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Rethinking Engagement: Transforming Space into Place via Sensing Technology

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RETHINKING ENGAGEMENT

Transforming Space into Place via Sensing Technology

by

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ABSTRACT

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The proliferation of media technologies can transform human's engagement and their sense of place with their environment, and it is important to revisit the role of architects when designing public physical places in the digital era. Juhanni Pallasmaa and Merleau-Ponty's arguments on senses, perception and movement within a space are all re-occurring themes in this design exploration. Yu-Fi Tuan's concept of transforming a space into a place is also used, especially when interacting with the space by utilizing our senses. Finally, Huizinga's ideas on what constitutes play within a space; has also been applied. This thesis aims to reconfigure a space and transform it into a place where sensing technology is used to stimulate senses to encourage the user to engage with the physical space. The advancement of digital technology in architecture has resulted in a new phenomenon referred to as interactive architecture which makes up the foundation for this thesis.

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DEDICATION

For my Mom and Dad

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- # INTRODUCTION

With technology advancing at an unprecedented rate, the infiltration of digital media and increased technologies continue to impact architecture in various ways. Whether it results in enhanced building materials or sensing technologies, one thing is for sure: digital technology has allowed architects to re-visit how architectural spaces can be created or renovated in order to enhance the user's experience within that space.

This thesis aims to create an architectural space that allows users to engage with the space by using their senses as a steering force in interacting with the space. Using highly refined sensing technologies and various case studies as a source of inspiration, the ultimate aim of the design exploration seeks to create an architectural space where users can truly see, feel, hear, taste and smell the space when interacting with the space.

Through scholarly guidance from individuals such as Merleau-Ponty, Pallaasmaa, Tuan and Huizinga, the additional objectives of the space is defined such as: promoting users to engage in a sense of play with the space, creating an augmented environment for the user who is experiencing the space while simultaneously stimulating all senses to heighten the experience. The means through which these objectives can be achieved will be done through sensing technologies that detect human presence and movement, allowing users to fully interact and engage with the space based on their presence and movement within the space. This kind of architecture is commonly referred to as interactive architecture or responsive architecture. The ultimate aim of this project seeks to transform a space into a place via the use of sensing technology that not only respond to human presence or movement, but it also stimulate our senses in light of optimizing or heightening the experience of interacting with the space.

BACKGROUND INFROMATION

Over the course of the last century, the relationship of the body and space has been reviewed by many philosophers and architects. From an architectural standpoint, the relationship of the body and bodily engagement with space can render in a meaningful space, transforming that space into a place. Yu Fi Tuan has elaborated on what differentiates a space from a place where:

> "In experience, the meaning of space often merges with that of place. Space is more abstract than place. What begins as undifferentiated space becomes place as we get to know it better and endow it with value" (Tuan, 1977, p6).

In this context, bodily engagement with a space can be invoked by stimulating our senses. This kind of engagement or stimulation of our senses has been elaborated upon through the works of Merleau-Ponty and Juhani Pallasmaa, both of whom have had a profound impact in this thesis; how senses are the steering force in terms of interaction with space, or in this case- interaction with architecture. Both Pallasmaa and Merleau-Ponty believe that in addition to our senses, there are other elements that are essential in making a space more meaningful or engaging; such as our perceptions and the need for freedom or mobility within a space. The concept of freedom or mobility within a space has been elaborated upon by Huizinga where his notion of play has been integrated into this design exploration. Huizinga states that:

> "Summing up the formal characteristics of play we might call it a free activity standing quite consciously outside 'ordinary' life as being 'not serious', but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner. It promotes the formation of social groupings which tend to surround themselves with secrecy and to stress their difference from the common world by disguise or other means" (Huizinga, 1949, p13).

Therefore, Huizinga's definition of "play" constitutes something that is informal, and something that is done at the will of the user who engages in play. In this design exploration, I have demonstrated how architecture can be used to create spaces that are meaningful where our senses are stimulated to engage in the physical space and engage in playful acts within the

architectural space. This is all done by utilizing "sensing technologies"[1] and digital media to heighten the experience that an individual goes through when engaging with a space.

In this project, the body integrating with a given physical space through its senses is essential in creating a meaningful space for that user. The human senses are what make the experience exciting and the space playful. For example, when a blind person enters a room, he/she could experience the space only through their sense of smell and touch giving way to how an individual can rely on their senses to create spatial awareness in terms of depth, texture and even spatiality of a space. This concept led me to consider the different ways in which space can be transformed into a place utilizing technology to stimulate all our natural senses so that we can truly feel, see, hear, smell and taste a space.

While technology continues to rapidly penetrate every aspect of our lives, sensing technology in architecture also continues to rise where we see many architects such as Dan Roosegaarde, Dan Argoyle and Cameron McNall utilizing sensing technology to create highly interactive architectural spaces. The Piano Stairs (Figures 1, 2 and 3) is a great example in this case. The project clearly demonstrates the ways of how sensing technology installed in staircases can transform the structure into something unique and fun which encourages more playful interaction with the structure. This particular sensing technology uses different piano notes and creates different sounds by the traveler's touch as they walk on each step. This kind of technology has rendered in the stairs being more engaging, where perhaps the travelers are more inclined to take the stairs instead of the escalator. (See figure 4 and 5)

Figure 1: Piano Stairway before installing the piano installation

[1]Sensing technology is a technology that uses sensors to detect human movement in the physical space and heighten their senses.

Figure 2: Piano stairway installing process

Figure 3: Piano stairway installing process

Figure 4: Piano stairway after installation

Figure 5: Piano stairway after installation

Throughout my thesis, I will refer to different case studies to illustrate the above mentioned points. Some case studies presented by Studio Roosegaarde, present numerous ways in how sensing technology can be incorporated into an architectural space which renders in a more meaningful physical space. The selected case studies, encourage human engagement within an architectural space; transforming the space into a place. For my own design exploration, I use similar sensing technologies to encourage or promote more human involvement, interaction and engagement with the space. My investigation begins by reviewing different sites that can be considered "placeless"[2].

I examined various different ways of how interactive technologies can be incorporated into these spaces and transform it into a place of social interaction and physical movement (play). For this thesis project, a place will be designed where our senses are the primary mode of interaction within the given architectural space, which not only promote social interaction and play, but it also creates a special kind of spatial awareness for the user who engages with the space subsequently creating an almost "augmented environment"[3].

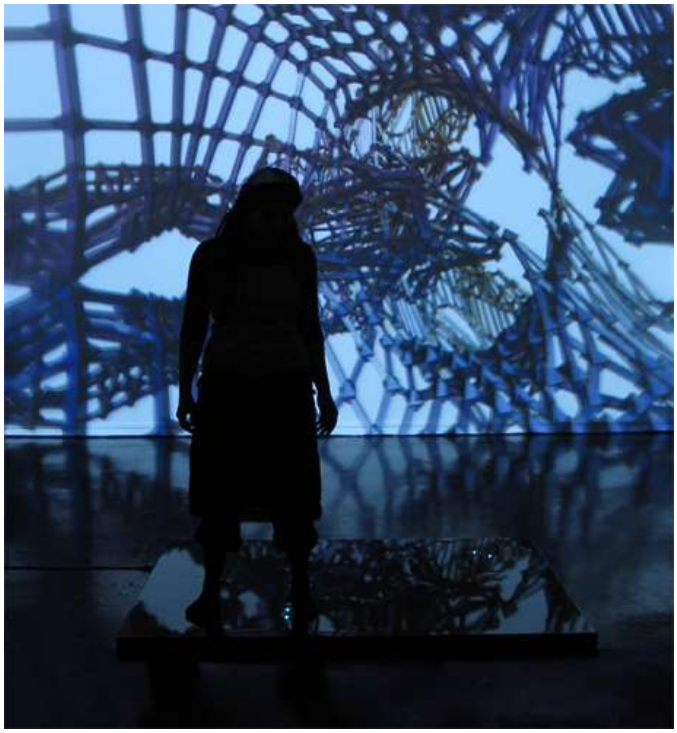


Figure 6: Conscious Space 01 project that shows the augmented environment.

[2] Sites that have no attached meaning to it as they are transitional spaces such as an underground pathway or airport corridor that act as a transition point from one point to another.

[3] The augmented environment is a built environment that coexists with layers of information and media content.

The theories presented by Pallasmaa, Merleau-Ponty, Huizinga, and Tuan have been integrated to result in a space that is highly engaging and instills a sense of play in the user who engages with the physical space. Technology in this sense is used to amplify the experience in the physical public realm. This thesis will essentially demonstrate how a transformation of the pathway into a play area and Café can encourage our sense of place and promote engagement between people, other users and the given architectural space. In the play area and café, my intent is to anchor people within the space through their senses by utilizing sensing technology. Users are encouraged to engage with their surrounding environment by testing different interactive play installations that are activated using human senses. Whether it is an interactive wall, interactive floor or interactive tables; these three sensing technologies are the direct response to my research in terms of creating a meaningful architectural space.

This thesis will also demonstrate how interactive architecture can instill a feeling in the user who is engaging with the space, where he/she is left better off than before they engaged with the physical space.

PROBLEM STATEMENT

The ultimate goal of this thesis seeks to transform space into architectural place by using sensing technology in order to encourage engagement and social interaction in the current underground pathway located at Yonge and Dundas in Toronto. This place is currently considered a transitional space as it is used as an alternative pathway by commuters and workers in the downtown core to get from one destination to another.

After researching the concept of our senses, perception and the human body's relationship with a specific space or environment through the writings of Juhani Pallasmaa and Merleau-Ponty, where human senses are the steering force behind ultimate engagement with a space or environment; however, it is important to point out how this relationship has changed over time as Meyrowitz also notes that:

> "Evolution in media…has changed the logic of the social order by restricting the relationship between physical place and social place and by altering the ways in which we transmit and receive social information" (Meyrowitz, 1985, p308)

The rapid advancement of new technologies such as virtual reality and digital simulation in architecture can assist humans to engage with their surroundings and establish a sense of place. This ideology forms the basis of this thesis and design exploration and in interpreting this concept; it becomes very important for architects to revisit their role in designing an architectural place that promotes engagement and social interaction in a placeless environment.

For this thesis, I intend to design a place that harbours the teachings of Juhani Pallasmaa, Merleau-Ponty, Huizinga, and Tuan by utilizing sensing technology. Sensing technology in this respect is technology that uses multiple modes of sensors to heighten human senses and creates an augmented space. I believe this integration can intensify and amplify the experience of the physical space that a user undergoes. The project will examine aspects of changing social interaction and spatial perception by evaluating different case studies that have successfully promoted users to engage with their surroundings and architectural space. This project will investigate our sense of place in the physical realm in the new digital era and also emphasize that as technologies continue to evolve, the way in which users engage with a space will also continue to evolve.

A thorough analysis of the underground path network will also allow me to speculate the different possibilities for social interaction and create an augmented environment that heightens social and place engagement. Sensing technology is the vector that is used to create an augmented environment, and it is done in a way that stimulates our senses to instigate the

primary interaction with the place. The thesis will demonstrate how sensing technologies can be beneficial in allowing users to establish a sense of place in this newfound digital era and how these technologies can assist in transforming a space into a place. In other words, the concept is to alter space into an architectural place via sensing technology to encourage engagement and create attachment to the place. Meyrowitz differentiates between space and place by asserting that:

> "the word 'sense' and the word 'place' have two meanings each; 'sense' referring to perception and logic; 'place' meaning both social position and physical location" (Meyrowitz, 1985, p308).

By using this concept of "place", I will demonstrate in my thesis how the transformation of the pathway into a play area and café can create a sense of place for users where my intent is to anchor people within the space with their sense using sensing technology and subsequently transform this space into a place as Meyrowitz has discussed above. This is done by testing different interactive play installations that are activated through various human senses

Therefore, sensing technology is also used in this design exploration to reconfigure the space into a place of heightened social interaction and bodily movement, and ultimately re-visit my role as an architect to re-think the concept of engagement in the public physical space in the digital era.

PROJECT GOALS

The goal is achieved through the following:

- Investigating the sense of place in the physical public realm in the digital era.
- Understanding the relationships between the human body and its senses and the physical space.
- Speculating about the possibilities of social and perceptual ideas.
- Demonstrating how new sensing technologies can assist to transform space into place.
- Introducing different programs to show how architecture and engaging senses with the space can change the experience of the public physical space and turn it into a meaningful place for a user.

- **CHAPTER 1:** JUHANI PALLASMAA and MERLEAU PONTY’S IDEAS

The foundation for this design exploration stems from the theoretical teachings of Juhani Pallasmaa (figure 7) and Maurice Merleau-Ponty (figure 8), where both individuals have had a significant influence in architectural theory and my design exploration in terms of how the human body experiences space through its natural senses. Their theories touch base on the body and how bodily engagement with space can render a meaningful space that allows for a multi-sensory experience. The term “multi-sensory” in this respect is referred to how multiple senses can be stimulated in order to heighten the body’s experience with a given space. In addition to how the body experiences space using simultaneous senses, Merleau-Ponty and Pallasmaa also emphasize that our perceptions have a great role in how we experience or enhance our experience with space. “Perception” in this regard refers to visions or memories created in our minds from previous experiences in dealing with a particular object by using one or more of our senses. For example, the smell of coffee may invoke memories of a pleasant café experience, invoking for a more pleasant or memorable experience with the space.

These common lines of thought from both theorists have greatly shaped the focus of my design exploration. The following sections seek to briefly summarize some of their teachings and will conclude on how their work have influenced this design exploration and inspired me to re-think the concept of engagement.

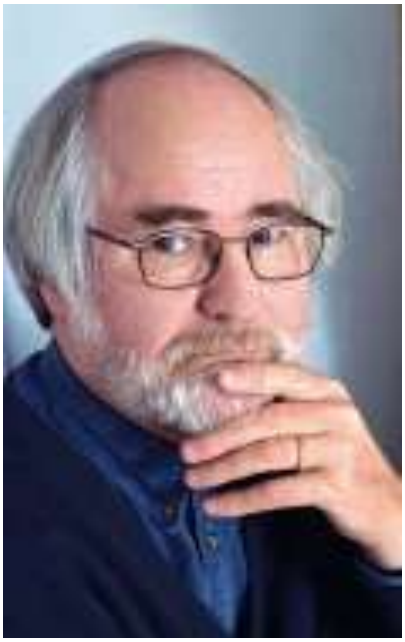


Figure 7: Juhani Pallasmaa

Figure 8: Maurice Merleau-Ponty

1.1 Juhani Pallasmaa's Ideas about Perception of Space

Finnish architect Juhani Pallasmaa emphasizes that experiencing architecture should be a multi-sensory process. Pallasmaa believes that:

> "Qualities of matter, space and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton and muscle" (Pallasmaa, 2005, p.28).

Essentially, Pallasmaa believes that our senses have a significant impact in the way we experience space, which is an expanded view from the traditional visual experience of architecture. While traditional visual experiences of architecture deal primarily with our sense of sight, Pallasmaa instead focuses on a multi-sensory interaction with space. According to Pallasmaa:

> "Architecture strengthens…one's sense of being in the world, essentially giving rise to a strengthened experience of self" (Pallasmaa, 2005, p.28).

Therefore experiencing architecture in this aspect is a multi-component process which is steered by our various senses, rendering in what is referred to as the sensory experience. Pallasmaa notes that:

> "Sensory experiences become integrated through the body, or matter, in the very constitution of the body and the human mode of being" (Pallasmaa, 2005, p.28).

Therefore, our senses are what primarily guide us in experiencing space. With regards to this design exploration, senses are what guide users in experiencing a space. As Pallasmaa's principle concept of biological senses and elaborates on the sense of sight, sound, smell, taste and feel and how it can be used to experience space. He refers to how the sense of touch (Figure 9) allows an individual to gain a sensation of:

> "weight, resistance and three-dimensional shape of material bodies and thus makes us aware of things extending away from us in all direction" (Pallasmaa, 2005, p.42)

Figure 9: Slow Furl Installation/ showing how touch sense interacting with architecture

With respect to the sense of smell, Pallasmaa believes that: (Figure 10)

“A particular smell makes us unknowingly re-enter a space completely forgotten by memory; the nostrils awaken a forgotten image, and we are enticed to enter a vivid day dream” (Pallasmaa, 2005, p.54), and that

“The nose makes the eyes remember” (Pallasmaa, 2005, p.54).

The sense of taste is touched upon as well, where

“There is a subtle transference between tactile and taste experiences” (Pallasmaa, 2005, p.59)

Figure 10: Slow Furl Installation/ showing how a person engaging with architecture with smell sense.

Also, he discusses the importance of the sense of taste where:

“the most archaic origin of architectural space is in the cavity of the mouth” (Pallasmaa, 2005, p.59).

Therefore when experiencing architectural space, it is possible to have a multi-sensory experience when physical space is experienced through our stimulated senses, so we can truly see, breathe, smell, feel and hear the space. Additionally, he also states that:

“our body and movements are in constant interaction with environment, the world and the self - informed and redefine each other constantly” (Pallasmaa, 2005, p.40).

This realization and engagement with the space is also a sequential experience where we are first guided by our senses, and encouraged to interact with the physical space through movement and interaction to gain depth and spatiality of the physical space.

Pallasmaa also focuses on the importance of action and movement in experiencing physical space, and how this forms certain perceptions within oneself as to how the space really

exists or is experienced. These perceptions enhance multi-sensory engagement since the body is no longer static; but rather dynamic. Pallasmaa notes that:

> "A building is encountered; it is approached, confronted, related to one's body, moved through, and utilized as a condition for other things. Architecture directs scales, and frames actions, perceptions and thoughts" (Pallasmaa, 2000, p.60).

While Pallasmaa emphasizes that the relationship between the body and space is a multi-sensory experience, where a person engages with the space through the mind, senses and perception; he also believes that this intricate relationship requires movement or interaction with the physical space in order to heighten the experience. Contrary to popular theories, Pallasmaa has created an anti-orthodox approach to architectural theory, where the emphasis lays more on a haptic experience in understanding architecture by virtue of each detail as it affects the body as a whole. Overall, the multi-sensory experience in architecture is further elaborated by Pallasmaa where:

> "Instead of mere vision, or the five classical senses, architecture involves several realms of sensory experience which interact and fuse into each other." (Pallasmaa, 2005, p.41).

With regards to the context of this design exploration, Pallasmaa's definition of space is what becomes architectural space and will be elaborated on in section 1.3.

1.2 Maurice Merleau-Ponty's Ideas about Perception of Space

French philosopher Maurice Merleau-Ponty has had a significant influence in the foundation of this design exploration, where he places great emphasis on the relationship between the body and the world (environment). His ideas in my design exploration expand upon Pallasmaa's emphasis on the importance of the body, senses and movement; where he places even more emphasis on the importance of our perceptions in experiencing the world. Monika Langer wrote a guide and commentary on *Merleau-Ponty's Phenomenology of Perception*. In a summary of Merleau-Ponty's thoughts on the perception of space, Langer translates Merleau-Ponty's work and states that:

> "Perceived world has emerged as a pole of bodily experience, and since the subject has recovered its body, the vital connection between body-subject and world has already implicitly been re-esatablished." (Langer, 1989, p 70).

With regards to my design exploration, the world or environment that is referred to in Merleau-Ponty's work is what I consider architectural space. Langer also maintains that Merleau-Ponty believes that people experience space through perceptions in that:

> "The structure of the phenomenal body already implies the structure of the entire perceptual field. It remains for us to suspect our traditional detached knowledge of the thing and the world in order that we may become aware of our actual perceptual experience" (Langer, 1989, p71).

Merleau-Ponty maintains that perception is the foundation for experience and that perception guides every conscious action. From an architectural standpoint human consciousness also gives meaning to experiencing space. In addition to Merleau-Ponty's view on perception of space, or in this case architectural space, Merleau-Ponty emphasizes on our senses, how they are embodied with us, how we experience the world, and how they give a way to unending exploration.

> "By virtue of having a body, we are already in possession of sensory fields – that is, we open onto a sensible world within whose horizons all particular sensory givens are located, lending themselves to unending exploration" (Langer, 1989, p74).

He also places emphasis on the act of sensing, where he commonly distinguishes amongst different senses:

> "We commonly distinguish among the different senses, relegating vision to the eyes, audition to the ears, olfaction to the nose, taste to the taste buds of the tongue, and touch primarily to hands" (Langer, 1989, p74).

Therefore, the importance of senses is tied back into my design exploration as it is a primary component considered by both Pallasmaa and Merleau-Ponty. However, the sensory experience that Merleau-Ponty refers to includes our perceptions as well as how they have a shaping role to play in how we experience the world:

> "Sensory experience is foreign to natural perception and inherently unstable, insofar as how it requires an extremely particularized approach to experience the senses separately or to make a definite sensible quality stand out from the perceptual field" (Langer, 1989, p 77).

Finally, Merleau-Ponty also ties in our senses to spatial existence or awareness. He believes that our multiple modes of sensing or senses, allow us to define our spatiality and the objects that exist in space; whether it's their depth, texture or weight.

> "Consequently, the senses are all spatial since they provide access to objects; moreover, each sense opens onto the same all-embracing space. The absence of such a common space would preclude the plentitude of the object – and hence, it's very being as an object for consciousness" (Langer, 1989, p75).

Merleau-Ponty believes that "space can be considered part of the real world" (Langer, 1989, p80), yet that the traditional notion of space:

> "will need to be rethought, and that the unity of experience can no longer be considered to lie 'out there' or 'in here' but must, rather, originate in that dynamic relationship between body subject and world through which 'objects' and 'subjects' come into being for us" (Langer, 1989, p80).

Merleau Ponty's beliefs on senses, perception and space are included in this design exploration because his ideas also expand further on the importance of Pallasmaa's concept of experiencing space or architectural space. As he further elaborates on Pallasmaa's view on the importance of our body in experiencing space:

> "the experience of our own body teaches us to embed space into existence" (Merleau-Ponty, 1962, p.171).

He also elaborates on how we connect objects in space and how we derive meaning of space where:

> "Space is not the setting (real or logical) in which things are arranged, but the means whereby the position of things becomes possible. This means that instead of imagining it as a sort of ether in which all things float, or conceiving it abstractly as a characteristic that they have in common, we must think of it as a universal power enabling them to be connected" (Merleau-Ponty, 1962, p. 284).

Figure 11: Interactive Floor – World Expo 08 Zaragoza, Spain- interaction between the body and architectural space.

Furthermore, the end result experience he refers to when experiencing the world around him, renders in a meaningful place; a space that the user has attached meaning to. In this regard, both Pallasmaa and Merleau-Ponty have elaborated on how we can give meaning to physical space through virtue of our senses, perceptions, sensory experience and movement. This core concept is what is being demonstrated throughout the course of my design exploration. The following section will describe how both Pallasmaa and Merleau Ponty's ideas are rooted even further into my design exploration.

1.3 Pallasmaa and Merleau-Ponty on Re-Thinking Engagement Design exploration

As indicated earlier, Pallasmaa and Merleau-Ponty's theories have had a significant influence in this design exploration. Both theorists agree that experiencing space should be a meaningful experience, and they have emphasized on the importance of our body, senses and perception with regards to experiencing space. Their notions of space or the world is what I regard as architectural space throughout this design exploration. Pallasmaa and Merleau-Ponty also gave meaning to the way in which we experience physical space, where both have placed great emphasis on the way our senses guide us to not only truly experience or feel the space, but to also how they can give a way to a truly heightened and sensory experience that allow us to truly see, hear, feel, smell and taste the space.

These common visions shared by both theorists have steered me to creating a space that allows an individual to re-think engagement and fully immerse their senses and body movements to experience various objects or components of the space. Essentially, what both Pallasmaa and Merleau-Ponty have influenced in my design exploration is how our senses are used to experience the space and then used to transform that space into place (this concept will be elaborated in the next chapter). The newly transformed place is one which has meaning or value attached to it by the user. This causes the user to re-think engagement because engaging with architectural space now entails being guided by our senses instead of by our traditional visual approach to architecture.

- **CHAPTER 2:** SPACE, PLACE AND PLAY

2.1 Space and Place

Merleau-Ponty argues that space is experienced through the human body and that subsequently, we attach meaning to a space through our senses, movement and perception. Juhani Pallasma also contends that a space can be meaningful to an individual if the space is created in such a way that engages the individual to interact with the space. Essentially, both theorists have found a way to transform space into place – which is essentially a space with meaning or value attached to it by the user.

Yi-Fu Tuan is a famous Chinese-American Geographer who further emphasizes the difference between space and place:

> "Space and Place are familiar words denoting common experiences. We live in space. There is no space for another building on the lot…place is security, space is freedom: and are attached to the one and long for the other" (Tuan, 1977, p3)

In his work *Space and Place: The Perspective of Experience*, Tuan maintains that space becomes a place when individuals familiarize with a specific location and through this, time allows the individual to give that place value and meaning. In this regard, place is a type of object which in effect defines space - making it a meaningful place filled with value. He elaborates more on the difference between space and place using animals as an example where:

> "Recent ethological studies show that nonhuman animals also have a sense of territory and of place. Spaces are marked off and defended against intruders. Places are centers of felt value where biological needs, such as those for food, water, rest and procreation, are satisfied". (Tuan, 1977, p4)

Therefore there is a sense of "need" that exists in a space. This concept of space transforming to place is another theme that is present throughout the course of my design exploration, where the ultimate goal of the design seeks to turn a regular space into a place that has resulted in a user using their senses, perception and movement in order to experience the space.

While space and place are two different concepts, Tuan believes that space and place are both mutually independent yet dependent on each other.

> "The ideas space and place require each other for definition. From the security and stability of place we are aware of the openness, freedom, and threat of space, and vice versa. Furthermore, if we think of space as that which allows movement, then place is

pause; each pause in movement makes it possible for location to be transformed into place" (Tuan, 1977, p.6)

While Merleau Ponty and Pallasma have previously focused on the role perceptions play in giving a space value and meaning, Tuan believes that:

"Experience is a cover-all term for the various modes through which a person knows and constructs a reality. These modes range from the more direct and passive senses of smell, taste and touch to active visual perception and the indirect mode of symbolization" (Tuan, 1977, p.8).

Therefore, a perception is created within the individual while experiencing the space or becoming familiarized with the space – and the best way to do this is to create a space that is highly engaging and where movement is a required element in order to experience the space. Tuan also places emphasis that our senses play a significant role in so far as how it shapes user's experience in transforming a space to a place: (see figure 12)

"An object or place achieves concrete reality when our experience of it is total, that is, through all the senses as well as with the active and reflective mind. Long residence enables us to know a place intimately, yet its image may lack sharpness unless we can also see it from the outside and reflect upon our experience" (Tuan, 1977, p.18).

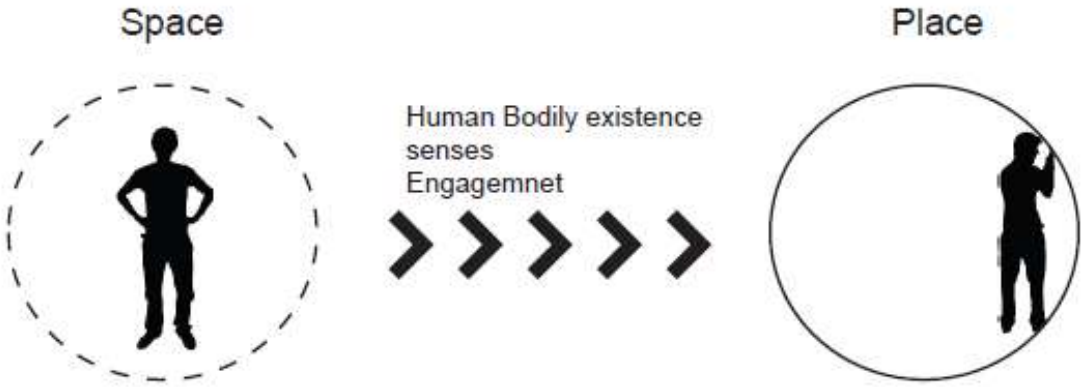


Figure 12: Transformation of space into place diagram

Furthermore, he suggests that space becomes place when the particular individual becomes familiar with the place via experiences with the space using mental imagery. Under these circumstances, the freedom of mobility can then have a great impact on the process of "place-making" for an individual. Therefore, movement or mobility within a space creates particular perceptions in an individual when experiencing the space and essentially engages the user. For this reason, the concept of including movement as a mechanism to experience the space in an engaging way is a common theme throughout my design exploration.

> "Space is experienced directly as having room in which to move. Moreover, by shifting from one place to another, a person acquires a sense of direction. Forward, backward, and sideways are experientially differentiated, that is, known subconsciously in the act of motion. Space assumes a rough coordinate frame centered on the mobile and purposive self" (Tuan, 1977, p.12).

Movement has a great role in making the space meaningful and in creating an experiential space and engaging a user with the space. With regards to this design exploration, Tuan's focus on movement within a space is what is used to engage the user in an architectural space to create an experiential space that transforms into a place with the help of senses and perception.

Further elaborating on human senses, Tuan states that:

> "Like the intellectual acts of seeing and hearing, the senses of smell and touch can be improved with practice so as to discern significant worlds. Human adults can develop extraordinary sensitivity to a wide range of flower fragrances" (Tuan, 1977, p.10).

Tuan is of the belief that odors themselves lend:

> "character to objects and places, making them distinctive, easier to identify and remember…as odors are important to human beings" (Tuan, 1977, p.10).

With regards to the human sense of sound – it can invoke spatial impressions. Tuan uses an example where:

> "The reverberations of thunder are voluminous; the squeaking of chalk on slate is 'pinched and thin'…spatial illusions are created in music quite apart from the phenomenon of volume and the fact that movement logically involves space" (Tuan, 1977, p.14).

With respect to the sense of touch – he states that touching and manipulating objects with your hands yields in an enhanced sensory experience as well where:

> "reaching for things and playing with them disclose their separateness and relative spacing"(Tuan, 1977, p.12).

Tuan emphasizes that purposive movement, perception and sensory experiences collectively allow an individual to undergo both a visual and haptic experience within a space – and with respect to this design exploration, it is this field that transforms space into place. Place according to Tuan is also regarded as a special object – where it is a:

> "concretion of value, though not a valued thing that can be handled or carried about easily; it is an object in which one can dwell. Space, we have noted, is given by the ability to move….hence space can be variously experienced as the relative location of objects or places, as the distances and expanses that separate or link places – and more abstractly – as the area defined by a network of place" (Tuan, 1977, p.12).

Through his many examples, Tuan has demonstrated how people think and feel about space and on the same parallel, how we form similar attachments to space (which inevitably become a place). It is the same way in which we form attachments to our home, neighborhood, sports team or even nation – all of which whose only limitation is time. With regards to this design exploration, Tuan's notion of engaging with spaces so they become meaningful or a "place" is further elaborated in my design exploration by incorporating an act of play in the space.

While Tuan has vocalized the importance of mobility in creating an attachment to a specific space - the next section will now focus on how mobility of movement is paralleled to the concept of "play" in this design exploration and how the act of play has been integrated as a way to experience the space. This subsequently further enhances the value or meaning that the user associates with that space.

2.2 Play

Maria Lorena Lehman who was awarded with Harvard University's *Digital Design Prize for Most Creative Use of Digital Media In Relation To The Design Profession stated that:*

> "While it is good to always assess the more serious sides to architectural or occupant problems, do not underestimate the power of incorporating "play" in your design. If done correctly, in an elegant and ingenious manner, the element of play will take you and your occupants far as it has the power to help your architecture better connect with its occupants — thus increasing its power to better be able to *help your occupants*." (Lehman, M. 2011. Sensing Architecture retrieved on Oct 12, 2011 from http://sensingarchitecture.com/7195/a-new-spin-on-sense-technologies-can-boost-your-designs-effectiveness/).

While Lehman has emphasized the importance of play in architectural design and how it can guide users to engage with their space, it becomes worthwhile to further investigate the characteristics and importance of play in so far as how this concept is embedded in humans so that architects can better understand the needs that play serves.

Johan Huizinga is a renowned anthropologist on the concept of play and his principles has been used as an authoritative source on this subject matter for this thesis project. His definition of play in this design exploration stems from his book *Homo Ludens.* Huizinga begins to explain what play is by asserting that even animals have an innate notion of play instilled within them.

> "Animals play just like men. We have only to watch young dogs to see all the essentials of human play are present in their merry gambols. They invite one another to play by a certain ceremoniousness of attitude and gesture. They keep to the rule that you shall not bite, or not bite hard, your brother's ear. They pretend to get terribly angry. And- what is most important- in all these doings they plainly experience tremendous fun and enjoyment." (Huizinga, 1949, p1)

Therefore in this regard, the concept or notion of play is something that is instilled deep within us and can be compared to an animal instinct which we cannot deny. For this reason, play is considered natural for the purpose of this design thesis. To further this point, Huizinga also states that play is a concept that has been long standing since the beginning of time where:

> "Play is older than culture, for culture, however, inadequately defined, always presupposes human society, and animals have not waited for man to teach them their playing." (Huizinga, 1949, p 1)

Therefore his concept of play is not only inherent within us and been a long standing feature in humans and animals but it is also natural. In addition to play being natural and inherent, Huizinga also believes that play cannot be denied:

> "Any thinking person can see at a glance that play is a thing on its own, even if his language possesses no general concept to express it. Play cannot be denied. You can deny, if you like, nearly all abstractions: justice, beauty, truth, goodness, mind, God. You can deny seriousness, but not play" (Huizinga, 1949, p.3)

In the above quote, Huizinga's emphasis on the fact that we cannot deny play further enforces the natural and inherent characteristics of play. Therefore for the above mentioned reasons I believe that instilling an element of play in architectural design is something that will naturally incline the user to engage with the space, as humans are biologically and inherently susceptible to play.

While establishing that play is natural, Huizinga also attempts to define what play is by stating that it could be regarded as a form of "vital energy" or "need for relaxation".

> "The numerous attempts to define the biological function of play show a striking variation. By some, the origin and fundamentals of play have been described as a discharge of superabundant vital energy, by others as the satisfaction of some 'imitative instinct', or again as a simply a 'need' for relaxation" (Huizinga, 1949, p.2)

The concept that there is a "need for play" further elaborates Huizinga's thought that play cannot be denied. Therefore this was another reason that play was integrated into this design exploration because play can feed a human need and in this case it can be considered as a need for relaxation. This leads me to Huizinga's next point of influence in this design exploration where there is a fun element to play:

> "Nevertheless it is precisely this fun-element of that characterizes the essence of play" (Huizinga, 1949, p.3)

Using the piano stairs as an example, the element of fun was brought into this installation where the stairs resembled piano keys and prompted users to use the stairs instead of the escalators.

Huizinga also formalizes the essential characteristics of play by outlining that play is primarily a voluntary activity, and that it can be deferred or suspended at any time; therefore, it is not a task, it is done at leisure by our own will. In this context, play is freedom.

> "First and foremost then, all play is a voluntary activity. Play to order is no longer play: it could at best be but a forcible imitation of it. By this quality of freedom alone, play marks itself off from the course of the natural process." (Huizinga, 1949, p.7)

“Play can be deferred or suspended at any time. It is never imposed by physical necessity or moral duty. It is never a task. It is done at leisure, during ‘free time.’” (Huizinga, 1949, p.8)

“Here, then, we have the first main characteristic of play: that it is freedom is in fact freedom.” (Huizinga, 1949, p8)

In this design exploration, the concept of play in this regard promotes users to freely engage with the space without any limitation. The choice is theirs to make, whether to choose the pathway or not. But when integrating the concept of play into this design, the freedom that is associated with the play is another way of luring users to engage with the space.

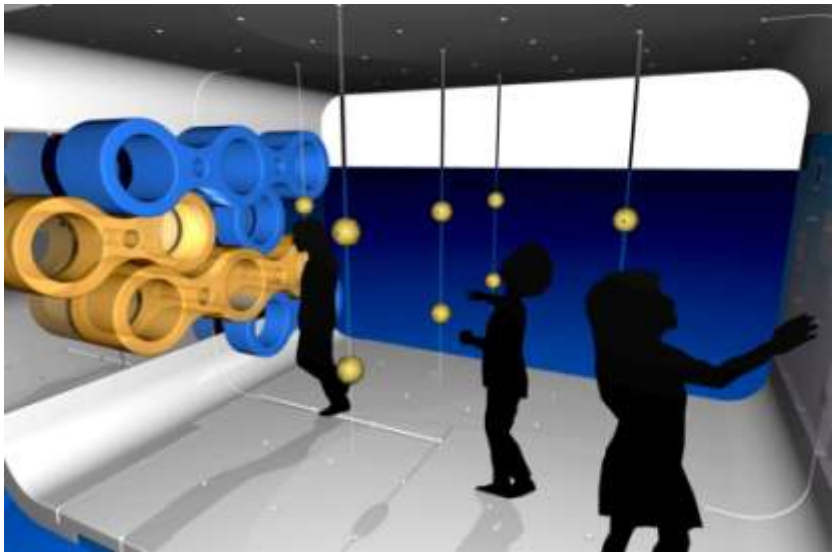


Figure 13: Magi by Anjalika Bose/ An interactive playing area

Another characteristic of play is that it essentially allows a user to step outside the realm of their real world – and engage in an act that removes them from their existing reality. The act of play is distinct from the real world and occurs in a given space.

“A second characteristic is closely connected with this, namely, that play is not ‘ordinary’ or ‘real’ life. It is rather stepping out of ‘real’ life into a temporary sphere of activity with a disposition of all its own. Every child knows perfectly well that he is ‘only pretending’, or that it was ‘only for fun’.” (Huizinga, 1949, p.8)

"Play is distinct from 'ordinary' life both as to locality and duration. This is the third main characteristic of play; its secludedness, its limitedness. It is 'played out' within certain limits of time and place. It contains its own course and meaning" (Huizinga, 1949, p.9)

With respect to this design exploration, architectural space that engages users in an act of play allows users to remove themselves from their real world momentarily while they are in a transition space. While Huizinga maintains that play creates a sense of order, he also maintains that it is an activity that bears no material interest, and that no profit can be gained by it (Huizinga, 1949). Therefore, there is no material benefit when engaging in an act of play allowing the act to be one which is left totally to the will of the user as to whether he/she wants to engage in the act of play.

Huizinga also believes that play can aid as a form of social construction:

"We shall not look for the natural impulses and habits conditioning play in general, but shall consider play in its manifold concrete forms as itself a social construction". (Huizinga, 1949, p4)

Huizinga's concept of play in promoting social interaction is of particular importance to this design exploration because play in this regard is used to encourage users to not only interact with the installation and their environment but to also with each other. This is very important in this design exploration because the underground pathway is a place where people are generally in a hurry to get to their destination and a place where people are not in the mood to mingle with each other. Therefore by inserting this program into this transitional space, it is a way of promoting intermingling amongst users and ultimately increasing social interaction within the place.

Figure 14: P.S.1 by BIG Architects/ Showing a play as a social ground

The concept of play that Huizinga presents in *Homo Ludens* is demonstrated throughout this design exploration. It is a common element within the architectural space presented, where

users go through a multi-sensory and meaningful experience when experiencing and interacting with the space and by virtue of their senses, perceptions and in this case movement which is now replaced by an act of play. The next chapter will explore how sensing technology aids in creating a meaningful space in order to aid a user's senses, perception, and sense of play in integrating or interacting with a space to transform it into a place.

- **CHAPTER3:** SENSING TECHNOLOGY AND CASE STUDIES

3.1 Interactive Architecture

The 21st century has brought about many technological changes, which have revolutionized not only various industries and trades, but especially in the way architects are able to create engaging spaces that are designed to instigate movement and interaction by the incumbent within the space. “The prevalence of technology and digital media now in architecture are pooled to aid interaction utilizing technology as a tool for ‘exchange, cohesion and communication’”. (Bullivant, 2005, p.4). With regards to installations and public art, interactive spaces and structures can now allow for interaction with architectural spaces based on sensory technology that respond to bodily presence.

This kind of architecture is sometimes referred to as Interactive Architecture. Michael Fox and Miles Kemp define interactive architecture in the book *Interactive Architecture*, as a *“*vision for the future through contextualizing and understanding the current landscape of projects and trends in IA, and its integration of new emerging technologies. The current landscape of interactive space is built upon the convergence of embedded computation (intelligence) and a physical counterpart (kinetics) that satisfies adaptation within the contextual framework of human and environmental interaction*”(2009, p.7). Interactive Architecture* is also simultaneously referred to as “responsive architecture”, where kinetics and embedded computation merge in architectural form with a focus on creating spaces that require human and environmental engagement. This circular interaction can be viewed as a conversation where there is continuity in the exchange of information between a user and the architectural space (Fox and Kemp, 2009). Interactive architecture through the aid of interactive technologies such as sensing technology is used throughout the course of this design exploration, in so far as how users experience a space, and are able to transform that space into a place. This is done by encouraging engagement with the space through an act of play (as was described in the preceding chapter) which are steered by stimulating our senses.

Marcos Novak is a renowned architect who originated various concepts in architectural theory such as “transarchitectures”, “transvergence”, “transmodernity”, navigable music and liquid architectures, all of which utilize a revolutionary form of technology that promotes an individual to interact and engage with the space. His concept of transactive intelligence outlines that this form of architectural intelligence interacts and transforms both the user and the space. Therefore, the end product renders in a space that allows for an optimal existential space that makes an individual question the state and intent of the constructed space. The rapid advancement of technology, now steers users away from traditional questions such as “what is

that building" or "how was this made" and instead pose questions such as "what does that building do?". (Novak, 2001)

Michael Fox and Robert Miles Kemp have both been commissioned on various projects that use technology to create unique design spaces that cause users to interact with their space. Their projects are known to not only facilitate interaction between users but also promote continuous participation within the confined space. The re-occurring focus of their design is to create spaces where individuals respond to the environment using human stimuli – in this case senses. They are both of the belief that the primary question to be considered when engaging in a space is what can this space do instead of what is this space or how was this space built, following the theories of Marcos Novak. While they acknowledge that individuals' response stimuli will vary depending on the evolving environmental, individual and social needs, the ultimate goal of their designed space is to invoke participation and engagement. They used various techniques, including recreating dynamic spaces and objects which hold great potential in instigating and conducting a range of functions. Their multi-faceted goals of physical interaction with "space are made possible by the creative fusion of embedded computation (intelligence) with a physical, tangible counterpart (kinetics)" (Fox and Kemp, 2009, p58).

By utilizing various high-tech techniques such as CNC[4], fabrication, sensory technology, physical modeling, virtual modeling, prototyping and robotics, physical computing, engineering and computer programming, their projects render in spaces that are highly optimized for physical interaction and movement by virtue of humanistic senses. For this reason, their spaces are also referred to as responsive or intelligent environments, soft space or smart architecture, where a plethora of digital media is used to optimize the experience. (Fox and Kemp, 2009) These highly intelligent spaces are a source of inspiration for this design exploration – as the spaces themselves are capable of instigating movement (play) and even social interaction within the space, turning the space into a meaningful place or a place of value.

Renowned theorist and visionary architect Maria Lorena Lehman who was awarded with Harvard University's *Digital Design Prize for Most Creative Use of Digital Media In Relation To The Design Profession* in 2004 also emphasizes the importance of technology in enhancing architectural space. Lehman states that new technologies continue to penetrate architectural design, and the rate of change in technology continues to affect architectural design at an even more rapid pace, especially with respect to what architectural space can do for users. Emerging

[4] "The abbreviation CNC stands for computer numerical control, and refers specifically to a computer "controller" that reads G-code instructions and drives a machine tool, a powered mechanical device typically used to fabricate components by the selective removal of material."(Wikipedia. 2011. Wikipedia on CNC. Retrieved on November 7th, 2011 from http://wiki.answers.com/Q/What_does_cnc_stand_for_as_in_cnc_machine)

technologies such as smart technology, nanotechnology and sensing ubiquitous computing technologies with their:

> "Goal oriented approach to new interactive and adaptive environments are just two examples of technologies that are impacting architectural design today" (Lehman, 2010, p.5).

As technology continues to progress the ways in which users can interact with their environment will also continue to change, further enhancing the experience of the space. Lehman believes that technology penetrates every aspect of architecture today, from the way new materials are built to sensory technology, all of which pave the way for highly refined interactive and adaptive spaces. Lehman believes that while technology continues to evolve, so will user's experience where technology will bridge the gap between a user's senses and architecture (2010). The following case studies will demonstrate how technology is used to stimulate humanistic senses, how spaces are created to optimize human interaction and engagement, and how these case studies are related to this design exploration.

3.2 Case Studies

3.2.1 ICE Installation by Klein Dytham Architecture (2003)

Location: Tokyo, Japan

Klein Dytham Architecture was commissioned on several projects to create spaces that encourage users to engage in a sense of informal play with the environment. Klein Dytham Architecture has coined the term ICE to reflect “Interactive Communication Experience”. This concept was demonstrated in Marunouchi, Tokyo in 2002 in a public space located near Tokyo Station. Klein Dytham architects maintained that they “felt that for this showcase for Bloomberg everybody should process and play with data it in a very tangible and touchable way.” (Klein Dytham, 2002. Ice Installation. Retrieved September 30, 2011 from Klein Dytham Architecture website: http://www.klein-dytham.com) A pure white element or object which resembles an icicle was suspended from the ceiling and when you approach the ICE installation, the infrared sensors situated behind the 5.0m by 3.5m glass wall not only detects human presence but detects humans from as far as 500mm away. The suspended wall displays FTSE[5] and NASDAQ[6] data normally but once it detects human presence, the wall encourages people to engage in informal play with the wall. The ICE installation also gives users 4 different play options where users can choose between a digital harp, digital volleyball, digital wave or a digital shadow. (Bullivant, 2005, p.12)

Figure 15: Image of ICE Installation project

Figure 16: Image of ICE Installation project

[5] FTSE stands for “It stands for Financial Times Stock Exchange”
(Yahoo Answers, 2011. Retrieved on November 5, 2011 from
http://uk.answers.yahoo.com/question/index?qid=20081016154250AAFVc5Y)

[6] NASDAQ stands for “National Association of Securities Dealers Automated Quotations”. (Wikipedia, 2011. Retrieved on November 5, 2011 from http://wiki.answers.com/Q/What_does_the_NASDAQ_stands_for)

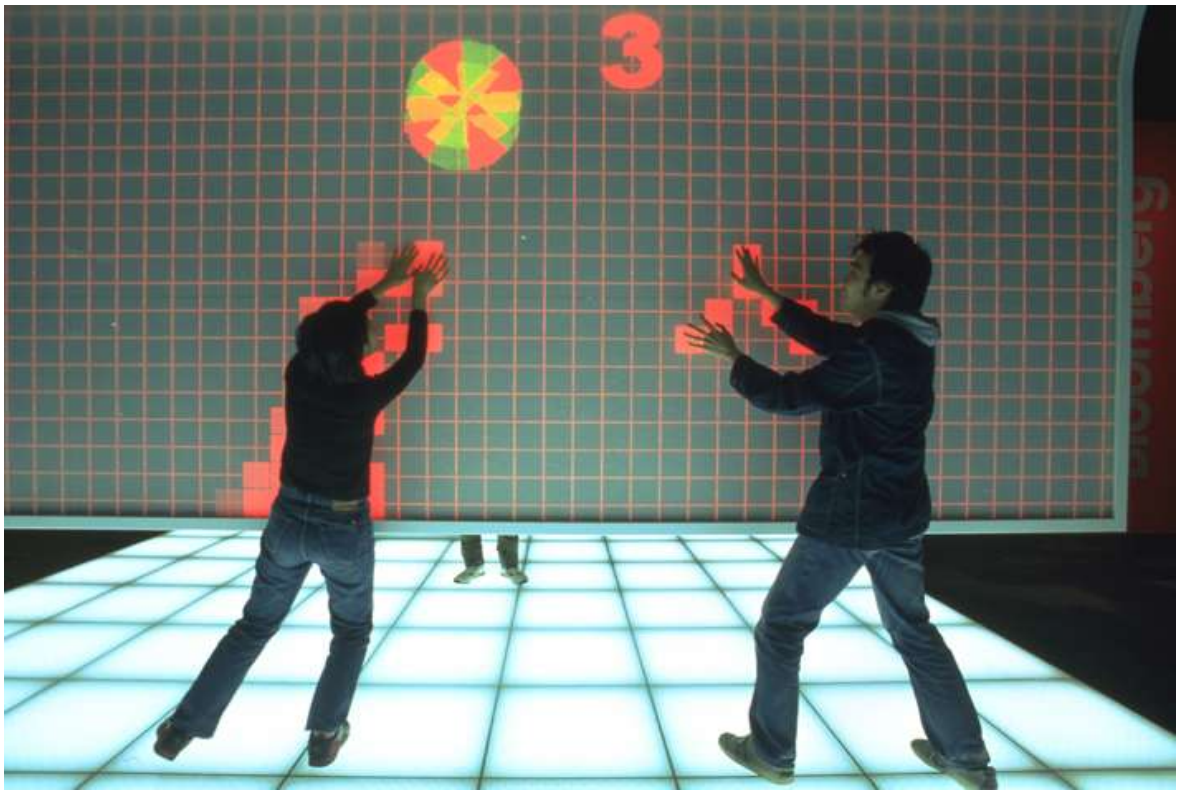


Figure 17: Image of ICE Installation project

Figure 18: Image of ICE Installation project

Observation:

This sense of touch has been integrated into my design exploration where touch is used to interact with the interactive walls/lowered ceiling and by creating different sounds. In essence, a user is then able to feel the space, obtain density, texture and even depth of their environmental surroundings. Furthermore, this kind of installation instills a sense of play within the architectural space where users are enticed to play with the fixture, and it is this sense of play that is mirrored throughout this design exploration.

3.2.2 DUNE by Daan Roosegaarde (2007)
Location: Rotterdam, Netherlands

DUNE 4.0 and 4.1 by Daan Roosegaarde is a virtual and interactive space which is comprised of a series of interactive installations which change its' appearance when it detects human presence. Both 4.0 and 4.1 allows for sensual interaction between the space and the user where technology such as hundreds of fibers, steel, microphones, sensors, speakers, software and other media are used. The various technological installations used are quite unique in that they respond to the movements and sounds of users within its near vicinity. Using hybrid technology which takes both nature and technology into consideration, it transforms the spatial environment for the user by promoting the user to look, walk and interact with the space. Dune 4.1 is a public and interactive space situated in the Maastunnel for the Rotterdam 2007 City of Architecture. (Roosegaarde, D. 2011. Dune 4.0. Retrieved September 30, 2011, from Studio Roosegaarde Website: http://www.studioroosegaarde.nl/project/dune/info/).

Figure 19: Image of Dune Project

Figure 20: Image of Dune Project

Figure 21: Image of Dune Project

Observation:

This kind of interactive technology inspired me to create an installation that also engages users with their sense of sound and touch. The sensory technology used in Dune 4.0 and 4.1 are used in the design exploration where sensory technology will be used to emit sounds and lights within the architectural space.

3.2.3 LUNAR by Studio Roosegaarde (2010-2011)
Location: Rotterdam, Netherlands

Commissioned for the Mental Health Care GGz Breda in the Netherlands and developed with SKOR Foundation for Art and Public Domain, Daan Roosegard creates an interactive space using materials such as molded white pillars, tubes of diameters of 30cm and heights between 100-160 cm, LED's, electronics, sensors and software allowing for children to instigate informal play between their therapy and the building.
(Roosegaarde, D. 2011. Lunar. Retrieved September 30, 2011, from Studio Roosegaarde Website: http://www.studioroosegaarde.nl/project/lunar/).

In addition to creating a space which promotes informal play, the interactive technologies allow for the objects to "come to life" by creating sounds and bright colours when the objects detect touch. Roosegarde's LUNAR space can be considered as a highly technological environment that responds to sound and movement in which subsequently renders the user and the space as one unit. This connection is referred to by Roosegarde as "techno-poetry" and conjoins the concepts of ideology and technology as a single unit.

Figure 22: Image of LUNAR Project

Figure 23: Image of LUNAR Project

Figure 24: Image of LUNAR Project

Observation:

Roosegarde's use of sensory technology to invoke a playful environment is demonstrated throughout my design exploration where users are encouraged to play within the architectural space and engage in the space in a meaningful, non-serious and playful manner. The lights and sounds emitted when children touch and play with the installation is meant to soothe and calm the children who are undergoing therapy and the way in how technology is used to obtain this objective was a source of inspiration in the design exploration because this was a good example of how users can engage with architecture using their tactile and aural sense. This case study was a good inspiration for me in terms of how to use senses to engage people with an architectural space.

3.2.4 SUSTAINABLE DANCE FLOOR by Daan Roosergaarde (2008)
Location: Rotterdam, Netherlands

Roosegarde was also commissioned in 2008 for Club WATT in Rotterdam, Netherlands to create an interactive dance floor to promote movement and in this case, dancing. Club WATT is also known to be a sustainable dance club (one of the first of its kind) therefore one of the objectives of this project was to ensure that materials used in the construction of the floor were sustainable, and that the energy used should be renewable. The size of the interactive, yet modular dance floor had a length and width of 65 cm and a height of 30 cm. The interactive dance floor was created using sustainable materials in addition to energy harvesting techniques, software and embedded electronics within the dance floor and essentially generates electricity through the act of dancing. The electricity is produced by virtue of movement and dancing which is detected using sensory technologies and softwares that are embedded within the floor itself. (Roosegaarde, D. 2011. Sustainable Dance Floor, Retrieved September 30, 2011, from Studio Roosegaarde Website: http://www.studioroosegaarde.nl/project/sustainable-dance-floor/). Therefore, when dancers dance on the floor – movement is detected and then energy is produced.

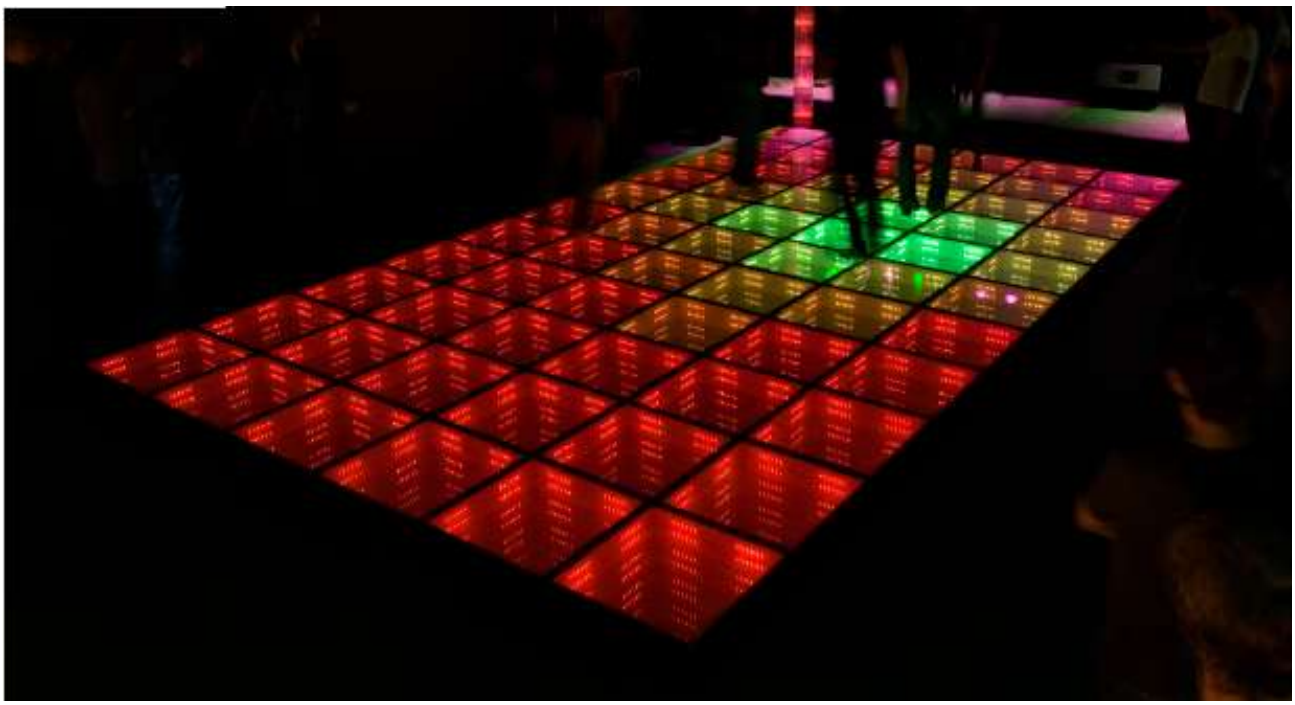


Figure 25: Image of SUSTAINABLE DANCE FLOOR Project

Figure 26: Image of SUSTAINABLE DANCE FLOOR Project

Figure 27: Image of SUSTAINABLE DANCE FLOOR Project

Figure 28: Image of SUSTAINABLE DANCE FLOOR Project

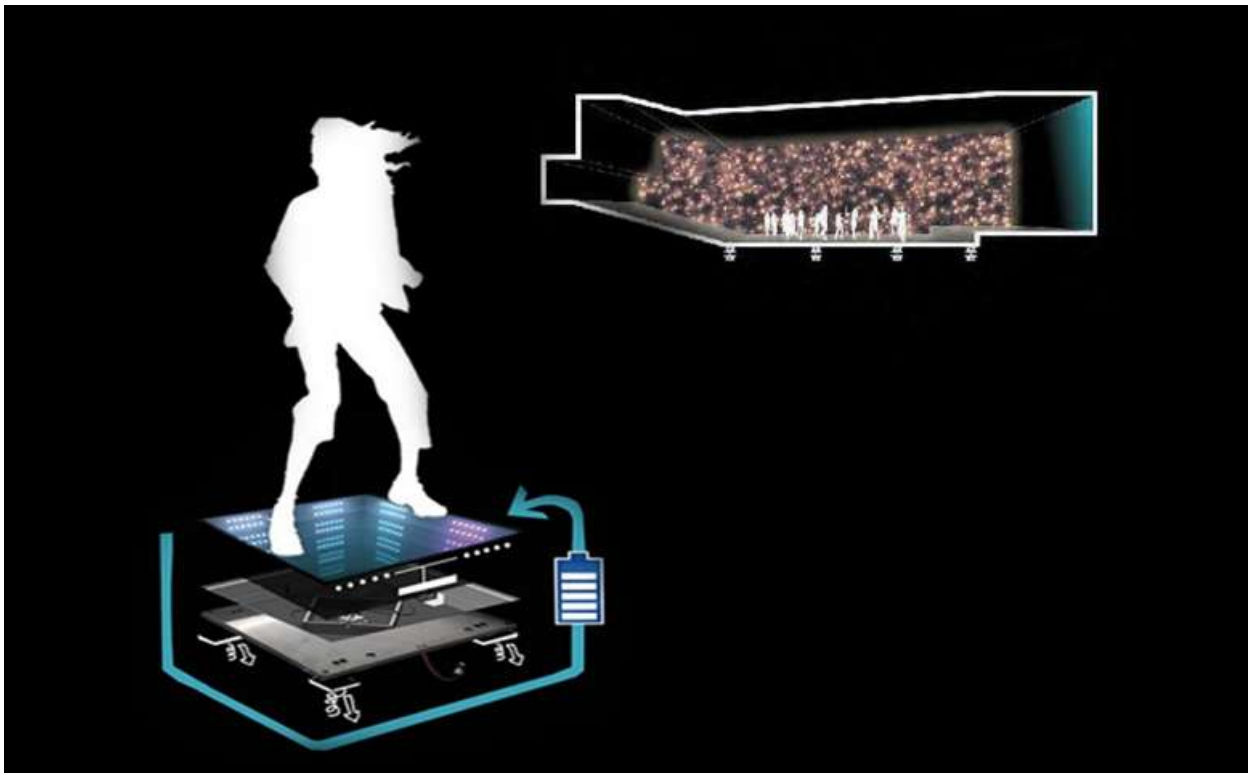


Figure 29: Image of SUSTAINABLE DANCE FLOOR Project

Observation:

The concept of an interactive floor is also evident in my design exploration, where when individuals walk on the floor, certain sounds are emitted. The fact that the sustainable dance floor is able to harness energy from users walking on it and then re-use that energy to produce electricity was a source of inspiration for this design exploration because sensing technology is not only used to detect movement but also transform that movement into electricity. This results in a mutually beneficial relationship between the user and the interactive floor, where more movement results in more electricity.

3.2.5 FLOW: Smart Ventilator Wall by Daan Roosegaarde (2007-2011)

Location: The Hague, Netherlands

Flow 5.0 is a highly intelligent wall that is made up of hundreds of ventilators that interact with users who pass by it. The interactive ventilator wall was displayed at various exhibitions between 2007 and 2011. This intelligent wall is a modular system with a length of 50 cm, width of 200cm and a height of 200 cm. The recent version is a 10 meter wall that consists of hundreds of ventilators, microphones, electronics, sensory technology and softwares. This project was commissioned by Kapelica Gallery and The Hague in the Netherlands to name a few. FLOW creates a heightened awareness for the user who interacts with it – where they become conscious of themselves as a collective body and where the user and the space become one with technology. Referred to as a smart wall, when a user passes by the wall ventilators interact and move on the surface creating an illusion of artificial winds and transparent fields (Roosegaarde, D. 2011. Flow Factsheet. Retrieved September 30, 2011, from StudioRoosegaardeWebsite:http://www.studioroosegaarde.net/uploads/files/2011/02/25/46/Factsheet%20Flow%205.0-%20Daan%20Roosegaarde.pdf).

Figure 30: Image of FLOW Project

Figure 31: Image of FLOW Project

Figure 32: Image of FLOW Project

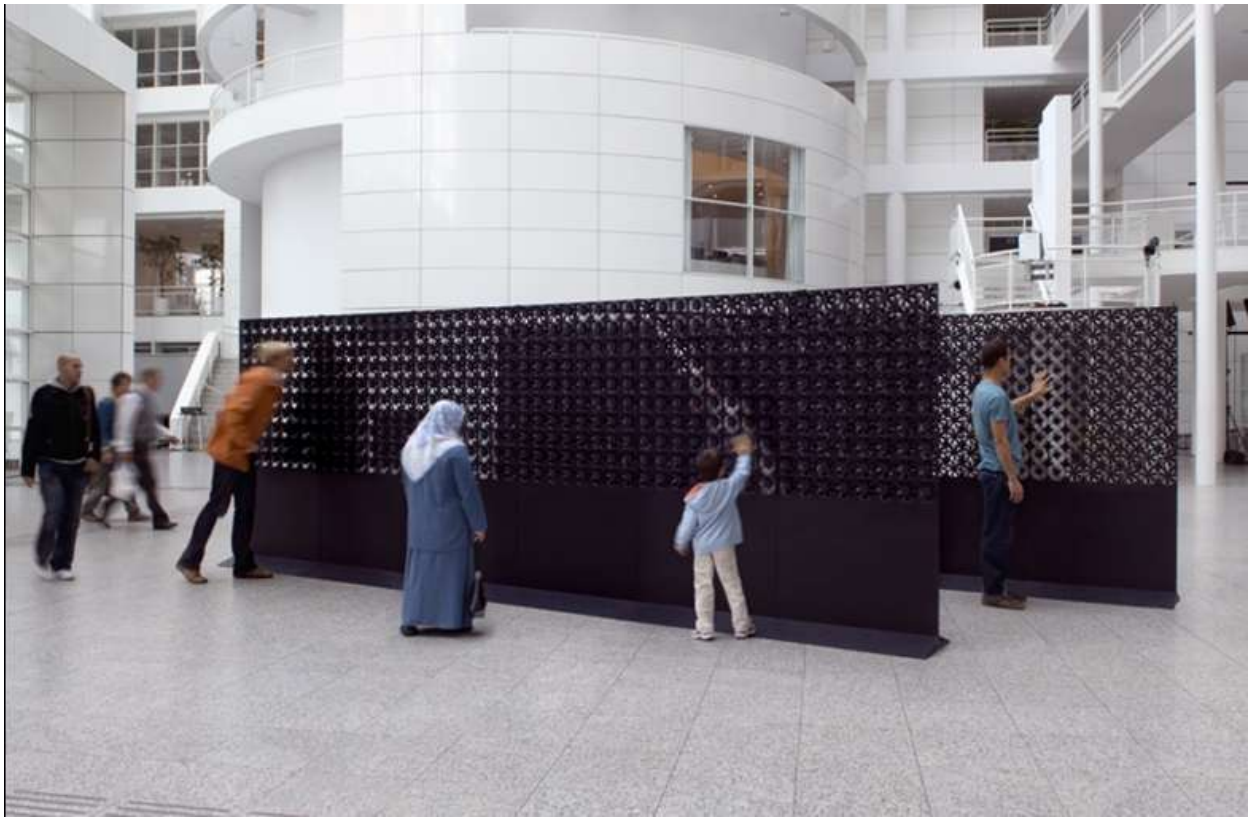


Figure 33: Image of FLOW Project

Observation:

The concept of the interactive wall is used throughout the design exploration to create awareness for the user who interacts with it, where the user and the interactive wall become one with technology. The interactive wall in this design exploration is used to instigate a sense of touch, and in essence the wall creates a sense of play between user and the wall.

3.2.6 Enteractive by Cameron McNall, Damon Seeley, Electroland (2006)

Location: Los Angeles, USA

Electroland is a team of designers who utilize a broad range of media including sound, light, images, motion and interactivity through architecture which promote users to interact with buildings and spaces through a sense of play. The Enteractive project took place in downtown Los Angeles – and creates not only a unique sense of place but also a heightened sensual experience where users are connected to spatial existence and orientation. This project was essentially a multitude of interactive LED tiles which were embedded into the ground which detected a user's presence using sensory technology and software. What's unique about this project is that it tied the building façade (which had the same tiles on the outside) to the floor inside the building, where the display of lights outside mimicked the patterns in the entrance of the building. Utilizing environmental intelligence, human surveillance activity and video-game sensibility, users are able to engage in a sense of play with the floor where the LED tiles would light up based on user movement on the floor.

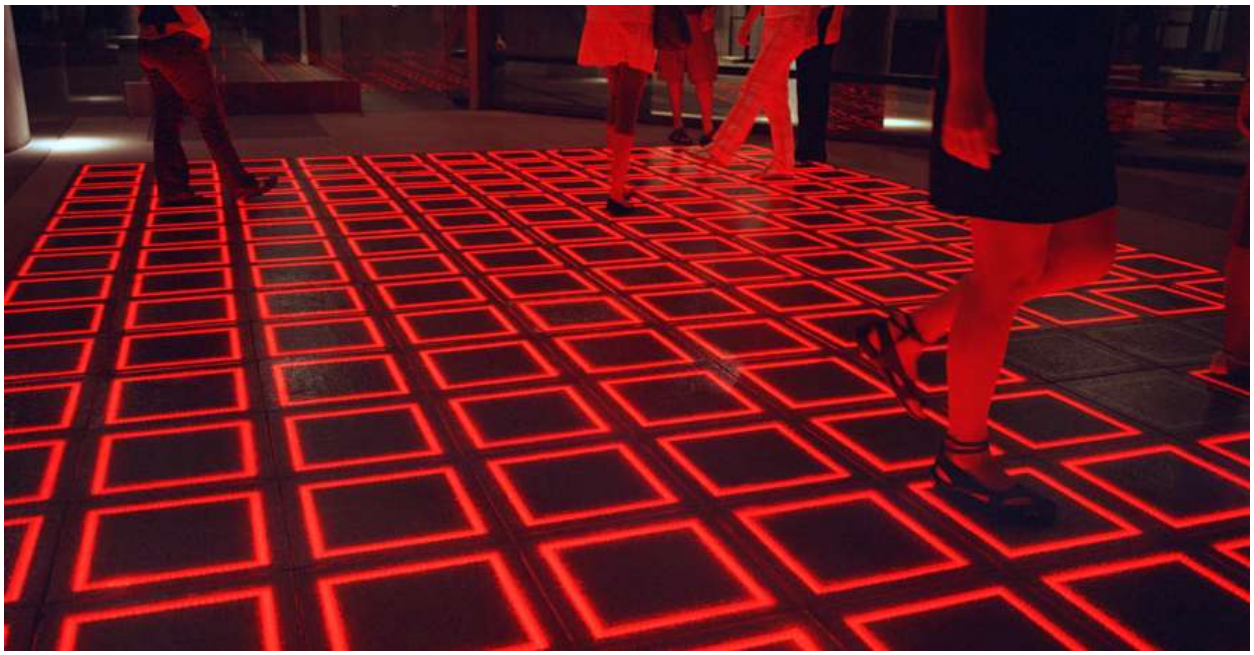


Figure 34: Image of Enteractive Project

Figure 35: Image of Enteractive Project

Figure 36: Image of Enteractive Project

Figure 37: Image of Enteractive Project

Figure 38: Image of Enteractive Project

Observation:

The sensory technologies used here inspired me in the way the floor detects movement and the end result of what happens when movement is detected. For example when the floor tiles detect movement, they light up in different colors and instill a sense of play amongst users who are engaging with the floor. This also creates a platform for social interaction as users are encouraged to move in various different directions on the floor to render in different lights.

3.2.7 SPACE INVADERS by Dani Armengol (2009)
Location: Lisbon, Portugal

Space Invaders was created in 2009 by Dani Armengol from Multitouch Barcelona using sensory and actuating technology. Multitouch Barcelona is an interactive design group that is reputed to integrate natural communication between technology and people to create situations where real-word interactions are simulated through a digital medium. In this aspect, senses play their natural role and allow users to play as if they were in a real world setting. Space Invaders is a multi-touch LED panel that seeks to create a play space for users. By using balls as input instead of fingers, users can play in an environment in a highly social way. This natural interaction project was presented at Offf Oeiras in Lisbon and was presented as a 4m by 6m screen. The aim of Space Invaders was to create a game where hundreds of people could play at the same time and heightening the use of technology to promote social engagement in a new way. (Multi touch Barcelona, 2009, from Multi Touch Barcelona website: http://www.multitouch-barcelona.com/?p=562).

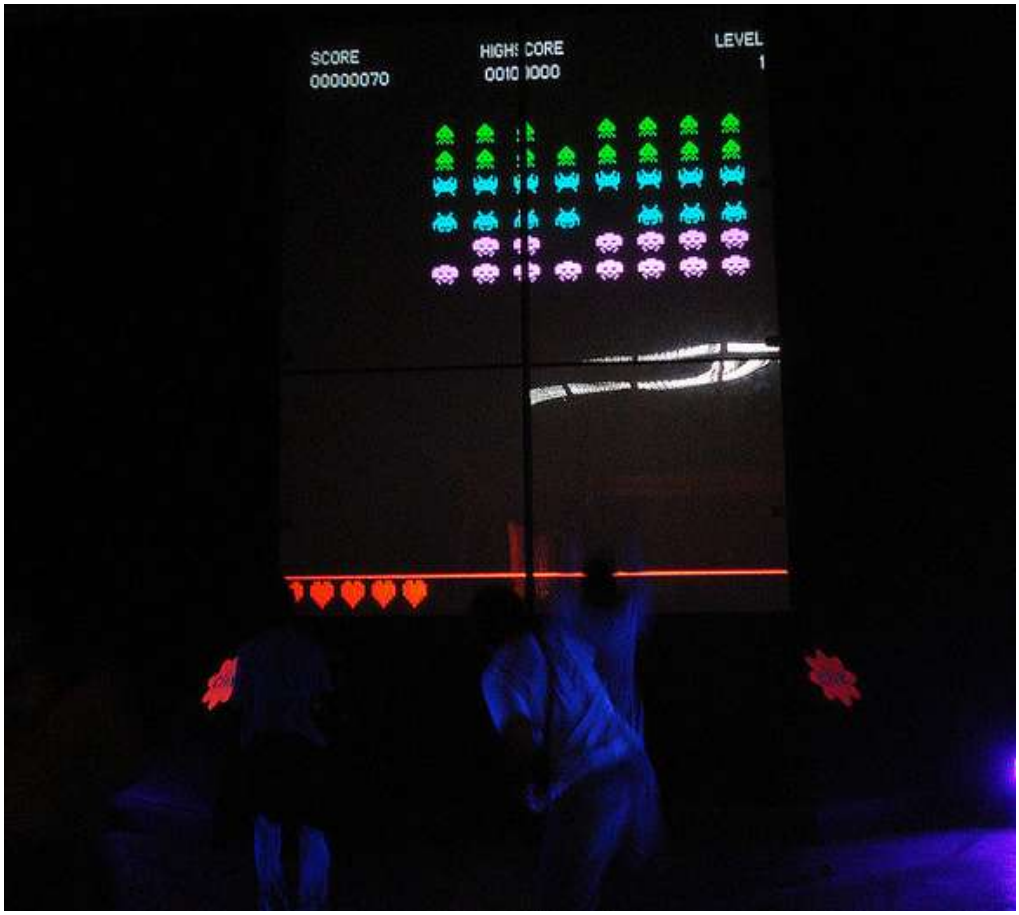


Figure 39: Image of SPACE INVADERS Project

Figure 40: Image of SPACE INVADERS Project

Figure 41: Image of SPACE INVADERS Project

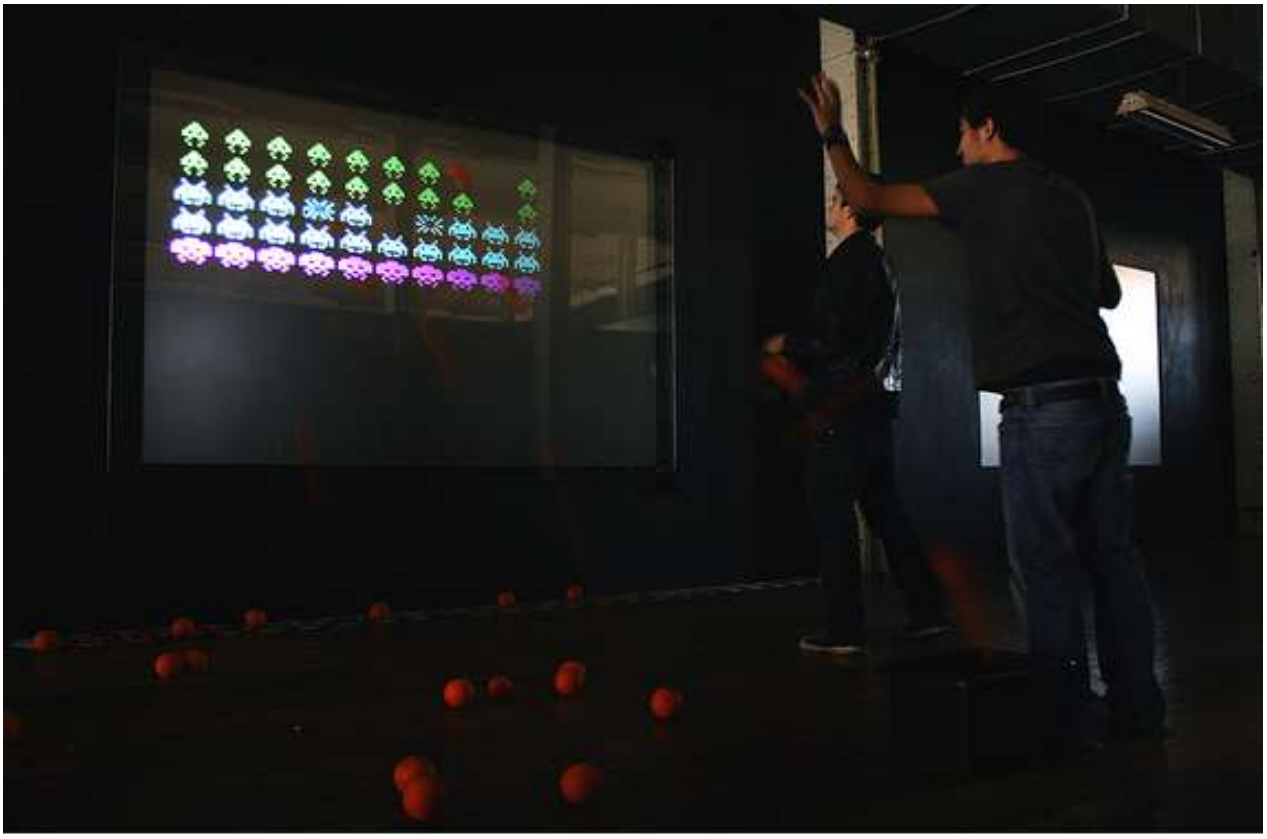


Figure 42: Image of SPACE INVADERS Project

Figure 43: Image of SPACE INVADERS Project

Observation:

The sense of play in a public space is what inspired me in this case study where the sense of play also promotes social interaction amongst users. In fact, it is a public space where multiple users are encouraged to not only interact with the installation but also with each other. In essence, it creates a public space for playful social interaction.

3.2.8 SCENTS OF SPACE by Usman Haque (2002)

Location: London, England

Renowned London based architect Usman Haque designed Scents of Space with an aim to create an interactive architectural space that promotes users to interact with the space using their sense of smell. Haque is renowned for his emphasis on using a multitude of humanistic senses with regards to how users understand and interact with architecture. Having collaborated with Josephine Pletts and Dr Luca Turin, the end project resulted in an interactive installation which emits scents. When users enter the space, they are subjected to a controlled scent or fragrance that helps the user establish their sense of space without using any physical boundaries. As users move through the space they are encountered with varying scents; regardless of whether they move horizontally or vertically through the space. Essentially the user is able to mix the various scents by moving their body around the space, allowing for a new way of experiencing space using the sense of smell. This remarkable space was designed using sensory technology and fans which direct air flow throughout the space. Computer controlled fragrances are dispensed throughout the space without dispersion, which makes it an olfactory wonder for users (Bullivant, 2005, p20).

Figure 44: Image of SCENTS OF SPACE Project

Observation:

What inspired me about this case study was how the sense of smell was used as a steering force for users to move within the space. For example, different areas within the installation emitted different smells, almost peaking a curiosity amongst users to see what other smells were apparent in the space. This subsequently renders in more movement within the space as users are encouraged to move around and engage more with the space.

- **CHAPTER4:** DESIGN EXPLORATION

In this Design Exploration, I intend to demonstrate that the integration of sensing technologies in architectural space can transform a space into a place which can heighten the sensual experience of the space in so far as how a user experiences the space using their natural biological senses. This Project is intended to investigate our sense of place in the physical public realm in the underground pathway network in Toronto where users experience this space as a transition point. Furthermore, this project aims to reconsider social and perceptual ideas to create a design that fully elaborates on physicality and interaction of the architectural space through sensing technology.

4.1 Context (Site Analysis)

The path network in Toronto is an alternative route that pedestrians can take underneath the city. It is a complex public network that winds itself through the core of downtown Toronto. It can be classified as a transition space as commuters and office workers use it to get from one location to another within downtown Toronto. One of the most critical points to note about the underground network is that there is no real opportunity to engage the public in social engagement except for the food courts. (See figure 45)

Individuals are able to enter the underground pathway through any of the subway stations or lobby entrances of major office buildings within the downtown core. Given that individuals who use the path are either on a destination to get to work or home, there is not much opportunity present for these individuals to step out of their own realm and engage with the space. A regular scene in this space would find individuals walking at a very fast pace through the crowd, many on their cell phone or iPod with their intended destination on the forefront of their agenda. Therefore it is a space that lacks social engagement.

Figure 45: View from Bloor Street Underground Pathway

This investigation starts by analyzing different sites in the underground pathway in Toronto and examining their potential for this design exploration. The Bloor Street underground pathway (Figure 45, 46, 47, 48, 49, and 50) was one of the sites examined for its potential in terms of variables such as length, dimension, location, dynamics, destination and needs. Figure 51 demonstrates the comparison of the Bloor Street underground pathway site to the Eaton Center underground pathway.

Figure 46: View from Bloor Street Underground Pathway

Figure 47: View from Bloor Street Underground Pathway

Figure 48: View from Bloor Street Underground Pathway

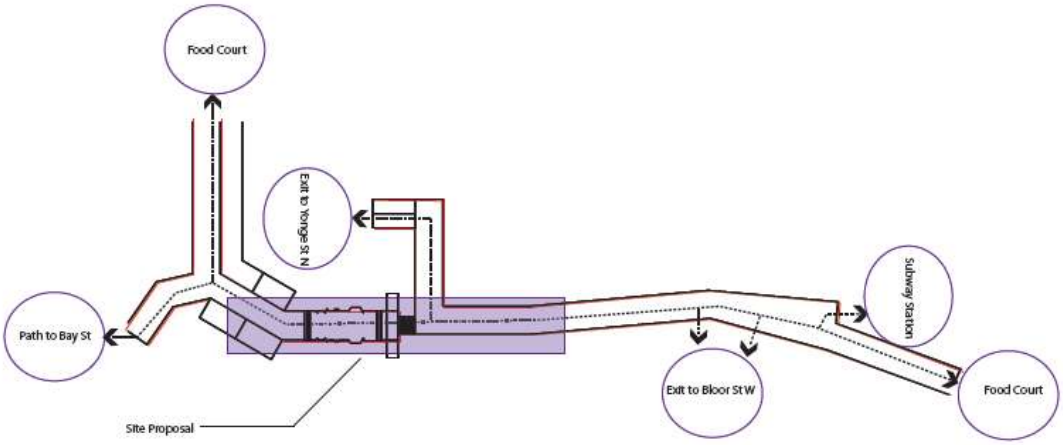


Figure 49: Circulation Plan Diagram of Bloor Street Underground Pathway

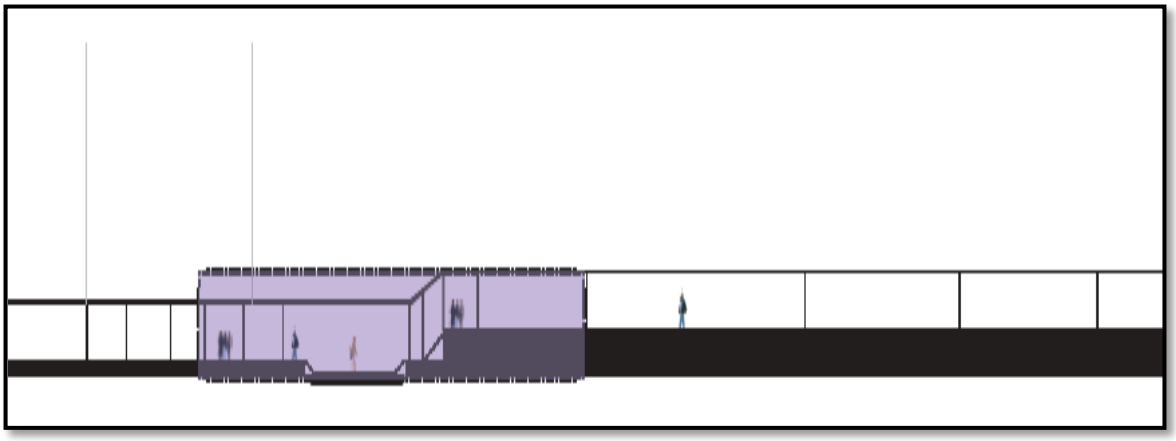


Figure 50: Sectional Diagram of Bloor Street Underground Pathway

Potentials	Bloor Street Pathway	Eaton Center Pathway
Length	It takes 1 minute to pass through the main path and 15 minutes through the whole path	It takes 5 minutes to pass through the path
Dimension	20 x 7 x 3.5 meters	106 x 6.5 x 4.6 meters
Location	Users are forced to pass through rather than choosing another path; surrounded by many shops and close to two major subway stations	Users can use another path because it is located in the area that people rarely pass through; very close to the subway station, stores and Ryerson University
Dynamic	High traffic with lots of potential to implement technology; opportunity to control circulation and experience; accommodations 100,000 pedestrians daily	Low traffic and has the ability to implement the technology; easier to control circulation and experience compared to Bloor Street One
Destination	Potential of becoming a destination is limited by space	Potential of becoming a destination and is not limited by space
Needs	To transform from the space of transition to the place of social interaction and engagement	Excitement; sense of attachment for occupants by creating different kinds of activities that engages people more with their environment and other occupants

Table 1: Site Analysis Comparison Table

After investigating these two sites and analyzing them for these different variables, I have chosen the Eaton Center pathway which is located underneath the Eaton Center shopping mall and is accessible from the extremely busy Yonge and Dundas intersection (Figure 52 and 54). This underground path is situated between the Canadian Tire store and the subway station entrance (Figure 62 and 63) for the Eaton Center and is considered a transition point between the subway station to Canadian Tire and Ryerson University, Ted Rogers School of Management. (See Figure 53, 58 and 59)

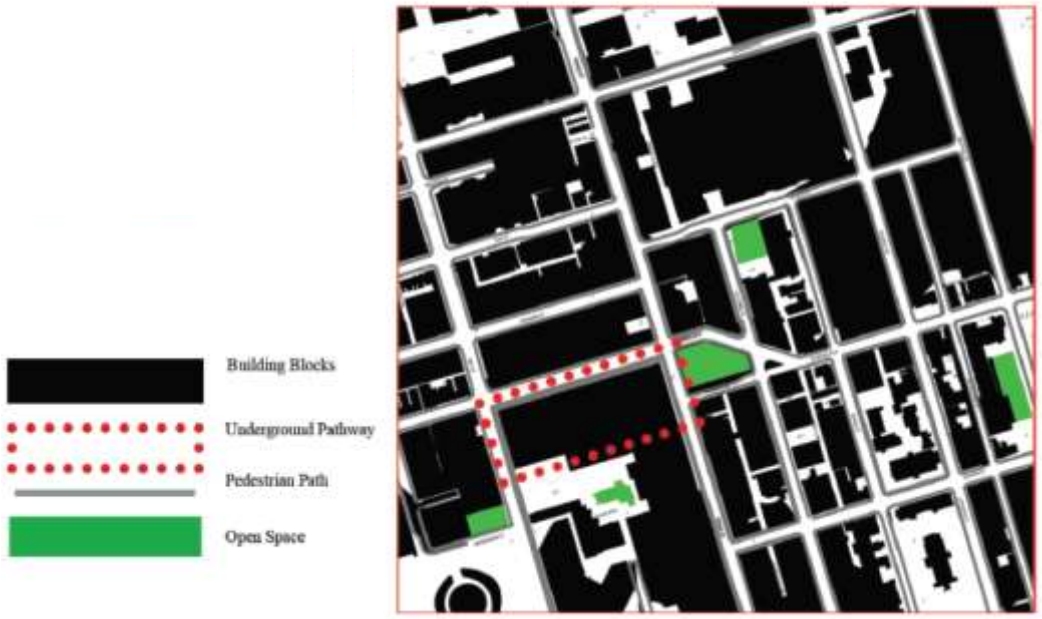


Figure 51: Yonge-Dundas Intersection Site Analysis Map

This pathway has dimensions of 106m in length, 6.5m in width and 4.6m in height and takes at least 5 minutes to pass through. This site is rarely traveled by people and is primarily used as a transition point between the shopping mall and the street. This particular space, despite being a public space, has no evident features to encourage users to engage with the space. Instead, people utilize this transition space en route to their destination while remaining in their own private realm. (See Figure 64, 65, and 66)

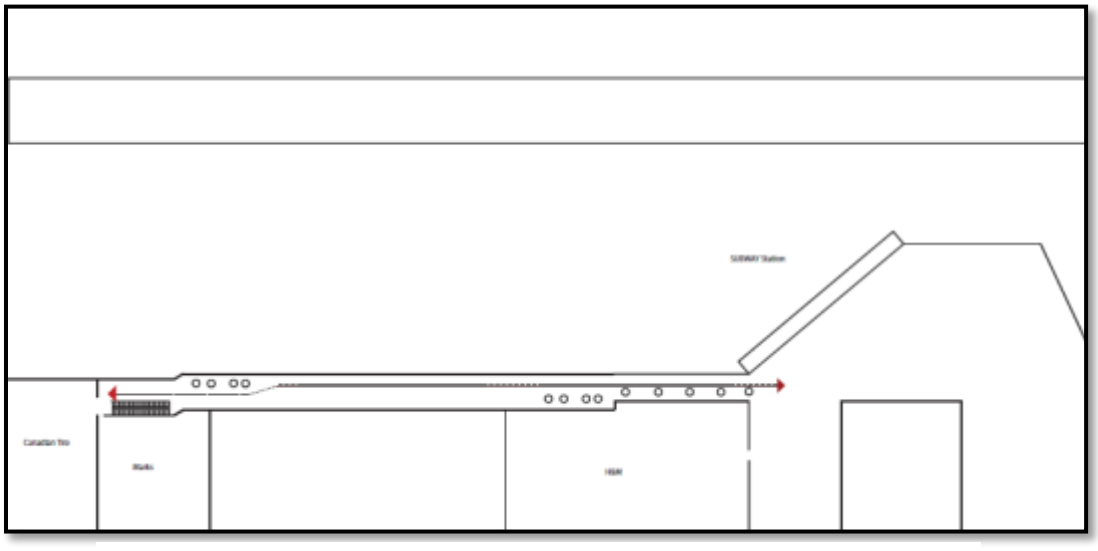


Figure 52: Current Plan of Eaton Center Underground Pathway Site

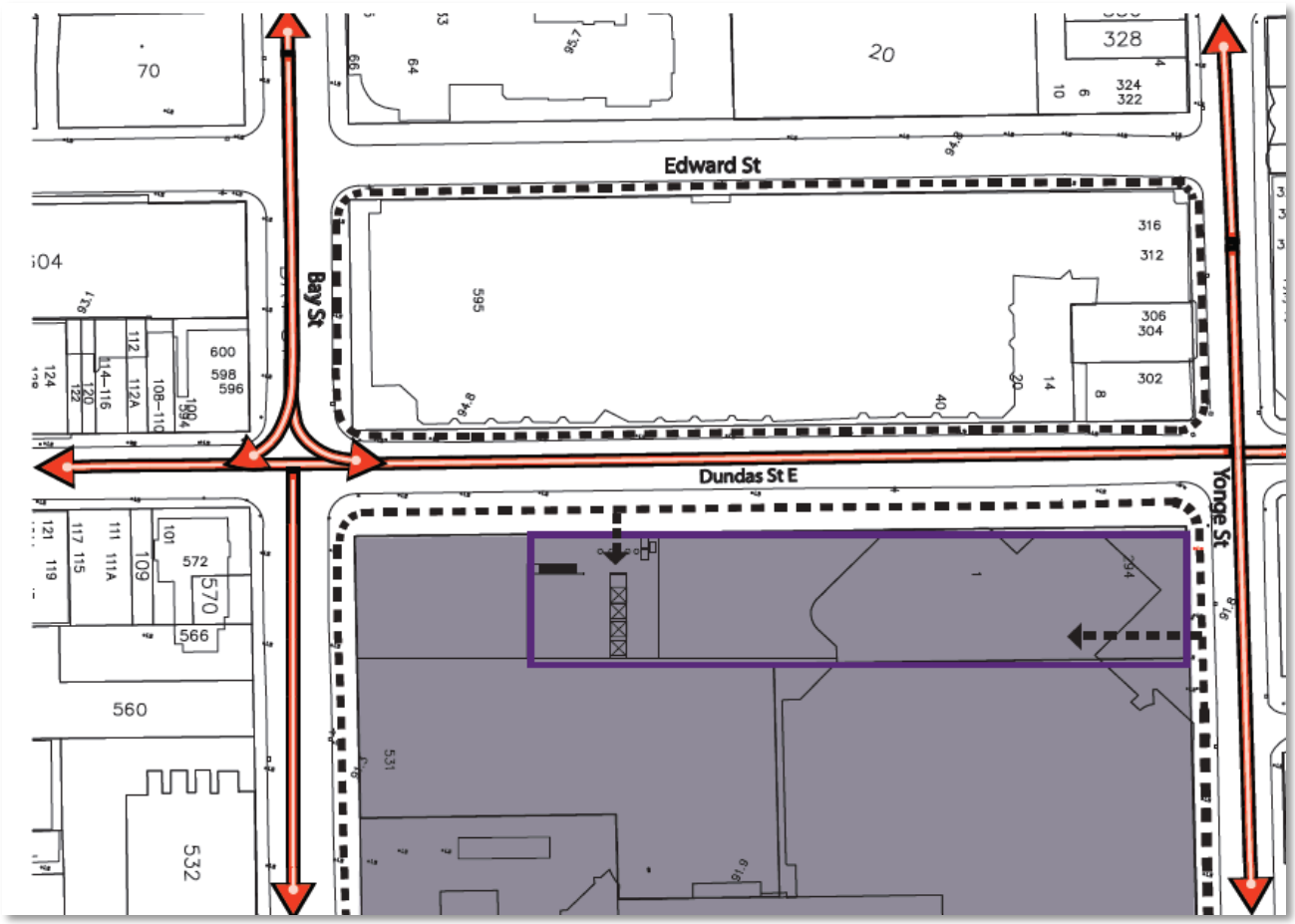


Figure 53: Eaton Center Underground Pathway Site Analysis Map

Figure 54: View from Yonge Street Site

Figure 55: View from Dundas Street Site

The pathway has an access point through Dundas Street (Figure 56) and Yonge Street (Figure 55), and is located in the lower level Ted Rogers School of Management. (See Figure 57 and 67) This area holds good potential for Ryerson students to use the space as an alternative accessibility route. Managing traffic and maneuverability will also be relatively easy because currently the traffic density is quite low in the area as it is primarily used as a transition point.

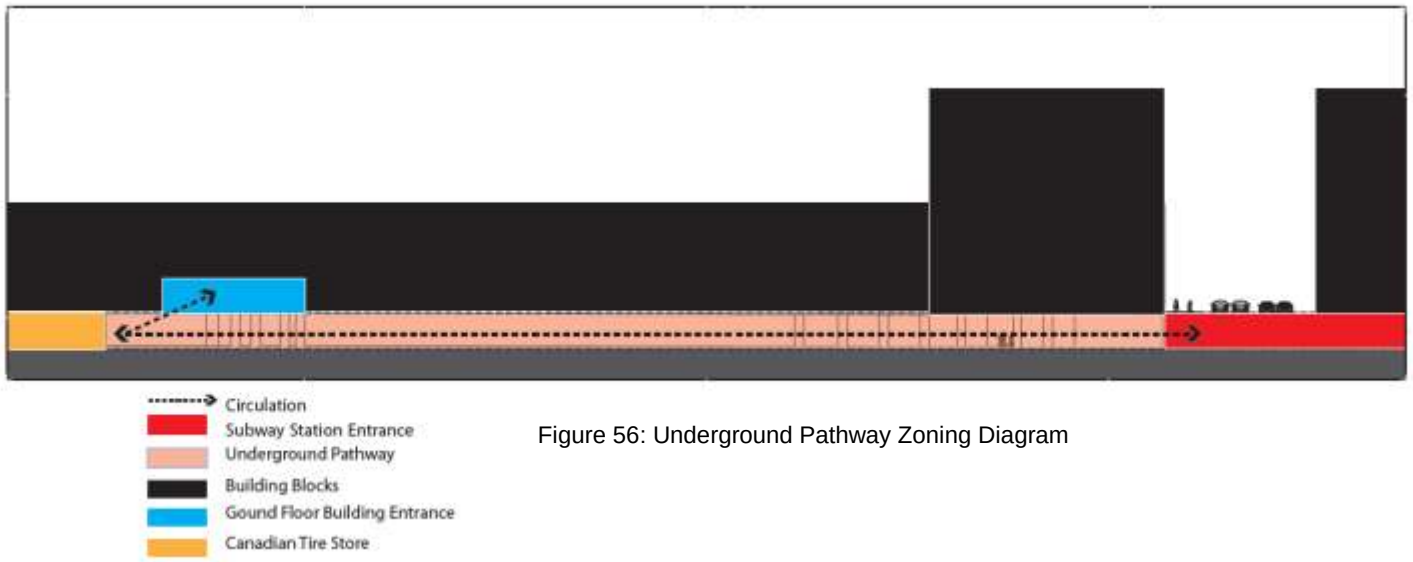


Figure 56: Underground Pathway Zoning Diagram

Figure 57: Ryerson School of Management Entrance

Figure 58: Ground Floor Building Entrance

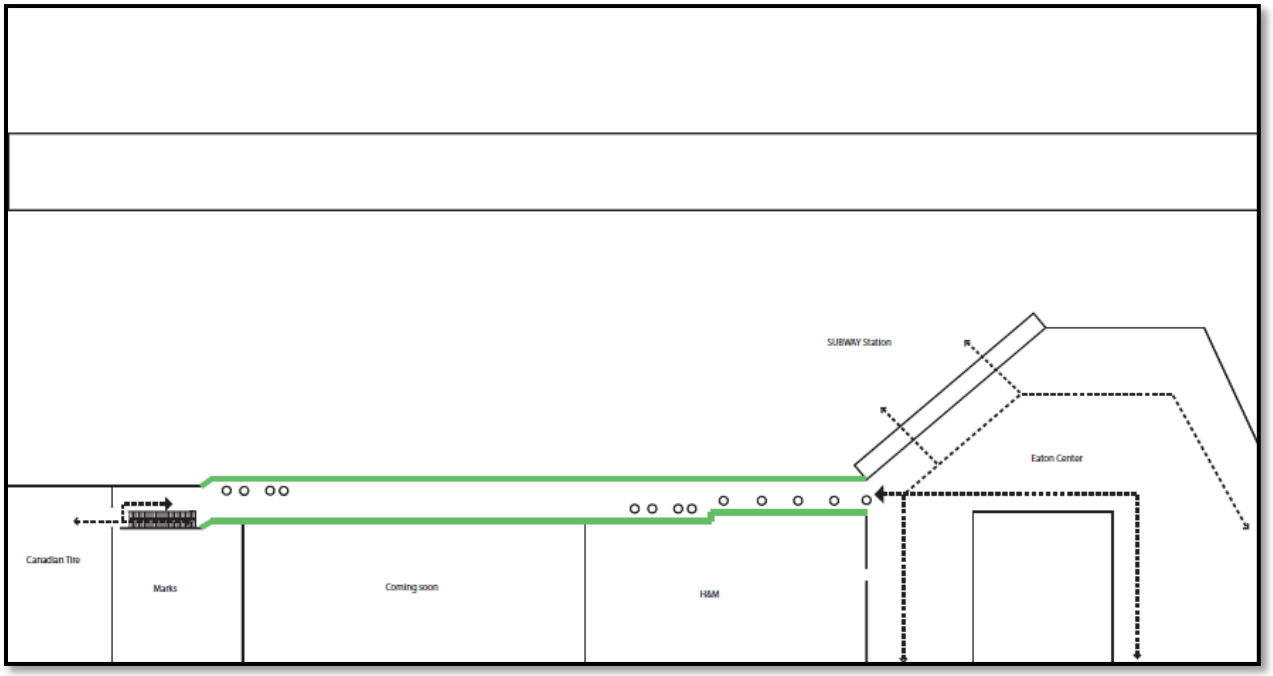


Figure 59: Eaton Center Underground Pathway Circulation Plan

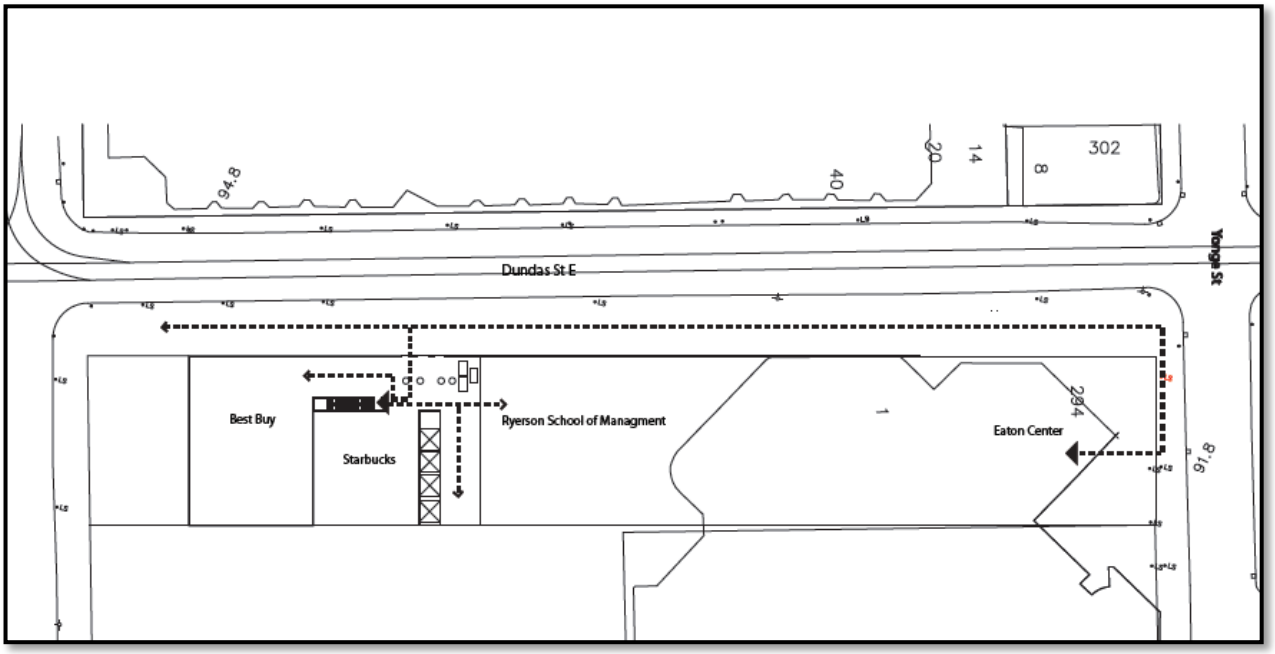


Figure 60: Ground Floor of the Building Circulation Plan

Figure 61: View from Eaton Center Shopping Mall Subway Station Entrance

Figure 62: View from Eaton Center Shopping Mall Subway Station Entrance

Figure 63: View from Eaton Center Underground Pathway

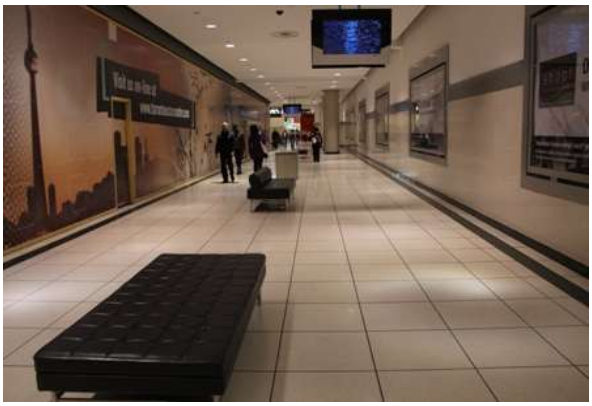


Figure 64: View from Eaton Center Underground Pathway

Figure 65: View from Eaton Center Underground Pathway to Canadian Tire

Figure 66: View from Eaton Center Underground Pathway to Ground Floor

The Circulation Plans (Figure 60 and 61) clearly show how traffic moves through this Pathway.

Therefore, by choosing the Eaton Center underground pathway due to its potential, I investigated different possibilities of reconfiguring a transition space that would allow for heightened sensual engagement and promote engagement of the architectural space using sensing technology.

4.2 Programs

After researching Juhanni Pallasmaa's and Merleau-Ponty's ideas regarding the relationship between the human body and its senses within the physical space, and investigating the idea of space and place and how these concepts are intrinsically linked, I intend to integrate these concepts into my design project. As Yi-Fu Tuan notes:

> "Place achieves concrete reality when our experience of it is total, that is, through all the senses as well as with the active and reflective mind." (Tuan, 1977, p.18)

Also, with respect to Yi-Fu Tuan's beliefs regarding the way space derives meaning and transforms into a place, my thesis project demonstrates that engaging different human senses in the space with the help of sensing technology can intensify the experience of that space and transform it into a meaningful place. Also, by inserting different programs like play areas and a café, the design illustrates how architecture, along with these concepts and sensing technology can re-think engagement. These two different programs can heighten different senses and as a result encourage engagement within the space and social interaction in this public space.

At first, I considered different programs that could be inserted into this public space which also held more potential with regards to engaging people by using their senses by interacting with sensing technologies. (See Figure 68)

Programs	Activities	Senses
Café	Sound of people, Sound of music, Taste of cake, Smell of coffee	Hearing, Taste, Smell.
Relaxing Area	Sound of Music, Lying, Looking at the people passing by	Hearing, Vision, Smell.
Playing Area	Sound of music, Sound of people, Movement of the body, Touching the wall, Touching the floor, Talking to other people	Hearing, Touch, Vision
Dancing	Sound of Music, Touching the Floor, Movement of the body	Hearing, Touch.

Table 2: Programs Comparison Table

After comparing different programs and the senses that could be heightened through them, and based on my previous research outlined in the first 2 chapters of this thesis, I have chosen the play area and café. By choosing play and café as programs, I aim to show how architecture and engaging human senses can change the experience of the public physical space and turn it into a meaningful place. As Huizinga indicates in the book *Homo Ludens:*

> "We shall not look for the natural impulses and habits conditioning play in general, but shall consider play in its manifold concrete forms as itself a social construction" (Huizinga, 1949, p4)

With admiration for Huizinga's theory of play and the potential of the play area to promote social interaction, I decided to insert a play area as a program to this space. Play can encourage engagement with vision, touch and sound to intensify the experience of the place and also promote social interaction between the occupants. (See Figure 69)

Play	
Activities	playing, talking, dancing, listening, meeting
Senses	visual, touch, sound,...
Technologies	interactive music wall, interactive dance floor, interactive game screen,...
Output	Social interaction, engagement

Table 3: Table of Potentials of Play

In addition to the play areas, I have suggested café for this place to evoke the sense of smell and taste and provide a calm area for people to enjoy and relax. This concept was inspired by one of Juhani Pallasmaa's quotes:

> "A particular smell makes us unknowingly re-enter a space completely forgotten by the retinal memory; the nostrils awaken a forgotten image and we are enticed to enter a vivid daydream". (Pallasmaa, 2005, p 54)

Therefore, by invoking scents into space, one is able to engage with the space and create a perception in their head as to what the smell is tied to. (See Figure 70)

Cafe	
Activities	meeting, talking, eating, drinking, studying, relaxing, smelling
Senses	visual, smell, taste, touch, sound, ...
Technologies	interaction wall, interactive cafe table, interactive screen,..
Output	Social interaction, engagment between space and the occupants

Table 4: Table of Potentials of Cafe

4.4 Concept

My thesis attempts to demonstrate how a transformation of the pathway into a play area and Café can encourage our sense of place and promote engagement between people, other occupants and the given physical space. In this play area and café, my intent was to anchor people within the space with their senses via sensing technology.

Users are encouraged to engage with their surrounding environment by testing different interactive play installations that work with the help of their senses. Elements such as an interactive wall, interactive floor, and interactive table are the three sensing technologies that I decided to include in my design to persuade engagement to subsequently heighten the experience of the public physical space.

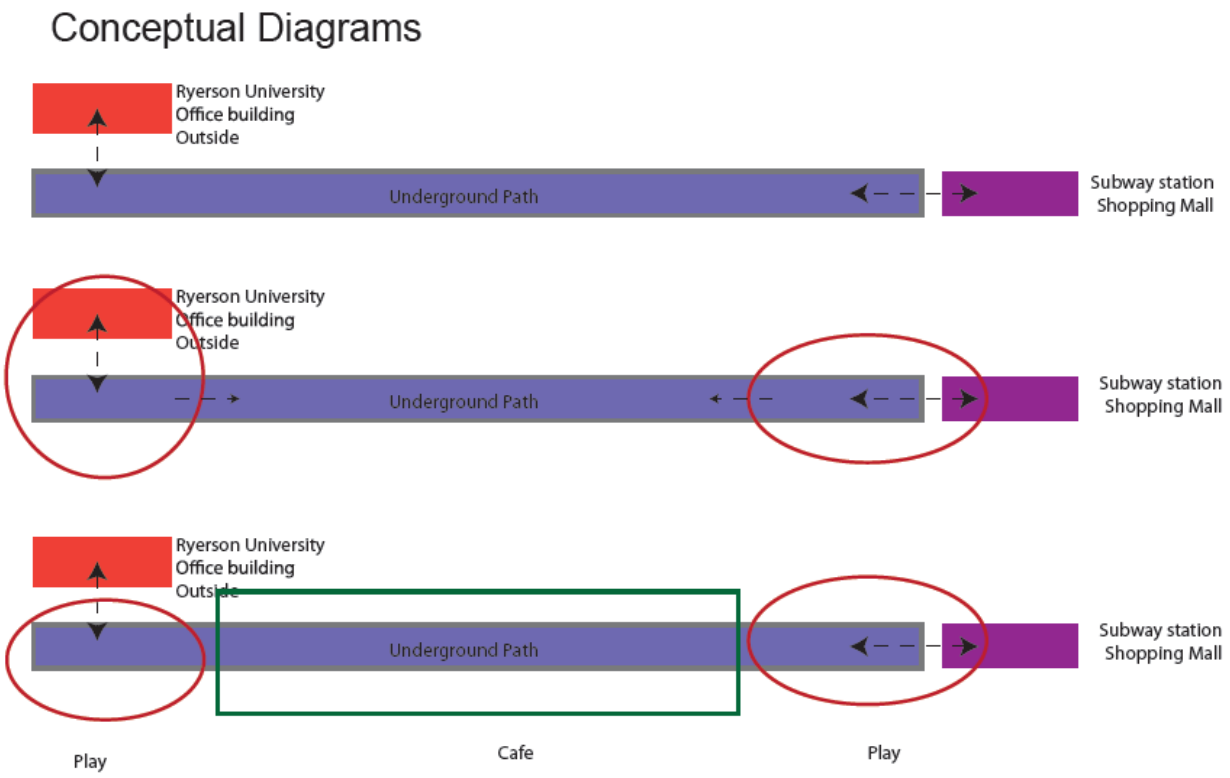


Figure 67: Primarily Conceptual Diagram

Therefore, I first considered how I can connect this path to its surrounding environments which are: (See Figure 71)

1. The Ryerson, Ted Rogers School of Management which is in the upper floor; and
2. The subway station entrance which is near this pathway.

In my design project I intend to bring people from these environments to the path (Figure 72) by introducing play areas (Figure 73) on both sides of this path and a café (Figure 74) in between these play areas.

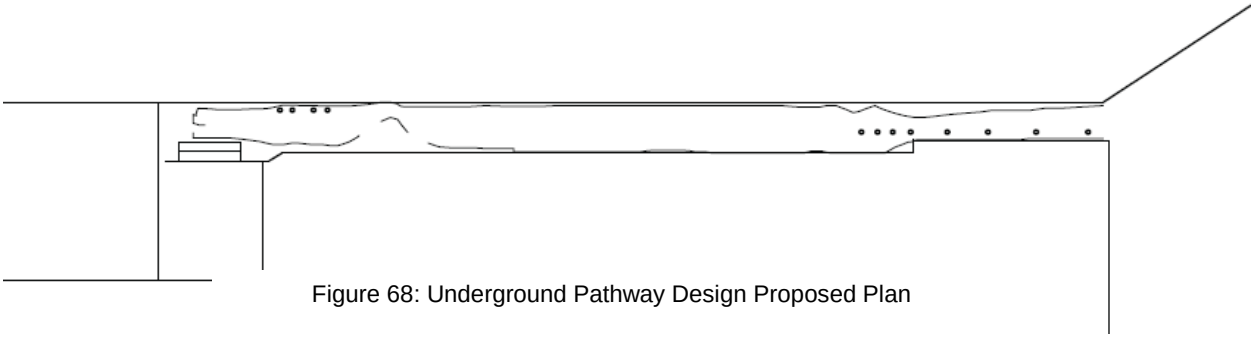


Figure 68: Underground Pathway Design Proposed Plan

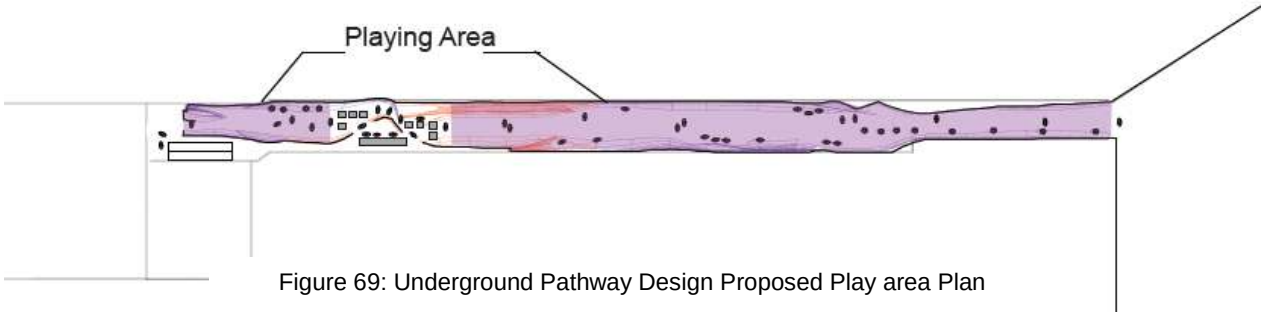


Figure 69: Underground Pathway Design Proposed Play area Plan

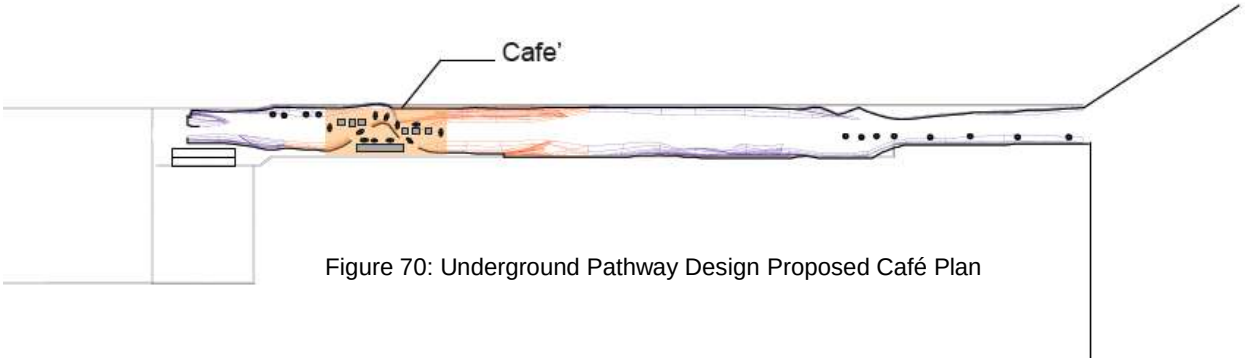


Figure 70: Underground Pathway Design Proposed Café Plan

With regards to instigating more engagement in the space I proposed a structure which forces the body to interact with architecture on a physical level. The concept is taken from the word “Proprioception” which means:

> “A body relying on its own balancing system instead of being upright by an architecture of vertical cues- posture as an emergent property produced by an interaction of architecture and body” (Spuybroek, 2004, p.139)

Therefore, the design concept also aims to introduce a different form for this corridor to engage people more with the space. By having lower ceilings which can be touched by people and curved walls that encourage people to interact with them, I aim to intensify the experience of this architectural space and to create a structure that can have an effect on the position of the users’ bodies in architectural space. (See Figure 75)

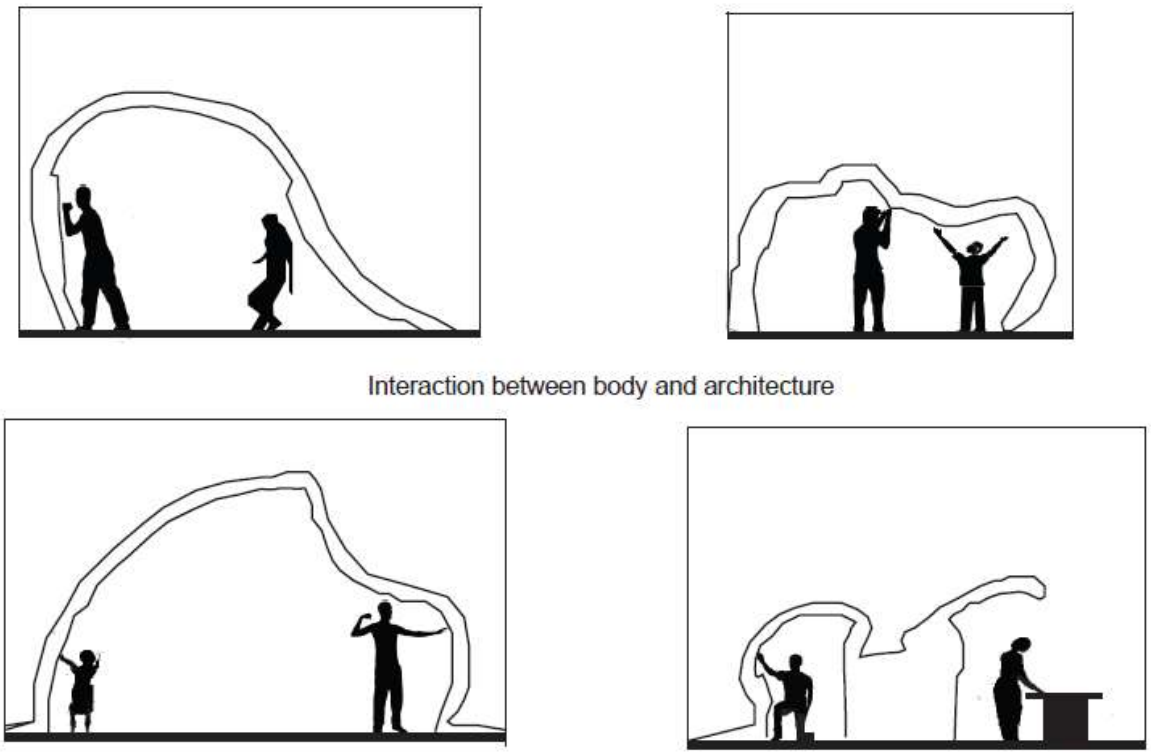


Figure 71: Conceptual Form Diagram

The section below (Figure 76) clearly demonstrates how the proposed architecture form is different from the current form of the pathway. Additionally, it introduces a new form that has a ceiling with various heights that can be touched in some lower lying areas by users. Essentially, the ultimate aim is to create a meaningful space through these various modes of architectural forms and user interactions encountered within.

Figure 72: Conceptual Section

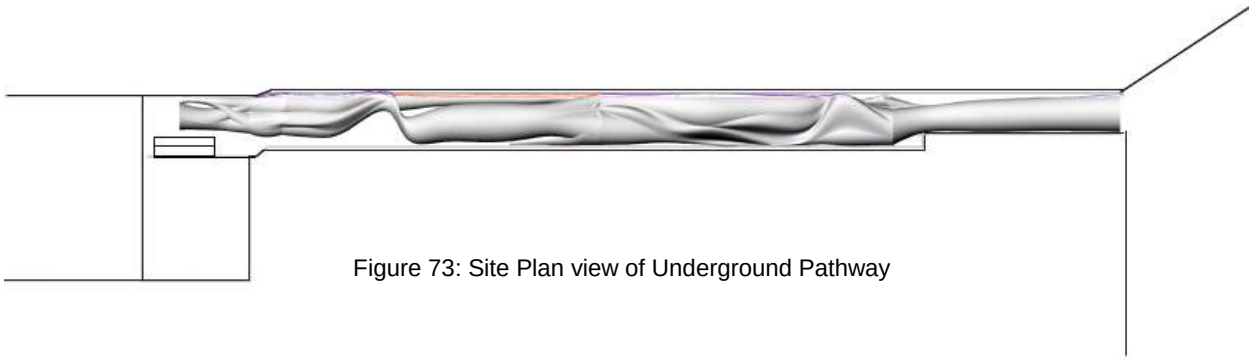


Figure 73: Site Plan view of Underground Pathway

The Figure 77, 78 and 79 show how the corridor transforms into a cave that is playful and has different heights which can bring about multiple experiences for the people within a space. In the next section, I will explain how the integration of sensing technologies can intensify the experience of the space and result in new modes of perception for users who are experiencing the space.

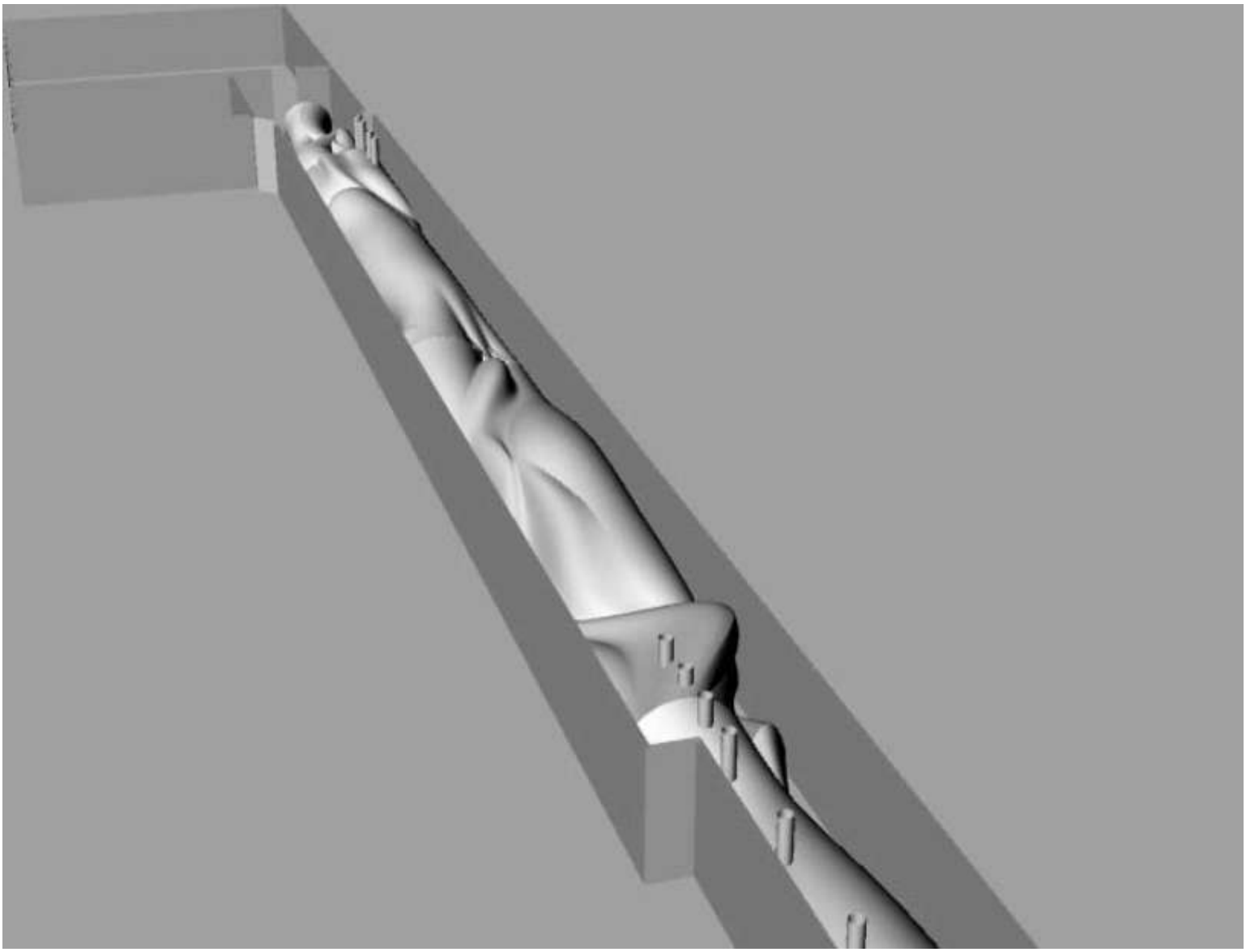


Figure 74: Perspective View of Underground Pathway New Form

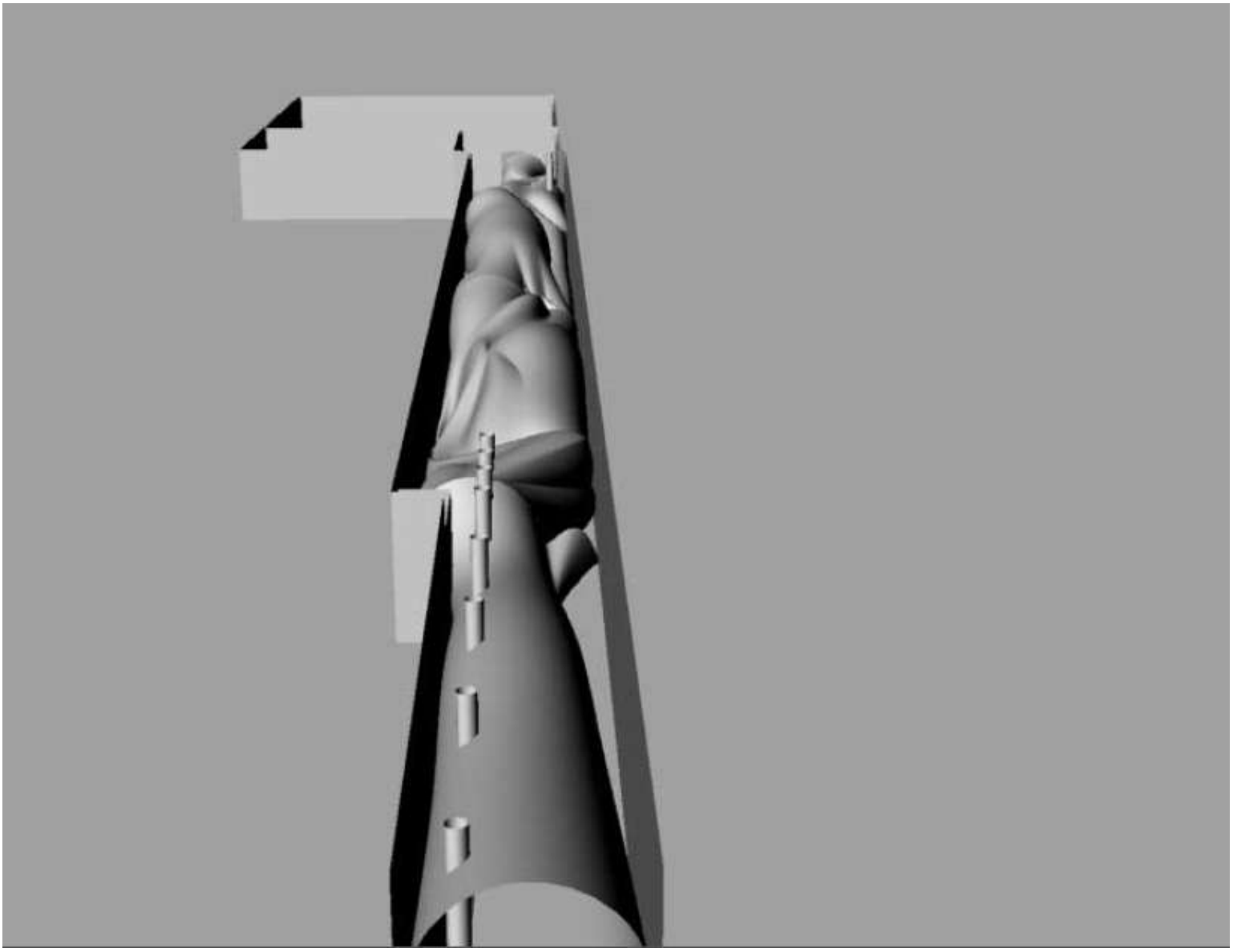
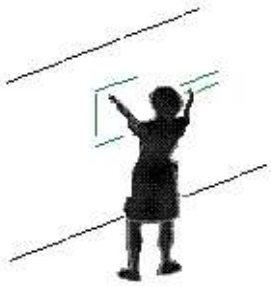


Figure 75: Perspective View of Underground Pathway New Form

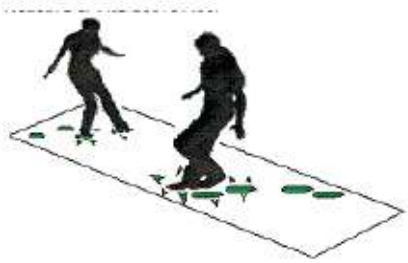
4.4 Interactive Technologies

I mentioned in chapter 3 about sensing technology and the way it works. Therefore, based on my previous research about these technologies and the way they engage human senses in architectural space, I have decided to insert some of these interactive technologies into my design project to persuade engagement and intensify the experience of the public physical space.

With the help of these technologies, interactive floor, interactive wall, interactive ceiling and interactive table (Figure 80), my design project intends to rethink engagement in the public physical space by virtue of digital interactive technology and persuade interaction between users in the space. These interactive technologies in my project aim to create a place where people interact with each other through play.



Interactive wall



Interactive Floor

Interactive Table

Figure 76: Interactive wall, Floor, and Table

In my design project, I intend to create a playing area by using an interactive floor, wall and ceiling all of which will stimulate user's senses who interact with the space whether it is the sense of sound, smell, touch, taste or sight. The continuity of this interaction will result in a meaningful space or environment that essentially has transformed space into place. The diagram below shows the preliminary stages of inserting these interactive technologies into different part of this space. (See Figure 81)

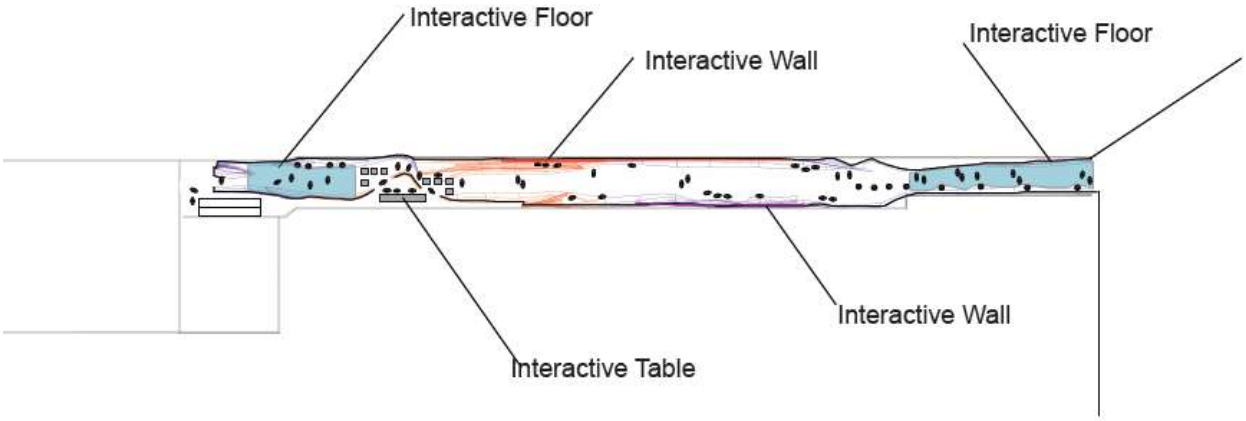


Figure 77: Sensing Technologies Insertion Diagram

For the interactive floor, I am using an interactive sound panel. These panels detect people's movement and by each step the panels start to generate sounds which sound different with each step on each individual panel. Therefore, users have the ability to play with sound and create music on their own or by collaborating with others. (See Appendix-B for more details)

Also, for the interactive wall, I am using interactive touch panels. These panels detect people who enter the space and start to generate lights which encourage people to go and touch them. After people touch the panels, they can start playing a game which is collaborative. These games can change every day or every week so that users do not get bored or too familiar with the space. (See Appendix-C for more details)

Furthermore, for the interactive ceiling I am using a panel that detects movement of people within the space which subsequently render in different modes of light and graphics on

the ceiling. The panels can be touched in lower lying areas so that users can engage with the ceiling as well – stimulating both the sense of sight and touch.

Finally, in the café I am inserting interactive bar tables to give people an opportunity to interact with each other by playing with an interactive bar table. (See Appendix-D for more details)

In summary, the use of interactive panels allows a new kind of space to be originated, where the integrated use of technology and stimulated senses create an architectural place that now promotes social engagement at a whole new level and where perceptions are being re-invented.

4.5 Narrative

As mentioned in previous section, my thesis design project has a playing area and café inserted into to this underground pathway design to promote social interaction. Also, by integrating sensing technologies such as an interactive floor, interactive wall and interactive table as a result of my previous research, I tried to intensify the experience users would undergo in these particular places using sensing technologies. These sensing technologies are utilized throughout the course of this design.

The narrative starts with the playing area and then the café in the middle which meets again with another playing area. The diagram below (Figure 82) clearly shows the narrative of the programs in this space.

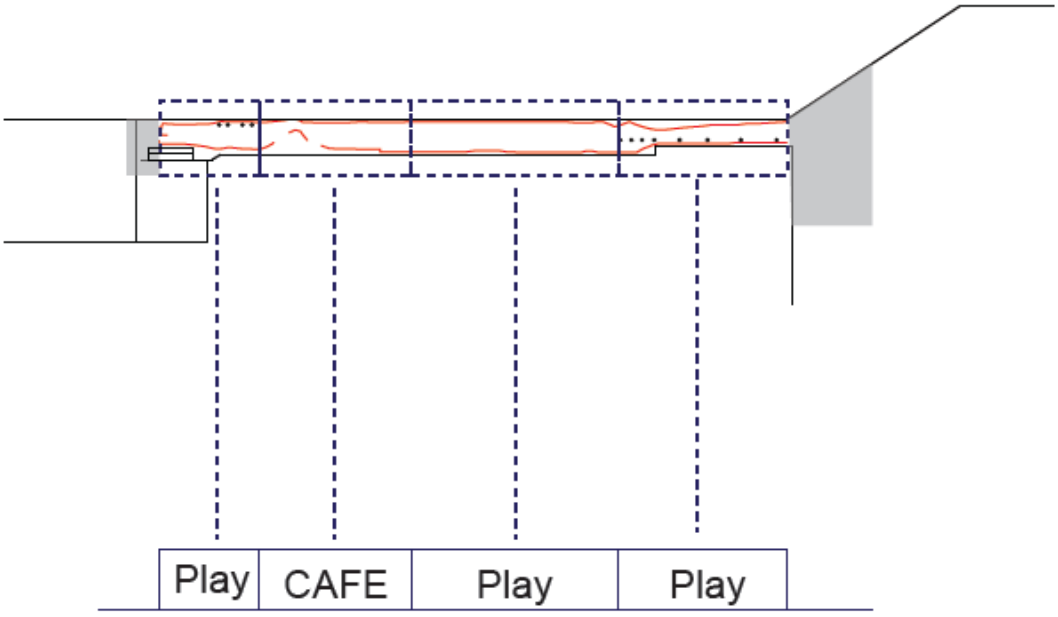


Figure 78: Conceptual Diagram of Narrative of the Space

Furthermore, people have different senses stimulated in different areas. The people, who access this place from the subway station and the shopping mall, will first experience the sense of sound by walking through the interactive floors which emit sound and this will be the initial engagement with the space. Further engagement with the space will be encouraged by

using different sounds and pitches to be emitted from the floor panels so that users can walk on the panels to create their own melody or tune.

After passing the interactive floor of the playing area, they will enter the next playing area where people are encouraged to start touching the walls that are covered with interactive touch panels. These walled panels will also detect the presence of humans as they walk by and start emitting light and graphics that will encourage people to reach out and touch the wall. These interactive walls allow people to become more engaged with architecture by touching and playing with them which can result in optimal interaction. The tactile sense is heightened by using these interactive panels and also through the form of the structure. In the next step, people enter a calm area which I call a 'café', and it is in this place where people engage with the space through their sense of smell and taste. They can also enjoy and interact with other people by sitting down or standing near the interactive bar table which uses sensing technology to create different lights on the bar table that detect human presence and objects. In the last step, people begin to engage with the space by playing with the interactive ceilings which emphasize more on their sense of vision and also because their spatial awareness now tells them the ceilings are much lower. Essentially this environment aims to promote active participation between the users and also with their surrounding environment, which subsequently intensifies their experience with the space and now turns it into a "place". These ideas are clearly shown in the below conceptual diagrams (Figure 83 and 84).

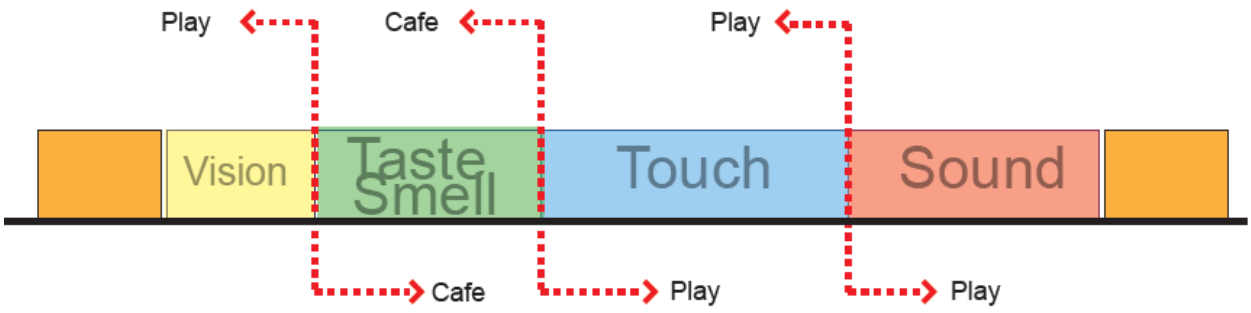


Figure 79: Conceptual Diagram of Narrative of the Space

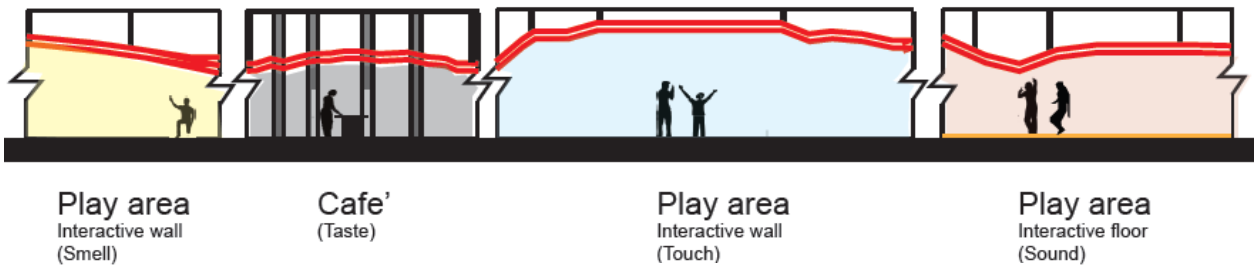


Figure 80: Conceptual Sectional Diagram of Narrative of the Space

With respect to connecting the transition points between these areas, I envisioned how I could overlap these experiences with each other, so I introduced the narrative of having interactive panels into various shapes throughout the designed space. The interactive floors will eventually conform to the interactive walls; and then the interactive walls will eventually conform to the ceiling. This concept allows users to undergo changing experiences as they move from one area to another. The diagram (Figure 85) below demonstrates how the floor transforms to the wall and finally to the ceiling, where users are stimulated at first through their sense of sound and then finally through their sense of vision.

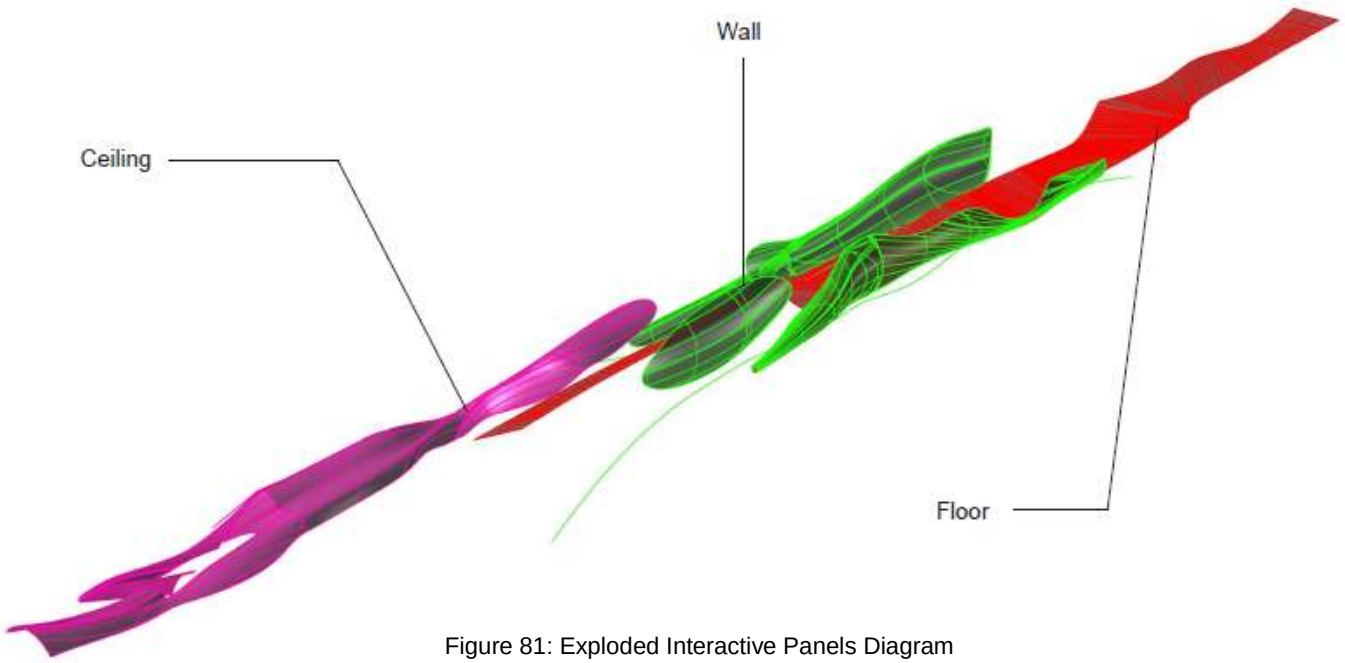


Figure 81: Exploded Interactive Panels Diagram

4.5 Final design proposal

The concepts and ideas from the previous chapters are now converged with the intent of designing an installation in the underground pathway which is illustrated in the following pages. After introducing the required criteria for my design proposal, I will illustrate the integration of all the previously mentioned criteria in the final design proposal.

Firstly, I started to connect the underground pathway design on both sides of this pathway. (See figure 86, 87 and 88) As you can see in the following conceptual diagrams and images, it is important to connect the installation on both sides of the pathway to capture people's attention whether they are entering or exiting the building. Initially, user's attentions are captured by using visual simulations to peak their curiosity.

Figure 82: Conceptual Diagram for connecting the pathway to the both sides

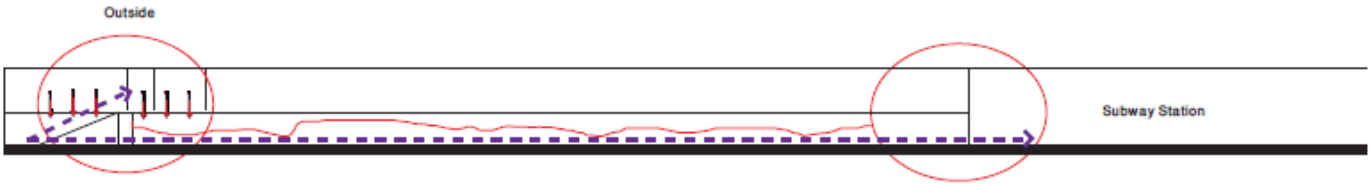


Figure 83: Sectional Diagram for connecting the pathway to the both sides

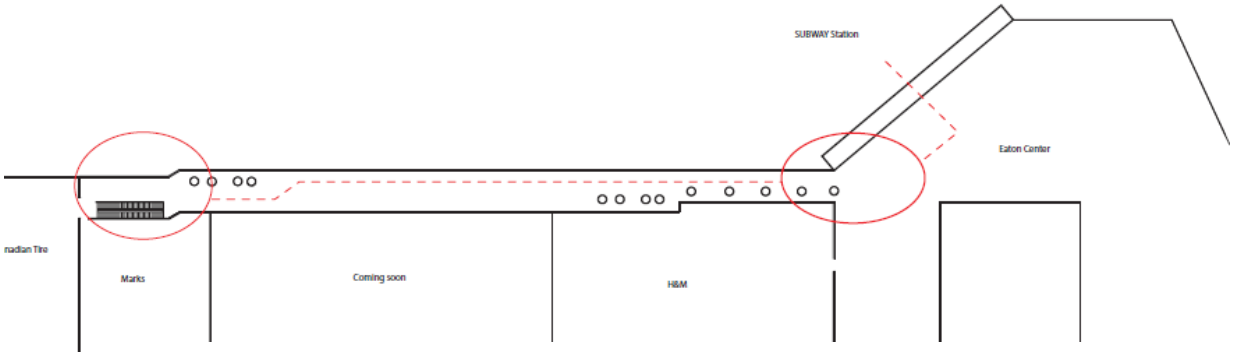


Figure 84: Underground pathway plan diagram for connecting the pathway to the both sides

For the part that is situated next to the subway station entrance and the Eaton Center shopping mall (Figure 89 and 90), I proposed some interactive LED light panels which will be located on the extension of the chosen floor site to grab people's attention at first glance. This essentially stimulates a person's sense of sight where bright colors are emitted to attract attention. As you can see in figure 91, these LED panels can capture people's attention by creating a visual connection with users and encourage them to explore this underground pathway. I chose the floor for this section as the primary place to have the LED panels on so that it serves as an extension of the interactive floor area, and entice people to explore the area further.

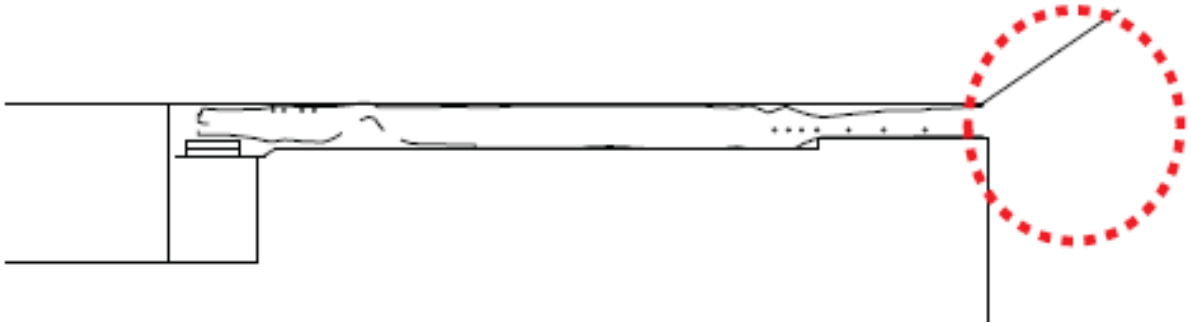


Figure 85: Diagram showing the part near the Subway Station Entrance

Figure 86: View from the Subway station Entrance

Figure 87: Perspective View from the Pathway Entrance and how the LED Floor Panel Inserted on the Floor

After people enter this section of the pathway, they will enter a play area (Figure 92 and 93) where people can play with sounds and create their own music by interacting with the sound floor panels. This allows people to engage with their aural sense as well where people are able to hear the sounds based on the pattern of their movement. In addition to stimulating a person's hearing sense, the aural sound emitted is also used to engage the users in an act of play with the fixture. Users interact with the floor panels by stepping on them which allows them to create a sound of a particular tone or pitch. The section (Figure 94) clearly illustrates how this playing area with the help of sensing technology can create a collaborative environment which heightens the experience for users who are steered by their aural sense.

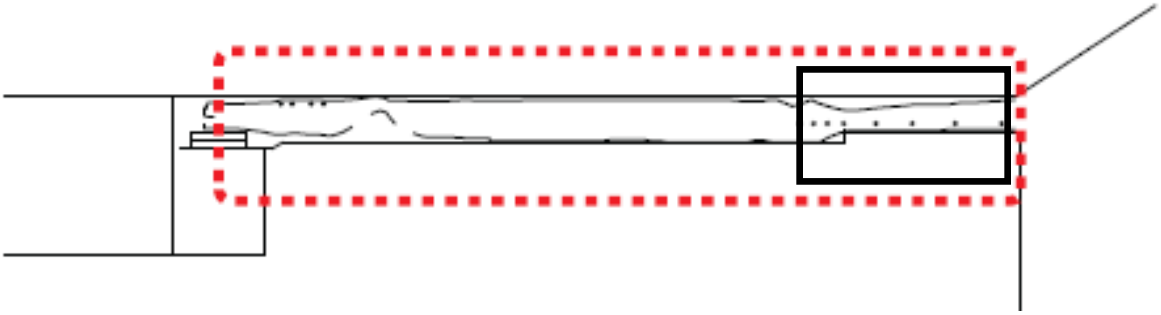


Figure 88: Diagram showing the first play area part

Figure 89: View from the Underground Pathway Corridor

Figure 90: Sectional View from the Interactive Floor Play area

Figure 91: Perspective View from the Interactive Floor Play area (Sound)

In the next step (Figure 96), the interactive panels convert to walls and people start to play by touching the interactive walls. These walls detect human presence by their sensors and generate some lights and graphics that can capture people's attention and encourage them to touch them. Utilizing digital tiles that display lights and images, the user is compelled to interact with the wall using their fingers which essentially stimulates the sense of touch. When people start touching the walls, they can start playing by choosing different play options that appear on the wall. The act of play is collaborative in the sense that they promote people to interact with each other. The games renew and are replaced by different panels every week in case there are people who pass by this corridor more than once a week; this way people don't get bored with the games. This play area gives people an opportunity to engage with the architectural space by using their sense of touch, and also the way this structure is constructed as it helps them to be more engaged with the architectural space. (Figure 98 and 99)

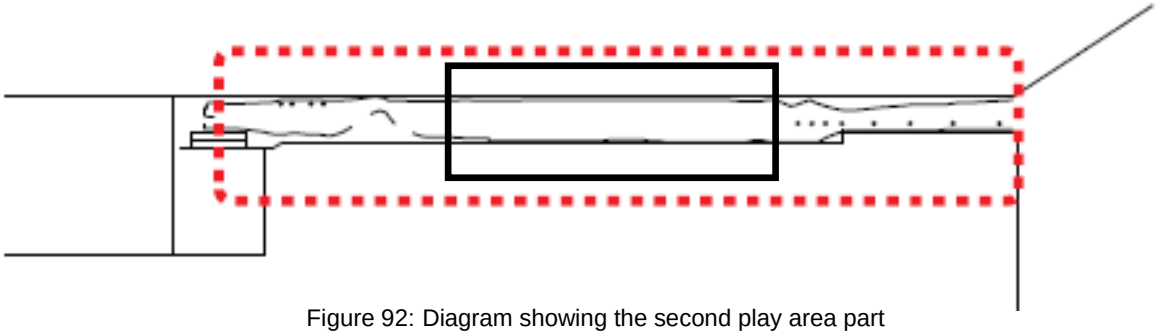


Figure 92: Diagram showing the second play area part

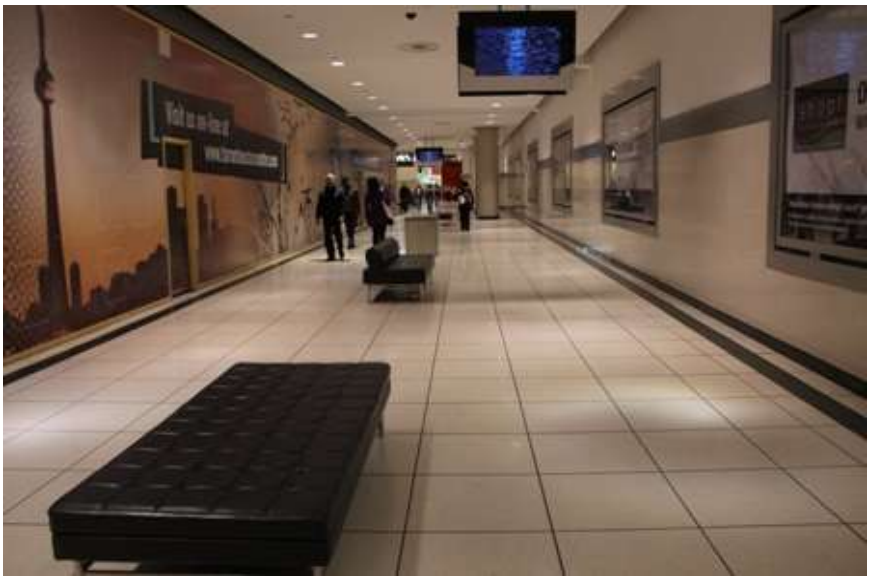


Figure 93: View from the Underground Pathway Corridor

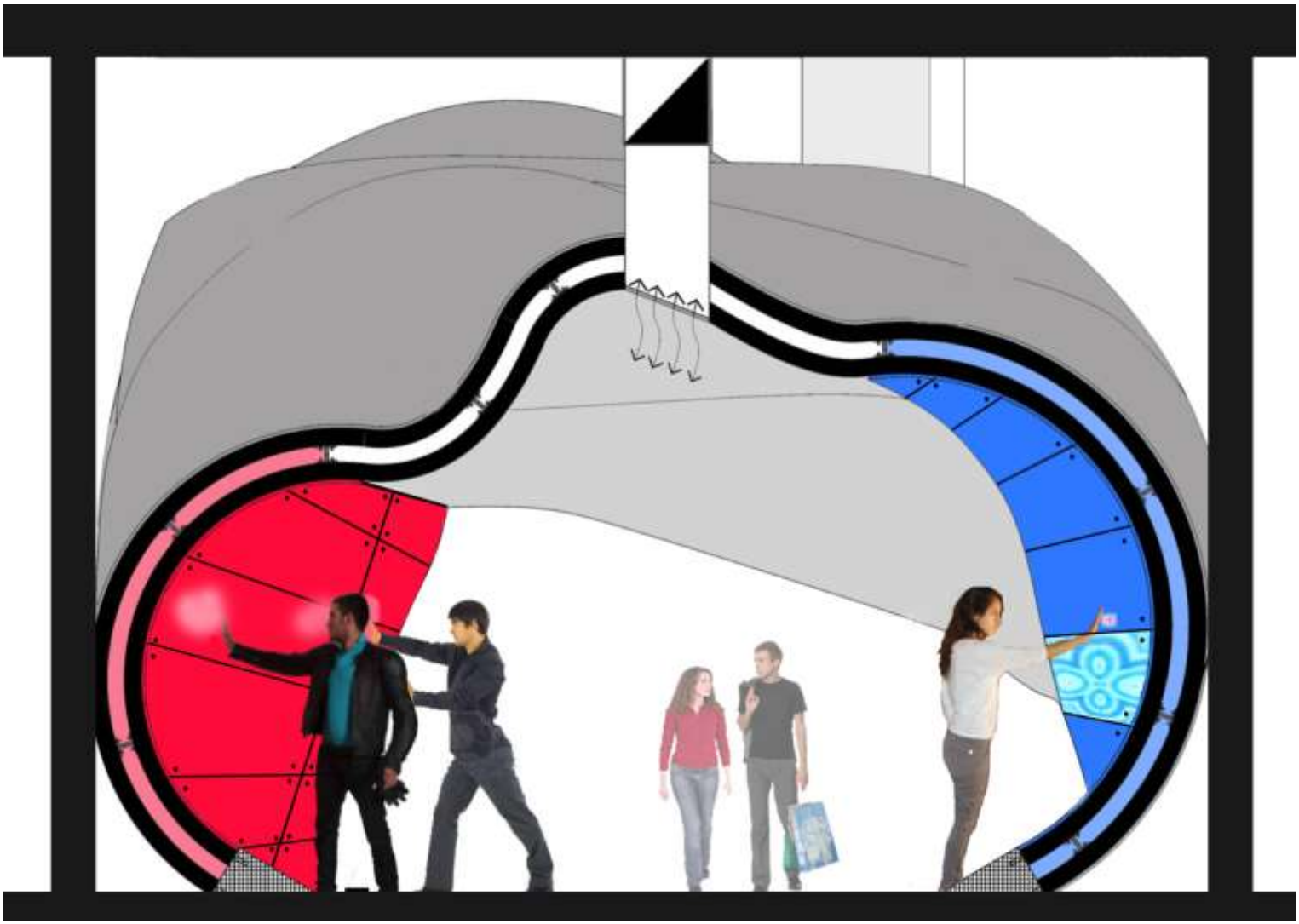


Figure 94: Sectional View from the Interactive wall Play area

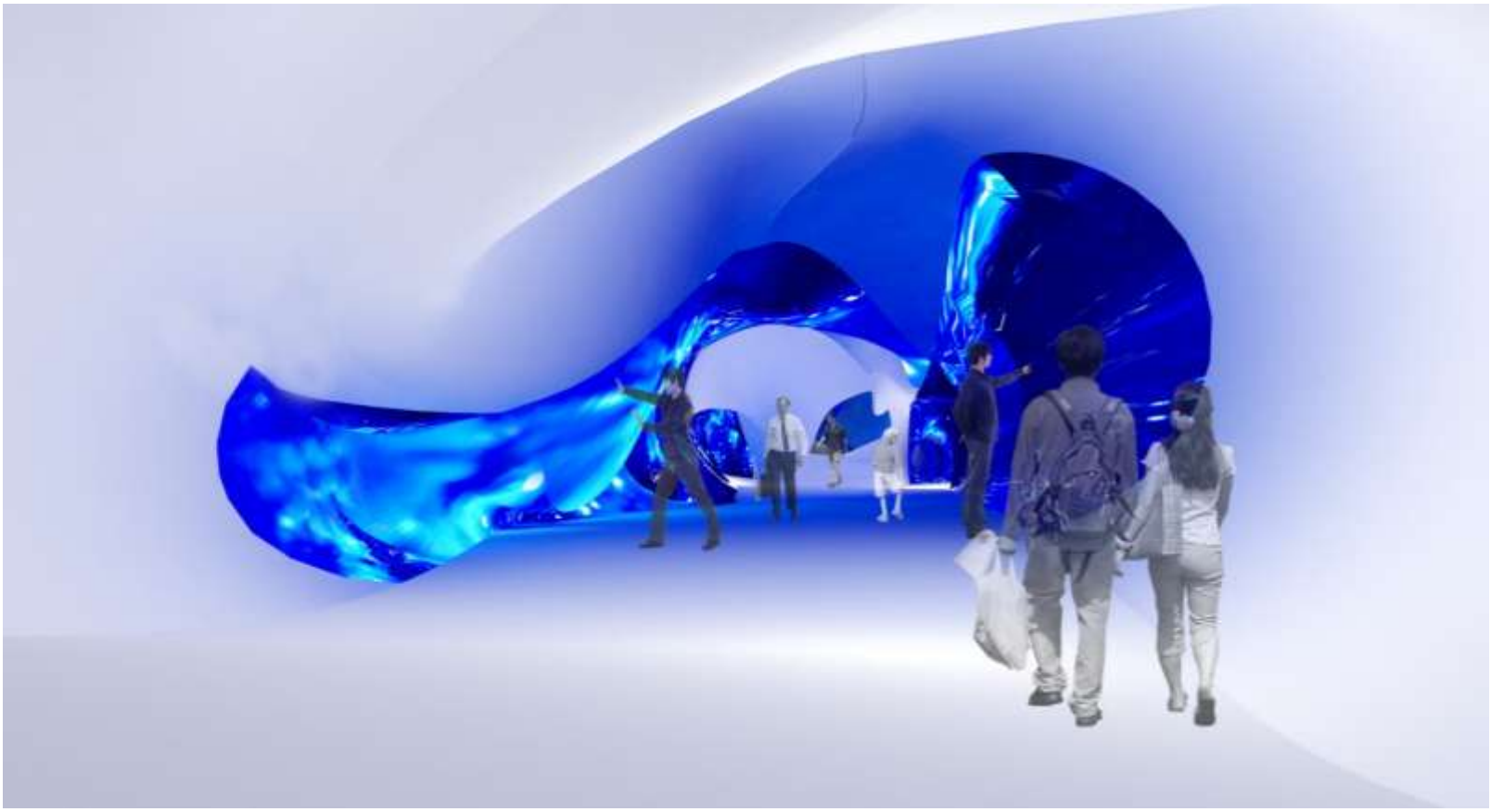


Figure 95: Perspective View from the Interactive wall Play area (Touch)

Between the play areas (Figure 100), people can find a calmer place where they can sit and enjoy their time by tasting and smelling different drinks and snacks. This Café encourages people to engage with the place using their sense of smell and taste. It also promotes people to socially interact with each other. (Figure 102) By installing interactive bar tables in this café, people are encouraged to interact with others by playing with this interactive bar table. The way this Café is designed, it allows people to choose whether or not they want to use the café, and the structure creates a sense of curiosity the way the café is half open to the passerby.

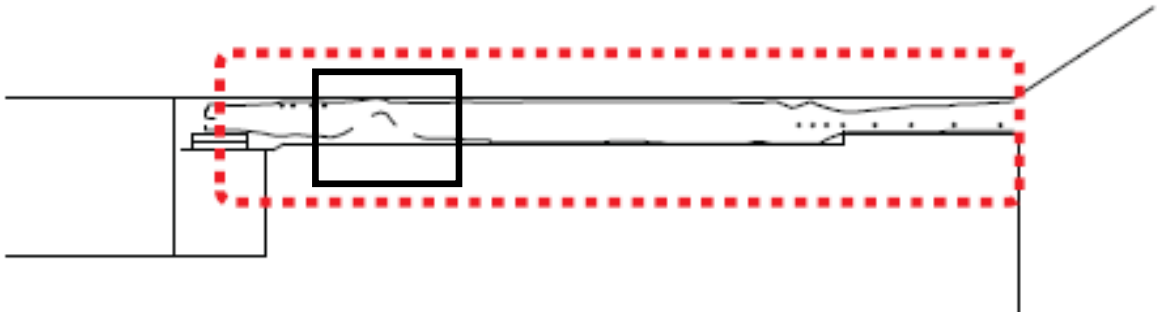


Figure 96: Diagram showing the Café part

Figure 97: View from the Underground Pathway Corridor

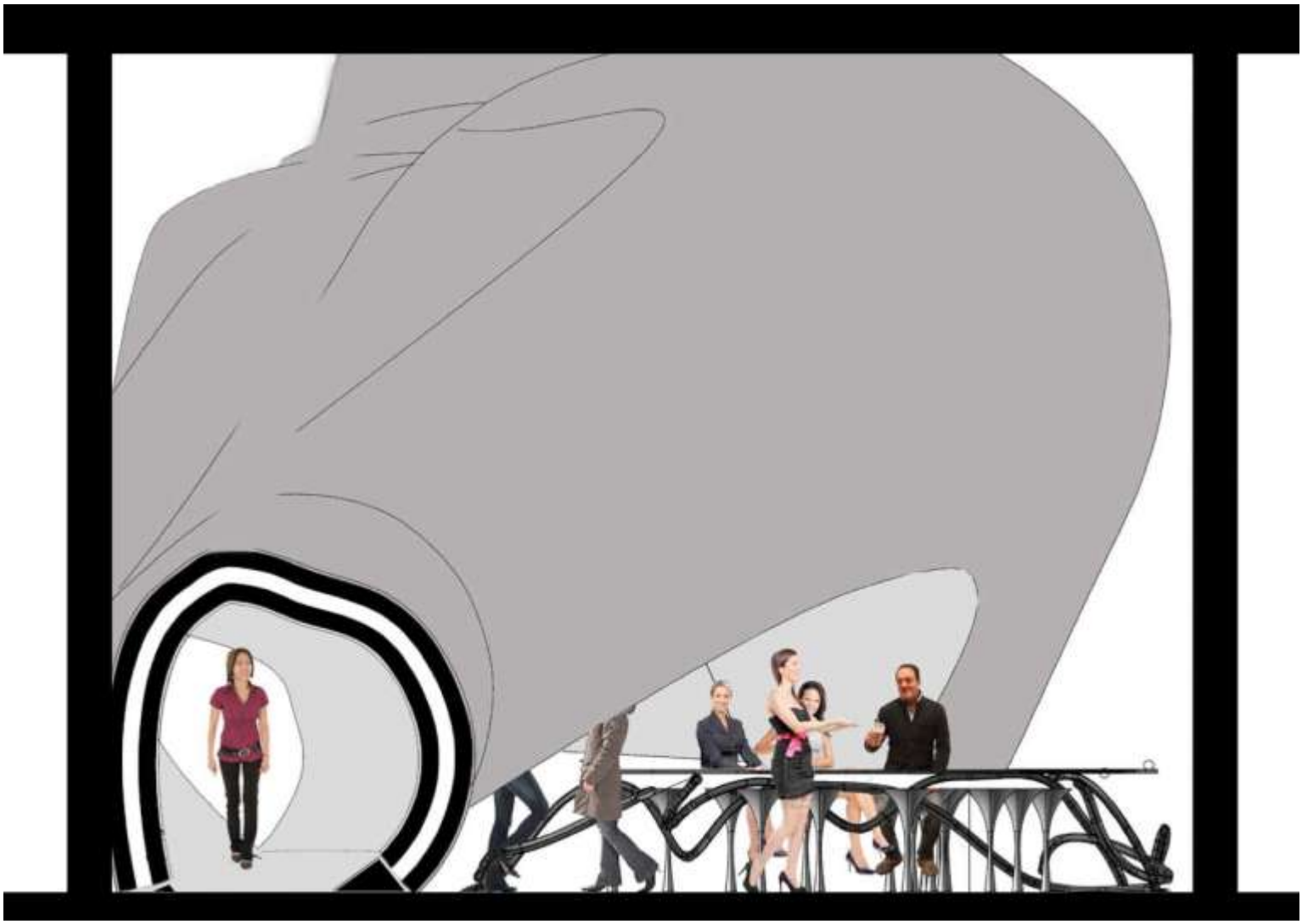


Figure 98: Sectional View from the Café

Figure 99: Perspective View from the Café (Smell and Taste)

In the last part of the pathway, there is another play area where people's presence is detected by the panels that are installed on the ceiling. The ceiling starts to interact with people by creating lights and graphics and people interact with the ceiling as they are moving in different directions. Also, people can touch the ceiling in some parts that have lower heights. This place encourages people to engage with the space visually and in some parts both visually and through their tactile sense. (See figure 106 and 107) This play area is next to the staircase (Figure 105 and 106) and connects this pathway to the upper floor where Ryerson School of Management and the building Entrance is located. Therefore, it is a good idea to connect this part to the upper floor.

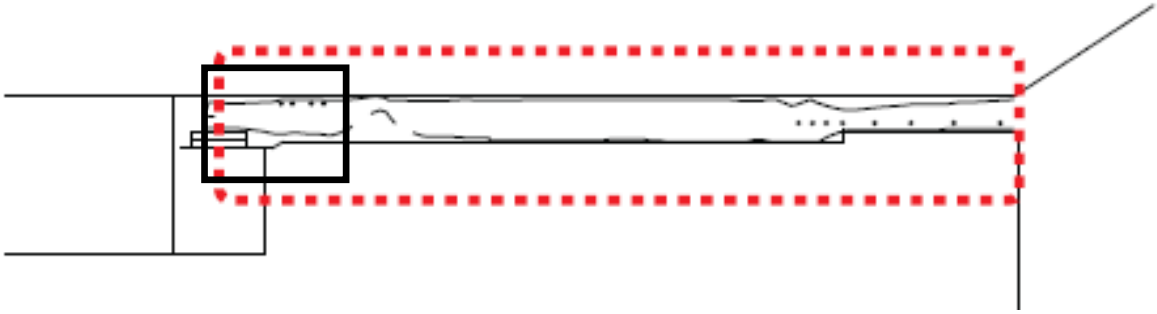


Figure 100: Diagram showing the Third Play Area Part

Figure 101: View from the Underground Pathway Corridor

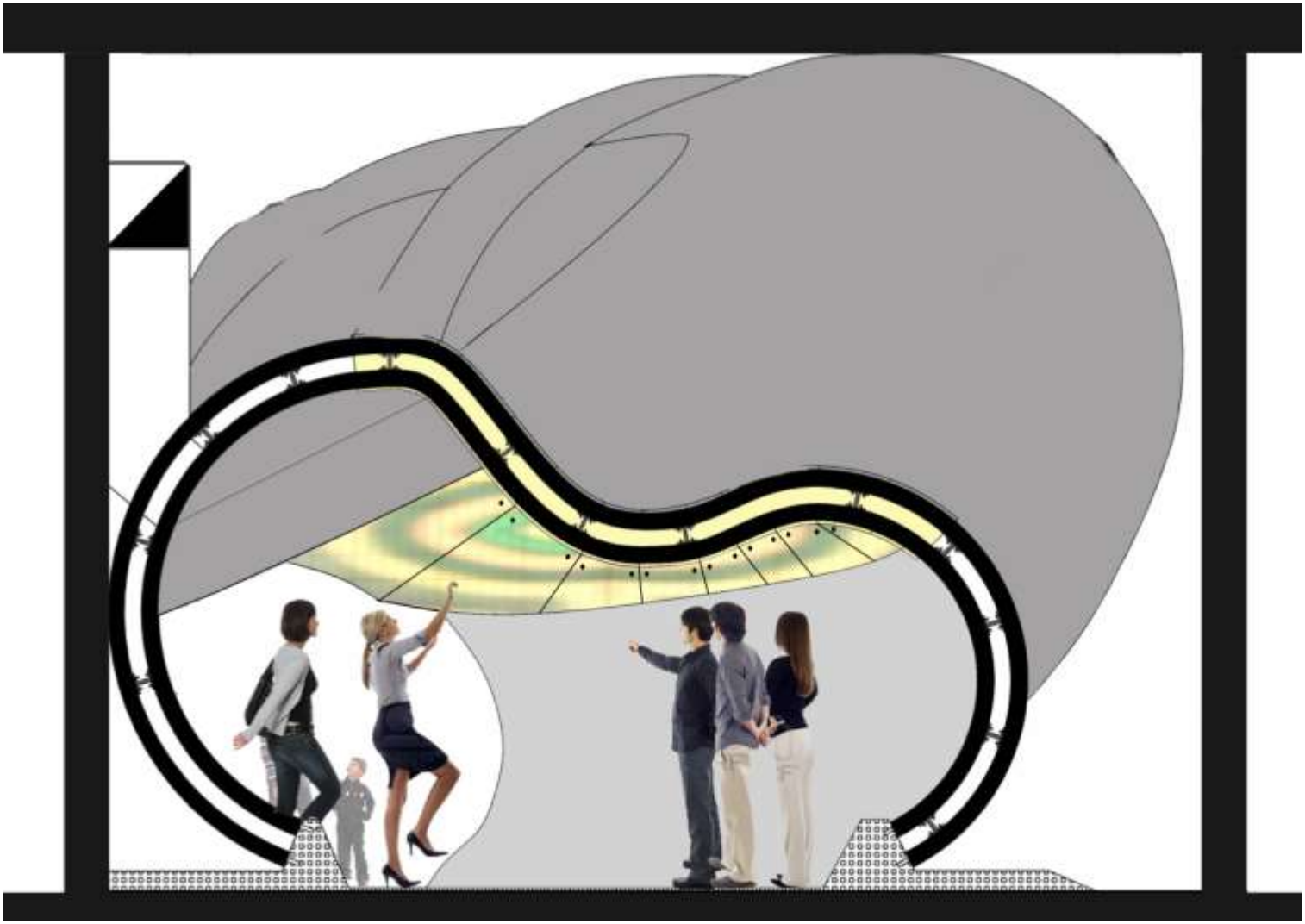


Figure 102: Sectional View from the Interactive Ceiling Play area

Figure 103: Perspective View from the Interactive Ceiling Play area (Vision and Touch)

For connecting the underground pathway to the upper floor and the building entrance, I decided to design some pipe fixtures that extend out of the pathway installation structure. By extending them to the upper floor with the help of the staircase that connect these two areas, the design aims to grab people's attention when they enter from the building or the Ted Rogers School of Management entrance. These linear pipes are the initial demonstration of the installation that is located in the underground pathway, and acting as a visual connection with people, it encourages them to go downstairs and experience the underground pathway. The pipes will be in different colors where each color represents the different senses that are heightened in this journey. Again, the sense of sight is stimulated using the pipes as an attention grabber. (See figure 110) This demonstration can be the beginning of this journey or the end of this experience.

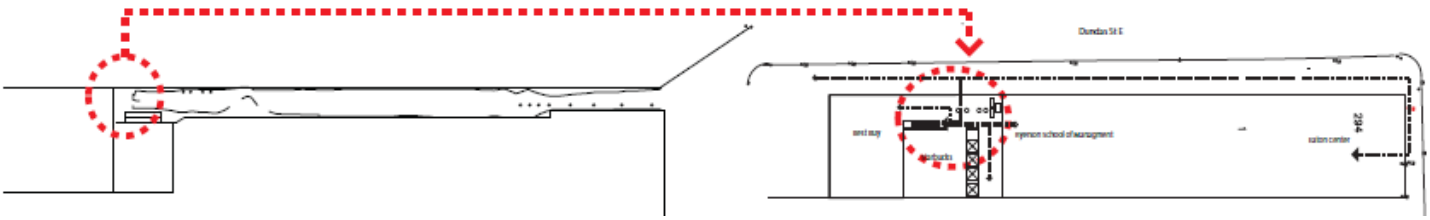


Figure 104: Diagram showing the part Near the Upper floor Building Entrance

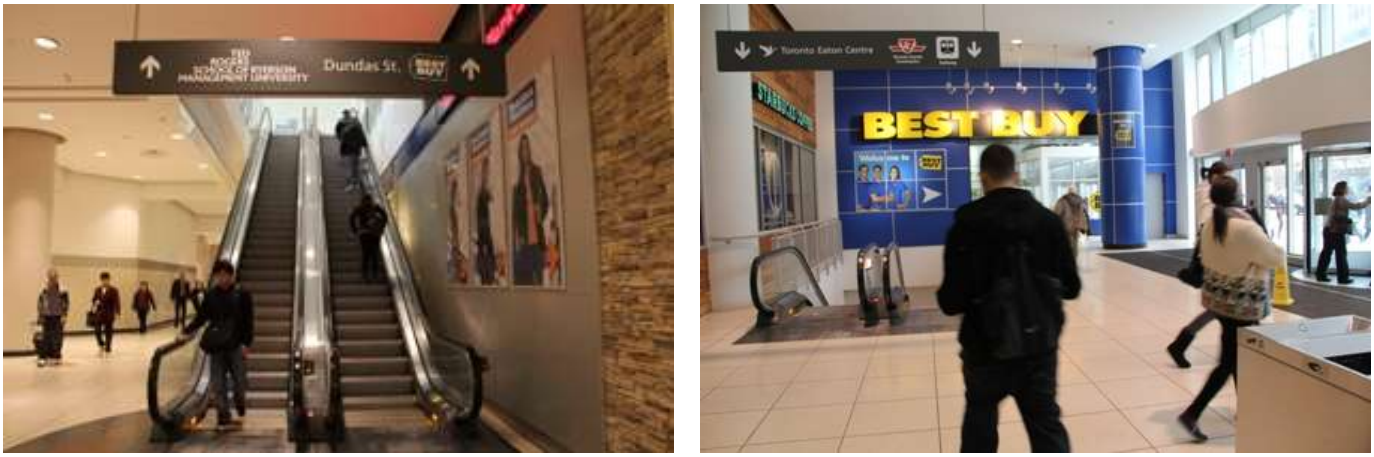


Figure 105: Views from the Upper Floor Building Entrance and Its Connection to the Underground Pathway Through the escalator

Figure 106: Perspective View from the Building Entrance that is connected to the Installation through the escalator (Vision)

Figure 107: Perspective View from the Building Entrance that is connected to the Installation through the escalator (Vision)

4.7 Structural Details

After illustrating the final design proposal and the new experience that the people can undergo by the transformation of the underground pathway into a meaningful place, the structural details of the proposed installation will now be discussed. The conceptual idea for the structural detail of this installation was a meshed grid system. This meshed grid system contains multiple wood frames that intersect together, forming a complex geometrical shape. (See figure 111)

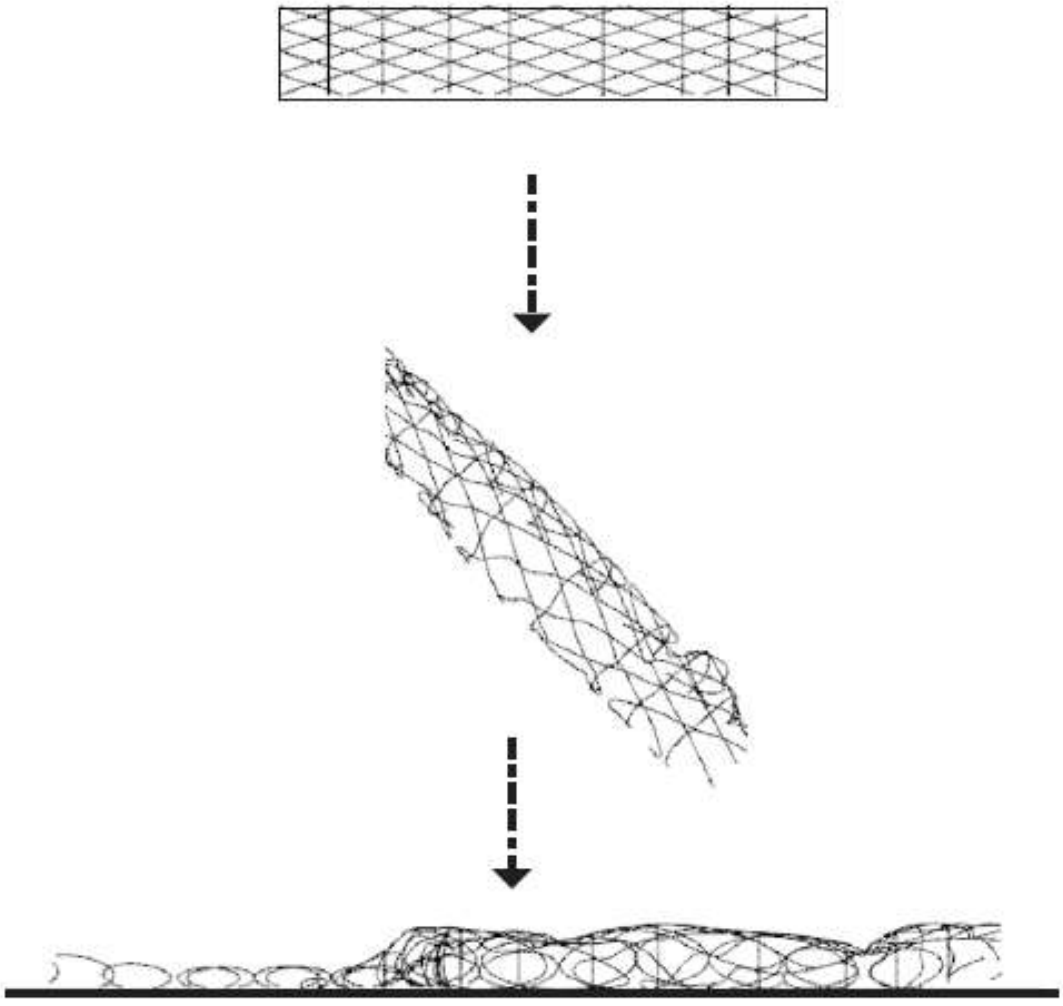


Figure 108: Primary Conceptual Structure

Also, the installation can be bolted to the floor and suspended from the ceiling through supports. (Figure 112) By having two grid meshes on top of each other and by putting a spacer in between them, I tried to leave some space for the digital panels and its technical wiring systems. The panels are bolted to the frames and are replaceable and removable in the event any technical problems arising. (See figure 113)

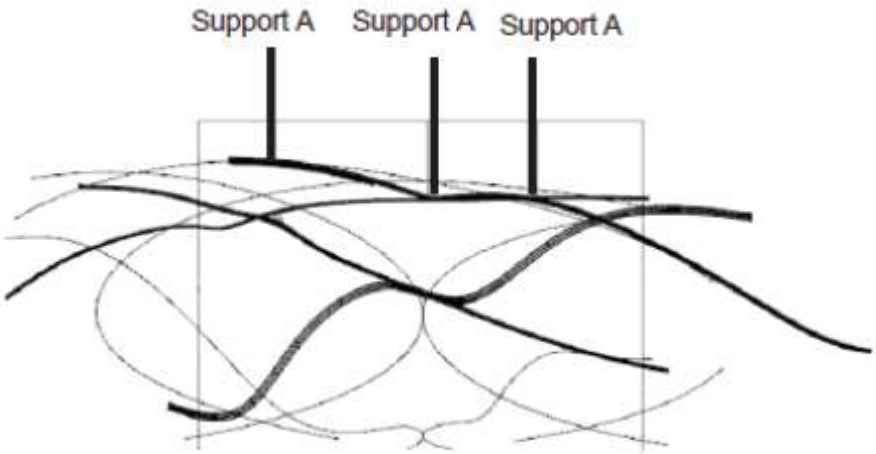


Figure 109: Conceptual Diagram showing the Way Structure Hang from the Ceiling with the Supports

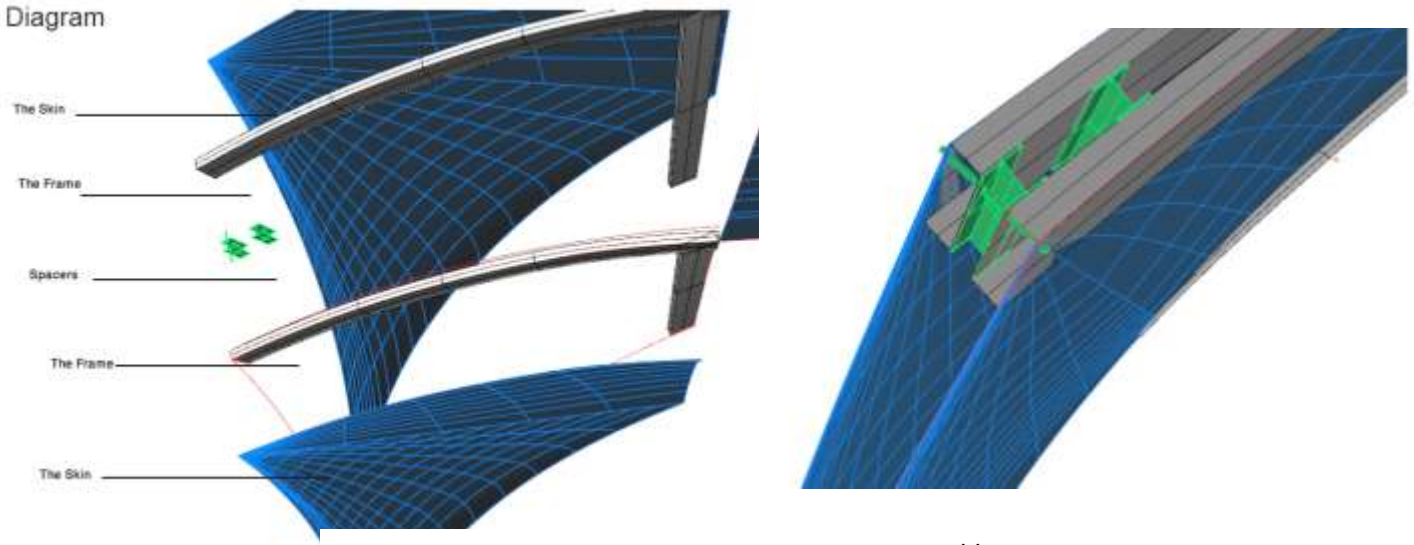


Figure 110: Conceptual Diagrams showing the structural idea

In some parts of this installation where the frames are twisted (Figure 114), I have introduced new “digital flexible panels” [7]that can be twisted. (See figure 115) These digital flexible panels are installed on the interactive walls and ceilings, and can be easily removed for fixing or replacement purposes. In the interactive floor play area, I have used sustainable interactive panels to generate electricity so that this energy can be re-used for the whole installation.

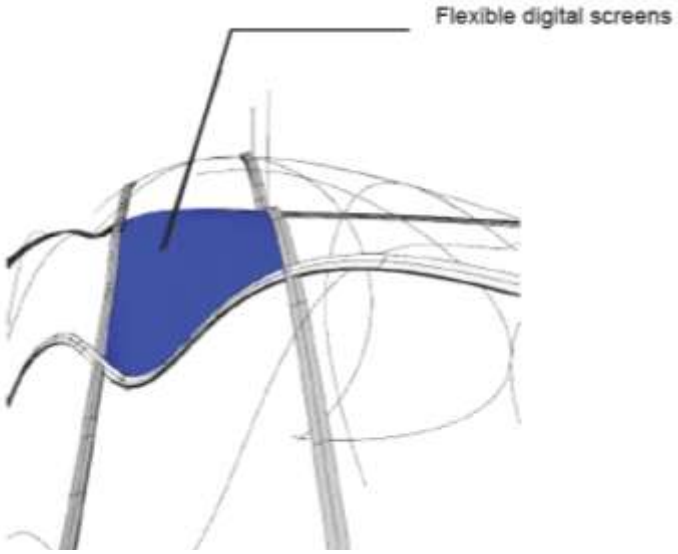


Figure 111: Conceptual Diagram Showing the way the Flexible Panel Install between the Frames

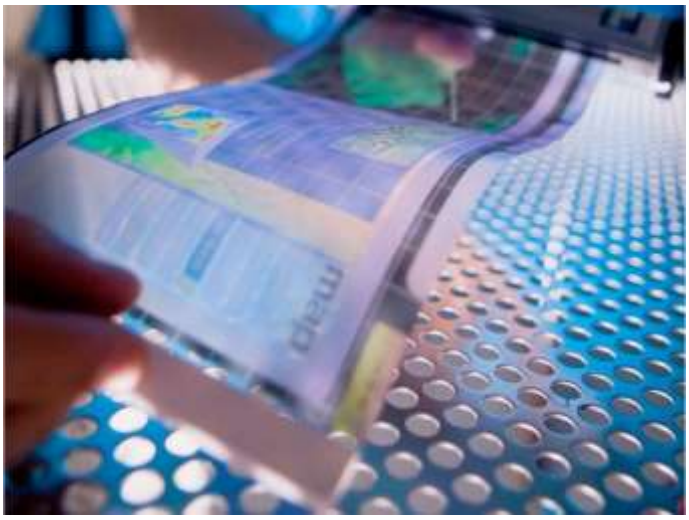


Figure 112: Flexible Digital Screen

[7] The crucial technological development happened recently at the Flexible Display Centre at Arizona State University in USA.(Wired, 2011. Retrieved on November 5th 2011 from http://www.wired.com/gadgetlab/2009/02/you-can-check-o/)

The detailed sections and structural diagrams, which are illustrated in the next pages- clearly show the way these panels can be installed on the surface of this structure. The exterior facade and interior surface of the wooden structure will be covered with a light outer casing. The frames will be 30cm in thickness and have enough space for wiring and rear projection. For this part of the design, the interior membrane is constructed using a fiber glass membrane material because it is light, hard and flexible in the way that they can be molded into any shape. Also, the exterior membrane of this structure is covered with a light outer casing that is made from silicon fiber mesh because it is light, flexible and high temperature resistant. (See figure 117)

For the HVAC system of this installation, I considered creating some openings from the ceiling and inserting some pipes in them from the outside. These pipes will be used to suction air in and out from the entrance and exit of the area, enhancing overall air circulation. (See figures 118)

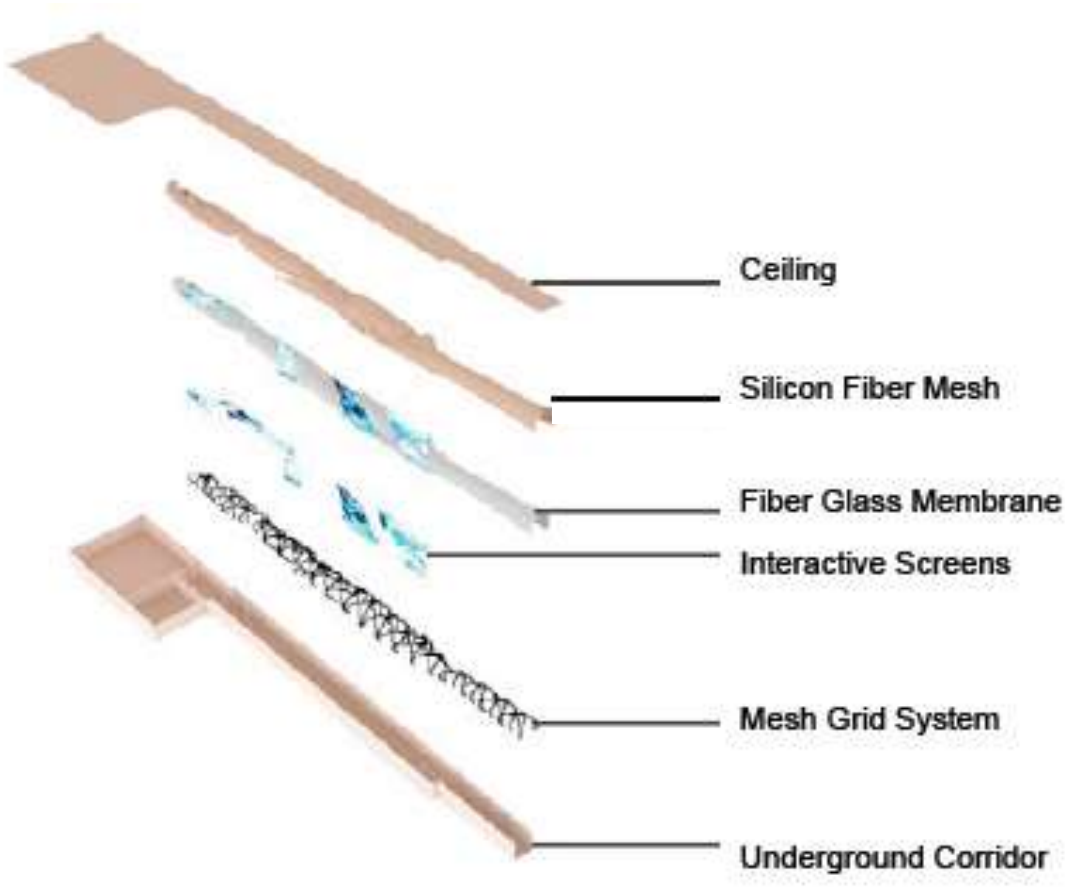


Figure 113: Installation Exploded Diagram

Figure 114: Detailed Long Section

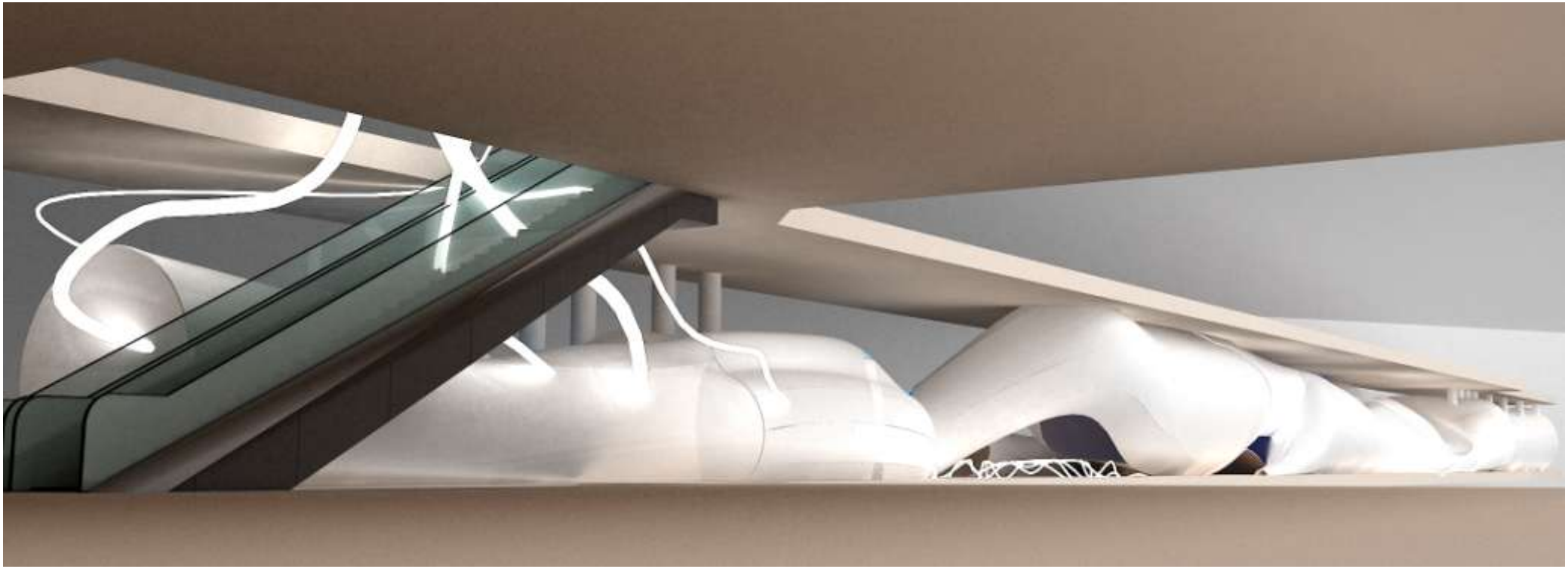


Figure 115: Perspective View from the whole Structure

Figure 119 shows the whole structure of the installation, and how the interactive panels located on the structure. In the next pages, the figures will demonstrate how the structure of this installation assembles together, and how the interactive panels install in this structure.

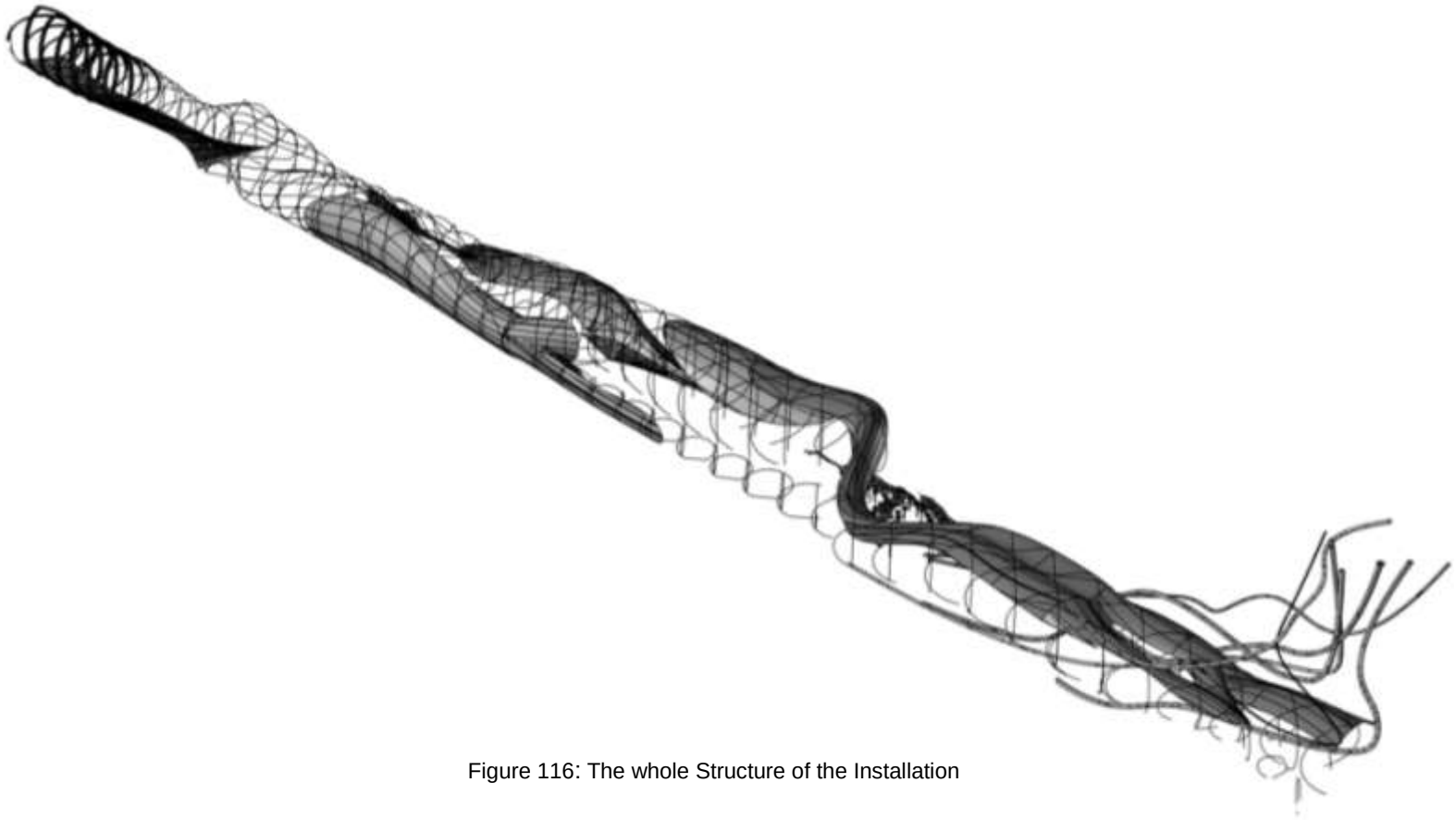


Figure 116: The whole Structure of the Installation

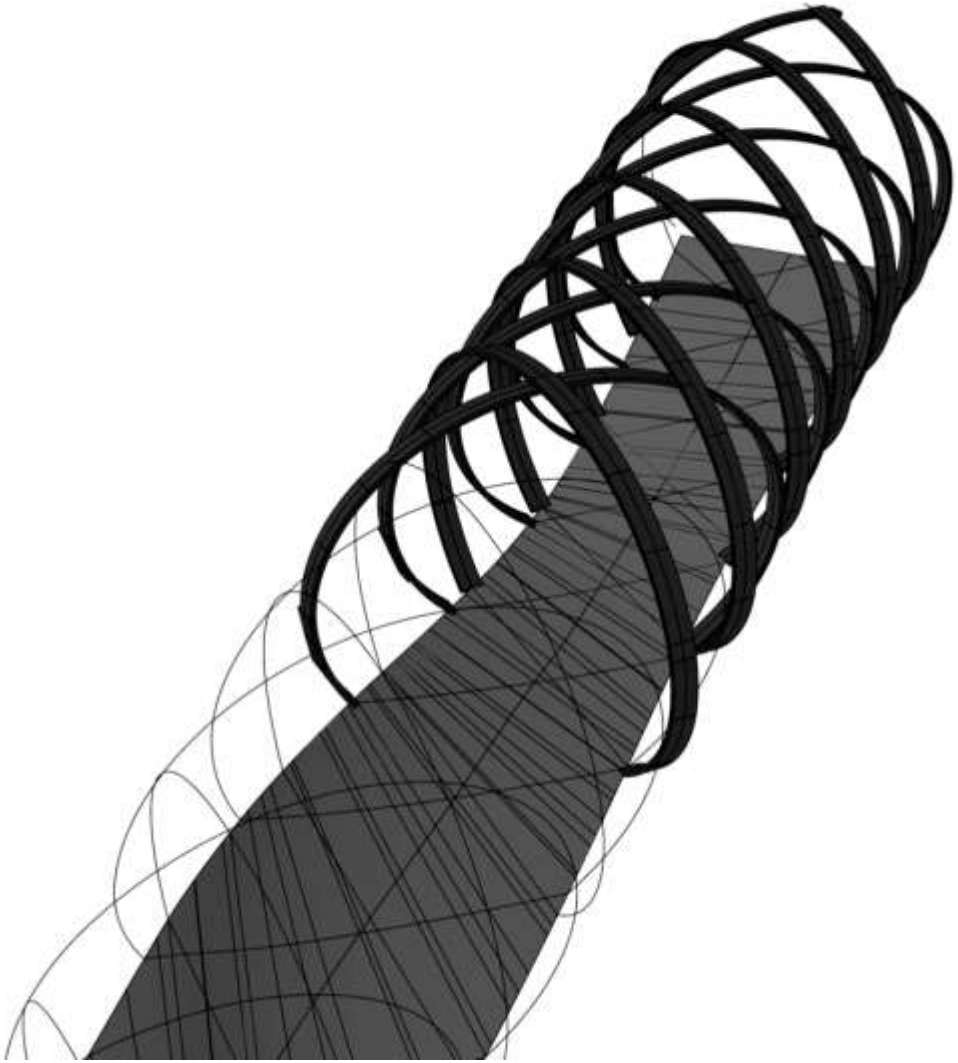


Figure 117: The Way the Installation’s Structure is designed

Figure 121 shows how the body of this structure assembles to the floor structure together. These structures are joined together by bolts and marbles.

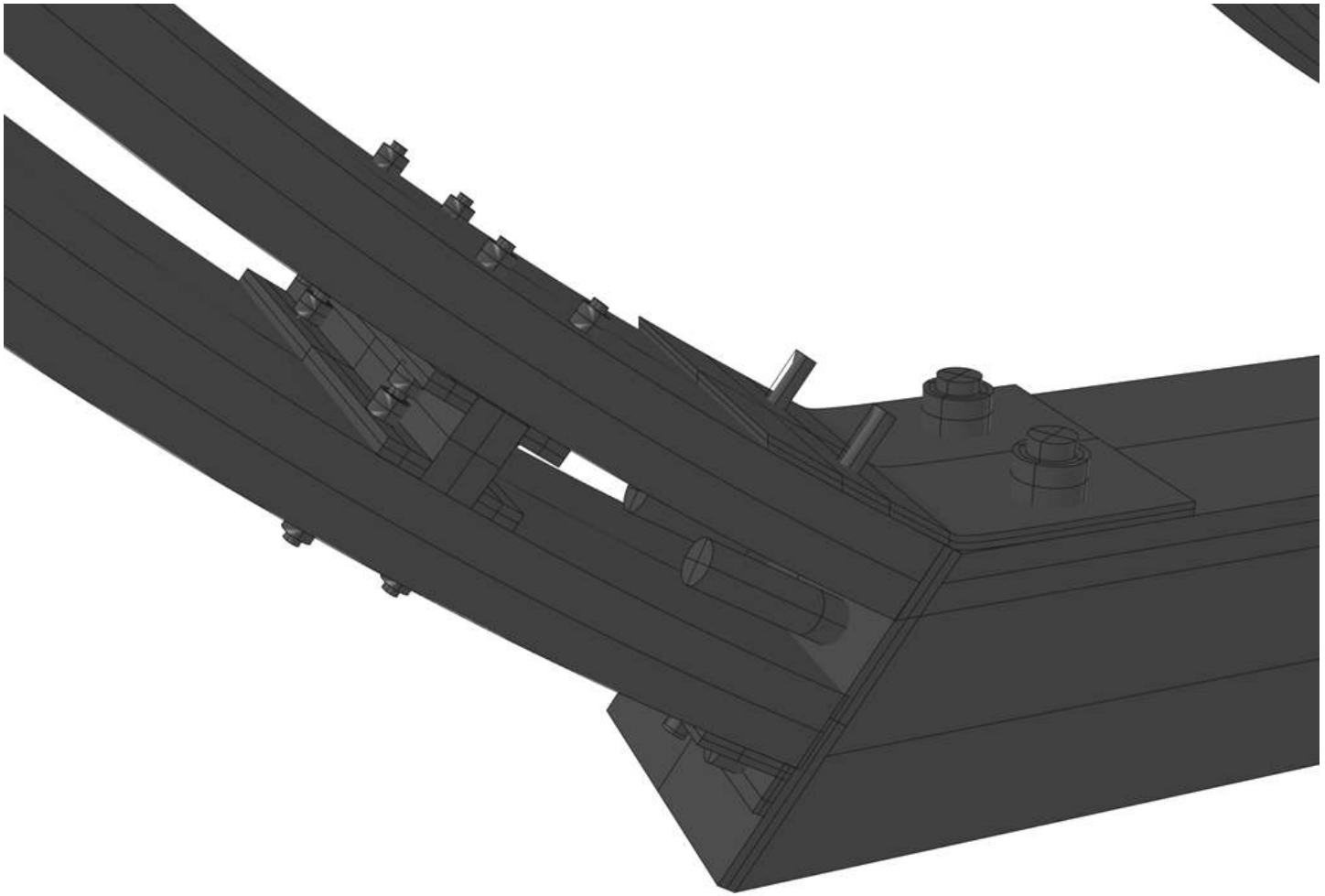


Figure 118: A Diagram shows how the Body and the Floor Structure assemble

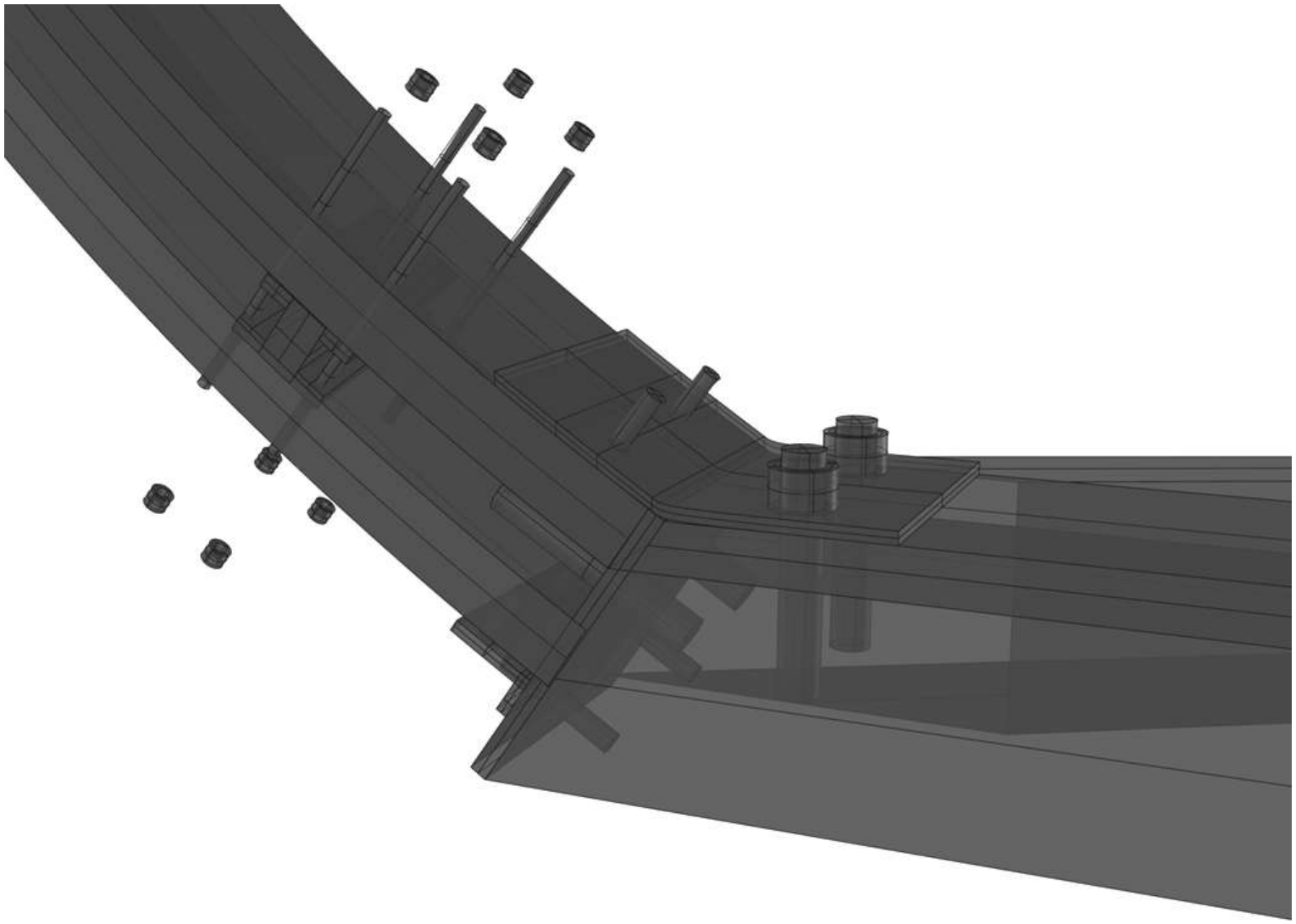


Figure 119: An Exploded diagram shows how the bolts fix together

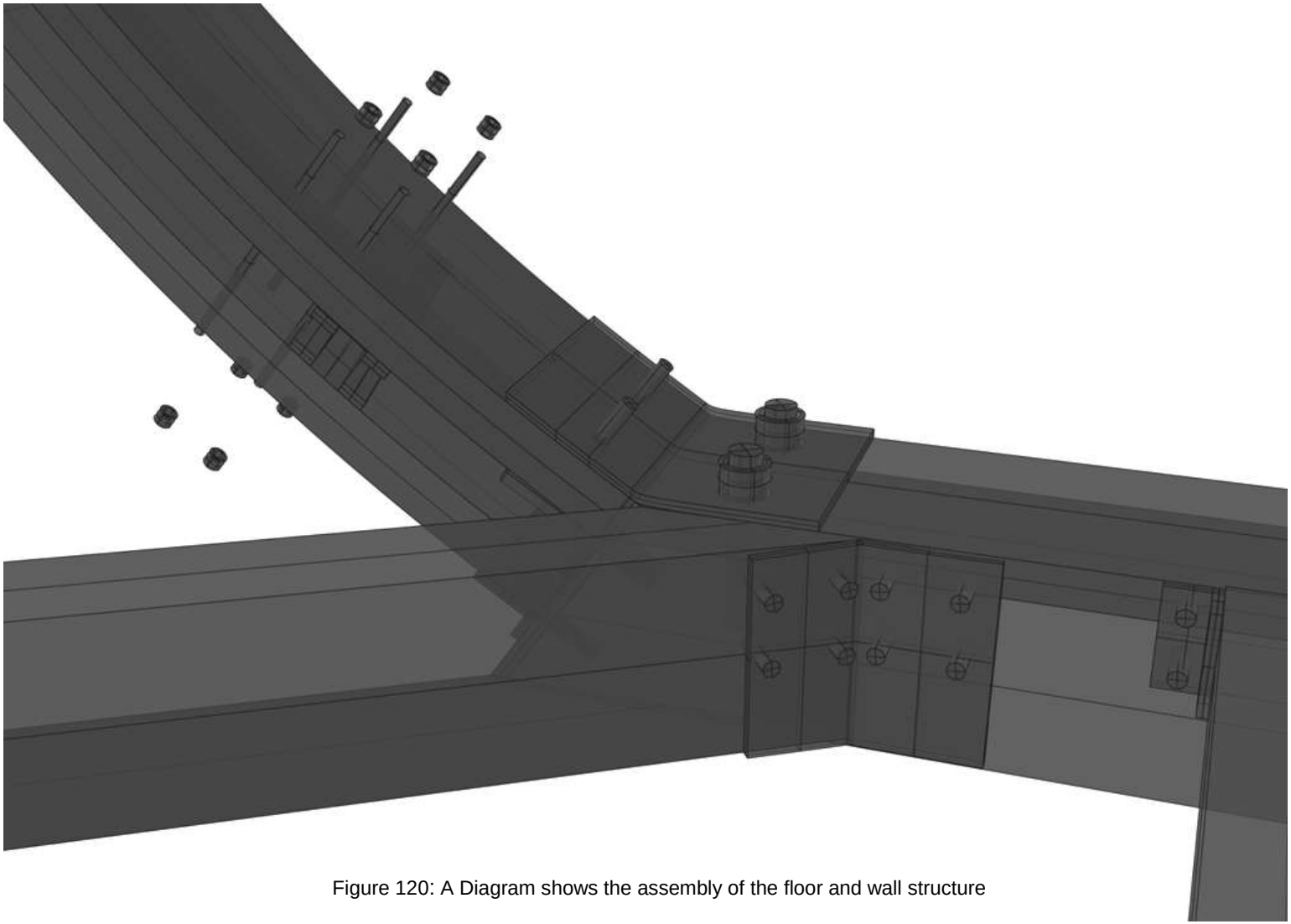


Figure 120: A Diagram shows the assembly of the floor and wall structure

Figure 124 shows the structural detail of the floor, and how the interactive sustainable floor panels are fixed to the floor structure. These floor panels are located on top of the spring sensors that help the panels to capture the energy from people who walking or jumping on these panels and consequently generate electricity.

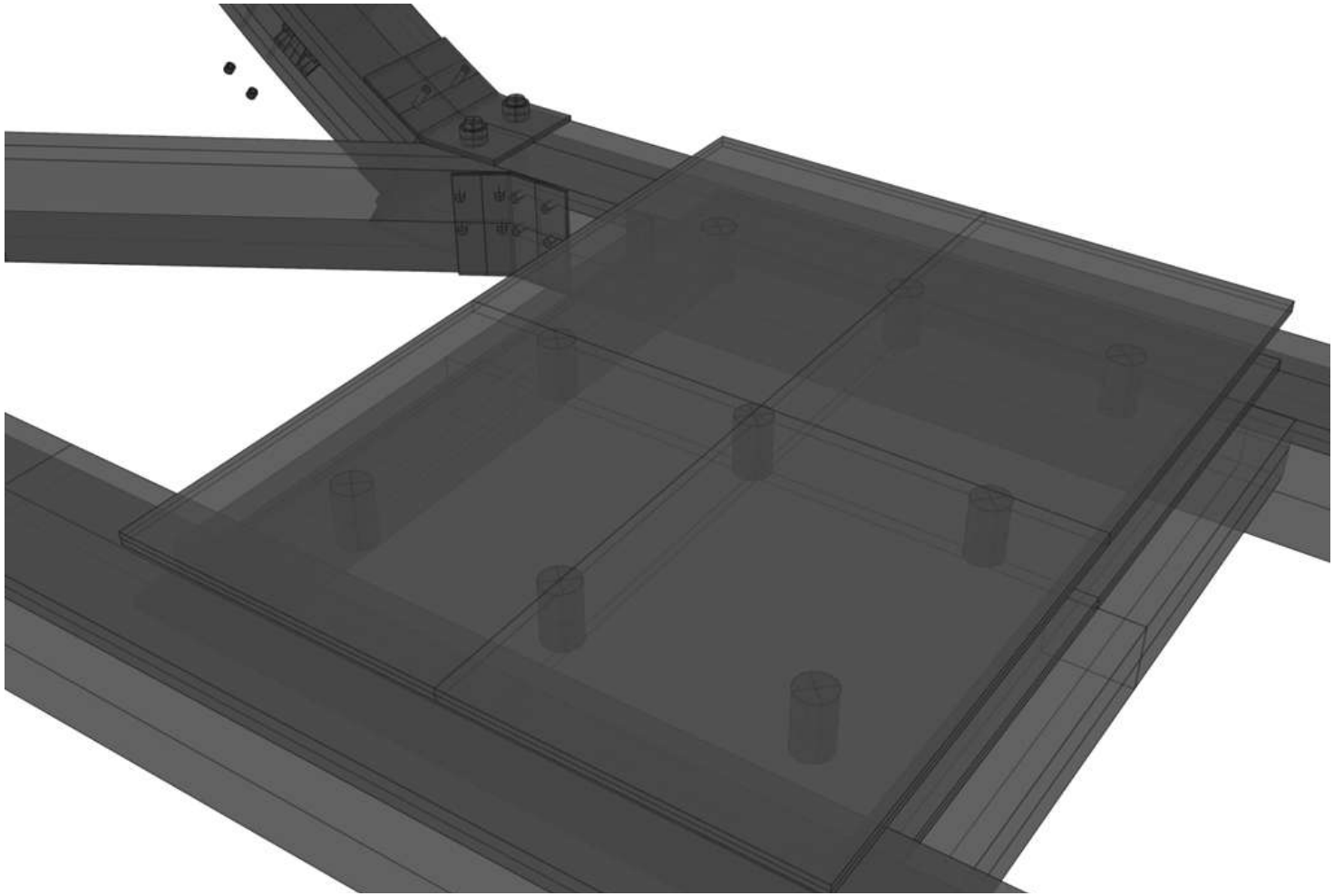


Figure 121: A Diagram illustrates the floor structural detail

Figure 125 and figure 126 are both diagrams on structural details that show the wall structure, and where the panels adjoin to the wall. These panels also fix to the structure with bolts. The structure can be made from wooden or metal hexagonal units that intersect together – forming a multifaceted geometrical shape that curves in different parts.

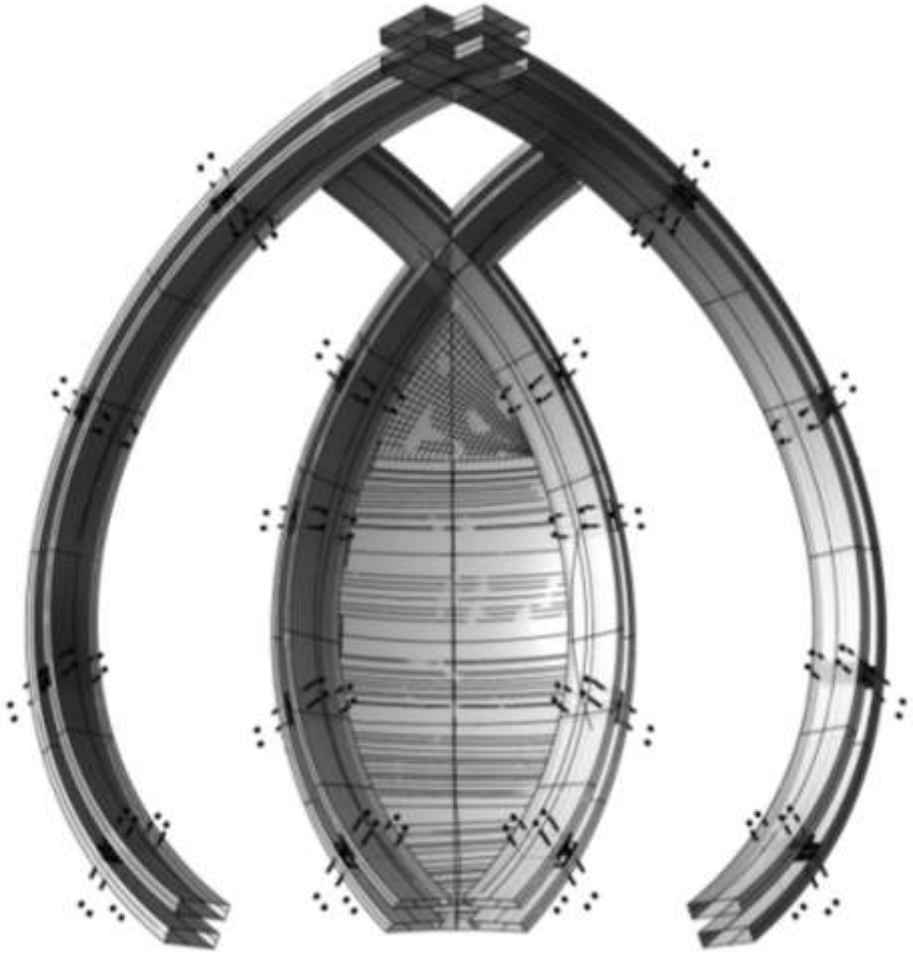


Figure 122: The wall structural detail

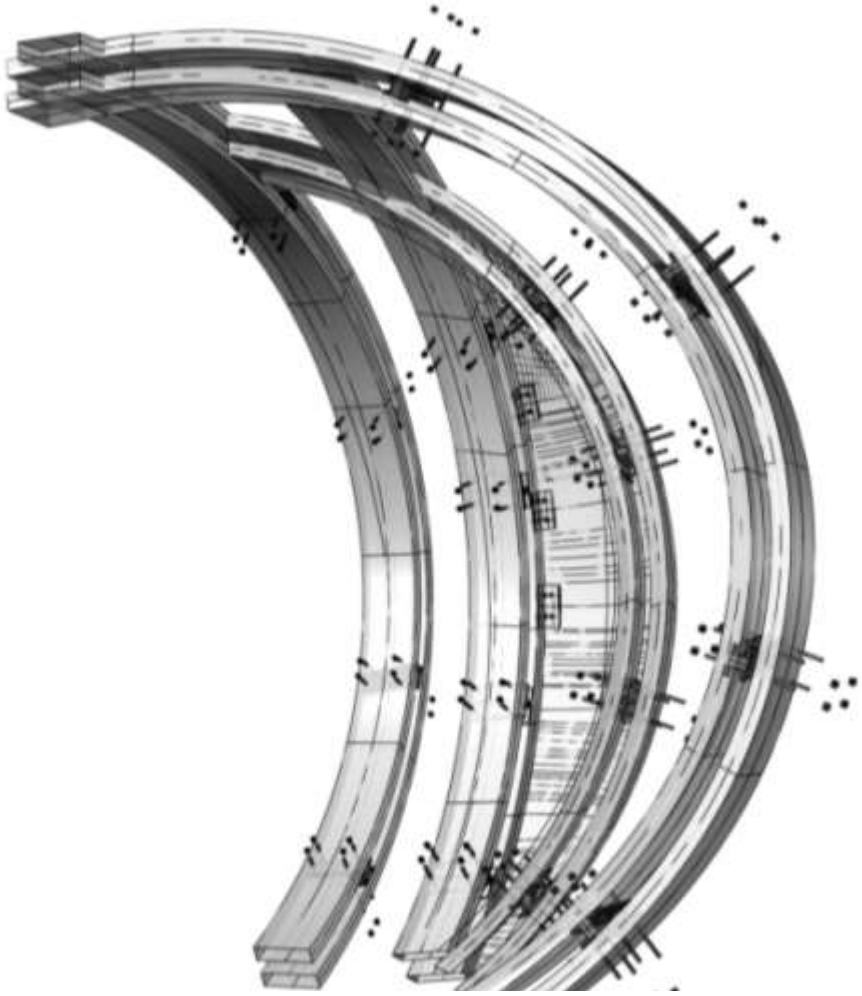


Figure 123: The Wall Structural Detail

The figures 127 and 128 show the structural details of the wall where the interactive touch panels are fixed to the wall by the bolts. In these figures, the space between the exterior and the interior frames are clearly demonstrated where the technical wiring of the interactive panels can be located.

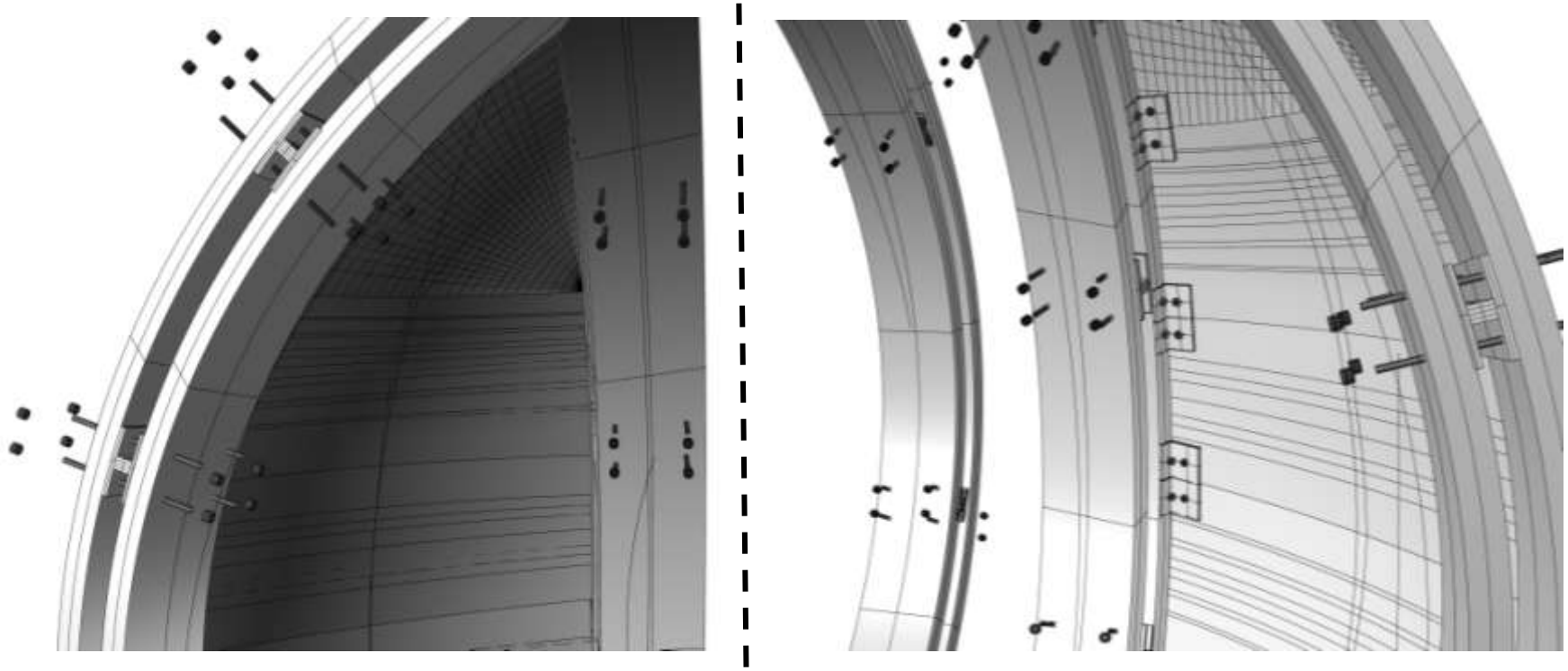


Figure 124: A Diagram shows how the interactive panels assemble into the wall structure

Figure 125: A Diagram shows how the interactive panels assemble into the wall structure

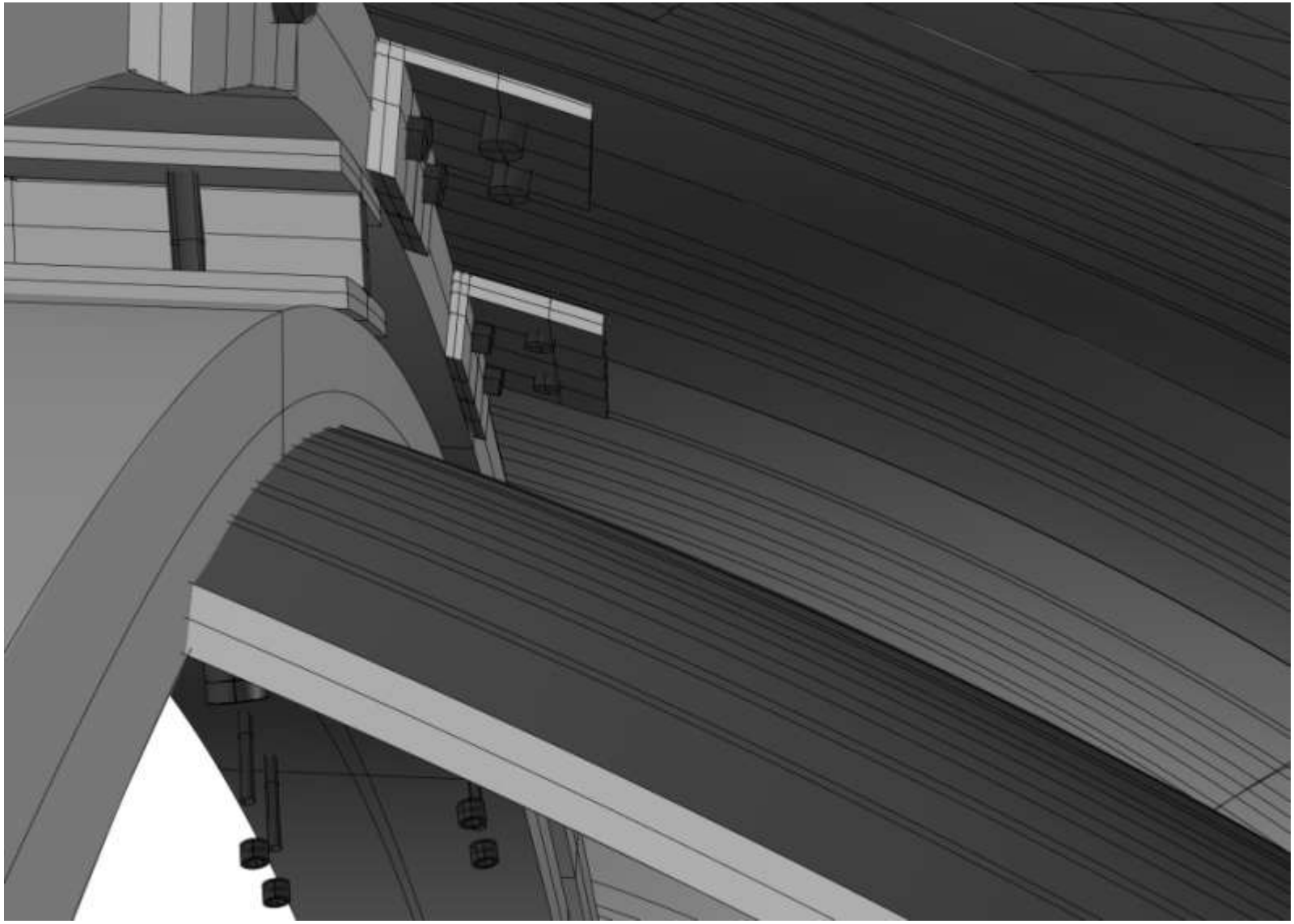


Figure 126: The diagram Shows how the wall panels install on the structure, and how they are connected to the wall structure

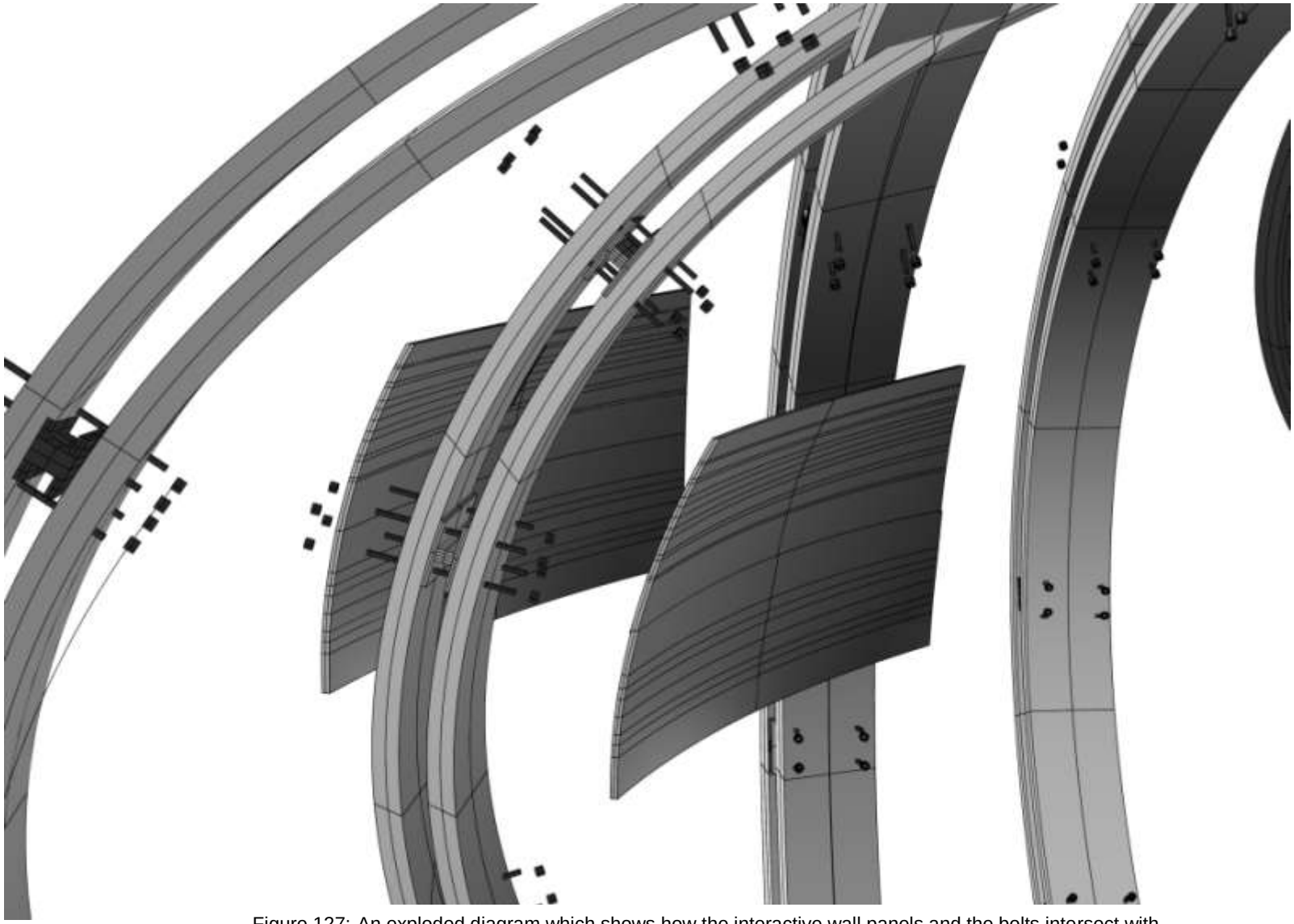


Figure 127: An exploded diagram which shows how the interactive wall panels and the bolts intersect with the design structure

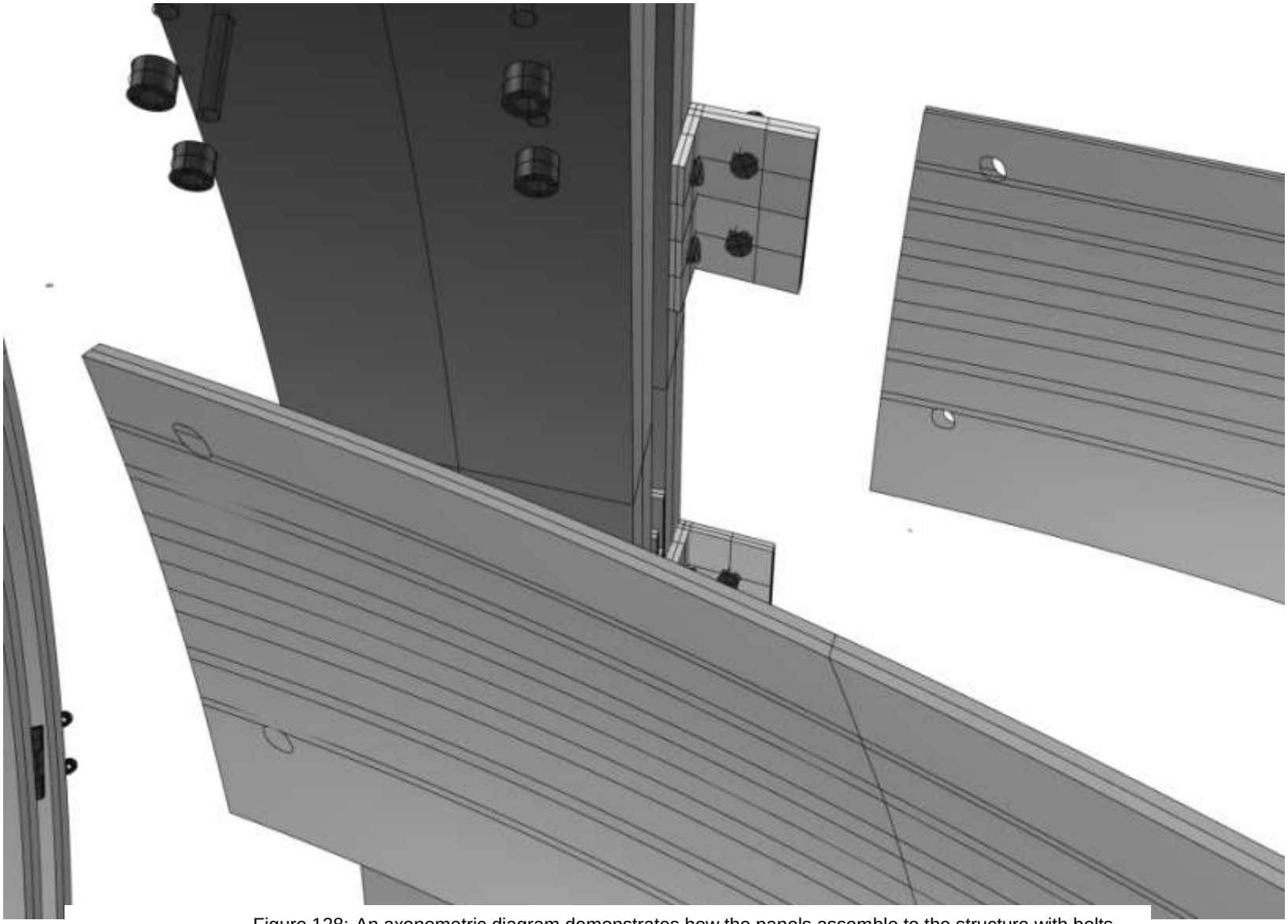


Figure 128: An axonometric diagram demonstrates how the panels assemble to the structure with bolts

Consequently, the idea of the assembly and installation of these complex units was inspired from Center Pompidou Metz project by Shigeru Ban and Jean de Gastines in 2006-2010. The way this structure was built, and how the architect used the wooden hexagonal units to create a complex geometrical shape, which intersect together and curves in different parts, is an interesting idea to use in the structure of my design project. The following figures show the description and illustration of this project.

Case Study: Center Pompidou Metz by Shigeru Ban, Jean de Gastines (2006-2010)
Location: Metz, France

The Metz museum situated in Paris contains a theater, auditorium and restaurant space. The roof of the building looks like a Chinese hat with a peaked top and rippled brim. The roof is made from wooden hexagonal units that intersect together, forming a complex geometrical shape that curves in different places across the entire building. This was done using a fiberglass membrane and Teflon coating which shields direct sunlight during the day and offers transparency during the evening. The performance of the tunnel was pre-assessed by utilizing aeraulic wind tunnels. The roof is the most complex and highlighted feature of the building which roofs a 10,000 sq meter space covered by glass-paneled walls and offering breathtaking panoramic views.

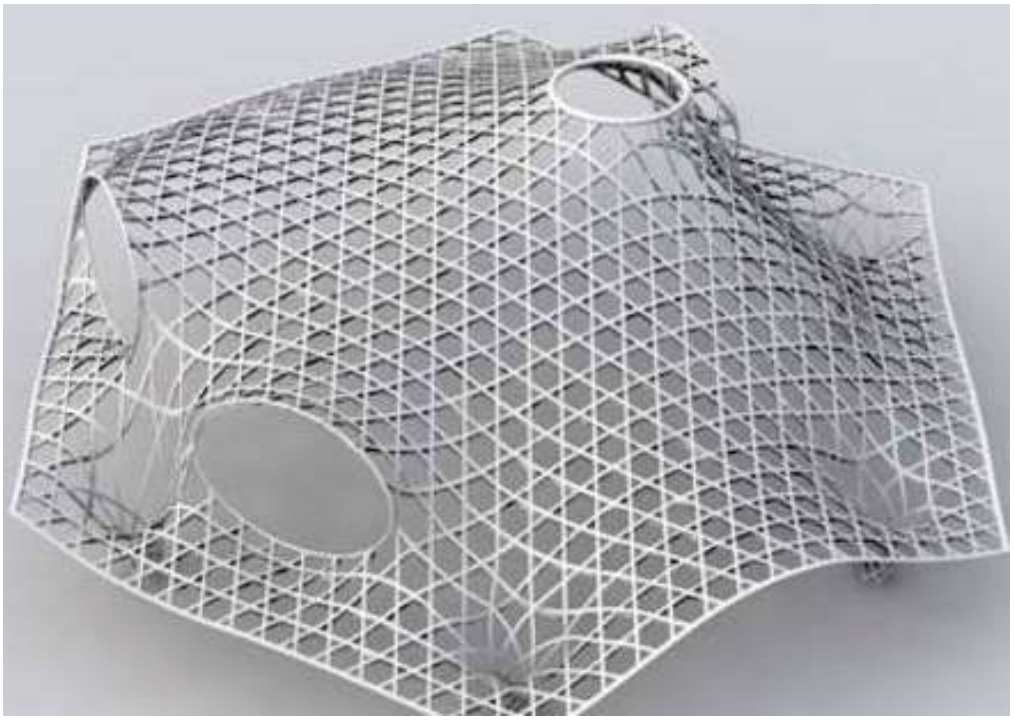


Figure 129: A model of the Center Pompidou Metz Project's

Figure 130: The Center Pompidou Metz Project Structure

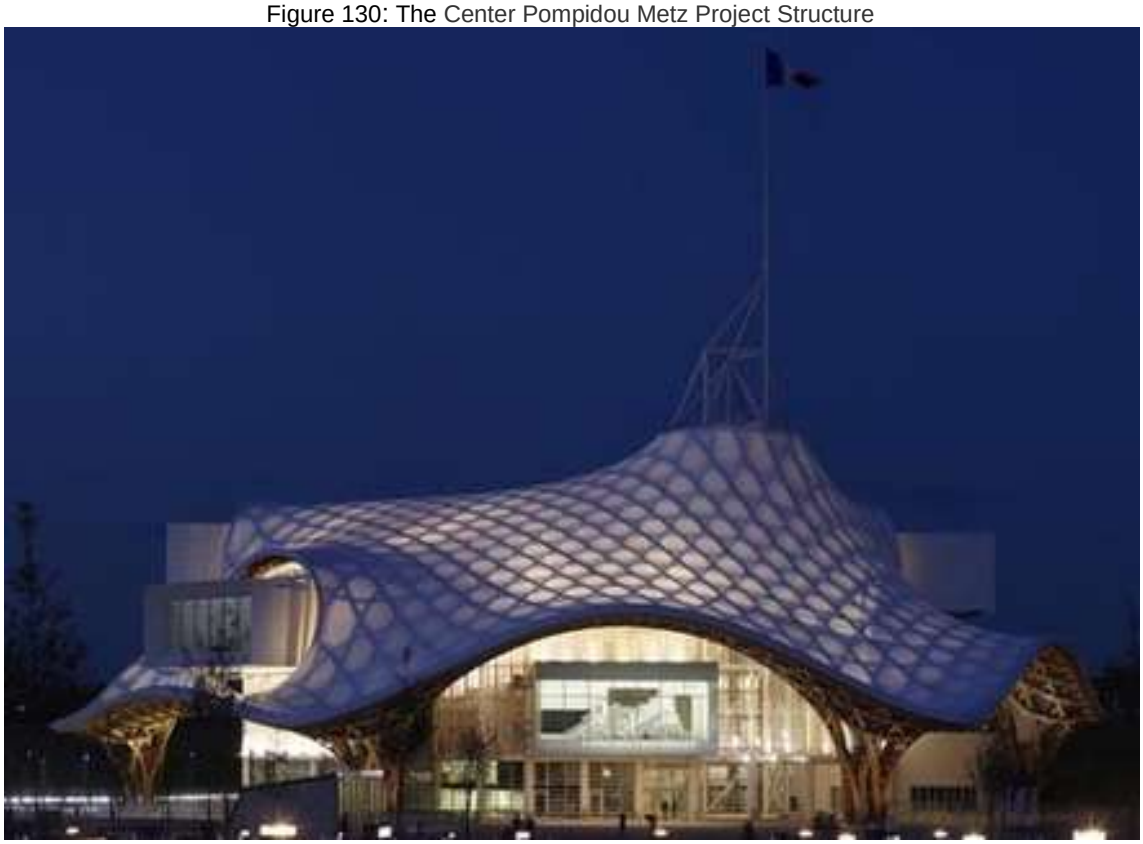


Figure 131: The Center Pompidou Metz

- **SPECULATION**

Sensing technologies can now be used by architects to transform transitional spaces into more engaging places, where the technology is used to encourage users to interact and engage with the physical public space by using their senses. While I have elaborated on the concepts through various authors as to what constitutes an engaging place, I have not until now attempted to define what my definition of a place is. To me, "*place"* is something that has been established sequentially by virtue of our senses, sensing technology and playing with architectural space. In this regard, human senses allow people to form a bodily relationship with the space by utilizing their sense of smell, sight, sound, touch and taste. By using the body to establish a connection with the public physical space, the body is virtually used as a vessel to form a relationship with the space. In addition to stimulating senses, sensing technologies can also be used to engage users to interact with the public physical space through an element of play. The element of play in this aspect adds to the bodily experience when the user interacts with the public physical space, subsequently enhancing the overall sensory experience of the public physical space, and also promoting social interaction amongst occupants of the space. Therefore, it truly is a sequential process in terms of how I have defined what place is, and how we transform space into place. Ultimately, the way in which technology enhances the experience is something that we can expect to continually change as technological advancements are made on an almost daily basis.

Even as it evolves, digital technology continues to affect many realms of our day to day existence. For example, with regards to social interaction, digital technology has revolutionized the way people interact with each other. Social media programs such as Twitter and Facebook now allows for people to interact, communicate and socialize with each other, but in a way that removes them from a physical public space. For example, two friends may not feel the need to meet up for coffee to catch up because they are so informed on what's going on each other's lives thanks to updates from Facebook or Twitter. Therefore, while technology has changed the way people socialize with each other, there remains great opportunity for architects to utilize this kind of technology to promote socializing with each other in the physical public space, and we can expect technological revolutions to accomplish these objectives. These kinds of technological revolutions will continue to further enhance the user's experience of the public physical space, but also render in more meaningful places as a result of these enhanced experiences. For this reason we can safely assume that these kinds of technological revolutions can render in transitional spaces being transformed into meaningful places as well. Transitional spaces in this regard are boring spaces that people do not interact with, as it is usually a place that a user uses to get from one point to another such as an airport, subway platform, long

hallway or essentially any space that is considered boring. Therefore there remains great opportunity for architects to tap into how digital technology can enhance the overall experience of transforming a space to place.

In addition to enhancing the overall experience, there may be other hidden benefits in utilizing this design exploration in reconfiguring transitional architectural spaces. For example, the piano stairs described earlier in this project is a good example of how the element of play was integrated into a design to engage people to interact with the installation, and also promote users to use the stairs as opposed to the escalator. The user's choice to use the stairs has another benefit as well, where it is better for your overall health to take the stairs. If less people are inclined to take the escalators, the overall electricity used to maintain the escalators can be reduced which can overall reduce environmental footprints. Reconfiguring boring or transitional spaces also may serve some economic benefits in the long run. For instance, renovating transitional spaces into a highly engaging place can promote tourism in the area by serving as a new local attraction. The place can also promote social interaction amongst individuals, so there remains great opportunity for commercial benefits as well.

This design exploration also brings up the challenges of public versus private space while the underground PATH in Toronto remains largely owned by the private sector (namely the large commercial banks that have opted to maximize their retail space into the foundation of the building itself), this inevitably brings up the question of whether a design like this would be better off as space that is publicly owned or privately owned. The reality is a project such as this may require massive amounts of funding that the public sector may not be so quick to fund. Additionally, being publicly owned means that the premises would be open to the public during off hours and security costs to look after the premises can be quite high, especially when considering the expensive technology used to operate to manage the project. Therefore, it may seem more viable to have a design such as this privately owned and funded so that there would be less bureaucratic red tape to go through when requesting funding and no chance for public outcry with regards to the high cost of securing or maintaining the space.

This design exploration also seeks to encourage architects to re-think the concept of engagement in the digital era while simultaneously encouraging users within a space to engage with their surroundings by using their senses and their body. In my design exploration, I have designed a structure form that allows people to touch and feel the structure as one form of interaction with the space. The construction of the form is also designed in a way that forces the user to consider their position and sense of balance within the space, where different parts of the form have different ceiling heights and form. Furthermore, this design exploration can be

used as a prototype for other transitional spaces (as described above) where users are encouraged to pause and engage in a multi-sensory bodily experience with the public physical space. By injecting an element of play into this design, I have also re-visited the concept of social interaction within the space where users are also promoted to socially interact with each other in addition to interacting with the space.

Finally, it is also crucial to note here that while digital technology is the main variable that allows architects to create these new augmented environments to interact with spaces via senses, the rate at which digital technology continues to change will definitely have an impact on how these new spaces are created. For example, technologies that just came out last year may no longer be relevant this year as new technologies continue to emerge on the market; rapidly changing the way we use materials to construct spaces or the whole technical component of environment of the space in general. Therefore, technology in this regard is no longer a static variable in creating new spaces, but rather a dynamic and rapidly changing variable. Furthermore, it may be evident that as digital technology continues to advance, there may be many different sustainable and environmentally friendly options to create spaces to give the same effect. Consequently, keeping up with sensory technological advancements is a very important aspect for architects when re-thinking engagement and creating new spaces.

In general, advancement of sensing technologies can be used to enhance the user experience of the architectural space and engage architects to consider newer and more meaningful ways in how a user interacts and engages with the space, in light of finding newer and more meaningful ways to transform that space into a meaningful place.

- **APPENDICES**

APPENDIX-A

Interactive Technology Projects Videos

Some of the interactive technology projects videos mention in the bellow:

Piano Stairway video:
http://youtu.be/2lXh2n0aPyw

Interactive LED Art Windows 'prettyugly' by Robert Stratton video:
http://youtu.be/GJZzT31XP1Q

Robert Stratton Interactive LED Art video:
http://youtu.be/7FyVx5p5bPI

Flexible Display Screens video:
http://www.youtube.com/watch?v=srS3Y6Ofhwc

SUSTAINABLE DANCE FLOOR project by Studio Roosegaarde video:
http://www.studioroosegaarde.net/project/sustainable-dance-floor/

LUNAR project by studio roosegaarde video:
http://www.studioroosegaarde.net/project/lunar/

DUNE project by studio roosegaarde video:
http://www.studioroosegaarde.net/project/dune/

LightFader, Interactive flooring by TAL video:
http://www.smartfader.be/

APPENDIX-B

Interactive Floor details

Technical Specifications:

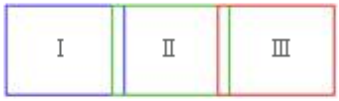
	System includes	System requirements
Interactive Floor System-Standard version  One projector only	- video capture - video capture card - Cable - Accessories - Interactive software - Effects: 8 default effects - User manual& warranty	- Laptop or desktop PC - One projector(we recommend 3000 lumens or better)
Interactive Floor System-Double size version  Two projectors	- video capture - video capture card - Cables - Accessories - Interactive software - Effects: 8 default effects - User manual& warranty	- Desktop PC (with Dualhead graphic card) available - Two projectors (we recommend 3000 lumens or better)
Interactive Floor System-Triple size version  Three projectors	- video capture - video capture card - Cables - Accessories - Multi-display - Interactive software - Effects: 8 default effects - User manual& warranty	- Desktop PC(with Dualhead graphic card) available - Three projectors (we recommend 3000 lumens or better

Table 5: Interactive Floor Technical Specification Table

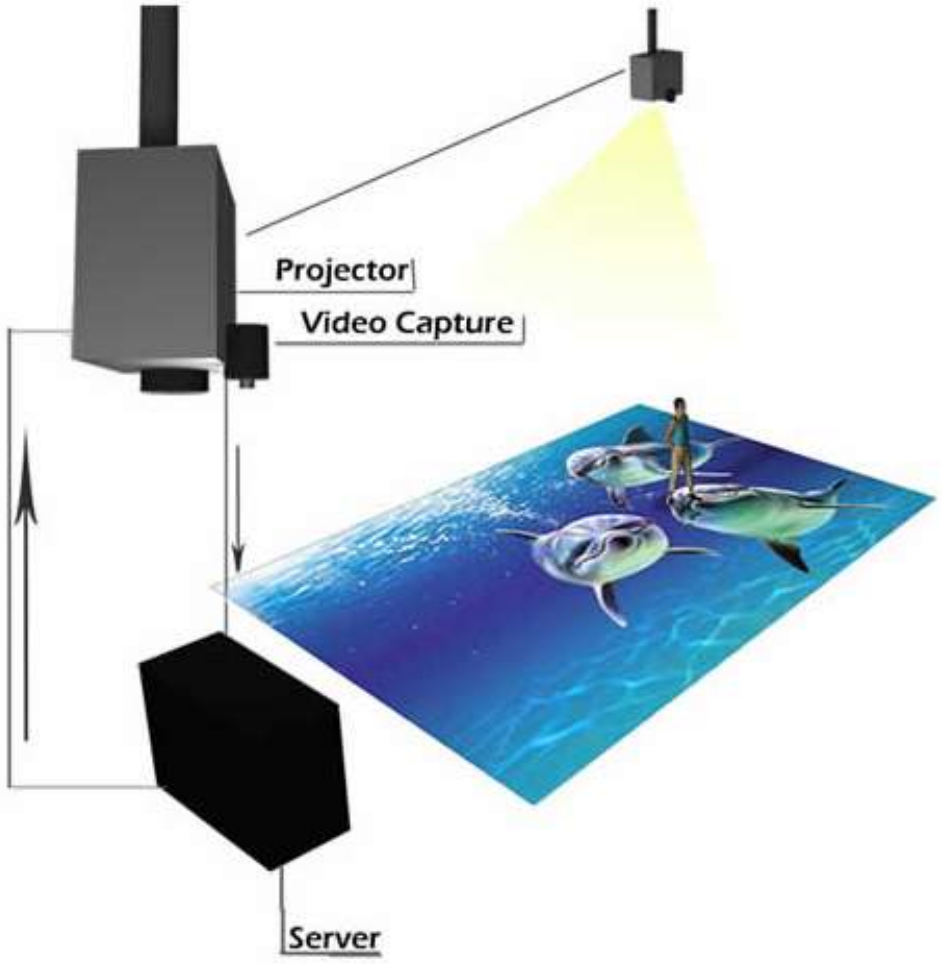


Figure 132: Structure of Interactive Floor System- standard version

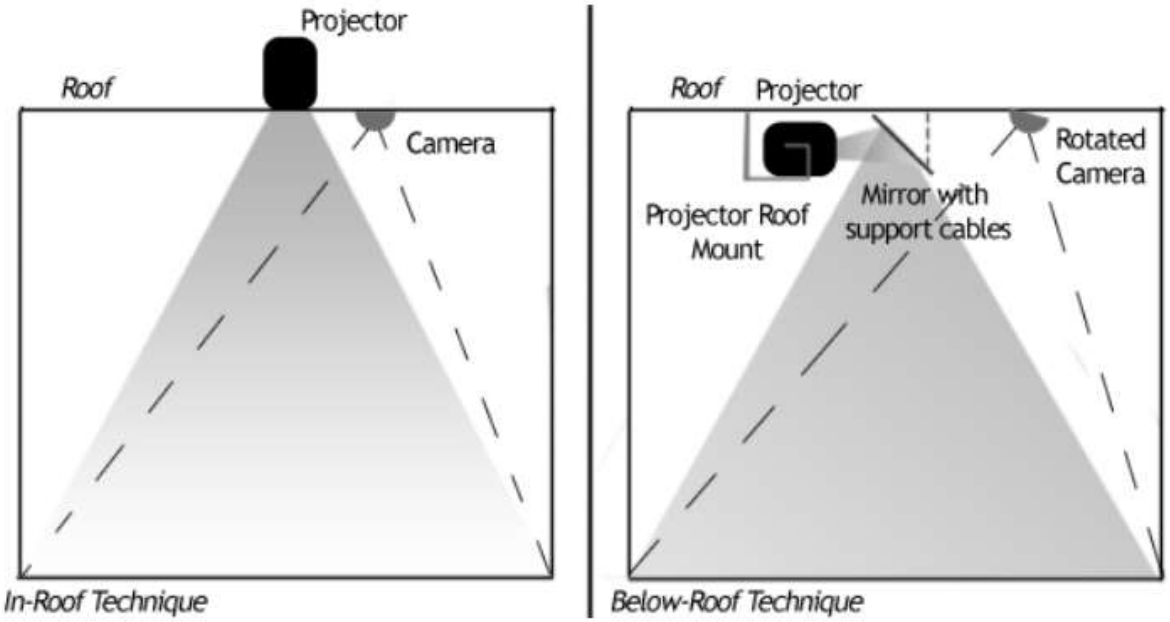


Figure 133: Main techniques used in an interactive floor setup

The weight of an individual walking across the floor leaves an imprint that is visible for almost one minute.

Figure 134: TAL Interactive Floor

Figure 135: TAL Interactive Floor

The LightFader is a modular system of tiles that measure 1000 x 1000 x 75 mm and is highly interactive.

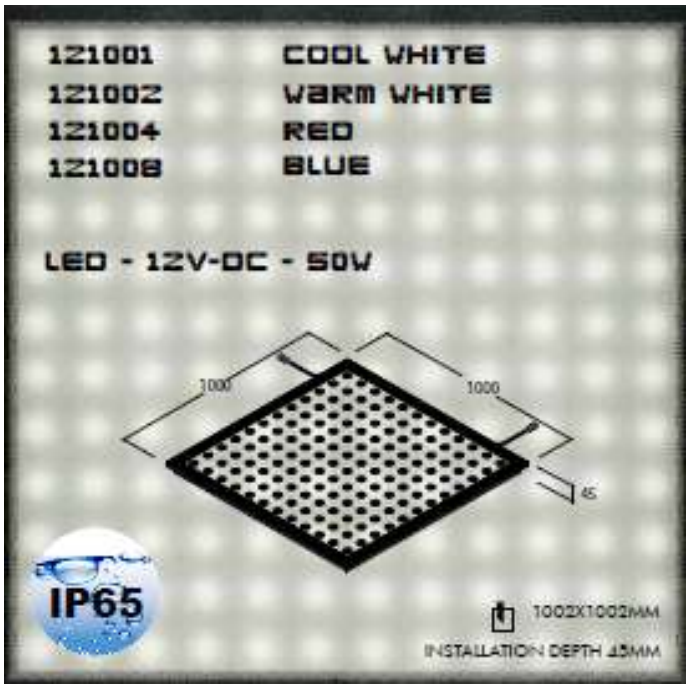


Figure 136: TAL Interactive Floor Details

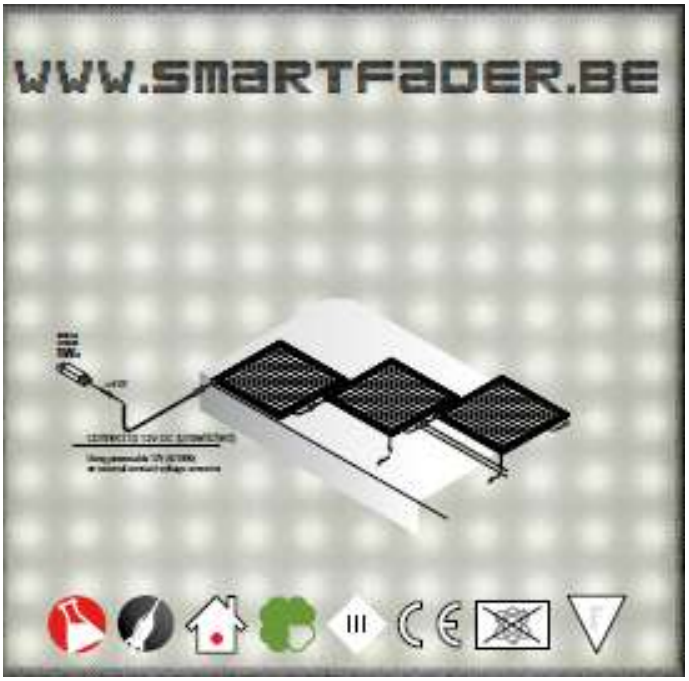


Figure 137: TAL Interactive Floor Details

APPENDIX-C

Interactive wall details

Technical Specifications:

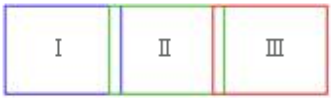
	System includes	System requirements
Interactive Wall System-Standard version  One projector only	- video capture - video capture card - Cable - Accessories - Interactive software - Effects: 8 default effects - User manual& warranty	- Laptop or desktop PC - One projector(we recommend 3000 lumens or better)
Interactive Wall System-Double size version  Two projectors	- video capture - video capture card - Cables - Accessories - Interactive software - Effects: 8 default effects - User manual& warranty	- Desktop PC (with Dualhead graphic card) available - Two projectors (we recommend 3000 lumens or better)
Interactive Wall System-Triple size version  Three projectors	- video capture - video capture card - Cables - Accessories - Multi-display - Interactive software - Effects: 8 default effects - User manual& warranty	- Desktop PC(with Dualhead graphic card) available - Three projectors (we recommend 3000 lumens or better

Table 6: Interactive Wall Technical Specification Table

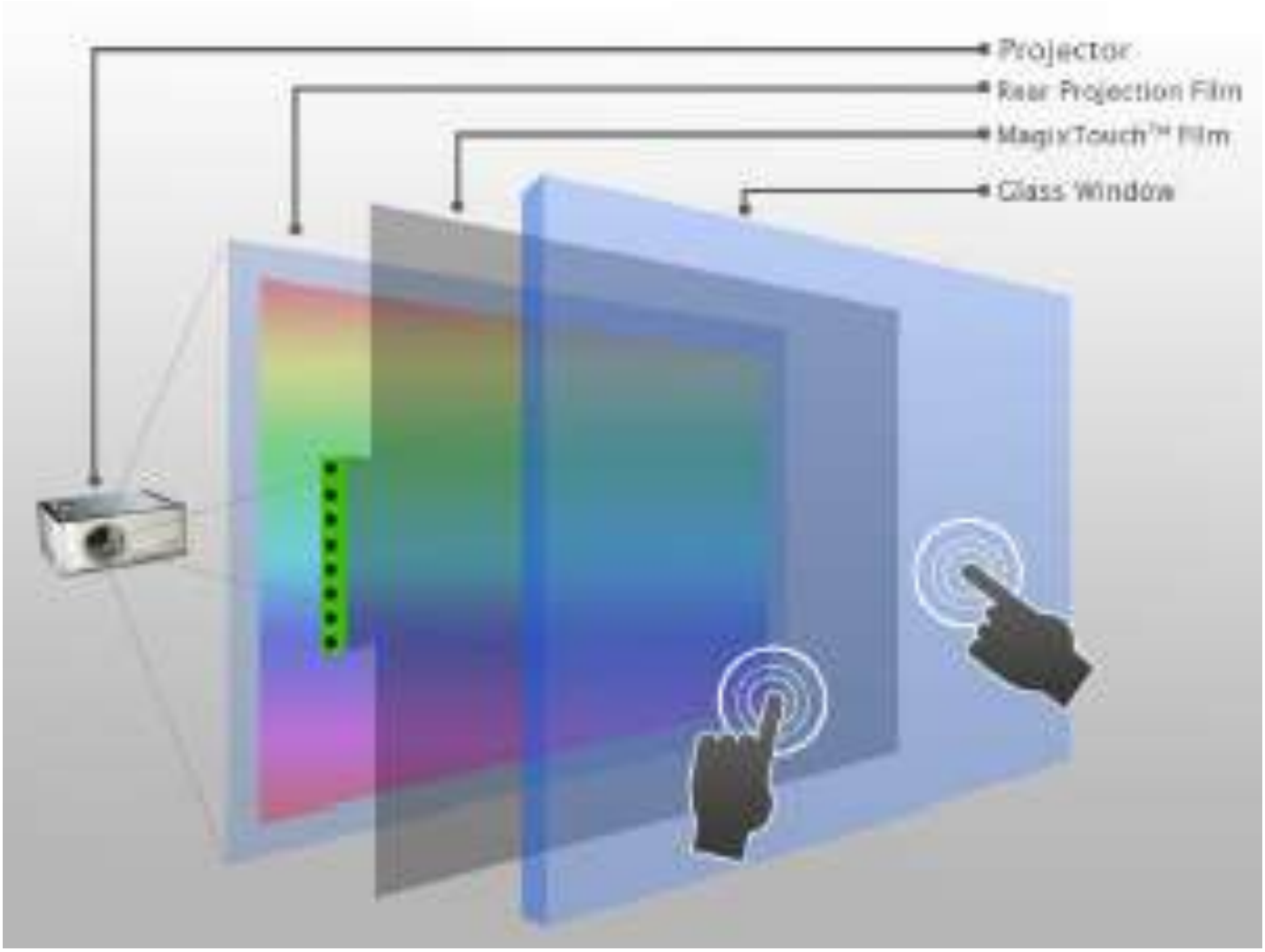


Figure 138: Interactive Wall Detail

FIGURES:

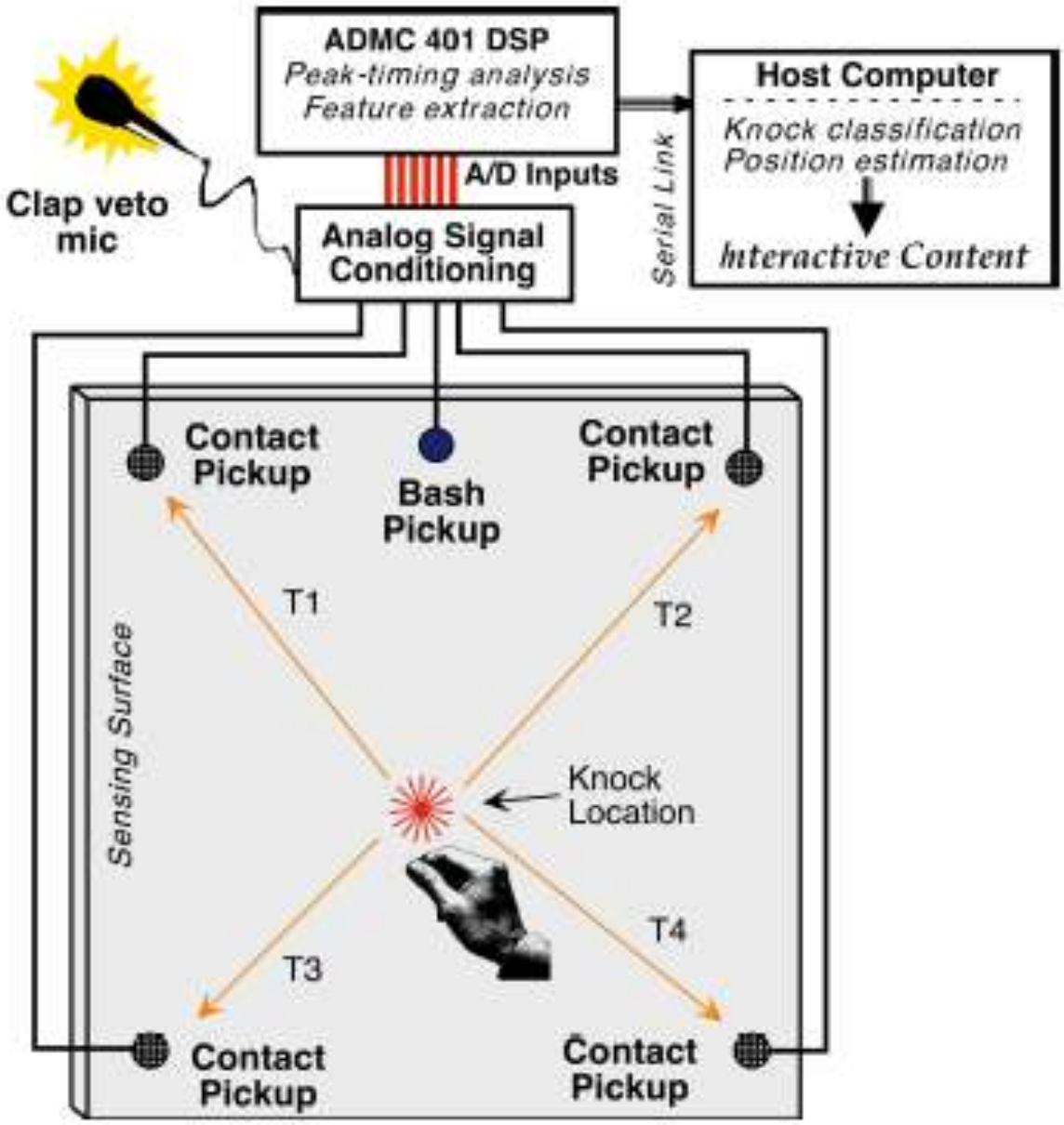


Figure 139: Passive acoustic knock tracker Diagram

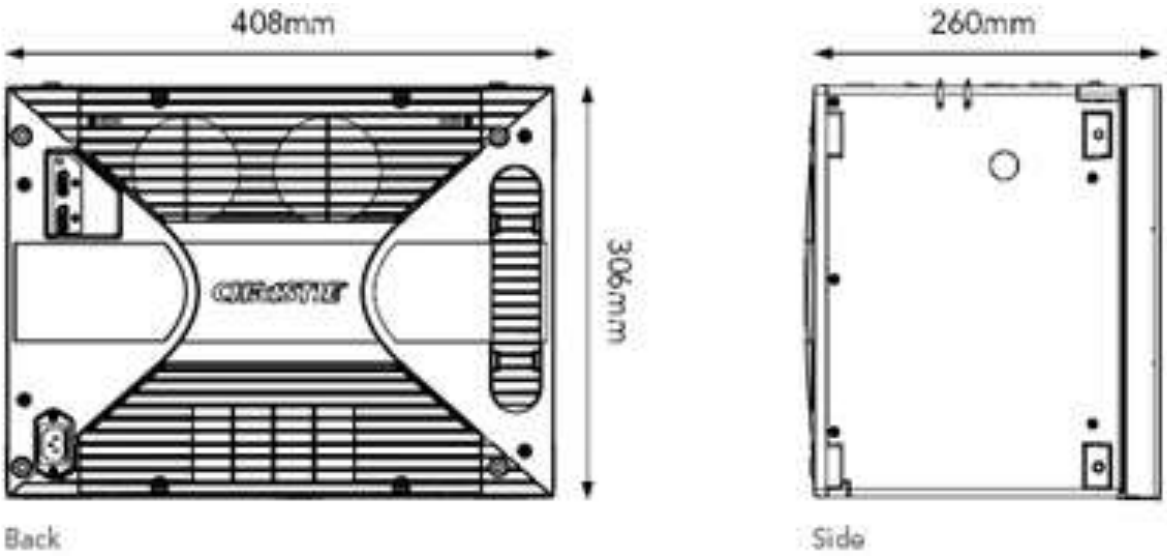


Figure 140: Digital Micro Tiles Size Details

Figure 141: Digital Micro Tiles

APPENDIX-D

Interactive table details

Technical Specifications:

	Projection version			LCD version	
	Top projection	Rear projection (Top-video capture)	Rear projection	Top-video capture version	Touch screen version
Size	1.2m×0.65m/ 2m×0.8m/ 4m×0.8m			32 inch- 100 inch	
Height	1.18m			0.508m	
Effect	8 effects			8 effects	
Installation	On Site installation	On Site installation	Free installation	On Site installation	Free installation

Table 7: Interactive Table Technical Specification Table

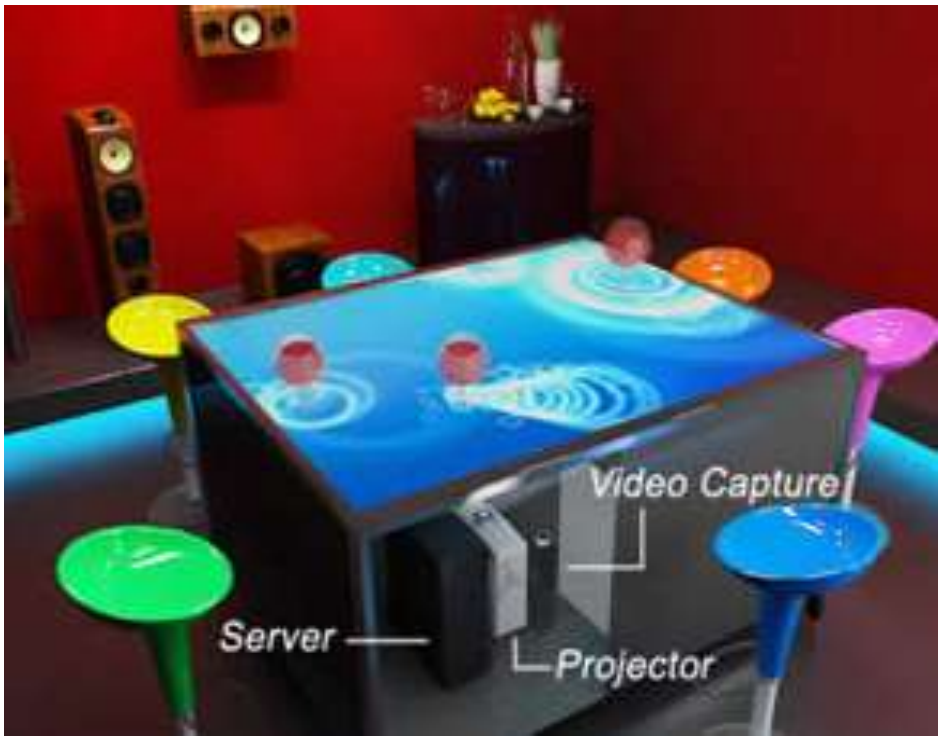


Figure 142: Interactive Table Rear Projection Version

Figure 143: Interactive Table Touch Screen Version

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