The University Of Sheffield.

Synaesthetic scape

By:

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Faculty of Social Science
School of Architecture

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How to read this research

This research comprises two components,

- Written material presented in this thesis
- Creative work is an immersive virtual environment (Synaesthetic Scape).

The creative work (Synaesthetic Scape) can be accessed by:

1. The Images and QR codes embedded in the foldout storyboards in chapter 3
2. The QR codes in section 8-Appendix. (2D experience).
3. Android Smart phone+ Google cardboard headset+ Bluetooth foldable keyboard. (Unfortunately, the system does not run on iOS and other mobile platforms).

Kindly benefit from the attached cardboard headset and the bluetooth foldable keyboard to follow the detailed steps in Appendix -section 9 to experience Synaesthetic Scape in a fully virtual experience.

I hope you find this note useful to better understand the Synaesthetic Scape experience.

Thank you
Maha Al-Ugaily

Declaration

I declare that this thesis is my original research and it is a representation of my Ideas, designs, and written materials. All supporting literature, resources, and collaborative contributions of my participants have been acknowledged clearly.

Signature
Maha Amer Al-Ugaily

Abstract

This research draws attention to the sensory experience of architecture, whereby all different sensory aspects of the built environment work together to stimulate and communicate with the users' senses. The thesis introduces a new term 'Synaesthetic Scape', which describes this experience. The term is also the title of the virtual landscape constructed as part of the Research by Design process.

Architecture is understood in the PhD thesis as the embodiment of human sensory interaction with an individual's environment through time and a way of holding users' stories of sensory interaction and perception.

However, representations of architecture have tended to have been limited to expressing the visual interactions with the surrounding environment, ignoring the comprehensive effect of the sensory experience of users in understanding and perceiving their surroundings. The thesis addresses this lacuna.

In this interdisciplinary practice-based research project, 'Synaesthetic Scape' explores and reveals the combination of 'synaesthesia' as a cross-sensory model with the use of virtual scapes in architectural design practice, where users' sensory associations, perceptions and emotions are blended in one experience. Moreover, it directs attention to the multi-sensory possibilities of architecture and thus explores possibilities for how architects might design in a synaesthetic way.

The thesis aims to combine different concepts and methods that are not normally used in architecture to understand, describe and explore the process and potentialities of VR to produce ways of representing architecture that appeal to the senses and elicit memory and emotional engagement by developing a framework and a methodology outlining the foundation of a design process in creating sensory immersive spaces or 'Synaesthetic Scape' experiences which will eventually enhance the Iraqi pedagogy and design concept.

Throughout both the theoretical and practical stages of the thesis, which used 'experimental inquiry' as a tool to operate three experimental creative projects, the work has been iterative and reflective of the design process as a whole. The first stage explored synaesthesia and architecture, taking into account aural architecture, sound studies, the phenomenology of architecture, emotions and virtual immersive environments. The second stage involved creating a virtual environment. It thus explored the potential of Synaesthetic Scape as an audio-visual sensory and immersive experience within the virtual reality context. It represents a co-productive stage where participants played a major role in the validation, evaluation and creative evolution of the project. The findings and recommendations of the research are thus relevant to the emergent area of the design of virtual scapes, as well as the design process in architecture and pedagogy more generally.

Acknowledgements

First and foremost, I would like to thank God Almighty for providing me with the strength and ability to go through my PhD journey. Without his blessings, the prayers of my parents and the patience, sacrifices and love of my husband and two boys, I would not have been able to reach this point.

I would like to express my sincere gratitude and appreciation as a scholarship holder to Al-Nahrain University and the Ministry of higher education and scientific research in Baghdad for giving me a lifetime opportunity to gain knowledge and develop from an esteemed University which will help me develop my career as an academic and researcher in the field of Architecture.

I would like to extend my gratitude to my supervisor Dr Renata Tyszczuk for being the best mentor one could ever ask for. Her guidance throughout the PhD was significant and very essential for my work to be as it is today. Special thanks to my second supervisors Dr Jian Kang and Dr Stephen Walker who always provided help and guidance when needed.

Special mention goes to my lovely cousin Zainab al-Ugaily for her kind and generous hospitality when I needed to dedicate the time to write and finish my first draft of the whole thesis. You provided a lovely and comfortable atmosphere away from my responsibilities as a mother. Thank you for this time and your priceless support through my PhD in general.

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Chapter One

Introduction and Methodology

Introduction

In simple terms, synaesthesia means the union of the senses; *'(Greek 'syn' = union/together + 'anaesthesia' = sensation/perception*' [1] and it was first used in medical literature in 1860 [2]. In clinical terms, synaesthesia 'is a neurological condition in which the stimulation of one sense produces experiences in a totally different sense' [3]. Architectural theorist Marco Frascari, introduced the term synaesthesia to architecture in his discussion of architect Carlo Scarpa's drawings (2003) and later in his book *Eleven Exercises in the Art of Architectural Drawing* (2011)[4]. Frascari emphasises that synaesthesia is not a neurological disorder, it is simply a different way to experience the world; subsequently, people with synaesthesia are referred to as 'synaesthetes' [5]. Frascari defines synaesthesia as the 'crossing of the senses' [6] and in *Eleven Exercises* he writes, '*It occurs through the associations of two or more physical senses and other sense modalities*' [7].

The experience of architecture is more about the multi-sensory interactions of our bodies with their surroundings, as opposed to reactions produced by the visual stimuli of design. Experience builds our memory of space and time; we are synaesthetes by instinct. However, we tend to lose this ability over time. Nonetheless, much of contemporary architecture seems to promote the visual aesthetics of spaces rather than seeking to deploy all of the senses that unite through the spatial experience. As a result, this research responds to the need to draw our collective attention to all of the senses in the experience of architecture and explores the possibilities of creating a 'Synaesthetic Scape'.

The research constructs the notion of 'Synaesthetic Scape' as a territory in which virtual perceptions are merged with other sensory associations, perceptions, and emotions (see Figure 1).

1 Cytowic, R. E. (2002). *Synaesthesia: a union of the senses*. Cambridge, Mass.: MIT Press, p.1

2 Ibid, p.1

3 Carlsen A., "Some people really can taste the rainbow", 18th March 2013, last accessed 16 April 2019. http://www.npr.org/sections/thesalt/2013/03/12/174132392/ synaesthetes-really-can-taste-the-rainbow

4 Frascari, M., 2011. *Eleven exercises in the art of architectural drawing : slow-food for the architect's imagination*, London: Routledge. p. 26.

5 Frascari, M. (2003). *"Architectural SYNAESTHESIA: a hypothesis on the makeup of Scarpa's modernist architectural drawings."* Academia.p.1. from https://www.academia.edu/308741/Architectural_Synaesthesia_A_Hypothesis_on_the_Makeup_of_Scarpas_Modernist_Architectural_Drawings.

6 Ibid, p.1

7 Frascari, M., 2011. *Eleven exercises in the art of architectural drawing : slow-food for the architect's imagination*, London: Routledge. p.26

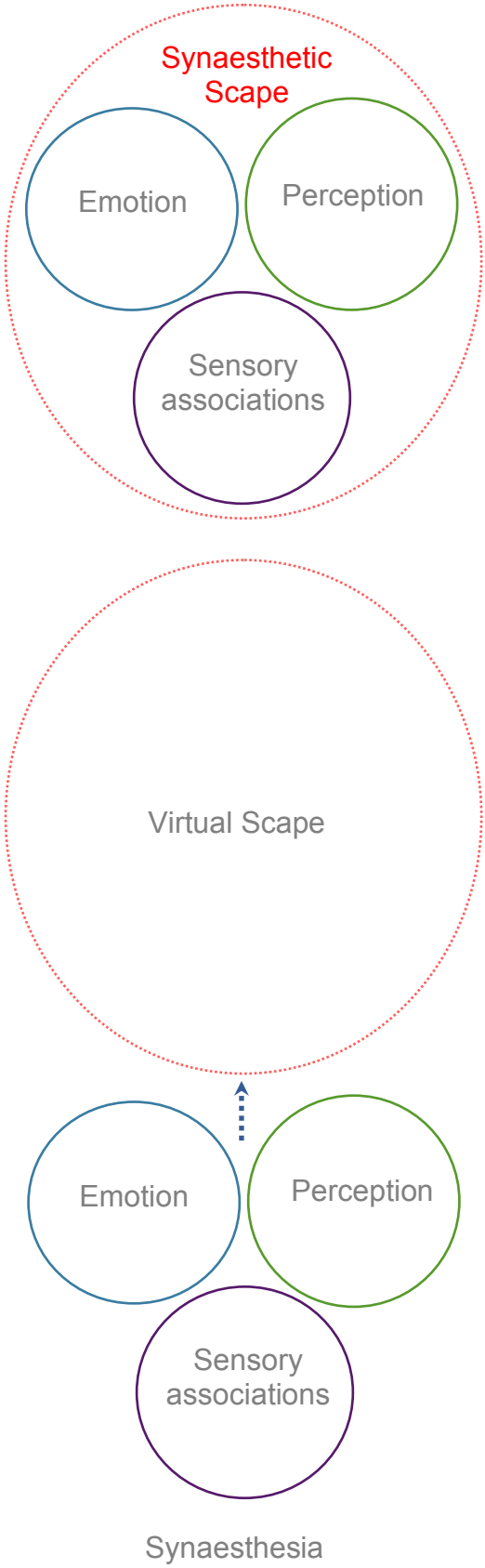


Figure 1; Synaesthetic Scape spatial explanation (design by the researcher in conjunction with Frascari's concept of synaesthesia)

For Frascari, sensory perception in synaesthesia transpires as an ‘emotional state of affairs’ that is difficult to describe:

‘Synaesthetic inter-sensory associations are emotional states of affairs appreciating that there are ineffable things you hear, invisible things that you see, and impalpable things that you touch, that are describable but beyond words’ [8]

Synaesthesia represents a condition which encompasses the cross-modality of the senses, something which differs from multi-modality[9] or a multi-channel communication concept.

Multi-modality refers to the use of more than one channel or mode (media) of communication when it comes to introducing an idea or concept. The collection of these modes contributes to how multimodality increases an audience's reception of a concept or an idea; notably, these channels can be studied and detected separately (see Lexicon for full definition). In contrast to this conceptualisation, this research uses a proposed framework of ‘Synaesthetic Scape’ to explore the spatial experience contained within the understanding of synaesthesia as a ‘cross-modality’ of the senses.

Through exploring Carlo Scarpa’s drawings as a key example, Frascari emphasised how the use of synaethesia as a sensory experience influenced architectural representations. The architect Juhani Pallasmaa, on the other hand, has a slightly different perspective to this understanding. He warns that the sensory and spatial experience of architecture can become limited when focusing on the medium of graphical drawings or other symbolic, photographic, conceptual or intellectual representations. He argues that embracing these descriptive tools of architecture only serves to value the abstract and static value of building designs over the active essence of the human natural perceptual movement in and around those buildings and spaces.

8 Frascari, M. (2003). *"Architectural SYNAESTHESIA: a hypothesis on the makeup of Scarpa's modernist architectural drawings."* Academia.https://www.academia.edu/308741/Architectural_Synaesthesia_A_Hypothesis_on_the_Makeup_of_Scarpas_Modernist_Architectural_Drawings, p.2

9 Sharon Oviatt, *Multimodal Interfaces.* Center for Human-Computer Communication, Computer Science Dept. Oregon Graduate Institute of Science & Technology Beaverton, Oregon, USA, https://www.cogsci.msu.edu/DSS/2004-2005/Oviatt/Multimodel%20Interfaces.pdf

He is therefore critical of architecture which alienates us from our environment by displacing design, as a multi-sensory interaction, with static drawings that favour the visual sense. In particular, Pallasmaa is critical of computer imaging and suggests that,

> *'computer imaging tends to flatten our magnificent, multi-sensory, simultaneous and synchronic capacities of imagination by turning the design process into a passive visual manipulation, a retinal journey. The computer creates a distance between the maker and the object, whereas drawing by hand as well as working with models put the designer in a haptic contact with the object, or space'* [10]

This research builds on the ideas of Frascari and Pallasmaa in regard to architectural representation and experience. It contends with Pallasmaa's theory that contemporary architecture is static and denies the real nature of human sensory perception. It further explores the potential of synaesthesia as a cross-sensory model for a virtual environment; an environment that allows for the sensory experiences of users when moving in and around virtual architecture.

The research introduces the term 'Synaesthetic Scape' as a framework for the design process. The term also describes, understands and reveals the potentials of the virtual environment which were created during the process of the research to elicit emotions and memory. The study investigates the potential of the 'Synaesthetic Scape' as a design tool which can create multi-sensory environments in order to enhance the experience of architecture and architectural pedagogy.

[10] Pallasmaa, J., 2012. *The eyes of the skin* [electronic resource] : architecture and the senses 3rd ed., Chichester, West Sussex [U.K.]: Wiley. p.14

Etymology 1-2

Establishing the etymology of the 'Synaesthetic Scape'

The etymology of my proposed 'Synaesthetic Scape' is explained in Figure 2. The suffix 'scape' has often been used in other words familiar to architectural design practice, such as landscape, soundscape and virtual scape, and is commonly used to describe a type of scenery. The combination of Synaesthetic and Scape thus suggests a cross-sensory spatial exploration.

Figure 2: Proposed Synaesthetic Scape etymology (designed by the researcher)

Research Question 1-3

The central research question is as follows: How to design in a Synaesthetic way?
The research answers this question by using an 'experimental inquiry' approach which is discussed in depth in the methodology section of this chapter. Briefly this approach involves a 'process of generating and testing hypotheses for the purpose of understanding'[11] and exploring the design process which produces the 'Synaesthetic Scape'.

The research also encompasses a number of sub questions which are as follows:

[11] Marzano, R. J. (2000). Designing a new taxonomy of educational objectives. Thousand Oaks, CA: Corwin Press. P.57

‘A ‘Synaesthetic Scape’ experience can be achieved by tuning the design tools of light, colour, texture and materials (which are believed to influence the mood in the space emulating any real architectural experience)’.

The subsequent two question relate specifically to the sound space:

- What are the right levels of light, colour, materials and texture to influence the emotional engagement of participants with the space?
- To what extent can music be used to provoke emotions in order to create the emotional aspect of the synaesthetic experience?

‘Using virtual immersive technology will give users’ perceptions a sense of reality of the space, and its immersive qualities will help achieve the ‘Synaesthetic Scape’ experience’.

- Will neutralising the effect of the design tools of light, colour, materials and textures, allow other qualities of the virtual reality design to be present and will they improve the quality of the synaesthetic experience? What might those qualities be?
- Can the virtual reality design share the same design tools as those used to produce real architectural spaces?
- Music was used to provoke emotions in this scape, can it also provide room for the participants’ imaginative understandings of the Synaesthetic Scape as in the first stage of experiments?

‘Using real sounds in the virtual environment will reflect a realistic synaesthetic experience’.

- How might sounds influence users’ interactions with the ‘Synaesthetic Scape’?
- Will real sounds influence the emotions and imaginations of participants as the music did in previous experiments?
- What are the differences between using real sounds as the emotional and multi-modality medium of the space and the music used before for the same purpose?

Aims and Objectives 1-4

A three-stage framework was designed with the aim of answering these research questions. Each stage has its own hypothesis, all of which are tested through a designed synaesthetic experiment, which, in turn, informed the subsequent stage.

The research aims to contribute to the design palette of architecture and the design process in general through the development of immersive VR tools for use in enhancing architecture as a sensory experience of place.

Thus, the objectives of this research can be summarised through two areas:

- To investigate the fields of synaesthesia and VR immersive environments in order to study the possibilities of designing in a synaesthetic way.
- To develop a co-produced design process for a ‘Synaesthetic Scape’ in which architects and users communicate and engage in the process of creating sensory immersive environments.

Methodology 1-5

The research developed a methodology which involved collecting, analyzing and deriving themes out of relevant data connecting to the virtual immersive experience. These themes were used to enhance the general design process of the ‘Synaesthetic Scape’.

The thesis is considered to be a narrative reflection of the researcher’s own research journey, whereby the aim of contributing to knowledge manifests through imparting both the methodology developed and the framework designed.

The research framework is designed around three accumulated experimental stages, all of which informed and led to one another (see Figure 3). As stated previously, this framework uses an 'experimental inquiry' approach as a tool to operate the three experiments.

As made clear, each stage has its own hypothesis to test as well as individual questions to answer. This is completed through a designed synaesthetic methodology and test.

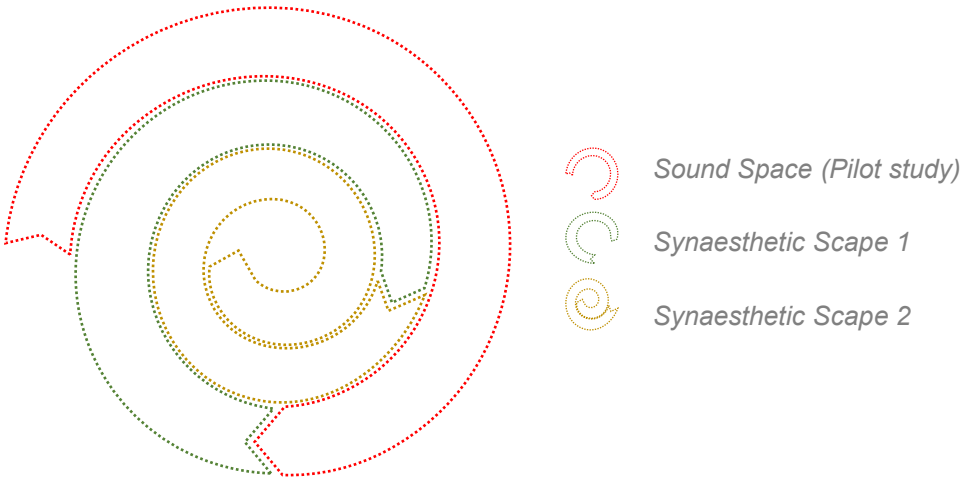


Figure 3: The three stages of a synaesthetic methodology (designed by the researcher)

This section relays the methodology and also discusses the process of data analysis. Chapter 2 returns to the research background of the 'Synaesthetic Scape' in more detail while chapter 3 engages with the experimental context of the research. The findings of the research are discussed in Chapter Four.

'Synaesthetic Scape' is an experience of space where perception, sensory association and emotion are blended together in a virtual immersive medium. Thus, in order to test such an experience, the decision was made to design a synaesthetic methodology that identifies each of its three components and evaluates the results through the users' experience of the space. This approach was carried out across every stage, with the

results informing each subsequent stage. In order to identify and evaluate each component, the following actions were carried out:

Perception: users' perceptions were identified by asking them to draw a map of the space as they perceive it (collecting artefacts).

Sensory association: In each stage, more than one sense was provoked. Users were asked to partake in a semi-structured interview to talk about their multi-sensational experience of the space.

Emotions: the users' emotions were detected[12] through every stage in consideration to each stage's individual circumstances. Accordingly they were evaluated by the participants within the semi-structured interview.

Each stage had a distinctive methodology, as described below.

[12] A small study of the existing tools for measuring emotions was carried out by the researcher. The study included the reasons as to why this method was chosen to detect emotions for the pilot study.(For the full assessment of these tools, i.e. the advantages, disadvantages and requirements for each, see appendix section four and see 'emotion as a service' program, appendix section one).

1-5-1 Stage one

Sound Space—hypothesis and questions

The initial stage in the design of the first 'Synaesthetic Scape', is referred to here as Sound Space [13]. The hypothesis for this stage was:

'A 'Synaesthetic Scape' experience can be achieved by tuning the design tools of lights, colours, textures and materials (which are believed to influence the mood in the space emulating any real architectural experience'.

The subsequent two question relate specifically to the sound space:

- What are the right levels of light, colour, materials and texture in influencing the emotional engagement of participants with the space?

- To what extent can music be used to provoke emotions in order to create the emotional aspect of the synaesthetic experience?

The first stage was tested through the pilot study case experiment titled 'Sound Space'. A total of four animated works from 2002 were taken as an early example of a possible 'Synaesthetic Scape'.

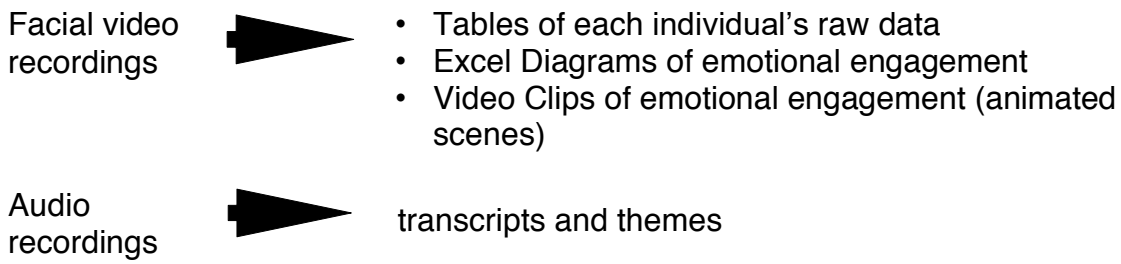
In the pilot study, a combination of quantitative and qualitative methods working together in two steps was proposed in light of the questions of the first stage (pilot study) and the hypothesis.

First step: Choose a method to identify emotions (quantitative method).

Second step: Focus group and semi-structured interviews with participants (qualitative method).

[13] "Sound Space'; four animated works of interior architecture. This project was my masters project which was submitted in 2002 for the MA Art & Space at Kingston University, London, UK. This PhD research pilot study tested "Sound Space" which represents an early example of the 'Synaesthetic Scape'.

Nature of data collected:



1. Facial video recordings were taken in three different situations:
   - Only listening to music in order to evaluate the level of music–emotion engagement.
   - Only watching the animated work (without the music) in order to evaluate the level of emotion–design engagement.
   - Watching the whole animation (with music) to identify the level of emotional engagement with the animated work as a synaesthetic experience.
2. An audio recording for the focus group
3. Audio recordings for the semi structured interviews

Nature of the data in the analysis stage:

This stage contains the visualised data in the form of tables and diagrams. All were made available to the participants, so that they could discuss in the focus group stage and later during the one to one semi structured interviews (see figure 4).

TimeStamp(msec)	angerct_emotion_	attentionct_u	au01ct_linear	au02ct_nonlinear	au04ct_nonlinear_	au09ct_linear_ca	au10ct_linear_ca	au15ct_linear_cau
0	0.00468622521	98.6196518	1.05828643	0.0690648109	0.00171960983	0.00450356631	0.00553352106	0.000592968834
71.4285736	0.00472830003	98.6852036	0.999735355	0.0649187043	0.00329321297	0.00454092957	0.00362603646	0.00152507098
142.857147	0.00475018751	98.5888596	1.17846727	0.0756969005	0.00604805816	0.0030355202	0.00337910419	0.00270185224
214.285721	0.00474529667	98.5906754	1.53991365	0.0819433481	0.0102025289	0.00395967253	0.00324276625	0.00335744023
285.714294	0.00475111417	98.516571	1.9756335	0.0922861919	0.0126793822	0.0040999013	0.00261972379	0.00365565345
357.142853	0.00474735256	98.690918	2.0633986	0.0850818753	0.0157473832	0.00316832354	0.0025962581 9	0.00413082354
428.571442	0.00474235322	98.7073746	2.0989418	0.0742011368	0.0175942387	0.00464760326	0.00294370158	0.0027452535
500	0.00475220988	98.633812	1.9408803	0.071747914	0.0176803544	0.00558160897	0.00312222214	0.0027004627
571.428589	0.00474391272	98.5016479	2.05222225	0.0701288134	0.0183979347	0.00357476622	0.00333795766	0.00279384293
642.857117	0.00474555371	98.5291672	2.10622001	0.069057785	0.0196945667	0.00252713775	0.00325023825	0.00229877746
714.285706	0.00477311667	98.5589828	1.90073156	0.0634146482	0.0220843088	0.00248452555	0.00318309152	0.00209183339
785.714294	0.00481270207	98.4271927	1.65690112	0.0594197661	0.0233397707	0.00370725244	0.00325796334	0.00221761758
857.142883	0.0048288051	98.3196182	1.61153746	0.0627619475	0.0231024139	0.00379317719	0.00317612523	0.00219958485
928.571411	0.00480855443	98.6448364	1.56864774	0.0681726038	0.0225412473	0.00417458033	0.00305591081	0.00196888228

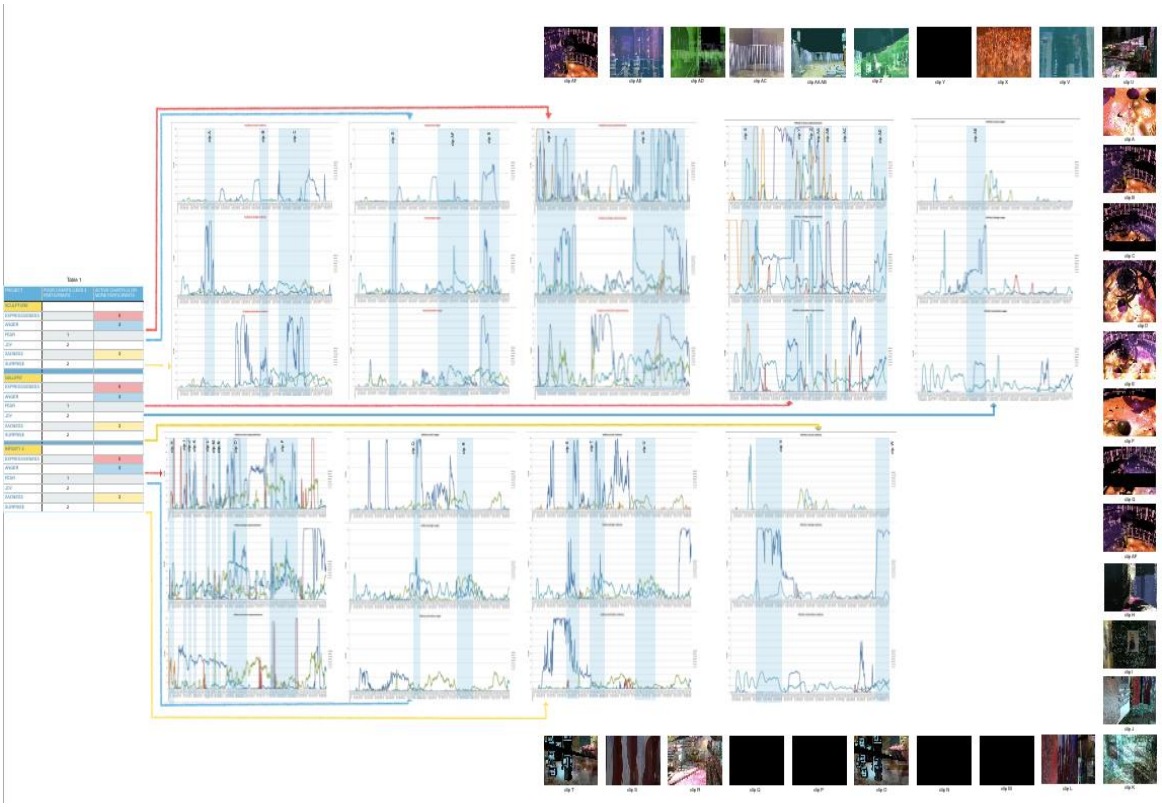


Figure 4: Sample of data collected from stage 1

1-5-2 Stage two

Synaesthetic scape 1—hypothesis and questions

'Using the virtual immersive technology will give users' perceptions a sense of reality of the space, and its immersive qualities will help achieve the 'Synaesthetic Scape' experience'.

- Will neutralising the effects of the design tools (light, colour, materials and textures), allow other qualities of the virtual reality design to be present? Will this improve the quality of the synaesthetic experience? What might those qualities be?
- Can the virtual reality design share the same design tools as real architectural spaces?
- Music was used to provoke emotions in this scape; will it also provide room for the participants' imaginative understanding of the 'Synaesthetic Scape'? (as in the first stage of experiments)

For this experiment, a combination of quantitative and qualitative methods were used in order to test the primary 'Synaesthetic Scape' environment. The experiment consisted of only one stage, unlike the first Sound Space experiment which consisted of two stages.

The Quantitative Method (E4 wristband)

The participants will wear an oculus kit (virtual reality kit to be worn on the eyes). The oculus kit will cover half of the participants' faces, which makes it impossible to detect their emotions from their facial reactions. Thus, there was a need to change the 'emotion as a service' method used in the experiment; the electro dermal activity detection device, known as the E4 wristband, will be used (see figure 5). This technology provides real-time data of the participants' arousal levels in order to derive features related to stress, engagement and excitement. For more information about how this technology works see: https://www.empatica.com/research/science/.

Figure 5: E4 wristband by Empatica, (https://www.empatica.com/research/e4/), Copyright © 2019 Empatica Inc. - ISO 13485 Cert. No. 9124.EPTC - All rights reserved

The Qualitative Method

Semi-structured interviews with participants.

Nature of data collected and analysed (see Figure 6):

1. Sketches showing how participants perceived the synaesthetic environment.
2. Before and after real time diagrams of the EDA (electrodermal activity) produced by participant engagement.
3. Screen recordings of the participants' 'Synaesthetic Scape' journey.
4. Audio recordings of the semi-structured interview.
5. Transcripts of the audio recorded.

1-5-3 Stage Three

‘Synaesthetic Scape’ 2—hypothesis and questions

‘Using real sounds in the virtual environment will reflect a realistic synaesthetic experience’.

- How might sounds influence users’ interactions with the ‘Synaesthetic Scape’?
- Will real sounds influence the emotions and imaginations of participants as the music did in the previous experiments?
- What are the differences between using real sounds, as the emotional and multi-modality medium of the space, and the music used previously for the same purpose?

Stage three methods

The same combination of quantitative and qualitative methods used in stage 2 are also used in the stage 3.

Nature of data collected

1. Sketches of what the participants remember from the previous ‘Synaesthetic Scape’ experiment.
2. Sketches of how the participants perceived the developed ‘Synaesthetic Scape’.
3. Before and after real-time diagrams of the EDA (electrodermal activity) produced by participant engagement.
4. Screen recordings of the participants’ ‘Synaesthetic Scape’ journey.
5. Audio recordings of the semi-structured interview.
6. Transcripts of the audio recorded.

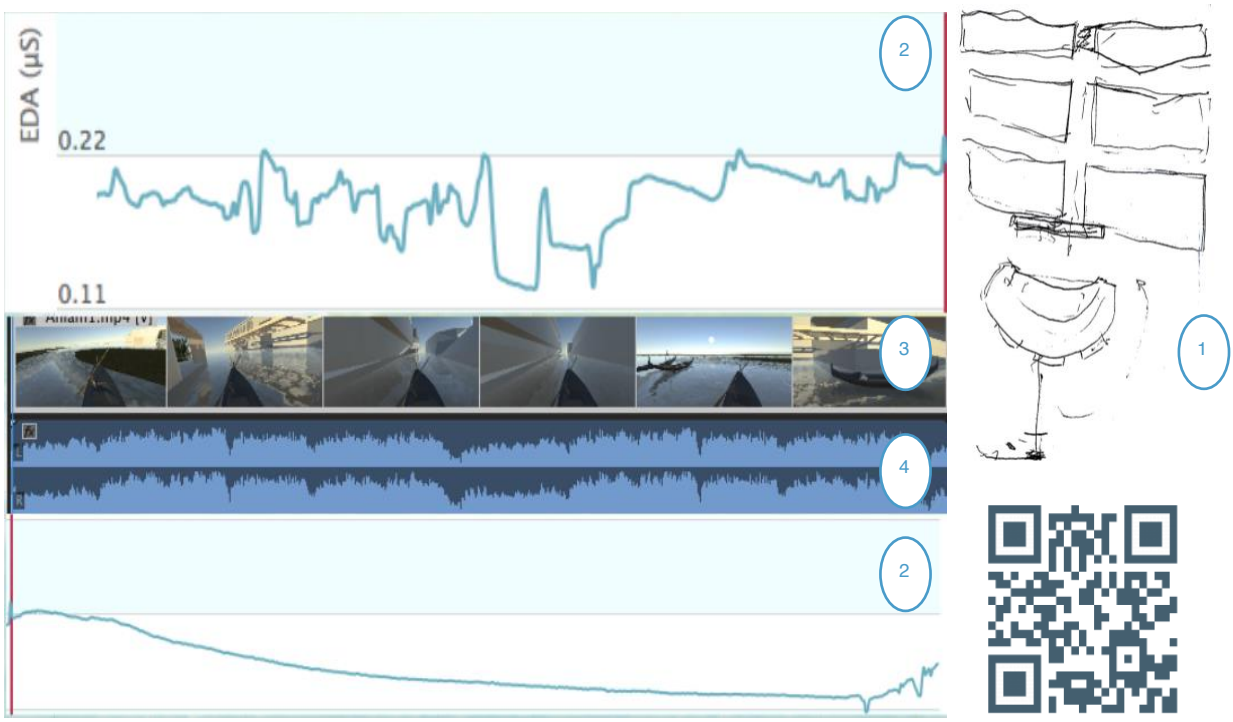


Figure 6: Sample of data collected from stage 2

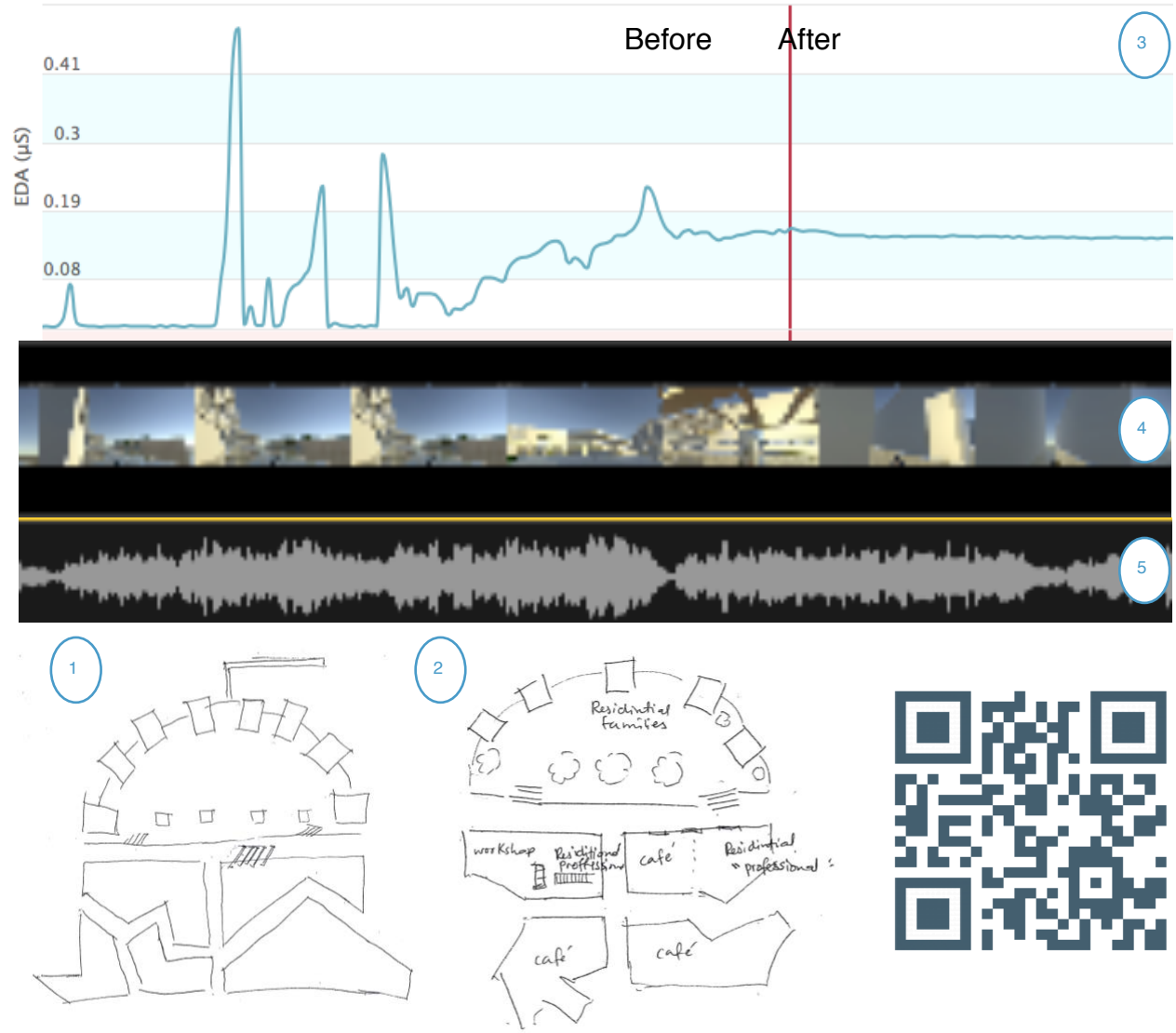


Figure 7: Sample of data collected in stage 3

Lexicons 1-6

'Synaesthetic Scape' making is a hybrid practice in which synaesthesia, aural architecture, soundscape, phenomenology of architecture, architecture, interior design, music and emotional experiences are all virtually merged together. The practice reveals that the majority of references discussing synaesthetic experiences seem to be located in fields that are adjacent to architecture. Therefore, there is a need to include a lexicon to this thesis which consists of those terms which are new to architecture.

1.***Aural Architecture:***

A. *"the human experience of a sonic process; hearing to the detection of sound and listening, to active attention or reaction to the meaning, emotions, and symbolism contained within the sound"* [14].

B. *"the properties of a space that can be experienced by listening"*[15].

C. creating a spatial experience where no physical space truly exists. So-named virtual, illusory and phantom spaces[16].

2. ***Multi-Sensory Design*** [17]**:** involving or using more than one of the senses.

3. ***Auditory Spatial Awareness:*** it is not only the ability to detect changing sounds in a space but also identifies the emotional and behavioural experience of space [18].

4. ***Inverted Perspective:*** *"visual perspective (as in Byzantine painting and medieval illumination) characterized by the divergence of parallel lines and diminution of objects toward the observer"* [19].

[14] Barry Blesser and Linda-Ruth Salter. *Spaces speak are you listening? Experiencing Aural Architecture* ,The MIT Press Cambridge, Massachusetts, London ,England 2007,p.5,
[15] Ibid, p.5
[16] Ibid, p.6
[17] English Oxford living dictionaries,2019,Multisensory, last accssed 25 May 2019. https://en.oxforddictionaries.com/definition/multisensory
[18] Barry Blesser and Linda-Ruth Salter. *Spaces speak are you listening? Experiencing Aural Architecture* ,The MIT Press Cambridge, Massachusetts, London ,England 2007,p.11
[19] The Merriam-Webster.com Dictionary, *"Reverse perspective"* Merriam-Webster Inc., https://www.merriam-webster.com/dictionary/reverse%20perspective. Accessed 5 December 2019

5. ***Soundscape:*** refers to the promotion of an 'Acoustic Ecology'; the idea's main concern is noise pollution. The founder of the term, M.Schafer, emphasised that, 'listening practice' should be developed in order to improve the world's soundscape. His aim was to make conscious decisions in the design process that affect the soundscape around us [20].

6. ***Soundspace:*** the concept of Soundspace is derived from Schafer's term Soundscape. This concept brings together critical perspectives in sound studies, architecture, planning and music in an effort to understand, respond to and engage with the built environment as a whole [21].

7. ***Sound Space*****:** is a term I proposed as the title of my master's project, This project was my first attempt of a 'Synaesthetic Scape' (pilot study). Sound Space is different from Schafers' term Soundspace as it involves establishing a creative and productive relationship between the sound and the space with respect to peoples' emotional experiences of sounds.

8. ***Thick Description:*** close observation to explain phenomena and analyse its context. In this kind of practice one can not only test the subject but also study the motivations and the contexts that affect behaviour, as well as environment [22].

9. ***Aural Architect:*** an architect who designs spaces using sound as an essential consideration. This is used in relation to Sound Spaces. Aural architects are mostly social and cultural forces rather than real people; the effects of these forces can be examined to see how much they influence the spatial design process [23].

10. ***Design Thinking:*** typically refers to solving problems through invention and improvement (in Architecture and Urban Planning] [24].

11. ***Sonic Thinking:*** thinking through listening [25].

[20]Ouzounian, G. & Lappin, S.A., 2014. Soundspace: A Manifesto. *Architecture and Culture*, 2(3), pp.305–316, p.305
[21] Ibid. p.305
[22] Ibid, p.308
[23] Barry Blesser and Linda-ruth Salter. *Spaces speak are you listening? Experiencing Aural Architecture*, The MIT Press Cambridge, Massachusetts, London, England 2007,p.5
[24]Ouzounian, G. & Lappin, S.A., 2014. Soundspace: A Manifesto. *Architecture and Culture*, 2(3), pp.305–316, p.310
[25]Ibid, p.310

12. ***Artificial Intelligence*** **(AI):** the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to projects which develop systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalise, or learn from past experience [26].

13. ***Virtual reality:*** the illusion of participation in a synthetic environment rather than the external observation of such an environment. It relies on three dimensional (3D), stereoscopic, head tracked display, hand and body tracking, and binaural sound. VR is an immersive, multi-sensory experience. Under this broad definition, VR also refer to virtual environments, virtual worlds or micro words [27].

14. ***Virtual heritage***:

    "is the use of computer-based interactive technologies to record, preserve or recreate artifacts, sites and actors of historic, artistic, religious and cultural significance and to deliver the results openly to a global audience in such a way as to provide formative educational experiences through electronic manipulations of time and space" [28].

15. ***Architecture parlante "speaking architecture":***

    this is a term used by theorists of architecture meaning *"architecture that explains its own function or identity"* [29].

16. ***Multimodality:***

    "Multimodal systems process two or more combined user input modes— such as speech, pen, touch, manual gestures, gaze, and head and body movements— in a coordinated manner with multimedia system output. This class of systems represents a new direction for computing, and a paradigm shift away from

[26] B.J. Copeland. *Artificial intelligence*, Encyclopaedia Britannica,Last updated: Apr 11, 2019, https://www.britannica.com/technology/artificial-intelligence

[27] Rae Earnshaw, *Virtual Reality Systems* ,Amsterdam: Elsevier Science, 2014, https://www.sciencedirect.com/science/article/pii/B9780122277481500093, p.3

[28] Stone, R. & Ojika, T., 2000. Virtual heritage: what next? *IEEE MultiMedia*, 7(2), pp.73–74. P.73

[29] Phrase was originally associated with Claude Nicolas Ledoux: one of the earliest French Neoclassical architects, its first use to an anonymous critical essay with Ledoux's work as the subject, written for Magasin Pittoresque in 1852, and entitled *"Etudes d'architecture en France".* https://en.m.wikipedia.org/wiki/Architecture_parlante

conventional WIMP interfaces. Since the appearance of Bolt's (1980)[30] *'Put That There' demonstration system, which processed speech in parallel with touch-pad pointing, a variety of new multimodal systems has emerged. This new class of interfaces aims to recognize naturally occurring forms of human language and behavior, which incorporate at least one recognition-based technology (e.g., speech, pen, vision). The development of novel multimodal systems has been enabled by the myriad input and output technologies currently becoming available, including new devices and improvements in recognition-based technologies"* [31].

17. ***Dramatic situation:*** *"is a situation, in a narrative or dramatic work, in which people (or "people") are involved in conflicts that solicit the audience's empathetic involvement in their predicament"* [32].

18. ***Attention:*** [33] can be defined as:

A. notice, thought, or interest.
B. to start to think about or consider a particular thing or person.
C. to watch, listen to, or think about something or someone carefully or with interest.

19. ***Tension:*** can be defined as:

A. *"a feeling of nervousness before an important or difficult event"* [34].

B. *"a feeling of fear or anger between two groups of people who do not trust each other"* [35].

C. tension also creates an anxious situation of anger and lack of trust between two groups of people.

[30] Bolt, R. A. (1980). *Put-that-there: Voice and gesture at the graphics interface*. Computer Graphics, 14 (3), 262-270
[31] Sharon Oviatt, *Multimodal Interfaces.* Center for Human-Computer Communication, Computer Science Dept. Oregon Graduate Institute of Science & Technology Beaverton, Oregon, USA, https://www.cogsci.msu.edu/DSS/2004-2005/Oviatt/Multimodel%20Interfaces.pdf, p.1
[32] Baker L. A. (2000); *Dramatic Situation/ Conflict,* Critical concept, last accessed 29th April 2019. http://www.k-state.edu/english/baker/english287/cc-dramatic_situation.htm
[33] Cambridge Advanced Learner's Dictionary & Thesaurus, Cambridge University Press, last accessed:16 April 2019, https://dictionary.cambridge.org/dictionary/english/attention
[34] Cambridge Advanced Learner's Dictionary & Thesaurus, Cambridge University Press, last accessed:16 April 2019, https://dictionary.cambridge.org/dictionary/english/tension
[35] Ibid.

D. *"tension is the suspense that holds an audience's attention as a performance unfolds. The release of tension may have a comic or a dramatic effect"* [36].

20. ***Conflict:*** may be defined as:

A. *"an active disagreement, as between opposing opinions or needs"* [37].

B. *"the forces that oppose each other to create the plot in a story, book, or film"* [38]. It can be expressed as an *external conflict which is considered to be "a struggle between characters or between characters and nature or society"* [39].

C. *"internal conflict: characters' struggles to change or understand themselves is internal conflict"*.

D. *"conflict generally occurs when a character cannot achieve an objective due to an obstacle. This obstacle may be internal or external and between characters or between characters and their environment. Conflict may be shown in a variety of ways, for example through physical, verbal or psychological means. Conflict may be embedded in the structure of the drama"* [40].

21. ***Illusion:*** "an idea or belief that is not true, or something that is not what it seems to be" [41].

22. ***The Shanasheel or Mashrabiya:*** *"Originally a place for drinking. Commonly used to designate windows or grills with latticed work screen of turned or carved wood. Mashrabiya were a hallmark of Islamic domestic architecture. These windows provided protection from the sunrays and offered privacy to women from passers-by "* [42].

[36] VCE Drama course (2019-2023*); Victorian Certificate of education: Drama; Study Design (pp.10),* last accessed: 5 December 2019, https://www.vcaa.vic.edu.au/Documents/vce/drama/2019DramaSD.pdf

[37] Cambridge Advanced Learner's Dictionary & Thesaurus, Cambridge University Press, last accessed 16 April 2019, https://dictionary.cambridge.org/dictionary/english/conflict

[38] Ibid.

[39] Ibid.

[40] VCE Drama course (2019-2023*); Victorian Certificate of education: Drama; Study Design (pp.10),* last accessed: 5 December 2019, https://www.vcaa.vic.edu.au/Documents/vce/drama/2019DramaSD.pdf

[41] Cambridge Advanced Learner's Dictionary & Thesaurus © Cambridge University Press, last accessed 16 April 2019, https://dictionary.cambridge.org/dictionary/english/illusion

[42] *The Glossary of Islamic Art and Architectural Terms.* Version II. December 1990. Creswell Library of Islamic Art and Architecture. The American University in Cairo, last accessed 7 January 2020, https://web.archive.org/web/20050305070342/http://www.aucegypt.edu/walking_tours/cairo/glossary/glossary.html

23. ***Colour:*** ***"***the quality of an object or substance with respect to light reflected by the object, usually determined visually by measurement of hue, saturation, and brightness of the reflected light" [43].

24. ***Hue:*** "commonly described as colour. This term describes the distinct characteristic of colour that separates for example, red from yellow, from blue. Hues are dependent on the dominant wavelength of light that is emitted or reflected from an object. Normal vision can differentiate between approximately 10 million different hues. From the colour spectrum, any pure hue/colour can be combined with white, black or grey to produce a tonal family" [44].

25. ***Colour Value:*** "the lightness or darkness of a colour; low value is dark; high value is bright" [45].

26. ***Colour Saturation/Intensity:*** "The equivalent terms "saturation" and "intensity" describe the strength of a colour with respect to its value or lightness. Or to put it another way, the intensity of a colour is its degree of purity or hue-saturation. For example, the colour of a geranium is more intense (more saturated with its red/orange hue) than that of mahogany" [46].

27. ***Colour Wheel:*** "a diagram showing colours in a circle so that you can see the relationship between them"[47].

28. ***Colour Scheme:*** There are certain colours which work well together, as decided by a long history of colour matching in design practice. It is especially used in interior decoration to draw attention or to create a certain mood within any design. In other words, it is a combination of two or more colours that go together in harmony[48].

[43]Dictionary.com Unabridged Based on the Random House Unabridged Dictionary, 2019. http://www.dictionary.com/browse/colour
[44]*Colour Glossary of Art Terms*, Definition/Meaning of Colour-Related Terminology, ENCYCLOPEDIA OF VISUAL ART, last accessed: 16 April 2019. http://www.visual-arts-cork.com/colour-art-glossary.htm
[45] Ibid.
[46] Ibid.
[47]Cambridge Advanced Learner's Dictionary & Thesaurus © Cambridge University Press, last accessed:16 April 2019, https://dictionary.cambridge.org/dictionary/english/colour-wheel
[48] Visualistan, *the-art-of-color-coordination*(2015), https://www.visualistan.com/2015/11/the-art-of-color-coordination.html

29. ***Zeitgeber:*** “A zeitgeber is any external or environmental cue that entrains or synchronizes an organism's biological rhythms to the Earth's 24-hour light/dark cycle and 12-month cycle” [49].

30. ***Kinaesthesia:*** “Sensation or perception of motion” [50].

A. “(physiology) the perception of the movement of one's own body, its limbs and muscles etc”[51].

B. “(performing arts) a spectator's perception of the motion of a performer, or, the effect of the motion of a scene on the spectator”[52].

[49] Ehlers, C.L., Frank, E. & Kupfer, D.J. (1988). Social zeitgebers and biological rhythms. *Arch Gen Psychiatry, 45*, 948–952, https://jamanetwork.com/journals/jamapsychiatry/article-abstract/494403

[50] Wiktionary; the free dictionary, last edited on 17 February 2019, https://en.wiktionary.org/wiki/kinesthesia

[51] Ibid

[52] Ibid

Chapter Two

Literature and Context Review

Establishing the Research Context

This chapter presents the research context for this study of Synaesthetic Scapes. It includes a survey of synaesthesia, aural architecture, sound studies, virtual reality, phenomenology of architecture, emotions associated with the experience of music and art and design practices. It reveals that the majority of references which discuss synaesthetic and aural experiences are located in the two fields of the phenomenology of the senses in architecture and soundscape studies. With the exception of acoustics, the majority of critical theory on sonic comprehension and sound can be found in areas adjacent to architecture, such as music, psychoacoustics, and soundscape studies. The original contribution of the research is to bring these different fields and areas together in the exploration of Synaesthetic Scape. Synaesthetic Scape is a hybrid framework that this research proposes in which these different fields and practices merge together in a virtual medium see Figure 8.

Synaesthesia 2-1

What is Synaesthesia?

Synaesthesia: In simple terms, the term means '*the union of the senses*' [63]. In clinical terms, synaesthesia is *'a neurological condition in which the stimulation of one sense produces experiences in a totally different sense'* [64]. Moreover, it is also defined as a crossing over of the senses. This is seen to '*occur through the associations of two or more physical senses and other sense modalities*' [65].

[63] Cytowic, R. E. (2002). *Synesthesia: a union of the senses*. Cambridge, Mass.: MIT Press, p.1
[64] Carlsen A., '*Some people really can taste the rainbow'*,2013, http://www.npr.org/sections/thesalt/2013/03/12/174132392/synesthetes-really-can-taste-the-rainbow
[65] Frascari, M., 2011. *Eleven exercises in the art of architectural drawing: slow-food for the architect's imagination*, London: Routledge. p.26

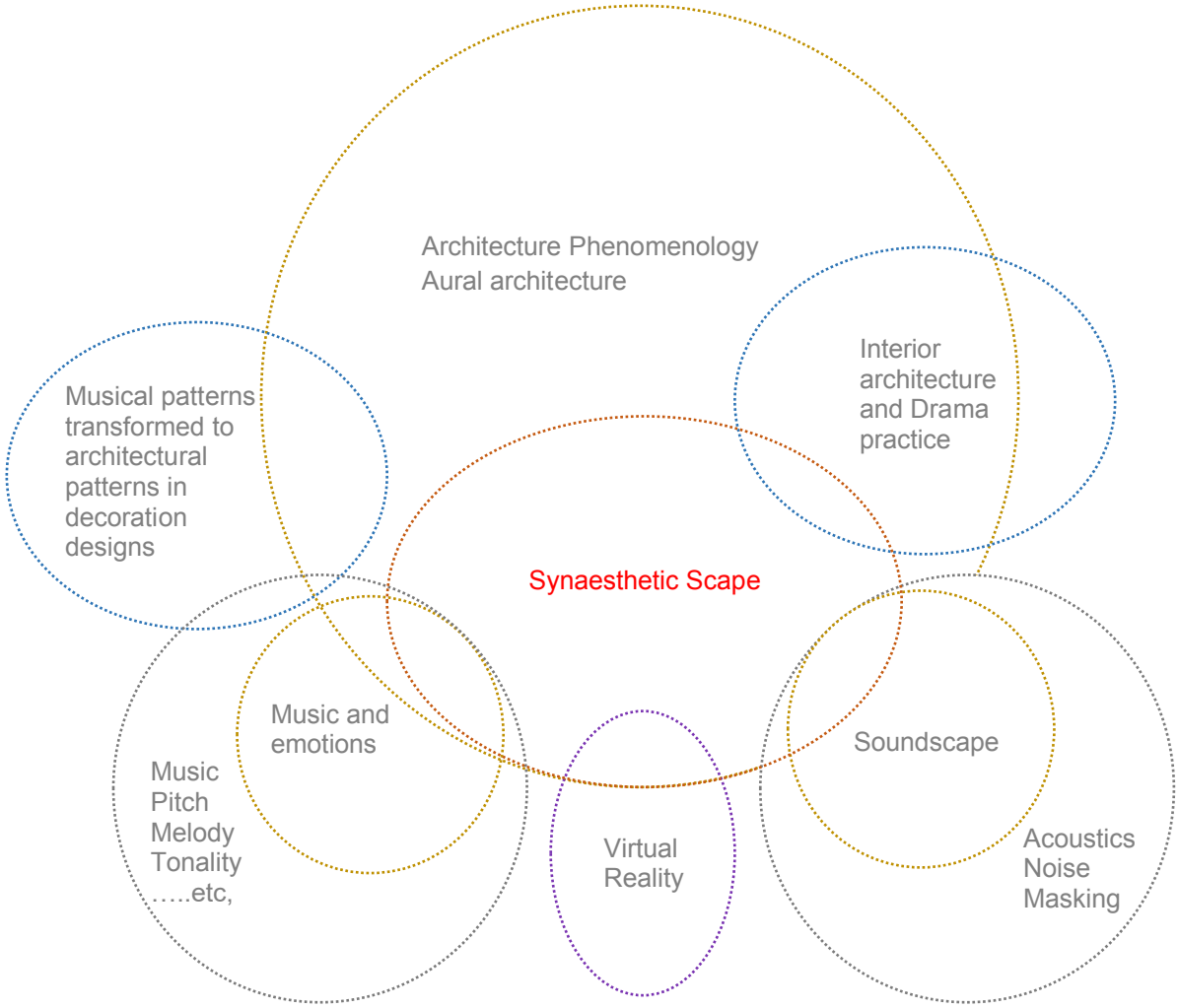


Figure 8: Synaesthetic Scape position accros the literature (designed by the researcher)

Synaesthesia is a blending of the senses, with 1 in 2,000 people potentially experiencing one form of it in their lives. People experiencing synaesthesia are referred to as syenaesthetes. Notably, in terms of prevalence, the female-to-male ratio is 3:1, which means that 75% of synaesthetes in the world are female [66].

Furthermore, all synaesthetes are left-handed since the condition is caused in the left part of the brain [67]. Synaesthetes can 'taste' shapes, 'hear' colours, smell colours or taste sounds. However, each synaesthete experiences synaesthesia in a totally different way. Following a '*peak of interest between 1860 and 1930*'[68], synaesthesia lost attention because of its subjective character, which made it unsuitable for scientific study. This was in a time when behaviourism was a dominating notion of interpreting what people do and also owing to the fact that the nature of behaviourism is based on observable behaviour. Therefore, behaviourism can be excluded from synaesthesia and cognitive science[69]. The absence of obvious agreement amongst synaesthete stories was enough 'evidence' that synaesthesia was not scientific enough to be studied [70].

Later, behaviourism started to fade and cognitive and multimedia studies took the lead in the world of psychology, with synaesthesia not considered an abnormal condition of the mind but rather '*as a norm of human perception, imagination and creativity*'[71]. Synaesthesia has also been considered *'a powerful variety of non-verbal thinking'* [72].

Synaesthesia is an emotional experience and is always *'accompanied by a sense of certitude (the 'this is it' feeling)'*[73], with synaesthetes always confident that what they see hear or smell is real and valid.

For centuries, this phenomenon has inspired artists and musicians to recreate sensations through sounds, colours, and shapes. In history, synaesthetic art has

[66] Travis, *Synaesthesia Statics*, Synaesthesia test, December 2011, https://www.synesthesiatest.org/blog/synesthesia-statistics
[67] Ibid
[68] Frascari, M. (2003). *'Architectural SYNAESTHESIA: a hypothesis on the makeup of Scarpa's modernist architectural drawings'* Academia.https://www.academia.edu/308741/Architectural_Synaesthesia_A_Hypothesis_on_the_Makeup_of_Scarpas_Modernist_Architectural_Drawings, p.1
[69] Amanda Steggell, *'Mind, the Gap. Synaesthesia and contemporary live art practice*', *Norwegian Artistic Research Programme*, 2015 (2015) https://www.researchcatalogue.net/view/148376/149033/0/0 [accessed 28/02/2019], http://www.testingtesting.org/synaesthesia/PDF/reflection.pdf, p.18
[70] Frascari, M. (2003). *'Architectural SYNAESTHESIA: a hypothesis on the makeup of Scarpa's modernist architectural drawings'* Academia.https://www.academia.edu/308741/Architectural_Synaesthesia_A_Hypothesis_on_the_Makeup_of_Scarpas_Modernist_Architectural_Drawings, p.1
[71] Ibid, p.2
[72] Ibid, p.2
[73] Ibid. p.2

referred to many artistic experiments that blend various art disciplines like, abstract painting and film, visual music, experimental theatre, science fiction, symbolist poetry, and electronic and generative art. The formation of synaesthetic art has frequently involved new inventions that can move the qualities of one sensory domain into another[74].

2-1-1 Synaesthesia and Art Practices

The term synaesthesia appeared in art approximately 100 years ago [75], and is used when referring to coloured and spatial images, those inspired by music, or through interactions between audio and visual arts.

Synaesthetes have a deeper experience of reality compared to others—arguably '*a richer synaesthetic capacity often means a stronger memory*' [76]. Synaesthesia as a 'condition is seven times as common in creative people as in the general population'[77], as stated by the neuroscientist Dr Ramachandran.

Through art, the synaesthetic experience becomes reachable, sharable, and blended with a personal vision [78] as mentioned by Dr Heyrman in his lecture (presented at the first International Conference on Art and Synaesthesia in 2005) [79] distinguished between 'personal synaesthesia' and 'created synaesthesia':

Personal Synaesthesia relates to natural-born synaesthetes where synaesthesia is an integral part of their perception.

Created Synaesthesia is the outcome of an artistic intent (a human-created form of synaesthesia)[80].

[74] Amanda Steggell, *'Mind, the Gap. Synaesthesia and contemporary live art practice.*', *Norwegian Artistic Research Programme*, 2015 (2015) https://www.researchcatalogue.net/view/148376/149033/0/0 [accessed 28/02/2019], http://www.testingtesting.org/synaesthesia/PDF/reflection.pdf, p.17

[75] 'Art and Synaesthesia: in search of the synaesthetic experience', by Dr. Hugo Heyrman; Lecture presented at the First International Conference on Art and Synaesthesia, Primer Congreso International sobre Artey Sinestesia, 25th - 28th July, 2005 - Universidad de Almería, Spain. http://www.doctorhugo.org/synaesthesia/art/index.html

[76] Ibid

[77] Ramachandran, Vilayanur & Hubbard, Edward. (2003). *Hearing Colors, Tasting Shapes*. Scientific American. 288. 52-9. 10.1038/scientificamericanmind1005-16, https://www.researchgate.net/publication/10800030_Hearing_Colors_Tasting_Shapes, p.57

[78] *'Art and Synaesthesia: in search of the synaesthetic experience*', by Dr. Hugo Heyrman; Lecture presented at the First International Conference on Art and Synaesthesia, Primer Congreso International sobre Artey Sinestesia, 25th - 28th July, 2005 - Universidad de Almería, Spain. http://www.doctorhugo.org/synaesthesia/art/index.html

[79] Ibid

[80] Ibid

2-1-1-1 Examples of personal and created Synaesthetic artworks as drawn from Heyrman;

Some general examples of Personal Synaesthetic Artworks include the following:

1. Wassily Kandinsky, a Russian painter and art theorist, was a synaesthete who used to hear tones and chords as he painted: for example, 'yellow is the colour of middle-C on a piano, a brassy trumpet blast; black is the colour of closure and the end of things'. His paintings, Compositions IV and VI in Figure 9A and 9B, are examples of how he used to paint what he heard [81].

2. American visual artist Melissa McCracken can see colours in sounds, and produced a number of paintings representing songs and musical pieces see example in Figure 10 representing her synaesthetic experience towards the song of *It's*

3. *Magic- Doris Day*.

Examples of Created Synaesthetic artworks include as drawn from Heyrman also;

1. Edvard Munch (1863–1944) Norwegian painter and printmaker. Heyrman considers that the painting in Figure 11 evokes a silent scream, she also said that '*Munch's expression of a 'synaesthetic experience' was taken to a hallucinatory level—a pictorial metaphor of primal fear: you scream and scream but no one can hear*'[82].

2. Meret Oppenheim (1913–1985) German-Swiss painter and sculptor. 'Fur Breakfast' or' Le Déjeuner en Fourrure' Figure 12, This work, a three-dimensional sculptural assemblage, was one of the sensations of both the Paris and New York Surrealist exhibitions in 1936. Heyrman considered this sculpture is as one of the artist's famous works of surrealism. She mentioned that It provokes the audience

[81] New world Encyclopedia, Wassily Kandinsky, last modified; 29th May 2014, http://www.newworldencyclopedia.org/entry/Wassily_Kandinsky

[82] '*Art and Synaesthesia: in search of the synaesthetic experience*', by Dr. Hugo Heyrman; Lecture presented at the First International Conference on Art and Synaesthesia, Primer Congreso International sobre Artey Sinestesia, 25th - 28th July, 2005 - Universidad de Almería, Spain. http://www.doctorhugo.org/synaesthesia/art/index.html

to imagine '*what it would be like to drink from a cup made of 'fur' and forces the anti-graceful sensation to focus on a mixture of senses'* [83].

[83] Ibid

Figure 9A: Composition IV, Oil on canvans by; Wassily Kandinsky (1911), Kunstsammlung Nordrhein-Westfallen, Dusseldorf, https://www.theartstory.org/artist-kandinsky-wassily-artworks.htm

Figure 9B: Composition VII, Oil on canvans by; Wassily Kandinsky (1913), *Tretyakov Gallery, Moscow* https://www.theartstory.org/artist-kandinsky-wassily-artworks.htm

Figure 10: It's Magic,Oil on canvas by Melissa McCracken (2017), Photographed by Melissa McCracken, solo exhibition; Convergence, Blue Gallery,Kansas City, MO, USA (2017), https://www.melissasmccracken.com/convergence

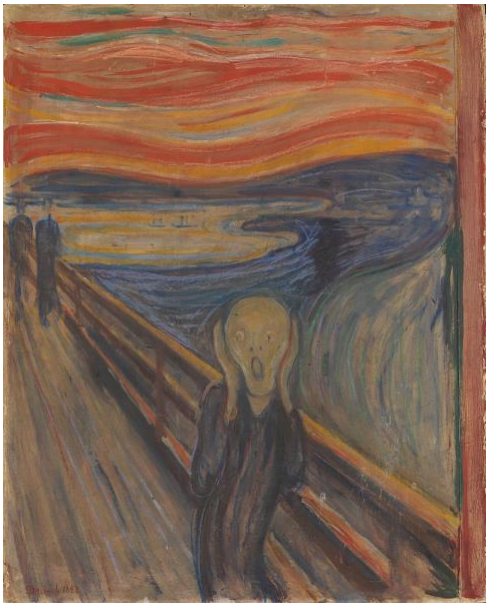


Figure 11: Edvard Munch, The Scream 1893 , Oil, tempera, pastel and crayon on cardboard, National Gallery and Munch Museum, Oslo, Norway,

https://en.wikipedia.org/wiki/The_Scream#/media/File:Edvard_Munch,_1893,_The_Scream,_oil,_tempera_and_pastel_on_cardboard,_91_x_73_cm,_National_Gallery_of_Norway.jpg

Figure 12: Le Déjeuner en Fourrure (Object), Meret Oppenheim 1936, Fur-covered cup, belongs to Museum of Modern Art, New York City collection, https://en.wikipedia.org/wiki/Le_Déjeuner_en_fourrure

2-1-2 Synaesthesia and the Architectural Practice

> *The passage of time; light, shadow and transparency; colour phenomena, texture, material and detail all participate in the complete experience of architecture.*[84]

Synaesthetic experience in architecture is presented in this research in terms of how a space is experienced and how, by being in a space, multiple senses come into play so as to actually understand and appreciate what the architect has intended the space to be and what he has designed.

Thus, the multi-sensory experience of architecture is what makes architecture a complete human experience through time. This blend of the sensory experiences and information received from the context frames the synaesthetic experience of architectural thinking. The research thinks of this experience as something that should be considered and explored during the early stages of any design, and when actually experiencing the designed work afterit has been constructed.

Architectural drawings are only the beginning of the experiences one can have of a building or architectural setting. An architect can think of the experiences and express them through drawings; the actual textures, sounds, smells, colours etc., which currently are experienced only when the building is actually constructed and one walks through it.

Architecture tends to be thought of in terms of its 'objects' rather than its experiences. The architecture of temples, cathedrals, civic buildings and palaces, often thought of as 'great architecture' has dominated architectural discourse. This architecture dominates the surroundings and the individual who experiences it. It triggers different senses leaving the individual in awe after he has walked through or experienced the building. Also vernacular architecture is readily understood as rooted in daily reality and not intimidating for the vistior. It is concerned with textures, the meeting of materials, and it also affects the senses.

In much the same way that 'great' architecture can trigger certain senses, this vernacular architecture also triggers senses but in a more subtle way. However this research is interested in the whole spectrum of senses called up by architectural experience and not in a particular style or form of architecture.

84 Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.41

The Suq al Safafeer market in Baghdad (Figure 13) is an example of synaesthetic architecture. Whenever you say Suq al Safafeer, you will immediately picture a long street full of shiny copper houseware, and you can feel the vibration of sound waves in the air; the sound of banging on cooper sheets is what gives this market its synaesthetic character '*bangs on copper symphony'*, as the locals in Baghdad say.

The essence of architecture cannot be completely understood and appreciated by only looking at it. Rather, there is a need for you to need to, feel it, smell it and touch it. You simply need to experience it through all the senses.

The majority of modern contemporary architecture relies on visual stimulations and, according to this, the uniqueness that comes from other senses in the architectural experience has been neglected. These designs, as Pallasmaa stated, 'attempt to conquer the foreground instead of creating a supportive background for human activities and perceptions' [85]. Such designs tend to promote bold visual contributions to their contexts. However, once visiting them, they can simply turn into empty shells. They are also considered to be an '*inappropriate noun in the narrative of the street scape'* [86].

My proposed Synaesthetic Scape can be considered a call to re-invest in the potential of multi-sensory design. The research explores Synaesthetic Scape in a virtual environment so as to be able to study the possibilities of this medium for the representation of an architecture of the senses (Figure 14).

Synaesthetic Scape is a virtual envelope where sensation, perception and emotions are all blended within a new synaesthetic experience in architectural practice. As Christopher Day has stated:

> *'We need to wake up our senses, the gateway between external reality and our inner feelings. Our senses tell us about what is important in our surroundings. Mostly, we experience things through the outer senses: sight, smell, taste, sound, warmth, touch. Architecture, in the sense of environmental design, is the art of nourishing these'.*[87]

[85] Pallasmaa, Juhani. (2000). *Hapticity and Time*. *Notes on Fragile Architecture*. The Architectural Review. 207. 78-84, 8th page.
[86] Budarick, J. (2011). *Synaesthetic architecture: the lost senses of architecture*, The university of south Australia, Australia. P.5
[87] Day, C. (1990). *Places of the soul: architecture and environmental design as a healing art*. Wellingborough: Aquarian.p.73

Figure 13: Souk al-Safafeer, Baghdad's coppersmith souk: A fading cultural treasure, article by; Arwa Ibrahim on 7August 2018 for the Al Jazeera news, photographer; Rayhan al-Mosully, copyrights for Al Jazeera.com, https://www.aljazeera.com/indepth/features/baghdads-coppersmiths-souk-fading-cultural-treasure-180807154654759.html

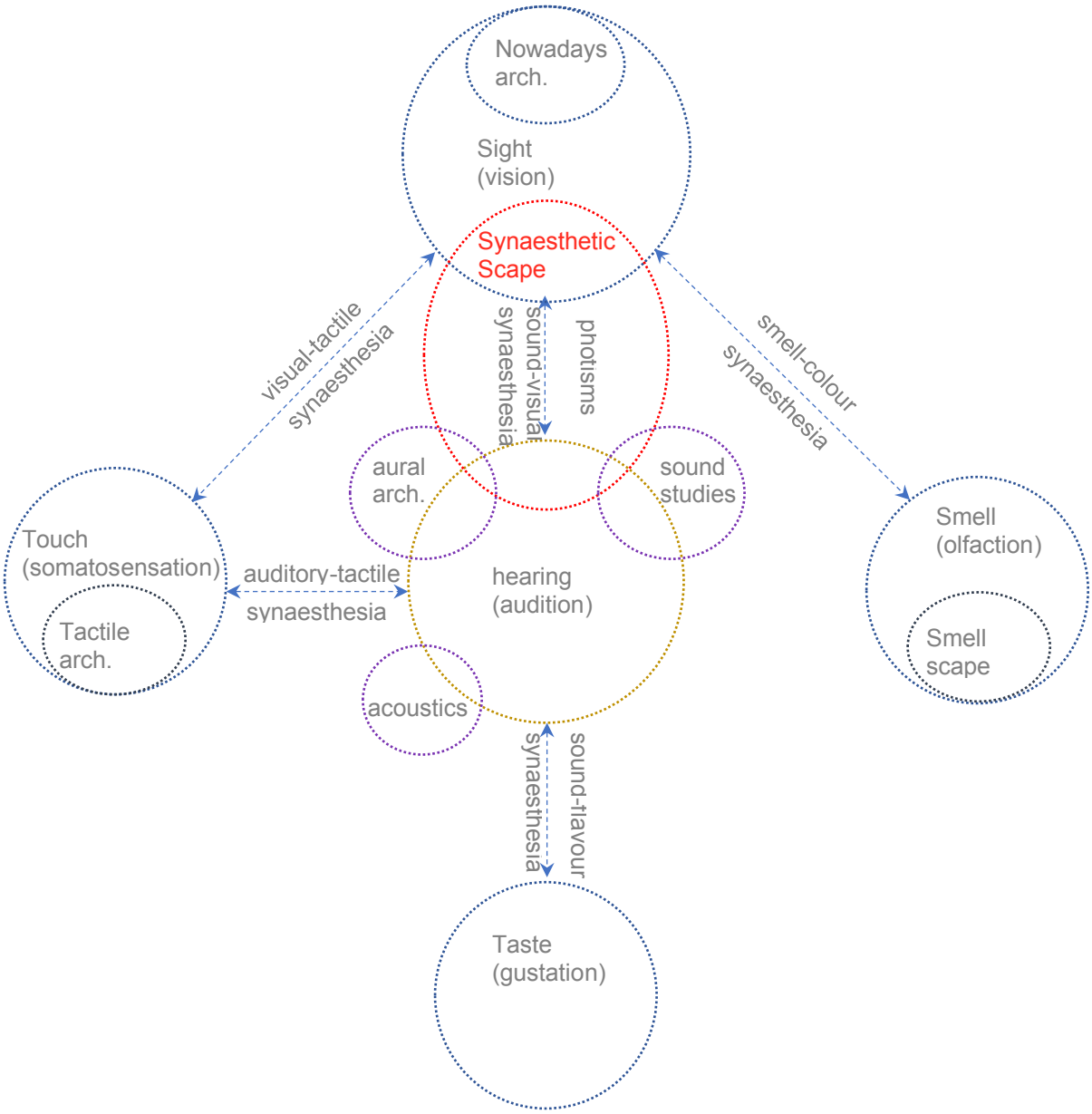


Figure 14: Synaesthetic experience in architecture
(designed by the researcher)

2-1-3 Synaesthesia and Architectural Drawings (Frascari's Ideas)

Frascari's ideas about implementing Synaesthesia in architectural drawings is one of the main two ideas underpinning this research, both intellectually and practically, as mentioned earlier in the introduction. Accordingly, this section will discuss Frascari's ideas and how they will be deployed in this research.

Frascari's article, '*Architectural synaesthesia: A hypothesis on the makeup of Scarpa's modernist architectural drawings*', published in 2003, introduced the term 'synaesthesia' to architecture in his discussion of architect Carlo Scarpa's drawings. Frascari encouraged architecture students to implement Synaesthesia as a cross-sensory mode in their architectural drawings following the influence of Carlo Scarpa's architectural drawings, which he believed to be sensory simulating drawings according to their use of technics and materials. Later, in his book *'Eleven Exercises in the Art of Architectural drawing; slow food for the architect's imagination',* published in 2011, Frascari extended his recommendations. In this book, he proposed eleven exercises to be taught in schools of architecture in order to help students design new synaesthetic ideas. here I mean by saying synaesthetic, the sensory interaction with drawings as well as being emotionally engaged with the process of design thinking. Importantly, emphasis is placed on encouraging the designer to be immersed with all of his senses with his non-trivial drawings—'*a way of making such that, while one makes, one invents the way of making*' (Pareyson, 1954, as quoted by Frascari [88]). Notably, with this proposal Frascari hoped to enhance the design thinking of students to enable more creative designs by establishing a new immersive relationship with their drawings through the use of innovative tools.

The process of architectural design produces two types of drawing according to Frascari:

The first are those that are conceptual brainstorm-related, which are intended to represent the designer's ideas or reflection of the designer's imagination (concept sketches, models, etc.). They normally do not have to follow any role or certain graphical techniques or certain materials or colours; they simply express the designer's feelings on paper with pencils, markers, colours and all sorts of graphic techniques.

[88] Frascari, M., 2011. *Eleven exercises in the art of architectural drawing: slow-food for the architect's imagination*, London: Routledge. p.15

There are no standard codes to follow, and they are basically related to the early stages of the design process.

The second type of drawing, on the other hand, comes in the latter stages of the design process, and intended to represent the findings of the design research or brainstorm (communication sketches for clients and building processes). They follow standard architectural codes of 2D or 3D presentations, which are plans, site plans, sections, elevations (facades) and perspectives, etc.

Conceptual sketches relate to emotions, whilst communication drawings mainly convey information do not necessarily have to be drawn by the architects themselves, wheras conceptual drawings are produced by the designers themselves. Frascari referred to conceptual drawings as ‘non-trivial drawings’, whereas communication drawings were referred to as ‘trivial drawings’.

Thus, Frascari’s book is mainly concerned with non-trivial drawings and the relationship between thinking and drawing or designing and drawing; Although, the book does suggest students use, it is applicable for use by university academics, as well as designers or anyone interested in the design topic.

The 11 exercises proposed by Frascari are outlined in brief by the researcher as follows:

1. *Food Colours*: instead of dipping your brushes or nibs in prepared store inks, use food colouring, juices, edible liquids, pastes and powders.

2. *Tools*: complete the construction of your own drawing tools (pencil or any industrial produced tools are not allowed) using paperboard, lightwood, metal or any other suitable material to do so. Use paperboard edges to draw lines (these do not have to be straight) and make your own compass.

3. *Improper drawing*: use design tools in an improper way, such as using a pantograph made in the previous exercise, for example. Alter the ration of its connected arms and draw with it. Alternatively, if you are using computer software that has in-built parameters, try to create your own characteristics and start drawing for a different level.

4. *Spolia*: a collage of different materials.

5. *The drawing of scale figures*: 'the man is the measure of all things' (Protagoras, a pre-socratic philosopher, as quoted by Frascari, 2011, p. 84). This proposes that embodiment is a way for establishing a proper architectural composition and elegant drawings. 'Architectural drawing [….] are not representations as photographic, artistic or commercial representations. They belong to a specific category of embodiment that makes architectural ideas possible since architecture itself is not disembodied, but rather arises from the coalescing of our and bodily experience'. Moreover, 'we need a body to build and inhibit architecture' [89].

6. *The mosaic*: 12 individual items of 70cm x 100cm double-ply Bristol boards necessary to portray a building on the scale of 1:1. Use strings to create a vertical and horizontal reference lines for the drawing, starting from the centre of the board.

7. *Hybrids*: mixing mediums. For example, start your drawings on paper and transfer them to digital software and then back to paper, or use printed images or scanned drawings, and apply handmade parts and repeat printing and scanning, whilst adding drawings to create something new.

8. *Blind drawing*: drawing for a blind person to read. No model-making but rather draw with raised lines and minimal textures to give meaning to those drawings.

9. *The single drawing*: in this exercise, it is mandatory to fit the whole developed design in one single drawing.

10. *Icons:* Inverted perspectives[90] are used in drawing some of the Byzantine and Russian icons, where you can see the surrounding objects and buildings in the background, this practice of an inverted perspective drawing provided visual effects which were important in these icons[91]. The aim of this exercise is to use inverted perspective to draw the interior of the building or the building elements and then draw a plan, section and elevation in CAD as if the inverted perspective is the correct representation of the building elements or the building itself[92]. 'In architectural drawings consciousness deals with this duality of perception and

[89] Frascari, M., 2011. *Eleven exercises in the art of architectural drawing: slow-food for the architect's imagination*, London: Routledge. p.5
[90] For definition and reference see Lexicon
[91] Frascari, M., 2011. *Eleven exercises in the art of architectural drawing: slow-food for the architect's imagination*, London: Routledge. p.164
[92] Ibid. p.165

imperception, split between the image of what has been directly perceived and the image of the indirectly perceived, through the intermediary of sensations.'

11. *Verso-Recto*: paper and cards are really 3D objects, and drawings on them are 3D as well; we tend to forget that paper has a thickness (three-dimensional) and can therefore absorb watercolour or ink, creating different effects on each face or side of the paper. Interestingly, things can take place between the sides of a card or a paper. Simply add another layer of paper on top and try to trace what you see fit before drawing on top of it again. In this way, drawings will evolve in an inspiring way. You can use as many layers as you see fit. Another way of doing this is through the use of a very heavy tracing paper or a light table.

2-1-3-1 Themes derived from Frascari's book

Many different themes and ideas were proposed in Frascari's book. These were an important starting point for the research on Synaesthetic Scape and will be discussed in the following sections.

'Slow vs Fast Food'—The Relationship of Digital and Non-Digital Drawings and Design-Drawing Tools

Slow vs Fast Food

'Slow food for the architect's imagination' is a refreshing reminder that the idea of architecture is not a building. In order for architecture to exist in human consciousness, someone has to draft a story. As such, by definition, a story needs time to be conceived, imagined, construed, constructed, experienced and shared' [93] .

[93] Frascari, M., 2011, reviewed by; Sabini, M.; *Eleven exercises in the art of architectural drawing: slow-food for the architect's imagination*, last acced: 21th April 2019, http://interstices.aut.ac.nz/ijara/index.php/ijara/article/viewFile/138/197

The above quotation comes from a review of Frascari's book by M Sabibi. The slow drawing skills teaching process describes the time taken to teach students the drawing skill. The slower the lessons move, the more progress the students achieve in their drawing skills. Students need time to digest the information fed by their tutors. In the design process of Synaesthetic Scape, the iterate manner of testing the VR design with participants makes it a slow process that matures with time; thus, it is like applying Frascari's proposed slow food idea to the researcher's design conceptual process.

Digital vs Non-Digital Drawings

Nowadays, digital drawings have the upper hand in terms of both of the architectural academic and practice sectors. They are favoured for their visual atractive influence and noted for their time-consuming quality. Sometimes, freehand drawings are much more efficient and quicker to be produced, yet freehand is becoming less and less attractive as a skill to architects, particularly junior ones—a skill that seniors will also have lost because of the excitement about computer technology was paramount in their youth. This is close to what Frascari is highlighting in his book, However the technology of VR—which this research is keen to explore—understands this to be Frascari's aim in his book, i.e. establishing synaesthetic technics to immerse architects with their designs in the conceptual early stages of the design process so as to enhance the creativity and imagination of architects. Here, the research question is posed as to how design can be carried out in a synaesthetic way in a VR medium? Moreover, in this way, the research argument centres on Frascari's ideas that VR can achieve his aim of immersion both in the earlier stages of design and the later stages of evaluation, where users are involved. The research will therefore expand on Frascari's ideas so that it will be directed not only towards architects and the development of their representational tools but also to users, allowing them access to the qualities of synaesthetic immersive sensory experience at the design stage.

Design/Drawing Tools

Amongst Marco Frascari's eleven exercises, three are concerned with the importance and influence of the drawing tools and representation techniques on the design process and result. This is an argument that has been discussed in-depth amongst

architects; otherwise stated, how and how much do the means of drawing (hands, 2D, 3D, CAD, etc.) influence the shape and form of architecture?

Frascari suggests trying to draw with crooked rulers, non-straightedges, and bent squares, etc., with the aim of building new tools to find new forms. Moreover, he advocates playing with representation techniques: imagining, as an example, that a reverse perspective is the natural view of a true space.

This research would like to consider that new tools are constructed only when the need for them arises, technology thus being a mere consequence of imagination, the necessary step to make desire come true.

Most of us are subject to the technical possibilities offered to us; in other words, the instruments acting as a motor for inspiration. This is why experimenting freely with available tools can produce interesting results. When the tool is eventually modified according to chosen rules, then a two-way relationship is settled between drawing and design. This applies to 2D and 3D generated images, where the results are always an image out of a printer. In VR, things are slightly different, and computer parameters are not completely fixed, with users still enjoying the ability to change the parameters of the design elements of light colour and materials, as well as sound parameters, which makes the space for the designer to manoeuvre much more than other 2D and 3D computer softwares.

This is all to be explored and evaluated in the design of Synaesthetic Scape experiments.

2-2 Soundscape

In the 1960s, Murray Schafer developed the idea of Soundspace, which promotes the ideas of 'acoustic ecology'[94]. He was focused on the problem of noise pollution, with the main aim of his work focused on encouraging 'listening practice'. Notably, he proposed that developing listening practice will improve the world's soundscapes.

2-2-1 Soundscape Practices in Arts and Architecture

'*Soundspace: A Manifesto*' by architectural theorists Ouzounian & Lappin, (2014) derived the concept of Soundspace from Schafer's previous aim. This concept brings together critical perspectives in sound studies, architecture, planning and music in an effort to understand, respond to and engage with the city's built environment as a whole. The impact of Soundspace has changed the ways in which bodies and space interact, combining categories and also questioning the boundaries between those categories; the manifesto edict is 'learn how to listen'[95]. In their manifesto, Ouzounian & Lappin completed a survey considering all the sound studies and soundscape studies. They classified these studies into a list of short phrases regarding their relevance to an idea or a subject. These phrases were an important inspiration for this research and are explored in the following paragraphs:

Learn How to Listen:

The first thing that comes to my mind when the word *listen* is mentioned is 'silence' or the 4'33 piece composed in 1952 by the American composer John Cage. Cage was one of the first artists to explored and presented the act of listening to modern sound studies, in which he considered sound as an actor in space and asked people to listen to the surrounding sounds and enjoy them as they are [96].

Take the People Out:

[94] Ouzounian, Gascia; Lappin, Sarah A. *'Soundspace: A Manifesto'*,Bloomsbury Journals (formerly Berg Journals),Architecture and Culture, Volume 2, Number 3, November 2014, pp. 305-316(12), p.306
[95]Ibid. p.305, p.306
[96] CAGE, J. (1973). *Silence: lectures and writings*. Middletown, Conn, Wesleyan University Press.

In the late 1960s, Max Haus, in his series of participatory works entitled simply *Listen*, invited the audience to a concert hall where they expected to hear a concert; however, he directed them away from the auditorium to the outside, where he then asked them to do 'listening walks' without saying a word. His aim was to get them to listen to the sounds around them. According to his opinion, this act of focused listening can change people's listening habits. In order to achieve this change, he considered that composers should not bring new sounds into the concert hall and that they must take the people out instead[97].

Similarly, architects and planners should study the challenges in which people understand, experience and engage with the environments they inhabit so as to improve the overall quality of the soundscapes of a built environment. A Soundspace involves becoming 'attuned' towards an environment and 'tuning into architecture' [98].

Listen Deeply:

Pauline Oliveros established the term 'deep listening' [99], referring to a meditative listening practice. Soundspaces work with active listening modes, drawing attention to processes of listening as creative ways of engagement with a space.

Take the Sound of the Room Breathing:

In 1963, Yoko Ono composed *Tape Piece II: Room Piece*, where the score reads: '*take the sound of the room breathing throughout the day at different times: at dawn, in the morning, afternoon, evening and before dawn*. *She also bottled the smell of the room at those hours*'[100].

The composer referred here to the voice of the room as a breathing, living element as it was seen to evolve throughout the day. She considered the space itself as the primary creative agent and not the performer, with her role to observe and document. Similarly, a Soundspace does not necessarily mean producing sound in a space; rather, it establishes

[97] Ouzounian, Gascia; Lappin, Sarah A. *'Soundspace: A Manifesto'*,Bloomsbury Journals (formerly Berg Journals),Architecture and Culture, Volume 2, Number 3, November 2014, pp. 305-316(12), p.306
[98] Ibid. p.307
[99] Ibid, p.307
[100] Ibid. p.307

a more productive and creative relationship between sound and space, as the researcher of this work is proposing in Sound Space the first pilot study which will be explored deeply later in chapter 3.

Listen Thickly:

Clifford Geertz is an anthropologist who coined the notion of ‘thick description’ and called for close observation in order to explain phenomena and analyse context. In this kind of practice, one cannot only test the subject but should also study the contexts and motivations influencing behaviour, as well as the environment.

Listening thickly involves hearing the social, political and cultural context of sounds, which are reflected in the sonic environment and must be considered in the process of design thinking and planning [101].

Listen Through History:

Emily Thompson, an aural historian, asks architectural historians to listen to and to look at buildings of the past. Cultural historians should analyse the aural histories of a place in order to reveal less concrete notions of past architecture used in sound recordings. More recently, urban sonic environments have been documented and archived—not only through the use of recording devices but networks and mobile technologies have also played a basic role in presenting new aural artefacts that invite new modes of historical and cultural analysis [102].

The Montréal Sound Map by Max and Julian Stein (2008–ongoing) gives anyone access to the recording of the Montréal soundscape on an interactive website. The recording can be used to study the urban composition and the aural geography of Montréal [103].

[101] Ibid. p.308
[102] Ibid.p.308
[103] Ibid. p308

The London sound survey by Ian Rawes is another type of aural mapping, featuring an ‘all in one London map’, which is a combination of historical and contemporary sound maps of London through time and space [104].

Open Out:

In 1984, Shuhei Hosokawa asked city planners to not only think about the spatial dimensions of the city but also to engage more with the sounds heard by the city inhabitants. Further, in 1996, Juhani Pallasmaa called for phenomenologically driven architecture in relation to sound [105].

Think of All the Sounds like They are a Symphony:

In 2004, Janet Cardiff produced an audio walk for Manhattan’s central park sound maps. ‘In Her Long Black Hair’ is a recording of Cardiff’s voices accompanied by pre-recorded sounds of traffic, ambulances, street music, people’s footsteps and horses in the street, and mechanical sounds. These pre-recorded sounds, as heard through headphones, merge with the sounds happening in the real space. These spaces are multiplied through Cardiff’s narrative, which spans the past, present and future, as well as real and imagined spaces. Listeners were cautioned that they have to think of all of the sounds like they are a symphony, otherwise they would go crazy [106].

What is considered noise for one listener might be a symphony for others. Architects should deal with the multiplicity of sound spaces in urban environments and how to engage with them in urban designs.

In relation to thinking about listening, the use of the illusory qualities of sounds and images can challenge the preconceived notions of space and reality the work of Janet Cardiff and George Bures Miller was exhibited as part of an exhibition named ‘Listening’ at the Site Gallery, Sheffield, 11 April–30 May 2015 [curated by Sam Belinfante]. These two artists are known for using specialised binaural recording techniques to conjure up three-dimensional spaces. In their ‘Sound in Cabin Fever’ (2004), footsteps and conversations

[104] Ibid. p.309
[105] Ibid. p.309
[106] Ibid. p.309

magically surround the viewer and seemingly extend far beyond the physical limits of the work.

Janet Cardiff and George Bures Miller incorporated audio tracks with installations to create three-dimensional spaces with sound. Cardiff and Miller's chosen painting was Antonello da Messina's *Saint Jerome in his Study* (c. 1475), as part of an exhibition named 'Soundscape', which took place in London at the National Gallery from 8 July–6 September 2015.

Think Sonically:

Jonathan Sterne states that sound studies begin by studying sonic phenomena, such as speech, sound technologies, hearing, music, art and architecture, for example, and may involve thinking sonically, although it does not have to [107].

Soundspace, urban planning and architecture must not only deal with concepts and methodologies in the design process; they should also adopt new modes of thinking.

Roy Hyde (2012) discussed alternative practices and spatial design, yet just a few planners and architects have sought to practice these ideas in relation to sound. 'Design thinking' in architecture and urban planning typically refers to experiencing problems and solving them in terms of invention and improvement. In music and sonic arts, thinking is directed to non-limited possibilities of making decisions in musical moments, forms, conditions, etc.

Sonic thinking is entirely different: this may involve receptive and responsive thoughts influenced by focused listening; sonic thinking is thinking through listening [108]. It is not definitive or perceptive; it is alive, ready to be changed, responsive, aware, and highly connected.

Brandon LaBelle argues that sonic thinking operates through a network of animated forces and it is not possible to think in isolation.

[107] Ibid. p.310
[108] Ibid. p.310

Live the Soundspace:

Soundspaces are, by nature, alive, changeable, and open to movement and evaluation in the planning and design process [109]. They make spatial designers take into account the unknowable, and ask how their practice can deal with the uncertain. As described by LaBelle, their practice involves a steady web of interferences. This works in an acoustic paradigm.

On another words, a Soundspace is a tuning of architecture towards an environment where the sound cues gives the built environment or the city soundscape its character and identifies its cultural identity it is a call to architects to bear in mind these cues [mostly acoustic]. It is about establishing a more productive and creative relationship between sound and space (mostly in the urban environment).

It's worth mentioning here that the term Sound Space I used to call my first attempt of Synaesthetic Spcape (pilot study) with is however different from Schafers' term of Soundspace proposed in 1960s since the term Sound Space I'm proposing involves establishing a creative and productive relationship between sound and its space with respect to peoples' emotional experience with sounds.

A good example of Soundspace within the acoustic paradigm is a collaborative project that took place in 2016 between the acoustic team in School of Architecture, University of Sheffield and the department of Energy, Politecnico di Torino, Torino, Italy by the research team (Aletta, Kang, Fuda & Astolfi). The research studied the effect of the use of different footpath materials in an urban context on the soundscape quality and walking quality perception [110]. They found that different walked-on materials used for footpaths in urban parks had a remarkable influence on the participants' perceptions and haptic comfort in the sound scape environment. They further examined the effects of the use of four materials (grass, wood, gravel, and stone), with grass found to be the most favoured material whilst gravel was the least favoured material to be used in paving footpaths, according to the recommendations of 88 participants for both haptic and auditory sensations.

[109] Ibid. p.310

[110] Aletta et al., 2016. *Differences in soundscape appreciation of walking sounds from different footpath materials in urban parks. Sustainable Cities and Society*, 27(C), pp.367–376. https://www.sciencedirect.com/science/article/pii/S2210670716300336?via%3Dihub

2-2-2 Soundscape and Virtual Reality

Soundscape studies have also recently started to adapt the VR technology and involve users in perceiving different soundscape situations and being involved in evaluating the sonic elements of those environments [111]. Here, VR is used to develop soundscape environments in the early stage of their soundscape acoustic design.

This approach is close in concept to that which Synaesthetic Scape proposes as a research, However, Synaesthetic Scape has more advanced steps in the process of using the VR immersive technology in the architectural design.The research also explored and benefited from the sensory experiences of the participants, whilst the soundscape virtual application has focused mainly on responses to sounds, affecting the sonic and acoustic environment design appraisal.

In consideration of the above, the following will provide a brief discussion on this new technology adaption.

In the journal article entitled '*The Effect Of 3D Audio and Other Audio Techniques on Virtual Reality Experience*', as published in the *Annual Review of Cyber therapy And Telemedicine* 2015 (pp. 44–49)[112], authors Brinkman, Hoekstra & van Egmond explored the use of different audio techniques in enhancing users' virtual immersive experiences in a three-stages test (The Wasp Virtual Experiment):

Stage 1: exposing participants to a wasp sound in four different formats, namely mono (1-channel), stereo (2-channels), Dolby surround (multiple-channels) and 3D audio (realistic audio representation); this was done so as to test whether participants could highlight the difference between the sounds.

Stage 2: exposing participants to a blind test where the previous four wasp sounds are heard but, this time, with a testing of feelings of anxiety, presence and spatial perception.

[111] Echevarria Sanchez et al., 2017. *Using Virtual Reality for assessing the role of noise in the audio-visual design of an urban public space*. *Landscape and Urban Planning*, 167(C), pp.98–107. p.99, http://isiarticles.com/bundles/Article/pre/pdf/148336.pdf

[112] Brinkman, W.-P.P., Hoekstra, A.R.D.R. & van Egmond, R., 2015. *The effect of 3D audio and other audio techniques on virtual reality experience*. *Annual Review of CyberTherapy and Telemedicine*, 13, pp.44–48. https://www.researchgate.net/profile/Brenda_Wiederhold/publication/291165363_Annual_Review_of_CyberTherapy_and_Telemedicine_Virtual_Reality_in_Healthcare_Medical_Simulation_and_Experiential_Interface/links/569e994208ae21a56424cb35.pdf

Stage 3: exposing participants to a virtual environment, consisting of 3D wasps flying in an in-door town hall environment, as taken from the Vizard tutorial on stereoscopic panoramas. The same wasp sounds are then played in combination, this time to test the effect of those different sounds on anxiety levels and the feelings of presence and the spatial perception for participants.

The methodology in this research was quantitative whilst the methods were centred on measuring participants' heart rates whilst also completing tests and a questionnaire afterwards. The conclusions of this study can be summarised into four points, as follows:

1. Participants could tell the difference in sound format when listening to them and, accordingly, their experience was different with each sound.
2. Sound alone can cause anxiety.
3. Sound enhances the virtual experience for participants.
4. No difference was witnessed between the use of stereo sounds or 3D audio upon the users experience in the virtual environment or to visual stimuli when combined with sound.

Another research worth mentioning here comes from a conference paper entitled '*Integrating Artificial Intelligence with Virtual Reality for Soundscape Appraisal'*, which discusses a research project by Professor To (Macao Polytechnic Institute, Macao), Andy Chung (Macau Instituto de Acustica, Macao) and Iris Vong (DingDingSound, Macao)[113].

In this soundscape, ongoing research project researchers study the possibility of developing a new generation of soundscape design VR application combined with AI (artificial intelligence) elements to crowdsource urban soundscape designs and appraisal for a better urban and soundscape designs. Here, it is relevant that the new term 'crowdsource', as coined in 2005 by Howe and Robinson, is explained, with editors at *Wired* (a monthly online American magazine, that focuses on the effects of the new technologies on culture, economy and politics) referring to the following:

> *'The act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. This can take the form of peer-production (when the job is performed collaboratively) but is also often undertaken by sole individuals. The*

[113] To, Wai Ming & A.W.L., Chung & Vong, Iris. (2018). *Integrating artificial intelligence with virtual reality for soundscape appraisal*. Inter-noise conference; Chicago, USA. last accessed 21st April 2019. https://www.researchgate.net/publication/327510556_Integrating_artificial_intelligence_with_virtual_reality_for_soundscape_appraisal

crucial prerequisite is the use of the open call format and the large network of potential labourers'.[114]

This project suggests allowing users to change different settings in a virtual space whilst experiencing various sonic environments and whilst walking in various locations with sound generators, such as trees, singing birds, fountains, traffic jam, outdoor large displays and speakers, etc. All sounds' acoustic properties are set to be as close as possible to the sounds as they are in reality; these sounds can be added or removed in order to achieve a better sonic experience for participants, as well as feedback to be collected from participants following the VR experience and its storing in the AI database of the VR application.

The importance of the AI components integrated with this soundscape VR application is to turn the information in this database into knowledge about successful soundscape designs in urban planning. As an example, AI will allow the VR application to address the favoured sounds and the preferred sound volumes, etc., which can then be used by urban planners in designing their projects and predicting users' acceptance of such before it is even built. This would save time and money.

Here, it would be valuable to consider how Synaesthetic Scape differs from the above ideas, despite in general serving almost the same purpose, albeit in a different field. Synaesthetic Scape is an attempt to turn architecture towards an environment where the sensory experience gives the built environment or the city soundscape its character and further identifies its cultural identity (it is a call to architects to bear in mind these cues). Moreover, it is about establishing a more productive and creative relationship between the senses and the daily practice of living architecture—mostly in the urban environment. Furthermore, the idea of the 'Synaesthetic Scape' project is considered as an attempt to establishing a creative and productive relationship between music/or ambient sounds and their virtual scape, and the participants and virtual scape. Broadly, it is an exploration/ understanding/ investing in the users' emotional sensory experience with the Synaesthetic Scape.

114 Howe, Jeff (June 2, 2006). *'Crowdsourcing: A Definition'*. Crowdsourcing Blog. Retrieved January 2, 2013 http://crowdsourcing.typepad.com/cs/2006/06/crowdsourcing_a.html

2-3 Aural architecture

> *'When our ability to decode spatial attributes is sufficiently developed using a wide range of acoustic cues, we can readily visualise objects and spatial geometry: We can see with our ears'.* [115]

Barry Blesser and Linda-Ruth Salter talked about this idea and discussed the term 'aural architecture' in their 2007 book *Spaces Speak, Are You Listening*? This can be considered one of the key sources of the researcher's own proposed idea of Sound Space (the first example of Synaesthetic Scape) in this research.

Aural architecture refers to '*the human experience of a sonic process*' [116]. In addition, hearing refers to the detection of sound and listening refers to the active attention or reaction given to the meaning, emotions and symbolism contained within the sound. Moreover, aural architecture *involves 'the properties of a space that can be experienced by listening '*[117]. Accordingly, in this research, the researcher is proposing Sound Space as an aural architecture practice.

An aural architect (sound space architect) acts as both an artist and a social engineer; someone who selects specific aural attributes of space based on what is desirable in a particular cultural framework. The language of an aural architect is derived from the vocabulary of an individual culture with all the cultural symbols, values and concepts embedded within it. In contrast, an acoustic architect is a builder, engineer, or physical scientist who implements the aural attributes previously selected by an aural architect[118].

The differences between an aural architect and an acoustic architect are shown in Table 1 below [119].

[115] Blesser, B. & Salter, Linda-Ruth, 2007. *Spaces speak, are you listening? : experiencing aural architecture*, Cambridge, Mass. ; London: MIT Press. P.2
[116] Ibid. p.5
[117] Ibid. p.5
[118] Ibid. p.5
[119] Ibid. p.5

Aural architect/soundspace architect	Acoustic architect
1. Artist or a social engineer.	1. Builder, engineer or physical scientist.
2. Selects specific aural attributes of a space based on a particular cultural framework.	2. Implements the aural attributes selected by an aural architect.
3. Uses language derived from the values, concepts, symbols and vocabulary of a particular culture.	3. Uses the scientific language of physics, manipulates physical objects, special geometries, and mathematical equations.
4. Focuses on the way that listeners experience the space (cultural acoustics).	4. Focuses on the way that spaces change the physical properties of sound waves (spatial acoustics).

Table 1: The differences between a soundspace architect and an acoustic architect; produced by the researcher M. Al-Ugaily.

The broad concept of aural architecture is that it involves creating a spatial experience where there is no physical space that actually exists; instead, there are what are referred to as virtual, illusory and phantom spaces. These are what Sound space (my master project mentioned earlier in chapter one) presents. Aural architects are mostly social and cultural forces as opposed to real people; these effects can be examined in order to determine the degree to which they influence the spatial design process.

The literature on aural architecture is sparse, fragmented and embryonic. According to Blesser & Salter (2007) [120], it is like this because:

1. There is a lack of means to store culture and heritage in archives.
2. The use of weak language to describe sounds.
3. Modern culture does not appreciate auditory spatial awareness in the same way that visual communication values are appreciated.
4. Professional architectural schools don't see aural architecture as an intellectual domain, thus very poor or no training in physical acoustics, aural aesthetics, or sensory sociology is provided to their students.

Auditory spatial awareness is not only the ability to identify changing sounds in a space but also involves identifying the emotional and behavioural experiences associated with a space. With this noted, Sound Space (Pilot study) proposed establishing a creative and productive relationship between sound and its space with respect to peoples' emotional

[120] Ibid. p.6

experience with sounds. Further in the research Sound Space was developed to be Synaesthetic Scape which goes even further in exploring the sensory assassinations, cross modality, perception in addition to emotions which supports the idea of auditory spatial awareness, and works to improve it and use it as an analytic tool to develop a new spatial design process in architecture.

Notably, aural architecture is not recognised as a logical domain to be taught in professional school topics such as aural aesthetics, sensory sociology, or physical acoustics. The following research has focused on aural architecture:

1. Bagenal & Wood [121]: In their article on spatial acoustics (1931), they emphasised the importance of aural architecture in terms of its social and cultural aspects .
2. Schafer (1977) [122]: Established the soundscape concept that involves a mixture of aural architecture and an examination of sound sources.
3. Pallasmaa (1996) [123]: Rejected the dominance of visually-based designs and considered sensory architecture in his book '*The Eyes of the Skin, Architecture and the Senses*' as an umbrella theme that includes aural architecture.

4. Sheridan & Van Lengen (2003) [124]: Proposed that the schools of architecture should include aural architecture as a topic to be taught in order to enrich the built environment.

This means that Synaesthetic Scape is like a natural development to the Idea of aural architecture that respects and responds to the growing and progressing research and technology of VR in 21st century.

[121] Bagenal, H., and Wood, A. (1931). *Planning for Good Acoustics*. New York: Dutton.
[122] Schafer, R. (1977). *The Soundscape: Our sonic Environment and The tuning of The World*. New York: Knopf.
[123] Pallasmaa, J. (1996). *The Eyes of The Skin: Architecture and The Senses*. London: Academy Group.
[124] Sheridan, T., and Van Lengen, K. (2003). *Hearing Architecture: Exploring and designing the aural environment*. Journal Of Architectural education 57(2):37-44

2-4 Architecture Phenomenology

The theory of phenomenology was mainly studied and greatly analysed by philosophers like, Kant, Hegel and later on by Heidegger, Bachelard and Merleau-Ponty. It emphasises on phenomena and how we experience them through the senses [125].

'Phenomenology may be defined as being the function of quality. Essentially, memories of place, when personal and meaningful in nature, are commonly seen to stem from complex details, therefore facilitating the generation of a bond that expands beyond a building's physical use—creating an experience—in such a way that it becomes ingrained in the person's memory' [126]

A good example on how these ideas were embodied in an architectural experience by Richard Buday [127] who wrote an article entitled '*Love a Building Lately?*' is an article which discusses his experience with architecture during his New York walk tour. He stated the following:

> *An old radio show came to mind.*
> *SOUND EFX: CHOOGA, CHOOGA, CHOOGA, CHOOGA, CHOOOOOO! (The sound of an approaching locomotive.)*
> *NARRATOR:(In a booming voice) Grand ... Central ... Station! SOUND EFX:(The train rumbles ever closer, bell ringing.)*
> *NARRATOR: As a bullet seeks its target, shining rails in every part of our great country are aimed at Grand Central Station, heart of the nation's greatest city [128].*

This fascinating image of a user exalting the architecture of the Grand Central Station in New York in a sensory narrative shows the potential of a sensory experience in affecting the way people communicate with architecture and the way experience with a place is built through time. Small things affect our senses to make it an unforgettable experience and build a memory to be remembered.

[125] Agapiou N,.2018, *Sensing Architecture: 'How can light, sound, and touch be used as architectural elements in the creation of atmosphere in an architectural space',* A thesis submitted to the department of Architecture for the architectural diploma, University of Nicosia.p.6, last accseed: 20th December 2019, https://www.academia.edu/35983737/Sensing_Architecture
[126] Ibid.p.6
[127] Richard Buday, FAIA is president and founder of Archimage, a 30 year-old digital arts studio, and president of Playnormous LLC, a health education video game company. A professional architect by training, Richard and his firm have won more than 40 international awards for digital media including video games and computer animation. Richard has served as Principal Investigator of approximately $10 million in National Institutes of Health grants and contracts.
[128] Buday, Richard. (2018). *Love a Building Lately?*. https://www.researchgate.net/publication/326331477_Love_a_Building_Lately. P.2

In this article, Buday outlines the reason as to why he believes The Grand Central Station plays a good role in the memory of people when compared to two other building, namely the New World Trade Center Transportation Hub and the TWA Flight Terminal at JFK, which he described as being not as good as the station in pleasing users in terms of their experience. He related his sensory experience to how meaningful the architecture is seen to be.

> *'In my view, architecture loved by generations is the result of satisfying people's innate search for meaning. Beloved buildings play to our hardwired need to know what things mean. When a structure screams for attention but fails to deliver a message worthy of our attention, or confuses its message, we are disappointed, and then bored '.*[129]

Moreover, he provided criticism as to how the architecture profession should be:

> *'There are three Viennese schools of psychotherapy, one based on Sigmund Freud's 'will to pleasure,' the other on Alfred Adler's 'will to power,' and the third on Viktor Frankl's 'will to meaning,' or what he called logotherapy. The first two schools are fascinating, but it's the last school that the architectural profession should study'* [130]*.*

What captured the researcher's attention with this article—and which therefore makes it worthy of mention here—is, that it is not only the criticism to new buildings that relies on pleasure to the eye in its existence; rather than presenting an experience to remember for its users—or, as he stated, '*a meaningful intention'*—he describes also user evaluating architecture through a sensory experience. He exalts the Grand Central Station in New York City through praising the building whilst music is playing in his head and the sounds of the fast trains leave and arrive at the station. His narrative makes a remarkable example of the sensory experience of architecture for the researcher, and has therefore provided encouragement in terms of the view of this research that meaningful architecture is not only the meaning behind it or its design concept but rather the context of senses, which makes it an experience to remember—a story of a place in a certain time. In this regard, the importance of the users can be

[129] Ibid. p.11
[130] Ibid. p.10

seen in terms of evaluating the experience and later developing it. This is what the co-productive design approach of Synaesthetic Scape has sought to do. This also emphasises the ideas and designs of Pallasmaa, where his ideas concerning the architecture of the senses and the perception of architecture as phenomena and his design practice shows, as Holl stated, in the preface to *The Eyes of the Skin*:

> *'The way spaces feel, the sound and the smell of these places have equal weight to the way things look* '.[131]

Architecture is the art of designing human experiences in the built environment through the use of elements of materials, light and shadow, and colour. All of these tools are used to stimulate the human senses and communicate with them in what I called an 'architectural sensory experience'—an experience where humans understand place and time in building their memories of their everyday experiences, which always occur in the architectural envelope that contains those human experiences.

In architecture, all senses are important; however, the sense of sight is recognised as favoured and dominant, while the other senses are underestimated or less invested. The combination of all the senses is what makes humans' perceptions of space comprehensive. Architects tend to leave much of their spatial experience to chance when ignoring the other senses or neglecting to include them in the design process. This makes the architectural experience incomplete.

Pallasmaa criticised modern architecture when stating:

> *'Modernist design has housed the intellect and the eye, but it has left the body and the other senses, as well as our memories and dreams, homeless'.* [132]

Therefore, architecture is a representation of the sensory interactions of our body with its surroundings. Architects' main and unique role is to create and design this experience. Furthermore, the duty of the architecture is to pursue the needs of human activity; this creates a relationship between human senses and the building in transforming emotions and perceptions.

[131] Pallasmaa, J., 2005. *The eyes of the skin : architecture and the senses* New ed.]., Chichester: Wiley-Academy. P.7

[132] Pallasmaa, J., 2005. *The eyes of the skin : architecture and the senses* New ed.]., Chichester: Wiley-Academy. P.19

The theory of phenomenology recognises this important role of architecture in terms of creating experiences and memories. The phenomenology of architecture suggests manipulating the design elements of space, i.e. material, colour, light and shadow, so as to create a memorable sensory experience.

2-4-1 Architecture of the senses

In this section, focus will be directed towards the ideas of three architects, namely Juhani Pallasmaa, Peter Zumthor and Steven Holl. These three architects are theorists, and each of them offers their own approach to architecture, with all of them having discussed the experiential qualities of spaces, thereby helping to define phenomenology. Their focus has been placed on the human body, not as the vehicle of embodiment but rather as an experience of the human body in a spatial environment. It is through this analysis that the thesis will gain insight into the tools to be used in the application to the design of the Synaesthetic Scape.

Juhani Pallasmaa

> *'The task of art and architecture in general is to reconstruct the experience of an undifferentiated interior world, in which we are not mere spectators, but to which we inseparably belong'* [133].

Juhani Pallasmaa is an architect and theorist from Finland and is well known for his phenomenological architectural position. In his writings, he focuses on the establishment of the architecture of human existence and the architecture of spatial experience—'the architecture for the senses'—where the human-combined sensory experience is important in reaching a comprehensive perception of the spatial environment. Importantly, he is well known for his criticism of the recent architectural products favouring the sense of sight over the other senses. With this noted, it is important to emphasise that, '*as a consequence of the power of the eye over the other sensory realms, architecture has turned into an art form of instant visual image. Our buildings have lost their opacity and depth, sensory invitation and discovery, mystery and shadow'.*[134]

Pallasmaa explains many attributes of an architecture of existential and experiential qualities: material poetics, multi-sensory experience and fragility [135]. These qualities

[133] Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.25

[134] Pallasmaa, J. 2000, *'Hapticity and time: Notes on fragile architecture*', *The Architectural Review,* vol. 207, no. 1239, pp. 78-84. Retrieved from https://search.proquest.com/docview/201144624?accountid=13828. P.78

[135] Ibid. p. 80, 81

create an experience not based on aesthetic and proportion, instead, they create an experience based on human perception.

Visual dominance and Multi-sensory architecture developed a lot throughout architectural history. Drawing much discussion to the theories of the philosopher Maurice Merleau-Ponty, Pallasmaa explores and invests the senses in the architectural experience to enhance it: '*Tactile sensibility replaces distancing visual imagery by enhanced materiality, nearness and intimacy'*[136]. Aesthetics based on and beauty and visual proportions create a hollow experience. Whereas haptic architecture creates intimacy and engages with the observer's senses through the channels of sight, sound, touch, smell and taste. Stimulating the observers' senses allows them to position themselves in the centre, to make the experience first-hand, to comprehend and appreciate *'gradually, as images of the body and the skin'* [137].

The narrative of the material is another dimension of the architectural experience. Pallasmaa resists modernist traditions of immaterial abstractness, flatness and timelessness in favour of an architecture of decay, weather, unconscious images and vulnerability. Pallasmaa references Gaston Bachelard in a distinction between *'formal imagination and material imagination'*[138]. Bachelard stated that material imagination creates deeper experiences than the images of form. In this regard: *'Matter evokes unconscious images and emotions'* [139]. *'Vision places us in the present tense, whereas haptic experience evokes the experience of a temporal continuum'*[140]. It is the reality of the experience in which individuals attach themselves. With perfection and detachment of materials from this reality, individuals cease to be vulnerable within the experience of the space. The human needs to experience and read the time of the architecture, in the view of Pallasmaa.

In the end, Pallasmaa discusses the experiential quality of a 'fragile' architecture. This is an architecture that permits the user to interact with the space. *'The architecture of weak image is contextual and responsive. it is concerned with real sensory interaction instead of idealized and conceptual manifestations'* [141]. Fragile architecture is the reaction against the aggressive design in support of an accepting and tangible

136 Ibid. p.79
137 Ibid. p.78
138 Ibid, p.80
139 Ibid. p.80
140 Ibid. 79
141 Ibid, p.81

experience. The experience moves from visionary display to engagement. It is within this weak 'fragile' architecture that Pallasmaa describes where architecture gets its emotional and expressive statement.

Without question, all of these ideas manly describe the old ways of design through architectural drawings and models, with the scholar providing an outline as to all the qualities of a good multi-sensory design to such an approach of architectural production. Therefore, he has a criticised position against the use of modern computer designs when stating the following:

> *'Computer imaging tends to flatten our magnificent, multi-sensory, simultaneous and synchronic capacities of imagination by turning the design process into a passive visual manipulation, a retinal journey. The computer creates a distance between the maker and the object, whereas drawing by hand as well as working with models put the designer in a haptic contact with the object, or space'.*[142]

This idea against the use of the computer technologies is what this research partially disagree with or argues. The researcher agrees with Pallasmaa in that computer-rendered images tend to flatten the gaze of the eyes and cause the architect to lose a haptic connection with the design. On the other hand, however, the researcher argues that it does not entirely flatten our multi-sensory experience, only because the mechanism of using this tool remains not very mature in terms of the haptic relation with the design. Nonetheless, what this research seeks to explore or investigate the use of computer technologies in this case the VR technology in exploration of sensory experience of architecture at design stage, and that VR technology has the potential to eradicate this fear of losing the haptic connection with design. In other words, Synaesthetic Scape adds the modalities of cross sensory design to the VR experience in such a way so as to make it communicate with the human senses and provoke emotions as an individual moves within the VR environment. These are the same qualities that Pallasmaa claims computer-generated designs tend to lack and which can only be found in the old ways of designing through drawings and models.

[142] Pallasmaa, J., 2012. *The eyes of the skin : architecture and the senses* 3rd ed., Chichester: Wiley.p.14

Peter Zumthor

Peter Zumthor, an architect from Switzerland who is known for having an uncompromising approach [143] and is described as a minimalist architect in an article by Richard Lacayo, entitled 'Swiss Minimalist Peter Zumthor Wins Architecture Prize' **[144].** he is the winner of the 2009 Pritzker Prize and 2013 RIBA Royal Gold Medal [145].

In his book *Thinking architecture* , published in 2006, he talks about his unique experience as an architect thinker and the effects of his old memories from childhood and early years of practicing architecture in his current architectural approach.

> *'Memories like these contain the deepest architectural atmospheres and images that I explore in my work as an architect'.*[146]

It is through such experiences that Zumthor has the ability to ensure forward-thinking with emphasis placed on experiences in spaces, without necessarily setting anything in stone. In this regard, he mentions that, at times when he reflects on memories and times of the past, he then makes a conscious effort to try to remember the actual architectural situation, including the meanings that go hand-in-hand, and accordingly aims to determine how such an atmosphere can be recreated through the presence of things, where 'everything had its own specific place and form' [147].

In this regard, emphasis is placed onto the architecture's primary experiences, with the mind and body seen to be in continuous communication with their surroundings. In this regard, Zumthor directs attention to not the form or techniques, nor the specific materials, but in fact towards the perceptions of the details, the form and the materials. What Zumthor describes as being the 'poetic quality' is described as emerging as a result of the ability of the architect to create a valuable circumstance for the materials owing to the fact that the materials themselves lack poetry. [148]

The approach adopted by Zumthor can be seen in the Thermal Baths in Vals, Switzerland. As stated by Zumthor, the bath depends on the 'silent, primary

[143] Newel, Conrad (13 September 2013). *'Dear Architecture Journalists: Stop Worshipping Peter Zumthor!'*. Architizer Journal, Architizer.com. Retrieved 12 March 2019. https://architizer.com/blog/practice/details/peter-zumthor-is-not-god/

[144] Lacayo R., *Swiss Minimalist Peter Zumthor Wins Architecture Prize*, Time newsletter , 12th April 2009, last accessed 21st April 2019, http://content.time.com/time/arts/article/0,8599,1890858,00.html

[145] Wikipedia, the free Encyclopedia, *Peter Zumthor*, last edited 19th March 2019, last accessed 23rd April 2019, https://en.wikipedia.org/wiki/Peter_Zumthor

[146] Zumthor, P., 2006. *Thinking architecture* 2nd, expanded., Basel ; Boston: Birkhäuser. P.10

[147] Ibid. p.10

[148] Ibid. p.11

experiences of bathing, cleansing oneself, relaxing in the water; on the body's contact with water at different temperatures and in different kinds of spaces; on touching stone'.[149] In this regard, the focus of the project is centred on the perspective of the individual as they transition through space. Furthermore, the stillness is recognised as facilitating realisation. Pivotal to Zumthor's own architecture is ensuring silent is included, which is seen to enable individuals to belong to the space without being disturbed [150].

In Vals, the project's core is focused on its materials. There was the replacement of local stone within the earth in cavernous configurations, with water—notably the accompanying material—allowed to run through the spaces, thereby meaning the firm, static role of the stone played in the stone could be reinforced. The materials are recognised as adopting the role of mediating between the site and its underlying aim, whilst at once providing a number of subtle, temporal attributes. Such a space is centred on achieving everyday performance actuality.

Steven Holl

For architecture, the challenge is the need to encourage perception both within and externally, as well as to increase the chance of a remarkable experience whilst at once communicating meaning, and also establishing and maintaining such duality in relation to the site and circumstance specific factors[151].

In the view of Holl, architecture may be recognised as a number of different partial experiences. In a number of his works, including the essay written on Phenomenal Zones, Holl investigates such partial experiences, which are aligned with the senses' perceptual phenomena. The various different aspects of his investigation surrounding perception comprise the 'unmeshed experience', alongside colour, detail, light, proportion, sound and time.

[149] Parnell,Steve(February, 2009); Peter *Zumthor's Therme Vals baths in print*, Architect's Journal, last accssed 23rd April 2019, https://www.architectsjournal.co.uk/peter-zumthors-therme-vals-baths-in-print/1990584.article

[150] Zumthor,P.,(11 February,2009); *The Therme Vals.* Arch daily, last accessed 23rd April 2019, https://www.archdaily.com/13358/the-therme-vals

[151] Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.42

In regards the unmeshed experience, this is outlined by Holl as being the merge of field and object. Importantly, it is noted that, outside of architectural objects' physicality and the requirements of programmatic contact, unmeshed experience is not only recognised as a place of activities, events and things, but also as a physical and tangible situation arising as a result of the ongoing revealing of overlapping spaces, detail and materials. Recognised by some as fundamental in architecture, the elements of space, colour, detail, geometry, light and material all make up this experimental continuum. It is across such a field that architecture activities, geometries and sensations exist.

It should be noted that, with regards to the approach adopted by Holl, there is the important sensuous experience of architecture. It is noted that material, temperature, texture, touch and smell all play a key role in everyday existence. In this regard, phenomenology is a consideration transforming essences into experience. Architecture, in its all-encompassing perception, depends on the haptic realm's details and material, with a meal's taste, for instance, depending on the ingredients' flavours. In a comparable vein to the view of Pallasmaa, Holl also emphasises the haptic experience, stating that, architecture's propensity to affect and influence out everyday experiences in detail and material presents a catalyst for change, which is both powerful and subtle[152]

. Importantly, when there is the intensification of sensory experience, there is the involvement and engagement of psychological aspects. An architectural project's strength is recognised as present in the propensity to investigate the detail and material's perceptions and experiences.

[152] Holl, Steven. *Parallax*. New York: Princeton Architectural Press, 2000. Print.P.71

2-4-2 Space, Materials, Colour, and Light and Shadow

> *The passage of time; light, shadow and transparency; colour phenomena, texture, material and detail all participate in the complete experience of architecture.* [153]

The above quote is from Steven Holl in 1994. With this recognised, it is also stated that *'a common theme in each phenomenological approach to design mentioned in this research; is the management of space, material, and light and shadow '*[154].

'Space' is determined by the development of a fluid, flexible programme and the utilisation of interstitial space. Holl elaborates on an 'architectural synthesis' in the book 'Questions of Perception', suggesting 'foreground, middle ground, and distant view', together with all the subjective qualities of material and light, form the basis of 'complete perception' [155]. *'This establishes the necessity for place-making through sensory observance. Initially, the combination of space, material and light design features creates a sensory observation for the person and then they develop an understanding of space'*.[156]

In the case of 'materials', Pallasmaa is recognised as being against the use of big sheets of glass, enamelled metal and synthetic materials, instead favouring natural materials, such as stone, brick and wood, etc. He justifies his opinion by stating that the use of materials such as wood or stone has potential, although in them not only a physical visual one but also the potential to express time and memories. Such materials communicate stories of time and events that left their fingerprints on those materials they work as a record to events and time. They simply reflect their age with all the memories that go along with them.

[153] Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.41

[154] Blake E.; *Theory of Phenomenology: Analyzing Substance, Application, and Influence,* Arch 630,Theory and Context, last accessed 23rd April 2019, https://cte.ku.edu/sites/cte.drupal.ku.edu/files/docs/portfolios/kraus/essay2.pdf p.3

[155] Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.45

[156] Blake E.; *Theory of Phenomenology: Analyzing Substance, Application, and Influence,* Arch 630,Theory and Context, last accessed 23rd April 2019, https://cte.ku.edu/sites/cte.drupal.ku.edu/files/docs/portfolios/kraus/essay2.pdf.p.4

On the other hand, the modern materials of glass and metal do not have stains of time integrated within them, they are flat and dull with no history or age. They do not tell a story, but are simply mute. As Stephen Holl writes,

> *'Natural materials—stone, brick and wood—allow the gaze to penetrate their surfaces and they enable us to become convinced of the veracity of matter. Natural material expresses its age and history as well as the tale of its birth and human use. The patina of wear adds the enriching experience of time'.* [157]

Moreover, material is the tactile form of phenomenology that facilitates memory. For Peter Zumthor, the phenomenon of materiality induces memories and emotions:

> *'Memories like these contain the deepest architectural experience that I know. They are the reservoirs of the architectural atmospheres and images that I explore in my work as an architect'.* [158]

Colour: This is seen to be a delicate element since its value depends on other determinants, namely light and texture, as opposed to actual colour. For example, the primary colours of blue, yellow and red are bright colours, yet they seem muted on a matt surface and when using a low-level light. On the other hand, the rainbow of colours formed by sunlight shining through a prism of ice against a white snowy background might look vivid and intense in colour. Furthermore, throughout the course of the day, the same wall might look differently in the day and night as a result of the difference in lighting.

Furthermore, culture can also play a valuable role in terms of giving colour its value—and when stating culture, this is to mean, for example, that people living at a particular site or in a certain place have different colour concepts based on the qualities of light and air in their area. For example, the Mexican culture is known for their extensive use of the bright colours yellow and orange, reds and blue on their houses' plaster elevations; being exposed to the intense sunlight of Mexico, this will make these

[157] Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.29

[158] LYNCH P., 14th April 2009; *Peter Zumthor speaks to the Architects' Journal,* Architect's Journal, last accssed 23rd April 2019, https://www.architectsjournal.co.uk/peter-zumthor-speaks-to-the-architects-journal/5200097.article

saturated colours fade, yet they get their potency from the authentic materials of the handmade applied textures.

The situation is, of course, different from desert societies, where the colours of the earth are dominant (black, white, grey, brown; all other colours have more of a grey shade to them). As Holl states,

> *'Situation, climate, and culture may determine use and subsequent experience of colour'.*[159]

Light and shadow*: 'Lighting is visual, experiential, environmental and sensual. The phenomenon lies in its effect on the human condition'.*[160] *'The phenomenological experience of space and material seem to be highlighted with cooperation of light and shadow'*[161]. Holl suggests that 'the perceptual spirit and metaphysical strength of architecture are driven by the quality of light and shadow shaped by solids and voids, by opacities, transparencies and translucencies. Natural light, with its ethereal variety of change, fundamentally orchestrates the intensities of architecture and cities' [162] .

Light and shadow create a playful interaction of colour, texture and the related emotions associated with the scene. The contrast between these two effects of light can be sharp or blurred, depending on the architects' aim of the lighting design. This strategy can create depth and display texture, and is one of the strongest design features in phenomenology [163]. Patterns of shadow are a very nice and effective playful tool for architects to use, such as in the case of shadows of trees on white walls, which would make the white walls look like a grey and white painting.

'Light is a necessity for the functionality of architecture. Its consideration for sensory reverence is critical in preliminary design'. The way in which 'light conveys the essence of space and depth is a valued determinant of the philosophy of phenomenology'[164]*.* Furthermore, phenomenology establishes the need for the observance of sensory sensitivity in design. This philosophy, despite elaborating on the connection to intimate

[159] Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.61
[160] Blake E.; *Theory of Phenomenology: Analyzing Substance, Application, and Influence,* Arch 630,Theory and Context, last accessed 23rd April 2019, https://cte.ku.edu/sites/cte.drupal.ku.edu/files/docs/portfolios/kraus/essay2.pdf, p.4
[161] Ibid. p.5
[162] Holl, S., Pallasmaa, Juhani & Pérez Gómez, Alberto, 1994. *Questions of perception : phenomenology of architecture*, Tokyo: A & U Publishing. P.63
[163] Blake E.; *Theory of Phenomenology: Analyzing Substance, Application, and Influence,* Arch 630,Theory and Context, last accessed 23rd April 2019, https://cte.ku.edu/sites/cte.drupal.ku.edu/files/docs/portfolios/kraus/essay2.pdf, p.4
[164] Ibid. p.6

human perception, remains multi-scale and also has a unique effect on both health and wellness. This philosophy is an extension of the natural phenomena found in the environment, perhaps establishing its powerful effectt[165]. It determines sense of place through awareness of the surrounding environment in perceptual details and design features. Maurice Merleau-Ponty, phenomenologist, describes the opposition between rationalism and phenomenology by illustrating the following:

> *'all consciousness is perceptual... The perceived world is the always presupposed foundation of all rationality, all value and all existence'[166]...[the phenomenologist returns] 'and this world with regards to which every scientific determination is abstract, signitive, and dependent, just like geography with regard to the landscape were we first learned what a forest, a meadow, or a river is'.[167]*

The integration of phenomenology within the present generation of designing will ultimately acknowledge architecture's respect to the human scale. Today, technology advances architectural design strategies, and it is encouraging to recognise that there are designers willing to harnessing this power in an effort to improve the human experience, which is what the essence of architecture seeks to accomplish.

The starting stage in the design of Synaesthetic Scape, was the pilot study, referred to as Sound Space,. Here the researcher used the design tools of light colour and materials to be tuned according to users' experiences. Music was playing in an animated environment to provoke emotions and set the basis for the first designed Synaesthetic Scape experience, where insights were derived from this stage in an effort to initiate the virtual project of the first proper Synaesthetic Scape. From here, the first hypothesis of the first pilot experiment was established, questioning whether the same design tools, in reality, can have the same qualities and effect in the virtual reality—a question that was answered later on in the Sound Space pilot study experiment.

To sum up, Frascari's ideas are concerned with synaesthesia as a cross-sensory mode to achieve an architectural parlance, where architecture speaks for itself. The

[165] Ibid. p.6

[166] Merleau-Ponty, M. & Landes, Donald A., 2014. *Phenomenology of perception*, London: Routledge, Taylor & Francis Group. P.xxxvi

[167] Ibid. p.lxxii. In another translated copy the quote is *'and in relation to which every scientific schematization is an abstract and derivative sign-language, as is geography in relation to the country-side'*. Merleau-Ponty, M., 2002. *Phenomenology of perception*, London: Routledge Classics.p.x

discussion also considered ‘the sensory experience of design in its drawings production stage’, with emphasis placed on architects needing to design with all their senses, thus making the design process very much alive and the product expressive in return. This then induced consideration as to how this can be reflected in the early architectural drawings and sketches of the design. Frascari proposed the use of the senses in the design process as being pretty much a design thinking process.

In the same path, the ideas of Pallasmaa and Holl can be reviewed when they speak about architecture as a phenomenon that is experienced by the senses and the way in which architects use their senses to produce a tactile architecture that fights that idea of favouring the visual sides of architecture over the other senses of touch and hearing. This is to communicate successfully with the recipients through talking to all of their senses without favouring one over another. Here, sensory experience is a goal to be achieved.

As a conclusion, all theorists and architects detailed here seek to achieve an *architecture parlante*, by using all terms such as *‘experience of the senses’*, *‘Synaesthesia’* as a *‘cross-sensory experience’* or even the term *‘meaningful architecture’*. In this regard, Buday experienced this in his walk tour in New York, which was of a sensory nature.[168]. All of them, in one way or another, referred to the *‘Sensory Experience’*—either through the design stage or the production stage of architecture, or otherwise the stage where recipients live the architecture of a place, or even when architecture plays its role in telling the story of place in time. All made reference to the sensory aspects of architecture but through different approaches

In the present research, the importance of the sensory experience in architecture is also underpinned by an attempt to take this sensory experience to another level by combining it with the emergent technology of virtual reality (VR). This will be done by designing a virtual environment that tests the new sensory experience and evaluates it through the use of co-productive design where users play the major role in evaluating the process and giving insights on how it can be further developed.

Before moving to the expoloration of VR and its potential implications in my research I will first finish exploring the synaesthetic experience which as mentioned, happens in am emotional envelope or the situation. This is because syneasthesia is always

[168] Buday, Richard. (2018). *Love a Building Lately?*, https://www.researchgate.net/publication/326331477_Love_a_Building_Lately.

accompanied with an emotional state. Therefore before moving to exploring VR I will briefly explore the possibilites of provoking that emotional state by the use of music as I did in my first Syneasthtic Scape design attempt which I called Sound Space.

2-5 Music and emotions

An old concern in music psychology attempts to understand how it is that music communicates with the listener's emotions. This is frequently considered as the main purpose of music. In this regard, Dowling & Harwood write:

> *'When we discuss our work with psychologists, the questions that most often arise concern music and emotion. Music arouses strong emotions, and they want to know why... Not only do listeners have emotional reactions to music, but pieces of music also represent emotions in ways that can be recognised by listeners'.* [169]

Much of the work done on music and emotions in the early 1950s, was reviewed by Dowling & Harwood, they focused on theories of musical semiotics that are deeply concerned with how listeners receive indexical associations, signs and icons when listening to music, and the possibilities in which such entities become connected with meaningful emotional implications. This effort, by necessity, is highly theoretical and separated from the practicality of performance and acoustic. However, it has been a fruitful field to explore [170].

The major work in modern music and emotions theories was the recognized effort of L. B. Meyer (notably a composer, author, and philosopher), who works in the field of the aesthetic theory and philosophy of music[171]. Primarily, he denies that music gives rise to constant, distinguished emotional behaviour (such as happiness), focusing instead on the level of arousal. Moreover, he equates the emotional response to music with arousal,

[169] Dowling, W. J. & Harwood, D. L. (1986). *Music Cognition*. San Diego: Academic Press. p.201

[170] Scheirer, E.D., & Vercoe, B. (2000).' Music-listening systems'. Semantic scholar. last accessed 20th May 2019 https://pdfs.semanticscholar.org/7c7b/b4cb6bdd506c0bf3ba65e7efe9ac99aa6a92.pdf?_ga=2.211488597.1927094821.1559079982-1422276088.1559079982, p.32

[171] Rosner, B. S. (1988). *Music perception, music theory, and psychology*. In E. Narmour & R. A. Sobie(eds.), *Explorations in Music, the Arts, and Ideas*: Essays in Honor of Leonard B. Meyer (pp. 141-175).Stuyvesant: Pendragon Press.

using terms such as ‘tension and release’, and further tries to relate the terminology to more accurate ‘emotional-psychology definitions’[172].

He also denies that the effective response to music is based on specified semiotics in the way mentioned before. Rather than that, he stated that all emotions and meaning in music is ‘intra-musical’; music only references itself, and thus the excitement and tension in music are present only if the listener appreciates the references. Accordingly, he considers expectation and fulfilment or the denial of expectation in music as odd carriers of emotion in music’[173].

Several papers by Crowder [174] have assessed the highest recognized emotional distinctions in music; the association of the major tonality with ‘happiness’ and the minor tonality with ‘sadness’. Crowder explored this issue from various historical, experimental, aesthetic, and developmental viewpoints, and more recently, experimentalists have attempted to quantify emotional communication in music. For example, P.N. Juslin a professor of psychology at the Department of Psychology, Uppsala University, Sweden, the director of research and teaching in music psychology conducted an experiment in which expert guitarists were asked to play a short piece of music to communicate one of the four basic emotions to listeners[175]. He then examined acoustic associates of tempo, sound level, and onset time in those performances, and sought to correlate these physical variables to the emotional aim of the musicians. Although he found that listeners were reliably able to detect the emotion being communicated, it was nonetheless difficult to determine exactly what physical parameter delivered the emotional aspects of the performance. Nonetheless, Juslin is credited for acknowledging the importance of the acoustic performance to convey and mediate the emotional material [176].

The definition of Synaesthetic Scape in this research is as follows:

[172] Scheirer, E.D., & Vercoe, B. (2000).’ Music-listening systems’. Semantic scholar. last accessed 20th May 2019 https://pdfs.semanticscholar.org/7c7b/b4cb6bdd506c0bf3ba65e7efe9ac99aa6a92.pdf?_ga=2.211488597.1927094821.1559079982-1422276088.1559079982, p.33

[173] Ibid.p.33

[174] Crowder, R. G. (1985a). *Perception of the major/minor distinction: I. Historical and theoretical foundations*. Psychomusicology 4(1), 3-12. & Crowder, R. G. (1985b). *Perception of the major/minor distinction: II. Experimental investigations*. Psychomusicology 5(1), 3-24.

[175] Juslin, P. N. (1997). *Emotional communication in music performance: A functionalist perspective and some data. Music Perception* 14(4), 383-418. https://www.jstor.org/stable/40285731?seq=1#page_scan_tab_contents

[176] Scheirer, E.D., & Vercoe, B. (2000).’ Music-listening systems’. Semantic scholar. last accessed 20th May 2019 https://pdfs.semanticscholar.org/7c7b/b4cb6bdd506c0bf3ba65e7efe9ac99aa6a92.pdf?_ga=2.211488597.1927094821.1559079982-1422276088.1559079982, p.33

Synaesthetic Scape is a virtual envelope where sensation, perception and emotions are all blended within a new synaesthetic experience in architectural practice

The research has explored the sensory, perceptional and emotional aspects of the Synaesthetic Scape. The research will now look at the virtual envelope which contains all of the other aspects of the Synaesthetic Scape experience.

Virtual reality 2-6

In this section, Virtual Reality (VR) technology will be explored, and the potential of its use in the production of Synaesthetic Scapes will be further highlighted.

Virtual reality (VR) [177] can be defined as the illusion of participation in a synthetic environment rather than external observation of such an environment, it relies on three dimensional (3D), stereoscopic, head tracked display, hand? body tracking and binaural sound. VR is an immersive, multi-sensory experience. under this board definition, VR is also referring to as virtual environments, virtual worlds or micro words.

Technology is advancing and improving very quickly. What was once believed to be impossible has now become concrete reality. Virtual reality is one good example of an advanced technology that has developed rapidly. It is becoming a fashionable technology in the current decade and is based on learning from human experience, perception and sensory stimulations in such a way so as to enhance its learning progress in mimicking reality to improve the virtual experience quality.

It is difficult to imagine any architect, designer or engineer working without graphic programs, not to mention virtual reality technology. Such technology makes it possible to see the context through other dimensions and further enables users to experience things that are not necessarily accessible in the real world—or even before they exist or have been created.

Furthermore, three-dimensional graphics technology has no borders or physical constraints. Therefore, architects are able to create and manipulate designs as they wish and can enhance them through their imagination as a fourth dimension. This makes virtual reality an unavoidable tool in the future design palette of architecture.

In terms of its history, the term ‘virtual reality’ gained its popularity in the 1980s after the foundation of the VPL research by Jaron Lanier, which designed, marketed and sold VR products, such as the head-mounted display, 3D audio systems, data gloves

[177] Rae Earnshaw, *Virtual Reality Systems* ,Amsterdam: Elsevier Science, 2014, https://www.sciencedirect.com/science/article/pii/B9780122277481500093, p.3

and virtual reality software systems.[178] However, the origin of VR goes further back to 1838 when Charles Wheatstone proved that the human brain can process two stereoscopic images placed side by side in such a way so as to create a sense of depth and a feeling of three-dimensional realism. Nonetheless, the immersive experience of virtual reality was first introduced in a project called the 'Sensorama'—a semi-closed chamber created in the 1950s by Morton Heilig; this project was based on simulating 3D visual and sonic effects, wind, and odour in various environments.[179]

Both VR (virtual reality) and AR (augmented reality) are part of this innovative advanced technology. Many people get confused over the two terms or even consider them to be the same technology.

2-6-1 What is VR and What is AR?

Augmented Reality (AR): Computer-generated images or object stimulations reflected as elements in the real world. Another label is Mixed Reality (MR).[180] In this regard, users are aware of their context and can see the augmented objects as an overlaid layer.

Virtual Reality (VR): A totally artificial computer-generated environment where users are unaware of their surroundings (the real world) and experience a fully designed immersive sensory experience.

Both systems use Optical Head Mounted Displays (OHMD).

> *'OHMD's consist of various sensors such as IMU's (Inertial Measurement Units) that consists of accelerometer, gyroscope, and magnetometer. It also has a sound capture system, which consists of various microphones, and a camera to display virtual objects, environments, etc.'*[181]

[178] Peter C. Ashline & Vincent S. Lai (1995) *VIRTUAL REALITY An Emerging User-Interface Technology*, Information Systems Management, 12:1, 82-85, DOI: 10.1080/07399019508962962, https://www.tandfonline.com/doi/abs/10.1080/07399019508962962

[179] Virtual Reality Society; *History of Virtual Reality*. Virtual Reality Society 2018.last accessed 23rd April 2019, https://www.vrs.org.uk/virtual-reality/history.html

[180] Chavan S. R., June 2016; *Augmented Reality vs. Virtual Reality: Differences and Similarities*, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 5, Issue 6, ISSN: 2278 – 1323 , https://pdfs.semanticscholar.org/7dda/32ae482e926941c872990840d654f9e761ba.pdf

[181] Sidiq M.˙, Lanker T., Makhdoomi K., June 2017, International Journal of Computer Science and Mobile Computing (IJCSMC), Vol. 6, Issue. 6, pg.324 – 327, ISSN 2320–088X, last accssessed 23rd April 2019, http://www.ijcsmc.com/docs/papers/June2017/V6I6201748.pdf

Such devices are used to make the immersive experience persuasive to the users wearing them. As examples, there are the Microsoft HoloLens and Oculus Rift. Moreover, HoloLens technology is used as an augmented reality kit, which is beyond the scope of this research. In regards The Oculus Rift, this is the VR kit used in Synaesthetic Scape experiments. This headset blocks users from their surroundings and takes them into a completely artificial virtual scape, losing all sense of their real world. This device was released in 2016. Notably, users using this devise are free to sit, stand or wander around the room, but are never too far away from the computer.

Virtual Reality provides a powerful human–computer interaction, where the feelings of not only sight and sound are invested, but also feelings such as wind, smell, touch, motion and heat, etc., with users able to watch and change the simulated virtual environment in the same way they interact in reality.

2-6-2 The Immersive Practice of VR Technology

Many people possess rather narrow viewpoints concerning the application and implementation of VRS; it is widely believed that this technology was developed as a computer and video gaming tool[182][183], as well as a tool for the application of special effects within the cinema production industry. However, this technology has not yet been used to its maximum potential; whilst it is, indeed, used within the gaming industry, VR is also used within other areas. Such areas will be discussed below.

Architecture and Virtual Heritage

Firstly, Virtual Heritage (VH) can be defined as *'the use of computer-based interactive technologies to record, preserve, or recreate artefacts, sites, and actors of historic, artistic, religious, and cultural significance, and to deliver the results openly to a global audience in such a way as to provide formative educational experiences through electronic manipulations of time and space'*[184]; the technology of Virtual and Augmented

[182] Gödde, Michael & Gabler, Frank & Siegmund, Dirk & Braun, Andreas. (2018). *Cinematic Narration in VR – Rethinking Film Conventions for 360 Degrees*. 184-201. 10.1007/978-3-319-91584-5_15. P.2, last accessed 20 january 2020, https://www.researchgate.net/publication/325488933_Cinematic_Narration_in_VR_-_Rethinking_Film_Conventions_for_360_Degrees

[183] Bassas M., 2018 *VIRTUAL REALITY IN INDUSTRY*, Department of Industrial Technology and Management, SCHOOL OF APPLIED TECHNOLOGY, ILLINOIS INSTITUTE OF TECHNOLOGY, last accessed 28th January 2020, https://upcommons.upc.edu/bitstream/handle/2117/167750/VIRTUAL%20REALITY%20IN%20INDUSTRY.pdf?sequence=1&isAllowed=y

[184] Stone, R. & Ojika, T., 2000. Virtual Heritage: what next? *IEEE MultiMedia*, 7(2), pp.73–74.

Reality have many applications within both Virtual Heritage and architectural research, such as the first ever visualised walkthrough systems, which were implemented within architecture in the University of North Carolina in 1986[185]. In the same vein, another remarkable VR visualisation was that of the first virtual tour in 1994, providing a walkthrough, 3D reconstruction of Dudley Castle in England as how it was in the year of 1550[186]. Recently—in 2018—, the heritage preservation and reconstruction of destroyed historic sites produced the 'Experience Castlegate', which can be defined as an augmented reality project, bringing academics from the University of Sheffield (Archaeology, Architecture, and Computer Science) together alongside city partners Human Studio, whereby the first full 3D module of Sheffield Castle was developed [187].

The special thing about such technology can that it is being derived from the unique experience of being inside those buildings, which is an experience that cannot be delivered by simple 2D images or graphic animations; similarly, architects and interior designers implement VR to design and model their sketches, visualising them as though they can change light and colour, remodelling objects and being able to instantly see the results within the surroundings.

In terms of museums' guided tours, the Louvre and Victoria & Albert both offer online Virtual Tours curated for public audiences and children[188]; further, there are also museums rendered in Minecraft[189] (like that of the British Museum's Museum craft or Tate craft). Furthermore, the EU's DigiArt uses augmented and virtual reality technologies for viewing or interacting with the 3D models as a pathway to deepen understanding of artefacts.[190] In the same vein, VR technology was adopted by Volkswagen to present a prototype for wind tunnels (i.e., a study centred on the air flow around cars); conversely, this technology was used to visualise the dynamics of air flow around planes and space shuttles, as well as to visualise and study chemical molecules within scientific research.

[185] F. Brooks Jr.: Walkthrough, 1986 - *A Dynamic Graphics System for Simulating Virtual Buildings.* Proceedings SIGGRAPH Workshop on Interactive 3D Graphics (1968).

[186] Susan S. Lukesh (February 1995). 'Imaging The Past'. CSA Newsletter, Feb. '95. Center for the Study of Architecture. Last accessed 14th May 2019. http://www.csanet.org/newsletter/feb95/nl029504.html.

[187] This project was introduced to the public alongside with more VR projects in the exhibition entitled, *FutureCade* at the Millennium Gallery, Sheffield, UK, 2018, last accessed 1st May 2019, https://digitalmedia.sheffield.ac.uk/media/Experience+Castlegate/1_pmqd833h

[188] Mohamed Gamal Abdelmonem et al., 2017. *VIRTUAL PLATFORMS FOR HERITAGE PRESERVATION IN THE MIDDLE EAST: THE CASE OF MEDIEVAL CAIRO*. Archnet-IJAR, 11(3), pp.28–41. P.30

[189] Minecraft: is a sandbox video game originally created by Markus 'Notch' Persson, maintained by Mojang AB, and part of Microsoft Studios. It is heavily inspired by Infiniminer. Minecraft focuses on allowing the player to explore, interact with, and modify a dynamically-generated map made of one-cubic-meter-sized blocks. F. Kimbo, 2018: *Minecraft Chronicles: Story Behind Minecraft* Kindle Edition, 608 pages, ASIN: B07KFP2T3N

[190] Ibid. p.30

Guided VR tours for various destinations are provided for users so they can experience them before their actual visit—reminiscent of a 'try before you buy' service[191]. In terms of education, VR became an accessible medium whereby data was easy to perceive and manipulate; surveys have demonstrated the fact that Immersive VR tours within classrooms, as well as VR training for teachers and students, are taking place within the UK (e.g., the Augustine House Experiment (AHE) project, which tested a data processing and visualisation method designed to locate sensing and associated user datasets combined with 3D architectural models of the Augustine House; this pinpointed the possibilities for further development into a credible research apparatus, which then became applicable to post-occupancy evaluation of learning landscapes to inform planning and design of future learning spaces)[192]. This makes VR a common teaching tool, and it is a tool that is expected to increase in use within the next five years or so[193].

On the subject of healthcare, Virtual reality exposure (VRE) treatment is used to treat different kinds of anxiety disorders and been developed to a treatment called posttraumatic stress disorder (PTSD) which was used to treat active-duty soldiers suffering from combat related PTSD, they were exposed to an immersive simulation of a military convoy in Iraq. Self-reported PTSD symptoms and psychological distress were reduced at posttreatment relative to pre-treatment reports[194], also VR technology is used within psychotherapy by Gareth Walkom, a student in Nottingham Trent who developed a software with the ability to assist those dealing with speech impediments; this software was successful in monitoring anxiety levels within a variety of situations, producing feedback in terms of how stress levels can be improved.[195] Furthermore, Annerstedt and his group of researchers (Department of Landscape Planning, Swedish University of Agricultural Sciences) underwent a pilot study on the use of natural sounds within a virtual green environment in order to aid those suffering from stress[196].

[191] Techworld Staff, 19th July 2018; *What could Virtual reality be used for?* , Techworld, last acsessed 23rd April 2019, https://www.techworld.com/picture-gallery/apps-wearables/ways-virtual-reality-could-take-off-beyond-gaming-3638229/

[192] Peng, C. (2013) Learning from a new learning landscape: Visualisation of location sensing data in the Augustine House Experiment. British Journal of Educational Technology, 44 (5). 795 - 809. ISSN 0007-1013

[193]Techworld Staff, 19th July 2018; *What could Virtual reality be used for?* , Techworld, last acsessed 23rd April 2019, https://www.techworld.com/picture-gallery/apps-wearables/ways-virtual-reality-could-take-off-beyond-gaming-3638229/

[194]Reger GM. and Gahm GA, 'Virtual Reality Exposure Therapy for Active Duty Soldiers', Journal of Clinical Psychology, 64.8 (2008), 940–46, last accessed 28th December 2019, https://doi.org/10.1002/jclp.20512

[195] Ibid

[196]Annerstedt et al., 2013. Inducing physiological stress recovery with sounds of nature in a virtual reality forest — Results from a pilot study. *Physiology & Behavior*, 118, pp.240–250, https://www.ncbi.nlm.nih.gov/pubmed/23688947

In terms of VR live surgeries[197], the first live surgery was carried out on April 14, 2016, the patient being a 70-year-old battling colon cancer; this was conducted as part of a surgery training session and, more recently, the Imperial College London also started to implement VR technology within live surgeries. When it comes to data visualisation, presentation, and manipulation[198], large data was a complex processing job before VR developers created specialised techniques aiding in the visualisation of data with the aim of making them easier to perceive and easier for users to navigate through.

When it comes to training, VR technology is implemented in things like training astronauts to avoid hazards in the spaceship[199][200]—, or, on the other end of the scale, predicting hazards in driving tests[201]. It has also helped people battling disabilities to use computers[202].

In terms of the entertainment side of VR, in addition to games and home entertainment, VR entered the film-making world[203], and is used to create virtual scenes and environments of various locations—particularly in the case of the fiction and fantasy films like Oblivion (Joseph Kosinski); Inception (Christopher Nolan); Avatar (James Cameron); Fantastic Mr. Fox (Wes Anderson). On this note, Facial WaldoTM and VActor systems are applications that have been developed by Hollywood to incorporate emotional expressions on actors' faces[204].

After completing this survey, it is apparent that this technology will have an impact on various aspects of design, and is significantly affecting the design process in its early stages; accordingly, this research has provided an attempt to employ this medium to the experiment and designing of the Synaesthetic Scape in order to study the possibilities of

[197] Techworld Staff, 19th July 2018; *What could Virtual reality be used for?* , Techworld, last acsessed 23rd April 2019, https://www.techworld.com/picture-gallery/apps-wearables/ways-virtual-reality-could-take-off-beyond-gaming-3638229/

[198] Mazuryk T. & Gervautz M. (1999), *Virtual Reality - History, Applications, Technology and Future.* Last accessed 23rd April 2019,P.9 https://www.researchgate.net/publication/2617390_Virtual_Reality_-_History_Applications_Technology_and_Future

[199] Ibid, P.9 https://www.cg.tuwien.ac.at/research/publications/1996/mazuryk-1996-VRH/TR-186-2-96-06Paper.pdf

[200] Salamon, Nicholas & Grimm, Jonathan & Horack, John & Newton, Elizabeth. (2017). Application of Virtual Reality for Crew Mental Health in Extended-Duration Space Missions, last accessed 20th January 2020, https://www.researchgate.net/publication/320508189_Application_of_Virtual_Reality_for_Crew_Mental_Health_in_Extended-Duration_Space_Missions/citations

[201] Chatterjee P., 2018, *Classic Driver VR; A VR car-driving simulator for evaluating the user experience of new drivers by helping them to learn driving rules and regulations*, A Master's Thesis submitted to the Faculty of the WORCESTER POLYTECHNIC INSTITUTE/ Interactive Media and Game Development, last accessed 18th January 2020, https://web.wpi.edu/Pubs/ETD/Available/etd-121318-101026/unrestricted/pchatterjee.pdf

[202] Cahalance C.,2017, *8 Ways Virtual Reality Could Transform the Lives of Disabled People,* Ability Net, last accseed 28th January 2020, https://www.abilitynet.org.uk/news-blogs/8-ways-virtual-reality-could-transform-lives-disabled-people

[203] Gödde, Michael & Gabler, Frank & Siegmund, Dirk & Braun, Andreas. (2018). *Cinematic Narration in VR – Rethinking Film Conventions for 360 Degrees*. 184-201. 10.1007/978-3-319-91584-5_15. Last accessed 20 january 2020, https://www.researchgate.net/publication/325488933_Cinematic_Narration_in_VR_-_Rethinking_Film_Conventions_for_360_Degrees

[204] Dale K., Sunkavalli K., Johnson M.K., Vlasic D., Matusik W.& Pfister H., 2011, *Video face replacement*, ACM Transactions on Graphics (TOG)Vol. 30, No. 6, last accessed: 2nd of January 2020, https://dl.acm.org/doi/10.1145/2070781.2024164

enriching the design palette of architecture alongside the further level of the users' synaesthetic experience (sensory, emotional, and perceptual experiences).

2-6-3 VR technology Potentials and Limitations

Nausea and Motion Sickness in VR Use:

Motion sickness is caused by moving around the virtual environment whilst not physically moving in reality, just like sitting in a car or travelling by boat. In this case, *'the inner ear sends different signals to your brain from those your eyes are seeing'*[205] those confusing messages are the cause of Nausea.

Limitations: Surveys have shown that 25%–40% of VR users complained from experiencing nausea and motion sickness whilst using VR technology.[206] This could be the biggest obstacle in the way of achieving worldwide use of this technology.

Potential: Game-makers have managed to minimise motion sickness by adding a virtual nose into the user's field of view or a virtual hand in the graphics of the user by including virtual hands in the graphics[207]. Nonetheless, the user's brain still needs to make sense of a horizon line that syncs with the user's inner ear fluid and movements, which causes feelings of nauseous in the first place.

Another efficient solution to minimising motion sickness is The Body Nav technology—a new technology serving VR navigation in a natural way. This technology has been introduced by Monkey media[208] (a small technology company in Texas). With this system, users carry out virtual navigation through the use of actual body movements, such as by physically tilting their head forward to move within the virtual environment, for example, and the same head movements to move in different directions. This system allows users to move their head in-sync with the direction they are moving in

[205] NHS, UK. *Motion sickness*, Last accessed 23rd April 2019, https://www.nhs.uk/conditions/motion-sickness/

[206] Samit J. Last updated 6th February 2018; *A Possible Cure for Virtual Reality Motion Sickness.* Fortune. Last accessed 23rd April 2019. http://fortune.com/2018/02/06/virtual-reality-motion-sickness/

[207] Whittinghill D.M., Ziegler† B., Moore J., and Case T., 2015, *Nasum Virtualis: A Simple Technique for Reducing Simulator Sickness*, College of Technology, Purdue University/ Purdue University News, *'Virtual nose' may reduce simulator sickness in video games*, last accessed: 20th of January 2020, https://www.purdue.edu/newsroom/releases/2015/Q1/virtual-nose-may-reduce-simulator-sickness-in-video-games.html

[208] Takahashi D., 6th February 2018; *MonkeyMedia's BodyNav lets you navigate VR without getting sick,* Last accessed 23rd April 2019 ,https://venturebeat.com/2018/02/06/monkeymedias-bodynav-lets-you-navigate-vr-without-getting-sick/

the VR environment, which has a great effect in terms of minimising motion sickness see Figure 15.

1. **The senses invested in the immersive experience of VR:**

The five senses of Sight, Sound, Smell, Touch and Taste are all involved in people's ways of perceiving the world. Our memories and experiences are the result of our sensory interaction with our surroundings. The more senses that are involved in the process, the greater the efficiency and immersiveness of the experience.

Limitations: Currently, the number of sense invested in the immersive experience of VR totals three, namely visionary, audio and the haptic VR experiences, all of which are not yet implemented in its full potential. As such, VR designers are working on developing the efficiency of the immersive experience of VR technology. The areas on which they are working include haptics, visuals, audio and tracking features see Figure 16.

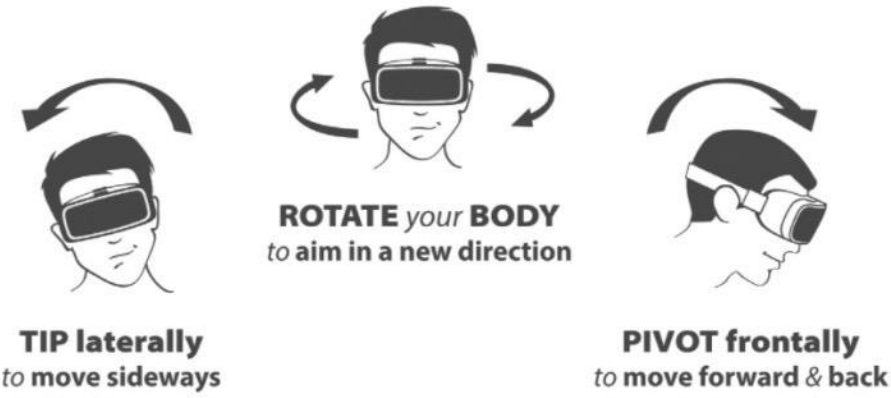


Figure15: Body Nav technology, How Body Nav works, Image Credit: MonkeyMedia, (https://venturebeat.com/2018/02/06/monkeymedias-bodynav-lets-you-navigate-vr-without-getting-sick/)

Figure 16: Oculus senses invested (to be improved).
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https://techcrunch.com/2015/03/26/the-biggest-challenges-left-in-virtual-reality-according-to-oculus/

Visionary experience: Improving graphics quality in the Oculus Rift headset is an ongoing process.

Potential in Improving the Visual Experience: There are a many steps to achieving this goal. The first and easiest step is improving the hardware on the PC end of the process, such as getting the best graphics card on the desktop powering the oculus headset. This would help with achieving more realistic shadows, more polygons, and more realistic materials and textures in the VR environment[209].

The second step would be to achieve an improved visionary experience through developing the optics and screen of the oculus headset.

The Third step would be to work on the goggle's field of view, which is currently 110 degrees, whereas the human eye field of view is 280 degrees. This means that the use of advanced lenses and screen with a resolution greater than the most recent version of iMac (Retina 5K); however, this begins at US$2500.

Limitations: The cost of this technology is an obvious obstacle against its widespread use.

Audio or Aural Experience: The older version of Oculus Rift requires plugging in a set of headphones to achieve the 'I'm incapsulated[210] in a virtual scape' experience, This headphone is noise-cancelling. Importantly, however, the new versions of the VR headsets intend to have their own headphone set built-in the VR Goggle itself.

Noise-cancellation is an additional feature to the built-in headset. However, there remains more room for improvement in regards the aural quality of the audio used and its spatial effects.

The Haptic experience controllers and tracking: This aspect is just as important as the visual and aural aspects of the immersive experience of VR technology; however,

[209] Interview with Robert Stacey, BSc (Hons), MIET. Teaching Technician - Virtual Reality, Multidisciplinary Engineering Education, Faculty of Engineering, The Diamond, University of Sheffield, interview was designed by the researcher.

[210] Russell, K., *The Biggest Challenges Left In Virtual Reality, According to Oculus,* techchurch, last accessed 21st April 2019, https://techcrunch.com/2015/03/26/the-biggest-challenges-left-in-virtual-reality-according-to-oculus/

it is the most complicated and is where the most investments like Sony, Microsoft and Valve are right now[211].

Limitations: The Haptic experience is still not used to its full potential in the immersive project of VR. Furthermore, Oculus has produced Touch controllers that are basically joysticks and button controls; they use technology similar to law-latency tracking. This technology captures the relative position of the headset, and allows mapping based on how users hold the controller.[212] The controller's design mimics the feeling and function of real hands when gaming, capitalising on internal tracking sensors and haptic feedback. Nonetheless, this technology still has a long way to go in terms of development in making the hand experience just like that of the real world.

Future Potentials: Oculus not only designs tracking hands to interact within the virtual environment but makes the VR environment interact in return with the user. This allows the user to feel the objects they touch. Gloves, joysticks and other VR controllers could further enhance the immersion of the VR haptic experience.

Tracking Limitations: On the tracking front, the Oculus provides 'nigh-perfect camera-based tracking'[213] up to four-foot by four-foot square, which is considered a relatively small racking area.

Future Potentials: The Oculus team are almost there in terms of developing a technology that allows a full-on Holodeck-style, where tracking sensors cover a living room's worth of space.

2. Individual Log to the VR system

The VR Technology has enhanced a fruitful communication between designers, investors and users whilst the design process is still ongoing. This has helped all members of this equation to be confident and satisfied with the final product whilst benefitting from minimum risks.

[211] Parisi D.,2015, *A COUNTERREVOLUTION IN THE HANDS: THE CONSOLE CONTROLLER AS AN ERGONOMIC BRANDING MECHANISM,* JOURNAL OF GAMES CRITICISM, last accessed 21st January 2020, P.1&3, http://gamescriticism.org/articles/parisi-2-1/

[212] Martindale, J.; *Oculus Rift vs. HTC Vive; Prices drop, but our favorite stays the same*, Digital Trends,14th December 2018, last accessed: 21st April 2019, https://www.digitaltrends.com/virtual-reality/oculus-rift-vs-htc-vive/

[213] Russell, K., *The Biggest Challenges Left In Virtual Reality, According to Oculus,* techchurch, last accessed 21st April 2019, https://techcrunch.com/2015/03/26/the-biggest-challenges-left-in-virtual-reality-according-to-oculus/

Limitations: Currently, the VR system allows investors, designers and users to test models in a virtual medium with an individual log into the system each time. For example, if those people are testing a specific model, each of them shall use the VR kit separately whilst others are watching and awaiting their turn.

Discussion and reactions around the model will occur after all members of the discussion have a go.

Future Potential:[214] Developing the VR system for use in social virtual environments where many users are allowed to interact with one another and with the environment itself. This creative environment is not an idea beyond each; it is actually a feature VR researchers are working towards achieving. The rapid progress of this technology will not only enable users to view models and ask questions, but will also allow users from many different locations around the world to gather in a virtual environment at the same time, allowing them to exchange ideas and truly collaborate in the design process. Users can even manipulate those environments and change their design parameters in such a way that ensures a fruitful time for design exploration. Eventually, this will lead to a successful built product that is well-tested before it has actually been built.

3. Expensive Technology

Limitations: This technology remains a very expensive one; the more realistic and immersive the experience, the more complicated and expensive the technology. Hopefully, however, with the passing of time, this technology will grow to be more affordable and therefore more available for everyone to experience.

After the exploration of the term `Synaesthetic Scape as a virtual experience, that benefits from synaesthesia as a cross-sensory experience to enhance the sensory experience of architecture in general.As a starting point to be able to design the first Synaesthetic Scape I decided to use the techniques of interior design that help achieve a situation that can be close to the proposed idea of Synaesthetic Scape.

[214] Mazuryk, T. & Gervautz, M., *Virtual Reality - History, Applications, Technology and Future,* Institute of Computer Graphics,Vienna University of Technology, Austria, research gate, December 1999, https://www.researchgate.net/publication/2617390_Virtual_Reality_-_History_Applications_Technology_and_Future
Rotella, J., *3 Ways Multi-User VR Will Enhance the Design Work of the Future,* ArchDaily, 7th February 2018, last acced ; 21st April 2019, https://www.archdaily.com/888583/3-ways-multi-user-vr-will-enhance-the-design-work-of-the-future

2-7 Interior Architecture Practice and Dramatic Situations

Many interior design studies have explored aesthetic issues in architecture and interior spaces, with some having focused on the metaphysical and psychological studies. It has generally been assumed that artistic metaphors are a key source for the language of contemporary interior spaces, as mentioned by Al-Akkam in his book *Aesthetics Of Architecture and Interior design* (2011) [215]. Notably, he focused on the dramatic phenomenon and its influence on the audience, and considered the arousal levels of drama as an affective source of interaction with the built interior spaces. Moreover, he also considered drama as one of the metaphoric artistic sources and used drama terms, such as tension, conflict, illusion and attention, to represent certain dramatic situations to be reflected in the design of contemporary interior spaces. In his study, he proposed a design method in interior design by combining the following:

A. Four basic factors (layers):
   1. structural principles (physical layer of the space) using the term 'interior space indicators', which consist of form, mass, surface, and time.
   2. 'Dramatic characteristics', which refer to attention, illusion, conflict, and tension.
   3. optical perception, involving features, segregation, stimulation, and cues.
   4. Meaning (the layer of the concept or, as he called it, the artistic metaphor of the space').

B. Complementary factors (light, colour and material).

Al-Akkam further proposed the stages of the design process, which he used to combine the factors mentioned below see Figure 17:

Stage 1:

a. Adopt a base map and determine the characteristics (positive and negative) to be resolved.

b. Addition of the functional requirements (activities, circulation, zoning) and specify the orientation, focal points and the visual axes within the base map.

[215] Al Akkam, A. (2010-2011). The Aesthetics of Architecture and Interior design (The dramatic situations in the aesthetics of the contemporary interior space language). Amman,Jordan, Dar Majdalawi Pub.&Dis.

Stage 2:

1. Specify the linguistic orientation in architecture (traditional, postmodern, deconstruction, integration, high- tech, etc.).
2. Choose a psychological concept (excitement, transparency, comfort, dynamism, etc.).
3. Discuss the indicators of the interior space language and select the ones that achieve the psychological concept; the indicators include:

- Form -> form of the space, furniture, and form elements within the space
- Mass -> the interior space mass, furniture (optical weight mass)
- Fourth dimension - (movement of light, fountains, statues, plants…)
- Surface of the inner space, which includes the following indicators:
- Colour (the colour of the furniture, the colour of the space)
- Light
- Pattern
- Material and texture
- Accessories (plants, paintings, statues…)
- Treatment of doors and windows

4. Determine the design approach adopted (interior architecture, interior design).

Stage 3:

Use the indicators of the interior space language used to achieve the chosen psychological concept, linguistic orientation of the architecture, and the design approach, and accordingly study how to achieve the space shell, furniture and other accessories, and examine the relationship between the shell and furniture.

Stage 4:

Design the insights of the chosen drama, achieving the indicators of the chosen language, and their impact on the design output of the preceding stage.

Stage 5:

Prepare the final drawings of the design for clients.

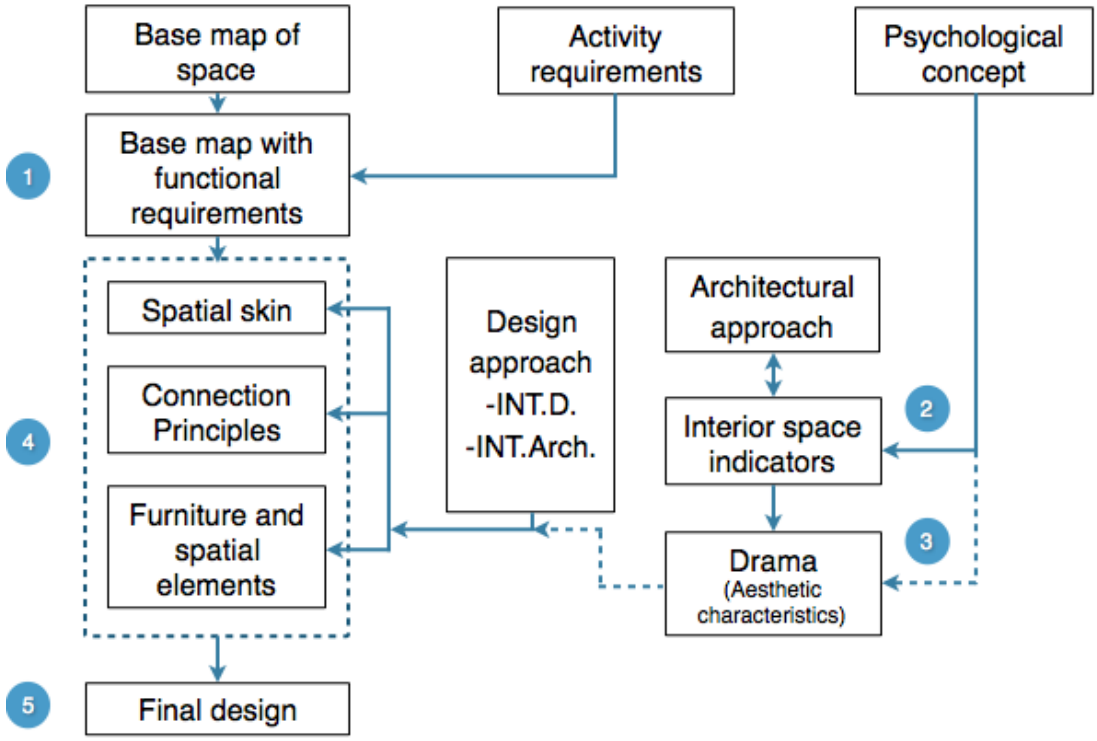


Figure 17: Al-Akkam proposed stages of the design process of contemporary interior spaces. (drawing by the researcher, based on self-notes from Al-Akkam University lectures of Interior design/ Department of Architecture/ The University of Technology, Baghdad, Iraq. (1999)

For the research design purpose, I used this design process as a starting attempt to design my proposed Synaesthetic Scape. Then allow it to evolve with the help of the participants' feedback and evaluation of the VR experience they went through, by evaluating and validating the quantitative and qualitative methods and indicators used and resulted from the research experimental approach. This was developed throughout the research.

This design process was approached in an iterative manner: it changed and developed during every stage of the Synaesthetic Scape experiments. These will be discussed in detail in the next chapter of this thesis.

2-8 The research participation to knowledge

Here I decided to summarise the research participation or addition to each filed which was explored in this chapter in the following diagram in Figure 18.

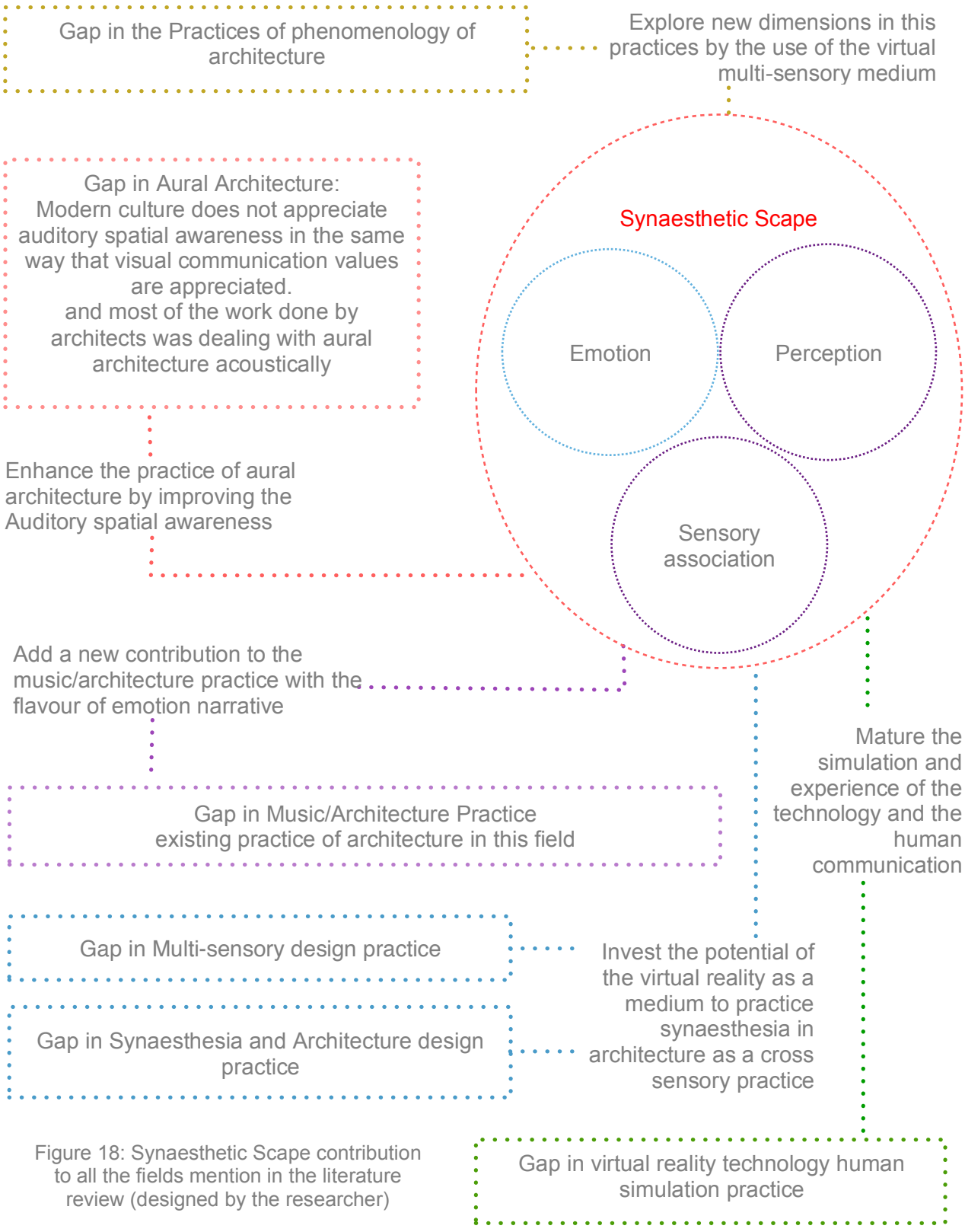


Figure 18: Synaesthetic Scape contribution to all the fields mention in the literature review (designed by the researcher)

Chapter Three

Research Experimental Context

Research experimental context

The previous chapter was concerned with setting the theoretical context of the research, describing its scope within the existing knowledge, and addressing its contribution to knowledge. This chapter is focused on establishing the practical experimental context of the research, which consists of three experimental stages. It will describe each experiment in terms of the design process and elements used in a comparative manner. It will then discuss the results drawn from the quantitative method applied, and also address the themes resulting from the qualitative method utilised in the work. The final chapter will then be dedicated to discussing the themes emerging from the research on Synaesthetic Scape within the existing knowledge in the field of architecture.

Owing to the fact that the research is essentially centred on the idea of the architectural sensory experience for both architect and the user, the aim is concerned with expanding such an experience, moving from representation primarily orchestrated via the dominant visual sense to a renewed communication with the other senses. This is done in such a way that mimics the real human experience with real lived environments, and it is hoped that this will reflect positively on the overall design process.

In this regard, the researcher needs to clarify two issues before going into detail with the experimental approach of this research:

First and foremost, in this research, there is a need to establish a difference between the Synaesthetic Scape multi-sensory approach and the new evolving approach of multimodality which is also based on the use of the multi-sensory channels. As a result of this, the Synaesthetic Scape multi-sensory approach and the project experience might also add knowledge and insight to the practices within the field of multimodality.

As mentioned earlier, this research explores the notion of the Synaesthetic Scape as a territory in which virtual perceptions are merged with other sensory associations, perceptions and emotions. For Frascari, sensory perception in synaesthesia transpires as an ‘emotional state of affairs’ that is difficult to describe: ‘synaesthetic inter-sensory associations are emotional states of affairs appreciating that there are ineffable things

you hear, invisible things that you see, and impalpable things that you touch, that are describable but beyond words'[216]

Clearly, the synaesthetic experience as referred to by Frascari is a blend of perception, emotions and sensory associations, where the senses cross involuntarily. Importantly, this makes it difficult to study the effect of each sense or 'channel', as multimodality refers to it in terms of the input stimuli or the output effect on the whole experience, either individually or from other senses or channels.

On the other hand, through the application of the multimodality approach, each channel affects each sense, which are studied and analysed separately so as to evaluate the overall efficiency of the multimodal process since it is basically directed towards serving a computer simulation of the human experience as part of the inelegant learning of the artificial intelligence[217]

With regard to the second issue, this centres on justifying the practice-based approach in order to answer the research question, which is, how can a Synaesthetic Scape be designed?

As mentioned previously, this PhD project is of a co-productive approach or nature, where participants are involved in the evaluation and validation of the experimental approach used in this research, giving insights in such a way so as to accordingly develop the design process of the experimental stages.

Consideration is directed towards why experiments are completed, how the experimental approach will enhance the exploration of the term 'Synaesthetic Scape', whilst addressing or highlighting its basic characteristics, and the way in which such characteristics in the architectural design process of VR can be both implemented and tested.

The researcher applied a practice-based research approach in order to tackle the research problem under examination. Moreover, design was used as a practical experimental approach, referred to as '**experimental inquiry**', and employed as a tool to explore and understand the newly proposed term of 'Synaesthetic Scape' and the

[216] Frascari, M. (2003). "Architectural SYNAESTHESIA: a hypothesis on the makeup of Scarpa's modernist architectural drawings." Academia.https://www.academia.edu/308741/Architectural_Synaesthesia_A_Hypothesis_on_the_Makeup_of_Scarpas_Modernist_Architectural_Drawings, p.2

[217]Bernsen N. (2008) Multimodality Theory. In: Tzovaras D. (eds) Multimodal User Interfaces. Signals and Commmunication Technologies. Springer, Berlin, Heidelberg. Last accessed 10th May 2019, https://link.springer.com/chapter/10.1007%2F978-3-540-78345-9_2, Or http://www.nislab.dk/Publications/MULTIMODALITY-THEORY-10.9.07-F.pdf

way in which its characteristics should be implemented within the design of architectural virtual environments. This implementation was further tested and evaluated through refined experiments.

Such a pragmatic approach of the research emphasises the practical application of the Synaesthetic Scape as an idea through its acting and exploration, and testing with human experience. Thus, participants have a major role to play in terms of evaluating and validating the findings of this experimental research.

'Experimental inquiry' is a concept that was initially presented by the pragmatist philosopher John Dewey. It is a 'process of generating and testing hypotheses for the purpose of understanding some physical or psychological phenomenon'[218]. Dewey proposed the concept of progressive education, which emphasises the importance of 'learning by doing' and a 'hands-on' approach.[219]

Pragmatists have proposed new directions when it comes to understanding the nature of social research by 'experience'. From Dewey's perspective in education, this means that, in order for students to learn, they have to be involved in an interactive relationship with the educational context. This similarly applies to teachers, meaning that teachers and students can learn together in an interactive relationship with the educational context or environment. In terms of the Synaesthetic Scape sensory approach of this research, this means that both designers and users learn through interaction with the newly proposed VR environment, which will eventually result in understanding and improving the Synaesthetic Scape environment. Dewey's proposed ideas of classroom interaction were reflected in his democratic ideals, which promoted an equal voice amongst all participants in the learning experience. This positions the user at the same level of importance with the architect in the design process of Synaesthetic Scape, where both seek deeper understanding in relation to the newly proposed concept of Synaesthetic Scape and ways of implementing this understanding in the process of improving the Synaesthetic Scape sensory experience in both VR technology and architecture.

'John Dewey's conception of experimental inquiry can be usefully described as a quantitative science for qualitative amelioration. The value of any science is the qualitative differences it makes in lived experience—qualitative changes achieved through material means, through means open to controlled and quantitative

[218] Marzano, R. J. (2000). Designing a new taxonomy of educational objectives. Thousand Oaks, CA: Corwin Press. p.57
[219] https://study.com/academy/lesson/john-dewey-on-education-impact-theory.html

investigation'[220]. Co-productive design was adapted by this practice-based research where participants have an advanced role in terms of evaluating and providing insights concerned with improving the newly proposed experience of Synaesthetic Space. A mixed-methods approach was adopted as a research method. Notably, this approach is widely used amongst new learning environments, new online learning settings (Furlong & Davies, 2012)[221] ; (Plowman, 2016)[222], learning on the move (Hwang & Shih, 2015)[223]; (Seta, Kukulska-Hulme, A., & Arrigo, 2014)[224], and learning virtually (Ainley & Armatas, 2006)[225]; Barbour & Hill, 2011)[226]. Furthermore, as mentioned at the beginning of this chapter, the research experimental phase consisted of three experimental stages, each with its own hypothesis with which to engage, questions to answer, and methods of collecting and analysing data for evaluation and validation by users.

The following text will discuss the three experiments in two different modes of discussion:

1. The first experiment will be descriptive in nature, involving the researcher describing everything about the three Synaesthetic Scape experiments (design concept, description, theme of design elements, and the criteria of choosing the participants of each experiment).
2. The second experiment will be comparative, with the researcher comparing the design process of each experiment and why it changed from stage to stage, the methods used, the quantitative results and insights, and the recommendations across all three experiments.

[220] Paper by Solymosi, Tibor; *Recipes for Experience: Democracy, Education, Art and the Brain*, Mercyhurst University, USA, published for the Pragmatism Today: Perspectives on Cognition, Education and Society Papers and Research conference proposals, paper no.5, p.1.
http://conferences.au.dk/fileadmin/conferences/2016/Pragmatism_Today/Papers_and_Reseach_Proposals_Pragmatism_Today_Perspectives_on_Cognition_Education_and_Society.pdf

[221] Furlong, J., & Davies, C. (2012). Young people, new technologies and learning at home: taking context seriously. Oxford Review of Education, 38(1), 45-62. doi:10.1080/03054985.2011.577944.

[222] Plowman, L. (2016). Learning Technology at Home and Preschool The Wiley Handbook of Learning Technology (pp. 96-112): John Wiley & Sons, Inc.

[223] Hwang, G.-J., & Shih, J.-L. (2015). Experiences of Using a Blended Mobile Learning Approach to Connect Classroom and In-Field Learning Activities in a Local Culture Course. In L.-H. Wong, M. Milrad, & M.

[224] Seta, L., Kukulska-Hulme, A., & Arrigo, M. (2014). What have we learnt about mobile LifeLong Learning (mLLL)? International Journal of Lifelong Education, 33(2), 161-182. doi:10.1080/02601370.2013.831954

[225] Ainley, M., & Armatas, C. (2006). Motivational Perspectives on Students' Responses to Learning in Virtual Learning Environments. In J. Weiss, J. Nolan, J. Hunsinger, & P. Trifonas (Eds.), The International Handbook of Virtual Learning Environments (pp. 365-394): Springer Netherlands.

[226] Barbour, M. K., & Hill, J. (2011). What are They Doing and How are They Doing It? Rural Student Experiences in Virtual Schooling. Journal of Distance Education (Online), 25(1), 1.

The research combines the design process in architecture with the architectural practice in a virtual medium, and evaluates/validates the designed environment with users in an iterative and refined experimental context.

As will be seen following the completion of these experiments, the researcher will seek to achieve the goal of using such experimental inquiry or attempts to reach these goals, which are as follows:

1. To explore the Synaesthetic Scape term and determine its basic characteristics, including: how does it look, how does it sound, how does it feel? Furthermore, questions will be posed as to whether the researcher can connect it with an old experience and whether any benefit can be derived from old experiences when seeking to perceive, explore and understand it.
2. To identify ways through which the experience of the Synaesthetic Scape can be achieved and the tools that can help in making it achievable.
3. To evaluate and validate, with discussion on how to evaluate and validate the above findings, and the extent to which users can help in the process, from the design stage through to the final product stage.

All of the aforementioned goals were attempted in the first pilot experiment, which tested 'Sound Space', which is understood to be representative of an early example of Synaesthetic Scape.

3-1 Sound Space

The Sound Space Design Concept

What is the Sound Space Concept and what is its Design Concept?

In 2002, the researcher undertook a Master's project [227], referred to as 'Sound Space', focused on four animated works of architecture. Sound Space is a developed version of Al-Akkam's Ideas in interior design. It combines Al-Akkam's method of design principles of dramatic situations aesthetics in contemporary interior design language alongside Meyer's Ideas of aesthetics and philosophy of music. Meyer denies that music gives rise

[227] 'Sound Space' the researcher's master's Project, submitted in November 2002 as part of fulfilling the requirements of the MA ART and Space Master's course, Kingston Upon Thames, Kingston University, London, UK. The supervisors were: Louis Nixon (first supervisor) and Shona Illingworth (second supervisor).

to constant, distinguished emotional behaviour (such as happiness), focusing instead on the level of arousal, using terms such as ‘tension’ and ‘release’ to express more accurate emotional–psychology definitions.

The work of Al-Akkam aimed at achieving four drama characteristics, namely illusion, attention, compression and tension. In line with this purpose, he developed guidelines and steps to facilitate the building of dramatic situations by achieving such dramatic characteristics in any interior space (see Al Akkam’s dramatic characteristics ways of achievement guidelines, Appendix, Section Four). Furthermore, the scholar used the design indicators of form and the third dimension, mass, the fourth dimension, light and colour, physical elements (structure, materials and texture), and furniture.

For the purpose of the researcher’s design, focus has been directed towards only the following indicators: light, colour, materials and texture. Accordingly, such indicator guidelines were used to design Sound Space, which consists of four animated works.

The Sound Space aims were as follows:

1. To create a platform where architects and users communicate in an emotional and at a multi- sensory level.
2. To discuss the pilot study hypothesis and answer this stage’s research questions.

The hypothesis and questions of this stage are as follows:

‘A ‘Synaesthetic Scape’ experience can be achieved by tuning the design tools of light, colour, texture and materials (which are believed to influence the mood in the space emulating any real architectural experience)’.

The subsequent two question relate specifically to the sound space:

- What are the right levels of light, colour, materials and texture to influence the emotional engagement of participants with the space?

- To what extent can music be used to provoke emotions in order to create the emotional aspect of the synaesthetic experience?

The four animated works are 4 different types of spaces which differs from each other in terms of the space scale and concepts.

3-1-1 Sculpture

A mono-interior space of a gallery section, display of an abstract sculpture (Figure 19). The sculpture floats in the centre of a cylindrical space, shaped by a spiral, stripped wall. There are four glass bubbles floating around it, and the camera is built into one of the floating bubbles. The bubbles move around the sculpture in a spiral path, generated from a lava-like ground at the bottom of the sculpture and all the way around the sculpture then back to the ground.

The bubbles' movement is synchronised with a piece of music playing throughout the course of the whole animation, which creates an emotional envelope for the animated experience. The design symbolises an abstract journey of a human from birth through to death.

The Theme of Design Elements Used

Colour: Warm colours, earthy shades of an analogous colour scheme project (orange, yellow, brownish-orange) and a split-complementary colours scheme with the addition of purple to the analogous scheme (see the Colour Schemes, Appendix, Section 3).

Light: The lighting system here was mainly white spotlights directed at the sculpture, with such spotlights located in a spiral order around the sculpture at different angles, which helped to create dramatic shadows on both the sculpture and spiral wall. A reddish spotlight was directed at the lava-like ground in order to emphasise the difficult moment of birth. A purple volumetric light was used to exaggerate the dramatic effect on the sculpture and its shadows.

Materials and textures: A wavy-textured concrete material with smooth finish, with a look similar to the bottom of a volcano (symbolising a difficult moment of birth). A rough material skin, which creates a spiral wall for the space, with horizontal strips of void within the skin. A transparent smooth material for the floating bubbles alongside a

smooth solid material for the sculpture's pointy parts body, and a wire framed material for the sculptures top.

Music: The music is a remix of the Arabic version of Les Misérables 'Leil Al Mousafirin'[228] , which is a heavy, deep, relatively sad piece of music with a narrative dimension that matches the design description of this part of Sound Space.

Dramatic Situations Achieved

The dramatic situation was achieved as follows (see the Dramatic Characteristic Ways of Achievement, Appendix, Section 3):

Attention: Through the use of excessive orange hues and contrasting them with dark shades of brown-orange.

Conflict: Mixing a split-complementary colour scheme with an analogous colour scheme. This leads to a contrast in the colour hues used.

Illusion: Manipulating the lighting system used in a way that makes it difficult to determine the real size or volume of the space by hiding the lighting source and showing the light cones directed into some parts of the space and the objects inside.

Tension: Using more than one light source directed into the objects and in different distances, this light manipulating process produces sharp and faint wired-looking shadows.

[228] S. Kwefati, 2000,' *Leil Al Mousafirin',* from Leil Al Mousafirin Album, Licensed to YouTube by**:** Watan Network Music (on behalf of Samir Kwefati), this music was composed to be the theme music of a Syrian series entitled *Leil Al Mousafirin* where the music got it's title from, the director was Ayman Zeidan. The series is an Arabic version of Victor Hugo's novel *Les Misérables*. https://www.youtube.com/watch?v=syEBAw2ocV8

Figure 19: Still images from the animated work SOUND SPACE ‘Sculpture’ by the designer Maha Al Ugaily as part of fulfilling the requirements of a Master’s degree at Kingston University, London, 2002.

3-1-2 Gallery

A three-levels art gallery, consisting of four small art spaces (sections), which overlook one off-centred double-volume space. The entrance is too narrow (Figure 20), just like a bottle neck or a rabbit hall, which opens up into an intermediate bigger art space with a smooth transaction between the two spaces. The transaction between one space and the other is either through narrow, tall openings in transparent partitions, or ramps vertically from one level to the other.

Theme of Design Elements Used

Colour: The colour palette for the gallery is a mixture between tinted and shaded primary and secondary colours. It is a rectangular tetradic colour scheme (see Colour Schemes, Appendix, Section 3).

Lights: General lighting is applied here, and coloured spot lights directed into sculptures and paintings are exhibited within the gallery.

Faint shadows are produced as a result of many over lapping light cones.

Materials and textures: Transparent material for interior partitions. Rough, coloured stone materials for the outer skin. Steel structures for the hand rails, which are used in the cases of the mezzanine and circulation ramp. Large ceramic tiles for the floors (Figure 21).

Music: The music is a remix of the known musician Anwar Abu Dragh for an Iraqi traditional old song ‘Chi Mali Wali’ by the known old Iraqi singer Yousif Omar. This is a remix of old Iraqi music melodies, played with new Western music instruments. They provide a good mix between the old and the new, with nostalgic, happy and sad moments all equal.

Dramatic Situations Achieved

The dramatic situation was achieved as follows (see Dramatic Characteristic Ways of Achievement, Appendix, Section 4):

Attention: The excessive use of rough textures and large scale of flooring tiles.

Conflict: The excessive use of rough materials and the contrasts of such with the use of transparent and reflective materials and objects. This contrast in texture enhances the conflicting situation.

Illusion: By creating layered scenes using transparent materials in front of rough objects and vice versa.

Tension: The light sources are not organised around a systematic order/, but rather are spread randomly around the space.

Therefore, not all objects and surfaces are brightened equally.

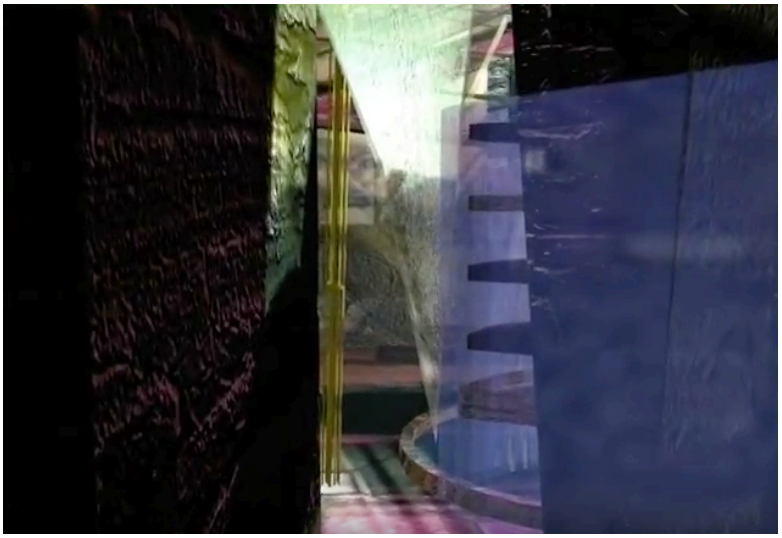
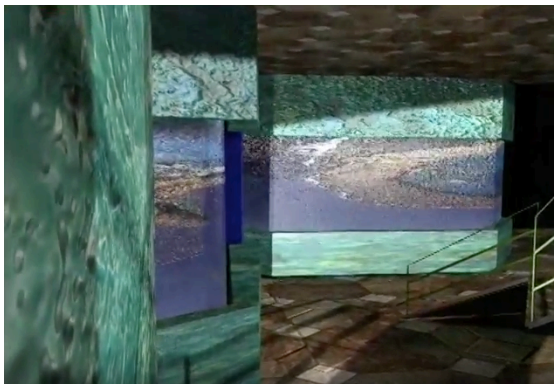
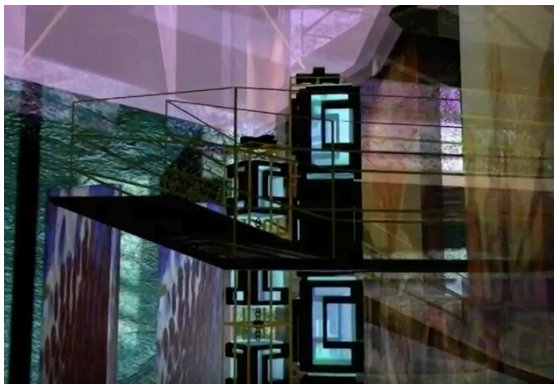


Figure 20: A still image from the animated work SOUND SPACE ‘Gallery’ that shows the space narrow entrance, (by the designer Maha Al Ugaily as part of fulfilling the requirements of a Master’s degree at Kingston University, London, 2002).





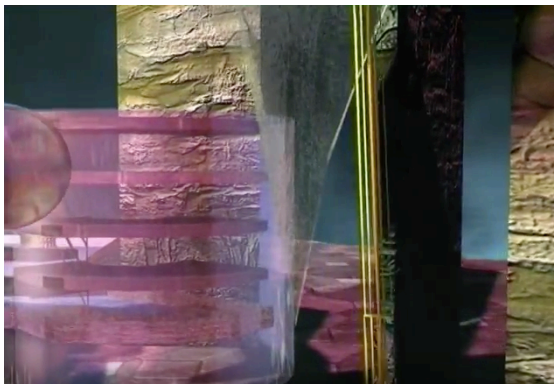


Figure 21: Still images from the animated work SOUND SPACE ‘Gallery’ by the designer Maha Al Ugaily as part of fulfilling the requirements of a Master’s degree at Kingston University, London, 2002.

3-1-3 Infinity 1 & 2

This animated work is referred to as infinity because it challenges the boundaries of time and space. This animated work integrates two over-lapped dissolved animations. Notably, one animation moves in a slow, constant motion, whilst the other one on top is in a fast constant motion so as to represent the concept of infinity on top of these two animated layers. There are places where the still images sit on top of the two layers in a dissolved effect.

Infinity is achieved by breaking the boundaries of space with confusion between many dualities, such as:

1. In vs Out
2. Industrial high tech vs natural organic style
3. Traditional vs modern architecture.

It also breaks the boundaries of time by confusion between the past, present and future. Even the music track was cracked in order to make sounds unclear, as in the case of blowing air into the music track to support the state of confusion.

The difference between Infinity 1 & 2 is that each of them starts in a different way (Figure 22).

Infinity 1: The animated clips are built on an infinite line, which has a starting point and no ending point, as in the case of an infinite ray (Figure 23a).

On the other hand, Infinity 2 has the animated clips built on an infinite line, which has no starting point and no ending point (Figure 23b).

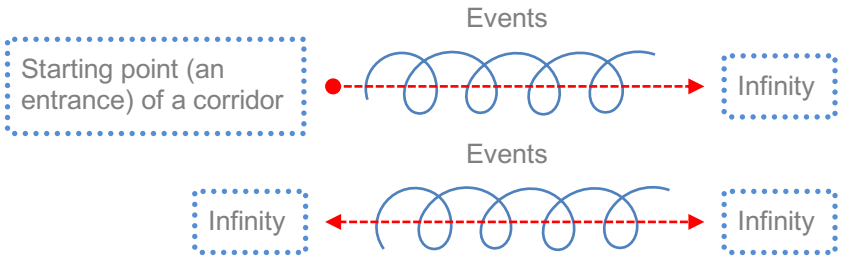


Figure 22: Diagram explaining the difference between Infinity 1&2 in terms of event sequence inside the animated work.

Figure 23a: A still image from the animated work SOUND SPACE ‘Infinity 1’, shows the first scene of the animation which represents the starting point of the infinite ray. (by the designer Maha Al Ugaily as part of fulfilling the requirements of a Master’s degree at Kingston University, London, 2002).

Figure 23b: A still image from the animated work SOUND SPACE ‘Infinity 2’, shows the first scene of the animation which represents no starting point to the infinite line of events. (by the designer Maha Al Ugaily as part of fulfilling the requirements of a Master’s degree at Kingston University, London, 2002).

Theme of Design Elements Used

Colour: The Tetradic Rectangular Colour Scheme is used here; four colours that are seen to complement each other in the colour wheel, namely yellow and green vs red and purple, both tints and shades (see colour, the colour schemes section, appendix, section five).

Light: General lighting is applied here, with the use of coloured spotlights directed into sculptures and paintings exhibited within the gallery. Faint shadows are produced due to many overlapping light cones (Figure 24).

Materials and textures: A combination of light and heavy materials, wooden and steel partitions vs stone and concrete elements. Smooth and transparent objects vs rough natural objects.

Music: The music here was remixed to the theme music of the known Syrian fantasy series ‘Al Bawasil’, which is a fantasy narrative that combines a unique melody of a mixed use of traditional and modern instruments. The researcher edited this remix personally and made it distorted in an attempt to blur the line between clear sounds and unclear sounds. This was done in order to enhance the idea of mixed contradictory elements.

Dramatic Situations Achieved

The dramatic situation was achieved as follows (see/ the Dramatic Characteristic Ways of Achievement, Appendix, Section 4):

Attention: The excessive use of rough textures and manipulating the scale of certain built elements in a way that makes it different from its normal scale.

Conflict: The excessive use of rough materials and their contrast with the use of transparent and reflective materials and objects. This contrast in texture enhances the conflicting situation.

Illusion: By creating layered scenes using two dissolved overlapped layers of materials and objects.

Tension: The light sources are not organised around a systematic order, but rather are spread randomly around the space. Therefore, not all objects and surfaces are brightened equally.

3-1-4 Participants

The participants comprise peer PhD students who were originally architects and designers because they can discuss and use the tools and vocabulary of the studied field and also because they are members of the public about whom the study is seeking to explore emotional interactions with certain pieces of music, and accordingly use them as insights to design an emotionally influential virtual environment.

The software used in the design of Sound Space;

1. 3D Max. (Architectural design and animation).
2. Adobe premiere (video editing).
3. Sound edit 16 (Music editing).

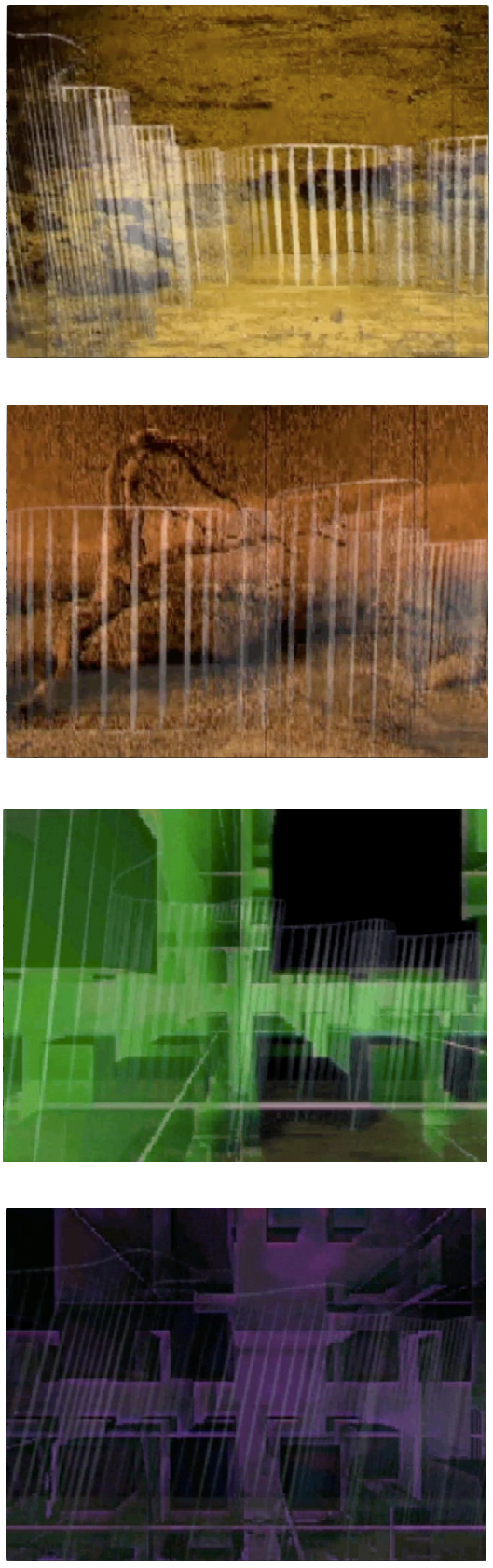


Figure 24: Still images from the animated work SOUND SPACE ‘Infinity 1&2’, shows the theme of colours and light used (by the designer Maha Al Ugaily as part of fulfilling the requirements of a Master’s degree at Kingston University, London, 2002).

3-2 Synaesthetic Scape 1

Synaesthetic Scape 1 Design Concept:

What is Synaesthetic Scape and what is its design concept?

Synaesthetic Scape is a platform designed to allow users to experience a combination of a virtual spatial experience with the concept of synaesthesia as a multi-sensory experience. However, the Synaesthetic Scape is primarily an audio-visual sensory experience with the haptic sense limited to use of the keyboard buttons used to navigate within the VR environment.

Synaesthetic Scape, The Stage's Hypothesis and its Questions:

'Using virtual immersive technology will give users' perceptions a sense of reality of the space, and its immersive qualities will help achieve the 'Synaesthetic Scape' experience'.

- Will neutralising the effect of the design tools of light, colour, materials and textures, allow other qualities of the virtual reality design to be present and will they improve the quality of the synaesthetic experience? What might those qualities be?
- Can the virtual reality design share the same design tools as those used to produce real architectural spaces?
- Music was used to provoke emotions in this scape, can it also provide room for the participants' imaginative understandings of the Synaesthetic Scape as in the first stage of experiments?

The previous Sound Space animated project showed various levels of emotional engagement, perception, acceptance and concept validation. This wide variation was owing to the use of different space volumes with different syntheses of elements and light effects. Therefore, there was significant for interpretation and imaginary provoked ideas and clues. However, this variation of spaces and design elements and effects allowed participants to go to an extreme with their imagination and trials so as to understand and perceive the Sound Space environment. Nonetheless, they found it

rather confusing to understand and locate themselves within those spaces since there were layers of objects, light and even meanings.

The participants described the relationship between the design objects and the design elements as arbitrary in some places. Thus, for the development of the Synaesthetic Scape, the researcher made the decision to narrow the gap for interpretation and go with a clearer concept.

The Synaesthetic Scape proposed is a generic platform where the parameters of light, colour, and materials and textures are brought to a neutral level. Moreover, the investment in an immersive sensual synaesthetic experience is used to complete the ideas and perception for the uncompleted rendered buildings and scenes.

Synaesthetic Scape 1; Environmental Description

Initially, the researcher first began with the music that plays along the users synaesthetic VR experience. It was notably an Iraqi remix of a traditional old song, where the listener can sense merged old and modern melodies, which adds an innovative layer of emotion and interpretation to the music.

The researcher attempted to reflect this in the design, where elements and features were merged from different eras and movements of architecture. The built area is divided along a linear axis into three layers, with each layer suggesting an architectural era or movement.

The first layer comprises traditional old buildings that can be interpreted as houses; they look very much like typical Baghdadi houses but without the ornaments and Shanshuls[229]. The Shanshul is defined as ‘a wooden box that encases the higher floor windows on the facade, provides privacy and used to prevent glaring and ventilating the house’ (for more details see Lexicon no. 20). Excluding the Shanshul of the houses opens discussion and gives more room for different interpretations.

[229] MOHAMED J., *THE TRADITIONAL ARTS AND CRAFTS OF TURNERY OR MASHRABIYA,* Graduate School-Camden Rutgers, The State University of New Jersey, Camden, New Jersey, May 2015, https://mals.camden.rutgers.edu/files/J_Mohamed.pdf, p.6

The second layer is a building with modern architecture features, such as abstract façade with many arches, no ornaments, long windows where glass floats free away from the structure and free open spaces.

The third part of the environment consists of linear white buildings with folded glass and concrete façades. This was done so that the Synaesthetic Scape would have the hint of every style and would not be tied to a particular style—all to help provoke discussion and interpretation.

A gondola ride starts from a small harbour or deck around a built area that sits entirely on water. This gondola ride is reminiscent of travelling through Venice, especially when users ride through the tunnels dividing the built area. However, the buildings forming the sides of the tunnels look nothing like the façades of Venice.

On the contrary, those façades look very much like modern-day architecture of huge steel and glass openings and concrete white façades—façades that look more like folded architecture. This is also a gap for participants to fill with their imagination and collective memory. No furniture in any building could prevent relating it to a certain function to leave it open for interoperation by users.

The blue sky and sunset scenes helped with the creation of a soothing emotional atmosphere, which integrates with the music, patterns of shadows and coloured shades of light, providing another depth and dimension to the plane white façades.

All of this aided user in developing their own understanding and emotional engagement with the environment and eventually sharing their synaesthetic experience narrative with the researcher (see foldout in pages 117&118).

The software used in the design of Synaesthetic Scape;

1. 3D Max (Architectural Masses design).
2. Unity (the Virtual reality environment design).

Theme of Design Elements Used

Colour: In order to keep the concept of the Synaesthetic Scape generic, colours of neutral hues and shades were used; whites, greys, greens, browns and blues, all with default parameters to allow natural appearances and shadows to objects.

Light: The main and only light source here is the sunlight, with all parameters set to a default sunset parameter with natural light colours and sky shades. On the other hand, it may also be interpreted as a sunrise.

Materials and textures: The materials theme (see Figure 25) here vary between the following:

1. Old brick blocks
2. Wooden window frames for the old houses
3. Light transparent big blocks of glass
4. Steel window frames for the post-modern buildings.
5. White concrete buildings

Music: The music used here is a remix of Iraqi traditional music. The sense of the Middle East tradition is present, yet the modern piano and melodies are also just present. The mix between the past and present has been enhanced by the architectural environment, which also represents a mix of the architectural traditional, modern and post-modern styles.

In addition to the music playing as an audio input and investment of the aural sense in this Synaesthetic Scape 1 sensory experience, other sounds were introduced as a secondary source of the environment audio; sounds such as river sounds were attached to the moving gondola, representing the water lapping of up the side of the gondola within the Synaesthetic Scape environment.

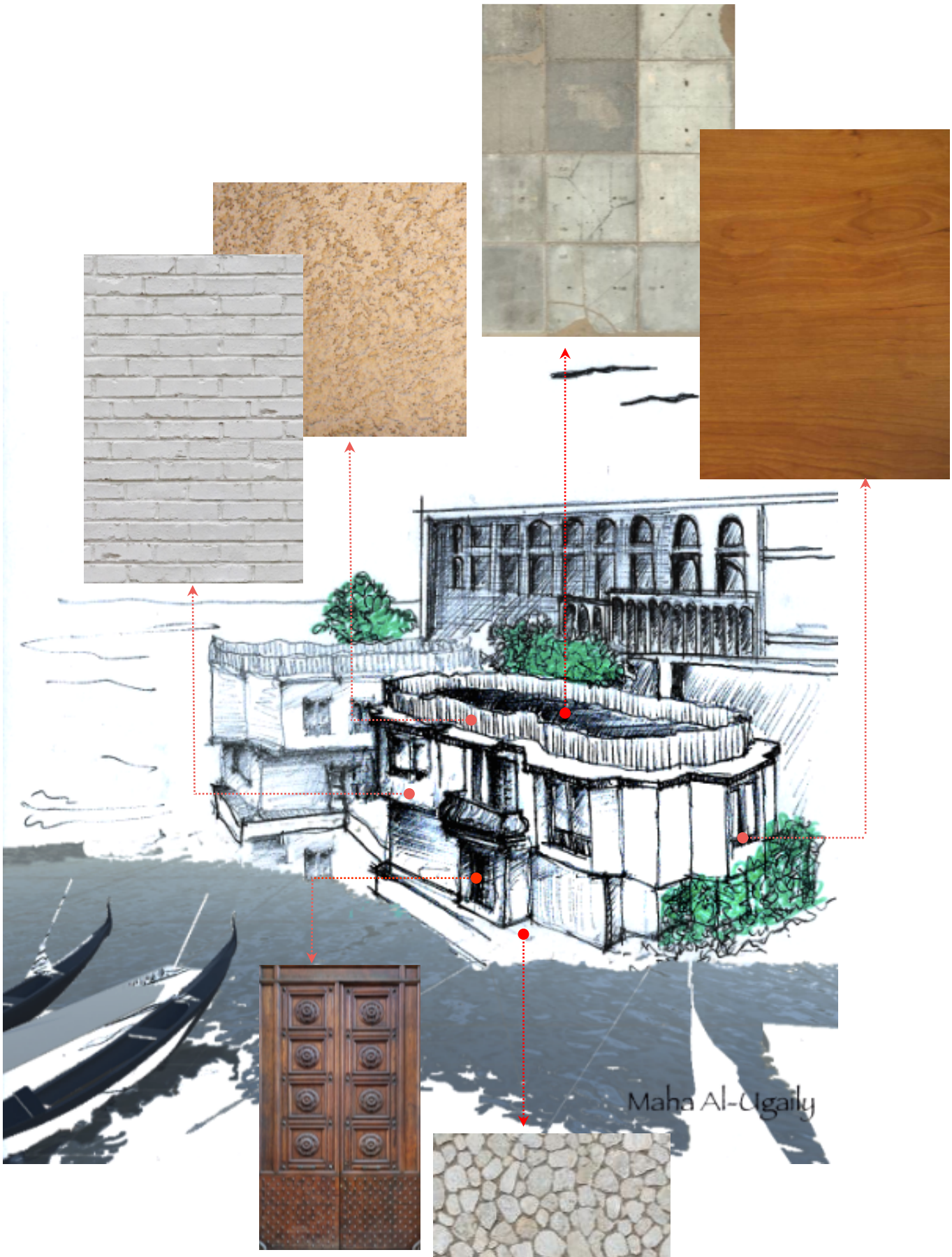


Figure 25; General idea about the nature of the materials and textures used in the design of the Synthetic scape 1(designed by the researcher)

Scenes from Synaesthetic Scape 1; Storyboard to a selected VR journey of one of the participants (KP.C)

Scan QR code with your QR scanner App (phone) to view the video showing different sound effects.

Scenes from Synaesthetic Scape 1; Storyboard to a selected VR journey of one of the participants (KP.C)

Scan QR code with your QR scanner App (phone) to view the video showing different sound effects.

3-2-1 Participants

The participants comprised peer PhD students (6 architects, 1 interior designer), with 4 of them participating in the previous Sound Space experiment.

This sample was chosen because they can discuss and use the tools and vocabulary of the studied field, and also because they are members of the public about whom the study is seeking insight into sensory experiences with the Synaesthetic Scape environment, with their insights accordingly used to design an advanced Synaesthetic Scape experience.

3-3 Synaesthetic Scape 2

Synaesthetic Scape 2 Design Concept

The advanced Synaesthetic Scape is a platform designed to allow users to experience the combination of a virtual spatial experience with real sounds of the environment to enhance the concept of synaesthesia as a multi-sensory experience.

In this regard, the researcher is investing in two senses: the visual and auditory.

For the audio; The music track (the emotional envelop) used in the previous Synaesthetic Scape attempt was replaced with real sounds of the environment, such as, for example, footsteps, the sounds of tree leaves, water streams, etc.

Synaesthetic Scape 2: Hypothesis and Questions:

‘Using real sounds in the virtual environment will reflect a realistic synaesthetic experience’.

- How might sounds influence users’ interactions with the ‘Synaesthetic Scape’?
- Will real sounds influence the emotions and imaginations of participants as the music did in previous experiments?
- What are the differences between using real sounds as the emotional and multi-modality medium of the space and the music used before for the same purpose?

Synaesthetic Scape 2; Environmental Description

The definition of Synaesthetic Scape in this research is that it represents a blend of experiences; emotions, perceptions and sensory associations building on Frascari's description of an experience of synaesthesia.

The first attempt of creating a Synaesthetic Scape research environment, 'Syneasthetic Scape 1', had an audio-visual sensory environment which depended on music as a keystone for an emotion-provoking effect. Although music played a major role in the first Synaesthetic Scape attempt as the audio sensory source, it was not the only audio input, the sound of water playing in the background was successful in adding an extra dimension of reality to the VR experience.

Thus, when studying the sound effects on reality-like experience, in-depth, the decision was made to exclude the music effect in this experiment and invest more in real sounds as the audio source to this audio-visual VR experience. The rest of the design parameters of light, colour and materials and textures all remained the same.

Although the water in this environment worked as the ground plane of the design participants still considered the buildings at the back of the designed environment as looking detached. Therefore, some design changes took place to connect the segregated buildings at the back, including (see foldout in pages 123&124) :

1. The addition of a visual connection between two of the modern segregated buildings at the back part of the project.
2. The redesign of the façades at one of the buildings at the back in such a way that makes the inner space expand to the outside through the use of more windows.
3. Adding a semi-private area into the same facade mentioned above to integrate the space with the space behind that building.
4. The addition of a little furniture to break the long windows, allowing more interaction between the inside and participants, yet still not enough indication to the function of the building, leaving the door open for interpretation.

Theme of the Design Elements Used

No changes were implemented in regards the theme of colour, light and materials and textures; they all stayed as in Synaesthetic Scape 1, yet the music element here was not as dominant as the main source of the audio input as in the previous experiment. Here it has a secondary part, and becomes part of the new sound palette developed for this Synaesthetic Scape 2 experiment.

3-3-1 Sounds Palette

The sound palette for this experiment was developed so as to contain a variety of sounds more so than those used in Synaesthetic Scape 1 experiments; this was done because at the recommendation of participants in the previous experiment.

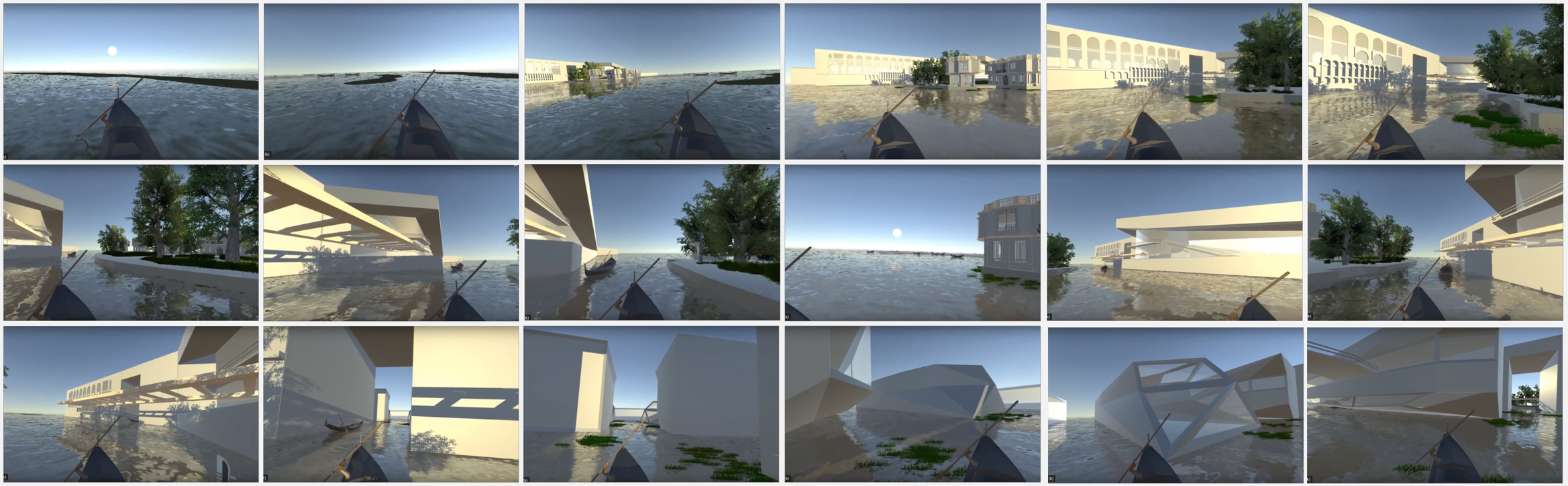
The new sound palette consists of the following:

6. Footsteps
7. Water waves sounds
8. Bout rowing sound
9. Bumping between objects
10. Sounds of people talking
11. Children Playing
12. People gathering in a public space
13. Steps on grass
14. Birds
15. Music playing
16. Banging on metals

In order to add those sounds I had to add some significant changes to the Unity file by adding 3 new scripts to make the sound effects feel real;

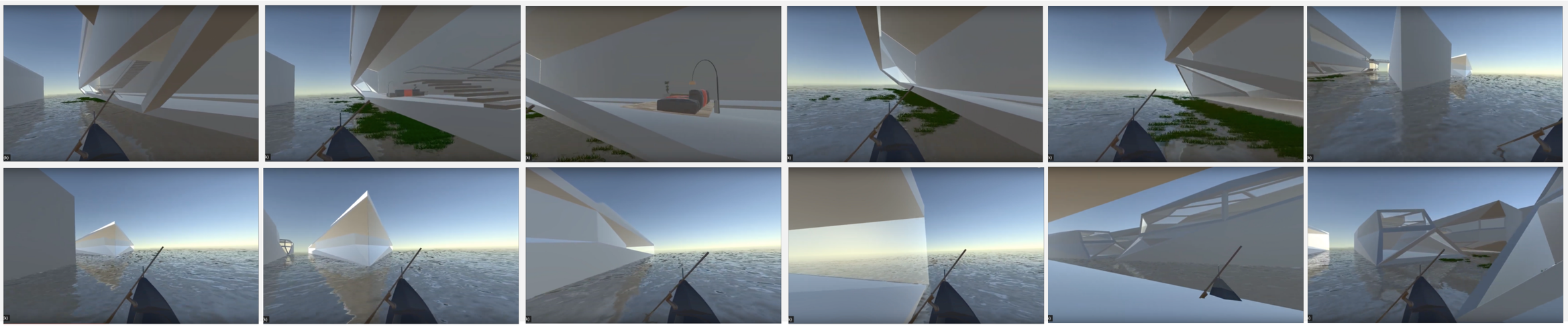
1. Bumping sound script; to play a banging sound whenever the boat bumps into any object inside the VR environment, and the boat bouncing back as a physical reaction. (See foldout in page 125).

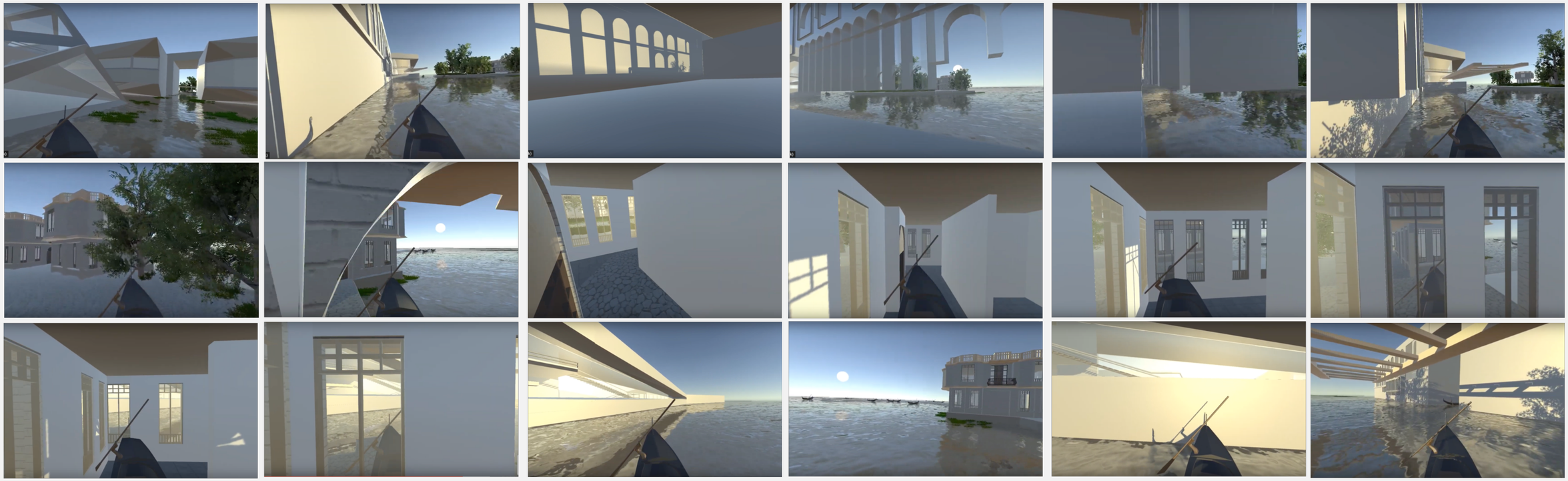
2. The disappearance of the boat when entering a specific façade in the VR environment and sound of footstep starts playing when moving inside this same building. (See foldout in page 126).



Scenes from Synaesthetic Scape 2; Storyboard to a selected VR journey of one of the participants (RS)

Scan QR code with your QR scanner App (phone) to view the video showing different sound effects.





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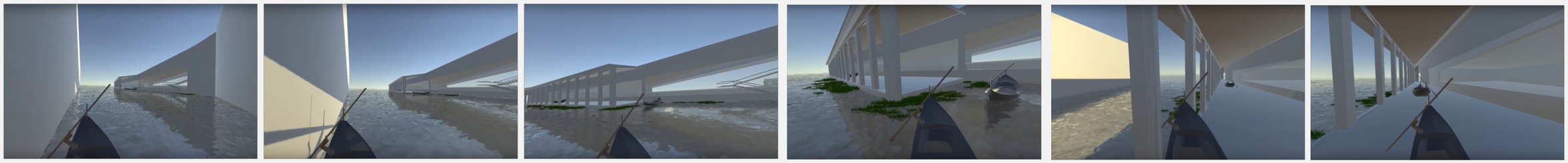
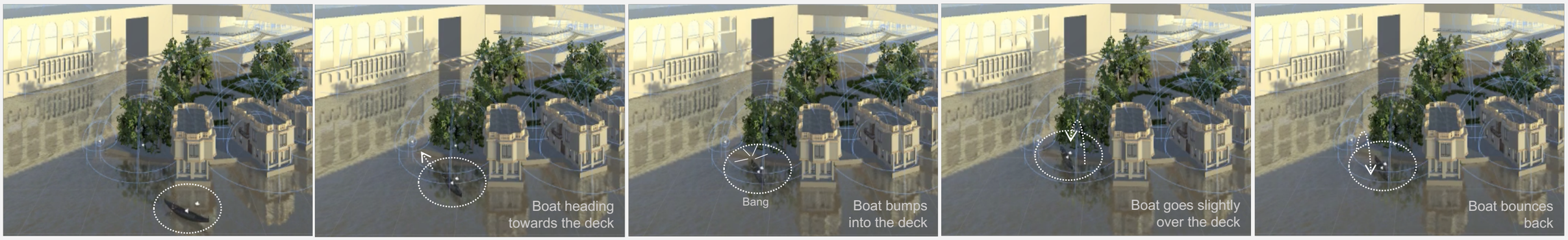


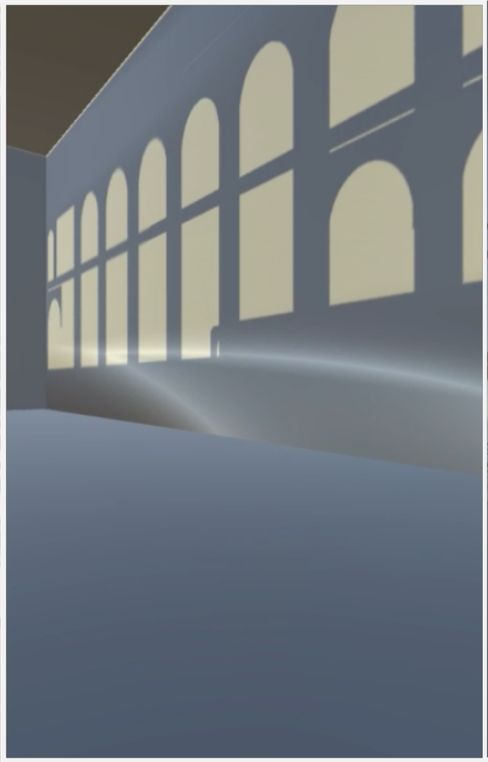
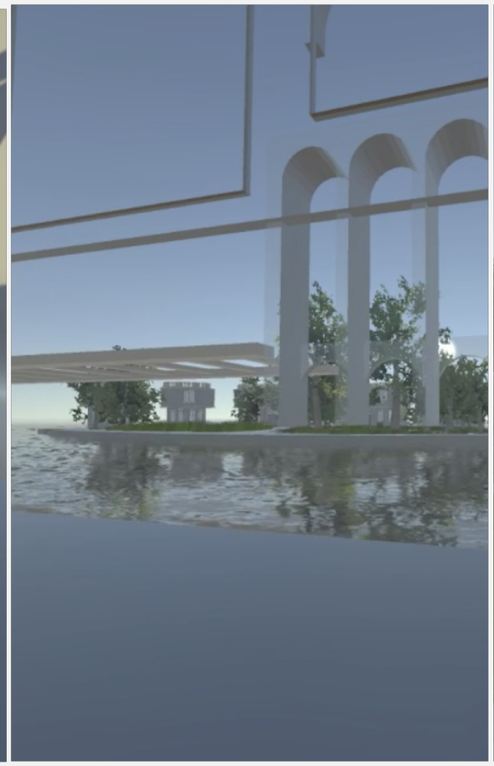
Scenes showing the view from inside the boat (camera's filed of view as boat riders).

Scenes showing outsider views of the action happens when the script runs.

Scan QR code with your QR scanner App (phone) to view the video showing the script running.



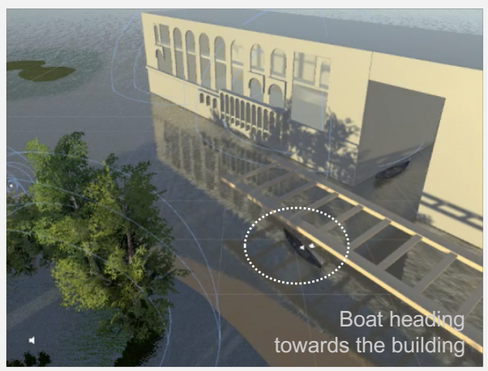
Script : Sound effect (bang) when boat bumps into object in the scene. **Author:** Robert Stacey ˚ for the Synaesthetic Scape 2 project. **Date created:** 2017-2018. **Credit** of all scripts of Unity used in the Synaesthetic Scape VR project goes to; ***Robert Stacey***; BSc (Hons), MIET. Teaching Technician - Virtual Reality, Multidisciplinary Engineering Education, Faculty of Engineering, The Diamond, University of Sheffield (till mid 2018).(see full script in Appendix; section 7)

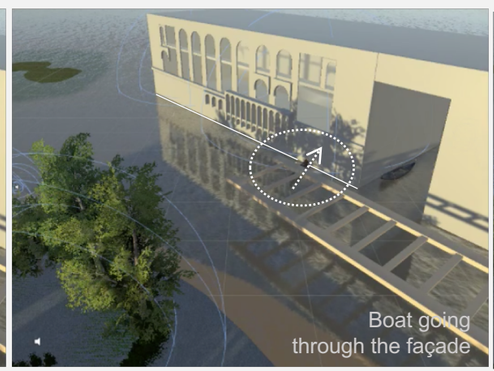



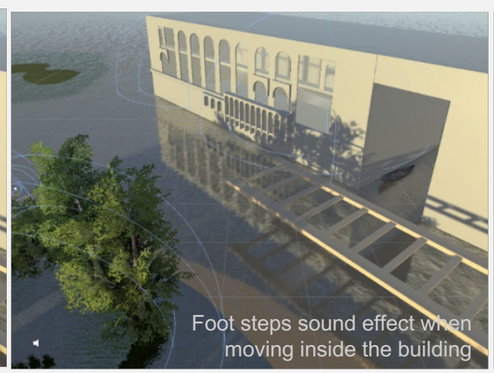
Scenes showing the view from inside the boat (camera's filed of view as boat riders).

Scenes showing outsider views of the action happens when the script runs.

Scan QR code with your QR scanner App (phone) to view the video showing the scripts running.







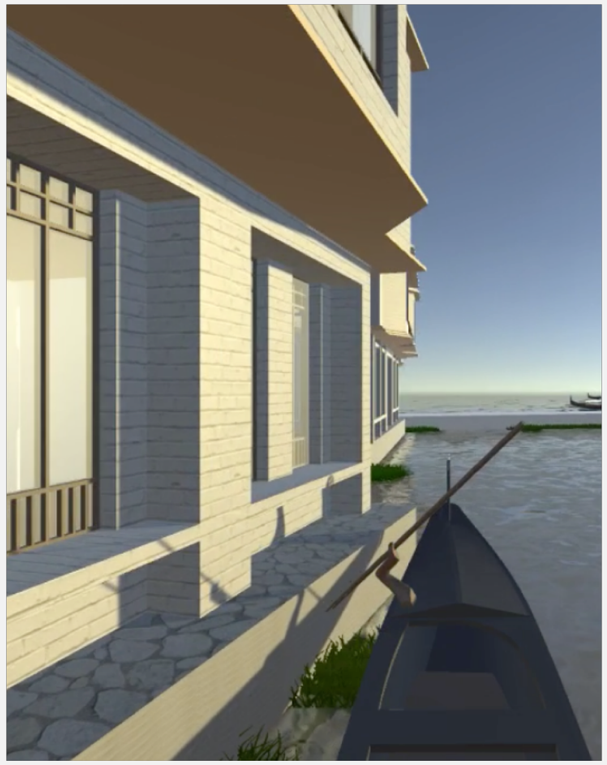
Scripts: Turns off the boat mesh and water related sound effects when entering a preset trigger area. Plays footstep sound effect when entering this particular building through this particular façade. **Author:** Robert Stacey * for the Synaesthetic Scape 2 project. **Date created**: 2017-2018. See Appendix (section 7) for the full scripts

3-3-2 Participants

A total of seven (7) peer PhD students (5 architects, 1 interior designer and 1 town planner) participated in this advanced Synaesthetic Scape experiment. Three participated in both previous experiments, namely the Synaesthetic Scape and Sound Space experiments. One of them participated in the Sound Space experiment. One of them participated in the previous Synaesthetic Scape experiment. Two of them are totally new. Again, they were chosen for the same reasons underpinning involvement in the previous experiments, which were: they can discuss and use the tools and the vocabulary of the studied field; and they are members of the public about whom the study sought to explore sensory experiences with the Synaesthetic Scape environment, accordingly using their insights to design an advanced Synaesthetic Scape experience.

For more understanding to the new sounds added please play the videos inbeded in the QR codes in foldouts (pages 128, 129, 130, 131, 132).

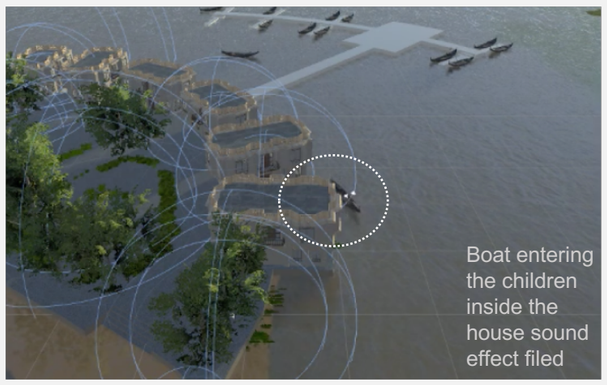
The following sections of this chapter will discuss the design process, methods, quantitative results, and insights and recommendations for each of the three experiments.

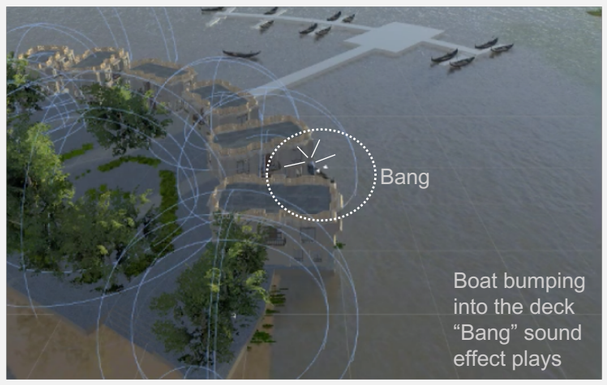


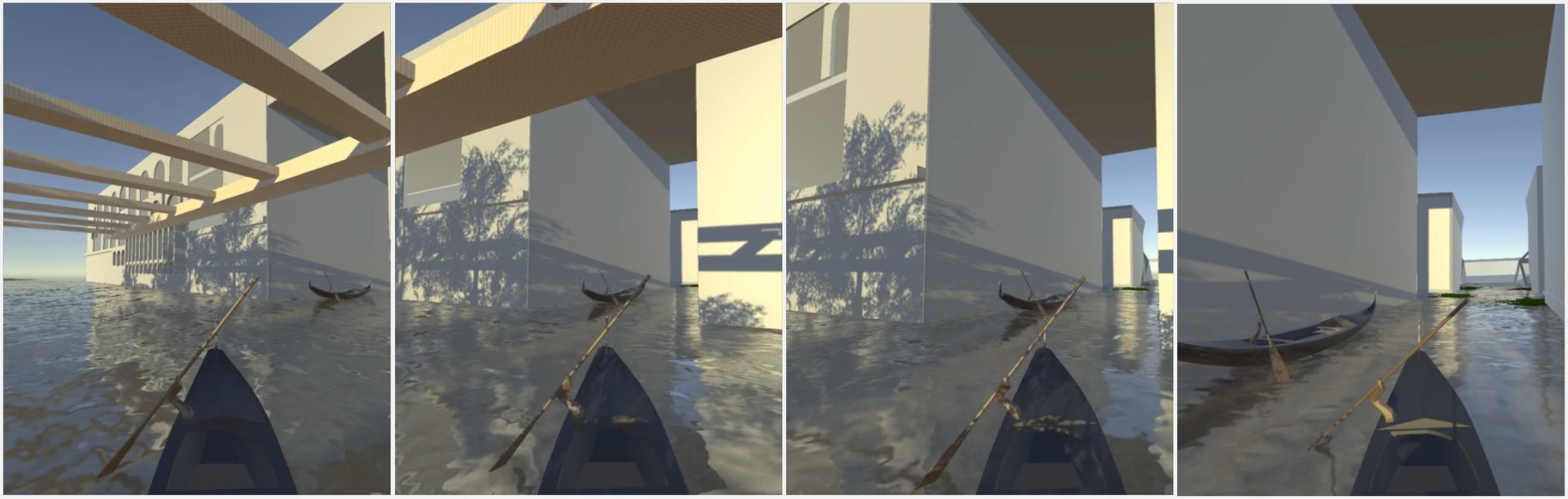
Scenes showing the view from inside the boat (camera's filed of view as boat riders).

Scenes showing outsider views to the boat entering different sound effects fields.

Scan QR code with your QR scanner App (phone) to view the video showing different sound effects.







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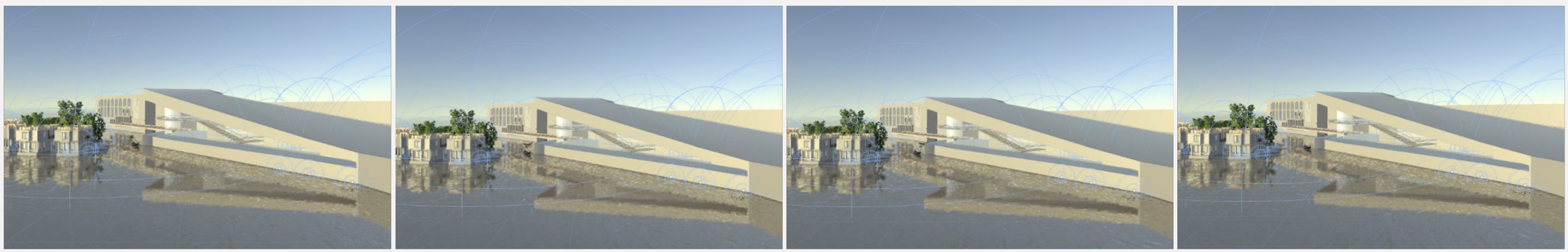

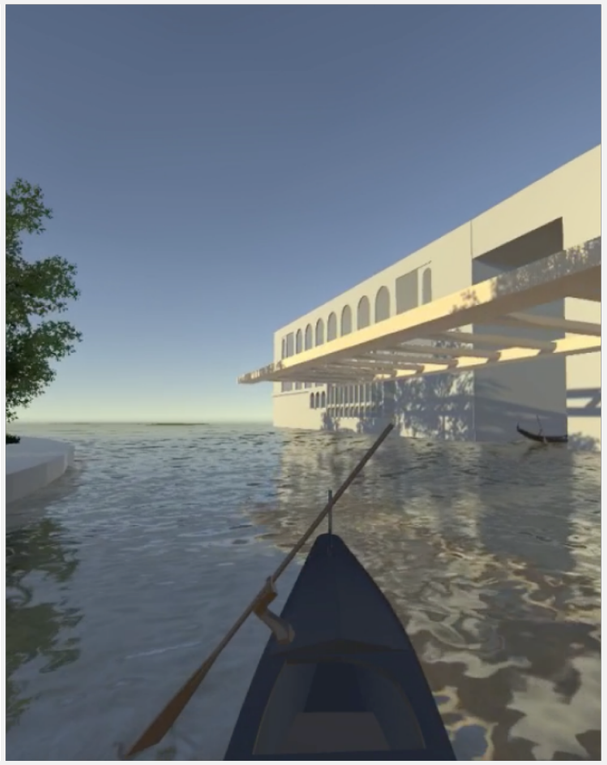

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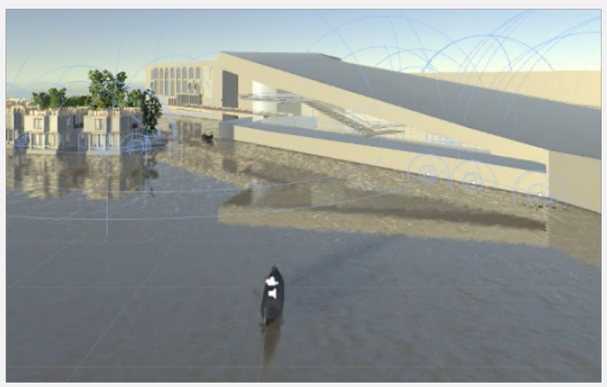
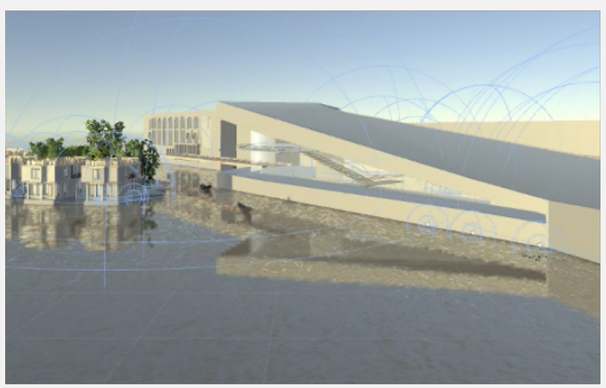
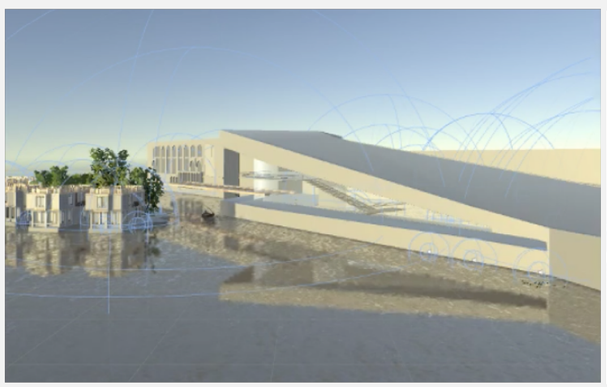
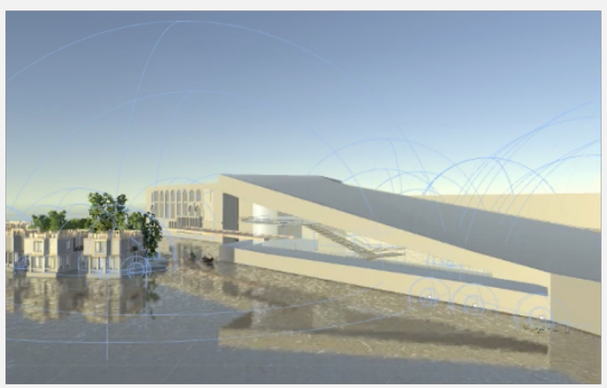
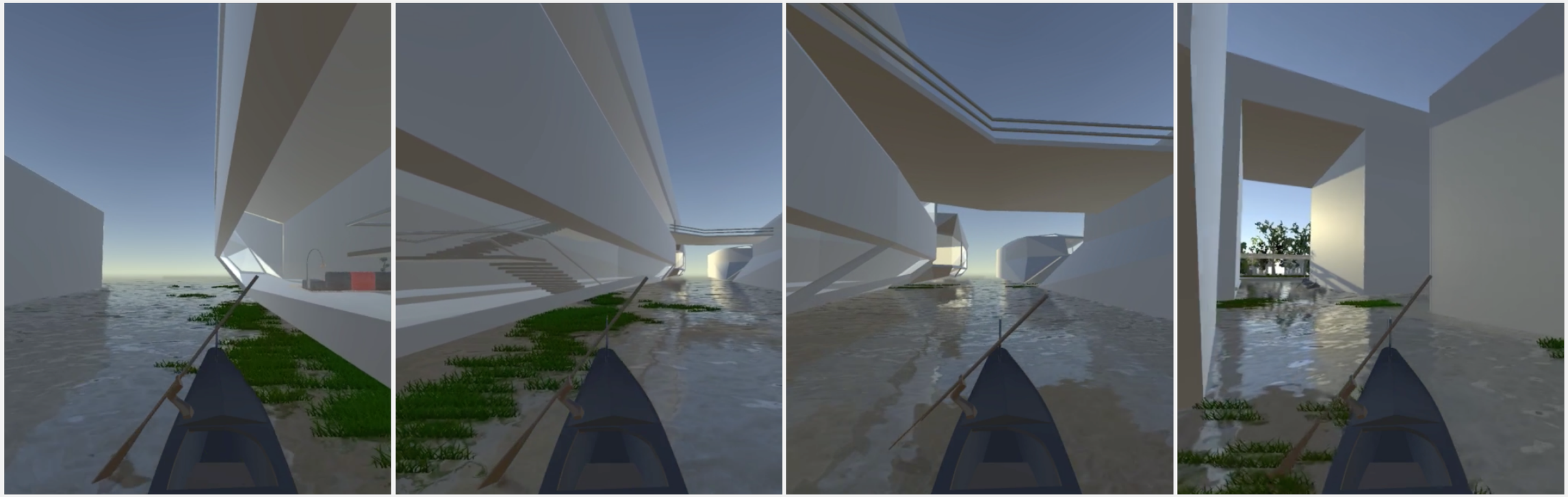
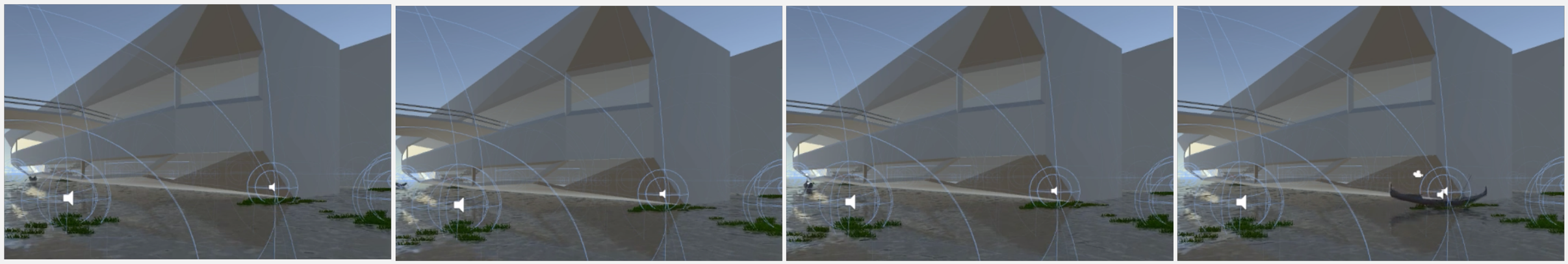





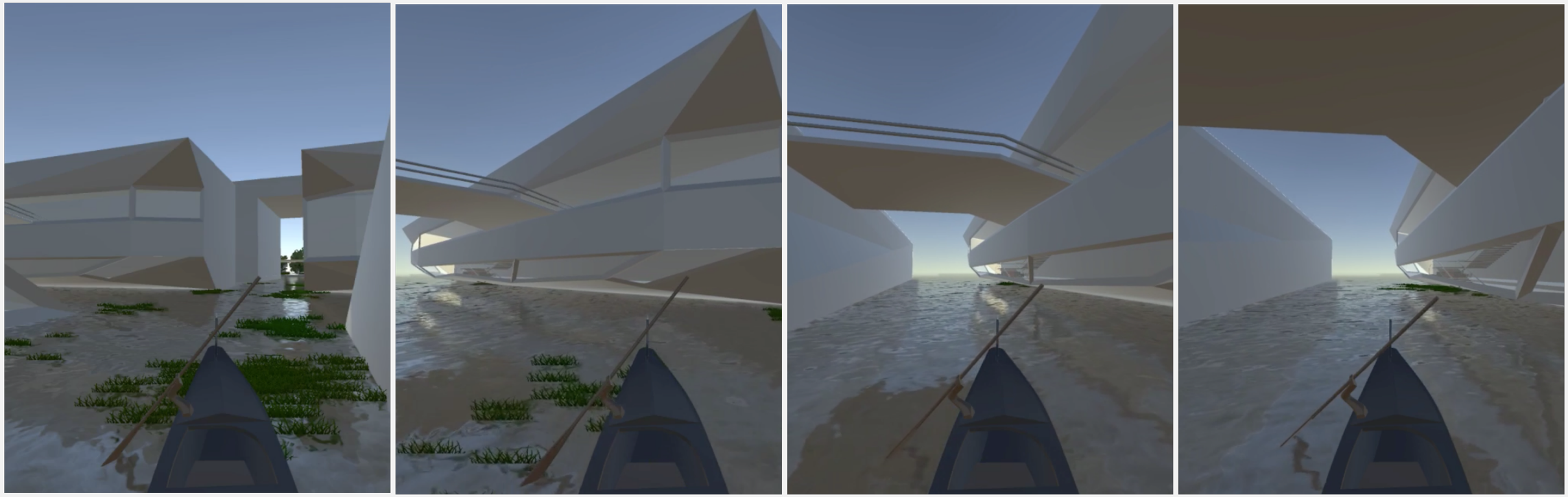


Scenes showing the view from inside the boat (camera's filed of view as boat riders).

Scenes showing outsider views to the boat moving around different spots inside the scene.

Scan QR code with your QR scanner App (phone) to view the video showing different views inside the scene.

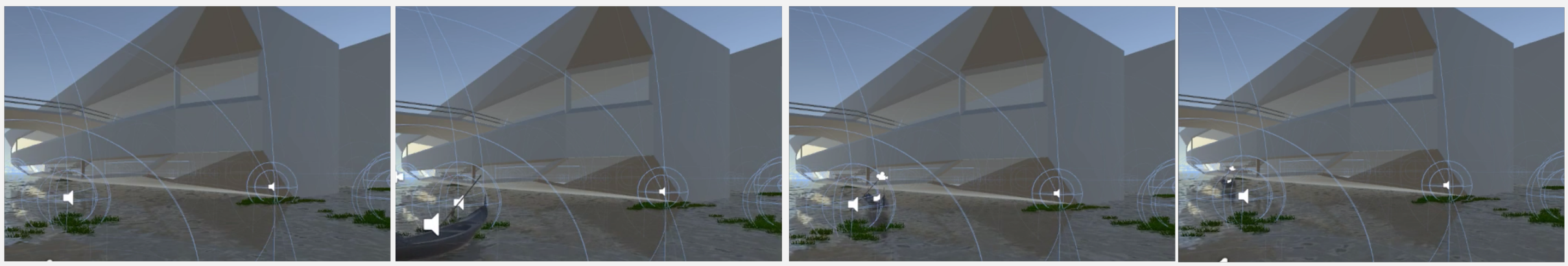




Scenes showing the view from inside the boat (camera's filed of view as boat riders).

Scenes showing outsider views to the boat moving around different spots inside the scene.

Scan QR code with your QR scanner App (phone) to view the video showing different views inside the scene.



3-4 The Three Evolved Design Processes

3-4-1 Sound Space Developed Design Process

For the first creative work, Sound Space, used in the pilot study, Al-Akkam's design process for interior designs was developed by the researcher. This process was further developed and shaped in this research so as to meet the needs of achieving an enhanced sensory experience for the both users and designer. Accordingly, drama was merged with the psychological concept; the researcher treated them as one input to the process. As such, changes took place in stages 2, 3 and 4 of Al Akkam's original design process Figure.26.

As in the original stage 2 of Al-Akkam's proposed design process, the following steps were followed:

1. Specify the linguistic orientation in architecture (traditional, postmodern, deconstruction, integration, high- tech, etc.).
2. Choose a psychological concept (excitement, transparency, comfort, dynamism, etc).
3. Discuss the indicators of the interior space language and select the ones that achieve the psychological concept; the indicators include:

- Form -> form of the space, furniture, and form elements within the space
- Mass -> the interior space mass, furniture (optical weight mass)
- Fourth dimension - (movement of light, fountains, statues, plants…)
- Surface of the inner space, which includes the following indicators:
- Colour (the colour of the furniture, the colour of the space)
- Light
- Pattern
- Material and texture
- Accessories (plants, paintings, statues…)
- Treatment of doors and windows

4. Determine the design approach adopted (interior architecture, interior design).

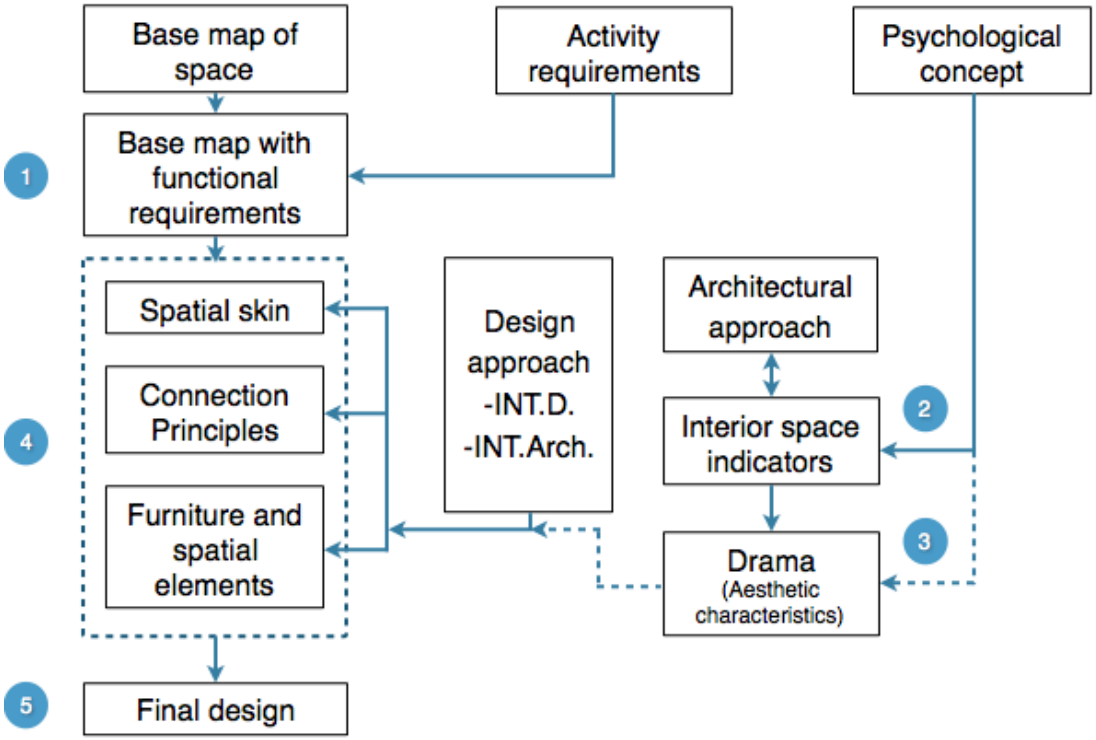


Figure 26: Al-Akkam proposed stages of the design process of contemporary interior spaces.

For Sound Space, stages 2 and 3 of the original design process were changed (Figure 27) to become:

For stage 2; The chosen psychological concept comes from the attached music, basically as the following:

1. Select a piece of music.
2. Analyse the emotional effect (detecting moments of tension and release as Meyer calls them).
3. Elect the dramatic characteristics to be achieved in regards the emotional–psychological effect of the music rather than the general psychological concept proposed before.

For stage 3, the interior design indicators or as this research call them' design elements' will be limited by focusing on Colour, Light, and Materials and textures—only due to this pilot study hypothesis, which is concerned with the possibility of tuning these design elements or indicators to be able to express the emotional psychological concept chosen for Sound Space.

This is then applied to the design indicators, as highlighted in the original process.

The indicators of the interior space language that are used to achieve the chosen psychological concept, linguistic orientation of the architecture, and design approach are used, which is either interior architecture or interior decor, with study carried out in line with how to achieve the space shell, furniture, and other accessories, and examine the relationship between the shell and furniture.

For Sound Space the only change to stage 3 is the design approach adopted which is animated computer environments instead of interior architecture or interior decor.

The original Stage 4 was as follows:

Design insights of the chosen drama, achieving the indicators of the chosen language, and their impact on the design output of the preceding Stage.

Sound Space Stage 4 became:

Design insights of the new musical drama, achieving the indicators of the language chosen, and assessing their impact on the design output of the preceding stage.

Findings garnered from the pilot experiment of Sound Space led to the insights and recommendations of participants regarding the development of this design process to create the first virtual environment of Synaesthetic Scape 1.

The focus was on changing the animation nature of the design to an immersive experienc/e, which is the virtual reality experience. Moreover, synaesthesia as a cross sensory experience was also introduced for the first time.

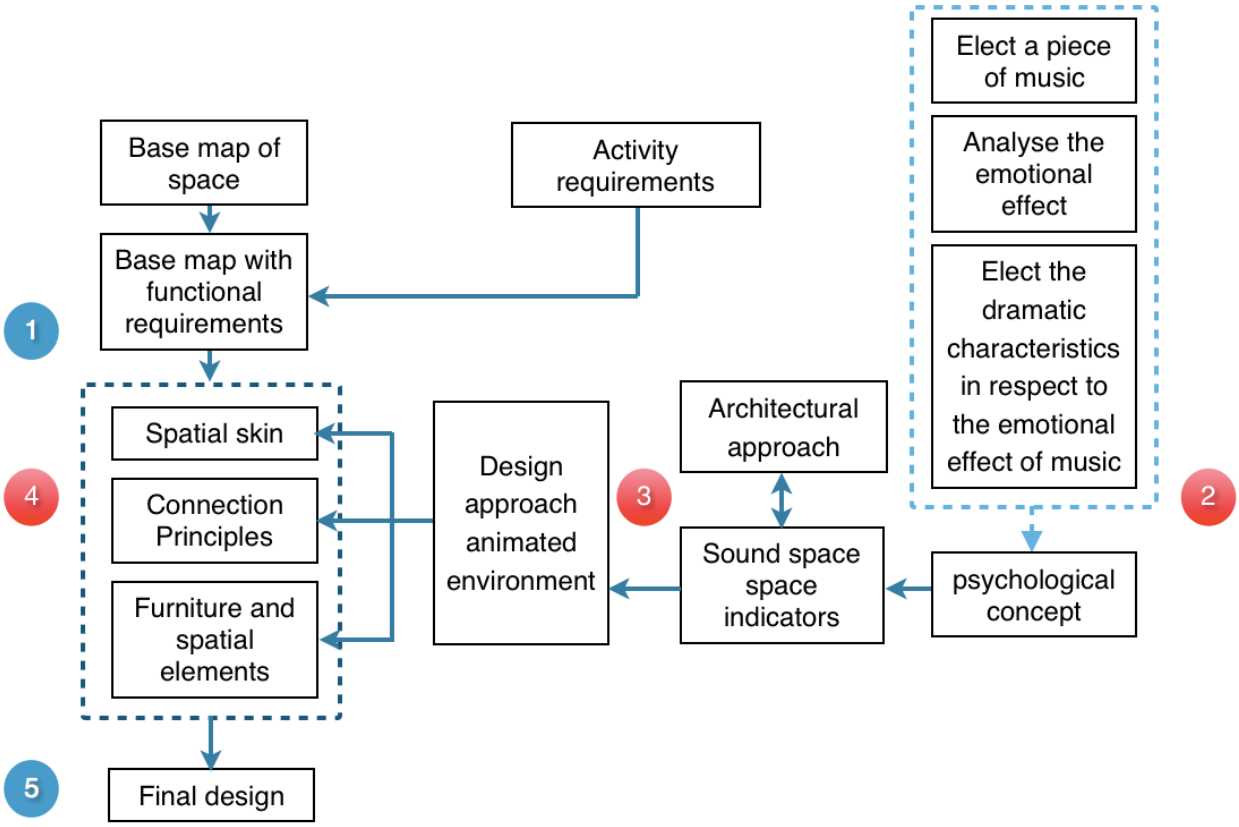


Figure 27: Diagram of Sound Space design process based upon the proposed idea of the researcher M. Al-Ugaily

3-4-2 The Synaesthetic Scape 1 Developed Design Process

Therefore, the following changes to stages 2, 3 and 4 in relation to the previous Sound Space design process are suggested see Figure.28.

Stage 2: For Synaesthetic Scape 1, the emotions provoked by music were considered, rather than the psychological concept in the Sound Space design process. Accordingly, a piece of music was chosen to create an audio emotional envelope to the virtual scape alongside a few number of ambient real sounds to support the immersive experience all as the audio input.

Stage 3: The only change to this stage is the design approach adopted, which is the VR environment instead of animated computer environments.

Stage 4: The indicators of the Synaesthetic Scape (emotions, perception and sensory associations) are discussed, with the ways of reflecting them chosen by using the design tools of light, colour and texture and materials and their impact on the design output of the preceding stage.

Results from the Synaesthetic Scape 1 experiment led to the insights and recommendations of participants regarding the development of this coming design process to create Synaesthetic Scape 2.

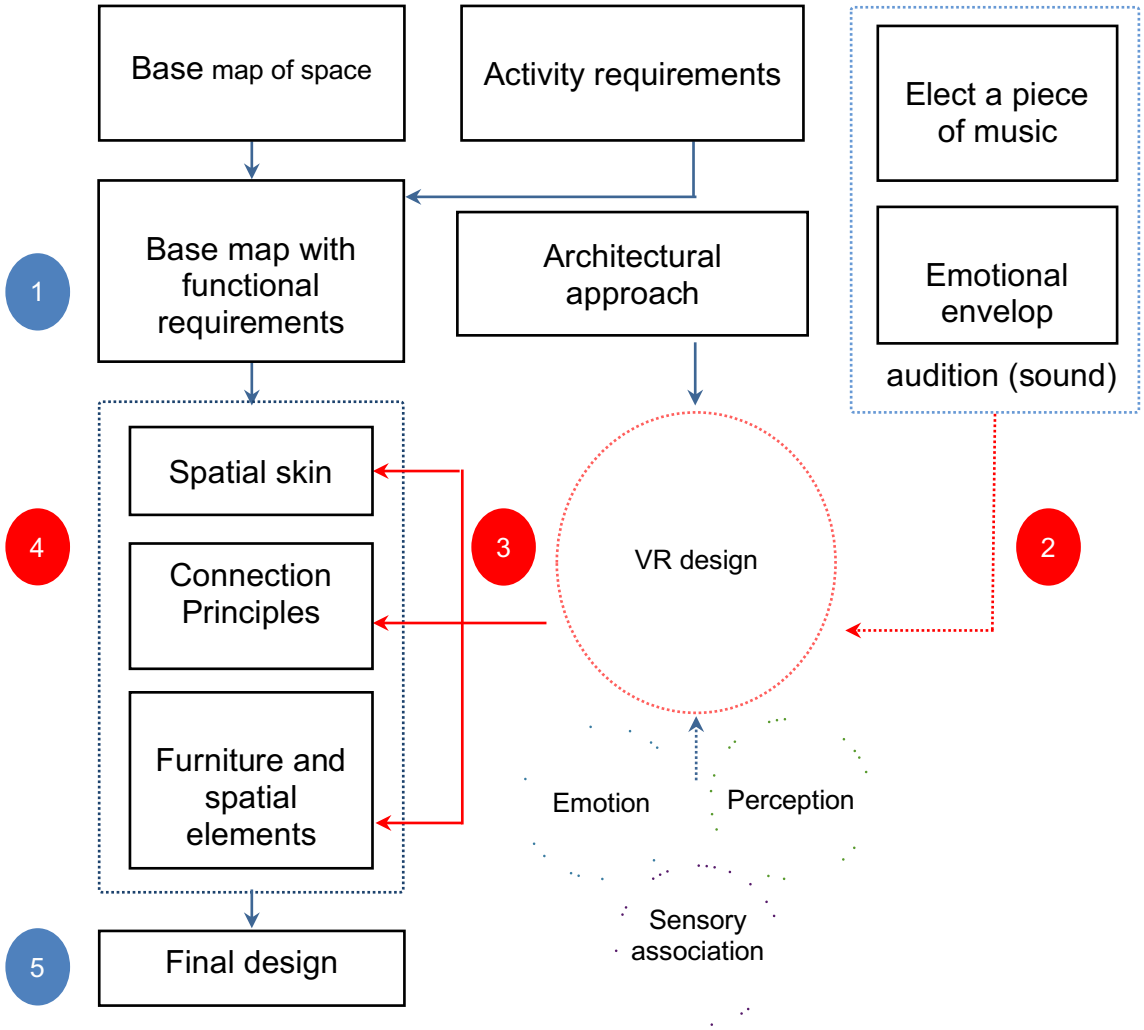


Figure 28: Diagram of Synaesthetic scape 1 design process based upon the proposed idea of the researcher M. Al-Ugaily

3-4-3 Synaesthetic Scape 2 Developed Design Process

The changes were completed in regards the ambient sound as the audio resource and add even more real sounds to the ambient sounds collection used. Therefore, for Synaesthetic Scape 2, the use of real ambient sounds was considered as the audio input of the audio visual Synaesthetic Scape experience. Thus, the following changes to stage 2 of the previous Synaesthetic Scape design process are suggested see Figure.29.

Stage 2:

Increase the palette of real ambient sounds as the audio main input for the audio visual Synaesthetic Scape experience see bellow diagram for the developed Synaesthetic Scape 2 design process.

From this point, discussion will centre on the methods used in each experiment and how they evolved from one experiment to another, according to users' input (insights and recommendations).

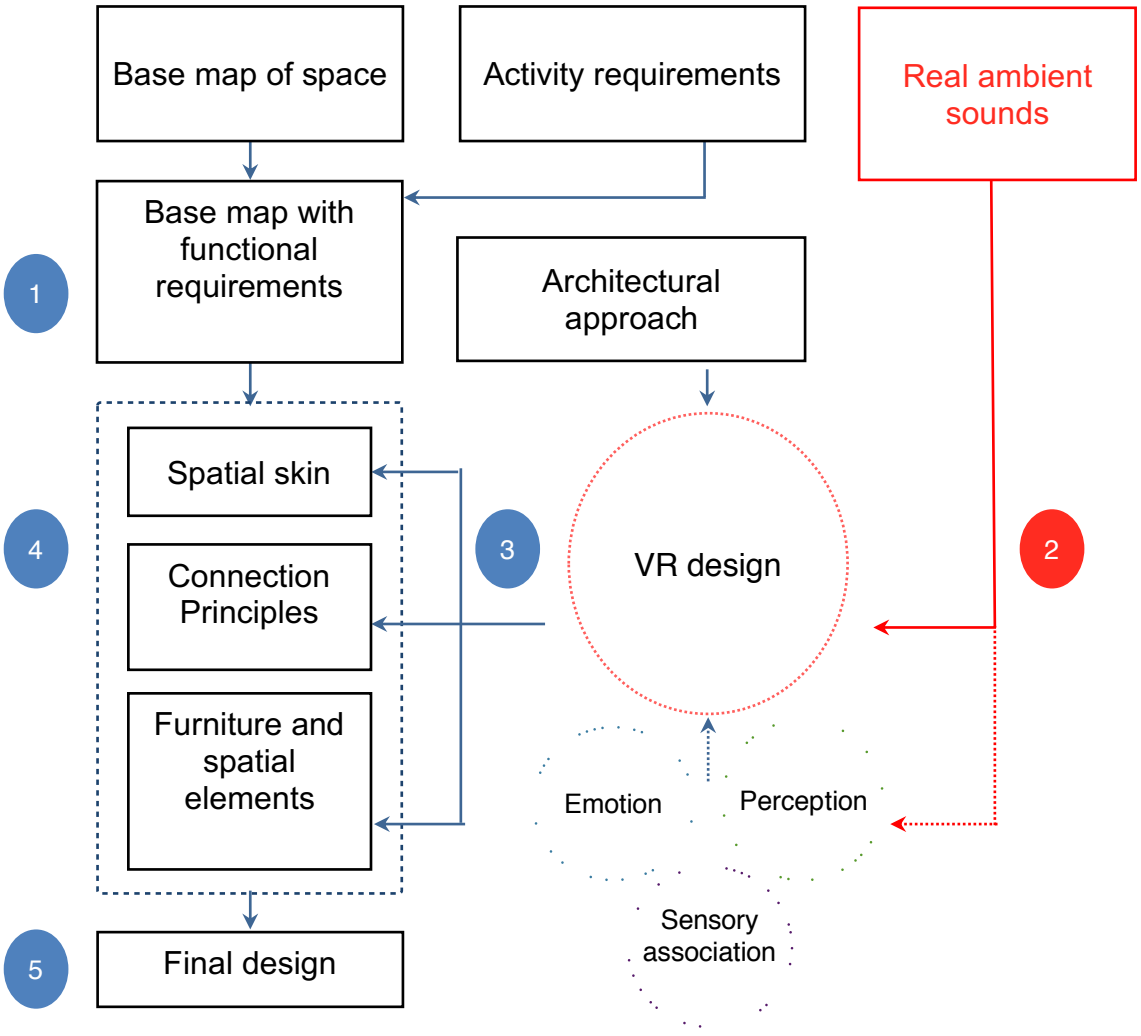


Figure 29: Diagram of Synaesthetic scape 2 design process based upon the proposed idea of the researcher M. Al-Ugaily

3-5 The Methodology and Methods Used

Each stage had a distinctive methodology, as described below:

3-5-1 Pilot Study (Sound Space) Procedure

The pilot study consists of two accumulated steps, which differed in terms of the methods used.

Quantitative Method—Step 1 (Emotion as a service from Affectiva):

Emotion, as a service from Affecitiva, is used to detect emotions from facial expressions. The videos of 7 participants' facial expressions were recorded while they were watching the animated work mentioned earlier. The videos were recorded across three different situations:

1. While they were listening to the music only.
1. While they were watching the design without music.
2. While they were watching the animated work as a whole, i.e. Music + Design.

These videos were /then sent to Affectiva for processing.

Affectiva sent the raw data back in the form of a table, as per the one in (Figure 30).

Afterwards, the raw data were fed into Excel and translated into readable diagrams, expressing the detected emotions of each participant in each of the three situations mentioned above. These diagrams were then studied and validated across the second qualitative step of the pilot study. Notably, this stage did not involve collecting any artefact from the participants (like sketches) unlike the next two experiments.

TimeStamp(r	angerct_emc	attentionct_(	au01ct_linea	au02ct_nonl	au04ct_nonl	au09ct_linea	au10ct_linea	au15ct_linea
0	0.00487654	85.7210617	0.01599882	0.02426508	0.55493385	0.06544746	0.00039503	0.00062633
71.4285736	0.00498309	80.3602524	0.01062802	0.02373397	0.79294187	0.05216936	0.00040833	0.00059259
142.857147	0.00500965	80.832962	0.01090703	0.02341159	0.83207625	0.0573013	0.00054808	0.00053622
214.285721	0.0050065	82.508667	0.01377779	0.03038323	0.8021909	0.07145379	0.00052774	0.00047806
285.714294	0.00499679	81.9346008	0.01128444	0.03230667	0.7384913	0.06463781	0.00051576	0.00052754
357.142853	0.00499563	79.5654068	0.00921579	0.03355715	0.77591676	0.05952626	0.00060066	0.00079432
428.571442	0.00496379	82.1797104	0.01208632	0.03587591	0.77997285	0.05597256	0.00072533	0.00089651
500	0.00495111	83.8670578	0.01445219	0.0334514	0.80160791	0.05268657	0.0008115	0.0010186
571.428589	0.00495517	81.114563	0.01949765	0.03249351	0.84213966	0.03541887	0.00084875	0.00123686
642.857117	0.00495085	77.6763077	0.02927706	0.03273672	0.84913987	0.02727197	0.00078884	0.00141045
714.285706	0.00496814	77.9598236	0.03079893	0.03238663	0.89412236	0.04269111	0.00077092	0.00175485
785.714294	0.00498358	77.5627823	0.03213591	0.03055186	0.94728315	0.09242374	0.00085881	0.0019267
857.142883	0.00497494	81.488472	0.04617287	0.0297487	0.9412418	0.05714649	0.0009218	0.00199517
928.571411	0.00493702	84.870163	0.04630909	0.03261232	0.85521054	0.03241399	0.00096444	0.00209455
1000	0.00491841	81.1694946	0.02820881	0.03047769	0.78551126	0.01246474	0.00105025	0.00200211
1071.42859	0.00499956	73.3472214	0.02741423	0.03018224	0.79104257	0.00267427	0.00095547	0.00187206
1142.85718	0.0052598	76.306282	0.02188496	0.02827847	0.80753082	0.00286207	0.00102135	0.00216758
1214.28577	0.00543241	74.2613831	0.02386999	0.02885178	0.80646569	0.01575899	0.00101479	0.0032548
1285.71423	0.00554492	71.9138489	0.04676858	0.03092656	0.82435596	0.05436713	0.00116519	0.01052587

Figure 30: a sample for the raw data provided by Affectiva (Emotion as a service).

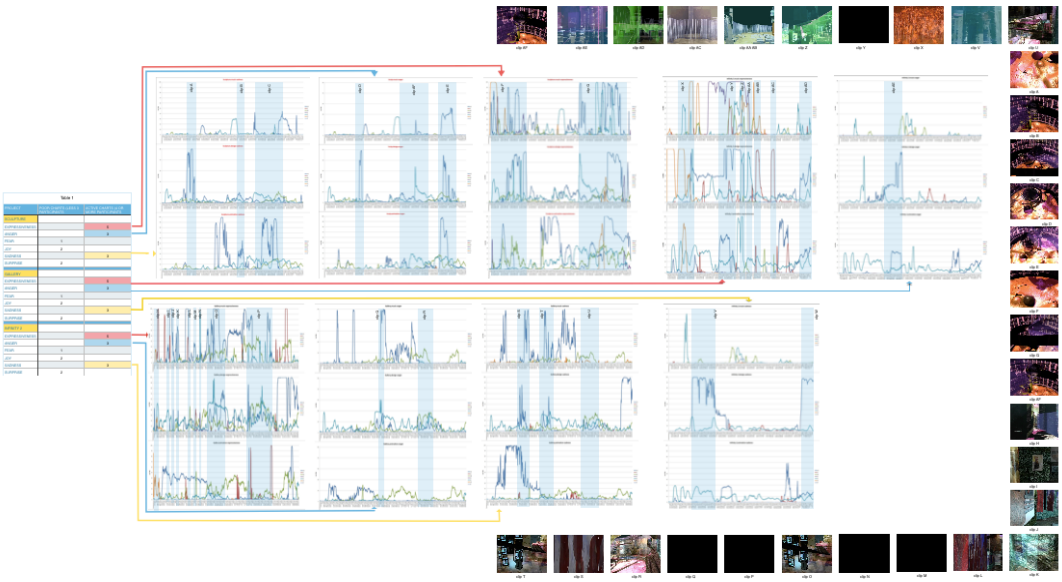


Figure 31: Results ready to discuss at the focus group (designed by the researcher).

Qualitative Method: Step 2—The Qualitative Method:

A focus group was convened to discuss the experiments, followed by individual semi-structured interviews with the same participants.

Focus Group Proposal:

Location: A room (preferably dark room) with a projector and a computer. (This focus group will be video recorded) Steps:

1. Presentation of the animated works followed by group discussion, involving the group comparing their individual data from Step 1 organised as in Figure 31.
2. Participants asked to talk about their ideas and emotional impressions of the work and compare them to the ideas and reactions of others and listen to their expectations of the work.
3. Qualitative analysis for all data gained from Step 2.
4. Results from the pilot study will be considered not only to evaluate the animated work but also to use insights from the study to inform the design process of a new immersive space.

Focus Group Objectives:

1. Validate the quantitative data gained by the used of Affectiva's service (detecting emotions from facial expressions).
2. Analyse the animated works in terms of the participants emotional schemes detected from the previous step.
3. Evaluate the expressive values of design tools which are (Texture, Colour and Lighting).
4. Gain insights and recommendations for a better design of Sound Space in terms of emotional engagement with the users.

Semi-structured Interviews:

Interviews were conducted with each participant following the focus group. The aim was to filter the data gathered in the pilot study for each participant, discuss the context of the data collected in the different steps of the study, and derive participants' final insights and recommendations.

3-5-2 Synaesthetic Scape 1 Procedure (Methods)

Synaesthetic Scape is an experience of space where three components (perception, sensory association and emotion) are blended together in a virtual immersive environment. As mentioned earlier in the first chapter, in order to test such an experience, the spiral methodology of this research was developed to identify and analyse each of the Synaesthetic Scape three components and evaluates the results by the users experiencing it. This strategy was carried out through the completion of three experiments, with the results informing the experiment after, and so on.

In order to identify and evaluate each component, the following was done:

Perception of the users was detected by asking them to draw a map for the space as they perceive it (collecting artefacts).

Sensory association, In each stage more than one sense was provoked and the users were asked to take part in a semi-structured interview to talk about their sense experience of the space.

Emotions of the participants were established through every stage differently regarding to the stage's circumstances, and evaluated by the participants in the semi-structured interview afterwards.

In this experiment, the use of the 'emotion as a service' quantitative method was no longer applied, which had been used in the Sound Space pilot study because, through the experiments, participants had been exposed to an immersive environment in Synaesthetic Scape virtual experiment where they were required to use the oculus kit,

which covers half of the participants' faces, therefore making it impossible to get their facial reactions in order to detect their emotions whilst doing the experiment. Thus, the Synaesthetic Scape 1 experiment consists of two accumulated steps, both of which differed in terms of the methods used in the previous Sound Space pilot study.

Quantitative Method (E4 Wristband, Electrodermal Conductance):

This technology provides the real-time data of participants' arousal levels so as to derive features related to stress, engagement and excitement [230].

In this step, the 7 participants used the wristband on two occasions: before being in the VR environment; and while inside the VR environment. Participants were then asked to sketch the Synaesthetic Scape they were in as they recall it (this method is used to help explain how participants perceived the experience and their sense of place and orientation within the environment).

Data derived from this step was discussed with each participant immediately after trying the VR environment experience in a semi-structured interview see Figures 32 & 33.

Qualitative Method (Semi-structured Interview):

The focus group method used in the previous experiment had to be missed since the results were not considered to be very accurate since they had been affected by group members' opinions. Nonetheless, individual semi-structured interviews with the same participants were considered essential in their results accuracy according to each participant's neutral, non-biased point of view.

The aims of the semi-structured interviews were as follows:

1. Filter the data collected in this study for each participant.
2. Discuss the context of the data collected in the different steps of the study.
3. Derive the participant's final insights and recommendation.

[230] Empatica Inc. *Advanced research on human behavior*,1 Broadway, Cambridge, USA-Empatica Srl, Via Stendhal 36,20144 Milano (MI), Italy. Last accessed 11th May 2019, https://www.empatica.com/research/science/

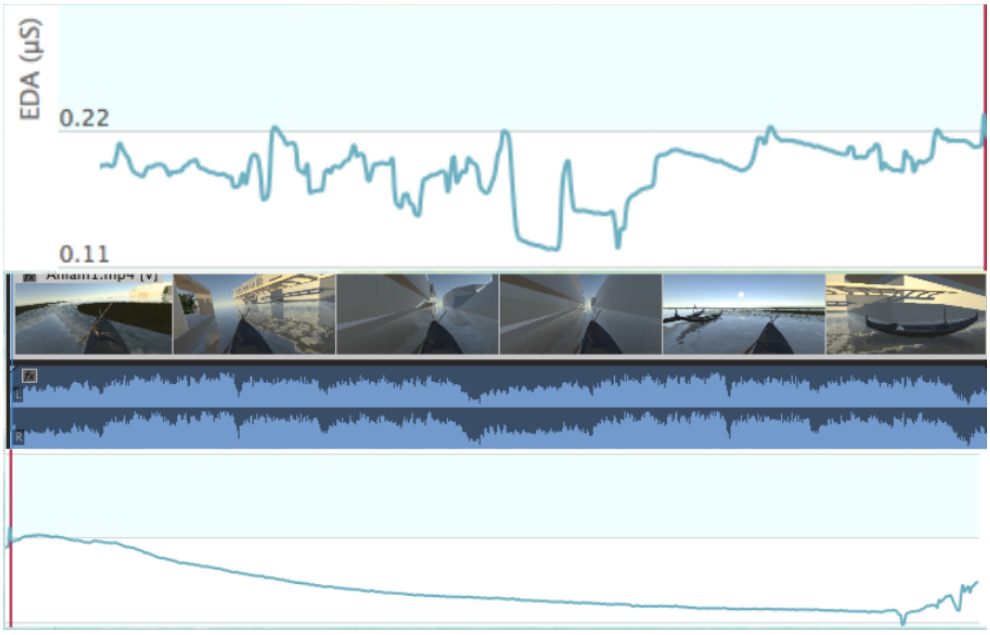


Figure 32: E4 wristband data before and after samples with screen recording of the Synaesthetic Scape 1 experience of one of the participants (collected by the researcher)

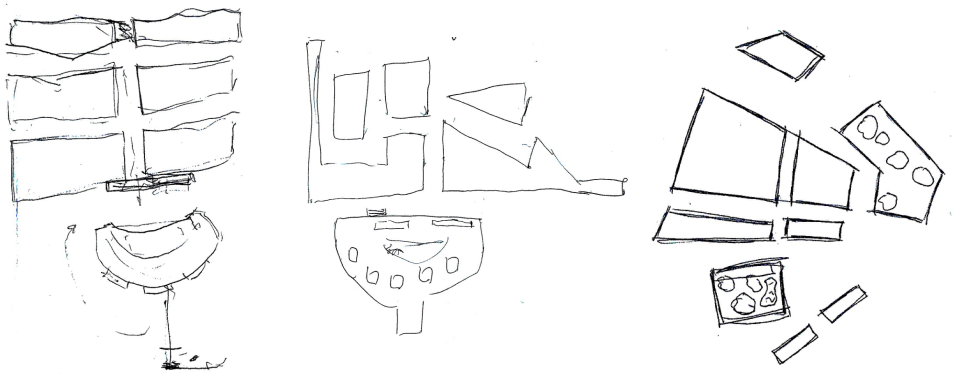


Figure 33: Samples of sketches of the VR perceived scape (collected by the researcher)

3-5-3 Synaesthetic Scape 2 Procedure (Methods)

The Synaesthetic Scape 2 study consists of two accumulated steps which differed in terms of the methods used.

Quantitative Method (E4 Wristband, Electrodermal Conductance):

This technology provides the real-time data of the participants' arousal levels so as to derive at features related to stress, engagement and excitement [231].

In this step, the 7 participants used this wrist band twice: before being in the VR environment; and while inside the VR environment.

Participants were then asked to sketch the Synaesthetic Scape they were in as they recall it (this method is used to help explaining how participants perceived the experience and their sense of place and orientation within the environment).

Data derived from this step was discussed with each participant immediately following trying the VR environment experience in a semi-structured interview see Figure. 34.

Qualitative Method (Semi-structured Interviews):

Individual semi-structured interviews were carried out with the same participants, the aim of which was to filter the data collected in this study for each participant.

1. Discuss the context of the data collected in the different steps of the study.
2. Derive the participants final insights and recommendation.

[231] Ibid.

3-6 Results and Discussion

In this section, the data collected from both the quantitative and qualitative methods will be displayed, analysed and discussed in chronological order. This applies to the data collected from the quantitative methods. This themes derived and evolved from the semi-structured interviews of the three experimental stages will also be identified. These themes will be further discussed in terms of the theoretical context in Chapter 4.

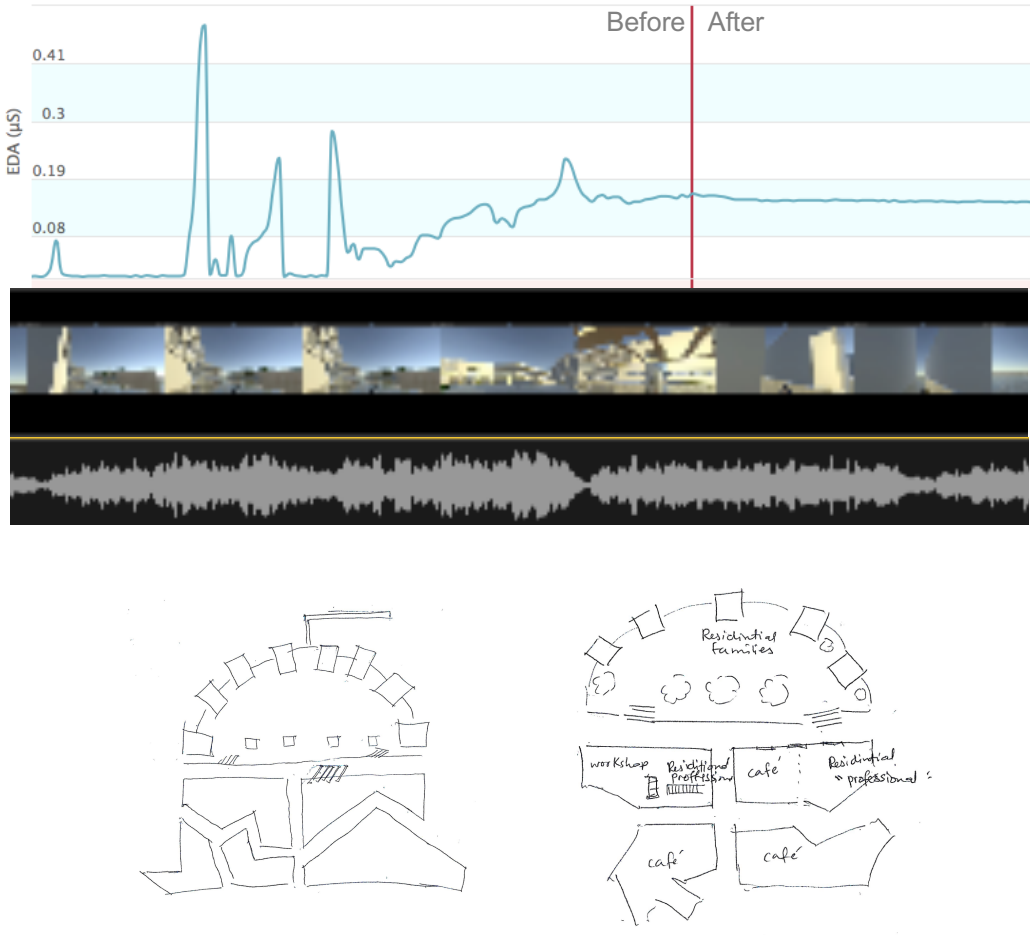


Figure 34: Sample of data collected from one participant from stage three (collected by the researcher)

3-6-1 Sound Space Pilot Study Outcomes

When taking a close look at the quantitative data gained from the facial expressions of the participants, some important issues can be seen, as follows:

The Affdex software claims to have the capacity to detect specific feelings of anger, attention, contempt, disgust, expressiveness (emotional engagement, fear, joy, sadness and surprise).

The focus group discussions validated the detected emotional engagement (Expressiveness) diagrams. Nonetheless, the information in regards the other emotions-specified diagrams (Anger, Fear, Joy, Sadness and Surprise) were not significant enough to be validated. Since participants said that they did not feel exactly those feelings while doing the experiments, their feelings were mixed and not that specific. See foldout in page 152 for a clearer understanding.

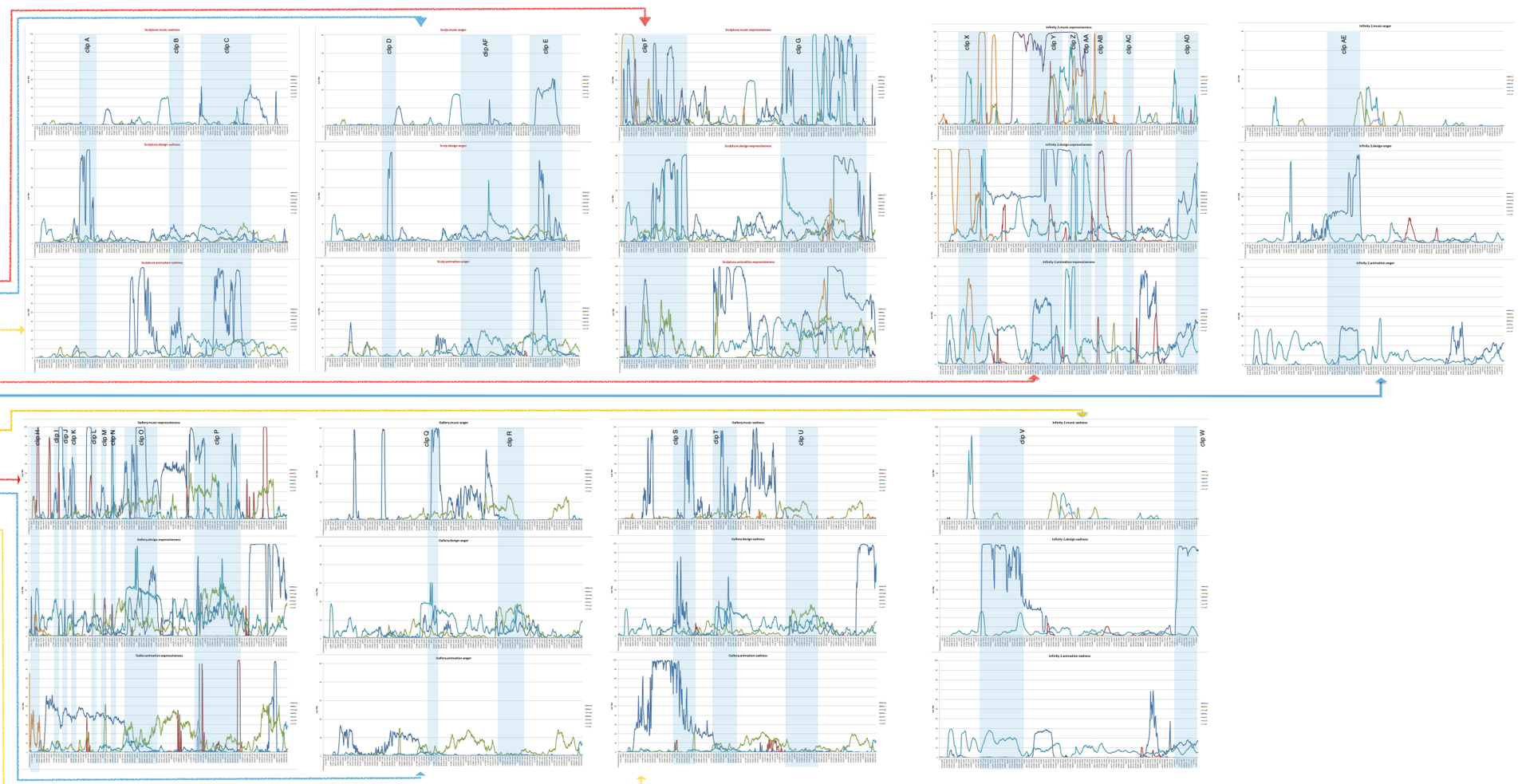
Detecting specific emotions, such as anger, fear, surprise or joy, is not accurate enough to be validated and still needs more work in terms of specifying such emotions whilst detecting and analysing them. Therefore, it can be stated that Affdex is good at detecting emotional engagement, yet is not quite there when it comes to relating this detection with a specific emotion. This means that this tool still needs improving by Affectiva (see Emotion as A Service from Affectiva, Appendix, Section 1).

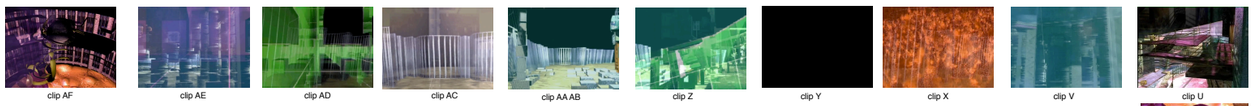
Another issue occurred in this stage was that some participants (2/7) said they were emotionally engaged, yet the software showed otherwise due to their poker faces (term used by participants), meaning it does not apply to all people.

Below, the emotional engagement diagrams of expressiveness will be compared across the three stages of music only, namely design and animation (music and design combined). This data was discussed and evaluated by participants in the focus group and individual semi-structured interviews through the validation process for this method.

Table 1

PROJECT	POOR CHARTS (LESS 3 PARTICIPANTS	ACTIVE CHARTS (4 OR MORE PARTICIPANTS
SCULPTURE		
EXPRESSIVENESS		5
ANGER		3
FEAR	1	
JOY	2	
SADNESS		3
SURPRISE	2	
GALLERY		
EXPRESSIVENESS		5
ANGER		3
FEAR	1	
JOY	2	
SADNESS		3
SURPRISE	2	
INFINITY 2		
EXPRESSIVENESS		5
ANGER		3
FEAR	1	
JOY	2	
SADNESS		3
SURPRISE	2	

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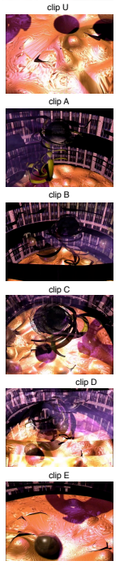

clip A clip B clip C clip D clip E clip F

clip G clip AF clip H clip I clip J

clip T clip S clip R clip Q clip P clip O clip N clip M clip L clip K

Sculpture

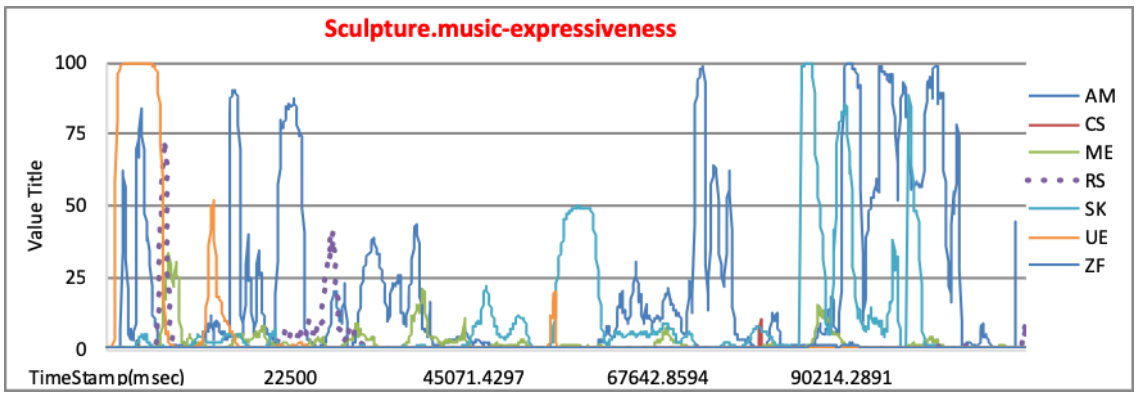


Figure 35: Sculpture expressiveness diagram (music only) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

It is obvious when reviewing data in Figure 35 that participants were emotionally engaged with the music more than the design itself.

This was because the music reminded them of certain memories. It was nostalgiac moments to most of the participants.

Therefore, In this stage, participants built their expectations of the design in line with the music they heard. Which is what was confirmed in the semi-structured interview later.

Almost 70% of the participants' results were right: some other participants who showed no change in expression were also engaged with the music.

Thus, it can be stated that the emotion detection was correct in 70% of cases.

Furthermore, participants could not confirm the moments of high emotional detection, nor reject them. They were not sure about the values of the emotion detection being correct.

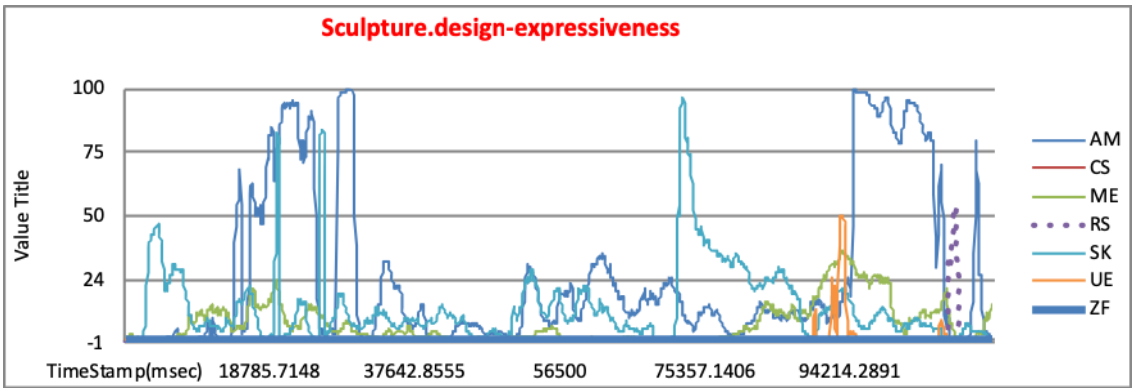


Figure 36: Sculpture expressiveness diagram (design only) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

In the design only stage, as shown in Figure 36, it is noticeable that the participants were engaged with the first part of the design and the last part of the design more so than the middle part.

In general, participants were seen to be less engaged in the design only stage as 4 participants justified that it was not as they expected it to be when they first listened to the music. Moreover, because the design was seen to be strange to them and provoked more thinking of what it might be and what its function might be.

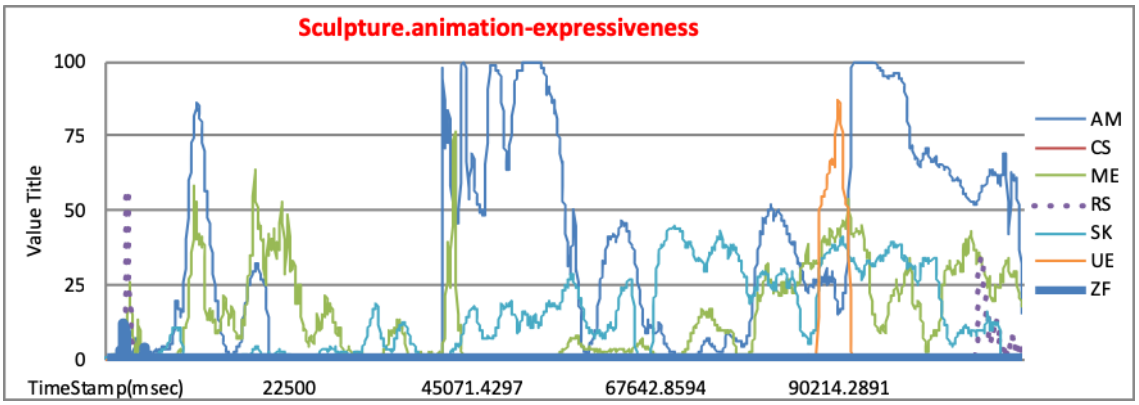


Figure 37: Sculpture expressiveness diagram (animation) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

The animation diagram (Figure 37) showed that participants were more emotionally engaged with the design while music was attached to it more than the design only stage. This states a situation where emotions and music enhance the communication experience with space in a synaesthetic manner (more sensese involved). Which made the design more acceptable to the participants.
This was confirmed by the participants in the semi-structured interviews afterwards.

Five participants said that the reason behind that was that; although they were aware of their location in respect to the smooth camera movement. Yet they found the design itself very strange. One participant said '*I cannot relate this design to anything I have ever seen before'.*
While adding the effect of music playing in the background gave the animation more of a friendly and familiar aspect to it. This made the design more acceptable and tempting to be explored and understood in terms of the concept behind it.

The music here provoked participants' imaginations to try to understand the design; through their narratives of what this space might be, it was considered unique to their imagination. Participants' narratives expressing the animations do not necessarily relate to reality.
The music helped by providing a theme, which allowed participants to build their imaginary narratives around.

This was the opinion of those who liked the music and enjoyed listening to it (6 of 7 participants). Although one participant did not validate his emotional engagement diagram, which showed a flat line due to his expressionless face (poker face).
He still validated the reasons that gave the music an extra value to the animated work.
The participants who did not like the music (one participant) simply rejected the whole animation (music and design) and did not want to interact with it.
Regarding the design elements used (colour, light, and materials and textures), all in the right tune and worked all together to express the strange theme of the animation.

Some comments of the participants regarding the design elements can be found as follows (see Appendix section5, *Pilot Study; Focus group and semi structured Interviews transcripts sample*):

> *'The outer skin reminds me with the Victorian cells where they used to torture people. No people' the participant thinks it's made it worse that there were no people there and he mentioned that the materials lights and colours are all successful in expressing sadness, torture and isolation.'*
>
> *'I received them all as a package with the music (the colour and light matches the form and the music.'*
>
> *'The sad music, like the aliens concurred the world and that is the end.'*
>
> *'The light and colours reminds me with the science museum and the floating bubbles are like planets.'*
>
> *'The texture is successful to convey the message, It reminds me with death.'*

From the above comments, I can see that participants here discuss the design elements (light, colour, and materials and texture) as a package with the music that conveys the design concept. I sense here the reveal of experiencing those elements of design as a whole as being like the synaesthetic experience, where emotions and sensory associations and perceptions are all blended in the experience, and participants might simply not separate those elements and individually talk about them.

What was also noticeable was that the researcher only needed to propose the elements or clues, and participants created their narratives reinforcing the music. In cases where they did not have a specific memory in mind that they could relate to; they simply created their alternative concept and lived the music as a narrative of their own, with plenty of room for imagination.

Several new factors were present in this experiment which were found to have affected the participants' engagement and evaluation of the designed spaces; namely their sense of place and orientation, and understanding the design and movement. These factors reflected in their evaluation of the work in general.

Sense of Orientation

A total of 6 of 7 participants confirmed that they can sketch a plan or a top view to space when asked if they could, which means they were fully aware of the place and quite oriented in the animated work, with only one participant not able to do so.

Understanding (Perceiving the Space)

Most of the participants (6/7 participants) agreed that the design ‘matches’ the music in the ‘theme’ as they said, the music was relatively sad and the design was also strange and provoked sad feelings.

They stated that the music was dominant in the scene and reflected on their feelings towards the design in general. After a bit of an explanation about what is the concept of the design all participants saw the reason behind designing a ‘strange design’ as they mentioned one said ‘ I could not relate this to anything I saw before’. They thought that the colours, light and textures where all on the same direction of the concept and the music (even the person who disliked the music he understood the justification of the design) yet they could not analyse and discuss the design elements in separate they just could talk about the design as a whole experience.

Movement

Participants were found to be mostly relatively comfortable (5 of 7 participants) with the movement because they understood the place and were fully aware of their position inside it, yet they raised some issues.

Because the movement was a camera movement their vision was restricted with the camera’s field of view, only looking at a 2D image and not being able to freely to turn their heads around, which made them feel trapped in the scenes they are watching.

Some of the camera angles were clearly not at a human eye height, which made it unconformable to look at things yet this was justified later when they knew the fact that the camera was implanted in one of the floating bubbles, which further made it reasonable to be at such a height and angle. The use of one camera and one camera path in the

whole animation helped keep the arousal in the design with the arousal of music match, as shown in Figure 38.

Figure 38: Camera Movement in Sculpture / Sound Space / Pilot study (designed by the researcher)

Gallery

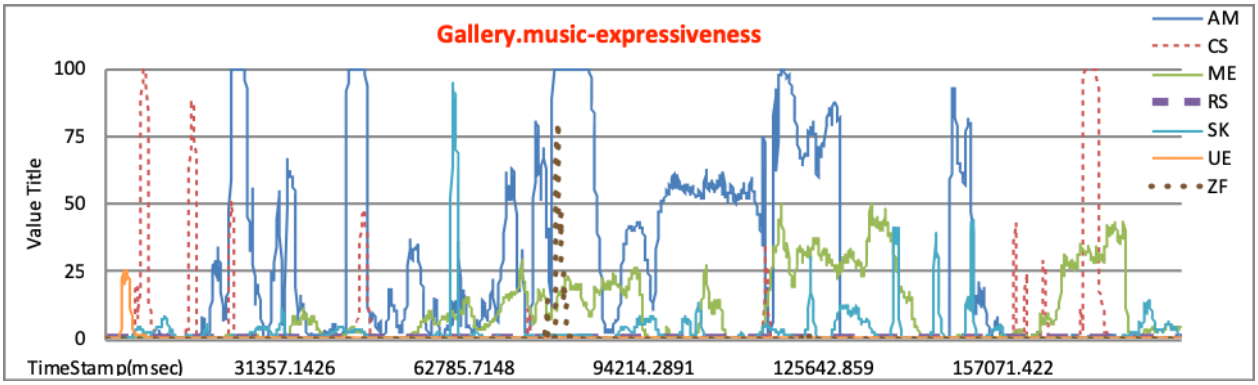


Figure 39: Gallery expressiveness diagram (music only) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

This diagram (Figure 39) shows that participants were engaged with the music in general and this what they confirmed in the interviews and the focus group even the participant with ‘a poker face’ represented by the big dotted purple line at the bottom of the chart confirmed that he was engaged with the music although it was not his ‘favourite type’.

The orange line in the diagram belongs to a participant who also confirmed the engagement with the music all along the music track. Yet the diagram shows otherwise.

So if I would score the emotion as service tool I would say that it got 5 out of seven partially correct and that would be almost 71% true emotion detection score. in this stage, participants started to have certain expectations on how the design might look like or presented since the music was very Iraqi traditional flavour.

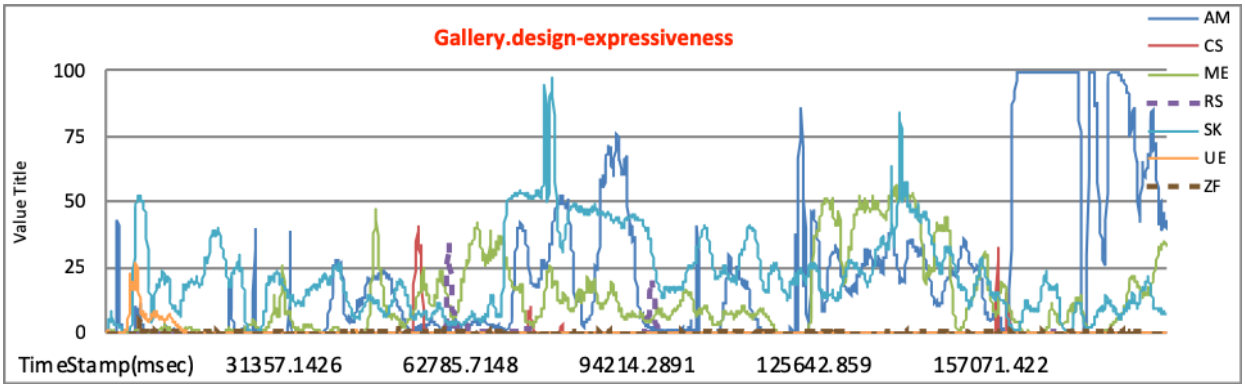


Figure 40: Gallery expressiveness diagram (design only) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

Compared to the chart in Figure 39, it is obvious that the participants were also engaged with the design in the chart in Figure 40, yet engagement levels were in different places from the music only stage. This is also confirmed by the participants during the interviews and focus group. They also said that they did not expect such a design; the music gave them the expectation that the design will be more of a traditional one in terms of materials and the design approach. The design here belongs to a mixed approach, where the design is very modern yet the materials were a mix of traditional and modern steel glass materials.

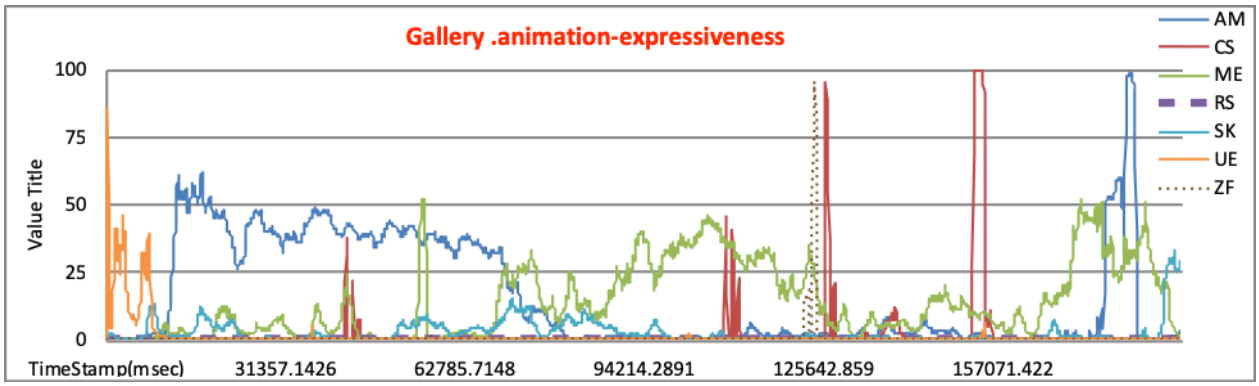


Figure 41: Gallery expressiveness diagram (animation) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

Here in Figure 41, the engagement level went to its lowest values between the three stages. This also confirmed by the participants later on.

The participants stated that the design does not match with the theme of the music. And, attaching the music to the design, making them both lost their value of communication or effect upon the participants' attention.

In this stage, participants were highly confused about the space and dissatisfied with the combination of design elements. This means that they do not see this work as an experience; rather, they deal with it as artwork that can be criticised. For this reason, participants were able to discuss and identify the flaws in the design elements and proposed ideas to fix them.

Colour: The colours are too much for this design; they should be something less contrasting and more harmonious to match the music.

Light: The lights were not successful here; the coloured spotlights directed into sculptures and paintings exhibited inside the gallery confused the participants and affected the objects badly in terms of understanding, and the faint shadows produced due to many overlapping light cones added an extra layer of confusion to the design.

Materials and texture: The use of transparent objects overlapping solid and rough textures in the movie clips made it difficult to 'digest' the scenes and accordingly the design as the participants expressed. And the use of big scale tiles here just annoyed the participants and reaped expressions such as 'uncomfortable' to see those objects.

Some comments of participants regarding the right tuning of the design elements used in Gallery (see Appendix section 5):

> *'It will be unfair to combine this design with this music unfair for both of the design and the music.'*
>
> *'The materials you used, are just like all the same characteristics, the same roughness, texture and the paintings are also the same texture as if you are inside a savage wild city.'*
>
> *'The music here doesn't relate to the design, that is way I put the music aside and I started to focus on the design itself to try to find the relation between what I here and what I see.'*
>
> *'Simplify the whole Design, less elements, less rough materials more focus on the lighting and the contrast between the dark and lightened area and the painting displayed related to tradition or a display to the art of certain old decade in the Iraqi culture. The design now is just uncomfortable.'*
>
> *'I need to feel Nature here, (In and out spaces). To feel this music in this space.'*

The same factors seen to have occurred in the first animated work were also present here and affected the participants' engagement and evaluation of the designed space according to the interviews and focus group—a sense of place and orientation,

understanding the design and movement—which reflected on their evaluation of the work in general.

Sense of Orientation

A total of 5 of 7 participants said that they can draw a plan after watching the animation for more 2–3 times, 2 participants said that they do not think that they can draw any sketch to the space immediately or even if they watch the animation again simply because there were too many dissolved images in the animation and they were not very oriented or aware of their position inside the Gallery space.

Understanding (Perceiving the Space)

Most of the participants (6/7 participants) agreed that the design ‘does not match’ the music in the ‘theme’ as they said. The music was a very traditional melody and instruments while the design is modern and the materials and textures used were natural materials true but the excessive use of coloured large sheets of glass and the steel elements contradicted with the traditional theme of the music. The animation also has many dissolved scenes that also contributed to the feeling of confusion the participants has. When asked about evaluating the design elements of light colour and texture and materials they could give an opinion here which was partially separating the design from the experience since they said that the experience is contradictory and incomplete here.

Movement

Participants mostly were not well oriented here and one of the reasons that affected their awareness of the place is again was the camera movement which one of the participants said that it was ‘An arbitrary movement’ while the music was so constant, this made them not in communication with the animated work. Furthermore, the different height of the camera gave an unrealistic perspective to space and the objects inside forming it. The use of different cameras and different camera paths also harmed

the animation and made it confusing as shown in Figure 42 only one participant could justify the jumping scenes by saying:

‘It's like my soul has left my body and started to act like a ghost wondering around this gallery and make me see those strange view angles and the excessive use of transparent layers enforced the feeling of a ghost wandering around’.

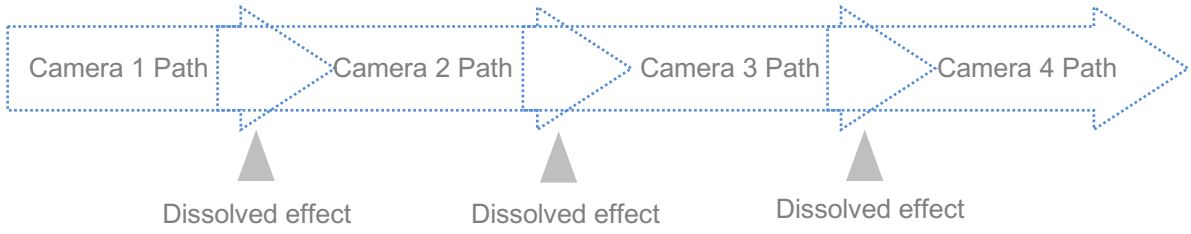


Figure 42: Cameras Movement in Gallery / Sound Space / pilot study
(designed by the researcher)

Infinity 1 & 2

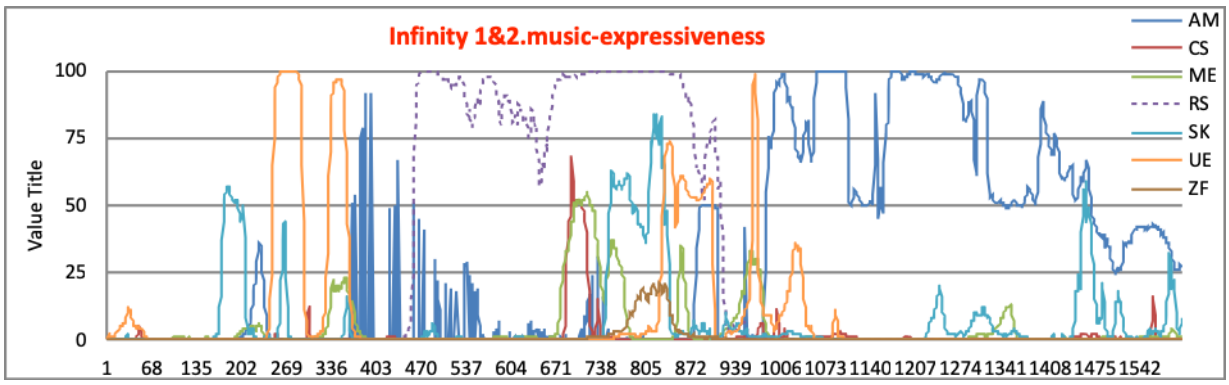


Figure 43: Infinity 1&2 expressiveness diagram (Music only) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

In Figure 43 which represents the music only stage in the Infinity 1 & 2 animation, participants here either highly engaged emotionally with the music or not really engaged with it in different timelines from the animation the problem here was caused by my edit to the music remix where I distorted the sound this made the participants not engage with the music in the distorted places. However, overall there was a good level of engagement with the music.

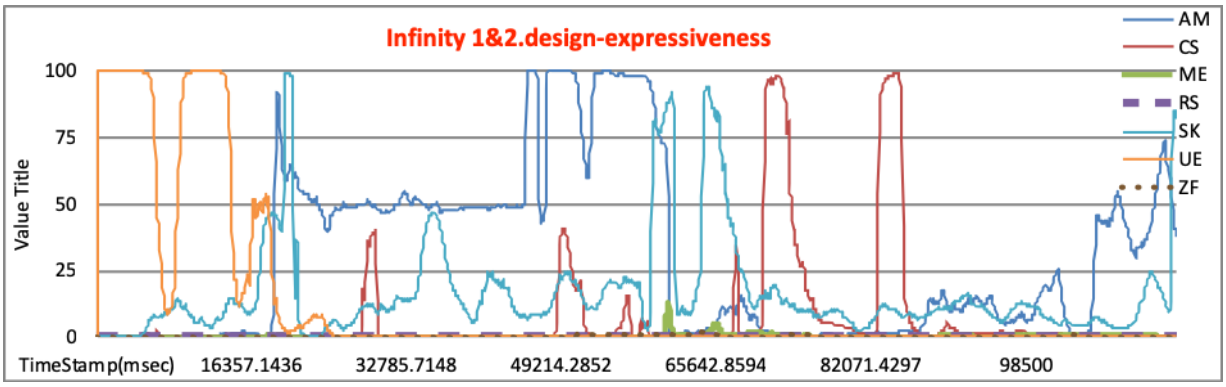


Figure 44: Infinity 1&2 expressiveness diagram (design only) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

In Figure 44, which is a representation of the design only emotion detection stage of Infinity 1 & 2, participants stated that the design was confusing, just like the music, with obviously less emotional engagement with the design. Participants partly confirmed their poor engagement with the design and said it was so confusing, that too many things were happening in a short timeline. There are two main layers of animation attached, one animation is of a fast track nature (the camera speed is relatively hard to follow) yet the other animation is much slower according to the speed of the camera movement. Many layers, the frames in this animation are barely clear, many objects and many contradictory elements. it was just hard to digest in this short time.

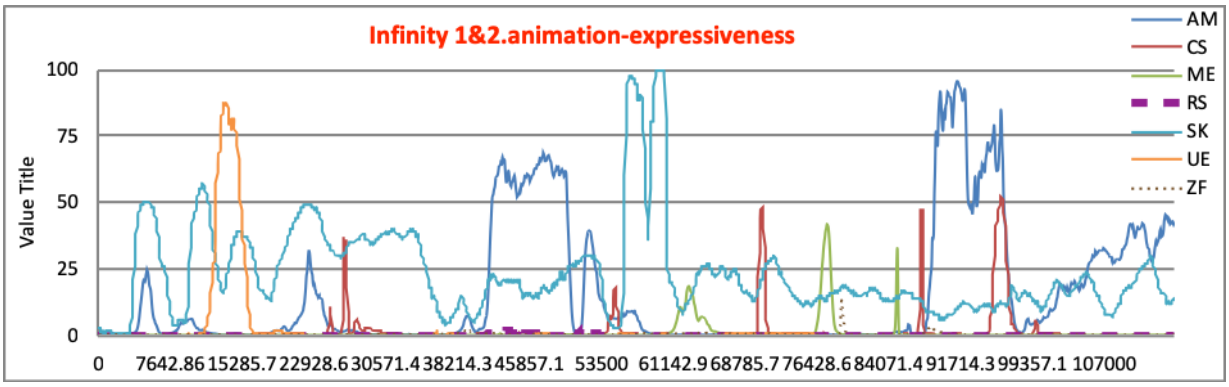


Figure 45: Infinity 1&2 expressiveness diagram (animation) as sample of the emotion as a service quantitative method collected in the pilot study (designed by the researcher)

Results in figure 45 show a dramatic drop in the participants' engagement levels compared to the previous stage of 'design only' in Figure 44. That is because of the excessive use of layers added. Although, 3 of 7 participants found that the speed of the animation matches the fast continues scenes of the animation that play alongside the slow one. Which matches a fast rhythm in the music as well.

Participants confirmed in the semi-structured interviews that the emotions detected here are almost right but they could not confirm the levels of arousal, which makes this quantitative tool work as a prompt reflection on how the participants emotionally engaged with what they have been watching this also applies to the previous works of Sculpture and Gallery.

Generally, This quantitative data was used to provoke conversation in the semi-structured interviews which took place later, to evaluate the animated work, the appraisal was for tuning the expressive values of the elected design tools of colour, light, and materials and textures.

Participants were able to discuss the design elements and suggest alternatives to enhance the concept of each animated work and building the right atmosphere to each of the animated works situations (see Appendix, section 5).

Some comments of the participants regarding Infinity 1&2 are as follows:

> *'The sound is annoying because the music is corrupted. And it doesn't reflect the infinity term.'*
>
> *'The design here is better than the music.'*
>
> *'I feel that this is a journey to the unknown. It's like being in a bad dream. As it someone pushed me from the top of a mountain and I didn't know if I will be rescued or not.'*
>
> *'This is good, but you distorted it and it became confusing, I cannot understand it well.'*

The same factors occurred in the last two tests, and were also present here and affected the participants' engagement and evaluation of the designed space according to the interviews and focus group outcomes;

Sense of Orientation

A total of 2 of 7 participants said that they can draw a plan after watching the animation for more 2–3 times, 5 participants said that they don't think that they can draw any sketch to the space immediately or even if they watch the animation again simply because there were too many layers and the images dissolved in the animation appear quickly and then disappear. Participants were not very oriented or aware of their position inside the infinity, they said that infinity 1 is relatively easier to digest because of the starting position, which was obviously a corridor which made it a good grounds to start an infinite journey unlike infinity 2, which let them feel totally lost or as one participant said, ‘It’s like being pushed from the top of a mountain and you are not sure you will be rescued, It was like a bad dream and I just wanted to wake up’.

Understanding (Perceiving the space)

Most of the participants (5/7 participants) agreed that the design ‘does not match’ the music in its ‘theme’. The music was ‘corrupted' as one participant said and it harmed the design which he thinks that it is much better in quality and potential than the music.

The animation also has a problem with its many dissolved scenes.

And two animated layers on top of each other contributed to the feeling of confusion the participants felt.

When asked about evaluating the design elements of light, colour and texture and materials, participants gave their opinion here by separating those elements from the context of the experience.

They said that the experience here was confusing in terms of understanding what exactly they are experiencing as a design with a certain function or meaning. So they had to evaluate the design elements separately of their context.

Movement

The participants found it difficult to be oriented within the animation, one of the reasons that affected their awareness of place was again the camera movement and its speed.

One of the participants said that it felt like he was ‘falling down a mountain’. The attachment for two different speed animations did harm the design and let it down (see Figure 46).

Due to the loss of focus and confusion, Participants were disconnected with the animation in general (they were not interacting with it).

The cameras were in different heights which also affected the reality of such perspectives, Participants referred to them as ‘unrealistic perspectives’.

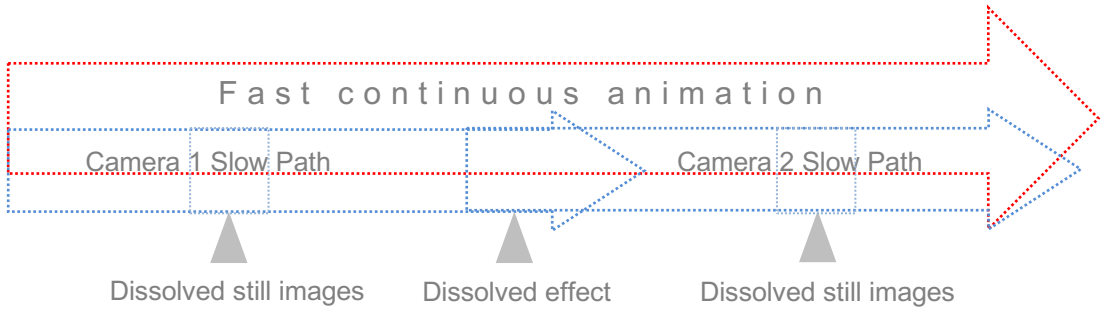


Figure 46: Camera Movement in Infinity 1&2 / Sound Space / pilot study (designed by the researcher)

To sum up the results of the quantitative method (Emotion as a Service from Affectiva), approximately 50% of the data was significant and partially described the participants' Sound Space sensory experience. This given percentage is fair in line with this growing technology, which needs to be tested and improved. The researcher depended 100% on validating the data gathered through the focus group and semi-structured interviews which took place afterwards. The outcomes answered the hypothesis and questions of this pilot study stage as well.

As mentioned earlier, the pilot study hypothesis and questions were as follows:

'A 'Synaesthetic Scape' experience can be achieved by tuning the design tools of light, colour, texture and materials (which are believed to influence the mood in the space emulating any real architectural experience)'.

The subsequent two question relate specifically to the sound space:

- What are the right levels of light, colour, materials and texture to influence the emotional engagement of participants with the space?
- To what extent can music be used to provoke emotions in order to create the emotional aspect of the synaesthetic experience?

The results and data analysis showed that:

1. Synaesthetic Scape design tools are just like the real environment design tools; light, colour and textures and materials yet with much less drama they are more like a neutralised parameters which are essentials to building the scene yet not to be over complicatedly used in building the experience of 'Synaesthetic Scape'.
2. Music was present as an important element in the designs of the animated work it played a major rule in provoking emotions.

In conclusion, Music was a successful tool to provoke emotional interaction between the participants and the animated works, as well as creating a theme for the participants to build their narratives around, and finally, somehow determine the era where this design is located within the architectural design movements timeline.

3-6-2 Insights and Recommendations of Sound Space (The Pilot Study):

Regarding the Experiment Context and Methodology:

1. A virtual reality camera will be used to create the animation; therefore, the participants will be required to use the VR kit in future experiments.

2. The quantitative part of the experiment will be excluded because of its time-consuming nature and its small effect on the resulting data. Individual semi-structured interviews will be conducted instead due to their importance in enriching the animated work analysis in regards to its design of expressive tools.

Regarding Movie-making Techniques:

Camera movement needs to stay consistent to as great a degree as possible because the jumping sense caused confusion to the participants in terms of orientation and understanding the space.

Avoid dissolved effects and filters as transactions between clips because they confuse in regards to applying the correct perspective clues to the animation.

The clips of every piece of work should include A clip which presents a general idea of how the space is shaped (does not have to be at the eye level), and clips showing the movement path of the participant inside the space (eye level) to help the participant identify his location.

Regarding Design Tools:

1. Texture: Use the general theme of moderate textures (not too rough not too smooth) with focus on one or two different textures and the scale of the used materials should be considered more.

2. Lighting: A general lighting theme should be applied with spotlights directed towards important objects or details to give a good effect of shadows to build the dramatic narrative of the space.

3. The colours: Depend on the concept of the emotional narrative reflected inside the space.

Regarding the Building of a Narrative:

1. Give the users clues throughout the movie to help them create their narrative.

2. Do not interrupt the perception process of the space by over complicating the visual elements and clues because users tend to lose communication with the work if it is too complicated to understand.

All of the above recommendations led to the next phase of design, which was the first Synaesthetic Scape design attempt.

3-6-3 Synaesthetic Scape 1 Outcomes

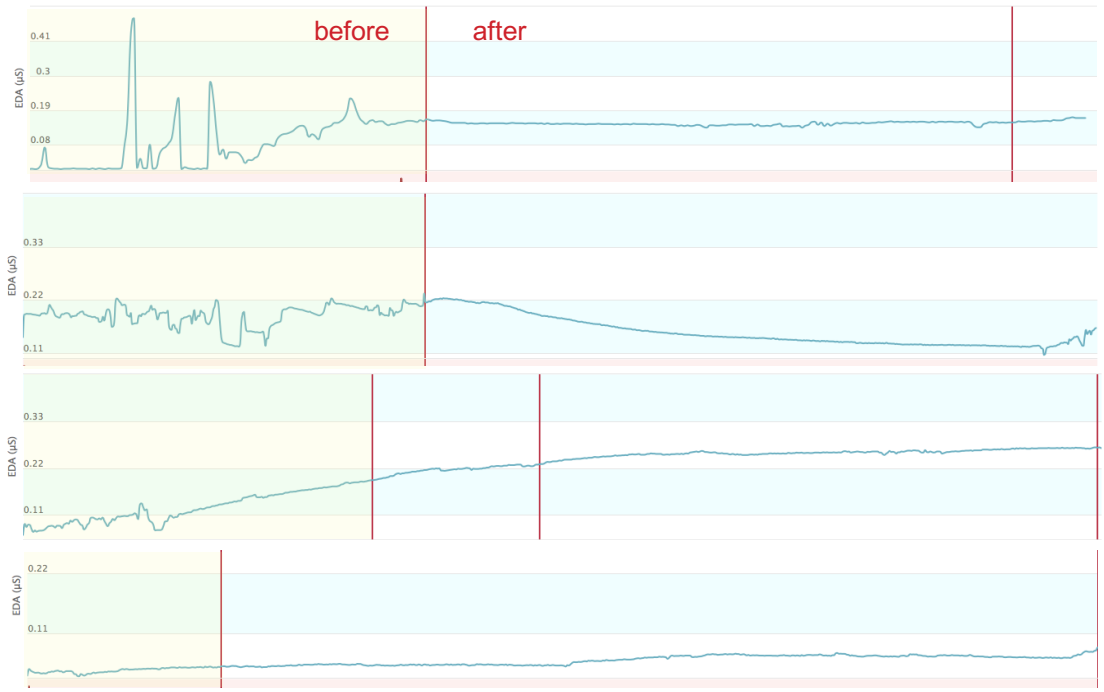


Figure 47: E4 wristband data before and after samples for the Synaesthetic Scape 1 experiment

When looking closely at Figure 47, the quantitative data gained from E4 wristband, it can be observed that there is a general calmness—a straight smooth line—for most of the participants (5/6 Participants E4 parameter) compared with their emotional status before being exposed to the virtual environment, where some of them were stressed to use this technology for the first time. As mentioned, 7 participants were involved in the test, yet one of them did not use the E4 wristband because the researcher left this at home.

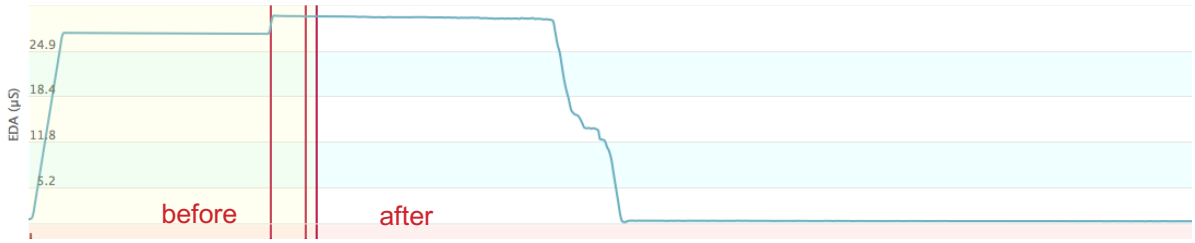


Figure 48: E4 wristband data before and after sample for the Synaesthetic Scape 1 experiment

In Figure 48, the participant confirmed she was excited and a bit stressed about using the VR Oculus kit for the first time, which is shown in this diagram. She took her time to relax and get used to the navigating method, which was, in this case, the keyboard (she could not see where the buttons are to navigate). After a short while of being in the Synaesthetic Scape environment, however, she was relaxed and calm.

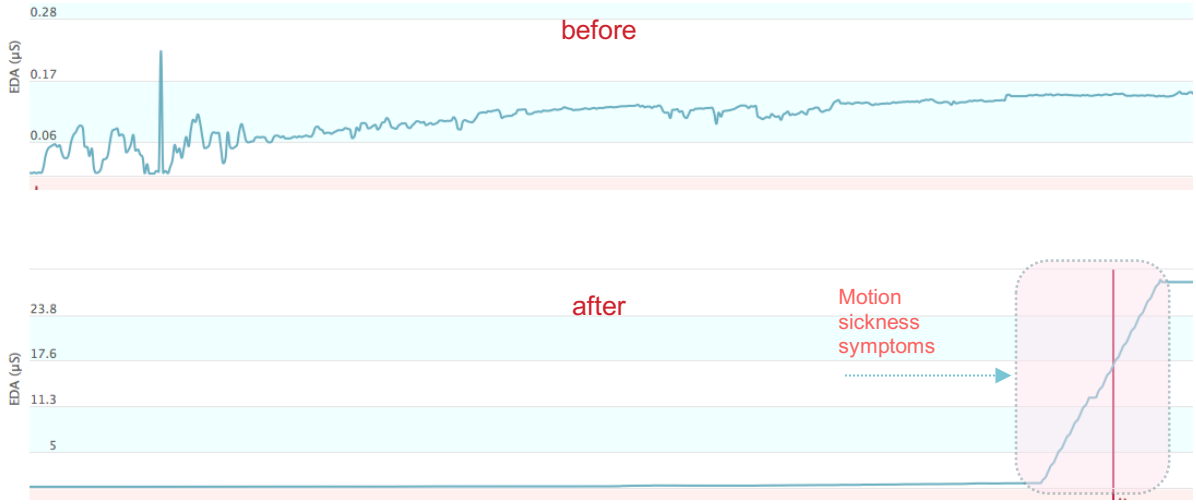


Figure 49: before and after E4 diagrams for a participant who started to feel dizzy towards the end of the Synaesthetic Scape 1 experiment

In Figure 49, an interesting case can be seen where the participant confirmed rushing to the lab so that he would not miss the appointment of the test. He was as shown in the 'before' diagram stressed and not comfortable. He became calm and relaxed during the test in the 'after' diagram and was then asked if there is a way to speed up his movement in the VR environment so that he could quickly skip the positions he already saw to explore somewhere new.

After a very short time of using the speed up button, he started to feel dizzy and showed the symptoms of motion sickness, which he denied having at the beginning of the test, yet once he changed the default speed of the Unity program, he lost control and asked to end the test.

The researcher was prepared for such a situation, and so gave the participant a small break and asked him if he wanted to continue the test with the use of a very big screen (Wall size) to check the synaesthetic environment on screen. The participant was willing to try.

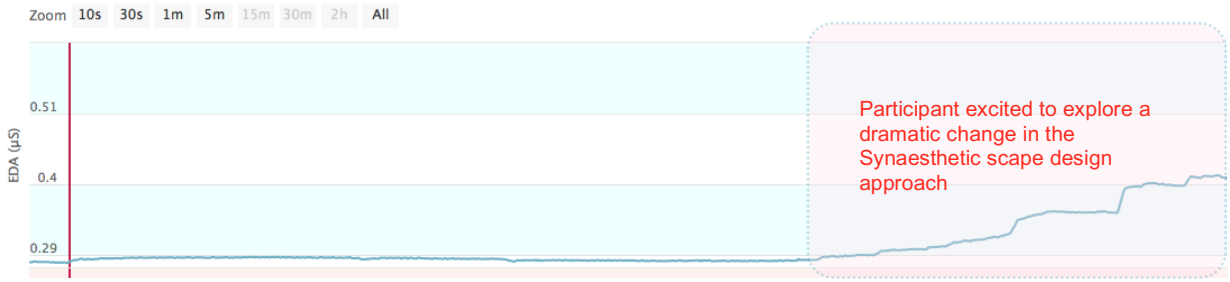


Figure 50: Big screen Synaesthetic Scape E4 diagrams for a participant who started to feel dizzy towards the end of the synaesthetic scape 1 experiment

Figure 50 shows the E4 diagram for the same participant but on a wall-sized screen. The participant confirmed that what caused highlighted incline in the engagement level above was that he saw unexpected scenes and started to get curious and wanted to explore this area more this started after passing an opening inside a building. He said; 'When I went further inside the environment the design started to change gradually', referring to a gradual change in the design and materials from a traditional approach into a modern one.

In the semi-structured interviews that took place immediately following the Synaesthetic Scape 1 experiments, participants confirmed the information of the E4 diagrams, but again just like the facial recognition, valid results participants could not confirm the levels of arousal in numbers they just confirmed the level of arousal being higher or lower than before or after moments, which makes this quantitative tool works like a prompt reflection on how the participants emotionally engaged or interacted with what they were experiencing. This parameter gives a general idea of how they received the VR experience in various points inside the VR environment.

This data was used to provoke the conversation in the semi-structured interviews and helped talk about and evaluate the design elements of light, colour and texture and materials, which was the aim of using this parameter yet participants confirmed that they cannot talk about and evaluate the design elements separately from the whole experience evaluation, they deal with the whole Synaesthetic Scape design and experience as a whole.

Regarding the factors which appeared before in the pilot study—the sense of place and orientation, understanding the design and movement—here in the Synaesthetic Scape 1, they were present as well but in a different way.

Sense of Place and Orientation:

Here, participants were oriented enough to make them comfortable to explore the VR environment without becoming lost or getting confused as they said they were in some of the animated works in the previous pilot Sound Space test. The sun was a very good reference to guide them through. This was confirmed in the sketches they presented in the semi-structured interview when asked if were able to sketch briefly the environment that they experienced.

Understanding the Design or Perceiving the Designed Environment

From the sketches in Figure 51, it is noticeable that the participants understood or perceived that the design consists of two main parts; ‘the front’ traditional part and ‘the back’ modern part (as the participants addressed them).

Also, they were highly right about the shapes and forms of the masses they saw in the front part and kind of got the back part mostly not right.

That is basically because they had the chance to see the masses forming the front part from different angles and different /perspectives and distances which made this part easier to understand and digest.

On the other hand, participants did not have the same opportunity to explore the back part of the project as freely as the front part. The reason for this is owing to the design itself. The limited distance in front of the buildings that are forming the narrow tunnels made it impossible for the participants to explore this part from a distance that allows them to see the whole picture then get closer to understand the details.

Instead, they were forced to be close to the buildings and interact with the facades' details closely. Therefore, in this part, they had to understand and perceive the whole design of the buildings by combing the details they saw.

For that reason, the participants sketched the buildings as un-unified pointy forms, despite being pretty much unified in rectangular forms in the top view of the Synaesthetic Scape design. The details of the folded façades were only on the front side of those buildings and did not at all affect their rectangular uniformed shapes.

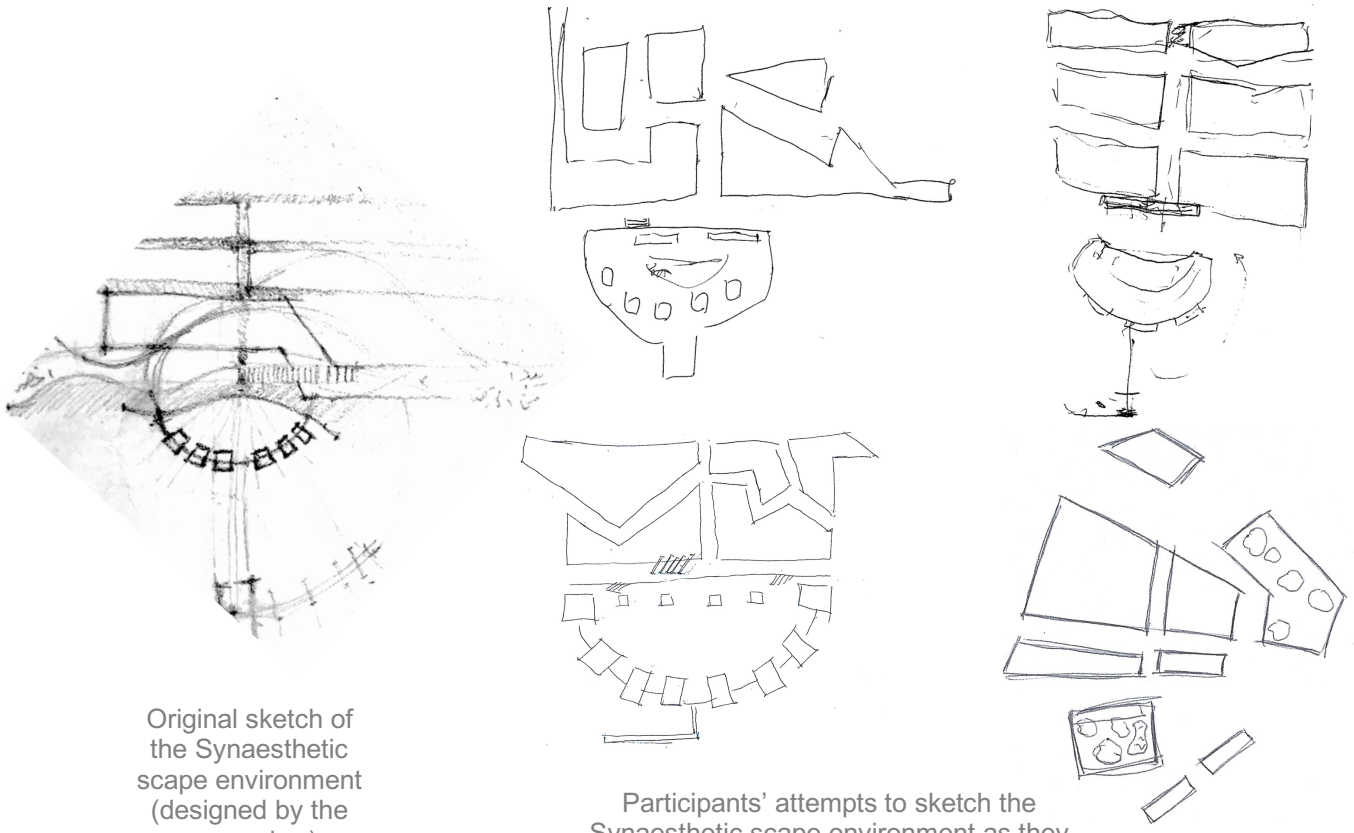
Here, the researcher (designer) intended to give the participants a unique experience of exploring the modern masses and feel the connection between the interior space and the exterior context, where the interior penetrates through the large glass facades and merges with the exterior space to become one flowing space between the in and out.

Movement

The movement factor was present here yet was nonetheless noticed as being quite different from the camera movement in the previous Sound Space pilot study.

The camera movement in the previous pilot experiment was proposed by the designer, and the participant did not have any choice but to see what the designer wanted him to see any movement along with the animated work.

Nonetheless, here in the Synaesthetic Scape 1, the VR technology allowed the participants to move freely and determine what to explore through the use of the Oculus headset. See (Glimpse from Synaesthetic Scape1 from different perspectives) foldout on page 181.



Original sketch of the Synaesthetic scape environment (designed by the researcher)

Participants' attempts to sketch the Synaesthetic scape environment as they experienced it

Figure 51: comparing the sketches done by the participants with the original sketch of the Synaesthetic Scape 1

Some comments from the participants' semi-structured interviews:

'This is more realistic than the previous one', referring and comparing with the pilot Sound Space experience.'

'I like the lighting and the shadows in the front part or the beginning of the project.'

'I like the settlement of the initial palette, may be just one or two areas need colour or more details to bring attention to it' referring for a particular part in the project).'

'Something traditional, something peaceful with lots of landscape around me, I mean the music suggests design more of this.'

'It's like. I can take it as it is, No changes, may be more vegetation more colours to give an oriental feeling to match the music more.'

'Add interior furniture to suggest function' referring to some buildings which looked the same from the outside.'

'It reminds me with Venice, It is the only city I saw on water.'

'The experience of the boat and the movement in that speed made me listen to my surroundings better… The music worked with the boat experience.'

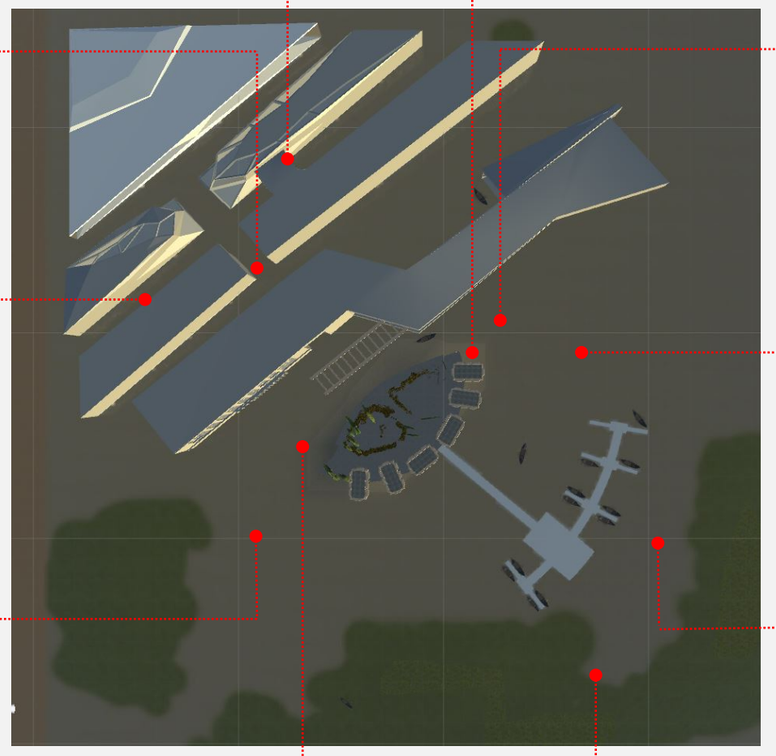
'Good setting, the music, the soundscape and landscape was ok for me, It was relaxing, cosy and I could not feel the time passing; It felt like two minutes but in fact it was 6 minutes.'

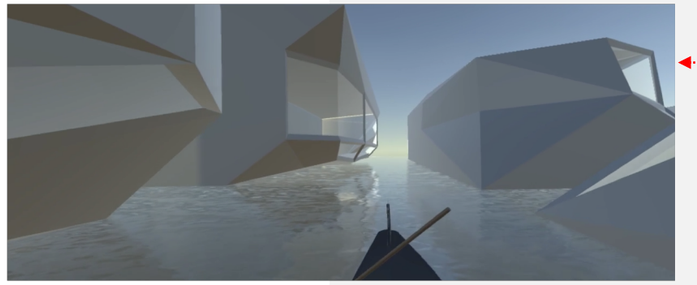
'I haven't thought that I stayed for more than 7 minutes.'

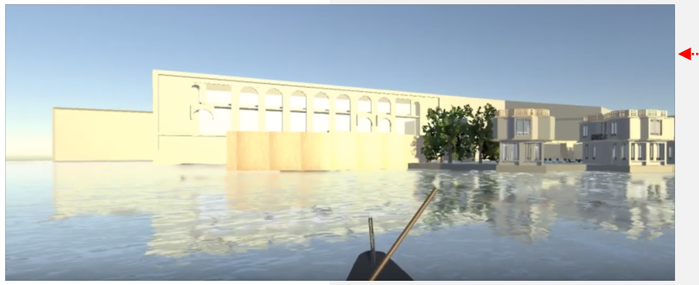
'An experience to remember.'

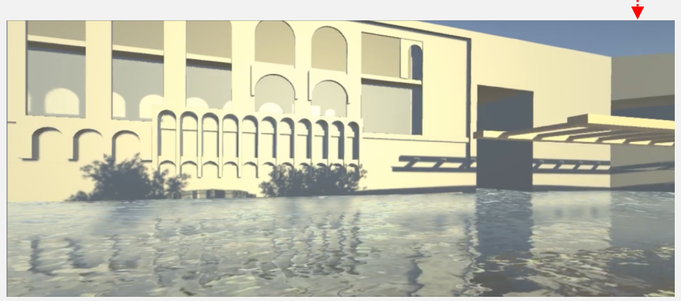
'It misses greenery and I wish i have seen people, I think the place misses the users'.

'My grandparent's house was exactly by the sea.' Trying to resemble what the participant saw and felt and relating it to an old memory.









Participants dealt with the virtual environment as a lived experience and were not fully able to critique the design elements efficiently in the separation of the Synaesthetic Scape experience as a whole. Instead, they tended to suggest adding one or two colours to enforce the character of some areas which they thought were a bit neutral or pale, just to match the music theme even more so or to otherwise enhance the music experience.

Most of the participants found areas in the VR environment that they could relate to in reality and were very engaged and interacted with it; they were trying to suggest adding more features to resemble their own provoked memories. This is what the researcher may refer to as a twisted augmented reality or a new mixed reality, where participants add things and elements from their imagination to the given Synaesthetic Scape in such a way to mimic a memory in their mind.

Participants were questioning what some parts of the virtual environment function as, and were wondering about the possibility of adding more greenery and people to the VR environment to make it even more real; however, as one participant mentioned, it would be a double-edged sword that might affect the experience unexpectedly because now it focuses on different things and generalises the elements on the scene, which causes some areas to lose their character and quality of engaging with participants.

Just as the pilot study revealed, the above factors affect the participants' evaluation of the Synaesthetic Scape sensory experience. This Synaesthetic Scape 1 experiment also revealed new factors or themes to be discussed in this research.

To sum up the results of the quantitative method E4 wristband, it would be accurate to state that the data was significant and indicated the general mood of the participants while experiencing the Synaesthetic Scape 1 VR environment.
The researcher depended 100% on validating the data through the semi-structured interviews, which took place afterwards. The outcomes provided answers in regards to the hypothesis and questions of Synaesthetic Scape 1 experimental sensory experience.

As mentioned prior to the Synaesthetic Scape 1, the hypothesis and questions were as follows:

‘Using virtual immersive technology will give users’ perceptions a sense of reality of the space, and its immersive qualities will help achieve the ‘Synaesthetic Scape’ experience’.

- Will neutralising the effect of the design tools of light, colour, materials and textures, allow other qualities of the virtual reality design to be present and will they improve the quality of the synaesthetic experience? What might those qualities be?

- Can the virtual reality design share the same design tools as those used to produce real architectural spaces?

- Music was used to provoke emotions in this scape, can it also provide room for the participants’ imaginative understandings of the Synaesthetic Scape as in the first stage of experiments?

Results and data analysis showed the following:

Synaesthetic Scape 1 was highly immersive, much like a real experience, as confirmed by the participants.

Neutralising the design elements of colour, light and materials and textures strategy reflected positively on the participants in terms of exploring and communicating with the Synaesthetic Scape 1 virtual environment. This helped to provide room for other qualities of the Synaesthetic Scape to be revealed, which, as mentioned previously, meant that the new mixed or augmented reality—where the participants were able to add to the environment from their own memory and experiences and tell their story with this sensory scape—provoked those old memories.

Another important quality appeared here in regards to the stretching of time, with both of those themes or qualities to be explored and discussed in the next chapter.

Music was present as an important element in provoking the old memories of the participants and in giving the Synaesthetic Scape 1 environment its main theme and character.

3-6-4 Insights and Recommendations for Synaesthetic Scape 1:

Regarding the experiment context and the methodology

1. A generic neutral context made a successful platform to communicate with participants.
2. Participants suggested adding details related to their memories provoked by the Synaesthetic Scape 1 VR experience (match their augmented reality).
3. The quantitative method, E4 wristband(the skin conductance device): The real-time data provided by this device was successful in detecting the participants 'arousal level' which describes their mood while experiencing the Synaesthetic Scape 1 environment.
4. This helped provoke the discussion in the interviews which took place afterwards.

Regarding the movement inside the VR environment

1. The participants were free to move inside the Synaesthetic Scape 1 since they had full control of the movement buttons of the keyboard which was easy to use as the participants assessed them.
2. Participants took different paths and each of them was well oriented and fully aware of their location inside the Synaesthetic cape 1(this was clear in the top view sketches they were asked to sketch later).

Regarding design tools

1. Texture: General theme of moderate textures was used to develop a generic environment. It was approved by all participants who said it matches the Synaesthetic Scape 1 theme although most of them suggested some different textures with similar effect to match their narratives of the scape.
2. Lighting: The general theme was the sunset. This was approved by the participants as matching the overall theme of the Synaesthetic Scape 1. The sun worked as a reference point for participants to locate themselves and keep them oriented through their virtual journey inside the Synaesthetic Scape 1.
3. Colours and forms: The participants recommended adding one or two colours to the Synaesthetic Scape 1 colour palette to emphasise certain features in the

design to let them speak for themselves and match the participant's perception of the scene.

3-6-5 Synaesthetic Scape 2 Outcomes

As in the previous Synaesthetic Scape 1 experiment, the data will be analysed and the outcomes of the E4 wristband quantitative methods discussed concerning the semi-structured interview outcomes, answering the research questions and hypothesis of this experimental stage of the PhD. Notably, the themes derived from the qualitative semi-structured interviews to be discussed in the next chapter.

As mentioned previously, the changes that took place in the updated design of the VR environment Synaesthetic Scape 2 were centred on limiting the effects of the music and making it play only in two different areas of the Synaesthetic Scape 2, while also adding more real sounds in different areas of the Synaesthetic Scape 2 environment.

Some of the sounds were located as speakers in the exterior. Whereas other human sounds (speakers) were placed in the interior of the buildings.

Those interior sounds were meant to give the buildings they are in 'functional character' to help participants understand what the interior space might be from its sound.

This action was taken concerning the participants querying the function of some buildings. And also to make the feeling of loneliness that some of the participants expressed disappear.

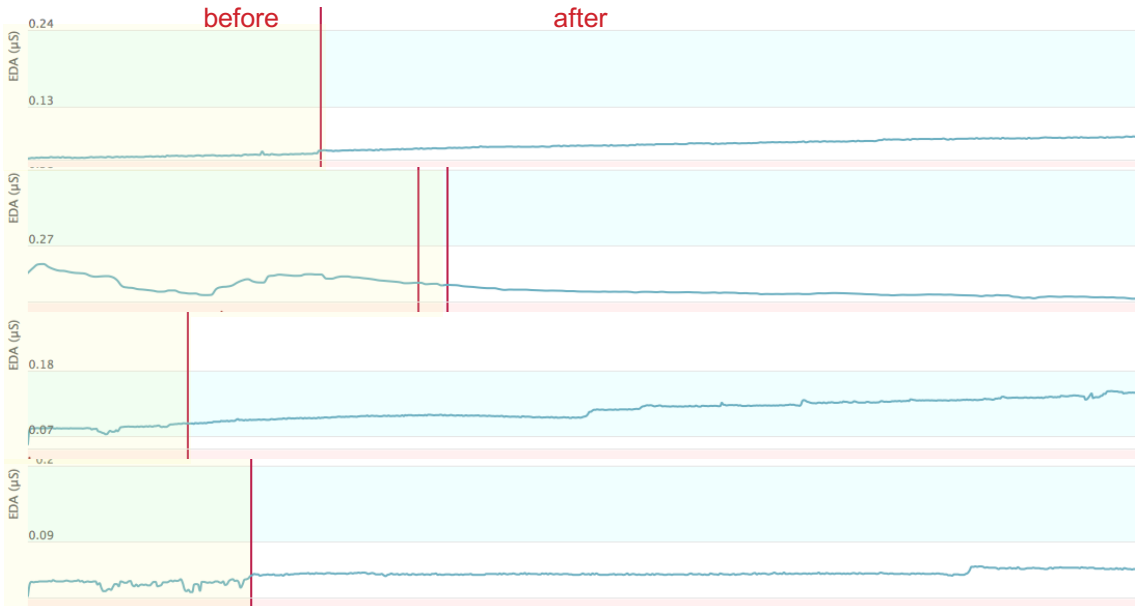


Figure 52: E4 wristband data before and after samples for the Synaesthetic Scape 2 experiment

This action improved the sensory interaction between the participants and their sensory surrounding virtual environment, which eventually lifted the sensory potential of the whole Synaesthetic Scape 2 experience.

As mentioned before, 7 participants took the Synaesthetic Scape test in Figure 52, which represents the E4 diagrams of the 4 of the 7 participants that also participated in the previous Synaesthetic Scape 1. Importantly, 3 of them were also participants from the first pilot study. All of the samples were able to distinguish the difference between the two Synaesthetic Scape experiences.

The participants were either calm or calmer compared to their levels or arousals before and through the Synaesthetic Scape 2 experiment, almost like the indications derived from the previous experiment.

Nonetheless, the participants confirmed that, here, they were more focused and alert with the sounds taking place through their journey in the VR environment. The more sounds added to the journey, the more interactive they were. This was found to be in contrast with the old experience, which was with one theme related to music and memory connections.

Figure 53: E4 wristband data before and after which belongs to a town planner experiencing the Synaesthetic Scape 2

In Figure 53, the participant was not a designer but a town planner with no idea about VR technology. Accordingly, her information about it was superficial. As such, she was very excited and nervous when wearing the Oculus headset; this reflected in her E4 diagram special in the (before) line, with the time she started to calm down and explore the different sounds and the virtual environment with more focus and attention. As she confirmed later in the semi-structured interview, this happened immediately after she took off the Oculus headset; her first impression was ‘Wow’.

Figure 54 shows the quantitative results for two participants that showed motion sickness symptoms. The top diagram belongs to a participant who confirmed that they did not suffer from motion sickness yet felt tired after having a long day and did not have anything to eat really, so he thought this was what caused those symptoms. However, he shouted ‘Wow! Nice!’ when he saw and experienced the very first scene of the Synaesthetic Scape 2.

Here, the participant was wearing glasses and preferred to wear the Oculus headset on top of his glasses and did not mention that he was very uncomfortable because he just did not see things as clearly as he should. This made him stop the VR test after having a ten-minute journey since he started to feel dizzy. He took a small break and continued to the semi-structured interview afterwards.

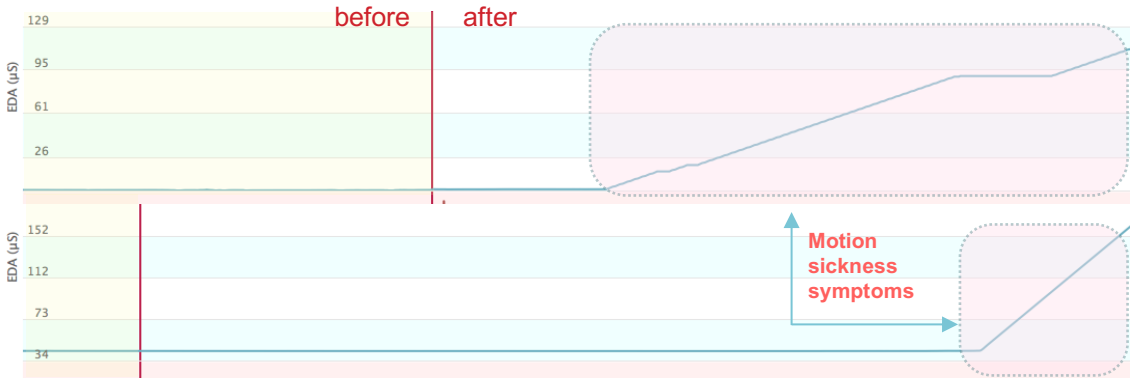


Figure 54: before and after E4 diagrams for participants who started to feel dizzy towards the end of the Synaesthetic Scape 2 experience

In the semi-structured interviews that took place immediately after the Synaesthetic Scape 2 experiments participants confirmed the information of the E4 diagrams are just like Synaesthetic Scape 1. This parameter gives a general idea of how they received and interacted with the VR environment in various points.

This data helped the participants to talk about their experience, especially those who did both Synaesthetic Scape 1 and 2 experiments. They thought this version was considered the mature version of the first one and felt more real due to the use of real sounds; they expressed their feeling that the other parameters of light colour texture and materials had been improved or changed compared to the previous Synaesthetic Scape 1. They further went to claim that the researcher changed those elements and updated them in this version, which was not the case.

The reason for that is that those participants spent more time exploring the scene than they did in the first experiment. And because they were interacting with the sounds and buildings. They were more focused and appreciated everything in the scene even more. They almost looked at the environment as if they are seeing it with fresh eyes. This was not expected by the researcher, who thought they would just talk about the new sound effects since they had already experienced this before.

One more thing helped the interaction even more, which was another modification made, which gave them the ability to explore going through the walls of some buildings. They could then explore the architecture from the inside and could hear their footsteps instead of a rowing boat in the water sound. Of course, not all the buildings had this feature; with others, you could only bump into them and hear the bumping sound and

bounce back, not able to go through the walls. This feature increased the interaction even more and encouraged the participants to stay longer to discover the interior spaces.

The remainder of the participants who took this experiment for the first time spent a shorter time relatively compared to the old experienced ones. Nonetheless, they all shared the same opinions of the Synaesthetic Scape sensory experience, which was as interactive with the sounds and spaces they saw. They all shared a good acceptance level for the design as it is with the suggestion to add more to the sound palette. Importantly, they all appreciated the immersive experience and referred to it as being a reality-like experience.

All the participants confirmed they were highly engaged and interacted with the sounds they heard, which helped them to stay excited and focused on exploring more places in the VR environment. Regarding the factors discussed in the experiments before—the sense of place and orientation, understanding the design and movement—in the Synaesthetic Scape 2, they were also present.

Sense of Place and Orientation:

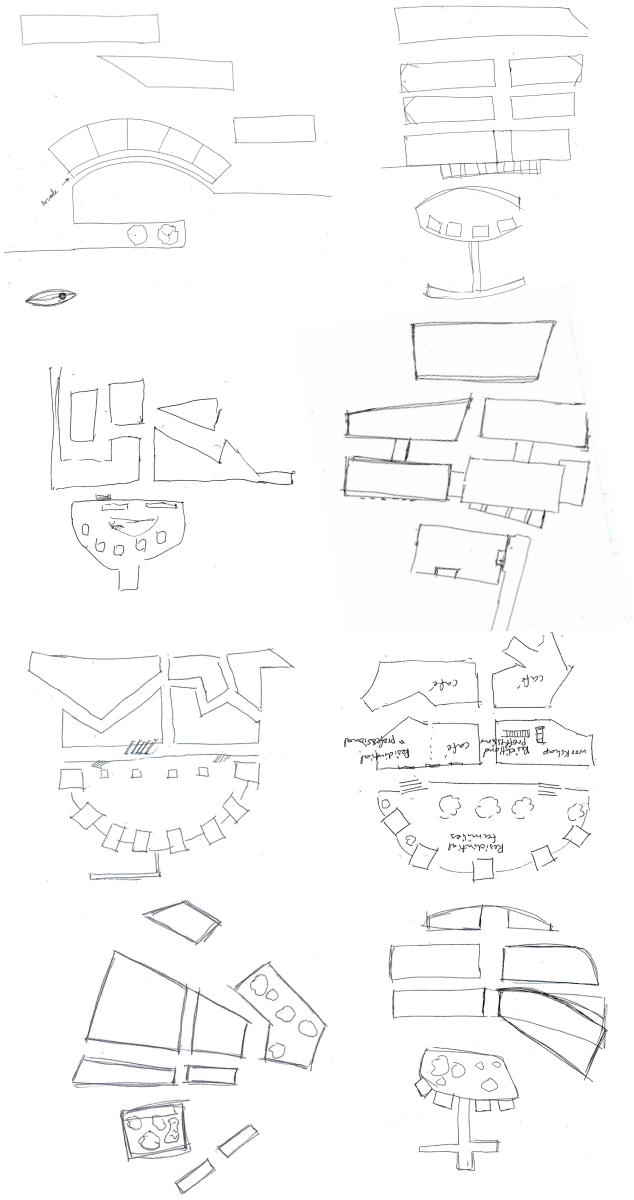
Just like the previous experiment of Synaesthetic Scape, old and new participants were fully oriented and aware of their position within the VR environment. This was obvious in the sketches when they were asked if they could draw a top view of where they thought they were.

Understanding the Design or Perceiving the Designed Environment

The participants were divided into two groups: the first group comprised the participants that took both Synaesthetic Scape 1 and 2 experiments; the other group comprised participants who had experienced Synaesthetic Scape 2 only and who were new to the sensory experience.

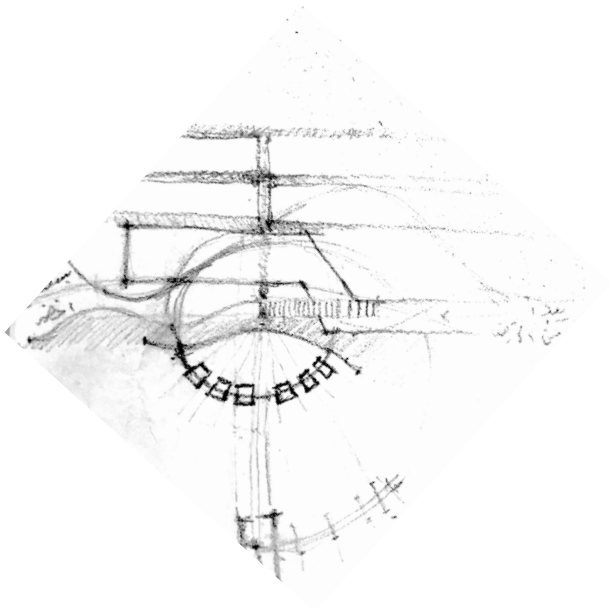
Comparing the sketches produced by each participant in Figure 55, We can see that the sketch from Synaesthetic Scape 2 is the most relevant to the original sketch designed by the researcher. Which means that the participants' experiences and understanding were deepened in the second test of Synaesthetic Scape 2. Of course, there is the fact that the participants took the test before yet, a decent percentage of them were more interactive with Synaesthetic Scape 2.

Participants spent more time and paid more attention to perceiving the details in depth in their second attempt with the Synaesthetic Scape2 even more. Adding a mixture of new real sounds to the Synaesthetic Scape 2 audio palette (as confirmed by the participants later in the semi-structured interview) and allowing participants to explore some places from the inside. Increased sensory interaction with the scenes during the exploration of the VR environment.



Sketchs of the Synaesthetic Scape 1 environment

Sketchs of the Synaesthetic Scape 2 environment



Original sketch of the Synaesthetic Scape environment

Figure 55: Comparison between the sketches of Synaesthetic Scape 1 and 2 produced from the same participants who did both experiments all compared to the original sketch (designed by the researcher).

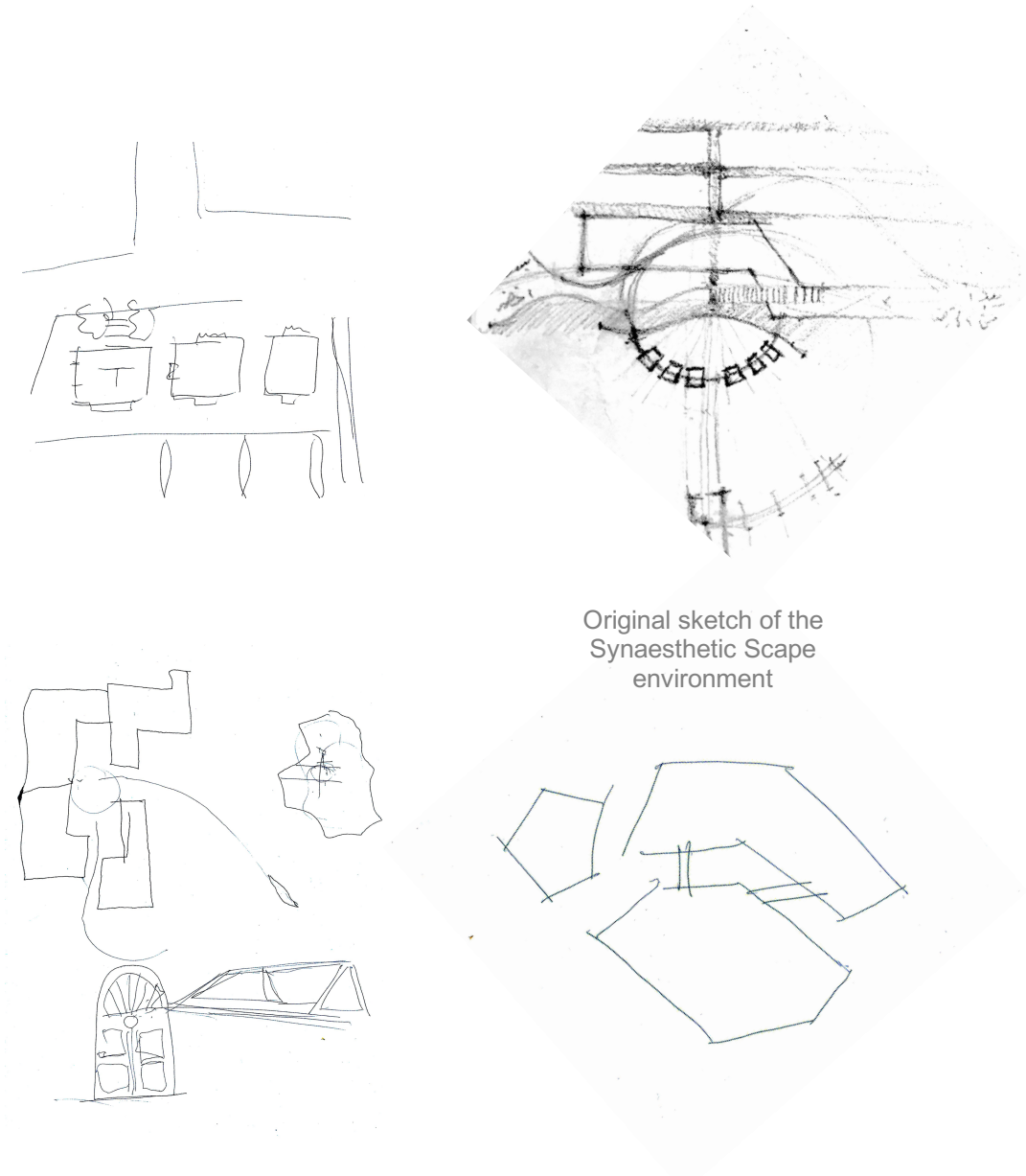


Figure 56: Synaesthetic Scape 2 sketches collected from the participants who did not take the synaesthetic Scape 1 experience (collected by the researcher)

The second group of participants presented the sketches in Figure 56, which, identify the main two styles of buildings in the front part and the modern back part as also confirmed in the semi-structured interviews. The sketch on the top-left corner belongs to the town planner, who said she was not very good at drawing; nonetheless, it is obvious that she got it relatively right as this reflects that she fully perceived the scene and was comfortable and oriented while moving around.

The bottom two sketches belong to the participants who showed signs of dizziness, but even though they were not physically able to explore the Synaesthetic Scape for long, it

remains that there was nonetheless a good understanding of the VR environment, which they perceived when compared to the original sketch of the designer.
The sketch on the bottom-left corner also have some physical elements, such as the old traditional door and pointed triangular windows in the modern part of the scene. This participant spent the least time exploring Synaesthetic Scape 2 yet he captured a lot in this short time of sensory interaction with the VR scape.

Movement

Although participants enjoyed the reality like flexibility and freedom of movement in the previous Synaesthetic Scape 1 (where music was playing in the background). Nonetheless, it created a theme or direction of the perceived space of Synaesthetic Scape 1.
In Synaesthetic Scape 2 the movement factor took another dimension by adding real sounds, and permission to explore some spaces from inside enhanced the participants' sensory interaction within the virtual environment.
The new qualities of the Synaesthetic Scape 2 paved the way for perceiving and understanding the environment's design within a sensory envelope, which further enhanced interaction with the scene and accordingly enhanced the whole sensory experience of Synaesthetic Scape 2.
All of the above led to the introduction of the term 'kinaesthesia' which means: The sense of movement. The sense of bodily position in the VR environment. Exploring the surroundings through the senses while moving.

Some key comments from the participants' semi-structured interviews for the Synaesthetic Scape 2 experiment are as follows;

'I like this door it remind me with the traditional architecture in my country.'

'Although I miss the music here, yet I feel the various sounds I heard helped me understand the space better.'

'The light is more real here, the shadows are more realistic here.'

'I feel hot here I think partly it's the lighting and the sea suggest a tropical climate.'

'The sounds helped me associate the space with its users, which gives an idea about its function.'

'It was more grey but I like this one more now,' (referring to the different feelings about the colours in Synaesthetic Scape 1 and 2).

'I don't remember seeing this material before, I think you changed it for this environment, I feel there is more complexity of materials more variety.'

'After I heard the first sound, I was intrigued; I wanted to explore what other sounds i will hear and what are the differences between them.'

'I like this one—it is more interactive.'

'I like the voices of the children in the traditional part, it reminds me with the family atmosphere.'

'Ten minutes?! Ooh, it feels like 5 minutes,' (referring to the loss of the sense of time).

'I', accepting the project this time, I had negative feelings towards the pointy edges but this time I'm accepting it and seeing the beauty of experiencing it and exploring it from the inside and the outside… It's like seeing a project in a magazine and you don't like its language but when I visit some projects in reality I enjoy exploring it more accept it and discover the beauty of it… This experience is pretty much similar to what I felt here.'

‘The sounds gave more richness to the experience.’

‘This experience is more human.’

The outcomes answered the hypothesis and questions of the Synaesthetic Scape 2 experimental sensory experience.

Furthermore, the participants dealt with the virtual environment as a lived experience and interacted with the changes happening. In regards the views and sounds, they were even more appreciative of the colours, materials and textures, and lights used in the environment design since they were more focused on the details and spent a relatively long time in the exploration of the VR environment.

They suggested adding more greenery and more variety in the real sounds to enhance the interaction with the environment even more.

Moreover, all the participants lost a sense of time in the Synaesthetic Scape experience, which was more of a stretched time, with all participants feeling that they spent half of the real-time it takes to explore the scene.

Like the Synaesthetic Scape 1 experiment, the new augmented reality appeared again, but this time they did not suggest adding a feature to enhance the memory; instead, they asked to add sounds related to those memories to resemble their own provoked memories.

Just as in the case of Synaesthetic Scape 1, this experiment revealed those factors that affected the participants’ evaluation of the Synaesthetic Scape 2 sensory experience (to be discussed in this research).

In this chapter, The research adapted the 'Experimental inquiry' approach to explore and identify the characteristics of the proposed term of Synaesthetic Scape, and answer the research question of; How to design in a Synaesthetic way?

The research was developed through this chapter by undergoing three accumulated stages of the experiments, each experiment led to the other in terms of the design process, methodology and the participants' insights and recommendations.

Participants were the key players in this chapter, and their role in the design progress was crucial. Their insights and recommendations led the progress from one stage to another.

In the end, the researcher was able to respond to the hypothesis and answer the questions exploring each stage (experiment). Several ideas and themes were generated. Participants were the leading actors of this chapter, and their rule in the design process was crucial. The themes derived from this chapter will be discussed in the final chapter regarding research literature.

Chapter Four

Research Findings and Future Development

Introduction

Going in detail about the contribution to knowledge and the potential of future research within this area, this chapter presents a summary of the research findings from the studies on Synaesthetic Scape, discussing the Synaesthetic Scape experiments, as well as the enhanced sensory experience of the involved participants; further, Chapter 3 centred on the 'Experimental Enquiry' approach, as well as on the practical nature of the research, the participants of which confirming and evaluating the analysed quantitative data within each stage of the experiments and providing insights and recommendations to aid in the development of the Synaesthetic Scape experience from one stage to the next. From this, we can see that the participants played a major role in both deciding how the research evolved and in influencing the trajectory of the development of the experiments (including the research progress throughout).

As discussed within the introductory chapter, the research put forward the term 'Synaesthetic Scape' as a framework for the design process; further, within Chapters 2 and 3, the virtual environment characteristics were described, created, and developed during the process of the research. Generally speaking, the research deployed mixed methods in order to collect and analyse the data, whereby:

- The quantitative methods of data analysis were implemented to either provide indicators, or to highlight the participants' interaction throughout the three stages of the Synaesthetic Scape experiments; it also indicated how their interaction evolved from one stage to the next according to the changes within each stage design.
- In order to confirm and evaluate the quantitative data—as well as aiming to address the themes derived from the participants' semi-structured interviews—, the qualitative methods of data analysis were implemented.

This concluding chapter will discuss the themes developed throughout the design of the research, as well as the implementation of VR within the theoretical context (bearing in mind more far-reaching research within this area) and the contribution to knowledge.

Themes Derived and Evolved from the Three Experiments

4-1 Compressed Time (the Loss of the Sense of Time)

Several interesting comments began emerging from the semi-structured interviews from the participants concerning their loss of their sense of time during their participation within the experiments (i.e., 'It's like I have a two- to three-minute maximum; I have not had a thought that stayed for more than seven minutes' (RS.); 'It was very relaxing and I could not feel the time passing; it was like two minutes, in fact; five or six minutes' (GF.); 'Ten minutes? It felt like three or four minutes' (KC.)).

The participants expressed their surprise within all of the Synaesthetic Scape experiments done within this research concerning how quickly the time seemed to have passed; they all said to have lost their sense of time with a ratio of around 2.5:1, or sometimes more (i.e., 2.5 minutes feeling like one minute within VR).

This was a generally agreed-upon situation amongst all the participants, reminding me of a children's film I watched several years ago with my family named *The Spiderwick Chronicles*[231]; within this movie, Arthur Spiderwick, our main protagonist, is a scientist who is very much immersed in his research on 'fantastic creatures', as he calls them. He is eventually captured by these creatures ('fairies') and loses his sense of time, thinking that he had spent only a few months with the fairies, only to realise, upon his return, that his little daughter, Lucinda, was already an old lady. It was because of this that I went and looked for a scientific explanation, investigating this issue further concerning whether or not this had been reported by VR users. According to Oculus founder Palmer Luckey, '…you'll likely end up spending more time in the virtual world than you realise, because really, how can you tell the passing of time in the physical plane when your head is trapped in the metaverse?'[232].

As a result of the above, a natural question that follows is, how do we estimate or perceive time in the first place? Researchers within psychological studies highlight

231 *The Spiderwick Chronicles* is a series of children's books by DiTerlizzi T. and Black H., May 2003-September 2009 , published by Simon & Schuster, A feature film adaptation, also titled *The Spiderwick Chronicles*, was produced by Nickelodeon Movies and premiered on February 14, 2008, last accessed 13th May 2019, https://en.wikipedia.org/wiki/The_Spiderwick_Chronicles

232Miller R.,17th March 2016; *Oculus founder thinks VR may affect your ability to perceive time passing; Time is an illusion. VR doubly so.* The Verge, last accessed 26th April 2019 https://www.theverge.com/2016/3/17/11258718/palmer-luckey-oculus-time-vr-virtual-reality-gdc-2016

that the senses play a major role in both how we perceive and estimate time; Two researchers at UCL (Misha B. Ahrens and Maneesh Sahani) conducted a study within this area, pinpointing the fact that humans use the senses to keep track of the small time changes occurring around them as a way to estimate time[233].

Ahrens & Sahani additionally highlighted that humans have learnt, with time, to expect changes in their sensory input within a certain average of time; thus, comparing the changes to this average value is what gives humans the ability to estimate the passage of time, which will eventually refine the internal timekeeping of humans. On this note, Ahrens & Sahani stated that, 'our sense of time is affected by outside stimuli, and is therefore highly mutable, which is something that resonates with people's feeling about the passing of time'[234]. Sensory stimulation can technically bias the perceived passage of time, but how exactly this occurs is unclear when considering the fact that everybody varies when it comes to their judgement of passing time; this means that in the real world, the estimation of time passing is a combination of our mutable internal clock and variations in the input of external stimuli to our senses.

Whilst these studies imply how time perception and estimation works in reality, the question of why the time estimation in VR is compressed/shorter than in reality is not yet answered; a quick assumption that comes to mind when attempting to answer this question is perhaps the lack of external changing stimuli cues on our senses whilst we experience VR, and that this is probably what triggers this different time perception or estimation. This makes sense if we consider the fact that we are simply blocked within the Oculus headset, missing the external changes within our surroundings, as well as the external changing cues that can aid in estimating time.

Schatzschneider, Bruder & Steinicke—researchers at the Human-Computer Interaction (HCI) research group at the University of Hamburg—conducted a research within VR confirming that time feels compressed (or 'flies') when you are engaged in a task; saying this, they also demonstrated that the use of time symbols (e.g., the sun) can play a role in altering a person's perception of time within VR environments. The researchers hoped the study results would pinpoint important cues for VR developers to consider

[233]Ahrens & Sahani, 2011. Observers Exploit Stochastic Models of Sensory Change to Help Judge the Passage of Time. *Current Biology*, 21(3), pp.200–206. https://www.cell.com/action/showPdf?pii=S0960-9822%2810%2901711-2

[234] Biliuti S., 21st June 2011; Human Senses Bias The Brain's Clock, Softpedia News, last accessed 15th May 2019, https://news.softpedia.com/news/Human-Senses-Bias-the-Brain-s-Clock-179667.shtml, p.1

when designing games and training programs[235], later conducting a series of tests with 21 student participants using variables of 'zeitgebers'[236] (i.e., time symbols) and user-tasks to measure how accurately participants estimated the amount of time that had passed [237]. The students performed three different tasks as an interaction with the VR environment within three different zeitgeber settings, using a sun as the zeitgeber symbol:

1. A sun with no motion.
2. A sun that moved in a realistic 24-hour cycle.
3. A sun that progressed at double the speed of the real 24-hour sun.

The results showed that when a user was just sitting without a task, the speed at which the sun moved greatly affected their perception of time, the user usually overestimating how much time they had spent immersed within the VR; conversely, once cognitive tasks were introduced, the user tended to underestimate the time, the sun manipulation making less of an impact since the user was not processing the settings as vividly. This was especially true for the spatial cognition test; this is probably due to the fact that the user needed to draw resources from the same area of the brain processing the spatial passage of the sun [238].

This correlates with the obtained result from the Synaesthetic Scape experiments, which corresponds to the first category, within which the participants were occupied exploring the sensory environment; the sun did not really change in position, creating a similar situation with the participants who said that time flew or who were simply compressed within the Synaesthetic Scape environment. The results additionally correlated with anecdotal, real-world evidence: when someone is busy, immersed in a task at hand, time flies, whilst time can seem to drag when lounging on the beach or waiting for water to boil; thus, it is essential to know that a virtual sun can make a difference in how the VR users perceive time, approximately matching the time spent

[235] Schatzschneider, C., Bruder, G. & Steinicke, F., 2016. Who turned the clock? Effects of Manipulated Zeitgebers, Cognitive Load and Immersion on Time Estimation. *IEEE Transactions on Visualization and Computer Graphics*, 22(4), pp.1387–1395. https://ieeexplore.ieee.org/document/7383328/authors#authors

[236] A zeitgeber is any external or environmental cue that entrains or synchronizes an organism's biological rhythms to the Earth's 24-hour light/dark cycle and 12-month cycle.

[237] IEEE Xplore Digital library, 8th April 2016;Humanizing VR Part 1: Could Virtual Reality Help Manipulate Time Perception?, last accessed 20th May 2019, https://innovate.ieee.org/innovation-spotlight/vr-time-perception/

[238] Ibid.

within the VR in reality; similarly, playing with other cues from external stimuli could have comparable effects [239].

As future research expands, work within this sector progressing, the incorporation of specific visual and sensory zeitgebers (e.g., the noise of a ticking clock; varying music genres; church bells, etc.) can be altered with the time of the experiment, tuning them to confirm if the sense of time of the users within the future Synaesthetic Scapes can be manipulated.

4-2 Movement (Kinaesthesia) as a Phenomenon

Kinaesthesia can be defined as 'the sensation or perception of motion'[240] and is occasionally referred to as 'proprioception'; within architecture, kinaesthesia can be defined as 'the exploration of our surroundings via movement'. [241] Distance, perspective, and speed are all variables within overall movement, and each of these generally producing a certain effect on how participants see, perceive, and forme judgements on the entire quality of their sensory experiences during the experiment; considering it has a great impact on the manipulation of sensory experience, as well as the evaluation of the Synaesthetic Scape experience and design, it is essential to discuss kinaesthesia. Further, according to the anthropologist Timothy Ingold, 'The bias of head-over-heels influences the psychology of environmental perception in one other way; we have already seen how the practices of destination-oriented travel encouraged the belief that knowledge is built up, not along paths of pedestrian movement, but through the accumulation of observations taken from successive points of rest' [242]

The design's visual aspects' dominance (or, as dubbed by Ingold, the 'head-over-heels' aspects) details the biased use of the eyes over the other senses, in this case increasing the haptic sense through the foot touching the ground whilst walking in an attempt to divert attention to the amount of data coming from the foot in terms of

[239] Ibid.
[240] Wiktionary; the free dictionary, last edited on 17 February 2019, https://en.wiktionary.org/wiki/kinesthesia
[241] Te Koloese D. & Ramadani K., Énoncé théorique de Master 2012-2013, Ecole Polytechnique Fédérale de Lausanne ENAC – Section d'architecture, last accessed 26th April 2019, http://archivesma.epfl.ch/2013/065/ramadani_te%20kloese_enonce/tekloese_ramadani_enonce.pdf/ , P.28
[242] Ingold, T., 2004. Culture on the ground. The world perceived through the feet. *Journal of Material Culture*, 9(3), pp.315–340, p.331

perceiving a certain location and/or understanding the surrounding environment. In the same vein, our perceptions of our surroundings are incomplete when we neglect the information gathered from stimuli.

Visual-based designs suggest that the user should perceive their surroundings from a stationary platform considering the fact that their legs and feet are at a standstill due to the fact that we normally perceive things from different angles, as detailed by Ingold: 'It is supposed that we might turn it around in our hands, or perform an equivalent computational operation in our minds'[243]. In reality, we tend to perceive things by walking around them, thus exploring them from different angles and distances (i.e., from different perspectives).

As James Gibson, the founder of ecological psychology, discussed within his work regarding visual perception, 'The forms of the objects we see are specified by transformations in the pattern of reflected light reaching our eyes as we move about in their vicinity. We perceive, in short, not from a fixed point, but along a "path of observation", a continuous itinerary of movement.'[244]. From this, we can draw the conclusion that moving our heads/eyes alters our windows on the architecture in question, as well as our perceptions of it.

Our perception and understanding of space expands when we move around through it, the more we explore it from different angles and different positions, the more information we collect concerning the space, thus influencing how we perceive it; whilst moving can be said to 'bind together' the varying stimuli we encounter via our senses, with movement, we are not necessarily talking about walking. An example of non-walking movement within this context is that of the rowing boat with moving oars within the Synaesthetic Scape; this allowed participants to accept the environment they were in, perceiving it in a different way. As confirmed by several of the participants later, the boat journey itself created a unique sensory experience.

When it comes to kinaesthesia and sensory experience, Pallasmaa harbours his own opinion, introducing kinaesthetic, haptic, and multisensory perceptions of the human body whilst delving into the phenomenology of architecture and architectural theory within his book *The Eyes of the Skin: Architecture and the Senses* in 1996,

243 Ibid. p.331
244 Gibson, J.J. (1979) The Ecological Approach to Visual Perception. Boston, MA: Houghton Mifflin p.195

emphasising the importance of using the senses in either the design process or the sketching of the sketching; he maintains that the relationship between the thinking mind and the drawing hand deepens via the drawing hand. Furthermore, he argues that designing and sketching by hand are both spatial and haptic exercises, allow the designer to 'fuse the external reality of space and matter, and the internal reality of perception, thought, and mental imagery into singular and dialectic entities'[245].

In the same vein, Pallasmaa notes that that there are three different categories of image within the process of sketching and drawing: 'The drawing that appears on the paper, the visual image recorded in my cerebral memory, and a muscular memory of the act of drawing itself'[246]; this is dubbed by Pallasmaa as the 'the ecstasy of work' within his recent article *Embodied and Existential Wisdom in Architecture: The Thinking Hand.* Furthermore, he writes, 'The pencil in the architect's hand is a bridge between the imagining mind and the image that appears on the sheet of paper in the ecstasy of work'[247].

A similar idea to Pallasmaa's 'ecstasy of work' was expressed by Barbra Stafford in their article *Thoughts Not Our Own: Whatever Happened to Selective Attention?*, writing neuroscience and cognitive research as creative processes in terms of biological activities[248], arguing, 'What is significant from both the artistic and the scientific standpoint is how equivocal imagery or ambiguous forms (belonging to two or more different categories or susceptible to several interpretations, depending on the viewer's perspective) elicits perceptual, cognitive, and even bodily motion in the observer'[249]. This means, in short, that when we activate our perception, biological systems take to combining colour, motion maps, sounds, etc., binding wavelengths from geographically separated features within our field of vision: 'This temporary conjunction of distant points elicits a pleasurable kinaesthetic sensation'[250]. The most noteworthy point here is that a process of binding wavelengths evokes affective pleasure, simultaneously occurring within both physical and mental processes of recognition; Stafford further claims that within biological activities, 'the associative

245 Pallasmaa J (2009) *The Thinking Hand: Existential and Embodied Wisdom in Architecture*. Chichester: Wiley, p.89
246 Pallasmaa J (2009) *The Thinking Hand: Existential and Embodied Wisdom in Architecture*. Chichester: Wiley, p.90
247 Pallasmaa J (2017) 'Embodied and Existential Wisdom in Architecture – the Thinking Hand'. *Body & Society*, vol. 23, 1: pp. 96-111. , First Published January 6, 2017. P.104
248 Tamari, T. (2017). 'The Phenomenology of Architecture: A Short Introduction to Juhani Pallasmaa'. *Body & Society,* 23(1), 91–95, p.93. https://doi.org/10.1177/1357034X16676540.
249 Stafford BM (2009) 'Thoughts not Our Own: Whatever Happened to Selective Attention?' *Theory, Culture & Society* 26(2–3): pp.275–293, p.282
250 Ibid. p.282

jump to connect resembling, not identical, formal features is enabled, because of the deep neurophysiological correspondence between the phenomenal and noumenal systems'[251].

Both Pallasmaa's 'the ecstasy of work' and Stafford's 'pleasurable kinaesthetic sensation' are triggered by the process of making sense of the world (a.k.a., a knowledge-embodied process), constantly filtering, disconnecting, and reconnecting information via multisensory reflections so as to determine a sense of 'being in the world'. Here, I would like to introduce another theme: the new augmented reality; this is part of the participants' perceptions of the Synaesthetic Scape by uncovering the resemblance with the previous collective memory.

4-3 The New Augmented Reality

As previously discussed within this research, augmented reality can be defined as 'a mixed reality where computer-generated objects are projected in the real world'; participants expressed their ideas of the Synaesthetic Scape environment as a new augmented reality during the research experiments, the augmented reality in this context being a mixed reality of imaginary objects and features from the participants' collective previous memory, metaphorically projected into the full virtual reality, this new, mixed reality being referred to as the Synesthetic Scape Augmented Experience.

Implemented to interpret, perceive, and interact on a sensory level with the Synaesthetic scape experience, this new augmented reality is the reflection of the participants' lifetime experiences and knowledge, which is an essential target for some other fields of research (e.g., virtual heritage; virtual culture). It is a difficult task to determine how is best to virtualise human life aspects that are not visible, the evidence of existence of which not being easy to find, analyse, and display; they are scattered items within history and archaeology (e.g., objects, spaces, and series of unconnected narratives) depending on the authors of the historic products, as well as their way of shaping public perception and sensory interaction in the past.

[251] Tamari, T. (2017). The Phenomenology of Architecture: A Short Introduction to Juhani Pallasmaa. Body & Society, 23(1), 91–95, p.93. https://doi.org/10.1177/1357034X16676540.

In order to preserve our current lifestyle and city experiences, Synaesthetic Scape can be applied as a sensory documentary as tool within architecture useable in the future; Hugh Denard[252] edited The London Charter for the computer-based visualisation of cultural heritage, an international guideline for heritage visualisation (2006) so as to ensure the methodological rigour of computer-based visualisation so as to accurately research and communicate cultural heritage [253]. This methodology was invested by M. Abdelmonem, G. Selim, S. Mushatat, and A. Almogren within their collaborative published article *Virtual Platforms for Heritage Preservation in the Middle East: The Case of Medieval Cairo*[254], whereby the Virtual Heritage Cairo[255] argues that 'while visualisation of archaeological sites, objects and artefacts offer a detailed record of physical environments, those intangible aspects of heritage experience, namely, cultural-feed, would enable effective human interaction and understanding of the historic narratives in line with modelled objects. As we focus on cultural heritage, in contrast to archaeological preservation, we have to refer to the human sensory experience with history. Cultural geographers, in particular, tend to associate culture with what is not seen'[256].

Via the implementation of both augmented reality and virtual reality as mediums so as to record, preserve, and display the historic, archaeological, cultural, and architectural features of cities, buildings, and monuments, this article discussed the possibility of investing the human sensory experience in the field of virtual heritage: 'Much of the effort in Virtual Heritage (VH) is directed towards accurate representation of historic structures, objects or artefacts. There is little attention paid, however, to the human aspects of city life, the intangible heritage to which people can actually relate. Digital models of historic buildings and spaces only give a sense of precision. Yet, rituals,

[252] Hugh is a historian of Greek, Roman and 20th-century Irish theatre and performance in the Department of Digital Humanities at King's College London. He has made major contributions to the development of digital visualisation methods for arts, humanities and cultural heritage research; he proposed and edits the internationally-recognised "London Charter for the Computer-based Visualisation of Cultural Heritage" (www.londoncharter.org), led the creation of the Virtual Heritage Network: Ireland (http://www.vhnireland.org/) and has jointly directed numerous projects funded by the AHRC, Arts Council England, British Council-Italian Ministry of Research, Eduserv Foundation, JISC, Leverhulme Trust and the Metropolitan Museum of Art.

[253] Denard, H., 2012. A new introduction to the London charter. In *Paradata and Transparency in Virtual Heritage*. Ashgate Publishing Ltd, pp. 57–71.

[254] Mohamed Gamal Abdelmonem et al., 2017. *VIRTUAL PLATFORMS FOR HERITAGE PRESERVATION IN THE MIDDLE EAST: THE CASE OF MEDIEVAL CAIRO*. Archnet-IJAR, 11(3), pp.28–41.

[255] Virtual Heritage Cairo is the online space for the Network of researchers and professionals working on creating Virtual Modelling of Cultural Heritage, or what we call "Virtual Heritage of Medieval Culture". It is a collaborative Network between British and Egyptian Universities, industrial companies and local authorities that aims to support building capacity of technologically able young generations in Egypt and the Middle East. http://www.virtualheritagecairo.com/about-virtual-heritage-cairo/

[256] Mohamed Gamal Abdelmonem et al., 2017. *VIRTUAL PLATFORMS FOR HERITAGE PRESERVATION IN THE MIDDLE EAST: THE CASE OF MEDIEVAL CAIRO*. Archnet-IJAR, 11(3), pp.28–41. P. 31,32)

human attitude and cultural traditions remain a gap in current research and advanced technology in heritage visualisation'[257]; in the same vein, the article additionally mentions a three-phase process of virtual production of heritage: Collect—not only the physical object, but also information from narratives of physical and spatial characteristics, depending on archaeological records, digital surveys, and scans, as well as sociocultural and historic narratives collected from literature within creating its archives, where the users are able to contribute with various types of multimedia to create/increase the collection via crowdsourcing[258]—Preserve — through the virtual digital collections[259]—and Display—various types of activities are designed to engage the user in different themes; this accessibility makes the Virtual Heritage products and collections available to anyone interested in this field[260].

The above differs from my research; whilst they developed their methodology to help interpret the previous human sensory experience via the historical local narratives associated with the virtual physical 3D model, my methodology depended on the users' sensory input in developing the design of the Synaesthetic Scape.

In order to improve the experience of architecture within certain areas (e.g., heritage and construction research; conservation and documentary research), this chapter will delve into the potential of the Synaesthetic Scape as a tool within design so as to create multisensory environments.

4-4 Limitations of the Technology Affecting the Study

This research has worked to stress the importance of perceiving architecture as a sensory experience at a certain place and time, its ambitions being to implement all five senses in the Synaesthetic Scape experience; saying this, the limitations of VR sensory technology impacted the design of the Synaesthetic Scape.

Considering the fact that the technology in question permits the participants to use their visual and auditory senses, the haptic sense was hardly used within the Synaesthetic Scape sensory experience; notably, it was only partially there by

[257] Ibid. P.28
[258] Ibid. P.32
[259] Ibid.p.32
[260] Ibid.p.33

pressing the keyboard buttons to control the movement and posting inside the VR rather than actually feeling the Synaesthetic Scape walls, objects, or feeling the breeze that moves the trees.

4-5 Future Research

As future work progresses within the progressing technology, this could be something for further investigation, possibly via the exploration/testing of alternative ways to use additional senses within the Synaesthetic Scape experience, bearing in mind the ongoing technology progressing every day.

Within the architectural field, the research at hand introduced the term ‘Synaesthetic Scape’ as a framework for the design process, also investigating the potential of the Synaesthetic Scape as a:

- Tool within design to create multisensory environments in order to enhance the experience of architecture when considering the fact that this Synaesthetic Scape experience can be invested within the early design stages of any future project; it allows the designer to relatively know how the design is going to be experienced by users and can also involve the public in a co-productive design process for a Synaesthetic Scape, whereby architects and users communicate and engage in the process of creating sensory immersive environments.

It also can be developed further to be a tool that can:

- Revive old, destroyed historic sites, allowing the public to revisit the old, demolished sites/buildings in a way that feels like they are in one of those old iconic buildings (e.g., Experience Castlegate, the augmented reality project from the University of Sheffield for Sheffield Castle, which was redesigned and represented in the augmented reality project mentioned in this thesis within Chapter 2).

- Within heritage preservation and Virtual Heritage (VH), and as an extension to the work of many architects and historians that work within the heritage and conservation fields of research by redesigning old cities, bearing in mind the contextual and cultural aspects of a place (i.e., the particular sounds, textures, etc. of a city).

- Digital archaeology, which centres on the accurate documentation, recording, and representation of historic sites and buildings; whilst the human aspects of the represented city life is still missing [261], Synaesthetic Scape can additionally act as a documentary tool, documenting the past, present, and future. An example of this would be that of the new project I was involved in within Iraq called the Baghdad Downtown Tour; this project was solely carried out by Mohamed Al-Hassani, his aim being to invite the people in Baghdad to a free tour of the old city, giving mention to the full historical and architectural explanation of each street and building within the walking tour route. He approached me, wanting to develop his guided tour into an online documentary tour to preserve some of the place's memory before it inevitably got demolished, as such old buildings are generally unprotected by the law. To this, I proposed augmented Synaesthetic Scape as a future development to his documentary project concerning Baghdad online guided tours.

The contribution of this thesis has been to develop a digital architectural design approach by introducing the framework and methodology of Synaesthetic Scape. This has involved reclaiming design as a process for the creation of sensory immersive spaces. The objectives of this research were focused on two areas: first, to investigate the fields of synaesthesia and VR immersive environments for the possibilities of designing in a synaesthetic way; and second, to develop a co-productive design process for designing Synaesthetic Scapes. These objectives were achieved through experimental enquiry in the pilot study and the creation of the immersive digital environment. The findings and insights of the research are relevant to both the emergent area of the design of virtual scapes, as well as the design process in architecture more generally. Moreover, the framework and methodology of Synaesthetic Scape could be adapted and applied in various architectural and design fields including urban and heritage design. Research in this area is an ongoing process as architectural design will continue to be challenged by developments in digital media and technology. I hope that this thesis invites reconsideration of both experiencing and evaluating architectural design in a synaesthetic way.

[261] Mohamed Gamal Abdelmonem et al., 2017. *VIRTUAL PLATFORMS FOR HERITAGE PRESERVATION IN THE MIDDLE EAST: THE CASE OF MEDIEVAL CAIRO*. Archnet-IJAR, 11(3), pp.28–41. P. 29

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Section One

Emotion as a service from affectiva

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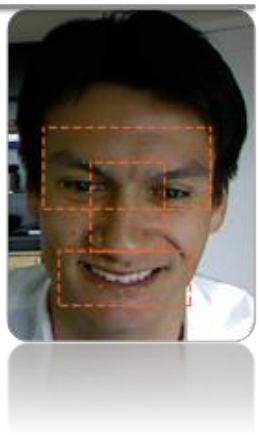
White Paper

Automated Facial Coding: Delivering Easy & Affordable Neuroscience Insights



Understanding Affdex

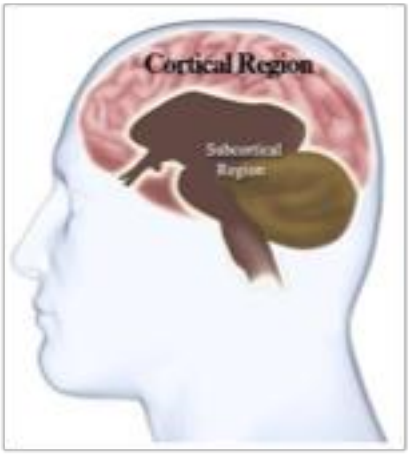
Overview

Marketers recognize the important role emotions play in driving brand loyalty and purchase decisions. Yet traditional methods of measuring emotional response, like surveys and focus groups, require viewers to think about and report how they feel—which most people find difficult. Contemporary neuroscience techniques provide new insight into how the mind works, but often require expensive, bulky equipment and lab-type settings that limit and influence the experience.

Affdex Automated Facial Coding offers something different. By "reading" faces inexpensively and at scale, Affdex introduces a cost-effective neuroscience technique that can be easily incorporated into existing quantitative and qualitative studies to add rich insights into communication and engagement effectiveness.

Background

The neuroscience behind facial expressions is both highly complex and fascinating.



Signals from the subcortical and cortical areas of the brain are carried along nerves that control our facial expressions. The subcortical center of the brain, in particular the amygdala, is known as the emotion center. The cortical area, or cerebral cortex, is associated with cognition. As facial muscles respond to these signals, the face communicates emotional states like enjoyment and disgust, as well as cognitive states like concentration and attention.

Facial coding is the systematic analysis of facial expressions. Research on facial coding dates back to studies by Charles Darwin, who concluded that common facial expressions are universal. In the 1970s, psychologist Paul Ekman's early work identified the universality of six core emotions. He also is well known for popularizing a facial action coding system (FACS) that systematically describes facial expressions and movements. Ekman's manual labeling methodology has seen wide spread use and is the premise behind the popular TV show, *Lie to Me*.

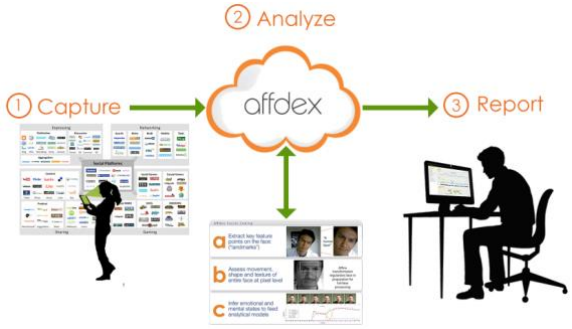
Affdex modernizes the traditional FACS process in two ways. First, Affdex automates the painstaking FACS manual labeling process, adding speed and scalability. Second, Affdex extends beyond the six core emotions to incorporate expressions and emotions better suited to real-world assessment of TV shows, advertising, movies, movie trailers and more.

Using Affdex to Generate Emotion Insights

Affdex delivers authentic emotion insights by employing advanced computer vision and machine-learning algorithms, within a scalable cloud based infrastructure. While the science underlying the Affdex platform is complex, the emotion insights are easily accessible. The only requirement is a standard webcam to collect the face video.

Let's look at the three steps involved in any Affdex study, whether for an ad, a trailer, a TV show or any other form of media content:

1) Data Collection
2) Facial Expression Analysis
3) Insight Analysis & Report



Data Collection: Collecting Face Video

Affdex uses standard webcams, like those embedded in laptops, tablets, and mobile phones, to capture facial videos of people as they view the desired content. The prevalence of inexpensive webcams eliminates the need for specialized equipment. This makes Affdex ideally suited to capture face videos from anywhere in the world, in a wide variety of natural settings (e.g., living rooms, kitchens).

The ability for Affdex to accurately capture face videos in these unique environments ensures that participant responses are authentic and free from moderator influence. It also removes the burden of incremental panel requirements or costs — there is no need to augment or boost the existing survey sample to support a robust Affdex analysis.

Note: Affdex can also obtain facial videos with external webcams in lab and central venue settings.[1]

[1] Minimum requirements for the face recordings are highly generalized with minimum resolution of QVGA 320x240 at speeds of 13-14 frames per second. The bandwidth requirements are also very modest at approximately 50 KBps per face video.

Online and In Venue

Affdex offers two modes of data collection: an online, internet–connected version and an offline, asynchronous version.

Affdex Online is typically integrated into existing online surveys where respondents view media content such as advertisements, movie trailers or even television shows. In this mode, as the respondents view the media content, their face video is captured and securely streamed in real-time, to the Affdex cloud.

Offline data collection is enabled by Affdex Anywhere, a Windows-based Affdex solution designed for projects in emerging markets where internet connectivity is unreliable or unavailable. Affdex Anywhere is designed to enable Affdex in central locations where a moderator is present. It provides for offline playing of content and recording of face videos. The transfer of face videos to the Affdex cloud is completed later, when internet connectivity is available.

Both online and offline projects are administered online via the Affdex portal where users can quickly and easily set up their projects and upload their media. The portal also provides real-time monitoring of in-field progress to determine when sufficient data has been collected for the analysis phase of the project.

Facial Expression Analysis with Affdex Emotion Classifiers

Once respondent face videos are available in the Affdex cloud service, sophisticated computer vision algorithms process them to generate emotion metrics. Affdex Automated Facial Coding applies scientific methods to interpret viewers' emotional responses quickly and at scale.

The core of the Affdex science consists of patent-pending, emotion-sensing algorithms that take face videos as inputs and provide frame-by-frame emotion metrics as outputs. Presented with demanding conditions, such as those found in natural, uncontrolled settings, these state-of-the-art algorithms have been optimized to provide highly accurate results – having been put to the test through thousands of studies worldwide.

Emotion Classifiers

Affdex provides two categories of emotion metrics: dimensions of emotion and discrete emotions. Dimensions of emotion are used to characterize the emotional response Discrete emotions are used to describe the specific emotional states.

The dimensions of emotion that Affdex measures includes:

- Valence – A measure of the positive (or negative) nature of the participant's experience with the content.

- Attention – A measure of the participant's attention to the screen, using the orientation of the face to assess if they are looking directly at the screen or if they are distracted (turning away) while viewing content.
- Expressiveness – A measure of how emotionally engaging content is, computed by accumulating the frequency and intensity of the discrete emotions including smile, dislike, surprise and concentration. Unlike valence, expressiveness is independent of the positive or negative aspect of the facial expressions.

The discrete emotion measures includes:

- Smile – The degree to which the participant is displaying a natural, positive smile. The smile classifier looks at the full face rather than just the mouth/lip area, incorporating other facial cues, like the eyes, to accurately indicate a true smile.
- Concentration – The degree to which the participant is frowning (displaying a brow furrow) that is not induced by a dislike response and thus more likely the result of focus, mental effort or even confusion.
- Surprise – The degree to which the participant is showing a face of surprise, indicated by raised eyebrows.
- Dislike – The degree to which the participant is showing expressions of dislike or even disgust. These expressions include nose wrinkles, frowns and grimaces.

In developing Affdex, we prioritized these measures based on their relevance for evaluating the emotional impact of media and advertising content. Through extensive experience in testing media and advertising content, we have accumulated over 300 million facial frames of representative data.

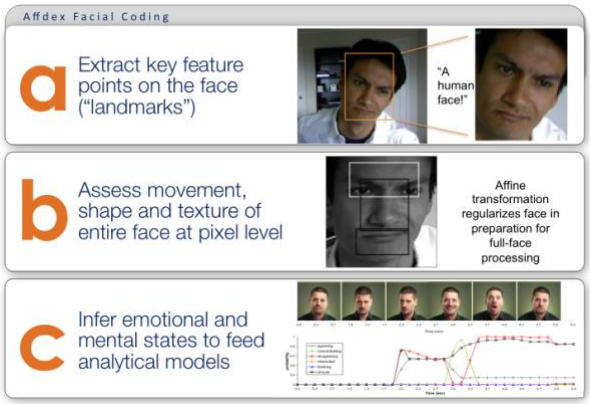
This repository is used to prioritize the development of new classifiers, as well as to improve the performance and accuracy of new and existing classifiers.

How Affdex Classifiers Work in the Cloud

With face videos gathered either online (streamed) on offline in a lab (asynchronous), the Affdex cloud service presents them to the sophisticated computer vision processes outlined in this section.

The Affdex cloud-based face video process includes three distinct procedures:

- Detect & Extract Features
- Classify Emotional States
- Assess & Report Emotion Response



Detect & Extract Features

The first step is to find a face and from the face extract the key regions ("landmarks") needed as inputs to the classifier

Once the human face is located, Affdex uses 24 key feature points on the face (e.g., corners of the eyes) to identify 3 key regions of interest: mouth region, nose region and upper-half of the face (eyes with eye brows). For the Smile and Dislike classifiers, the entire face is defined as a region for enhanced context, leading to improved accuracy.

Once the region of interest has been isolated, Affdex analyzes each pixel in the region to describe the color, texture, edges and gradients of the face .

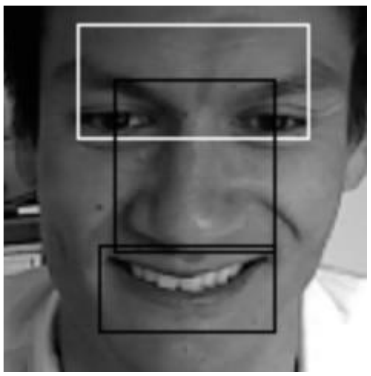
At this point, Affdex has not evaluated the nature of the facial expression — only that the facial regions exhibit certain characteristics. Evaluating these characteristics is the job of the Affdex classifiers .

Classify Emotional States

Affdex classifiers take extracted features as input and classifies them into emotional states. Given that most Affdex data is received at 14 frames per second, Affdex is capable of capturing both subtle and fleeting facial expressions — even those lasting only a split second.

There are two classification techniques employed by Affdex classifiers:

1) Frame-by-frame analysis, where a classification is made on a single frame;
2) Dynamic analysis, where features are analyzed temporally based on a sequence of frames.



Combining these two techniques significantly improves the accuracy and robustness of the classifiers. For example, they allow us to accurately assess a person's baseline state (thus eliminating the need for calibration).

Once the emotion classifiers have categorized the facial features, the resulting emotions are assigned numeric values for each frame of video and for each emotion classifier. Depending on the classifier, the classifier value corresponds to increased likelihood of occurrence and may also indicate higher intensity[2].

For example, an Attention score approaching 100 signifies an increased likelihood of the viewer being on task (i.e., 'face on camera"). Lower Attention values, on the other hand, indicate the viewer is looking away from the camera—usually an indication of boredom or fatigue (i.e., he or she is "inattentive").

The respondents' emotion metrics are then made available for processing by the Affdex reporting processes.

Assess & Report Emotion Response

The accumulated classifier results for all respondents participating in a study are visualized in the Affdex dashboard. The Affdex dashboard displays a time series curve for each emotion metric that aggregates respondents' emotional experiences. Each time series is further segmented by survey self-report responses collected as part of the overall study. For example, it is easy to highlight differences in smiles by gender, age, buying intent, and more.

The classifier results are also delivered to the Affdex analytic platform, where they form the basis for normative benchmarks. This normative data is exposed in the summary metrics area of a Dashboard, where study results are compared to the Affdex norms that have been compiled across thousands of studies. By offering regionally specific norms, Affdex provides important context for interpreting study results.

[2] For some classifiers, like smile, the classifier's numeric values are also correlated with the intensity of the response.

The Affdex analytics platform also allows us to develop models to tie emotion metrics with consumer behavior and media effectiveness measures. These models are primarily focused on:

- Likeability
- Desire to view again
- Purchase intent
- Sales effectiveness
- Virality

We continue to collaborate with leading market research firms to draw connections between emotions and behavior. Preliminary findings are promising and Affdex papers have been published in these area and can be found on our website at http://www.affdex.com/clients/affdex-resources/).

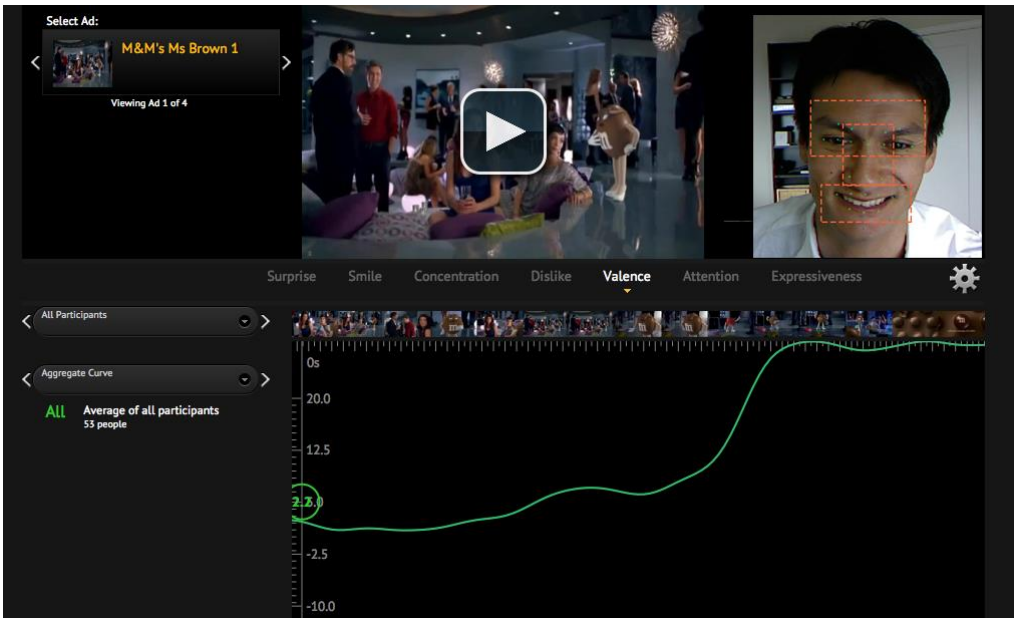
Insight Analysis & Reporting

Once a face video has been processed by Affdex classifiers, the results are compiled, aggregated, and delivered through a number of analytic tools that are accessible via the Affdex portal.

The two primary analytic tools are the Affdex Dashboard and the Summary Metrics.

Dashboards

Affdex Dashboards are primarily a diagnostic tool where the stimulus media (e.g., advertisement) is synchronized with the various emotion traces to highlight which parts of the creative execution are driving which specific emotional response.

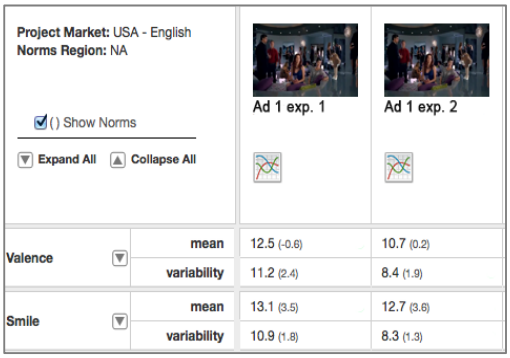


The dashboards include:

- Emotion Traces – For each of the Affdex Emotion Classifiers, an interactive trace is synchronized to the stimulus video. This trace is an aggregate of all the individual participant traces.
- Survey Self-Report Segmentation – Within the dashboard, the interactive trace can be further segmented by the data collected in the self-report survey. The ability to understand the emotional response by key segments leads to more insightful analysis.
- Participant Filtering – The dashboard also supports the ability to filter the participant pool and focus on the more expressive participants.
- FaceFinder – Sample participant faces videos are also presented in the dashboard, and are played back along with the emotion curves and stimulus video. Example face videos bring the data to life, emphasizing potential media performance issues and adding transparency to the results.
- Other Support Tools – In addition to the analytic tools, the Affdex dashboards also include key usability features. Capabilities like bookmark annotations and PowerPoint friendly views make it quick and easy to create compelling client reports.

Summary Metrics & Normative Benchmarks

Affdex Summary metrics provide ad-specific emotion measures that are compared to normative benchmarks. Metrics are flagged when they are determined to be significantly different from the norm. These Norms are maintained at the market level, and requires at least 30 data points in order to establish a norm within a given market.



While Affdex norms are currently geographic aligned, other cuts of this comprehensive study repository are available on request.

Conclusion

Affdex Automated Facial Coding is a robust and accurate neuroscience technique that is delivering rich emotion insight in thousands of studies. By seamlessly integrating into existing surveys, it provides fast, easy and scalable results without disrupting validated and trusted methods. Affdex is rapidly becoming a standard part of the market research toolkit.

Section Two

Oculus general risk assessment

The University Of Sheffield.

Faculty of Engineering

Multidisciplinary Engineering Education

General Risk Assessment : Unique ID 008205

Task or Activity : Use of the Oculus Rift Headsets

Valid until 10th June 2019

Persons At Risk : Staff/Postgraduates/Undergraduates/Other (null)

Name : Rob Stacey

Supervisor : James Screaton

Location : Diamond (VAR LAB)

No Out of Hours Working Allowed

If ANY changes are made to the task or activity described on this form please create a new Risk Form.

Hazard Type	Risk of Injury & Details	Control Measures	Risk Rating
Other	Virtual Reality Sickness - loss of awareness, eye strain, visual abnormalities, dizziness, disorientation, nausea, lightheadedness, drowsiness, fatigue, motion sickness.	Ease into use of the headset to allow body to adjust to Virtual Reality environment taking regular breaks from using the headset. Do not use the headset is tired or under the influence of drink/drugs or suffering from an illness as this would increase susceptibility to symptoms Immediately discontinue use if you begin to experience any discomfort of symptoms listed. Do not use headset again until all symptoms have subsided Please report any sustained symptoms of VR sickness to the person in charge	1
Electrical	Risk of electrocution, electric shock, injury damaged equipment power cable, equipment kept in inappropriate conditions.	Perform a visual inspection on the equipment before each use. Make sure that the Equipment PAT or visual inspections are in date. Equipment is PAT tested and cables and plug visually checked to be in good condition before use. Only use the correct designated power supply units on the equipment.	1
Electrical			1
Other	Radio Frequency Interference The equipment can emit radio waves that can interfere with nearby electronic devices.	Do not use the equipment is you have a cardiac pacemaker or other implanted medical device until you have consulted with a doctor or manufacturer of your medical device.	1
Other	Injury or damage to user, the equipment or others. Slips, trips or falls while using the equipment. Entanglement/tripping over the cables running to the headset	Always use the product in a clear and safe area preferably seated if possible. Do not rely on the equipment's chaperone system for protection. Ensure area is clear of people, furniture, obstacles that will block you from freely moving around. Only use under supervision of another person who is ready to warn of any hazards and keep an eye on the cable to the headset to ensure it doesnt get tangled or pose a trip hazard. Check you have enough room to fully extend your arms outwards and upwards. Hold controllers firmly and always use the wrist straps	1
Other	Physical and Psychological Effects form intense, immersive and very life-like content may cause brain and body to react accordingly. Certain content could trigger increased heart rate, spikes in blood pressure, panic attacks, anxiety,PTSD,fainting, and other adverse effects. Simulated objects encountered while using the equipment do not exist in the real world and may cause injury when interacting	If you have a history of negative physical or psychological reactions to certain circumstances avoid using the equipment to view similar content. It is advisable to notify the person in charge if you suffer from a condition that may be exacerbated by use of the VR systems Care should be used when interacting with simulated objects as if they were real to avoid injury for example attempting to sit down in a virtual chair.	1

Other	Overuse of equipment, Repetitive stress injury Negative impact to hand-eye coordination, balance and other effects, Hearing loss if earphones too loud	Take regular breaks from using the equipment, length and frequency of breaks may vary from person to person. Please report any sustained symptoms of VR sickness to the person in charge. Operate in a comfortable posture. Discontinue use if you have any discomfort. Do not use the earphones at a high volume or for a prolonged period of time.	1
Other	Photosensitive Seizures, severe dizziness, epileptic seizures or blackouts triggered by light flashes or patterns.	Anyone who has had a seizure, loss of awareness or other symptoms linked to an epileptic condition should consult a doctor before using the equipment. It is advisable to notify the person in charge if you suffer from a condition that may be exacerbated by use of the VR systems	1

Key		
High Risk	Medium Risk	Low Risk

Section Three

Al Akkam's dramatic characteristics for interior architecture

Al Akkam,s Dramatic Characteristics for interior Architecture; Guidelines of Al-Akkam studies

The visual elements of interior design

In Al Akkam studies, he considered light and colour as the visual elements of Interior design.

Where light is the basic element that defines the interior space and colour is the element responsible of creating the physical and psychological atmosphere of it.

These elements were discussed in details in Al-Akkam studies [1] because of their huge impact on building the aesthetic phenomena in the interior design.
The discussion was in two accumulated aspects:

The first aspect: discussed Colour on two different levels;
Colour definition and glossary and colour schemes (discussing the psychological effects of each scheme).

The second aspect: the design dimensions of light

Colour definition and some colour theory glossary

Colour [2] : The quality of an object with respect to light reflected by the it, usually determined visually by measurement of hue, saturation, and brightness of the reflected light.

Hue [3]: Commonly described as colour. This term describes the distinct characteristic of colour that separates for example, red from yellow, from blue. Hues are dependent on the dominant wavelength of light that is emitted or reflected from an object. Normal vision can differentiate between approximately 10 million different hues. From the colour

[1] Al Akkam, A. (2010-2011). The Aesthetics of Architecture and Interior design (The dramatic situations in the aesthetics of the contemporary interior space language). Amman,Jordan, Dar Majdalawi Pub.&Dis.
[2] Dictionary.com Unabridged Based on the Random House Unabridged Dictionary, 2019. http://www.dictionary.com/browse/colour
[3] *Colour Glossary of Art Terms*, Definition/Meaning of Colour-Related Terminology, ENCYCLOPEDIA OF VISUAL ART, last accessed: 16 April 2019. http://www.visual-arts-cork.com/colour-art-glossary.htm

spectrum, any pure hue/colour can be combined with white, black or grey to produce a tonal family.

Saturation/Intensity[4]:
The equivalent terms "saturation" and "intensity" describe the strength of a colour with respect to its value or lightness. Or to put it another way, the intensity of a colour is its degree of purity or hue-saturation. For example, the colour of a geranium is more intense (more saturated with its red/orange hue) than that of mahogany.

Colour value [5]:
The lightness or darkness of a colour; low value is dark; high value is bright.

Earth colours [6]: These usually include neutral colours (not included in the colour wheel) such as browns, beiges, greys, ochres and the like. They are called earth colours as they remind us of certain earthy hues found in soil or rock. Earth colours are made by mixing complementary hues.

Tint: A combination results from adding white to a pure hue or colour.

Tone: A combination results from adding grey to a pure hue or colour.

Shade: A combination results from adding black to a pure hue or colour.

The colour wheel or circle

The first ever colour wheel was drawn by sir Isaac Newton in the year 1666.
In the above diagram twelve colours are arranged in a certain order that he believed is pleasant and work well together Figure 1;

The primary colours (red,yellow,blue): they are called primary or basic because they are colours that exist in their original hue they just exist as they are they are not the result of any colour mixture.

[4] Ibid
[5] Ibid
[6] Ibid

The Secondary colours(orange, green and purple): they are the colours resulting from mixing the primary colours together;
Red+ yellow = orange, yellow + blue = green, and blue + red = purple.

The Tertiary colours: they are six colours which are the result of mixing a primary colour with a secondary colour.

Colour schemes:

There are certain colours that work well together, this was decided through a long history of colour matching in the design practice especially interior decoration to drag attention or create a certain mood inside any design.

In other words, it is a combination of two or more colours that go together in harmony.

There are six basic techniques to create the colour schemes, these techniques vary in relation to the colours chosen and their position in the colour wheel;

1. Warm and cool colour schemes
The colour wheel is decided to warm colours which have a hot energetic and vivid effect to using them, and cool colours which have cold, calm and soothing effect to using them see Figure 2

2. Monochromatic Colour Scheme
The monochromatic colour scheme is a colour project that uses variations of tints, tones and shades of a single hue or colour.
This scheme is famous of being elegant and clean with a soothing effect on the eye.
Each slice from the figure below makes a good example of the monochromatic colour scheme.

Figure 1: colour types (https://www.visualistan.com/2015/11/the-art-of-color-coordination.html).

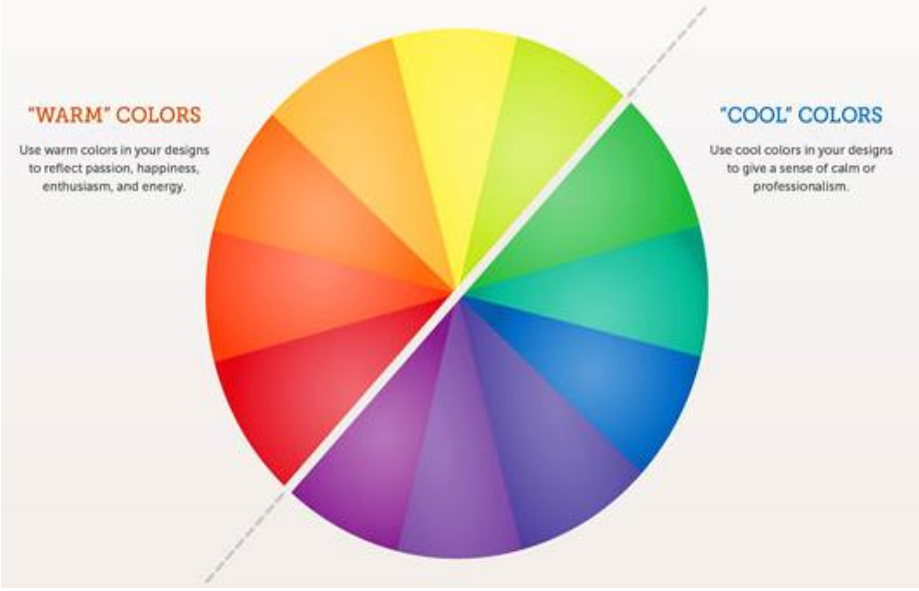


Figure 2: The colour wheel shows warm and cool colours (https://www.visualistan.com/2015/11/the-art-of-color-coordination.html).

3. Analogous Colour Scheme

The analogous colour scheme is a colour project that uses any 3 colours that are adjacent to each other on the colour wheel.

In this scheme (Figure 3) one of the selected colours should be dominating on the other two colours which are used to enrich the dominating colour or hue.

This scheme has a similar effect of the monochromatic scheme but with more richness of colours in terms on tints, tones and shades used.

4. Complementary Colour Scheme

The complementary colour scheme is a colour project that combines two colours that are opposite to each other on the colour wheel like for example combining red and green or yellow and purple.

This scheme has an eye catching effect (provokes attention) because of the contrast use of colours.

5. Split Complementary Colour Scheme

The split complementary scheme is a colour project derived from the complementary scheme.

In this colour scheme a single colour is combined with the two colours adjacent to its complementary colour on the colour wheel.

Thus the contrast effect is much smoother (less tension on the eye) than the complementary colour scheme.

6. Triadic Colour Scheme

The triadic colour scheme is a colour project that combines three colours located equally around the colour wheel.

This scheme has also a contrast effect but more harmonious and balanced than the complementary and the split complementary schemes.

7. Tetradic Rectangular Colour Scheme

The tetradic rectangular colour scheme is a colour project that combines four colours from two complementary colour pairs.

In this scheme its better to make one colour dominant and the other three is less dominance and used to support and enrich the dominant colour.This scheme is a bit tricky since it is hard to find the right balance between the used colours.

8. Square colour scheme

The square colour scheme is a colour project that combines four colours located equally around the colour wheel.

In this scheme its better to make one colour dominant and the other three is less dominance and used to support and enrich the dominant colour.

This scheme is rich in colours yet it is a bit tricky since it is hard to find the right balance between the used colours.

9. One or two colours with black and white or grey scheme

This colour project recommend using a warm colour like red or yellow with black and white, or a warm colour with grey to create a dynamic and energetic space which provokes excitement.

While using cool colours in this scheme will create a calm stable influence to the space.

Al-Akkam study discusss the importance of the design colour scheme decision and the influence of this discussion on the audience (the space users).

Al-Akkam concluded that changing or tuning the hue’s value and intensity of the colour schemes can tune the design’s dramatic characteristics as a result.

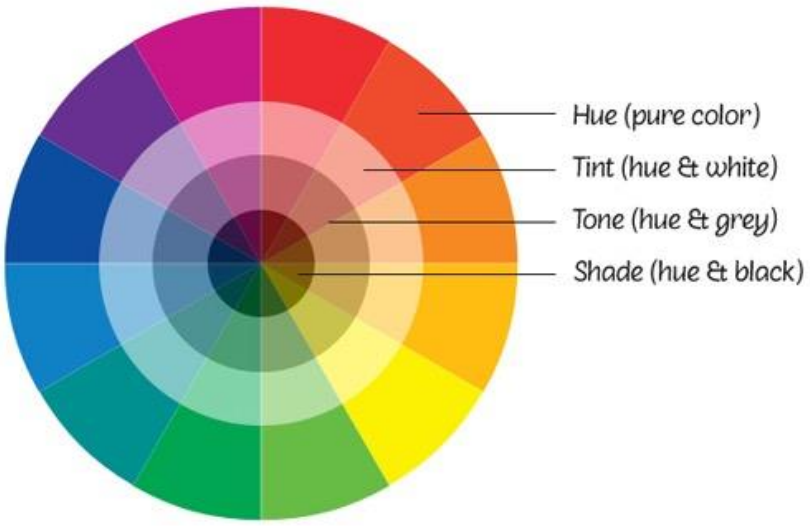


Figure 3 : The colour wheel shows tints, tones and shades of the basic 12 hues or colours (http://k4architecture.com/pantone-color-of-the-year-2015/)

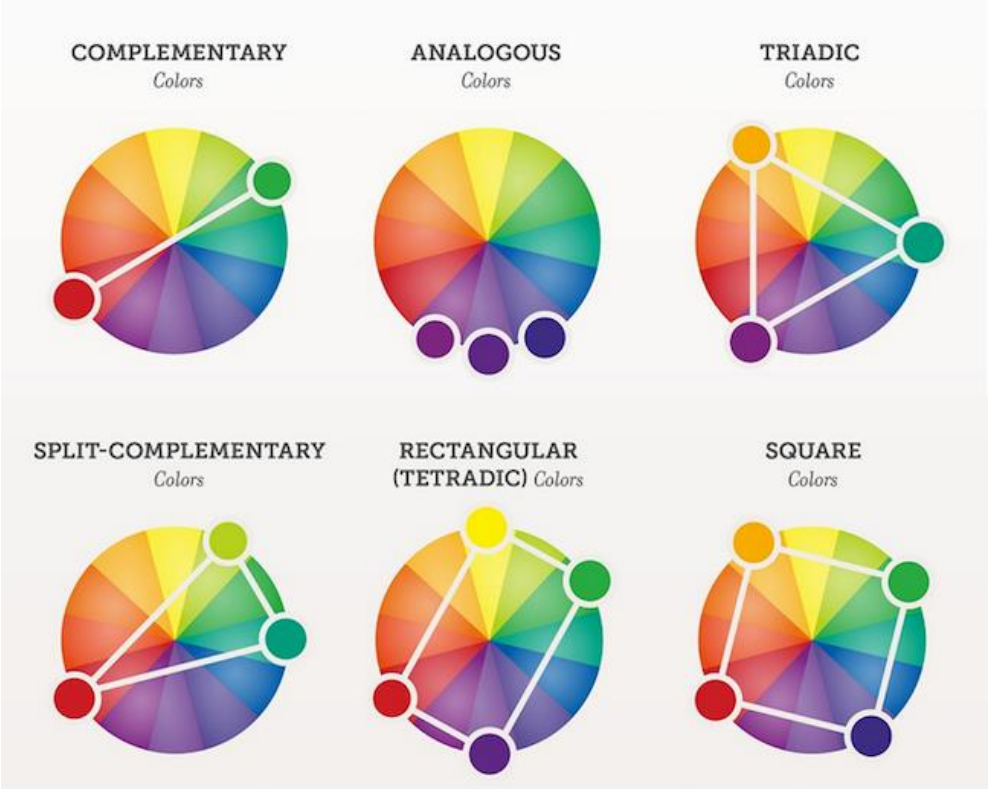


Figure 4 : colour schemes (https://www.pinterest.co.uk/pin/494059021603783779/).

Light

Light [7]: is the natural agent that stimulates sight and makes things visible.

Vision is an important sense that enables us to receive most of the information forming our world, our worldLight is the medium where we get the most information about our world through mainly perceive our world through our eyesIt is the most important element to define space and identify its form and features, without light there is no visual perception to the space.
Light has its own qualities that affect the perception of any object and space, these qualities are;

- Brightness
- Intensity
- Contrast
- Colour

Thus, it is an important element of design which helps the space function and creates psychological atmosphere to it.

Here comes the importance of knowing all the types of lighting and the qualities of each one in order to be able to plan and design the lighting system of any space.

Studies and research of the field showed that light can be classified to two main resources;
1. Natural lighting
2. Illumination or Artificial lighting

Daylight vary in its psychological influence throughout the day because of the different intensities and colour for example. In Sunny days shades and shadows are sharp in edges because of the direct sunlight effect.
While shadows tend to be smoother and lighter in cloudy days as if light comes from all directions.

[7] English oxford living dictionaries, last accessed : 16 May 2019, https://en.oxforddictionaries.com/definition/us/light

Artificial lighting can be divided into 3 levels in terms of brightness;
Brightness is used to create a sense of drama in the space, the brighter the light source the less amount of light is used to made the space comfortably visible and attract attention.
The less brightness used the more amount of light level is required and less contrast in shadows is achieved.

1. High brightness: achieved by using either the Incandescent light or Fluorescent tube or both of them.
2. Low brightness: achieved by using hidden light resources.
3. Glitter brightness: achieved by using many points of light with low brightness in a direct or indirect lighting system. Switches are used to control the level of brightness up to the satisfactory level.This is considered as an active way to create different levels of lighting within the space with different influence or mood each time.

William Lam's (as mentioned in the handbook of lighting-design) thinks that it is possible to design a space regarding to the psychological and functional needs of the users by using different systems of lighting to present different atmospheres every time you change that system.

Lights can also be classified regarding to the light distribution, pattern produced area, and the shape of shadows generated;

- Accent or Focal Lighting: this system is used to attract attention by focussing on vertical visual tasks, and is applied by the use of Recessed lighting fixtures
- Scallops Lighting: The shape of a hyperbolic beam of light [8].
- Wall Washers Lighting: are used to provide uniform lighting over walls, ceilings and floors.
- Cove Lighting: lights applied inside a groove either in the ceiling or the wall which normally accommodate fluorescent lamps. This system is used for indirect lighting.

[8]Rüdiger Ganslandt & Harald Hofmann, 1992. *Handbook of Lighting Design.* ERCO Edition ed. Berlin: The Vieweg publishing company.p.280

Lights can also be classified in respect to the direction of the light beam;

Direct lighting: it is emitted by point light sources. The beam direction is from one angle only, which provides modelling and brilliance effects. Exposed lamps also produce directed light. The variable beam directions within the space are generally aligned to produce uniformly directed beams of light. Controlling light [9].
Bright surfaces, sharp shadows, and it makes the surface looks wider.

Semi-Direct lighting: Part of the light pool is direct to the opposite direction of the light beam which creates smooth shadows in comparison to the direct light effects on shadows.

Semi-indirect lighting: most of the light pool is reflected from the surface opposite to the light source since the only a small part of the light is directed into a surface or object and the rest is directed to the opposite direction which provides smoother shadows and brilliance.

Indirect lighting: All of the light beam is directed to a surface to be reflected from it to the space, like being directed to the ceiling. Which provides a feeling that the chilling is higher than its real hight.
Diffuse Lighting: this system is used to provide equal light pool in all direction of the space.
Direct-Indirect Lighting: this system provides equal light pool on the horizontal surfaces like the floor and the ceiling and a less light pool on the vertical surfaces like walls

[9] Ibid.p.274

Section Four

Assessment of the existing Tools for the measurement of emotions

Assessment of Existing Tools for the Measurement of Emotions

Emotions are divided into three main components [10]: physiological arousal, motor expression, and subjective feeling. These components can be defined as follows:

Physiological Arousal

Through the use of specialised apparatus (i.e. diodes, and thermometers, etc.), it is possible to quantify the physiological changes the body experiences as a result of an emotion-triggering event. Changes in blood pressure, heartbeat rate, skin conductivity and brain waves can all be easily and accurately monitored [11] .

Advantages:

1. They are not consciously controlled by the individual, but rather are triggered by the body at an unconscious level; therefore, they are considered objective measurements.
2. They are independent of any cultural or social variables.

Disadvantages:

1. These measurements are not yet confirmed in terms of how certain physiological reactions are linked to a specific emotion, although the measurements themselves are highly accurate.
2. These physiological measures can be affected with external variables, such as physical activity prior to testing, which can affect the subject's heartbeat rate or body temperature, independent of emotional state, for instance.

Requirements:

A qualified workforce of experts on physiology and high technical instrumentation requirements.

[10] Scherer, K. R. (2001). Emotion, the psychological structure of. In: Smelser, N. J. & Baltes, P. B. (Eds.) International Encyclopedia of the Social and Behavioral Sciences. Oxford: Pergamon.

[11] Caicedo.D and van Beuzekom.M (2006),How do you feel?:AN ASSESSMENT OF EXISTING TOOLS FOR THE MEASUREMENT OF EMOTIONS AND THEIR APPLICATION IN CONSUMER PRODUCTS.Delft University of Technology Department of Industrial Design, https://www.academia.edu/10653393/HOW_DO_YOU_FEEL_AN_ASSESSMENT_OF_EXISTING_TOOLS_FOR_THE_MEASUREMENT_OF_EMOTIONS_AND_THEIR_APPLICATION_IN_CONSUMER_PRODUCTS_RESEARCH

Motor Expression:

Measuring gestures, facial expressions and changes in voice tones [12].

Advantages:

1. Cultural independency (at least concerning basic emotions); therefore, it can be used for cross-cultural assessments.

2. The observation and assessment of these expressions can be carried out in a non-intrusive manner as the tools (video cameras and microphones) used can be set-up in a matter that does not disturb the individual, therefore making it less likely to affect or interfere with reactions towards the stimuli.

Disadvantages:

1. The measurement can identify basic emotions but are not reliable when it comes to measuring mixed emotions.
2. Motor expressions can be controlled by the individual to a certain degree, which means that the emotion read is, in fact, the emotion experienced.

Requirements:

This approach demands high technical requirements for instrumentation and expertise.

Description of Emotion Facial Action Coding System—EMFACS (Ekman and Friesen)

FACS is a system measuring facial expressions depending on the muscles producing them. The system was developed in the 1970s by Paul Ekman and W V Friesen [13], It is a descriptive means, and so does not give information regarding meaning of the facial behaviour to the subject.

In order to be able to 'translate' the results obtained through FACS into more meaningful concepts so as to assess emotions, EMFACS (Emotion FACS) needs to be used. EMFACS is an advanced version of FACS with the ability to identify basic emotions to a certain degree. However, other software has recently been developed to

[12] Ibid
[13] Ibid

detect emotions from facial expressions with a greater degree of accuracy and more emotions to identify such (Internet link 9). The top ten popular facial expression detection technology are as follows:

1. Emotient: tracks attention, engagement, and sentiment from users.
2. AFFDEX from Affectiva: With 3,289,274 faces analyzed to date for engagement detection with identification to 7 emotions.
3. EmoVu: produced by Eyeris, to detect emotional engagement and affectiveness.
4. Nviso: specializes in emotion video analytics by the use of 3D imaging thechology for 7 main emotions.
5. Kairos: detects smiles, surprise, anger, dislike and drowsiness.
6. Project Oxford by Microsoft: artificial intelligence focused on computer vision, speech, and language analysis.
7. Face Reader by Noldus: Largely used in the academic world, solid research backup and analyse 6 basic facial expressions as well as neutral and contempt.
8. Sightcorp: is a cloud analysis engine for automated emotional expression detection.
9. Face++: tagging photos in social media networks.
10. Imotions: Imotions syncs with Emotient's facial expression technology, to detect confusion and frustration.

Recognising Emotion in Speech[14]

The recognition of emotion in speech can be achieved through a complex analysis of voice patterns, rhythm and pitch; however, although this is a non-intrusive method, it remains not entirely accurate.

- **Subjective Feeling:** A self-report method providing an assessment of the individual's subjective feelings.

These methods take the form of questionnaires in which users can rate their emotions through the use of a given scale or otherwise by expressing emotions verbally.

Advantages:

[14] Caicedo.D and van Beuzekom.M (2006),How do you feel?:AN ASSESSMENT OF EXISTING TOOLS FOR THE MEASUREMENT OF EMOTIONS AND THEIR APPLICATION IN CONSUMER PRODUCTS.Delft University of Technology Department of Industrial Design, https://www.academia.edu/10653393/HOW_DO_YOU_FEEL_AN_ASSESSMENT_OF_EXISTING_TOOLS_FOR_THE_MEASUREMENT_OF_EMOTIONS_AND_THEIR_APPLICATION_IN_CONSUMER_PRODUCTS_RESEARCH

1. The ability to assess mixed emotions.
2. Requires only little technical support, a few sheets of paper and a pencil to take the test.
3. Easy to collect data from users.
4. Little technical expertise.

Disadvantages:

1. Difficult for users to clearly express their emotions as they actually experience them.
2. Users are conscious of the assessment, which can distort that which is being reported (either consciously or unconsciously).
3. It is important that it is assessed as quickly as possible owing to the fact that taking a long time after the stimulus event to complete the assessment can destroy measurements.
4. Users concentrating on a given list of emotions for too long can mislead the evaluation of their experience.

Most of these methods incur significant expense; however, the support of Affectiva experts was provided with a reasonable amount of financial spend. Their offer of using their ‘Emotion as a service’ service was provided (for more information on the service, see Emotion as a service, Appendix, section one).

Section Five

Pilot study; focus group and semi structured interviews transcripts sample

Focus Group transcript
Date: 20th January 2016 from 11.30 am to 1.00pm
Location: Room 13.18 Arts Tower.
Number of participants: 6
Research Leader: Maha Al-Ugaily
Participants: SK, PA, UE, RS, ME and ZF

Researcher: First of all let me thank you all for showing interest in participating in this focus group.
Researcher: Most of you already took the emotion test earlier,
Today we are here to discuss the results and to:
1. Validate the results I got from the use of the Affdex program.
2. Analyze the animated works in terms of its design in relation to the emotion schemes resulted from Affdex.

Researcher: Most of you have recorded videos of their facial expressions which was analyzed by Affdex.
The outcomes came in the form of a table of row data in this format (the researcher showed the Participants an example of the table).
The data is given for every 14 frames of the video and a timeline in (msec).
So there are 14 frames between each msec and another.

Researcher: I imported this data in an excel sheet and translated the data into diagrams (the ones which we will be discussing today). the software gives indicators of emotions States and emotional responses of:
Anger, Contempt, Disgust, Fear, Joy and sadness (emotion states), and Surprise, and Valence, Attention, Expressiveness (engagement), (emotional responses).

Researcher: Shall explain what does every term mean?

SK (smiling): I feel like we are in “Inside-out”.

Researcher: The emotions I chose to explore are the basic emotions states of Anger, Fear, Joy, Sadness and the emotional responses of Surprise and Expressiveness.

Researcher: Depending on the music you heard results showed emotions of sadness and a high rate of expressiveness.
The indicators of anger aroused some times in the facial videos, the other emotions of fear, joy and surprise was poor in information.

ME: Maha can I interrupt you, please?

Researcher: Sure.

ME: The music you provided us with is sad, for example, if you add the music of "Fayroz" we will have another reaction you let us listen to sad music, of course, we will be sad, this is the first thing.
The second thing: I would like to question to what extent is the methodology of the program you used to detect emotions from facial expressions is right?
What about "Poker faces" for example my own family "very angry emotions", My mother side "the happy faces" but, these were not their emotions, these were their expressions.

PA: that's a good point, maybe there is a bit of confusion, is that: "
RESEARCHER I am trying to use emotions to get to that Image.

PA: That is the thing: " I do not know what exactly the question of your research? I mean Are we discussing how this methodology or your question is going to work, Or you what is to validate the program or what we saw? Or you want to discuss if it is possible to discuss emotions in architecture or music and architecture? I just do know what is the PhD about.

ZF: That is the question Until now I do not know what will you do in the next stage or what is the propose of the theses.

RS: the context?

ME: the Outlines?

SK: The contribution to knowledge?

Researcher: I am trying to design tools in the design process, these tools are taken from music, I am trying to develop the tools that can help me achieve the emotions people have when they listen to music. When people listen to music they start to imagine some spaces, pictures? related to this influence of music, So I am trying to develop design tools to reflect those Imagining spaces.

ME: It is very complicated.

ZF: We saw the work without music and then with music was there any difference in the results, to what extent is the program trustable to get our emotions regarding what we hear and to what we see?

SK: My question is about the music itself, why this music? if we change music are we going to get the same film? Maybe if I will listen to the music in the morning or midday or at night what will be the difference in my emotions.

UE: what if we listen to music in the dark ? it will be scarier?

PA: that's all variables in the process.

ME: I listen to music while I was sitting (during that test). but how about listing to it while I am walking in the city centre (outdoor).

Researcher: I am targeting people visiting Galleries or Art Museum people coming for a certain purpose of looking or exploring the artwork.

Researcher: I have three animated works: Sculpture, Gallery and Infinity 2, for these projects I elected these emotions to discuss. Expressiveness, Anger, Joy, Sadness, Surprise and fear. People showing information in these parts when poor in the information (joy, fear, surprise). why did I consider this poor? because I have 7 participants, One of them was disconnected showed zero emotions in everything. So we have the data of 6 people. So if the diagram has the information on three people and above I will consider discussing the results now with you. if the diagram gives the data of two people or less I am not going to consider it in this focus group maybe I will ask them later about what were they thinking? the high lighted parts are the parts with

significant changes every highlighted part of the chart is related to a clip this is my methodology of narrowing down the analysis of the given data.
Most of you were engaged with the work (gallery) more than the other works. (The Indicators said this).

RS: Can we see the gallery (just to remember it).
(show the clip with information (clip O))

PA: the video itself, most of the time I was confused the music maybe make me sad a few times at the beginning with that block ..... (regarding sculpture) (he described a volume of a cylinder) Subcon. I was a bit scared, if I was in that environment I would feel like I'm in the middle of a black hole. scary feeling the rest of the time I was just confused because to me it's not just not clear (I do not know if you made that in purpose, it's just not clear what is this environment. lines and then the texture and the size of the texture is not accurate the quality of design it is a different thing "you may have in your head a very nice design but your render it bad, it does not mean that the design is bad, but the graphics are terrible.

Researcher: This design was made 14 years ago.

ME: About the design quality, these sharp angles.

ZF: very complicated elements in many colours.

ME: you should mention what design movement you chose you can not speak about all design movements in the world.

ZF: I feel that you are guiding me to a sad experience which made me heel nerves.

PA: design is about how the space is formed to me this is not a buildable building from my point of view as a designer this is a weak design and weak visualization me in my head I am trying to figure the plan of this space its just not clear how did I get up to this layer and I trying to resolve these issues but nothing is resolved if it will have a good plan and very well read and then I will have different reaction, so instead of me saying why would this building made me feel weird, I will say this building mane me feel sad.

Even if they are weird plans, good visualization of it made feel they do not confuse me they give me different feelings I think most of the emotions I got from looking at this is confusion and a bit scared at the beginning my emotions in regards to what I saw and what I heard is completely different scenarios.
I was observing my face while I am watching and it was a poker face I could not see any expressions coming out yet I had different thoughts and emotions of confusion, scared at the beginning and happy same time with music) yet my face I did not show how all of this (your work ..... emotions in me but I did not know are the exactly).
RESEARCHER Any other comments.

UE: your main hypotheses, that we hear music while we design? and is this should apply to a student if they hear this kind of music or the studio while they are waiting and see that kind of project will they design according to their emotions at that moment and compare these designs and get the result out of them. elect two studio students working with your methodology and the other studio students working in normal conditions and then your result will be for certain age and maybe have happy music and sad music to compare between fit your work.

RS: back to your experiment, can we see the emotions diagram of is while we were listing to the music only.

Researcher: this is the chart regarding music only.

RS: ok can we see the chart of the design only.
They are the same.

PA: the design with music, its different (lower lines). Or maybe because we got used to the music.

Rsearcher: I was hoping to develop tools in design to help me change the chart of emotion into a similar chart of music or maybe the
Same chart flow but higher numbers, this is what I am hoping for the future.

PA: So that why you play the same music I wonder (I mean it is going to be interesting if you produce the same design with different music. the design is kept and the music does change in the background.

Researcher: I cannot do this because I am claiming that every music has its design I am starting with the music, not with the design, so I can't say this is the design and play another music with it, I am, to build the design upon the emotion scheme of music in the first place. but you can have a version of the design to one piece of music.

PA: that will show your claim so you can prevent people from saying that what you claim does not relate to this music at all, you can play any other music in this space and still get the same result? you have to look from different angles to your work. at the end of the day disproving what you are claiming is part of the research if the same one will ask you if you tried that and you say no they will say check again because you have to look at the all options and say see this is what I was claiming and this music with this specific design has this specific reflect on design or maybe it has this specific effect on people because designs now about architecture too much, I am just assuming. because at the end of the day you have to narrow it down.

ZF: Your work is very complicated and has a lot of factors affecting.

PA: that the issue lots of factors but I think it is durable its just that you have to reduce these factors you have to narrow them down very much Like for example "The effect of what is the home of this piece of music on the Iraqi people and when they look at this design it will be correct", but you just say the effect of music in emotions on a human being, maybe it's very big, too many factors how do you know the emotion, that's why the discussion keep going put to methodology. maybe if its narrow down and make it clear for us if you want to have a discussion for the PhD then it will be more useful for you unless if you just want to ask me did you feel that feeling when I showed that work to you, yes I can tell you I felt sad, disgust .,,etc, but it would not be that question.

ZF: it's a matter of approach you need to discuss specific music, specific feelings and specific space to get specific answers you approach mow is for 10 PhD.

PA: it's about the scale of it.

PA: At the end of the day I think this is something right to be up to because I think music has a huge effect on designers because it brings emotions and architecture is about emotions.

ZF: you mean design or designers? design process?
PA: Both I mean who is in the design process? the designer so its the designer subjectivity. The design process itself does not get affected by music "it's like a computer it's a logical step to do but the person evolving in the design is affecting.
I and you can have the same design process but the completely different outcome, the process is not affected by music but me as a designer I have a subjectivity to be affected by music.
Unless you say I want to add music to the design process which a logical selection but as a designer, I will defiantly be affected, give me that music for a month I will give you to forward if you will give me happy music all the time I will probably be doing from good I assume. you have to be very specific with what you mean.

Thank you all.

Semi structured interview with SK
Date: 28th January 2016 from 11:30 am- 12 pm
Location: Arts tower, Room 13.17
Interview led and organized by: the researcher

Sculpture

Researcher showing clip c from sculpture

Researcher: you think this clip Provokes Sadness?

SK: Yes.

Researcher: Can you tell me why you think it does? is it just because of this music? we need to talk about the design, shall I remove the music? we have 4 parameters to look at Coluor, lighting system, Interior skin and form.

Researcher: What do you think about the colours do you think they provoke sadness.

SK: Is this suppose to be a gallery?

Researcher: Yes.

SK: So because it is a gallery I think you can see these colours sometimes but what is the gallery about.

Researcher: its an art gallery and this sculpture is these for an art show.

SK: OK, because it would not work if you are talking about history for example or cultural heritage, there are other issues. So if its art, its this is acceptable. it gives us the feeling of being in space or a high technology environment. outer space feeling flowing things.

Researcher: The camera is inside one of the bubbles, you get inside the bubble and you flow towards the sculpture, music will be played in the side the bubble so what you see is synchronized with what you hear.

SK: if its a cotemporary postings gallery the colours and design is acceptable for example the national history museum and the science museum they are both galleries but displaying different thing each of them has a theme related to what is it being displayed. The science museum is generally dark with spat coloured spotlights directed toward the displayed features you feel you are in space when going them.
On the other hand, the national history museum has an acceptable degree of general lighting and diffused lighting is used over the displayed it because these items are big so the general lighting is to put you in mood and the spotlights to focus on detailed features. The colours and lighting system is your animation remind me with science museum the floor and the bubbles are like planets yes I feel like in space. (is like the surface of the sun). If you tell me that these walls will be having Ricardo's pointing I shall say no. but works if Zaha Hadid for instance, Yes.

Researcher: What about the form any recommendations?

SK: As I told you it depends upon the type of items being displayed here?

Researcher: you are in a chamber looking at a sculpture. The sculpture is the displayed item.

SK: Yes I like it I think the form fits what is beginning displayed in it.

Researcher: What about the music are they matching together or not?

SK: if this is Martyrs Monument something related to dead people yes the design is perfect.

Researcher: Now you changed your mind.

SK: Sure.

Researcher: you said the feeling of outer space.
SK: because I did not think of the sculpture as a sculpture I considered it as part of the design, not something displayed in the designed space. I felt that paintings will be hanged on this cylindrical well. Now my idea about the space is different. if this sculpture expresses sadness.

SK: This music is sad, it reminds me of AlAmriah Shelter. I think it's our culture as Iraqis like this music is related to death.

RESEARCHER culture is one of the common parameters between you all.

SK: The people here who did not live such circumstances do not feel this way with this music.

Researcher: They might see this as some alias from space.

SK: Perhaps.

Researcher: what do you think of floor.

SK: Again this sculpture is a symbol of what? what is the concept behind the sculpture itself? what did you mean to convey when you did this?

Researcher: I did not deal with it as a separate part, to me I wanted to make something sad, thus I design the sculpture to be the abstract situation of the beginning of the formation of a human I considered it as a sad life journey from birth to death.

SK: if you mean to symbolize the life journey of an Iraqi person, its the perfect design. let me put it this way. But if you tell me a life journey of an English person who has been raised in this environment, impossible, irrelevant to the subject of sadness at all.

Rersearcher: when you said outer space the speech shows high imagination does this watch the sad music.

SK: if you design this here in Britain, our characteristics will dominate the design. you as a designer raised in an Iraqi culture you lived the daily Iraqi life, you witnessed all of the events happened through the past 3 decades in Iraq all the daily life pressure (social economic and political) pressure, you have to take all of this defiantly your outcome will look like this exactly as I imagined it, but if we explain this to someone American or Mexican I do not think they will feel the same, and would not feel the music in the same way.

SK: Culture here is a very important factor, the environment when you were raised in. your background influences your design.

Researcher: Sure, basically I listened to this music and I reflected my emotions in this design. It's a subjective matter, this is my journey.

SK: The life journey of an Iraqi person.

Researcher: are you miserable?

SK: Not at all, misery is unlike sadness, some times sadness convey such outcome "We from this environment we progressed and reached to higher achievement in life".

Researcher: you started from the ground and ended in the ground (where is the achievement).

SK: No, why you do not say started from (the ground looks like lava or the sub from this a human was raised and made it to the outer space " let me think optimistically why negatively?

SK: I told you from the beginning I need to understand what is this then I will apply my interpretation to it. Now, My concept and understanding of this design are now different from my first slight or experience with space and different background. Every person reflects this work according to their idea and interpolations of life.

Researcher: Now, colours, lights, form skin and skin as combination goes well with the music attached ? or you think I have should have used darker colours of example.

SK: darker? No, it is optimum.

Researcher: More light.

SK: No, it's ok, the object displayed and my basic reactions of the environment it's ok.

SK: Some places have spotlight directed to them to show some important and some no, some times darkness indicates the importance of a scene it depends really about the concept behind displaying object in any space.

Displaying the emotion diagrams

Researcher: look here you showed indicators of anger.

SK: no, I was not angry I told you before this is the part where I saw the strange thing.

Researcher: let’s check this.

SK: This, yes, I thought the animation is over and it started again, this black element is like the curtains in the theatre when they go down it mean that the show is over. then I was surprised it started again.

Researcher: the black element confused you here.

Researcher: When you listen to music only you did not show this indication.

Researcher: True, because you saw the black element later in the design that’s why the indicators showed that difference between the two situations.

SK: In the third time I do not guess the indicator will show the same dramatic increases. Researcher: in the animation part you still have this lunch in your line but this shows your real emotional engagement with the scene since you already know about the black element.

SK: Yes, I still focus on this sense because it is different from the previous sequence of this sequence and their emotional interaction.

Researcher: I realized that this software can Identify how much interaction between you and what you see but it cannot identify exactly what these changes of interaction type of emotion is this. it gives options such facial expression can be translated as ... (anger, sadness, ..) the emotion which is relativity similar in term of facial expression it needs clarifying by the person himself to know what is exactly this emotion.

SK: then It still shows valid information in term of engagement.

Gallery

SK: The Music doesn't relate to the design when I listen to this music like the first work of sculpted.
SK: This music I feel it relate to Baghdadi culture, old Iraqi tradition, Maybe because I used to listen to such of music with images of traditional Baghdadi culture.
Is it a piece of famous music.

Researcher: no this is Iraqi music.

SK: I expect to see an old " Haush "
However, I see some forms which remind.

Researcher: with the monument of Al-Khillani in Baghdad, but the colours the texture the skin all doesn't relate to the music, The design is very modern and doesn't relate this music. this construction design. I think my results will show that I engaged with the music in a way which is different from my engagement the design. And when you combine them I think my results will show less engagement with the work.
It will be unfair to combine this design with this music unfair for both of the design and the music.
This part at the beginning physical impossible to build, I need to see the plan and drawings of this space. So, I can it. Some are confusing just too much information to digest.

Infinity: The disgusting music, the sound is just not working probably how to stand and where to go? (dis-oriented)
I remember this in this part I felt not scored but I stayed focused to see to were this will take me.
Researcher: lets check your results, that's dramatic in the case in your engagement this can detect them, in your engagement but it can not be very in teams of classifying this emotional engagement.

Researcher: Do you feel that music is related to space design.

SK: No the sound is annoying because the music is corrupted. And it doesn't reflect the infinity term.

SK: I feel that this is a journey to the unknown.

Researcher: consider it as a bad dream.

SK: Yes, I just didn't want to put it in this description.
As if someone pushed me from the top of a mountain and you didn't know if you are going to be rescued or not.
I can't read it as a composition as space.
The music needs to fix.

Researcher: Thank you

Semi structured interview with ZF
Date: 28th January 2016 from 12 pm- 12:30 pm
Location: Arts tower, Room 13.17
Interview led and organized by: the researcher

Gallery

ZF: Gallery Unclear circulation, the floor tiles are not realistic. I can see flow ting things and I don't know how they stand. too many elements the layer are more than I digest interims of understanding and comfort. (I can't stay).

Researcher: let's analyze it in terms of food proctors. Here more than 1 colours, skin and texture, form and lighting system.

ZF: they are all uncomfortable to deal with.

Researcher: from your point of view the main problem in this space is the unity of layers.
Researcher: Is it uncomfortable because you don't understand it?

ZF: the materials you used is just like all the same characteristics, the same roughness, texture and the painting are also the same texture as if you are inside a savage. Wild city.
The feeling of constancy is not found here for example if the scare is comfortable to the eye and at a specialist moment I see things as rough as this it's all right but this is a combination of focal points. Focal points can be positive or negative ones, here they are all negative focal points.
For instance the rump here it has a material which is harmful to the eyes in terms of the unrealistic scale of the tiles. The only thing that I positively am the Coloumbs. The glass and the wooden frame used it is something I like and I understood in this chaos.

Researcher: This is it is not a column they are hanging from the ceiling.

ZF: how can I perceive this from which angle you did not give me a scene to the whole element so I can perceive it as it is. OK, I can see it now just from this angle and the

scene is very short I missed it for the first time. regardless of the view angle this element is nice for me it is similar to the type of designs I like in Architecture I like clear design not complicated ones.
I don't find the strategy of being unclean and complicated a good tool to attract an audience. the pathways are critical I feel you will fall over at any moment the rail is not firm enough to avoid me from falling.
It's not safe for children.

Researcher: what about the music, does it relate to the design?
The music itself is very sad it makes me depressed, and the design is complicated I don't think they are a good combination to digest.

ZF: The design is depressing.

Researcher: why?

ZF: there are unclear the material is very rough, the colours are also too much for the design. you tried to use layers and transparent surfaces to solve the problem but you didn't manage to do so.

Researcher: It's a conflict.

ZF: Yes just uncomfortable.The same space the same designs, use different colours and materials I think the result will be better, much better than this.

Researcher: what about the lighting system.

ZF: I don't feel the lighting system is designed, It's so natural here.

Researcher: The form is fine.

ZF: It's complicated I think the texture made it even more complicated. If you change the texture and colours I think it will be better. I just feel lost here, One tone, the same. Way of expressing the form everywhere in the floor, walls, ceiling, texture everything is the same nation.

Researcher: let's move to infinity.

ZF: I can see the arch here and I see these lines I don't get this well, this, lines let me lose my focus.This is layer one, and this layer two is coming towards me It's very annoying it makes me lose my focus. This is layer one, and this layer two is coming to words me It's very annoying it makes me lose my focus.
Secondly where I am standing here?
I am floating here. I may be like the design for the floor the cubic system used is something I like dealing with. too many layers to capture and understand which makes it ready confusing and hard is images this space.
I was wondering did you deliberately make this.

Researcher: Yes. Because the music has these layers on it. Basically the design is created is from this music.

ZF: this music is horrible.

Researcher: you hated it.? It's made of layers. Doesn't explain the design?

ZF: Sorry the design has is better than the music. what is these lines (fence) I didn't get why it's these.

Researcher: I represent Infinity by this element it's like bars yet you still go through it.

ZF: there is your point of view which I don't agree with. you are claiming that I'm going through this fence yet the movement adjustment the fence it doesn't go through it the second Infinity video. this is good, but you distorted it and it becomes confusing I can not understand it well.

Researcher: why do you find it better than the first one?

ZF: because it's clear that there are a gate and some other elements which I understand as a structure forming the space.

Researcher: By the way, it is the same space but the video C camera movement is different.

ZF: I didn't realize this. too many layers, deliberately distorted and the layer of the fast movement ready annoying it doesn't let me understand the space properly (I feel disoriented) my eye should fight to focus on one layer and the other one to be able to understand. I think if you will just get rid of this layer movement I can easily digest the design apart of the fence which I cannot justify its existence.

Researcher: Thank you.

Semi structured interview with UE
Date: 29th January 2016 from 11 am- 11:30 am
Location: Arts tower, Room 13.17
Interview led and organized by: the researcher

Sculpture

Researcher: Let's review your emotion diagram of the design clips.

UE: yes I remember this.

Researcher: what is it and the design that made you engage with this clip, did you like this?

UE: It's not the matter of like dislike here, but it was more like a more in terms someone is thinking in depth as if you were thinking broadly and here you reached is a decision the thinking became deep in terms of decision making. Like someone, need is to think alone for a moment (I don't know how to describe this (like or dislike) I don't know.

Researcher: How is the form here?

UE: I didn't evaluate the from here separately maybe if there is no music I can evaluate the through the lighting design which is used but when the music is played they all become one composition.

Researcher: do you think that the design matches its music?

UE: I didn't think whether they match or not, I saw it as one composition. RESEARCHER, you didn't feel that the design and the music are going in different directions. no, the final videos they are one theme I perceive it as a package.

Researcher: what do you think this video represent?

UE: I don't know maybe our position now as researchers I feel there is something broad we are looking at, and that we followed or gone through some steps or a journey to

reach to a touring point or a deeper position where you have to take a decision, a change should take place now.

Researcher: this is part of a gallery and this is a chamber where the sculpture is displayed, you should be inside one of the bubbles and what you see is synchronized with what you hear. It's like a journey starting from the ground and ending these. Between the start and the end, this is a journey is to understand the sculpture and are these journey in your brain to live and perceive the context.

UE: yes, I didn't think of Its circulation or how to do this sculpture stand, or how these bubbles are moving against gravity, no I didn't think of all of this I just thought if I had the decision to stop and think more about the sculpture and the context I'm In. I feel I need more time to perceive this scene, the animation of the gallery a lot I wanted to pause some times to think more of the context and the design to digested better. But the last animation of infinity it was complete lose I was lost these and it has too many surprises. Where you don't want to stop your just want to pass these levels, unlike gallery I wanted to stop at one corner. And perceive the context in more depth.

Researcher: what about the colours and lights used here? (sculpture):

UE: I didn't think of them separately, they were like one composition.

Researcher: I mean the lighting did it serve the music and design concept.

UE: yes it suite them

Researcher: The colours?

UE: It matches it well. well you could express more feeling with theme tools specify in the places where the music gets higher reach to admix maybe you need to show something stronger than what you have shown.

Researcher: what can you say about the form?

UE: again I related everything as one package I did not look at form as a separate issue.

Researcher: let's move gallery.

Let's check moving to the next one.

Gallery

Researcher: checking the music charts, Did you like this music?

UE: Yes I like it because it is our culture Music.

Researcher: your chart has shown low engagement with the music while you are engaged with it well.

UE: Yes I was engaged with all the music you presented.

Researcher: you showed a high level of engagement at the beginning of the gallery work, let's check what happened here (clip H), can you get the theme?

UE: No, Their space is very harsh, the angler and the colours Its just too many colours and textures, the space scale and proportions are not logically accepted. In any gallery, you should think about the paintings, how they are located, the Background and the forms used, I mean even the stairs have I am not sure if it works functionally or not. Are these stairs or a ramp?

Researcher: you thought of the circulation system have?

UE: yes, become I needed to orient myself have. too much transparent materials and why did you use them if you wanted to see the wall beneath? too many elements, confusing space. When I listen to the music I recall the scene of sunset on the river bank in Baghdad, I remember the silence, culture.

Researcher: Not many confusing elements?

UE: I need to feel Nature here, (In and out spaces). To perceive this music in space.

Researcher: what about the lighting systems?
UE: I don't know it was not realistic to the level that I could feel the light effects. I need to be in a traditional environment to feel this properly. The music here doesn't relate to the design, that's why I put the music aside and I started to focus on the design itself to them to find the relation between what I hear and what I see.
Unlike the first work of "sculpture: I was not familiars with Both the music and the design All the design elements and the music integrated to a way to convey a special situation or went. But this work No the music is not integrated with the design.

Researcher: what you think can be changed in the design to improve it to wands a better integration with its music?

UE: Simplify the whole Design, fewer elements, less rough materials more focus on the lighting and the contrast between the dark and lightened area and the painting displayed related to tradition or a display to the art of certain old decade in the Iraqi culture.
UE: The design now is just Uncomfortable.

Infinity 1&2

Researcher: This music is annoying?

UE: In this work, the music is integrated with the forms and shapes used Its all distorted, random, As If space had am an accident. Both the composition or the music is distorted in a way. They are abnormal.

Researcher: which is annoying.

UE: Yes, become it is just unexpected. This is not what I wanted to see or experience. This is not the perception I'm looking for. It's very random every the movement is very random Its like a nightmare you see many indicators and they are random. When you wake up and recall it, you think whey did time happened. How did I get to have while you are dreaming which such nightmare it was ok at that moment but when you recall it later you start to wonder about the reasons at what you sow?

Researcher: Does this design match or reflects the music?

UE: yes, as I told you they are both one distorted care.

Researcher: Did the Design reinforced or enhanced the music?

UE: They are one case I can not separate the came here.

Researcher: Does this design match and reflects the music?

UE: yes, As I told you they are both one distorted care.

Researcher: Did the design reinforced or enhanced the music?

UE: They are one care I can not separate the case here.

Researcher: let me ask this question in a different way, The music is annoying or disturbing? Did the design enhanced this feeling did it confirm thing? or the design is less disturbing or maybe more disturbing?

UE: when I saw the design separately it was annoying and when you combined it with the music it becomes highly annoying as it made the effect more condense.
Design with music become one horrible experience to go through. the design is stronger in terms of effect and influences them.

Researcher: unlike gallery?

UE: In the gallery, the music was a certain situation and the design just weekend that influence. Unlike here. The design is strong in interns of its effect and the music has is just a good integration to a worst effect os disturbance. The design is like hallucinations. You should not call it infinity. You should call it the way to hell or move.

Researcher: The colour levels?

UE: It's all enhancing one annoying level of distortion. I really engaged badly with this work.
Researcher: while the emotion soft wave didn't detect any remarkable engagement become your force did show them.

UE: I had to go out relax after this session. It's good personation to the "wish" in the and of the old broadcasting of any TV channel.

Researcher: Thank you.

Semi structured interview with ME
Date: 29th January 2016 from 11:30 am- 12 pm
Location: Arts tower, Room 13.17
Interview led and organized by: the researcher

Sculpture

Researcher: what do you think this experience overall?

ME: Sad experience. the music is sad and has a very sad influence of its relation to my previous experience one of the wents related to this music is the tragedy of Al-Amriashefter. (The music of sculpture).
This voice in the Background is always accompanied by whatever traduce event, images of people suffering, death and wan, bloody historical events. The Design reinforces the same tragedic event.
This is the representation of someone being hanged it makes me feel upset. For 12 years in the Annual remembrance of Al -Amriah Shelter. The Tv of Bagdad broadcast some of the destroyed shelter with images of the people who did there. They didn't keep the piece of burned on the wall it is a very tragedic event and always a combined with music from the same rhythm.

Researcher: do you find the design successful in expressing its music?

ME: Yes, possible why not? The design reinforces these painful memories, this sculpture skeleton, and the skin surrounding the space reminds me of the Victorian person calls, a place of for torture.
The spaces are abended, desolated, there are no figures this reinforced this painful, frightening expression
Even the colours used and the lighting system, I can feel the spotlights yet No Normal reflection of the materials and surfaces.
This is an Isolated space where they torture people.
RESEARCHER This is (explanation of the Design concept).

ME: This Ground is not a floor it's a volcano.
The sculpture is harsh it's like inside a volcano, or a cave lived by a person from the stone age. The design, In general, is graphical presented well I don't really feel the depth in these images.

Researcher: can you visualize the space?

ME: NO, I can't have a good image of this space the camera movement is existing don't make me visualize and enjoy the scene check" comes effects and animation movies " in Google when the animation continues.
Now, yes I can see more elements I can have a better visualization to space yes I can see more elements I can have a better visualization to space yes I see that you neglected the visual clues here which make it hard to locate these elements in the space.
I don't know who is behind whom the shadows distributed everywhere it is not presented graphically well. Transparency, over lab its all unclear, the texture and high ting really affecting the work negatively. If you work on them the design will be more representative.

Researcher: the form?

ME: It is horrifying.

Researcher: if I give you a paper can you sketch the space?

ME: No, I will draw a circle for plan only.

Researcher: No, perspective.

ME: No, As I told you the movement of the camera is in a loop it doesn't help me in building a clear idea of the space. Unlike the vt views when I can look might left, up and down. You need to use a 360◦ camera to have a better feeling of the space. the camera movement is causing thing confusion for this space I can feel Its details But a complete visualization to It in terms of borders and outlines No, I cannot visualize it. I can feel circulation in the ground, and a mother one in the ceiling.

Researcher: you cannot see it a cylinder. ground, ceiling No walls because it's black when the camera moves yes I can see the walls then it disappears and come back in the animation.

Gallery

Researcher: you remember this one?

ME: This transparent object doesn't allow you to comprehend or recognize the space. This scene the feeling of space disappeared the movement is not constant and smooth enough to understand the special influence in this same. As if I am in amaze I can't comprehend or absolve the space. The camera is too close to the objects. I can comprehend the objects but Not the whole space. for this, I can never draw a plan. the transparent walls here are not 100% transparent yet not really solid they distorted the scene I don't feel perspective clues in this scene. The movement between the cameras is not successful in term of keeping me with the flow of the space sequence.
It's like a jump in the sense which makes the audience lose their focus.
The camera is not related to the human scale and the light of the human eyes. It doesn't help to absorb the space and keep me oriented here. (again texture and lighting, perspective cue).

Researcher: what about music?

ME: this music is Baghdadi heritage this music is usually accompanied by the images of traditional all Baghdadi houses. the music is unrelated to this space.

Researcher: Thank you.

Semi structured interview with: PA
Date: 17th February 2016 from 11am- 12 pm
Location: Arts tower, Room 13.17
Interview led and organized by: the researcher

Sculpture

PA: the music and animation in this one support each other when I watch this it gives me I don't know "not" scared. It's like doubt or stress other " the feeling you get when you have not studied a might before the exam it's not necessary "stress" it's like you are scared what are you going to do. But I think if you don't look at the design and hear the music only you still get that feeling m so I think there is a sort of relatively direct relationship between the music and what has been shown.

Researcher: do you feel that they merge in a way to convey something?

PA: you mean the sound and the work? Researcher yes. I think they "match" they are not, in contrast, is also a relationship but it's not like it's doing something else m they are doing the something maybe in a different way but they are supporting each other " this is how I feel about this " because what I see is very much like something you don't see on earth it looks like if it is another planet or something is happening here , that sort of there how it look when I see the video " in my perspective" I see something that I did not have any precedence any example I don't know if human being doing that normally but at least this how my brain work , I usually look for example that I have seen like when you show me an architect are I automatically connect it to something I have seen before, when I see this I don't have any example to relate it to it in my head the only thing it reminds me it might sound crazy but there was this strategic game in computer that I used to play.
Researcher: what if I called?

PA: Starcraft, it's a strategic game and there are that group of aliens and there are humans who have to kill those aliens , the sculpture looks a little bit like the bones of that alien and it sort of connects me to that m with the music m tome this music is relatively a sad music it is more like that they have concurred the world and this sad music finish, ok they won and we lost like it sort of o know this is crazy but I am just being very honest, as crazy as it sounds that's how it reminds me of like it connects me to that becomes I mean this surface in the bottom I have not seen such a thing in my life .

(Comment) Researcher: found the bottom surface not realistic because of the lights and shadows which were undesigned perfectly which made him lose the ability to match it with the volcano he mentioned earlier and that angered him because of the confusion." My opinion this helped him release his ideas and imagination to live his own narrative of the tour he mentioned.

PA: even, I mean at least in the academic world but in the game world you see alit of this, specially interims of a 30 and if you go back a little bit maybe ten years ago that is how it reminds you so that is the feeling I have that I can't tell you.

Researcher: looking at four design factors here, the form, lights, text we and colour, let's talk about colours do you think that the colours here backed up feeling for the space?

What is nice here is that you only need to propose the elements and people create their own narratives which reinforce the music finding in case they don't have anything in mind to relate the work to they do their own match from their collective memory and live the music as a narrative of their own.

I mean the colours here is hot colours the red family you were talking about space do you think maybe cold colours would match the narrative be her?

PA: no, not necessarily m I think when I loot the work there is a level of consistency is all the colours like am not saying that they are perfect match, but they support each other like if for instance this orange colour and the pink here and black and again pink they sort of in the same family to me . for example this orange here and if this some uns neon green, then they will not match they would have looked crazy to me, but the

whole space looks relatively real become of this consistency but not real. it can not happen in earth its real of somewhere else.

Researcher your Imagination is accepting what you see, but your logical brain don't?

PA: yes, kind of " yes ", I would say that is correct the way have said it is like it seems to me like if I would have died and somewhere else in the next life, I would say I might see this, ok. but it's not something normally logically there.
But if you have a bad dream sometimes or maybe a good dream I don't know, because some times when you are in a dream there is a level of consistency on whatever happens
You know like you might see your family, your friends and there is a building it might shape differently, but the colours I mean whatever happened might not make so much sense this, it doesn't make sense for me the movement of the balls and the sculpture, why they are like that or how they came to be this way, I can not understand it because I did not see an example of it before . but they are not on complete contrast with each other, like as a space it can be created that's how I feel it but no one has tried or will they to make it that's how I feel at least its very hard to say , as said the logical part of me does not really understand what is happening in the whole design I mean in at other videos it did make more sense m when I look at it , I feel its like a building somehow it might not work you might not be able to build it, I don't know , but it looks like a building to me, in sense of corridors and windows, room and lights coming.

Researcher: familiar elements?

PA: yes, but with this one (sculpture) there is nothing familiar to me. yes what I look at the bottom surface its like sand but no its like a skin of an animal or something I am trying to make sense of what it is , but I can not find it in my head I mean , maybe its because the quality of render or o don't know if you did it on purpose , its just that I am thinking that you would be able to make that maybe "tomorrow " but u have not seen such example so it contradicts in my head .

Researcher do you think you can draw a plan, section and a perspective to time work? Can you visualize it in a 3D world?

PA: yes I can do that, I think yes I can understand what it is and what is the structure of it, I can understand all of those aspects, it's very much for me why is it this way, is still again a question? other than that there are physical contradictions like a ball moving like that and the sculpture seems to be floating which in reality you don't see that. if it was having from sort of a structure that would have connected to it then I would have started to understand its ok it seems that its real but because there are some factors and the movements that don't look real, then it contradicts ok, is it happening on earth or is it in space , I mean it about the physicality of this how can you build this , or maybe ads designer am thinking that way , I don't know but other than that it would be why is it built in this way as well I can not find a reason for this.

Researcher, you need to find reasons for the things you see?

PA: for me it is like that I think many people don't care.

Researcher: you don't take things as they are?

PA: no, for me I always look at why I constantly keep questioning why something is like that, I don't accept things as they are. usually, I need to have an explanation, I know the explanation sometimes is too complicated, but as long as there is an explanation exist I would have become more happy about it but when it comes to architecture and maybe politics as well and social aspects I want to find why? why this from us like this.

Researcher: do you want to know why?

PA: yes .

Researcher: I was trying to reflect a human-like journey, the is in one of the bubbles. so the sequence of the scenes you see is synchronized with music you hear.
So, it's a sad life journey which start's not from earth but let me say it starts from a point when you live your journey and you go back to where you started.

Researcher: this is an abstract formalization to the concept and the feelings I had when I listen to this music this subjective.

I listened to the music, I felt it, my emotional reflections are here.
So, this is what I get. It's not elements borrowed from the existing images of my memory. if you will ask me why did it go out like this, I probably won't have the right answer to this, the right logical answer for it, can it physically be built, how are these elements relate to each other? Is it a cylinder? is it not?

PA: I think the fact that you said that this an abstract is enough explanation for me. Because an abstract art doesn't necessary have an explanation like that. I mean when you make it clear to me that it is a journey for a human being and that how the music makes you feel like when you made that clear and you say "abstract" that's enough.

The explanation for me because it makes sense. It makes sense why happening Its feeling and you express it, you can express it with line and circles and that's it, or you can express it in a360 form. It doesn't Metter how you express it.
So, I would say yes it makes sense now, I know what it is. It doesn't matter to be build or not.

Researcher: Did you have these ideas when you first saw the animation, or you brought some thoughts about how while we are discussing it in depth.

PA: No, I had the thoughts of aliens and the games earlier but, with the discussion I expanded those thoughts in Terumi whey I felt this way.

Gallery

Researcher: what do you think of this work in terms of design, I know you have previous bad experience with the music, so let's look at design now.

PA: In terms of design let me say it seems to me it's not correctly designed, the texture and the quality of rendering is not of view, its not a working example.

Researcher: can you draw a plan to this one?

PA: No, I don't think so, I mean I can draw a plan, but as looking at it now, No, I cannot , I mean the movement of the camera does not give me a whole Idea of the space look

like, I feel it jumps sometimes and avoiding me from some angle and there are lots of corridors and walls at triangular wall, it doesn't give me any idea of how this space is shaped. but, if I look at it 20 or 30 this maybe I can draw something But not at the moment.

Researcher: Is it not "comfortable" from a reasonable perspective?

PA: comfortable, it really depends on me, I think at the end I am not only thinking of it as a designer or an architect maybe I am looking at it as a teacher and I want to fix it, I feel there are issues here.

Researcher: such?

PA: a lot of, the texture doesn't match, the size of the spa like the width and light and many of the corridors don't match, they are too tall and too narrow the lighting in some eares are too dark and some areas are too bright. if there is a specific purpose for it usually there is a level of consistency of how you go from dark to light, to me, it looks like relatively random you know deconstruction in architecture they sometimes get buildings that sometimes does not make sense.

Researcher: the architecture here is folding architecture, which is the past of deconstruction.

PA: yes kind of but usually with deconstruction I mean it depends who you are talking about if its Frank Gehry or Zaha Hadid they kind crazy but if you look at Peter Eisenman work, there are series or levels of reasons of why he is doing it and when you go into his architecture you are doing through a journey to make too feel these feelings.

You can also take some boards cut them off and threw them on the table and become random there is a difference between reasons and making people feel some way becomes with consistency of you are doing that and the person understands maybe at the beginning but maybe later on , what they feel or being just arbitrary this to me seems a little bit arbitrary trying to make sense rather than making sense try to be arbitrary.

So, I think there is a level of you know when you add salt in your food when you look it you don't have any salt it's just without salt it doesn't taste anything if you add too much salt it becomes too salty, this seems a bit too salty, so, if you would have put out some of that too much or give real proportion rather than being too narrow or too a bit more understandable, I mean milder it would have started to make sense to me look at the textures there is no consistency suddenly there is the stone and then there is a golden metal and then black and some of the materials here as well there are not as they are in real life I mean there might be a technical issue here you know what I mean like the technical I don't know is it brick the brick sizes are this much here the bricks are this much look at this flooring this size of the flooring I haven't seen before in real life but here there is not the same inside in my head I am trying to say this need to be fixed this is not how it should be if this the real work .
Again the way that video is made, the way that the camera is moving sometimes it is through the wall or through the building or through an art piece or something, lack of people in space, these can help me understand the scale, lack of these aspects that give me a scared feeling and this a lot confusing to me but maybe from the point of view of designer/ tutor.

Again if you say that this work is an abstract of how you feel it would be a different scenario become you make abstract modules as well for an idea and that makes this acceptable for me like it the beginning of the video you say this is an abstract work or abstract ides then any point of view would change than thinking this is something that is going to build and this is what you are suggestive.

Researcher: what else is wrong in addition to the texture and the size of the material?

Researcher: the lighting? You said; its either too dark or too light?

PA: I feel they are random ok when you see this it makes sense that this is a gallery.

Researcher: I said gallery in the beginning.

PA: I didn't notice this. I still feel its a gallery or a museum from the artwork displayed here. 60 as an art gallery art pieces should be brighter and corridors sometime bright

and sometime not but your instance you look at peter I think man Jewish museum in Berlin, when you enter at the beginning there is darkness with light only to you get used to darkness it's giving you an idea where are you going to and you come to some clear but confusing area but the art pieces are very lighted so you can't see the pieces well and then you go into a space that is text is extremely dark there is just only one opening on top that light is coming from you right away get from bright area to a dark one through the door so this sudden change but you understand the purpose, in that cold dark area he didn't put an art piece he just want you to get the feeling of being in a cell or being in prison that makes you think that how somebody felt during the Nazi time if you were Jewish, that feeling is coming to me even if I am, not an architect you start to get that feeling of a second lack of light rough concrete on the wall nothing else there its all quiet the sound of ears passing out you absorb all of that .

Researcher: you felt comfortable because they were separate scenes?

PA: not because they are separate, because there is a connection between them.

Researcher: yes, but I assume that you are comfortable because inside each space you have one feeling.

PA: yes, relatively it makes me…
Researcher: you have one concept to think about not many concepts to think about at the same time.

PA: yes, kind of, yes. yes it's correctly put than having in your work I can see and feel all of them at the same time, yes it seems arbitrary and there are no relations between them.

Researcher: do you see that this might be a representation of the music?

PA: actually, the music is very consistency if you get someone to play the drums while this music is playing yes you get such architecture to me it's like two people trying to talk to you at the sometimes.

Researcher: this is what mainly causing the problem.

PA: of the decision yes. I am not talking about the music, I mean music on its own is working it did, I might don't like it but it is ok. But, this work is a bit arbitorary that's all I can say this music to me is very mimiual when I listen to this music to me the space that I can imagen is very much like desert, when you look at desert it's a very minimal scene you just have sa nothing else and you have the sky that is blue and slly might have a few clouds and when you look at desert the form is very random, you might see piece of vegetation maybe but everything us consistent while its minimal and this music remind me of that sort of scene so if it's me I will design relatively an empty space relatively dark with one source of light coming round or just focused on one piece of art that saying everything this how I feel the way to conect the music to the design, rather than a lot of information a lots of pictures and lots of corners its very soft and simple music just trying to say I am sad for whatever reason behind the Japanese poem is like that very much he might have two or three sentences but it talks about extremely complicated feeling that maybe you need to write 5 books about it, but he is just saying it in these sentences . this is the 5 books, this is not these sentences.

Infinity 1&2

Researcher: The music is the same in the last two works. they are two versions of the same music.

PA: oh really.

Researcher: you didn't realize this?

PA: No, with this music I didn't really understand it because is a bit overexposed music like distorted m you know when you increase the sound volume too much the speakers cannot perform well that's how I hear it so I cannot really understand the music, (hastened to the original music).

PA: this enhances energy not like the tour before I mean different kind of energy (physical energy) I could have assumed that the music is happy but I could not understand it because of the quality of sound I thought maybe my speaker is broken.

Researcher: I did this to enhance the idea of infinity.

PA: I think where you manipulate was the wrong place to manipulate you know the quality or resolution of the sound is nothing to do with I listen to a lot of Iranian music and Dashti is one of my favorite ones it fills me with enjoyment like I feel complete , some times when I listen to it these are that pleasure in that pain when I listen to Dashti but the composer for this music is actually taking you through a journey and tricks you because sometimes they actually don't change the resolution or quality of the music like they don't ruin the instrument they actually play the music in a way that you feel sometimes like you are in hell like it not good if I put value on it, and then suddenly they take you up to like make it dance music no the melody itself changes in a way than increase your slowly to that feeling of completeness I think what you manipulated here is guiding the instrument rather than the music .
The movie is just like the music its two things on the top of each other.

Researcher: Thank you

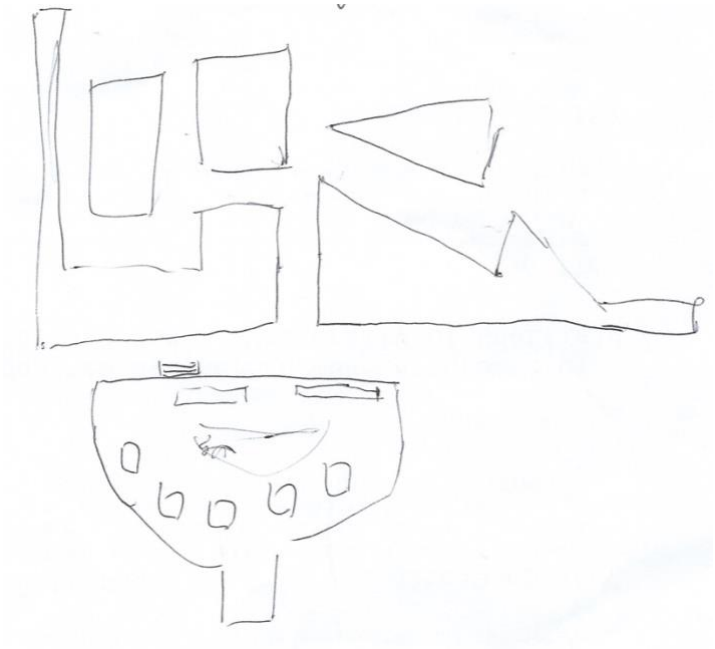
Section Six

Synaesthetic Scape 1&2; participants' sketches

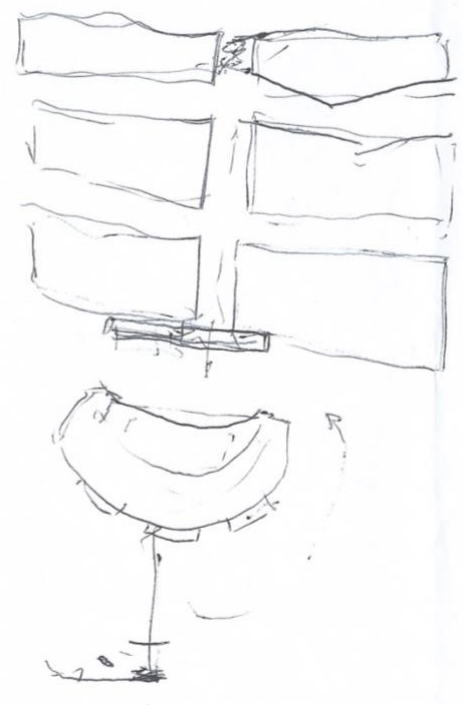
For Synaesthetic Scape 1 and Synaesthetic Scape 2 experiments as part of the semistructured interviews, each participant was asked to sketch the VR environment he or she experienced.

The researcher used these sketches as indicators to study how participants perceived the VR scape and to what extent they remember the detailed of the VR environment and whether they were fullu oriented or not.

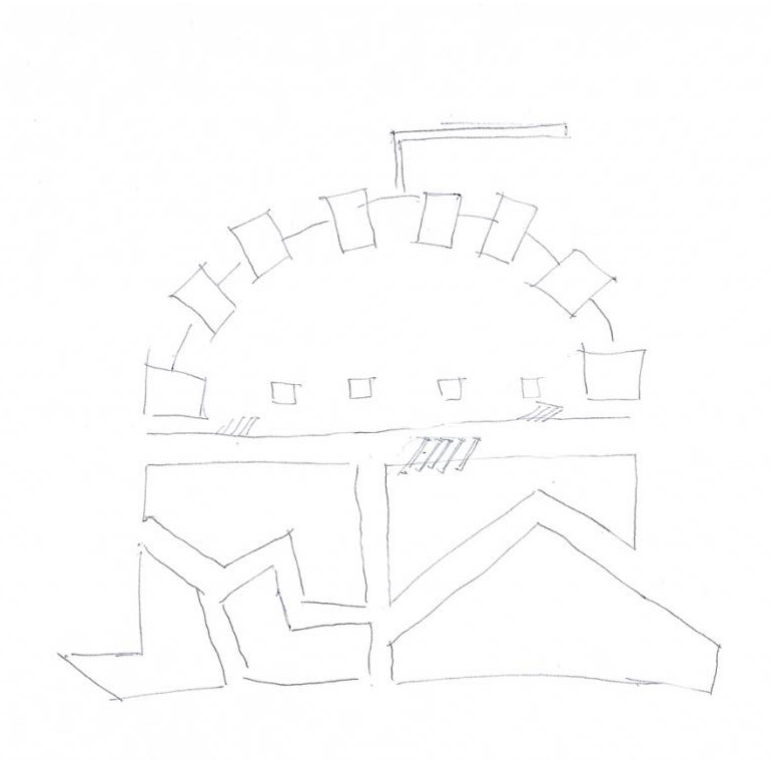
Here I include those sketches.



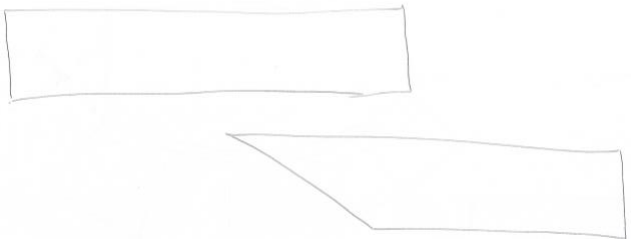
Experiment: Synaesthetic Scape 1
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:7th June 2017
Sketched by: RS
Collected by: the researcher



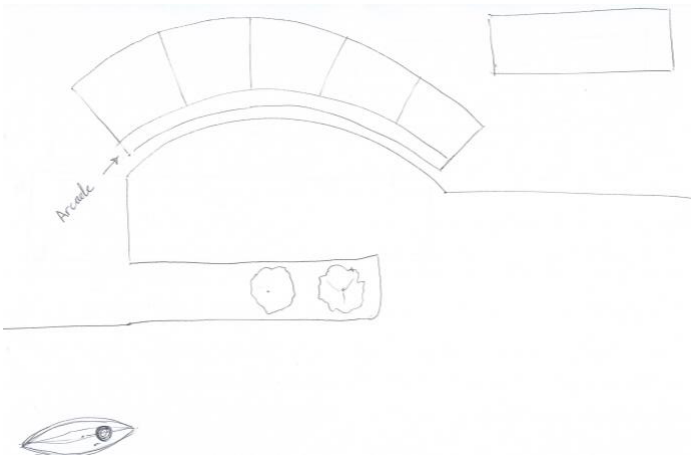
Experiment: Synaesthetic Scape 1
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:19th June 2017
Sketched by: KC
Collected by: the researcher



Experiment: Synaesthetic Scape 2
Location: The University of Sheffield,
The Diamond, VR Lab, room 3.08
Date: 22nd January2018
Sketched by: RS
Collected by: the researcher

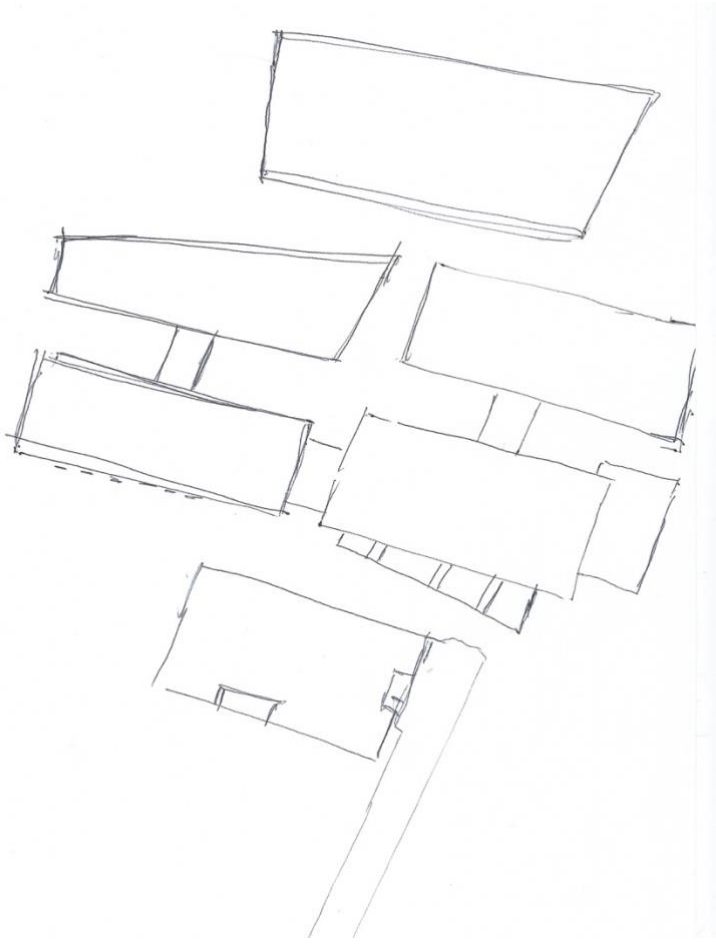


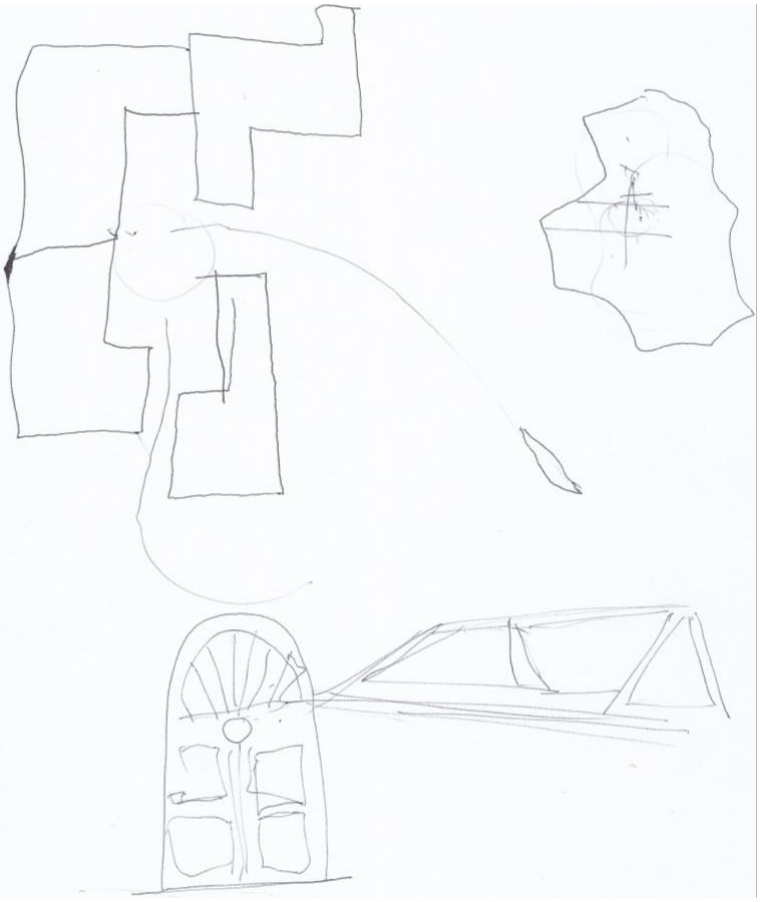
Experiment: Synaesthetic Scape 1
Location: The University of Sheffield,
The Diamond, VR Lab, room 3.08
Date: 24th May2017
Sketched by: AH
Collected by: the researcher



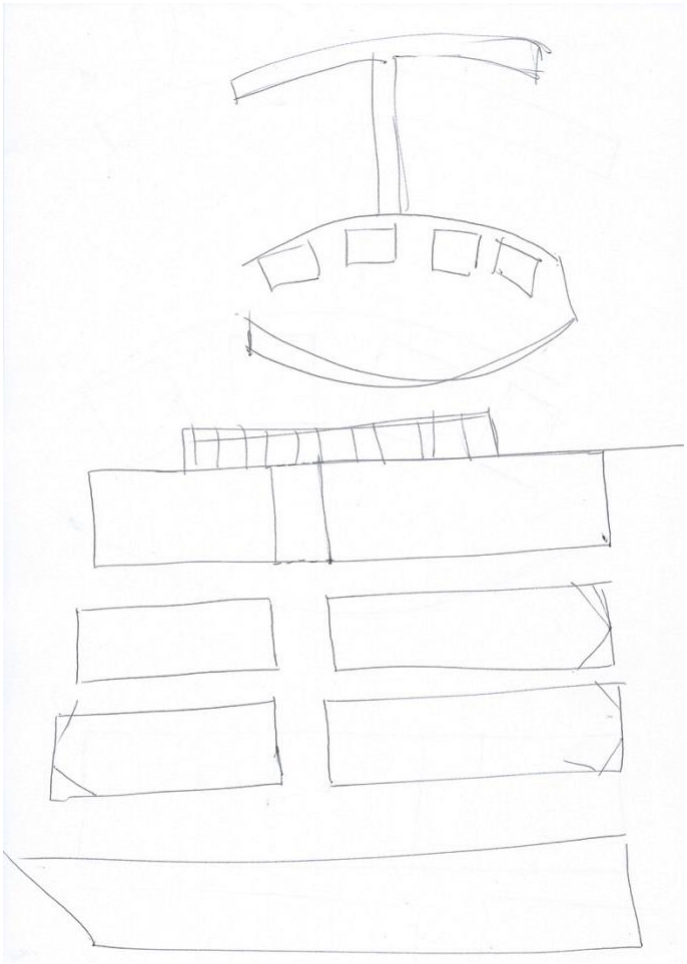
Experiment: Synaesthetic Scape 1
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:3rd April 2017
Sketched by: GF
Collected by: the researcher

Experiment: Synaesthetic Scape 2
Location: The University of Sheffield
The Diamond, VR Lab, room 3.08
Date:19th January 2018
Sketched by: UE
Collected by: the researcher

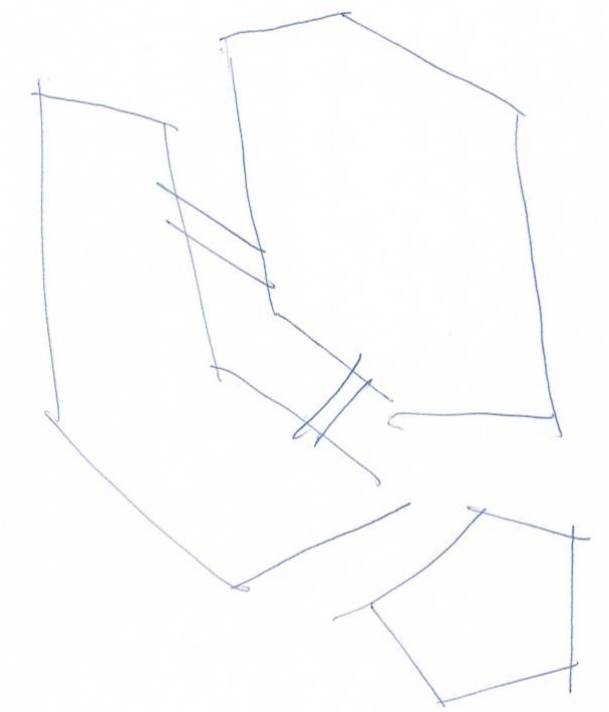




Experiment: Synaesthetic Scape 2
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:19th January 2018
Sketched by: YA
Collected by: the researcher

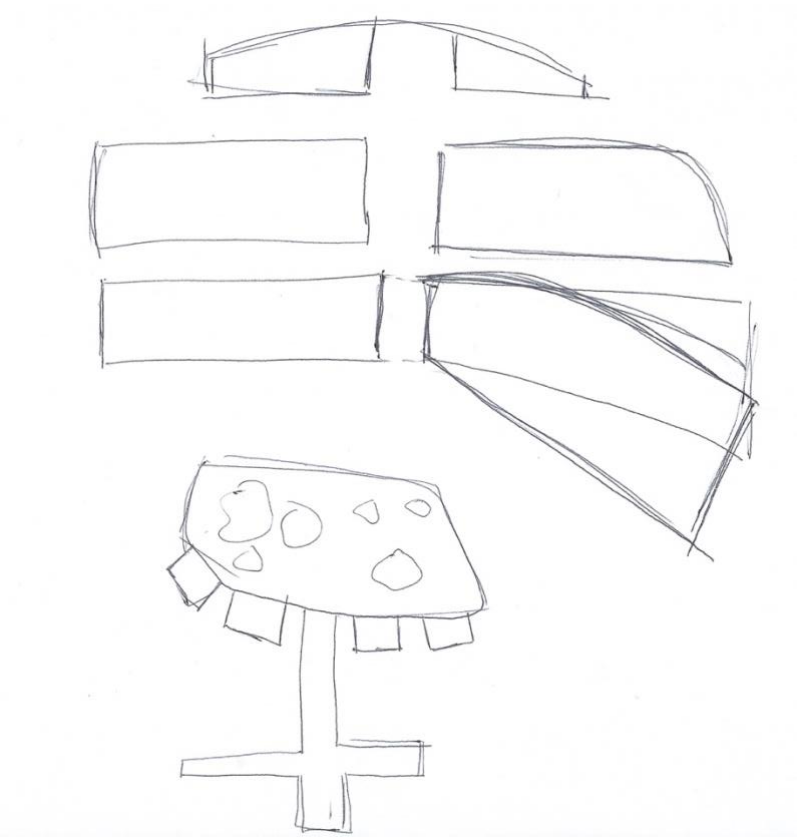


Experiment: Synaesthetic Scape 2
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:19th January 2018
Sketched by: AH
Collected by: the researcher

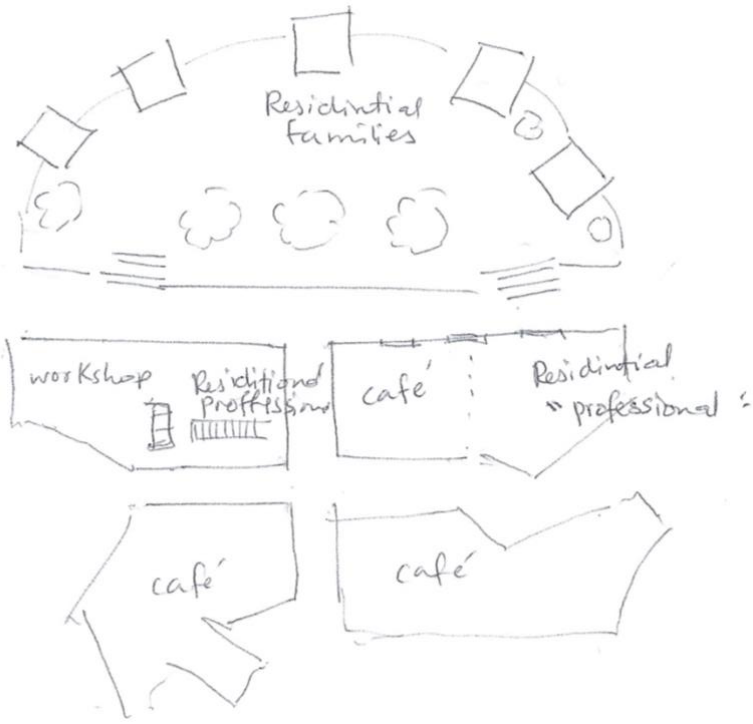


Experiment: Synaesthetic Scape 2
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:19th January 2018
Sketched by: ZF
Collected by: the researcher

Experiment: Synaesthetic Scape 2
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:25th January 2018
Sketched by: JB
Collected by: the researcher



Experiment: Synaesthetic Scape 2
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:22nd January 2018
Sketched by: GF
Collected by: the researcher



Experiment: Synaesthetic Scape 2
Location: The University of Sheffield, The Diamond, VR Lab, room 3.08
Date:22nd January 2018
Sketched by: RS
Collected by: the researcher

Section Seven

Unity transcripts; by Robert V Stacey

```
... Project\Ambient Sound\Assets\Scripts\CameraControllerv2.cs                    1
 1  /*****************************************************************************
 2  * AUTHOR:                   Rob Stacey
 3  * CREATE DATE:              2017-2018
 4  * PURPOSE:                  V2 of script for moving the player object around the
      scene
 5  *                           for second/final version of the project with ambient
      sounds
 6  *****************************************************************************/
 7
 8  using System.Collections;
 9  using System.Collections.Generic;
10  using UnityEngine;
11  using UnityStandardAssets.Utility;
12  using Random = UnityEngine.Random;
13
14
15
16  public class CameraControllerv2 : MonoBehaviour {
17      //Movement
18      public float panSpeed;                          //Variable for refining speed of
          movement(multiplier)
19      float Speed = 1.0f;                             //speed of movement variable
20      public float RotationMultiplier;                //variable for refining speed of
          rotations
21
22
23      //Rotator
24      public AudioSource SoundEffect;                 //sound effect when bumping into
          objects in the scene
25
26      void Start()
27      {
28          Cursor.lockState = CursorLockMode.Locked;   //lock any cursor movement to
              game window
29
30      }
31
32      void Update()
33      {
34
35          if (Input.GetKey("left shift")) {           //if left shift is pressed double
              the movement speed (useful for debugging)
36              Speed = panSpeed * 2;
37          } else {
38              Speed = panSpeed;
39          }
40
41          Vector3 pos = transform.position;                   //vector of position
              for movement
42          if(Input.GetKey("w") ||Input.GetKey("up") )          //when forward key is
              pressed increase position vector
43          {
44              pos += transform.forward * Speed * Time.deltaTime; //using speed variable
                  and length of time of keypress
45          }
46
47          if(Input.GetKey("s") || Input.GetKey("down"))       //when reverse/
              backward key is pressed decrease position vector
48          {
```

```
... Project\Ambient Sound\Assets\Scripts\CameraControllerv2.cs                    2
49              pos -= transform.forward * Speed * Time.deltaTime; //using speed variable
                  and length of time of keypress
50
51          }
52
53
54          if(Input.GetKey("a") || Input.GetKey("left"))          //when left key is
              pressed rotate left
55          {
56              transform.Rotate(-Vector3.up * (Speed*RotationMultiplier) *
                  Time.deltaTime);
57
58          }
59          if(Input.GetKey("d") || Input.GetKey("right"))         //when right key is
              pressed rotate right
60          {
61              transform.Rotate(Vector3.up * (Speed*RotationMultiplier) *
                  Time.deltaTime);
62          }
63
64          transform.position = pos;                 //update position
65
66          if (Input.GetKeyDown ("escape")) {        //release cursor when esc is pressed
67              Cursor.lockState = CursorLockMode.None;
68          }
69
70      }
71
72      void OnCollisionEnter(Collision collision)  //check for collision with objects
          (should only occur once)
73      {
74          if (collision.gameObject.name != "Water") { //if the collider object isn't
              the water
75              SoundEffect.Play();                       //play boat "bump" sound effect
76          }
77      }
78
79  }
```

```
...PHD Project\Ambient Sound\Assets\Scripts\SoundController.cs                    1
 1  /*****************************************************************************
 2  * AUTHOR:                   Rob Stacey
 3  * CREATE DATE:              2017-2018
 4  * PURPOSE:                  Turns off the boat mesh and water related sound effects
      when entering a preset TriggerArea
 5  *                           Uses public variables for customisability.
 6  *****************************************************************************/
 7
 8
 9  using System.Collections;
10  using System.Collections.Generic;
11  using UnityEngine;
12
13  public class SoundController : MonoBehaviour {
14
15      public GameObject Boat;           //Boat GameObject
16      public GameObject Mesh;           //Mesh of the boat GameObject
17      public bool AudioDisable;         //bool for muting audio track 1
18      public bool MeshDisable;          //bool for disabling Mesh
19      public bool Birds;                //bool for disabling bird effects
20      public bool Water;                //bool for water effects
21
22      AudioSource audio1;                //Audio track 1 - Generic audio
23      AudioSource audio2;                //Audio track 2 - water
24      AudioSource audio3;                //Audio track 3 - birds
25
26      // Use this for initialization
27      void Start () {
28          var audioSources = Boat.GetComponents<AudioSource>();  //get all the audio
              sources in an array
29
30          audio1 = audioSources [0];                             //get audio tracks
              from the array
31          audio2 = audioSources [1];
32          audio3 = audioSources [2];
33
34      }
35
36      void OnTriggerEnter(Collider other)                        //if object enters
          the box trigger collider
37      {
38
39          if (other.gameObject.name == "Player") {               //check collided
              object is a player
40
41              if (MeshDisable == true) {                         //check bool and turn
                  off mesh if required
42                  Mesh.SetActive (false);
43              }
44              if (AudioDisable == true) {                        //check bool and mute
                  relevant audio tracks
45                  audio1.mute = true;
46
47                  if (Water == true) {
48                      audio2.mute = true;
49                  }
50                  if (Birds == true) {
51                      audio3.mute = true;
52                  }
```

```
53
54              }
55          }
56      }
57
58      void OnTriggerExit(Collider other)                          //if object leaves
          box trigger collider
59      {
60          if (other.gameObject.name == "Player") {                // check if it is the
              player object
61              Mesh.SetActive (true);                              //enable boat mesh
                  again
62
63              audio1.mute = false;                                //enable audio tracks
                    again
64              audio2.mute = false;
65              audio3.mute = false;
66
67          }
68      }
69  }
70
71
72
```

```
... Project\Ambient Sound\Assets\Scripts\FootstepController.cs                    1
 1  /*****************************************************************************
 2  * AUTHOR:                   Rob Stacey
 3  * CREATE DATE:              2017-2018
 4  * PURPOSE:                  Plays footstep sound effect under certain conditions when
      player is moving
 5  *****************************************************************************/
 6
 7  using System.Collections;
 8  using System.Collections.Generic;
 9  using UnityEngine;
10  using UnityStandardAssets.Utility;
11  using Random = UnityEngine.Random;
12
13  public class FootstepController : MonoBehaviour {
14
15      private bool Walking = false;           //bool for walking or not
16      public AudioSource m_AudioSource;       //audio track
17
18      // Use this for initialization
19      void Start () {
20
21      }
22
23      // Update is called once per frame
24      void Update () {
25
26
27          if (Input.GetKeyDown ("w") || Input.GetKeyDown ("up")) {    //if player is
              moving forward on keypress
28              if (Walking == true) {                                  //if walking is
                  enabled (i.e not in boat)
29                  PlayFootSteps ();                                   //play sound
30              }
31          }
32
33
34          if (Input.GetKeyUp ("w") || Input.GetKeyUp ("up")) {       //when key is
              released
35
36              StopFootSteps();                                        //stop sound
37
38          }
39
40
41          if (Input.GetKeyDown ("s") || Input.GetKeyDown ("down")) {  //when player is
              moving backwards on keypress
42              if (Walking == true) {
43                  PlayFootSteps ();                                   //play sound
44
45              }
46          }
47
48          if (Input.GetKeyUp ("s") || Input.GetKeyUp ("down")) {       //when key is
              released
49
50              StopFootSteps();                                        //stop sound
51
52          }
53
```

```
54
55      }
56
57
58      void OnTriggerEnter(Collider other){                    //when player enters
          trigger area
59          Walking = true;                                     //set walking to true
60          //Debug.Log ("Footsteps");
61          PlayFootSteps ();                                   //play sound
62
63      }
64      void OnTriggerExit(Collider other){                     //when player leaves
          trigger area
65          Walking = false;                                    //set walking to
              false
66          //Debug.Log ("Stop Footsteps");
67          StopFootSteps ();                                   //stop sound
68      }
69
70
71      private void PlayFootSteps(){                           //function for
          playing sound
72          m_AudioSource.mute = false;
73
74      }
75
76      private void StopFootSteps(){                           //function for
          stopping sound
77          m_AudioSource.mute = true;
78
79      }
80  }
81
```

Section Eight

Synaesthetic Scape 1&2

QR Codes (samples)

KC Synaesthetic Scape 1
VR journey video
Date; 19th June 2017

SK Synaesthetic Scape 1
VR journey
Date: 31st May 2017

GF Synaesthetic Scape 1
VR journey
Date: 3rd April 2017

AH Synaesthetic Scape 1
VR journey
Date: 24th May 2017

UE Synaesthetic Scape 1
VR journey
Date: 24th May 2017

Synaesthetic Scape 2
Boat going through the wall script action (video 1)
Date: 9th April 2019

Synaesthetic Scape 2 Boat going through a wall script action (video 2)
Date: 9th April 2019

Synaesthetic Scape 2
Bumping sounds of objects
Date: 9th April 2019

Synaesthetic Scape 2
Music sounds (video 1)
Date: 9th April 2019

Synaesthetic Scape 2
Ambient sounds (video 2)
Date: 9th April 2019

Synaesthetic Scape 2
Ambient Sounds (video 3)
Date: 9th April 2019

Synaesthetic Scape 2
Ambient sounds (video 4)
Date: 9th April 2019

Synaesthetic Scape 2
Ambient sounds (video 5)
Date: 9th April 2019

Synaesthetic Scape 2
Ambient sounds (video 6)
Date: 9th April 2019

RS Synaesthetic Scape 2
VR journey video
Date: 22nd January 2018

AH Synaesthetic Scape 2
VR journey video
Date: 19th January 2018

ZF Synaesthetic Scape 2
VR journey video
Date: 19th January 2018

Synaesthetic Scape 2
Ambient sounds (video1)
Date: 9th April 2019

Section Nine

How to experience Synaesthetic Scape

How to experience Synaesthetic Scape

- For a 2D Synaesthetic Scape experience (**without the use of a headset**), I recommend using the QR codes in section 8 of this appendix as follows:

1. For Synaesthetic Scape 1 experience use: KC Syneasthetic Scape 1 Journey QR code.
2. For Synaesthetic Scape 2 experience use: RS Syneasthetic Scape 2 Journey QR code.

- For a fully virtual Synaesthetic Scape experience, please use the google cardboard, bluetooth foldable keyboard (attached to this thesis) and your android smartphone, by following the steps in the next two pages [15]:

[15] unfortunately, it is not possible to use an iPhone here since the Synaesthetic Scape application is only in the google play store, I could not upload it to the apple store because the process is very complicated.

How to Use the Synaesthetic Scape Application For Androids

1 Download any QR code scanner app

QR Code Reader
TWMobile
Tools

2 Scan QR code and press “Browse Website”, this will redirect you to the application in the play store

3 Install the application

Synaesthetic Scape
Smart Delivery Lmt.
Education

4 Connect phone to the foldable Bluetooth keyboard

5 Open the application in the smartphone

6 Place the phone in the google cardboard after assembling it

7 For a better experience connect headphones and adjust the volume to your comfort

Section Ten
Ethical approval

Downloaded: 25/12/2018
Approved: 13/10/2015

Maha Al-Ugaily
Registration number: 130142698
School of Architecture
Programme: PhD Programme

Dear Maha

PROJECT TITLE: Sound Space
APPLICATION: Reference Number 005297

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 13/10/2015 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 005297 (dated 23/09/2015).
- Participant information sheet 1012212 version 2 (21/09/2015).
- Participant information sheet 1012379 version 2 (21/09/2015).
- Participant consent form 1012197 version 2 (21/09/2015).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Christie Harrison
Ethics Administrator
School of Architecture

Below I attach a copy of the new approved ethical application for the Synaesthetic Scape 1 & 2 experiments.

Cheryl Armitage <c.armitage@sheffield.ac.uk> Thu, 8 Dec 2016, 12:10

to me

Dear Maha

Thank you for your email.

I can confirm that all amended supporting documents have been uploaded to your ethics application and Nishat Awan has confirmed that she is happy with the amendments. I have spoken with our Ethics Department who are happy that the ethics approval is complete and the research work can now go ahead.

Please let me know if you have any other questions.

Regards
Cheryl

--
Cheryl Armitage
Postgraduate and Research Support Officer

School of Architecture
University of Sheffield
Arts Tower, Floor 13
Western Bank
Sheffield
S10 2TN
United Kingdom

Tel: 0114 2220351
Fax: 0114 2220315
Twitter: @SSoA_news

Section Eleven

Experiments Information sheets and consent forms

The University of Sheffield
The School of Architecture

Information sheet

Research Title: Sound Space

Name of researcher: Maha Al-Ugaily

Supervisors:
1.Renata Tyszczuk
2.Stephen Walker

I am a postgraduate student at the University of Sheffield conducting research into sound as part of my Ph.D. studies.

You are being invited to take part in this research project.
Before you decide to take part or not, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with me if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you want to participate. Thank you for reading this.

1.What is the Purpose of this study?
This is a pilot study that aims to investigate the emotional influence of music and to what extent it can be effective in the design process of Architectural spaces.

2.Why have I been chosen?
1. You are chosen because Design is your profession and you can discuss, use the tools and the vocabulary of the studied field.

2. You are one of the Public whom the study is trying to meet their emotional impressions and use those impressions as a design tool to design spaces that can reflect such emotional impressions.

3.Do I have to take part?

Your Participation in this focus group is entirely voluntary; It is up to you to be part of it or not. If you decided to take part then, you would be given this information sheet to keep, and you will be asked to sign a consent form.

You can still leave the group interview at any time you prefer, However, please note that I will record the focus group and that I will not guarantee that your part will be neglected or removed from the video, data, study analysis and results.

4.What will Happen if I take part?

First Maha will ask you individually to:

1.Listen to music (for 10 minutes in total) meanwhile Maha will be recording your facial expressions by the use of the laptop camera.

2.Watch (10 minutes in total) of four animated works (without music), meanwhile your facial expressions will be recorded, the same way as done in step 1.

3.Watch (10 minutes in total) of the same animated work but with music attached to it (the music you listened to before, meanwhile your facial expressions will be recorded, the same way as done in the prior two steps.

Later Maha will send these videos to Affectiva to use their Emotion response data service, they will process these in bulk and provide Maha with the resulting expression metrics for each participant.

I will translate these metrics to diagrams which will be the subject of the focus group held later on in this case study.

5.what are the possible disadvantages of taking part?

The only disadvantage I think of is that the focus group and the individual emotions data collected will be time-consuming. Therefore, you are free to leave whenever you like.

6.what are the possible benefits of taking part?

There are no immediate benefits to your Participation in this study; you will be offered juice and digestive biscuits for refreshment.

7.What if something goes wrong?

If you are unhappy about something that has occurred in the interview, it is important that you inform The University of Sheffield. Any complaints can be addressed to Dr. Renata Tyszczuk or Dr.Stephen Walker at The Arts Tower, The School of Architecture, The University of Sheffield, Western Bank, Sheffield, S10 2TN.

8.will be taking part of this study will be kept confidential?

The information you share in this study will be kept confidential. Furthermore, you will not be identified in any reports or publications.

9.who is organizing the study?

This study has been organized by the University of Sheffield. The researcher is working towards a Ph.D. by Design in Architecture.

Thank you for taking the time to consider Participating in the study. If you have any questions, please contact me at maaal-ugaily1@sheffield.ac.uk.

The University of Sheffield

The school of Architecture

Information sheet

Research Title: Synaesthetic Scape

Name of researcher: Maha Al-Ugaily

Supervisors:

1.Renata Tyszczuk

2.Jian Kang

I am a postgraduate student at the University of Sheffield conducting research into Virtual Reality as part of my PhD studies..You are being invited to take part in this research project.
Before you decide to take part or not it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with me if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide

Wether or not you wish to take part. Thank you for reading this.

1.Who is organising the study?

This study has been organised by the University of Sheffield. The researcher is working towards a PhD by Design in Architecture.

2.What is the Purpose of this study?

I'm working on designing a Synaesthetic Scape which is exploring a sensory environment so the purpose of this study is to test the virtual reality environment which I created with the participants to see how they experience it through different senses. that will help me assess this process of design.

3.Why have I been invited to take part?

1. You are invited because design is your profession and you can discuss, use the tools and the vocabulary of the studied field and question.

2. As an architect you may have a general interest in the sense of perception in the space.

3. You are maybe interested in developments and design tools in the future such as virtual reality.

4.Do I have to take part?

Your Participation in this experiment is entirely voluntary, It is up to you to wether you want to take part of this experiment or not .If you decided to take part then you will be given this information sheet to keep and you will be asked to sign a consent form.
You can still leave the experiment at any time you prefer.However please note that the experiment in its second stage will be audio recorded and that we will not guarantee that your recorded voice and data will be neglected or removed from the Audio, study analysis and results.

5.Where will I take the experiment?

The experiment will take place at the VR Lab in the diamond room 3.08.

The University of Sheffield

6.What will Happen if I take part?

The experiment consists of two parts :

Part one: participants who does not suffer from motion sickness will take the virtual reality experiment.

Here you will be exposed to a virtual environment wearing the oculus VR kit for around 5 minutes, during that time you'll be asked to listen to music and take a journey through the virtual environment whilst being connected to a physiological sensor that detects your physiological emotional reactions, the sensor is completely non-invasive and you'll be wearing the sensors as a wrist band.

After that you will be interviewed for around 30 minutes to discuss the sensory experience you had, listen to your own narrative of the journey regarding to the diagrams resulting from the sensor you wore. (the interview will be audio recorded).

Part two: participants who does suffer from motion sickness will take the wide screen experiment.

Here you will be shown the same virtual environment mentioned above but on a wide screen.

You will be asked to take a journey through that environment for around 5 minutes, during that time you'll listen to same music mentioned above whilst being connected to a physio- logical sensors that detects your physiological emotional reactions, the sensor is complete- ly non-invasive and you'll be wearing the sensor as a wrist band.

After that you will be interviewed for around 30 minutes to discuss the sensory experience you had, listen to your own narrative of the journey regarding to the diagrams resulting from the sensor you wore. (the interview will be audio recorded).

7.What are the possible disadvantages of taking part?

1. The experiment will be time consuming, but it will not be longer than one hour maximum including the interview.

2. Participantstakingthevirtualrealityexperimentusingoculusshouldbeawareofthe following possible discomfort and risks. (Please read attached Oculus Risk Assessment document).

3. Discomfort to do with wearing the sensore wristband.

However, in order to ensure consistent results, if you have hearing difficulties; heart and skin health conditions; are taking prescribed medication; or have mental health problems then you should not participate in this study.

8.What are the possible benefits of taking part?

It is a good opportunity to visit the VR lab and know all about this new VR technology, and it is an opportunity to discuss how this technology is used in the design process.

9.What if something goes wrong?

If you are unhappy about something that has occurred in the interview, it is important that you inform The University of Sheffield. Any complains can de addressed to Dr. Renata Tyszczuk or Dr. Jian Kang at The Arts Tower, The School of Architecture, The University of Sheffield, Western bank, Sheffield,S10 2TN.

10.Will my record kept confidential?

Information you share in this study will be kept confidential. Furthermore, you will not be identified in any reports or publications.

Thank you for taking time to consider Participating in the study. If you have any questions, Please, contact me at maaal-ugaily1@sheffield.ac.uk.

The University of Sheffield

Title of Research Project: Sound Space

Name of Researcher: Maha AL-Ugaily, Sheffield School of Architecture, The University of Sheffield, Art Tower, Western Bank, Sheffield S10 2NT

Participant Identification Number for this project:

1. I confirm that I have read and understand the information sheet/letter dated: explaining the above research project and I have had the opportunity to ask questions about the project.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline.

3. I understand that my responses will be kept strictly confidential (only if true). I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.

4. I agree for the data collected from me to be used in future research and conference papers.

5. I agree to take part in the above research project.

_____	_____	_____
Name of Participant (*or legal representative*)	Date	Signature
_____	_____	_____
Name of person taking consent (*if different from lead researcher*) *To be signed and dated in presence of the participant*	Date	Signature
_____	_____	_____
Lead Researcher *To be signed and dated in presence of the participant*	Date	Signature

Copies:
Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, the letter/pre-written script/information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be placed in the project's main record (e.g. a site file), which must be kept in a secure location.

The University of Sheffield

Title of Research Project: Synaesthetic Scape

Name of Researcher: Maha AL-Ugaily, Sheffield School of Architecture, The University of Sheffield, Art Tower, Western Bank, Sheffield S10 2NT

Participant Identification Number for this project:

1. I confirm that I have read and understand the information sheet/letter dated: explaining the above research project and I have had the opportunity to ask questions about the project.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline.

3. I understand that my responses will be kept strictly confidential (only if true). I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.

4. I agree for the data collected from me to be used in future research and conference papers.

5. I agree to take part in the above research project.

_____	_____	_____
Name of Participant (*or legal representative*)	Date	Signature
_____	_____	_____
Name of person taking consent (*if different from lead researcher*) *To be signed and dated in presence of the participant*	Date	Signature
_____	_____	_____
Lead Researcher *To be signed and dated in presence of the participant*	Date	Signature

Copies:
Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, the letter/pre-written script/information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be placed in the project's main record (e.g. a site file), which must be kept in a secure location.