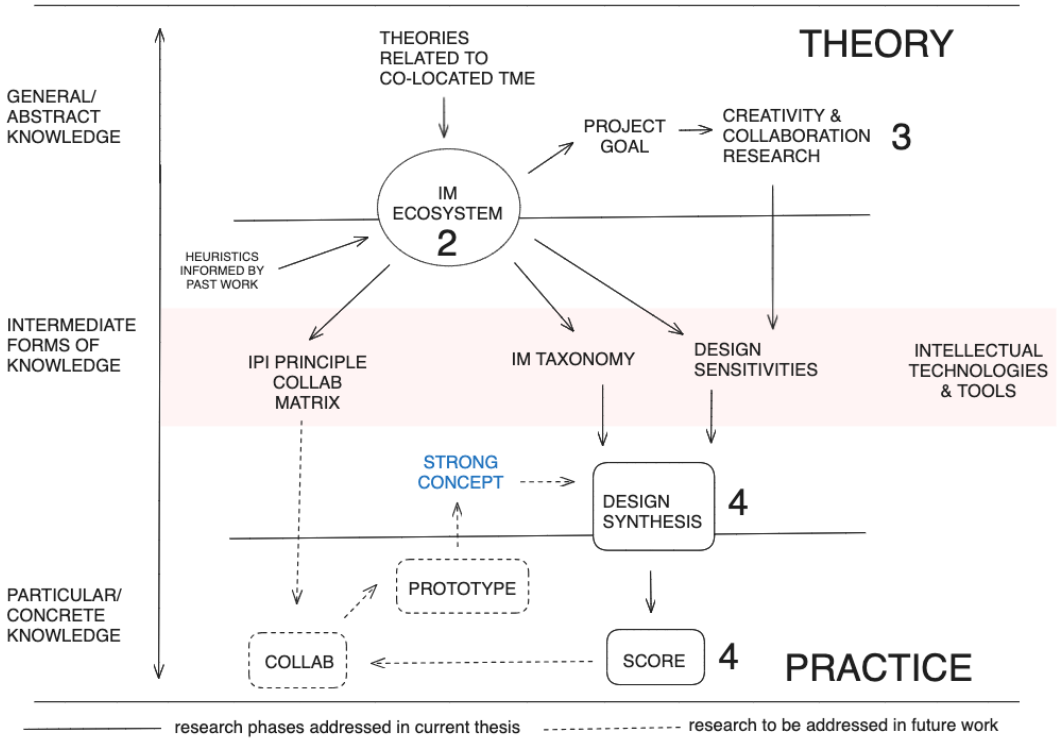

Figure 5.1: Knowledge Flow from Theory to Practice within IM design methodology

Interactive Mediascape Ecosystem is a conceptual construct which is grounded in theory and serves as base for a new inquiry. As pointed in the diagram, depending on the project goal, research from related fields can then be merged with IM Ecosystem through intermediate forms of knowledge. As proposed by Delsgaard & Dindler (2014) these are heuristics, bridging concepts, patterns. In the course of this thesis I was able to develop specific forms of such intermediate knowledge, namely IPI principle (Figure 2.7), collaboration matrix (Figure 2.8), IM taxonomy (Figure 2.4) and describing them under a broader umbrella term of intellectual technologies and tools (Figure 5.1), spanning from Deweyan definition. I was able to contextualize IM Taxonomy within Buchanan's Four Order Design system (Figure 2.5) and adapt Fishkin's metaphor/embodiment HCI approach for TUIs within the same conceptual framework as Metaphor/Embodiment Chart (Figure 2.6).

These findings provide a greater insight into the interconnection of research fields in tackling

a complex problem and serves as a step towards the ”integrative discipline” (Buchanan, 1992), where specialists from various areas can complement each other's knowledge in order to find answers in achieving a common goal (in this case to design an Interactive Mediascape). Interactive Mediascape Ecosystem, combined with project-specific research, provides a structure for implementing design based on intuition, intelligence and possibilities, while encouraging multidisciplinary collaboration.

Interactive Mediascape Ecosystem can be further employed to create hypotheses and design practice-based research methods specifically for the given problem. This was illustrated in the given work by applying the structures provided by IM Ecosystem (and especially by IM Taxonomy) to design evaluation methods of a particular research case: IM Experience Designed for Collaborative Creativity. Evaluation tools such as CTS (Figure 3.4) as well as Metaphor/Embodiment Chart (Figure 4.12), Descriptive Scenarios (Figures 4.9 to 4.11) and Augmented Feedforward/Feedback Interactive Design Principle (Figure 4.8) can all be attributed to the existence of the IM Ecosystem, which enabled me to describe and address complex ”wicked” problems in a systematic way and to formulate a question, followed by a method to examine it. Thus, depending on the project's goal, IM Ecosystem, and the Taxonomy especially, provide a possibility of a hypothesis based on specific elements and ability to check that hypothesis through practice by assigning variables to certain elements/parameters of the system.

Additionally, IM Ecosystem is at the center of the Complete Experience Score (Figure 4.5), which allows us to see the experience elements and their dynamics overtime, to address questions such as: interaction (scaffolding/learning curve), plot/narrative, media density, and participants' agency. The Full Score illustrates how all elements are intended to work together to create a user journey. As in a musical score, we see which elements come through brighter at a certain time in the experience and also can track the dynamics of a specific element throughout the entire score. The Full Score as a tool helps in creating awareness among designers and developers working on the project about each other's parts within a greater whole.

Further, each element can be described more specifically and depending on the requirements of a given specialist. For example, in outlining interaction design, points of access (interactive events) can be shown schematically in a Media Chart (Figure 4.15), which is useful for the software engineer, while metaphors/embodiment relationships (Figure 4.3) can be provided for the prop/set designer and media artists.

In answering the question of How to design an Interactive Mediascape for Collaborative Creativity? I brought the research of scholars from multiple fields under the umbrella of a com-

mon topic, while trying to understand how to design a co-located interactive participatory experience for a group of people, an experience which is a narrative and encourages collaboration and creativity. Key points from research were passed through to design practice. Design sensitivities were formulated and a “theoretical mood board” was established in the process of integrating IM ecosystem with Creativity and Collaboration research from chapter 3. These ideas allowed to define the script, the score, and evaluation tools. System software architecture which can facilitate the project was outlined with a specific example taken from the scripted material.

Buchanan quotes Dewey: ”...science is an art, (...) art is practice, and (...) the only distinction worth drawing is not between practice and theory, but between those modes of practice that are not intelligent, not inherently and immediately enjoyable, and those which are full of enjoyed meaning.” (Buchanan, 1992) By making intelligent choices in design, we can then evaluate them through practice. Having an understanding of reasoning behind the choices made, allows to pin point what in our reasoning worked and what didn’t, then, based on these conclusions, we can adjust our reasoning in future practice.

In addressing the question of How to design an Interactive Mediascape experience for collaborative creativity and following current research on creativity, I identified dynamic creativity as the most appropriate approach and proposed to make a major distinction between the creative act, creative experience and the creation. While designing a collaborative experience, I proposed to focus on the *creative act* and *creative experience*, rather than the outcome (i.e. the creation) and to explore research pointing to the best favorable conditions to foster creative action in a collaborative setting of Interactive Mediascape experience.

Although I was not able to go into a greater level of detail within each topic covered in this thesis, I was able to formulate a solid starting point for IM experience design as a ”discipline of integrative thinking”. Further experimentation is needed but existing methodology now makes it possible to continue where I left off. Such systematic approach to a complex problem allows for continuity of research and comparability of results in future practice-based research, which was one of the major challenges as I began this research. Ideas provided in this thesis move the topic forward and allow for the knowledge-base, related to co-located TMEs (i.e. IM), to be formed over time.

> *”...a typical concept design is futuristic and new; it is founded in visions of future use scenarios. At the same time a good concept design, one that is both conceptually and historically grounded, bears signs of the intended theoretical considerations. The integration of and tension between the traditional and futur-*

istic aspects may be one of the hardest challenges for any concept design. This means that a good interaction design researcher has to be able to, in the design, manifest both something that is theoretically relevant and new as well as paying tribute to existing established theoretically concepts." (Stolterman and Wiberg, 2010)

5.2 Discussion

Ideas set forth in this thesis are an invitation to a dialogue. Stolterman and Wiberg define "a typical concept design [as] futuristic and new; [as] founded in visions of future use scenarios". IM experiences have not been developed yet, it's an ephemera, which, by seeing the development of technology and the pace of growth in experience economy attractions, can become reality sooner rather than later.

5.2.1 IM Ecosystem - Painting in Color

Seeing the possibility for this content presentation paradigm and trying to understand how to develop engaging experiences within it, can help us avoid designing systems promoting the "together alone" attitude and instead, design systems which help users connect with each other. It is easier to design an experience where interaction is one on one: user - system, but it is more rewarding and valuable to aspire for designing a many to one system where users co-create and engage with other participants.

My view has been criticized for being too broad. To this let me ask, can we paint a full picture such as a landscape with one color? Yes, but it will be highly abstracted. While painting in color gives us a chance to see the relationship of one color to the other. In a multicolor painting we can single out red and try to examine its significance within the whole, while painting the whole picture red doesn't give us that opportunity. Human experience is a complex phenomenon and reductionist approach hardly stands the ground in current times.

Through a diversified view this research strives towards interdisciplinary work and provides a base for practitioners from various fields to better understand the full complexity of IM experience phenomenon and to contribute knowledge in relation to the proposed design ecosystem. IM semantic model and taxonomy circumvent all structural entities combining them into one whole - this can allow practitioners from various fields a "point of entry" into the design of IM.

That said, IM design ecosystem provides practical tools for organizing, identifying and configuring the elements within the system making it possible to control for variability in specific elements during research phases. While keeping the perspective of spatiotemporal relation between elements, the semantic model gives an overview while the taxonomy establishes lineage between these elements. The conceptual construct carries over into the implementation domain, suggesting a method for interdisciplinary collaboration in designing IM experiences. Although, due to time and resources constraints, I was not able to implement the collaboration matrix in practice, this idea completes IM ecosystem. Understanding how to collaborate on developing interactive group experiences supplemented by a narrative and situated in physical space makes it feasible to accomplish this complex task.

It would be interesting to see how IM ecosystem can support the design and development of systems across domains such as collaborative edutainment, team building, group gaming, participatory events at brand/product launches, co-creative supplemental content activities to major media events such as movies and cultural events such as museum exhibitions, etc. Additionally more exploration needs to be done in the software integration realm, finding shortcuts and optimal technical solutions for specific interaction dynamics can be useful in shortening implementation phase during prototyping and would add to the overall understanding of the experience phenomenon; from such research a domain-independent generalized modular back-end structure can potentially emerge.

5.2.2 Challenges and Opportunities in Practical Work

This brings me to the second part of the thesis - designing for collaborative creativity. I used the structures outlined in IM design ecosystem to find the best solution in making an experience for a group of people. The methodology calls for conducting research in related areas - thus, in this case it was collaboration and creativity. The question of criteria came to the forefront as I began the literature review. While I focused on several concepts which resonated with my personal views, there might be another, more evaluative approach. In addition to singling out several concepts, I relied on a number of literature reviews as well. The results from my research approach may not yield the scientific truth but rather a well educated opinion, however, I would argue that in the field of creativity the truth as such is an elusive term. My collaboration/creativity research results were sufficient, however, to move forward with IM design method and to establish design sensitivities for the design process.

During the scripting ideas were flowing from design sensitivities to particular manifestations in SUI, interaction, dramaturgy, spacial configuration. Starting from a simple narrative it was

easy to come up with ideas how to incorporate design sensitivities into the script. Design sensitivities served as a roadmap in constructing the story through the available elements of the taxonomy, it took one brainstorming session to come up with the main narrative and its focal points. As mentioned earlier, I did not have a chance to collaborate with another creative, that said, scripting decisions I made seemed a lot more grounded and less arbitrary than in the past and I would assume, having had a collaborator designer or a dramaturg, I would have a much better footing at explaining choices and proposing ideas. In addition, I would think that design sensitivities and the taxonomy would help setting creative boundaries in a conversation with a dramaturg and contextualize the brainstorming activity not only from the point of content but also from the point of interaction and technological possibilities.

One of the contributions made in this thesis is the CTS-t.0 chart which can serve as a supplemental evaluation tool for IM experience designed for collaborative creativity. The chart is drawn on the basis of challenge/skill axis and the concept of "flow" proposed by Mihalyi Csikszentmihalyi. This idea provides an opportunity to measure participants emotional state during the experience directly through SUI, offering participants a chance to self-report during the engagement. The future development of this tool may not only help in understanding the experience/emotional state relation, it may help in shaping dynamic content, generated based on user response. At this time it is difficult to say what type of content/interaction has to be offered in response to boredom or confusion, for example, but such understanding may come with experimentation and analysis.

The idea of CTS-t.0 reporting also opens up possibilities for event mapping according to reported state, it could be further developed to establish optimal relationships between challenge and skill through attributes such as information, tools, motivation, action opportunities and the learning opportunities to understand how the change in the dynamics of one can affect the other.

5.2.3 AI and Future Possibilities

As AI assisted research becomes widespread, our understanding of fundamentals which comprise complex systems such as IM can pave the way to rapid prototyping and experimentation with parameters. At this time we are painting with many colors yet the subject matter of the painting is not quite clear, we are beginning to learn the colors - taxonomy of elements, but not yet the shapes - elemental configuration. However, with practice-based research patterns of the knowledge landscape may emerge first as "the binding concepts" and then as more defined theories of design.

From a humanistic perspective and considering that in the near future, as predicted by many specialists in AI domain, a profession of programmer may become obsolete with computers writing code (AI already can pass a BAR exam (Stanford, 2023) and outcompete humans in diplomacy (Porterfield, 2022)). IM paradigm creates a new structure where human abilities to make choices and develop an idea are actually quite necessary. Because it's a new form of content presentation which consists of multiple elements in spatiotemporal dimension, handling of reasoning and outsourcing design task to AI is not feasible (yet). Still, considering that the programming aspects will become more seamless, experimenting with within this paradigm will become easier. This opens possibilities for creatives from different areas to practice their craft while developing IM experiences. While moving image and online content will soon be outsourced to AI supported application, it is cannot be readily done so with an artifact such as IM experience.

Another potential expansion of IM experience system is into the shared content space. In the example outlined in this thesis I assumed that the media triggered by the participants is stored and generated locally on a machine dedicated to the project. However, we can think in broader terms, if the content is supported by a remote database, the experience may include media art produced by the community of artists. Any video or audio produced by artists can be integrated into the fabric of the experience through the use of APIs. The possibility of integrating content augmented by open source AI models of Stability AI (Bilyeu, 2023, StabilityAI, 2020), for example, is highly probable in respect to image and sound. As of this day, it has already been implemented as a base for an image generating model which can be accessed through an API (Whidden, 2023, Blankensmith, 2023, Tschepe, 2020) in Touchdesigner, which attests that in the near future such systems can be easily adapted for IM experiences. Today, the processing time is still not sufficient to bring this technology into a live experience, but with the pace of progress, it is clear that technicalities will be overcome.

At the same time, building a structural software base for IM experience can lighten the burden of coding and let artists experiment more with the content. The same as in an orchestral score, the harmonies inherently exist (considering traditional western pieces) in the lines written for each instrument, this allows the conductor and musicians express those harmonies rather than try to come up with them first.

In this thesis IM dramaturgy is presented as a practice aided by extensive instructions about how the space-stage should be set or about participants' position in it, a mise-en-scène; such concrete appears to be neccessary.

The question of how much instruction should be provided in an IM script still remains open. I began with a simple outline and then added details of environment, interaction dynamics etc.

It appears that the extensive description of what will be taking place is necessary. There is a certain parallel to the movie industry of the 1940, when the equipment was already available but technologically full scale production was still a challenge. Yet, today, anyone with a smart phone can create a compelling video narrative. Similarly, in theater today this practice of prescribing details could appear dull as there are plenty of experimental and novel ways to construct and present a narrative on stage. Perhaps some years from now co-located TMEs will become so familiar that we'll be able to experiment with form and content freely, without having to pay much attention to the basics, or rather the basics of this expression form will become tacit knowledge. Today, however, very few experiences are being produced and most of them are not explored to their fullest potential because of the risk involved in producing an experiment rather than a consumer ready product.

Yet, IM certainly has the potential to be developed as a "consumer-ready" experience. Because, in the context of this thesis, I purposefully have set the limitations of IM space to a black box theater, particularities which have emerged from integrating research with the IM design ecosystem are specific to that setting. However, it is possible to think that adaptation of the same integration strategies is possible, for example, if the IM experience is presented in a style of a labyrinth, where each scene is in a different room.

Taking this a step further, we can speculate producing an IM experience outside of the closed door environment. Could such project development be supported by the systems presented in this thesis? For example, how would one develop and IM experience in the setting of Ostia Antica park-museum near Rome? The method presented in this thesis can still apply, although the goals may change. It could be a quest journey through an ancient city, with the action taking place outside, in the ruins of Ostia Antica. The research question addressing the elements in the Taxonomy would be altered by the presentation space (a historic park) and the goal. However, employing systems outlined in chapter 2 and their integration with goal-aligned research can provide a foundation for developing such a project, even in the outdoor environment.

IM opens a new opportunity for interaction designers, digital artists and other media enthusiasts to create experiences where a narrative emerges through generative content from participants' actions. It also provides a new outlet for commercial utilization of interactive systems as supplements and brand enhancement activities for customers engagement and value-added service in today's growing experiential economy.

5.3 Closing Remarks

IM Ecosystem does not prescribe the use of tools in any particular order. The way I constructed this research in chapter 3 and 4 is an example of how these tools can be used and what information can be considered. Depending on the goal of the project and inclinations of a designer/developer working on it, they can choose a different set of research data and may use the IM ecosystem tools in a way suitable to them. Edward de Bono was criticized for not really explaining how to use the 6 hats approach, not providing ”strict methodology” for how to apply lateral thinking. His approach was to give examples of use (Gonzalez, 2001). There is no one size fits all, but it’s helpful to have the tools (intellectual technologies) and to know what materials are available (IM taxonomy)

IM Ecosystem can be used in a *classroom setting* to experiment with co-located experiences. In groups, students can make use of available tools to create prototype experiences experiments. Throughout academic classwork this was one part that was not present. Whenever we were asked to make a group project, there were many details but no one could describe the whole experience. From the ”patchwork quilt of specializations” we would try to make something, but because there was no common ground to begin with, the projects began and ended with ”the particular”, never addressing the bigger picture of where they are in relation to other projects. When a designer makes a chair, they know that it’s a chair and it can be placed within a context of other similar items binding it with those objects through its form and function. It is my hope that this thesis will propel a conversation about such understanding of form and function within co-located TMEs. In order to have specialists who can create these experiences, we need a body of knowledge which can be utilized by newcomers, so that a novice can stand on the shoulders of the ones who have already discovered something, instead of always starting at ground level.

Networks capacity is constantly improving and embedding interaction into physical environment is going to become more widespread in the coming years. Thinking about creating playful experiences for groups of people now, can prove fruitful down the road because such experiences not only bring people together, they can serve many different functions, from entertainment (imagine a ”Barbie Interactive Mediascape” walk into a Barbie world - would be a great supplement for a movie theater) or education (imagine, ”New York City of 1950s Interactive Mediascape”, walk into the streets of Little Italy and have a slice of pizza (the experience could actually have real pizza!) could be an experience offered in Manhattan, or anywhere else for that matter) to name just two. There are so many possibilities, but implementation is difficult and imagination stops at this challenge. With this thesis I make the first

step to solve this challenge and offer a systematic view of co-located TMEs at large and in detail.

> *"A concept design sets the agenda for forthcoming research that will pick up theoretical elements from the concept design. As such, the concept design should serve as a guide or raw model for other researchers. This purpose is not just a question of the concept design functioning as a template but also of how a concept design can lead to stimulating, intellectual, and creative theoretical explorations in a certain direction."* (Stolterman and Wiberg, 2010)

5.4 Conclusion

By the ideas presented in this thesis and by examining my work of the last two years I hope to raise questions and suggest a method which can be adapted in order to understand the phenomenon of co-located TMEs better and through empirical practice-based research to prove certain experience outcomes mediated by correlation between studied elements. Technologically our society is ready for such interactive experiences in physical spaces and building a knowledge base about them would open new possibilities not only for expanding interdisciplinary research, but also for grasping the attention of socio-cultural structures which can bring these experiences to the public.

In retrospect this research presents one overarching theme, that is, phenomenology and pragmatism are two leading philosophical strains among the researchers mentioned. What does it tell us? Whether it is wicked problems in design, questions of human creativity or spatial interaction, such issues can only be fully addressed through empirical research. Practice-based inquiry is the method which should always go hand in hand with conceptual construct provided in this thesis. Practice supported by the structural elements proposed in this work can yield research results which are authentic, comparable and can be continuously built upon by researchers and practitioners.

All things considered, the main contribution of this thesis is that it proposes a multi-disciplinary way of examining a particular phenomenon, without prioritizing one field of research over another. It poses the problem in the center and allows theoretical background from all directions to merge at the start so that the balance may be achieved through ”theoretical osmosis”, where these concepts overlap and/or complement each other.

When I began working on this thesis last fall, I made this drawing (Figure 5.2). It reminded me of Klimt's painting ”The Kiss”. The kiss of digital and physical. It looks all ”entangled”,

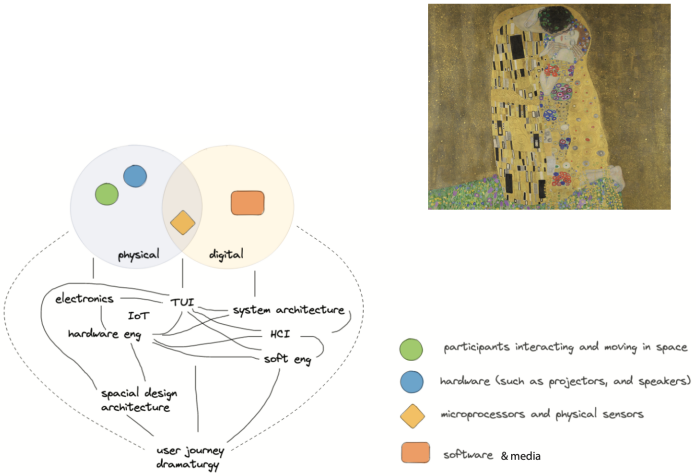

Figure 5.2: ”The Kiss” of Digital and Physical

to use Neri Oxman’s word, and that is how it remains until we make an effort to ”untangle” it. Relationships are complicated but that doesn’t stop us from trying to figure out how to perpetuate them. It is only possible with love and understanding.

The scope of research in the thesis turned out to be more than I bargained for but it led me on a journey to better understanding of the phenomenon I spent last two years experimenting with. No volume of empirical practice could amount for this understanding, having a solid starting point grounded in theory as opposed to acting on a hunch in designing such complex experiences is the only way for attempting to create a systematic knowledge-base. The starting point may need adjustments, sure, but to skeptics I would say: having something to disprove is already a step forward from having no point of reference at all; and to explorers I would say: probe the ecosystem, think about it, improve, finesse and expand!

Bibliography

Mihaly csikszentmihalyi. https://www.researchgate.net/profile/Mihaly-Csikszentmihalyi. Accessed: (August 23, 2023).

Asim, F., Rai, S., and Shree, V. (2020). Biophilic architecture for restoration and therapy within the built environment. 15.

Bae, J.-H. and Lee, H. (2017). *Design and Implementation of the Mobile Learning App for Creative Problem Solving Activities*, pages 786–792.

Bateson, P. and Martin, P. (2011). Play, playfulness, creativity and innovation. *Play, Playfulness, Creativity and Innovation*, 1:1–153.

Beghetto, R. and Kaufman, J. (2007). Toward a broader conception of creativity: A case for mini-c creativity. *Psychology of Aesthetics, Creativity, and the Arts*, 1:73–79.

Bilyeu, T. (2023). The 3 year ai reset: How to get ahead while others lose their jobs (prepare now) emad mostaque. https://youtu.be/Se91Pn3xxSs?si=A55WI5Jg-3cZEYbG. Accessed: (August 31, 2023).

Blankensmith, T. (2023). Touchdesigner tutorial - generate ai images with stable diffusion using image-to-image generation. https://www.youtube.com/watch?v=mRXTR9vcHAs. Accessed: (August 31, 2023).

Boden, M. A. (2007). Creativity in a nutshell. *Think*, 5(15):83–96.

Bonetto, E., Pichot, N., Pavani, J.-B., and Adam-Troian, J. (2020). The paradox of creativity. *New Ideas in Psychology*, 60.

Booton, S. A., Kolancali, P., and Murphy, V. A. (2023). Touchscreen apps for child creativity: An evaluation of creativity apps designed for young children. *Computers Education*, 201:104811.

Braun, E. (1998). *Meyerhold: A Revolution in Theatre*. Biography and Autobiography. Bloomsbury Publishing.

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

Chen, T.-H. and Lu, K.-T. (2012). Creating spatial-interactive service experiences: A framework for designing interactive service spaces.

Cherry, E. and Latulipe, C. (2009). The creativity support index. pages 4009–4014.

Ciolfi, L. (2004). Situating place in interaction design: enhancing the user experience in interactive environments. *Unpublished doctoral dissertation, University of Limerick, Limerick, Ireland*.

Corazza, G. (2016). Potential originality and effectiveness: The dynamic definition of creativity:. *Creativity Research Journal*, 28:258–267.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the Psychology of Discovery and Invention.* New York HarperCollinsPublishers.

Csikszentmihalyi, M. (2008). Ted talk by mihaly csikszentmihalyi: Flow, the secret to happiness. https://www.youtube.com/watch?v=fXIeFJCqsPs. Accessed: (August 22, 2023).

Csikszentmihalyi, M. (2014). *Society, Culture, and Person: A Systems View of Creativity*, pages 47–61. Springer Netherlands, Dordrecht.

Csikszentmihalyi, M. and Asakawa, K. (2016). Universal and cultural dimensions of optimal experiences. *Japanese Psychological Research*, 58:4–13.

Dalsgaard, P. (2008). Designing for inquisitive use. pages 21–30.

Dalsgaard, P. and Dindler, C. (2014). Between theory and practice: Bridging concepts in hci research. *Conference on Human Factors in Computing Systems - Proceedings*.

Dalsgaard, P. and Hansen, L. (2008). Performing perception-staging aesthetics of interaction. *ACM Transactions on Computer-human Interaction - TOCHI*, 15:1–33.

Damasio, A. R. (1994). *Descartes' Error: Emotion, Reason, and the Human Brain*. Putnam.

Dewey, J. (1934). *Art as Experience*. Perigee Books, New York.

Dourish, P. (2001a). Seeking a foundation for context-aware computing. *Human–Computer Interaction*, 16(2-4):229–241.

Dourish, P. (2001b). *Where the Action Is: The Foundations of Embodied Interaction*, pages –256.

Eberts, R. E. (1994). *User Interface Design*. Prentice-Hall, Inc., USA.

Ens, B., Lanir, J., Tang, A., Bateman, S., Lee, G., Piumsomboon, T., and Billinghurst, M. (2019). Revisiting collaboration through mixed reality: The evolution of groupware. *International Journal of Human-Computer Studies*, 131:81–98. 50 years of the International Journal of Human-Computer Studies. Reflections on the past, present and future of human-centred technologies.

Escudero-Mancebo, D., Fernández-Villalobos, N., Martín-Llorente, [U+FFFD], and Martínez-Monés, A. (2023). Research methods in engineering design: a synthesis of recent studies using a systematic literature review. *Research in Engineering Design*, 34(2):221–256.

Fishkin, K. (2004). A taxonomy for and analysis of tangible interfaces. *Personal and Ubiquitous Computing*, 8:347–358.

Fitzpatrick, G., Kaplan, S., and Mansfield, T. (1996). Physical spaces, virtual places and social worlds: A study of work in the virtual. In *Proceedings of the 1996 ACM Conference on Computer Supported Cooperative Work*, CSCW '96, page 334–343, New York, NY, USA. Association for Computing Machinery.

Forlizzi, J., Zimmerman, J., and Evenson, S. (2008). Crafting a place for interaction design research in hci (human-computer interaction). *Design Issues*, 24:19–29.

Frankjaer, R. and Dalsgaard, P. (2018). Understanding craft-based inquiry in hci. pages 473–484.

Frish, S., Maksymenko, M., Frier, W., Corenthy, L., and Georgiou, O. (2019). Mid-air haptic bio-holograms in mixed reality. pages 348–352.

Fuks, H., Raposo, A., Gerosa, M. A., and Lucena, C. (2005). Applying the 3c model to groupware development. *International Journal of Cooperative Information Systems (IJCIS)*, 14:0218–8430.

Gibbs, R., Lima, P., and Françozo, E. (2004). Metaphor is grounded in embodied experience. *Journal of Pragmatics*, 36:1189–1210.

Glăveanu, V. P. (2013). Rewriting the language of creativity: The five a's framework. *Review of General Psychology*, 17:69.

Glăveanu, V. P. and Beghetto, R. (2020). Creative experience: A non-standard definition of creativity. *Creativity Research Journal*, 33:1–6.

Gondomar, R. and Mor, E. (2021). Understanding agency in human-computer interaction design. page 137–149, Berlin, Heidelberg. Springer-Verlag.

Gonzalez, D. (2001). The art of solving problems: Comparing the similarities and differences between creative problem solving (cps), lateral thinking and synectics : a project for studies in creativity.

Gropius, W. (1922). Bauhaus wheel. https://www.bauhaus.de/.

Hornecker, E. (2005). Space and place – setting the stage for social interaction. In *Position paper for ECSCW05 workshop "Settings for Collaboration: the role of place"*.

Hornecker, E. (2006a). *A Design Theme for Tangible Interaction: Embodied Facilitation*, pages 23–43.

Hornecker, E. (2006b). An encompassing view on tangible interaction: A framework.

Hornecker, E. and Buur, J. (2006). Getting a grip on tangible interaction: A framework on physical space and social interaction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '06, page 437–446, New York, NY, USA. Association for Computing Machinery.

Höök, K. and Löwgren, J. (2012). Strong concepts: Intermediate-level knowledge in interaction design research. *ACM Trans. Comput.-Hum. Interact.*, 19:23:1–23:18.

Inie, N. and Dalsgaard, P. (2020). How interaction designers use tools to manage ideas. *ACM Transactions on Computer-Human Interaction*, 27:1–26.

Ishii, H. and Ullmer, B. (1998). Tangible bits: Towards seamless interfaces between people, bits and atoms. *Conference on Human Factors in Computing Systems - Proceedings*.

Jacob, R., Girouard, A., Hirshfield, L., Horn, M., Shaer, O., Solovey, E., and Zigelbaum, J. (2008). Reality-based interaction: A framework for post-wimp interfaces.

Jain, R. (2003). Towards experiential computing. *Commun. ACM*, 46:48–55.

Jung, C. G. (1923). *Psychological Types*. Pantheon Books.

Kampylis, P. and Valtanen, J. (2010). Redefining creativity - analyzing definitions, collocations, and consequences. *Journal of Creative Behavior*, 44:191–214.

Kao, Y. (2021). *Place-oriented design: A framework for designing interactive installations for public spaces*. PhD thesis, Queensland University of Technology.

Kendon, A. (2009). Spacing and orientation in co-present interaction. pages 1–15.

Kirsch Pinheiro, M., De Lima, J., and Borges, M. (2003). A framework for awareness support in groupware systems. *Computers in Industry*, 52.

Kluszczynski, R. W. (2010). Strategies of interactive art. *Journal of Aesthetics & Culture*, 2(1):5525.

Krestanova, A., Cerny, M., and Augustynek, M. (2021). Review: Development and technical design of tangible user interfaces in wide-field areas of application. *Sensors*, 21:4258.

Mantau, M. and Benitti, F. (2022). Awareness support in collaborative system: Reviewing last 10 years of cscw research. pages 564–569.

Marsh, J., Plowman, L., Yamada-Rice, D., Bishop, J., Lahmar, J., and Scott, F. (2018). Play and creativity in young children's use of apps: British journal of educational technology. *British Journal of Educational Technology*, 49.

Marzo, A., Corkett, T., and Drinkwater, B. W. (2018). Ultraino: An open phased-array system for narrowband airborne ultrasound transmission. *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, 65(1):102–111.

Masterson, V. (2023). Future of jobs 2023: These are the most in-demand skills now - and beyond. https://www.weforum.org/agenda/2023/05/future-of-jobs-2023-skills. Accessed: (August 22, 2023).

Murray, J. (1997). *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. Free Press.

MusicHackspace (2023). Touchdesigner meetup - arduino sensors - april 2023 / kyle duffield irina petrova. https://www.youtube.com/watch?v=4YnZVLuAICI. Accessed: (September 5, 2023).

Nikulin, S. and Pichihadze, L. (2008). In *Iskusstvo Rezgissuri. XX vek. (Russian - The Art of Directing. XX century: Vs. Meyerhold, Lectures 1918-1919)*, Anthology. APT - M.

Oxman, N. (2016). Age of Entanglement. *Journal of Design and Science*. https://jods.mitpress.mit.edu/pub/ageofentanglement.

Papadakis, S. and Kalogiannakis, M. (2017). Mobile educational applications for children. what educators and parents need to know. *International Journal of Mobile Learning and Organisation*, 11:1.

Pichot, N., Bonetto, E., Arciszewski, T., Bonnardel, N., and Pavani, J.-B. (2021). Toward a general factor of disruptiveness: the most novel creative objects tend to be the least valuable and feasible ones.

Porterfield, C. (2022). Meta's ai gamer beat humans in diplomacy, using strategy and negotiation. https://www.forbes.com/sites/carlieporterfield/2022/11/22/metas-ai-gamer-beat-humans-in-diplomacy-using-strategy-and-negotiation/. Accessed: (August 31, 2023).

Prasch, L. (2022). *Creativity—a human factors challenge*. PhD thesis.

Qian, M., Plucker, J., and Yang, X. (2019). Is creativity domain specific or domain general? evidence from multilevel explanatory item response theory models. *Thinking Skills and Creativity*, 33:100571.

Rai, S., Asim, F., and Shree, V. (2019). Biophilic architecture for restoration and therapy within the built environment: A review.

Remy, C., MacDonald Vermeulen, L., Frich, J., Biskjaer, M., and Dalsgaard, P. (2020). Evaluating creativity support tools in hci research. pages 457–476.

Renom, M. A., Caramiaux, B., and Beaudouin-Lafon, M. (2023). Interaction knowledge: Understanding the 'mechanics' of digital tools. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI '23, New York, NY, USA. Association for Computing Machinery.

Rhodes, M. (1961). An analysis of creativity. *The Phi delta kappan*, 42(7):305–310.

Rohrer, T. (2008). *The body in space: Dimensions of embodiment*, pages 339–378.

Runco, M. (2007). A hierarchical framework for the study of creativity. *New Horizons in Education*, 55.

Runco, M. and Jaeger, G. (2012). The standard definition of creativity. *Creativity Research Journal - CREATIVITY RES J*, 24:92–96.

Ryan, C. O., Browning, W. D., Clancy, J. O., Andrews, S. L., and Kallianpurkar, N. B. (2014). Biophilic design patterns: emerging nature-based parameters for health and well-being

in the built environment. *ArchNet-IJAR: International Journal of Architectural Research*, 8(2):62.

Ryan, R. M. and Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, 25(1):54–67.

Schubert, E. (2021). Creativity is optimal novelty and maximal positive affect: A new definition based on the spreading activation model. *Frontiers in Neuroscience*, 15:612379.

Spiegel, L. (1981). Manipulations of musical patterns. pages 19–22.

StabilityAI (2020). https://stability.ai. https://stability.ai. Accessed: (August 31, 2023).

Stanford (2023). Gpt-4 passes the bar exam: What that means for artificial intelligence tools in the legal profession. https://law.stanford.edu/2023/04/19/. Accessed: (August 31, 2023).

Steffen, D. (2021). Taking the next step towards convergence of design and hci: Theories, principles, methods. In Stephanidis, C., Antona, M., and Ntoa, S., editors, *HCI International 2021 - Posters*, pages 67–74, Cham. Springer International Publishing.

Steinmacher, I., Chaves Steinmacher, A. P., and Gerosa, M. A. (2013). Awareness support in distributed software development: A systematic review and mapping of the literature. *Computer Supported Cooperative Work (CSCW)*, 22.

Stephanidis, C. C., Salvendy, G., of the Group Margherita Antona, M., Chen, J. Y. C., Dong, J., Duffy, V. G., Fang, X., Fidopiastis, C., Fragomeni, G., Fu, L. P., Guo, Y., Harris, D., Ioannou, A., ah (Kate) Jeong, K., Konomi, S., Krömker, H., Kurosu, M., Lewis, J. R., Marcus, A., Meiselwitz, G., Moallem, A., Mori, H., Nah, F. F.-H., Ntoa, S., Rau, P.-L. P., Schmorrow, D., Siau, K., Streitz, N., Wang, W., Yamamoto, S., Zaphiris, P., and Zhou, J. (2019). Seven hci grand challenges. *International Journal of Human–Computer Interaction*, 35(14):1229–1269.

Stolterman, E. and Wiberg, M. (2010). Concept-driven interaction design research. *Human–Computer Interaction*, 25:95–118.

Ståhl, A. (2015). *Designing for Interactional Empowerment*. PhD thesis.

Thoring, K., Mueller, R., Desmet, P., and Badke-Schaub, P. (2018). Design principles for creative spaces.

Tschepe, B. (2020). Sonic flowers – touchdesigner x stablediffusion tutorial 1. https://youtu.be/4wpn_3JNaIc?si=ewtyJM119vgABqU0. Accessed: (August 31, 2023).

Tuan, Y.-F. (1979). *Space and Place: Humanistic Perspective*, pages 387–427. Springer Netherlands, Dordrecht.

Turchet, L., Fischione, C., Essl, G., Keller, D., and Barthet, M. (2018). Internet of musical things: Vision and challenges. *IEEE Access*, 6:61994–62017.

Underkoffler, J. and Ishii, H. (1999). Urp: A luminous-tangible workbench for urban planning and design. pages 386–393.

Walia, C. (2019). A dynamic definition of creativity. *Creativity Research Journal*, 31.

Warr, A. and O'Neill, E. (2004). Getting creative with participatory design.

Weisberg, R. (2015). On the usefulness of "value" in the definition of creativity. *Creativity Research Journal*, 27:111–124.

Wensveen, S., Djajadiningrat, J., and Overbeeke, K. (2004). Interaction frogger: A design framework to couple action and function through feedback and feedforward. volume 177-184, pages 177–184.

Whidden, P. (2023). compute(r)ender. https://computerender.com. Accessed: (August 31, 2023).

Whitinga, K. (2020). These are the top 10 job skills of tomorrow – and how long it takes to learn them. https://www.weforum.org/agenda/2020/10/top-10-work-skills-of-tomorrow-how-long-it-takes-to-learn-them/. Accessed: (August 22, 2023).

A

Past Projects: Descriptions and Takeaways

Past Projects 2021-2023

I am providing description and analysis of my past projects as evidence of the fact that IM experience can bring people together in a co-creative space and can be fun. I also offer the overview of these implemented ideas to illustrate the evolution of IM concept development. This is a two year journey of exploration and discovery through presenting prototypes in different settings to various groups of people.

The projects themselves, the descriptions and analysis, although not ready for quantitative analysis, provide qualitative insight into IM experiences and can serve as examples of implementation. Takeaways presented after each project are based on different feedback instruments such as observation, questionnaires, interviews, group discussions. Because these projects organically developed over a period of time and were not part of a study from the onset, they may lack in scientific congruity, however, they provide empirical value and ground

for the current thesis. I describe these projects and my takeaways in as much detail as possible given space and time limitations of this thesis.

A.1 Abel Salazar Might Have Heard...

Project 1 Project Name: Abel Salazar Might Have Heard... An Interactive Sound Installation based on Assemblages and Musique Concrète Aesthetics Presented on June 18, 2021 at Casa Museu Abel Salazar, Porto, Portugal

Figure A.1: Abel Salazar Might Have Heard... Participants Interacting

Project 1 description Please note, this is not a public work of art - this is an in-progress prototype.

Installation. In the spirit of A. Salazar - combining art, tech and creativity. The chapel. This is an amazing space and this idea is perhaps the most "out of the box". The acoustics of that space are great and when we were walking through I thought of music. What if that room had an interactive installation focused on the music/sound of that era? This would give another dimension of the historical context which existed back then. The project would involve sound design combined with proximity sensors - people would walk around the room and depending on which sensor they approach various snippets of sound would be heard. Cabaret, the war, do you have any recordings of A. Salazar himself speaking? Fado, we would think of other sound samples which would paint the era to create a journey through the soundscape of an epoch from Salazar's childhood to end of life. This would be a temporary installation for a presentation in June.

The installation is inspired in part by Abel Salazar himself, by his life's credo - always in

creative search, seeking to see art in science, technology in art with inexhaustible curiosity for life. Musique concrète carries the spirit of innovation and mixing of art and technology. This sound installation is based on this idea because it unifies the chosen melodies and sounds into an interactive musical/soundscape. It connects us with the past through experiencing the scientific achievements of previous generations, while they echo in today's reality. In the chapel space where you are right now, we hear etherial yet recognizable sounds while imagining that Abel Salazar could have listened to these (or similar) sounds and musical expressions in his own lifetime.

The installation is utilizing sensors and interactivity technology as a tribute to Abel Salazar's passion for art and science. In greek Art and Technology are practically the same word "Techne" means art, which also means to create. Imagination is one of humanity's most interesting abilities. Abel Salazar as you will see from the exhibit at Casa Museu, never lost that sense of curiosity and continued to explore his own abilities and express them in various art forms and in science. This is well illustrated by his various activities presented at the museum.

Figure A.2: Abel Salazar Might Have Heard... Setup

What is Musique concrète? The installation is inspired in part by Musique concrète - a concept first introduced by a French composer, writer and engineer Pierre Shaeffer in early 1940. With the advancement of recording technology it became possible to experiment with sound samples (yes, today's idea of a Remix is directly related to this). Back in the 1940 just after World War II Pierre Schaeffer began experimenting with small samples of recorded

sound. Electronic music was already beginning to emerge at that time as well. Shaeffer distinguished Musique concrète as a separate movement and his work resulted in establishment of a Research Center which later would influence a great variety of musicians from Boulez to Xenakis and in popular music such as the Beatles and Pink Floyd. Shaeffer also coined a term acousmatic sound - that is a sound which is familiar yet we can only hear but not see the source of sound. Musique concrète also had a great impact on the development and exploration of soundscapes as an art form. The experimentation with acoustic qualities of sound extracted from recorded samples which continues today in music research and in popular culture "the Remix" of everything - all take roots in Musique concrète.

Here you will experience a very literal soundscape of the era when Abel Salazar lived and created his art and science works. These "musical quotations" of his life-time are meant to create a link between his times and ours. We are listening to these recording today and imagining how it might have been to hear these sounds when they originally appeared, in the time when they were created by his contemporaries. We imagine Abel Salazar listening to them in his daily life and this brings us closer to experiencing his art and glancing at his life with a wider spectrum of senses.

A list of musical/sound material in the installation: Amalia Rodrigues 1920 — 1999 Edith Piaf 1915 – 1963 Marlene Dietrich 1901 – 1992 Maria Callas 1923 — 1977, Anna Bolena Mad Scene Jazz — instrumental Maurice Ravel - 1875 - 1937, "Mirrors" written between 1904 and 1905 World War II - sounds Church - a recording from a Portuguese Catholic service Train - a sound Nature - a sound of frogs in the pond

A brief explanation of musical/sound selection

To contextualize Abel Salazar's life through the use of sound and historical moments we, as people living today, can relate to on emotional level, we drawing parallels between events and people of Abel Salazar's lifetime and our present reality through experiencing the sound in combination with his artworks.

The four women singers.

Although we don't have documents precisely stating that he enjoyed listening to any of these Divas, each in their own right in their music genre, we can speculate that he was familiar have have heard of them. We know that he traveled to France and Germany and could very well have been in company of people familiar with these women's art. He favored cabaret where a different type of music was performed but, of course, he was a cultured person so his familiarity with Piaf - the staple of French chanson, Dietrich - a German singer with American citizenship who was praised for her humanitarian efforts during WW II, Callas - the

unmatched opera diva to this day (although it is less likely that Abel Salazar knew about her specifically, she became famous right before his death, he enjoyed opera as art form) and Rodrigues - the most famous muse of Fado here in Portugal.

Additionally we know that A. Salazar appreciated the music of Maurice Ravel. Ravel was closely associated with the impressionist movement in painting which was one of A. Salazar's passions. We can speculate that he also admired Ravel for his ideas of democratizing the music through recording it, as these ideas might have been echoed by A. Salazar's own to promote science among the public.

In the music/sound-scape of this installation you will also find present other acoustic excerpts of the times.

Project 1 takeaways

The presentation of prototype took place during covid restrictions and it was not possible to have a large group of people take part in the experience. However, there were 5 people who had a chance to interact with the installation. From observing the interaction it can be concluded that participants found the presented interactive paradigm quite easy and they freely triggered different sound bites individually and together. Although some were trying to touch the sensors, after a brief explanation, their actions towards the sensors became more appropriate, they would hover their hand in close proximity to the frames and notice the sounds they were triggering. Some participants also tried to "test" the range of effect by stepping closer and farther away from the sensors. The proposed installation scenario provided a reason for people to move in space and thus also embodying their own experience and observing others. The selection of sound bites varied and so did the participants' reactions, from contemplative to amusement. Overall it was an enjoyable, creative and novel experience for everyone. It also provided the "sound" experience dimension to a museum setting which normally contains only visual and archival information.

A.2 Interactive Happening 2

Project name: Interactive Happening 2 Presented on June 22, 2021 at ESMAD, Vila do Conde, Portugal

Project 2 description

The concept is based on Happenings (A happening is a performance, event, or situation art, usually as performance art) as initially coined by Alan Kaprow in 1950s, only here I am adding the interactivity through sensor technology, so that the audience can participate based on a

Figure A.3: Interactive Happening 2 Participants Interacting

proposed script yet at their own pace and configuration of the performance flow. Another inspiration is Marina Abramovic's artwork The Artist Is Present 2010 at MoMa.

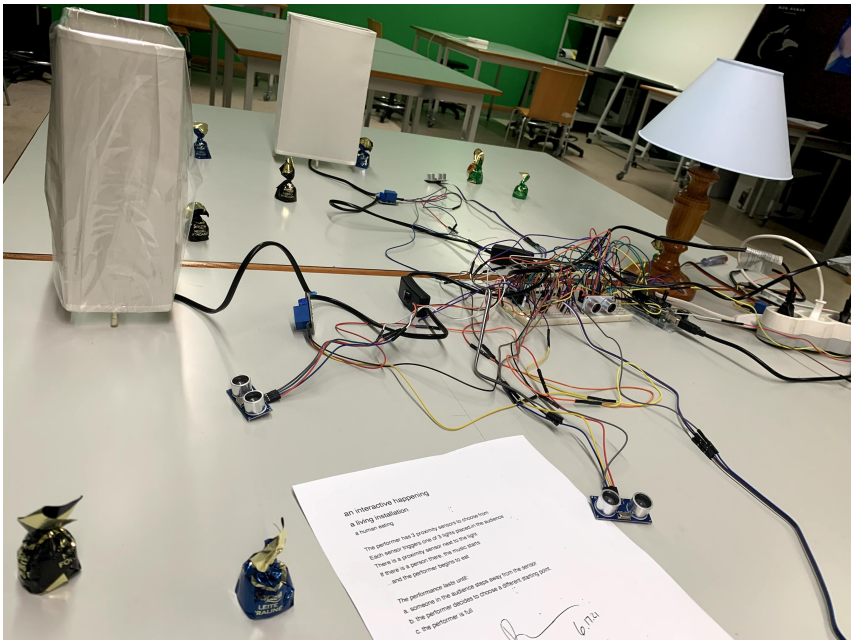

Figure A.4: Interactive Happening 2 Setup

The project consisted of a presenter/performer and three participants. There were a total of 6 proximity sensors, 3 of them were at the disposal of the presenter, the other three were placed individually next to each participant. The three sensors of the presenter were coupled with participants' stations. The main idea was something of a game between the presenter and the participants. The presenter would trigger one of the sensors, a corresponding station would get activated, the participant would see a lamp light up and it would serve as a cue

for them to interact with the sensor. Once the two coupled sensors, the presenter's and participant's, are both triggered at the same time various sound would be heard. Originally I also wanted to have a "singing" presenter so that once the participant triggers a cued sensor, the presenter would sing, however, because of covid restrictions and as a precaution, the idea changed and the presenter was eating candy instead of sining.

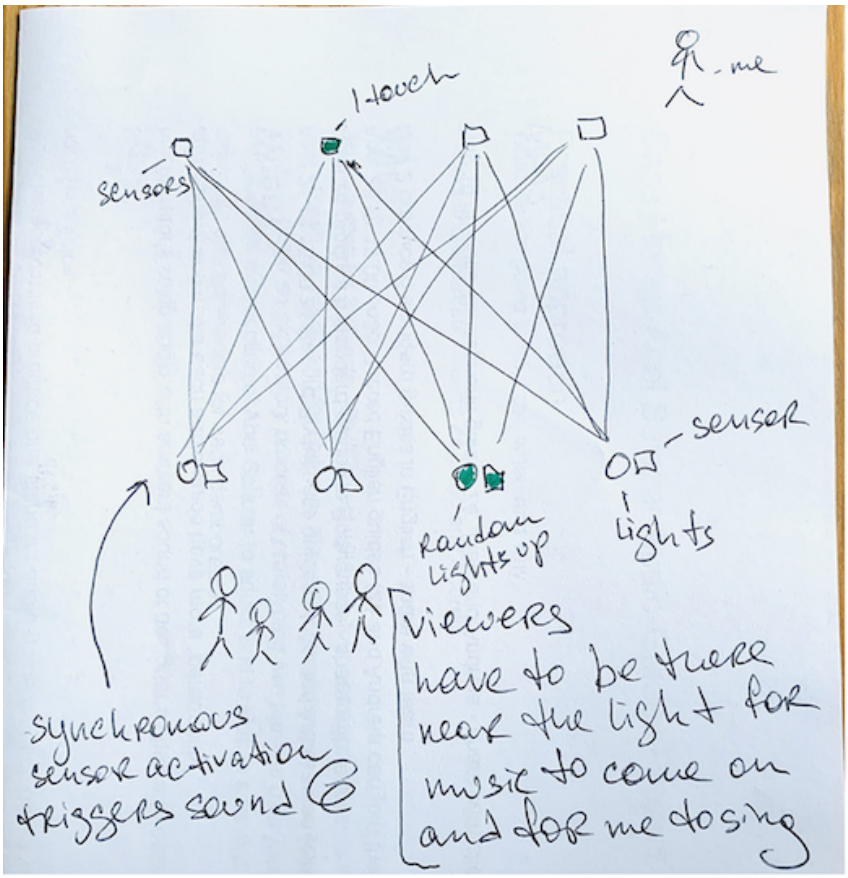

Figure A.5: Interactive Happening 2 Interaction Sketch

The presentation also included a "Happening script". All participants were invited to read the script to understand what is going to happen during the experience. The script was placed on the table and also at one point passed around for the participants to read. As the experience commenced all had a good understanding of how to interact with the installation. Participants also observed each other and were able to pick up on the nature of the experience through noticing others' reactions.

Project 2 dramaturgy

Project 2 takeaways

Because the project was presented in an open space of the classroom, participants could

an interactive happening

a living installation

a human eating

The performer has 3 proximity sensors to choose from
Each sensor triggers one of 3 lights placed in the audience
There is a proximity sensor next to the light
If there is a person there, the music starts
…and the performer begins to eat

The performance lasts until:

a. someone in the audience steps away from the sensor
b. the performer decides to choose a different starting point.
c. the performer is full

Figure A.6: Interactive Happening 2 Script

easily see each other and observe each others' actions and reactions. This could have helped with establishing a playful place which was the intention behind this installation. Participants laughed and were surprised, seeing others interact with the system could have encouraged others to do so as well while also heightening their sense of curiosity and lowering their shyness and inhibitions. The original script proposed that only the presenter will be eating the chocolates but during the experiment one of the participants said "Can we also eat the chocolate?" This prompted the change in the script and participants also began enjoying the sweets. There was, however, one participant who, even when the logic behind interaction was explained to her still could not understand the purpose of the installation. To me this was an indication that no matter how explicit the designer's intentions are, there can always be an audience member who cannot make meaning for themselves from the perceived experience. That being said, I was surprised that for the most part participants had embraced the idea of the "happening" even though the script was a bit unusual, namely the candy eating part (which was an intended slight artistic provocation). This observation served an indication that curiosity and the spirit of exploration may break (or bend) conventional thinking/accepted behavior patterns. Again, that being said, the experiment took place at a university where most participants are familiar with the technology and maintain open-mindedness towards novel

experiences.

A.3 The Talking Vessels

Project name: The Talking Vessels Interactive Happening 3 Presented on July 15, 2021 at FAMO COSE co-working space, Rome, Italy

Figure A.7: The Talking Vessels Participants Interacting

Project 3 description

When we manifest ourselves through voice we breathe light and movement into reality. Bouncing through numerous perceptions of others, our voices then morph into new forms until all individual qualities disappear into a synthesis of a soundscape fabric - a social happening.

Used technology - Ultrasonic proximity sensors / Arduino / PureData. When we manifest ourselves through voice we breathe light and movement into reality. Bouncing through numerous perceptions of others, our voices then morph into new forms until all individual qualities disappear into a synthesis of a soundscape fabric - a social happening. Influenced by Golan Levin's installation Eyecode and Andy Warhol's Campbell Soup. In this Interactive Happening the visitors voices become part of the soundscape comprising a mix by adding semantic and abstract sonic expression.

This was an independent experiment conducted during my stay in Rome. While attending FAMO COSE a maker space, I gathered everyone who was in the space on July 15, 2021 and presented the prototype.

Project 3 dramaturgy

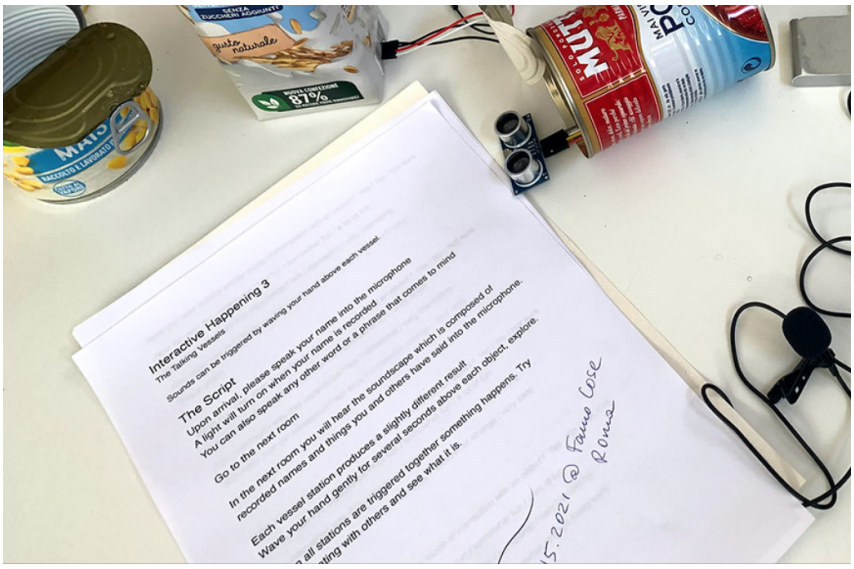

Figure A.8: The Talking Vessels Setup

Props

At the entrance there is a microphone, it is accompanied by a light or a fan (at the discretion of the director)

In the next room*, there are vessels (they can be food cans, pots made of clay or any other object which, at the time of happening, the presenter considers to be a “vessel”)

In the room with vessels the sounds can be triggered by waving your hand above each vessel.

*The Script**

> Upon arrival, please speak your name into the microphone
>
> A light will turn on when your name is recorded
>
> You can also speak any other word or a phrase that comes to mind
>
> Go to the next room
>
> In the next room you will hear the soundscape which is composed of recorded names and things you and others have said into the microphone.
>
> Each vessel station produces a slightly different result
>
> Wave your hand gently for several seconds above each object, explore.
>
> When all vessels are triggered together something happens. Try collaborating with others and see what it is.

*The script was not played out exactly as written because there was only one large space with no rooms. All events happened around my working desk.

Project 3 takeaways

A group of 8 people participated in the experience. Individuals from 20-50 y.o who happened to be in the co-working space at the time of presentation. A microphone was passed around and each person said something “meaningful” or “funny” or anything else they wanted to say. These messages were recorded by the system. The participants were invited to trigger the sounds generated from the messages by hovering over cans and cardboard packaging which served as props in the TUI set up. Proximity sensors were placed inside and participants together triggered a soundscape composed of bits extracted from what was previously recorded. The sounds were generated by algorithmic protocol which would clip the message timeline in random place. These sounds together with several other initially chosen sounds (which were also triggered by the participants) made up a soundscape.

From observing participants it can be concluded that there was a general feeling of “good times”, interactors were surprised and amused by the experience. One co-worker suggested that the project should remain as a permanent installation in the space. The interaction method and the concept itself were easily grasped by the group after my brief explanation of the idea. Participants were also offered a written script (few read it however) At the end I collected short questionnaires asking participants about the experience. The results showed a prevalent similar positive perception of the event. Although some people found the interaction “somewhat difficult”, the majority said it was “easy” and answering whether the experience was fun all were in the positive saying somewhat fun or fun with no one saying that it was not fun.

From observation and other feedback collected during this experiment it was apparent that an interactive balance was achieved, meaning the project structure left enough room for experimentation while giving each participants “a distinct voice” when they were triggering devices. Each participant could hear exactly what the impact of their action was on the overall soundscape, perhaps this resulted in a greater sense of dramatic agency perceived by each participant. It was also apparent that participants enjoyed both, interacting and watching others interact with the system. Also, viewing this experiment from a social perspective, it could be noted that co-workers who’s normal interactions during the day are rare (especially between those who work for different companies) here had a chance to come together as a community. It was a fun experience for everyone.

One notable observation was that when asked to say “whatever” into the microphone, most participants froze and I suggested “just say your name” then the actions began to flow. A

couple of people did say something funny down the line. This occurrence made me realize that such terms as “whatever”, “anything”, “something” as part of instruction are not specific enough for some people to proceed with the action. Although my intention was to leave the subject matter completely open to participants’ liking, this vagueness was perceived as confusing by some. I would speculate that such broad open instruction terms can be used only when the context of the experience, i.e. the metaphor which unifies the narrative, have been established.

A.4 Via Tuscolana to Pigneto

Project Name: Via Tuscolana to Pigneto Interactive Happening 4 An impression of one journey on July 21, 2021 Presented on July 30, 2021 at FAMO COSE co-working space, Rome, Italy

Figure A.9: Via Tuscolana to Pigneto, project artifact - photograph from metro

Project 4 description

This interactive happening brings together images and sounds captured on the same day during the same journey from one station to another in the Roman metro. It’s an expression of an impression. It is designed for the participants of the happening to invoke the scene into a dynamic mix of media by triggering the sensors. An interactive art collage based on media collected from a specific place during a specific time period.

Project 4 dramaturgy

Figure A.10: Via Tuscolana to Pigneto Visuals Setup

Take a trip with me from Via Tuscolana to Pigneto! Explore images and sounds of the Roman metro.

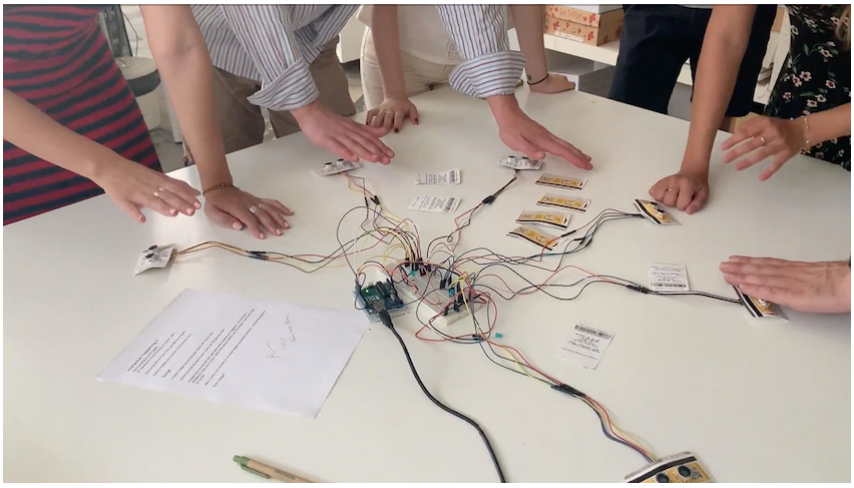

Figure A.11: Via Tuscolana to Pigneto Participants Interacting

Script

Control images by waving your hand over the B+ side.

Control sounds by waving your hand over the barcode side.

Images and sounds will stop and start when sensors are triggered. To continue a slideshow, keep your hand in place and wave it gently over the sensor. Same logic goes for sound.

After 4 and a 1/2 minutes of non-stop triggering between sensors - something happens!

Buon Viaggio!

Project 4 takeaways

Here the visual element was introduced and the participants quickly caught on the idea and that the interaction setting is similar to the previous project. During the presentation I observed laughter, playfulness, participants trying to engage with the sensors in creative ways and not only through waving the palm of hand over it. They were trying to use objects and other parts of their bodies as the proximity trigger. After 4.5 minutes of interaction, which was a subdued tribute to John Cage's 4.12 on my part, the participants were surprised with a song. We all laughed and danced. It was a nice 15 minutes spent socializing and communicating while engaging in a creative activity.

A.5 stairwellbeing

Project name: stairwellbeing Interactive Happening 5 - Audio/Visual Installation with a Performative Element Featuring a singer Presented on December 22, 2021, ESMAD, Vila do Conde, Portugal

Figure A.12: stairwellbeing Participants Interacting

Project 5 Description

With the idea of public art in mind and considering public spaces to be a great democratic outlet for the arts, this project aims to create an interactive collaborative environment for an art experiment. Choosing a public staircase at a university (ESMAD) I hope to transform a utilitarian space regularly used solely to get from one floor to another into a gallery space prompting contemplation and exploration of the space as a creative means.

Historical background: The idea of this project arises from Dada and The Happenings. Both movements from last century equated art with an ephemera of the present moment. Something which cannot be readily identified through a pragmatic or a subjective concept but rather as a way which through deconstruction of meaning leads to an alternative perception. I take the idea of a happening and add interactive audio/visual elements to it.

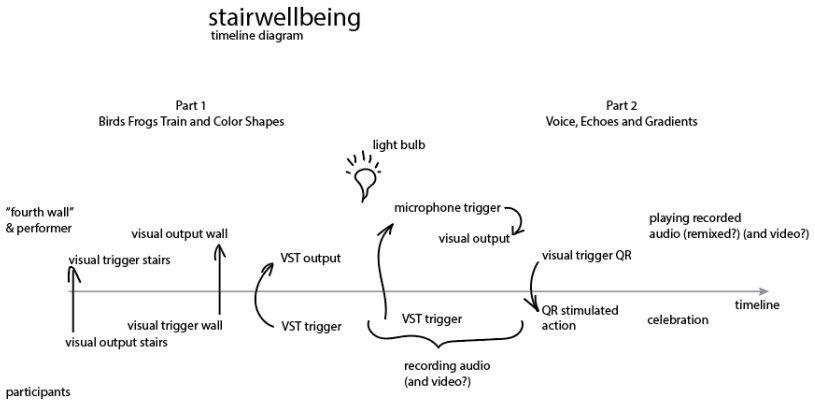

Figure A.13: stairwellbeing Timeline Interaction Diagram

Research objectives: The project is a stepping stone in further understanding participants' interaction with an audio/visual system through proximity sensors placed throughout the environment. Considering the concept of somaesthetics (Richard Shusterman), I choose to use proximity sensors as a communication medium and let the participants use their presence in space and specific hand positions to trigger multimedia events. Considering the concept of Dramatic Agency (Janet Murray) I experiment with the trigger timing to understand what can result in the most organic and satisfying HCI process under these circumstances.

Structural outline: The project is conceived in two parts. The first part consists of sounds and visuals which are not connected in any thematic way. For the sounds using sampling and musique concrète techniques, for the visuals using simple shapes and unedited videos of nature. This lays the ground for probing the audience's sentiment towards such elements placed together. This also gives the participants a chance to learn how to interact with the system. The second part including a live performer, is contained within a given stylistic boundary comprising an event which is more integrated from the perceptual perspective. The audio/visual elements are well connected with each other and there is a sense of linearity in the happening.

Proposed location Staircase ESMAD Building B: The proposed idea would be to position the sensors on the railing area and to have several projectors on several walls while the speakers and the microphone are positioned at in the middle flight between stair bottom and top. For

Figure A.14: stairwellbeing Spatial Configuration Sketch

the prototype presentation a table in the middle flight of the stairs will be used with sensors positioned next to the computer with video projection generated on one wall.

This project was presented without a publicly available script. It was my intention to see if an interactive system like this could be used intuitively without any prior information given to the participants.

I was hoping to make this questionnaire at the end of the showing but there was no printer available at the university. It was suggested to make the questionnaire available online following the experience but to me the answers provided right after the experience would be the most valuable as they would carry the immediacy of perception and reflection without too much pondering. Whereas an online form would not provide the same. Plus a printed questionnaire in my view is also more appropriate in this case as an instrument because the experience takes place in physical reality and not virtual. In the end I had relied on my observations during the experiment and conversations I had with participants after in order to evaluate the feedback and find a direction for expanding the knowledge upon what has been presented so far.

Project 5 Questionnaire

How easy was it to interact with?

Not easy Somewhat easy Very easy

Which part you enjoyed more? Part 1 Part 2 Enjoyed Both Didn't Enjoy Any Can't Say

Why (optional - if you want to write your opinion, please do!)

When you interacted with the sensors, did you feel like you were part of the happening?

Yes No Not sure

When others interacted with the sensors, what drew your attention?

The people who interacted The sound and visuals Both Nothing in particular

How fun was the overall experience?

Not fun Somewhat fun Very fun

Any other thoughts, comments, feedback is appreciated! Write below:

Project 5 takeaways

I basically threw everything I knew up to this point at this project. Multiple ultrasonic proximity sensors, audio, vocal performance and my newly gained skill in projection mapping. The fundamental question for me was: How would interactive experience comprised of these multiple elements be perceived by the participants?

The initial challenge in developing this project came right from the beginning, at the time when I set down to program the events. As can be seen from the sketch above, the concept is quite complex, full of general dependencies while lacking in details. My initial thought was that once I sit down to program, I'll figure out how to develop a structure for interaction coupled with content. It did not turn out to be so. For the most part my design/development process came down to "just doing it", events and content morphed into a script through my explorative action. This was the first time when I realized that there is a lack of understanding how to approach the design of such experiences. However, it was an experiment and I proceeded with events as they were - a compilation of creative serendipity.

The first major takeaway from presenting this project was related to content cohesiveness. In the first part shapes and sounds triggered by the participants did not have any meaningful connection, they were a random compilation of events. The objective was to see how this will resonate with the participants. As expected, participants were confused and hesitating to interact with the system, and those who did interact with the sensors did not find it motivating for continuing engagement. The second part, on the other hand, was designed with a metaphorical idea in mind, while an image resembling the sun and the sea was projected, a complementary soundtrack made of soothing sounds and a vocal line were triggered in the audio. This produced an overall calming effect.

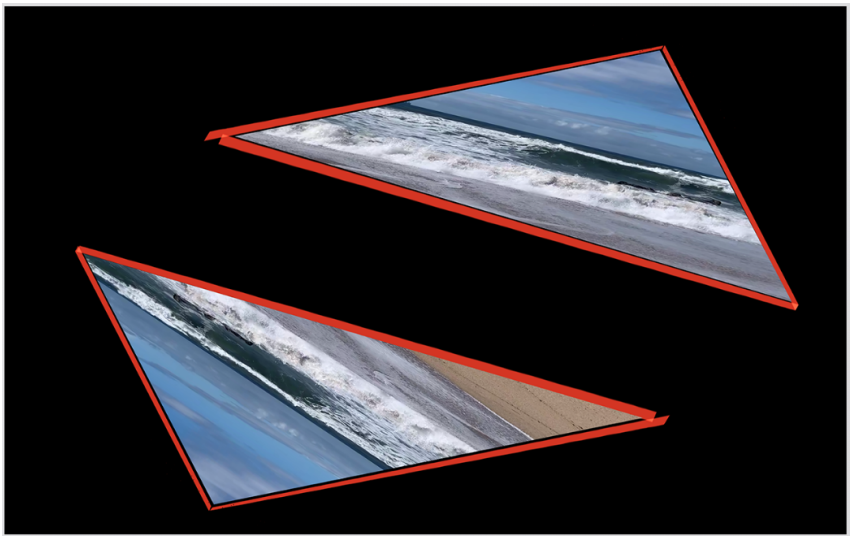

Figure A.15: stairwellbeing, a screenshot visual

I had a chance to speak with a few participants after the demonstration and they said they enjoyed the second part more than the first one. This point in a way proves the ideas I found in my research in the past few months which are explained in previous sections. For, example creating a sense of place, thinking about what can serve as metaphorical cornerstones for evoking “latent zones” of participants’ past experiences, to always balance between familiar and unfamiliar. Also skills and challenges alignment, in this case, in the first part participants did not understand the goal, thus, they could not identify the challenge by which they could achieve the goal and with no challenge there was very little motivation. In the second part, because it was also a performance, the participants knew that their interaction provides a background soundtrack for the singer as well as the visuals, this was a clearer task and perhaps participants’ perceived that their actions had more meaning and thus were motivated to engage.

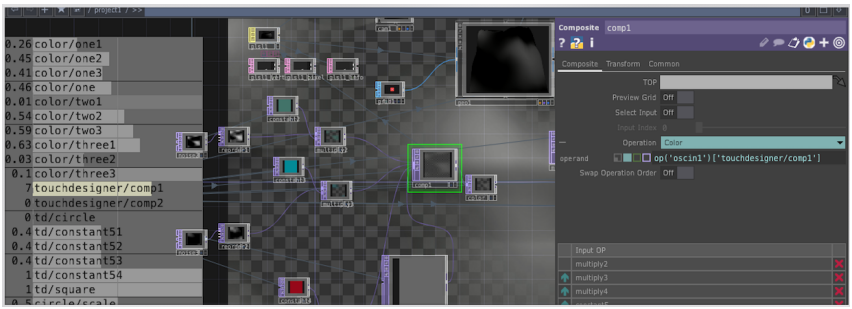

Figure A.16: stairwellbeing, Touchdesigner OSC mappings

Another observation I made after the prototype presentation, was about the spatial distribu-

tion of video. Because of technical challenges I was not able to follow my plan and create mobile interactive devices, nor to project on the wall surrounding the staircase. There was only one projector and all of the scenes were changing in one projection space one after the other. Considering that the first part had several scenes with varying visuals while they were projected interchangeably onto the same area, it would be curious to see how participants' perceptions would change if the visual scenes were more spread out, perhaps this could have resulted in a more engaging experience? Having the scenes change in the same place prevented participants to a great degree from seeing how their actions change the scenes. Using strong shapes with all video elements located in the same position may have overwhelmed the participants. I thought the variation of visual expression, the timing, and the plain of view all should be considered in constructing further works. I remembered this finding in the next project with visual media I developed a few months later.

To summarize the questions which came out of this prototype presentation:

Number one: how to determine the triggered visual media density per given space, what is the optimal balance?

Number two: how to script such interactive experiences, especially when there are many overlapping and interdependent events?

Number three: how to create an appealing narrative and a goal which would be shared by all participants?

I began exploring these questions in the experiments which followed and ultimately, this lead to the research presented in the current thesis.

A.6 Azulejos of the Sea

Project name: Azulejos of the Sea An interactive mediascape Presented on June 14 & 17, 2022 at ESMAD, Vila do Conde, Portugal

Project 6 description

The idea is inspired by the ocean and by azulejos. I came to Porto almost 3 years ago and over this period it has become apparent to me that the connection with the sea is inseparable from this region's traditions. The love of the sea is rooted deeply in people's hearts here since for centuries the sea has provided the people of this region with its wealth of fish and other seafood and was the livelihood of many generations. Azulejos is another part of local culture which cannot be overlooked - the tiles which decorate facades of houses are ubiquitous

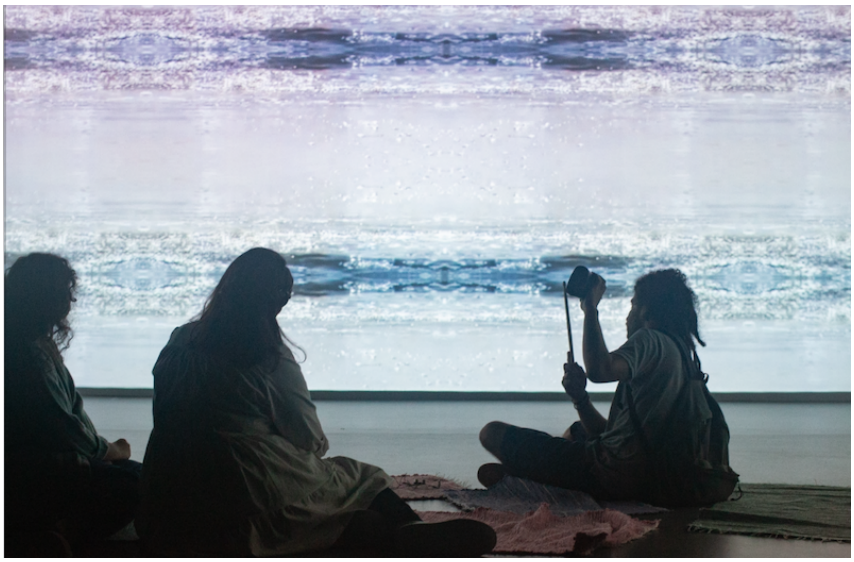

Figure A.17: Azulejos of the Sea Participants Interacting

throughout the region. When I began working with the visuals based on ocean videos, I noticed a resemblance of the azulejos patterns and decided to make a project connecting the two traits of Porto's culture. While experimenting with the visuals I also kept in mind a theme of past and present, tradition and novelty - here I though of it as organic and digital in terms of visualization.

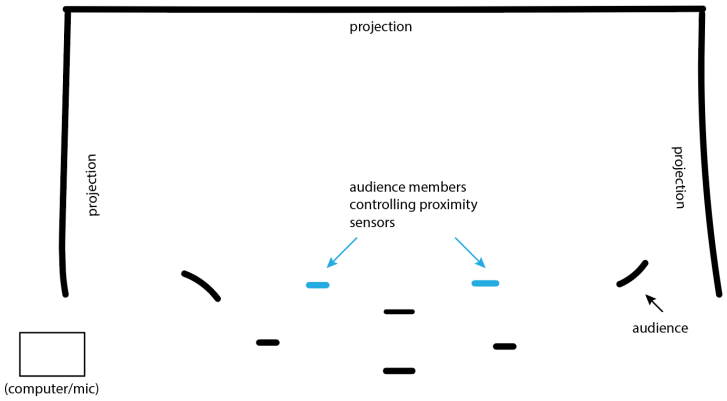

Figure A.18: Azulejos of the Sea Spatial Diagram

The setting is informal without a defined "fourth wall". During the interactive part of the mediascape different audience members can try to control the sensors. Projectors are attached to the ceiling thus providing an unobstructed use of the inner space within the projection walls.

In part 1 the participants are invited to interact with the visuals by clapping. The visuals presented in this part are a kaleidoscope of organic shapes derivative from videos of the sea

and the sand. The videos used in the project were shot on iPhone, the video of the sand is in slow motion, while the video of the ocean is manipulated to have frames overlap to create a dreamy quality of the visuals. Here the participants can change the projected scenes if they clap once and projected details inside the scenes if they clap twice. They can also use a bell instead of clapping, an instrument provided by the artist.

Figure A.19: Azulejos of the Sea Setup

In part 2 the participants are invited to interact with the visuals by using proximity sensors SR04. Here the visuals are created by applying the “organic” ocean and sand textures, same as in previous part, to geometries of a square, a sphere, a sun-like star and a particle system. These geometries exist in the context of black space independently as a pair - a square is always accompanied by a shape. The participants can change the camera proximity and the shapes of geometries which appear above the square as well as textures of the geometries. Part 2 is accompanied by a soundtrack.

Project 6 takeaways

Following my experience from last semester’s project (stairwellbeing) when I created an interactive installation in the university’s staircase I tried to limit the number of interactions / variable in this audiovisual environment. One lesson I took away from the previous project is that even if everything works the way it’s supposed to, when the participants are overwhelmed by the number of events that are happening at the same time, they may loose interest/motivation to explore the environment. Hence for this project I decided to focus on a few dynamic elements, for example I wanted to use live voice to effect the visuals as well,

but I let go of that idea because there seemingly was no sensorial room for it. The visuals were already very strong and different in two parts, thus I decided to keep the voice as part of the soundtrack, while leaving the microphone in part 1 to perform an audio sensor function to capture the sound from clapping.

Figure A.20: Azulejos of the Sea, Opening Visual from Part 1

After having presented this project, I can say that it was a good decision to leave live voice out of the mediascape mix, at least for the time being. This also gave me a better chance to observe and record what was happening during the presentation. I had a chance to present the project on two different days to several groups ranging from about 10 to 3 people. It's interesting to note that it seemed that the group dynamic had a lot to do with how the installation was perceived and the length of interaction with it overtime. It seems that such installation is best for groups of 2-5 people when everyone can take active part and/or see others interacting with the installation. This observation is also inline with the answers received on the survey.

After the presentation I was able to collect 13 survey answers. The question which I wanted to bring into focus here in particular is this Please check all that apply: A. I enjoyed interacting with the installation B. I enjoyed being a passive spectator C. I enjoyed seeing others interact with the installation

4 people responded A only 8 people responded A and C And only 1 person says A B and C This tells me that the most enjoyable part was the interaction and/or observing others interact with the installation. Such participation dynamic can be easier achieved in smaller groups.

Nearly all participants says that the interaction was "somewhat easy" for both - the mic and

Figure A.21: Azulejos of the Sea Participants Interacting Part 2

the sensors. The positive takeaway from this is that “not easy” was selected only 3 times - twice for interacting with the sensors and one time for interacting with the mic. It has to be noted that participant selecting “not easy” for one type of interactive device have selected “somewhat easy” or “very easy” for the other device. Thus, the positive takeaway is that overall the interaction was comfortable. Still, very few have said that it was “very easy” - this is however to be expected in a setting where participants’ engagement is encouraged through exploring a novel interactive system.

All 13 participants said they enjoyed the experience in general and that it was a relaxing experience. The preference of sensors and their ease of use varied to a great extent, there is no consensus as to which part is preferred either, although a few more people have said they preferred the second part. 7 People said they liked part 1 and part 2 equally while the others were divided between the two parts with 5 people voting for part 2 and 3 people voting for part 1.

The question about the part preference was in the survey not to exclude one of the parts, but rather to understand how the parts fit together and how they are perceived in the overall experience. Still more analysis is needed in this area to understand the perception of events in within the interactive mediascape phenomenon in a temporal dimension.

I had a chance to present the experiment to a large group of students (it was the whole class, about 10 people) and to smaller groups whom I invited individually. The smaller groups seemed to have a more meaningful experience as opposed to a larger group. In the former not every individual had an opportunity to use the interactive device or even observe some-

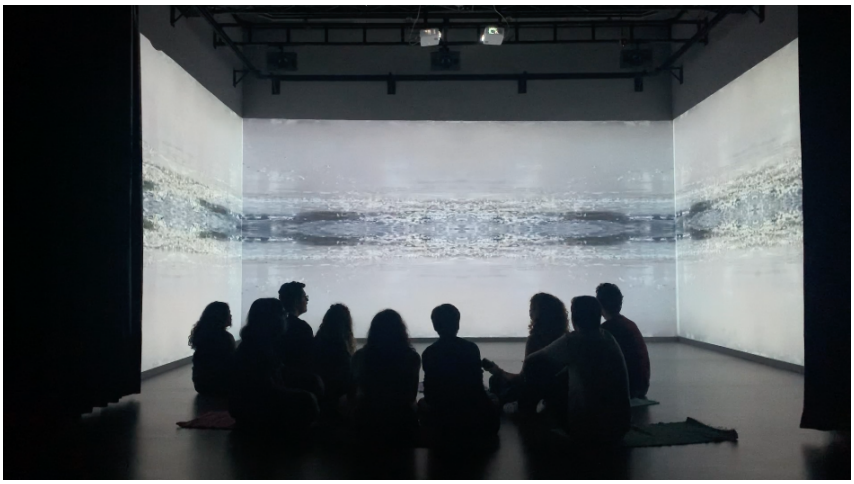

Figure A.22: Azulejos of the Sea Large Group of Participants Interacting

one else, participants could not easily see each other, plus some were distracted by checking their phone, which was a distraction for others. Participants in the larger group who wanted to interact with the devices also appeared to be intimidated by the others watching them as opposed to participants in smaller groups who took turns and participated in the experience in a more organic way.

Also, observing the spacial configuration of the room with 10 people vs 3 provides a clue as to the geometric balance between the area occupied by the media vs the area occupied by participants. It could be true that this balance is a contributing factor in the quality of the overall experience. Plus in a larger group setting it was practically impossible for the participants to arrange themselves so that they would see each other equally well and still be able to see the projections, hence they naturally arranged themselves in two rows which prevented the people in the back seeing people in the front and vice versa. Participants in a smaller group, however, could easily achieve situating themselves within the common plain of sight. The takeaway from this was that I would try to focus on making experiences for smaller size groups.

This was the time when the term Interactive Mediascape emerged in my mind. After I've been calling previous experiences "interactive happenings" I thought that "interactive mediascape" would be a more accurate description. Although a Happening refers to the nature of the event, a Mediascape reflects the contextual and sensual qualities. Because previously, while using sound, I would think of these events as interactive soundscapes, by introducing other media, it seemed like a logical adjustment to refer to these events as Mediascapes as opposed to soundscapes.

At the time while developing this project I also noted: "I came up with this definition [IM] to

refer to the artistic expression form which is presented here [project 6]. I still have to think through the particular aspects of a mediascape in more detail but overall I can say that it's something of a 4 dimensional art object. The dimensions are the visual part, the audio part, the interactive part, and the overall shape of the experience. Each of these parts further carry a structure within themselves. At the end point when the interactive mediascape is presented, all of these parts form a narrative in time and space while the participants help creating this narrative." When I look back at this statement today, I see the conceptual saplings of the IM taxonomy and how they've morphed following the research presented in this thesis.

After a somewhat disastrous presentation of stairwellbeing (project 5) with all of its media, content and experimentation which left the participants confused, I toned down the ambition for Azulejos of the Sea and thought to make interactions simpler in terms of modalities and design for a more perceivable/palpable interaction outcome. To achieve this I thought to incorporate interactivity modalities "asynchronously", meaning that I would not have audio and video interactions offered at the same time. Instead, I focused on video interaction only complementing it by a pre-designed soundtrack. In part one audience's clapping and playing the bell served as the soundtrack, in part 2 the soundtrack was a pre-recorded ambient composition. Participants' feedback supported my hypothesis, having a more defined set of interactions limited to one modality helps to make the experience less confusing and more enjoyable.

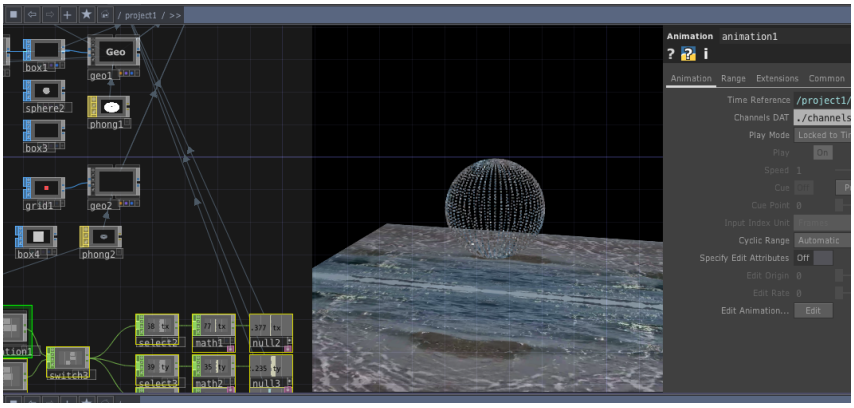

Figure A.23: Azulejos of the Sea, Touchdesigner OSC screenshot

Azulejos of the sea - Variations

Questionnaire June 14 & 17, 2022

Did you enjoy the overall experience?

Yes No I don't know

Which part did you enjoy the most (check one or more, if you liked them equally)?

Part 1 Part 2

Did you try to interact with the installation?

Yes, in Part 1 Yes, in Part 2 No

What type of interaction was the most fun? The mic The sensors Both

Please check all that apply:

A. I enjoyed interacting with the installation

B. I enjoyed being a passive spectator

C. I enjoyed seeing others interact with the installation

How easy was the interaction with the mic?

Very easy somewhat easy not easy I don't know

How easy was the interaction with the sensors?

Very easy somewhat easy not easy I don't know

Would you say it was a relaxing experience? Yes No Not sure

How old are you?

less than 20 20-30 31-40 41-50 51-60 over 61 Thank you!

A.7 IamBITus

Project Name: IamBITus Interactive Happening 6 - Stylistics of Gregorian Chant Re-purposed. Presented as a work in progress on November 9, 2022 at IRI festival in Vila do Conde, Portugal

Project 7 description

One of the greatest challenges and curiosities that today's technology presents is the new paradigm for creating art enabling collaborative creativity through technology mediated devices. There are big questions that come along as we think about developing such art: How

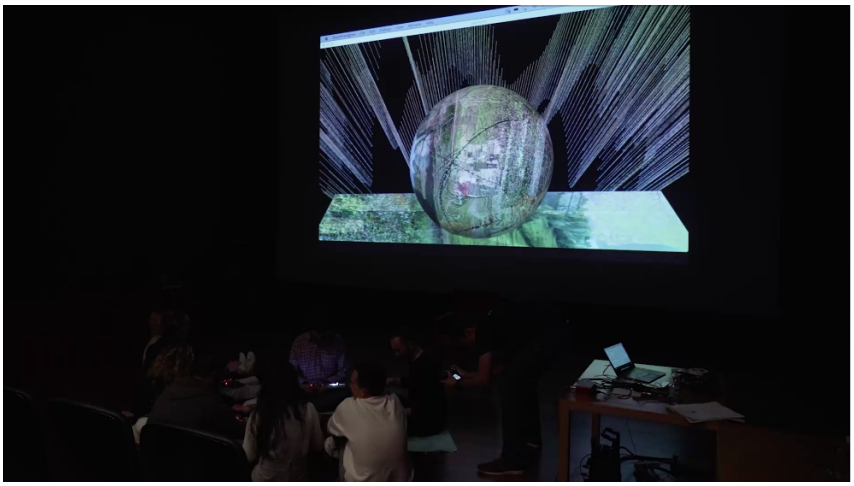

Figure A.24: IamBITus Participants Interacting

do we make it simple enough but not trivial? How do we make human interaction at the center and not the gadget? How do we shape these art events to be aesthetically and culturally enriching? How do we cross the fourth wall in a places like theaters which essentially were conceived and built to create that wall?

This piece is a work in progress. My research is based in the subject of technology mediated collaborative creativity experiences in physical space. I believe there can be places and scenarios created for such experiences and with IoT capabilities these experiences can be happening in real space and time. This is our chance to look away from our phones and look at where we are, see who is next to us and zoom into the present moment in our physical reality while finding beauty, surprise, contemplation and ambiguity in events triggered by us.

Ambitus (enclosure, Latin) is the range defining between which notes a performer can move freely. Thinking about how to "compose" such an interactive piece I looked at Gregorian chant as the inspiration for the way it was composed and presented. I looked further into the elements which constitute the composition - ambitus "struck a chord" with me, it's a limit that the composer gives to the performer. In an interactive piece I can bring this idea into a different modality and define the audiovisual components of the interactive happening as an ambitus of my interactive palette. Whatever material I choose to use in the composition will define its mood, color, emotional affect perhaps... The material will be used sometimes in unexpected ways due to audience participation and this is what makes me curious (and a bit nervous with anticipation). There is no definitive final form - it's the process that shapes the experience. After it's done, we stop and reflect.

Project 7 dramaturgy

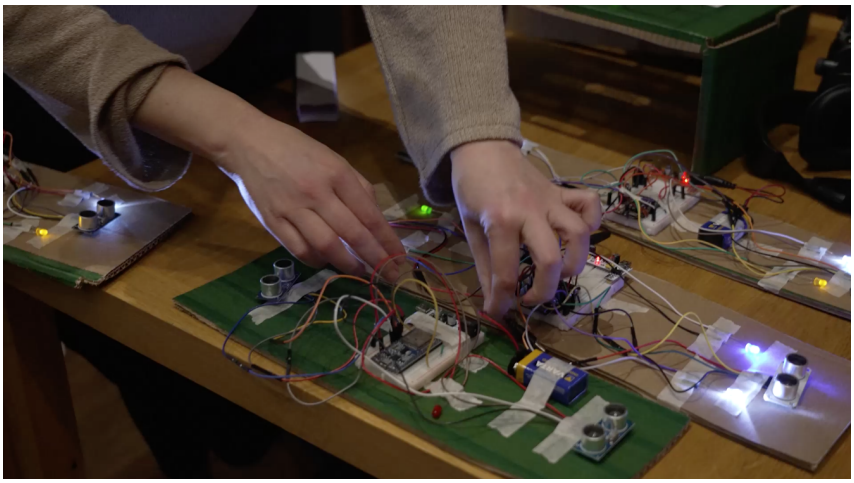

Figure A.25: IamBITus Interactive Modules Testing

IamBITus - Interactive Happening in 3 parts

1. Here we are
2. Slowdown
3. Happy ideas (Pessoa)

Script

At the beginning we will throw the dice to set the performing algorithm in motion.

During the entire event everyone can move around freely, go onto the stage, sit in the audience or stand in the passageways.

There will be a VR mask (a prop) placed on the stage and at any time a person can go and take the mask, look at it, put it on. There will be a chair where one can sit while keeping the mask on.

A singer will perform a vocal improvisation during a portion of the event.

A singer may also sing a song.

Interactive modules will become active overtime: at the beginning it will be 3, then 4, then 5,6,7. LED lights will indicate when the modules are active.

Interactive modules will trigger the sound tracks & video projections.

If everyone stops interacting with the modules, there will be silence.

The event lasts approximately 25 minutes.

Have Fun!

Interactive system feedforward - presented to the participants in a form of a pamphlet before the experience.

> *How to interact - two ways:*
>
> To hover over the sensor - continuous triggering, like for a musical track To pass your hand over the sensor - this is on and off - it will trigger an event, such as the animation of the visuals
>
> *When to interact - follow or choose:*
>
> Some sensors have a White LED light indicating when you can interact with the sensor and you can follow those light cues. However this is only suggestive - it's a timing created by the algorithm. At any point you can choose to interact with the sensor, making your own decision of when and for how long you want to trigger it.
>
> *What to expect:*
>
> We are creating this experience together. To make the mediascape sounds and visuals are blended.
>
> You may not immediately be able to distinguish what part you are playing but you will see an indication from a Color LED on your board telling you that you are effecting the events. But then again, you just may notice exactly the changes you are triggering.
>
> Remember, this system is not instantaneous, after you make a move, count to 2 to see the effect.

Project 7 takeaways

I was offered an opportunity to present a project at IRI festival a few weeks before the event so the time to put this together was very limited. There were a lot of unknowns - most importantly, how many people would participate at the same time. It was also not clear whether 3 projector plains can be utilized. With space and resources guidelines being somewhat ambiguous, I decided to make the interactive modules movable. There was a discussion about limiting the number of people entering and participating, to maybe have groups of 4-5 people enter the space and try out the experience, however, at that time I rejected that idea because for me a discussion after was the most valuable part of feedback and having people enter in groups would complicate scheduling and perhaps many of them would leave before the discussion. I decided to create the experience for 4-8 people. As it turned out, the evening of the presentation was cold and rainy and only the most dedicated and curious people came

to the event. After the experience was presented we had an hour long discussion. This and my observations were the sources of information for the following analysis.

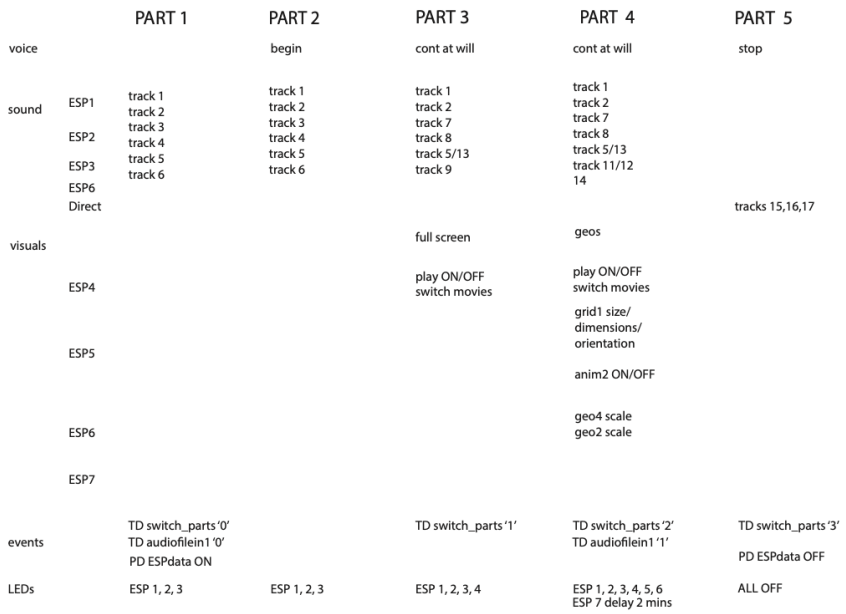

Figure A.26: IamBITus, Media Mappings Diagram

Project 7 discussion

This led to a small audience in a large auditorium. The experience began with audience members sitting in the auditorium part, however, quickly the participants decided to come to the stage area and sit down all together in a circle. This was the first telling observation, that although the interactive devices could be activated from anywhere in the auditorium, the participants felt more comfortable to sit closer together.

Failure of feedforwarding. Although I made the explanation, printed several copies and each participant received a copy before the beginning, no-one read it. It was ignored by 100% of participants. This could be partly due to the fact that it was a cold rainy night and we started a few minutes late and there was simply no time between the audience received the instructions and the beginning of the experience. However, it could also be due to the fact that such instructions were too lengthy and cumbersome, the participants were not prepared to read a full page of instructions before jumping into the experience. Unfortunately, I didn't ask the question about this during the discussion session but drawing conclusions of my own was helpful as I would try to minimize instructions during the experience and would perhaps offer a "training station" available before the experience instead. This way the participants

can learn about the sensors not by reading but by doing and when they enter the IM space they would be already familiar with the principle of interaction.

Failure to script events in a systematic way. This project utilized 14 proximity sensors with multiple interactive events in audio and visual modalities. Having learnt from experience I began by introducing one modality - audio (in part 1), then adding video (in part 2) and leaving part 3 for reflection only, without any interactive events. Even with these defined limitation I ran into a challenge of organizing events in a way which can form a narrative. I created a grid of interactive events. Media mapping matrix. In my notes I separated the experience into 5 parts according to the interactive mappings which take place (as opposed to contextual - as in the description of the project which has 3 parts). Here Part 1 and 2 correspond to “Part 1 - Here We Are”, Part 3 and 4 correspond to “Part 2 - Slowdown”, and Part 5 correspond to “Part 3 - Happy Ideas”. The benefit offered by this system was mostly in software integration. It did not help with the content part, it only helped to organize the events as they had to be programmed on the timeline. Because I did not have a lot of time to think this through I took the content which I had in mind and mapped it to various sensors. I was curious if the event would be confusing as was the case with “stairwellbeing” or if my efforts to separate interactive modalities and to organize the events would help in making the experience more cohesive from participants’ perspective.

Figure A.27: IamBITus, Discussion after Presentation at IRI

The discussion showed that there was progress, in starting with audio only most participants were able to perceive the results of their interactions within the overall soundscape. It is interesting to note that for some people it was easy to hear how they were affecting the sounds while others said they only became aware of their impact on the media once visuals were introduced. This perhaps reflects a point about personal differences and that some

people respond more easily to sound, while others to visual stimuli.

There was a general consensus during the discussion that at some point the group felt like they became in tune with each other and it was agreed that sitting in a circle was one of the factors which had propagated that feeling. While one person said that when she entered the space and saw the interactive modules she was a bit confused but then her perception of the situation changes. When I asked if she enjoyed the experience, she said yes. To me the point of change from confused to interested and engaged was important and I asked if she remembered specifically when the feeling of confusion subsided and gave way to curiosity. The participant said that that she began feeling more comfortable when the visual of the ocean was projected. This was an interesting statement, considering that Porto is an ocean city and locals feel connected to the sea, was the ocean a symbol familiar to a particular local and therefore comforting or is the ocean a universal symbol which can mediate the state of calm? The participant had also noted when she was interacting with the visuals, she felt like being in control of “something bigger than me”. Perhaps the participant was surprised by the fact that she could control the video content by waving her hand over a sensor.

Figure A.28: IamBITus, Setting Up Interactive Modules

Project 7 interactive modules - designed to fit across the lap (Figure A.28) for participants in the audience, the group of participants decided to bring them to the stage area

This introduces the question of interaction effort in proportion to physical impact value, it could be hypothesized that the more palpable the interaction result the greater the perception of personal agency. In this case palpable can mean great in physical size and contextual impact on overall experience. With a greater perception of personal agency perhaps the participant becomes aware of the significance his/her interaction brings to the experience and becomes more attentive and engaged. An interesting question to explore would be: does this

feeling of controlling “something bigger than me” originate from interactor’s awareness that the group is watching and noticing his/her actions and / or if the original interactor’s awareness of his/her own actions is enough? Also, is this feeling mediated by the context/structure of experience itself?

This feedback also opens another question. Wireless interaction is not a new phenomenon and, if we put the idea of controlling a projection remotely in another context, we may say this is quite common, in fact, presenters can control their slides with a wireless device, there’s remote control for TV and many other examples. However, in the context of Interactive Mediascape experience this type of interaction felt like something novel and exciting, why? Was it because the interactive modules looked unfamiliar or because the type of content was poetic and entertaining? This would be an interesting question to explore.

A few weeks before the project was presented at IRI, I tested part of it at FAMO COSE Figure A.29. It was only the first part with the sound and vocal improvisation. The folks participating in the experiment were all new to the idea (they were different people from the ones who had experienced the projects 3 and 4). One of the participants at FAMO COSE said something which was very similar to the feedback comment described earlier. He said, although he could not always understand exactly what his actions produced, he felt like he was part of something larger than him. I thought that this comment reflected the ultimate goal of the experience. If this state of presence can be achieved during the experience, the outcome becomes something larger than the sum of parts. However, it’s unclear how to invoke such understanding in the whole group of participants. In this particular case the comment seemed to be coming from an individual who had a personality inclined for collaborative work. However, at the same time another individual said that he could not understand what his role was and that triggering/effect pairing has to be more precise, otherwise, he said, he could not understand what was going on and the interaction seemed pointless. I think again, here were two different personalities - one that functions more on intuition/feeling and the other which functions more on thinking/sensing. Although at this time it’s not clear how to account for these individual differences in designing an IM experience, it could be a topic for future research.

Coming back to the discussion after the presentation at IRI, one participant suggested that a microphone would be a nice addition to give an opportunity for improvised spoken word. He was compelled to add something to the soundscape during the experience but was not able to. I wonder why he didn’t use the microphone which I was using to sing nor did he ask me? Perhaps I was not clear enough in communicating that this is an experiment and anything is possible, perhaps I had overestimated the ability of the public, unfamiliar with IM experience

Figure A.29: IamBITus, Practice Run Discussion at FAMO COSE

Figure A.30: IamBITus setup

format, to just “jump in”.

Once again, in essence, project 7 has proven that IM can be fun, yet there were more questions than answers. Once again, I was left with the biggest question of all: how to script IM experience, where to draw limitations and where to allow for expansion, how to structure the project and choose media? Although I came one step closer to understanding that separating triggered media by modality is helpful in fostering the feeling of personal agency, I was still at loss for the guiding principles to construct an IM.

A.8 Touchdesigner Roundtable Presentation

Touchdesigner Roundtable Presentation on co-located TMEs Presented on May 25, 2023 at Metropol, Berlin, Germany

Figure A.31: Node Institute Touchdesigner Presentation

I needed to create a simple project to demonstrate to the touchdesigner community how proximity sensors can be integrated with TD in realtime. This was the last of my experiments so far and it was the most straightforward one as far as the narrative and interaction complexity. Because I have already done some research for my thesis, I thought it would be interesting to use a direct metaphor connection from TUI device to the triggered media.

This project had no audio, only video output. I made a total of 3 interactive devices. Two devices (A & B) had individual sensors, the third device (C) had a pair of sensors. Devices A and B were placed inside empty packaging from nuts and chocolates. The initial visual showed 4 spinning squares with the title of TD Roundtable and Date, once the devices A and B were triggered the image changed to nuts and chocolates respectively, when both were triggered at the same time, cookies would appear. I first introduced these devices to the audience and asked them to pass them around and try.

The audience were very curious to try these devices and passed all the way to the back of the room. Once the audience “got a hang” of the idea, I introduced device C which consisted of two sensors. These sensors were mapped to geometric configuration of the image, sensor C1 changing the number of squares from 4 to 1 and sensor C2 changing the size of the squares from original to large. I passed device C around as well. As I continued with my presentation, audience members continued to experiment with the interactivity passing the devices to each other.

Figure A.32: Touchdesigner Presentation Interactive Modules: Chocolates and Nuts

For this project I did not use internet WiFi, I used a dedicated router instead. It was located next to my laptop. During the experience it was established through audience's feedback that people in the back could not successfully trigger interactivity. This makes me believe that the router's reach was about 20 meters, perhaps it would be better to place the router in the middle of the space.

From observing the scene, I would hypothesize that having the devices as direct metaphors reference from object to visual could be a good way of introducing people to the interaction paradigm created by ultrasonic proximity sensors coupled with media. The sensors' small size creates a versatility of possible usage scenarios. Sensors can be embedded in physical objects resembling particular metaphors. Introducing such object may produce an organic more intuitive comprehension by the user/participant/actor. Once the understanding is reached a less obvious design can be introduced.

My presentation recorded at the Roundtable can be viewed here:

https://thenodeinstitute.org/event/touchdesigner-roundtable-xxiii/

A.9 Evolution of interactive modules

Here I would like to briefly describe the development of metaphor and shape in interactive modules design. This also speaks to the versatility of ultrasonic proximity sensors when it comes to creating interactive devices with this technology. In project 1 the sensors were embedded into empty picture frames, the installation was at the museum and the frames

seemed like a natural element in the design, it was also curious to have the frames which usually carry visual information to contain a trigger for audio information instead. In project number 3 cans were used to represent the “vessels”, in project number 4 Rome metro tickets were attached to sensors to contextualize the experience. In project number 7 the modules were designed in a way so that the platform containing the sensors would comfortably fit across someone’s lap, thinking about participants being in the audience sits, the design idea was directed towards comfort and for a few moments that someone had used the modules from their sit the design seemed to work. In project 8 a direct metaphor connecting interactive devices with the content they represented was introduced, this was the most obvious pairing of triggering and media, it has proven to be very effective in providing a good quality of experience.