ABSTRACT

Title of Document: Spatial ┃ Perceptual ┃ Transformation: a thesis in body_scale_form_movement.

Degree candidate: Shawn Faulkner

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Directed By: Associate Professor Ronit Eisenbach, RA, Chair
Associate Professor Carl Bovill
Associate Professor Brian Kelly, AIA

This thesis is based on three stems of interest. First, the love and respect of making and the knowledge that comes through the process of making. Second, the interest in the thesis as a proposition and the process in which a thesis is developed, similar to that of a scientific experiment. The third interest is the profound intersection between the human body and space.

Building at full-scale allows one to ask questions important to the field of architecture that are not possible to explore through the conventional means of scale models, drawings and writing. The tangible qualities of a full-scale structure allow for inhabitation and direct modulation of space. This strategy enables an inquiry into the relationships between the body, embodied movement, perception, and space.

The thesis will address the effects of transformational space upon the individual psyche, while exploring ways to record and measure bodily movement and perception in a changing space. This is accomplished by testing whether the introduction of change at the boundaries of an enclosure might affect human experience. The following questions are raised by the work: Is it possible to create an environment whose form alters human perception? How can we record this transformation and successfully analyze, and interpret the results? Can a dynamic, ever-changing space participate in relation between body, mind, and form?

The first step of this thesis is the production and fabrication of a device in which the spatial configurations can be modulated and the reactions and movement of people can be recorded. Captured data will be analyzed to gain understanding into the relation of environment and the psychology and motion choices of the inhabitants. Knowledge gained from this experiment will be applied to design choices in which an existing movement-oriented site will be transformed. This second phase of the thesis will further speculate and reflect on the relationship between a designer’s choice and the effects that choice has upon the inhabitant's movement.

Spatial │ Perceptual │ Transformation: a thesis in body_scale_form_movement.

By

Shawn Faulkner

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Master of Architecture
2010

Advisory Committee:
Associate Professor Ronit Eisenbach, RA, Chair
Associate Professor Carl Bovill
Associate Professor Brian Kelly, AIA
Professor John Ruppert

Preface

Much of the content of this investigation is ill-suited for print distribution. To view animations and to interact with the author and this content directly please visit: http://sfaulkner.carbonmade.com/

This is dedicated to
Keri.

Acknowledgements

The following played an essential role in this realization and process:

Joseph Kunkel, for creating intellectually and culturally meaningful opportunities as well as challenging my understanding of a thesis as a proposition.

Stanley Mathurin, for his commentary, critique and conversation which always seems to challenge our understanding and investigation.

Jose Chang, for opening my eyes to the vast possibilities a Thesis may encounter.

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Introduction

The foundation for the thesis grew from a variety of endeavors and encounters throughout my undergraduate and graduate studies. First and foremost, this exploration starts and develops from a profound interest and enjoyment in the “making” through the use of physical and digital modeling, as well as the fabrication and production of material objects.

Secondly, this thesis comes from the introduction to a vast array of design projects which challenge the integration of "making" and "thesis". This thesis is developed and based around the processes of a scientific experiment and the steps of the scientific method. The acts of posing a question, doing background research, constructing a hypothesis, testing the hypothesis through experiment, analyzing the data, drawing a conclusion, and communicating the results.

Thirdly, this thesis comes from the profound interest in the psychology of architecture and that of making space. This includes but is not limited to the relationships between human psychology, embodied movement, perception, and space. Addressing the question of how we, the architect, as designers of *space* should understand how our design may affect the occupants of that space? To look at architecture as a form of social science because of the obligations and responsibilities we have to the general safety and well being of people. It is for this reason we must take this question seriously.

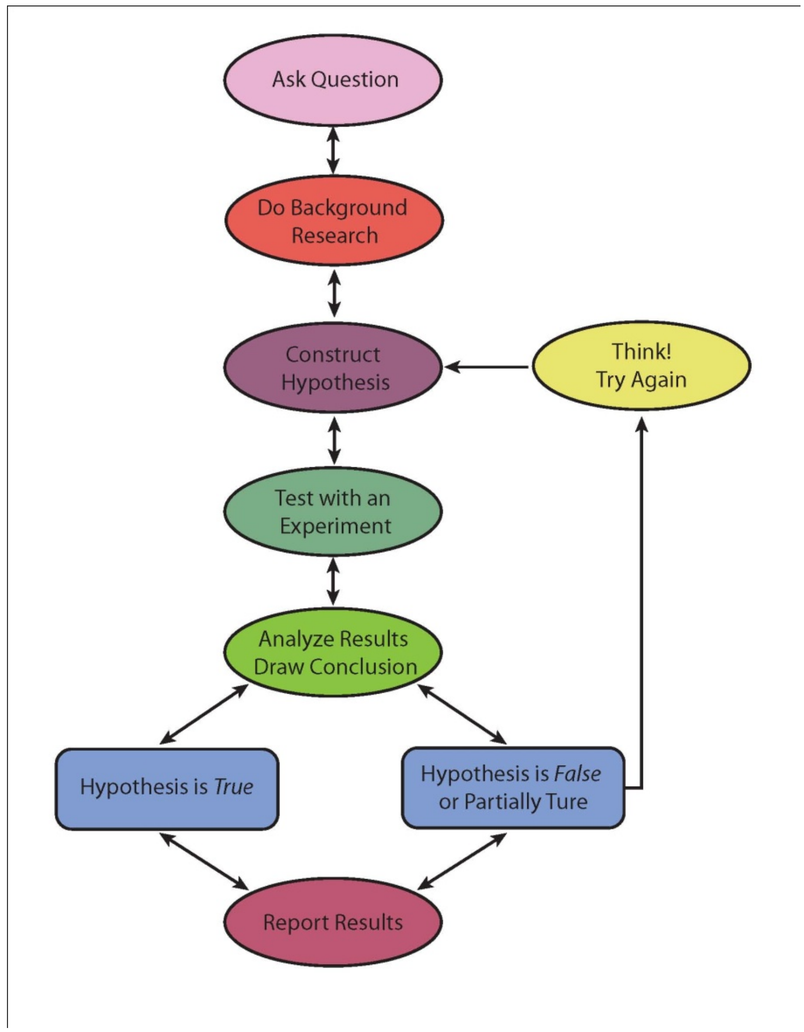

Fig. 1 (Faulkner) Scientific Method Diagram

This thesis begins with step one of the scientific method by asking the general question, How does the space we design (as designers of space) affect its occupants? It then explores the process of research through precedent studies. This is then followed by the construction of a hypothesis, which is to answer the question by generally saying *yes*, the space we design affects its occupants, but how so? The testing of this hypothesis comes through an experiment. The design of the experiment is based around the effects of transformational space upon the individual psyche, while exploring ways to record and measure human behavior and perception in a changing space. To conduct the experiment, there was the fabrication of an environment in which the spatial characteristics of the environment can be modulated and the reactions and movements of people can be recorded. The machine is setup in two different locations for a period of five business days each. Each day the configuration of the space created by the machine is changed and each configuration is recorded to track the path of movement taken by the occupants of the space. The experiment is also accompanied by an optional questionnaire which serves to gain extra insight into the effects of the space.

Following the running of the experiment, the captured data will be analyzed to gain understanding into the relation of environment and the psychology and movement decisions of the inhabitants. The knowledge gained from analyzing this data will be applied to the design choices used in the transformation of a series of existing movement-oriented sites. The second phase of this thesis, the application of the knowledge into today's architectural world, will look to further speculate and reflect on the choices designer's make with relation to the effects those choices have upon the inhabitant's psyche. It will do so by applying the knowledge gained from the collected data to a series of transformations to movement-oriented sites.

Background Research

The second step of the scientific method and this thesis is to do background research. The background research that supports the question lies within the realm of human perception and psychology based on space. This research began by looking into theoretical writings on architecture and the human and concerns of phenomenology. It also started to make the connection between architecture as design and architecture as social science.

Phenomenally, the interests of this thesis are based within the underlying psychology of space. Within the architectural world, as designers, we are the makers of space. Since we shape space, we should understand and facilitate the psychological effects of space within our designs. As the occupiers of the space, we must be conscious of the spatial environments around us.[1] In *A Psychology of Building,* Gregg Lym realizes and defines the human psychological

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[1] Lym, Glenn Robert. *A Psychology of Building : How We Shape and Experience Our Structured Spaces*. Englewood Cliffs, N.J.: Prentice-Hall, 1980.

engagement with the spaces we occupy. He claims that we have a romantic relationship with the spaces that we encounter and embody on a daily basis.

> *"Day to day, year after year, we carry on a romance with space. This romance leads us to seek our place and build on the face of the earth. We are in love with our spatial environments whether we are aware of it or not. Our ordinary way of seeing space conceals this romance. Ordinarily, we consider our physical environments as neutral space. We think of space as a container for our activities, a supporting structure for lives proceeding independently of space."* [2]

Our responsibility as architects is to design space for the people who occupy that space. As such designers we know that space should and hopefully will affect its users. Whether our intentions are to blatantly impose an effect upon the user, or to subconsciously provide the user with a psychological transition that we hope they realize at a later point in time. The city planner Edward Bacon speaks of the factors in which the users become participants in *Design of Cities:*

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[2] Lym, Glenn Robert. *A Psychology of Building : How We Shape and Experience Our Structured Spaces*. Englewood Cliffs, N.J.: Prentice-Hall, 1980.

"The purpose of a design is to affect the people who use it, and in an architectural composition this effect is a continuous, unbroken flow of impressions that assault their senses as they move through it." "In order to emphasize this point I use the word "participator" to designate the person who so senses the flow of messages that are transmitted by a design." [3]

From the psychology world of this understanding, Michel Denis and Jack Loomis have written a journal editorial which describes some of these notions in great respect. In the article titled *Perspectives on Human Spatial Cognition: Memory, Navigation, and Environmental Learning* they speak about the capacities of human cognitive systems and studies which have led scientists to the connections between psychology and other cognitive sciences such as linguistics and computer science.[4] Along with those other sciences I would include the connection of architecture as a cognitive science. Denis and Loomis go on to speak about spatial cognition in relationship to human behavior.

"…psychology has seen the emergence of "spatial cognition" as a new domain in its own right, intended to account for spatial behavior in terms of underlying mechanisms and the associated representations (e.g., Siegel & White, 1975). At the same time, the emphasis on the cognitive determinants of spatial behavior has led to their inclusion in more general

[3] Bacon, Edmund N. *Design of Cities*. New York: Penguin Books, 1976.
[4] Denis, Michel, Loomis, Jack M. *Perspectives on Human Spatial Cognition: memory, navigation, and environmental learning.* Santa Barbara, Ca. : Springer-Verlag, 2006

theoretical accounts of human cognition, including its architecture and computational mechanisms." [5]

This journal is the jumping point for the understanding and viewing of architecture as a social science. In *Behavioral Architect: Toward an Accountable Design Process*, Clovis Heimsath makes an interesting statement with regards to architecture as a social science. Heimsath states, "If a physical space will dimensionally accommodate a person, we feel that somehow that person has been provided for properly. Yet only by considering an individual's behavior in the space can we validate the design."

In an article from the Journal of Material Culture titled *Mind, Gaze and Engagement: Understanding the Environment*, James Carrier informs the commonplace thought that environment is one of those things in our society that different sets of people can perceive in different ways. His concerns lie, in how people engage and understand their surroundings. He follows this with exploring the relationship

[5] Denis, Michel, Loomis, Jack M. *Perspectives on Human Spatial Cognition: memory, navigation, and environmental learning.*

between people and their environments.[6] He claims that the following is a simple but bluntly and provocative assumption.

> *"…people who are engaged with their surroundings in material and practical ways who have a meaningful and consequential relationship with their environs, one in which, for instance, people may not distinguish themselves from their surroundings in any obvious or profound way. This is part of the growing espousal of more phenomenological orientations within anthropology, concerned with the primacy of bodily experience and knowledge."* [7]

Precedent Studies

Looking into literal and tangible precedents for understanding the human body and space took this study back to my undergraduate education. This is where the relationship of the act of building and modeling at full-scale with that of the human body with respect to mind and form started. Nearing the end of my first year of undergraduate architecture school, I participated in the viewing of a Thesis at The University of Buffalo School of Architecture and

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[6] Carrier, James. *Mind, Gaze and Engagement: Understanding the Environment*. London: SAGE Publications, 2003

[7] Carrier, James. *Mind, Gaze and Engagement: Understanding the Environment*. London: SAGE Publications, 2003

Planning, by Jose Chang. His thesis was called DYNAMIC CONCRETE FORM[WORK], and was completed in the Spring of 2005. (Fig. 1-3) The basis of his thesis was to create a new application for concrete formwork that was not static. He did this by developing and fabricating a machine to facilitate the forming of the concrete.[8] This machine was then configured to record and analyze the movement on the human body. The literal machine is an interest due to its visual experience and the thought process of transforming the application.

The machine as an application was appealing. With some redesigning and the fabrication of a new machine, its use seemed instrumental in closing the gap between space and the human. The bridging of this gap is in needed to facilitate step four of this thesis and the scientific method of testing with an experiment. More about the design and fabrication of the new machine is further explored in following chapters.

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[8] Chang, Jose. *Dynamic Concrete FORM[WORK]*. Ann Arbor,MI.: ProQuest, 2005

Fig. 2(Chang) Photograph of machine fabricated by Chang, 2005

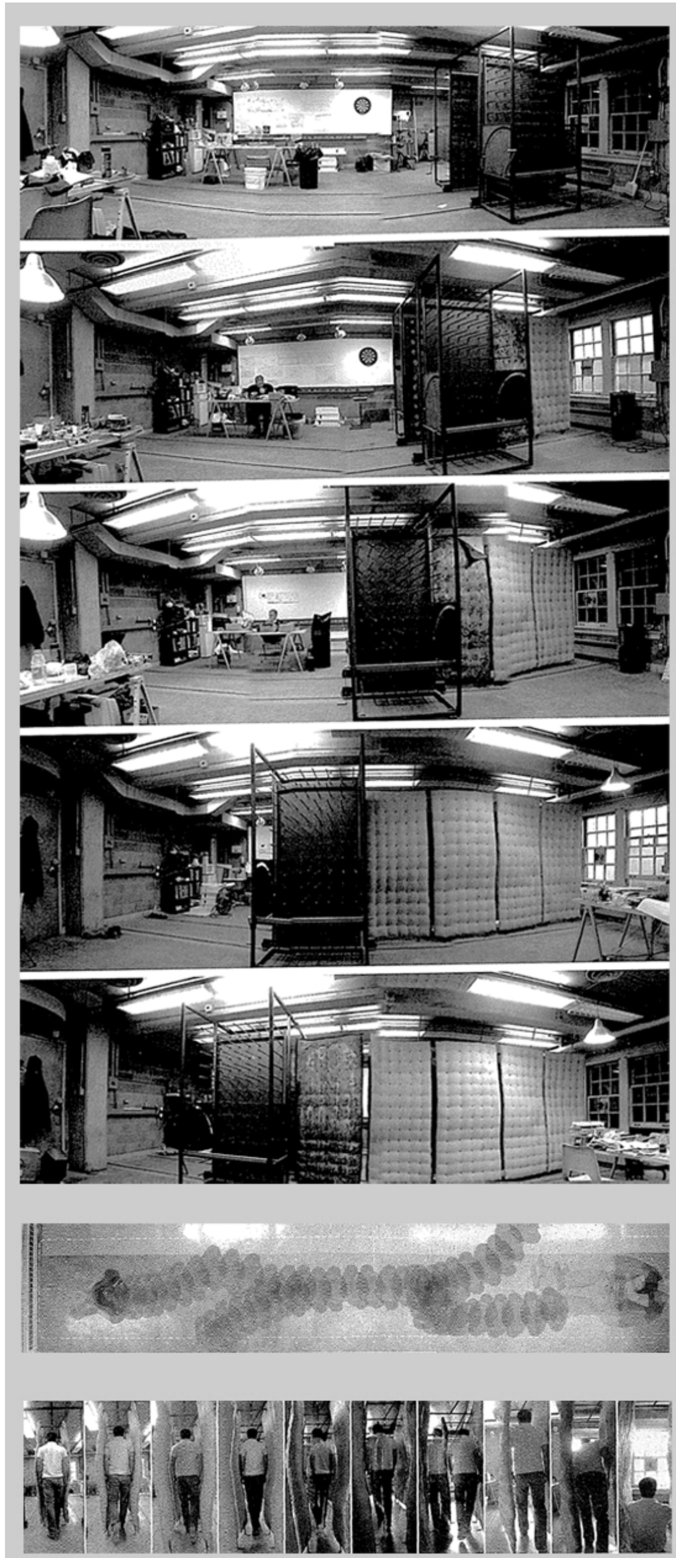

Fig. 3 (Chang) Series of Photographic Studies and Diagrams by Chang, 2005

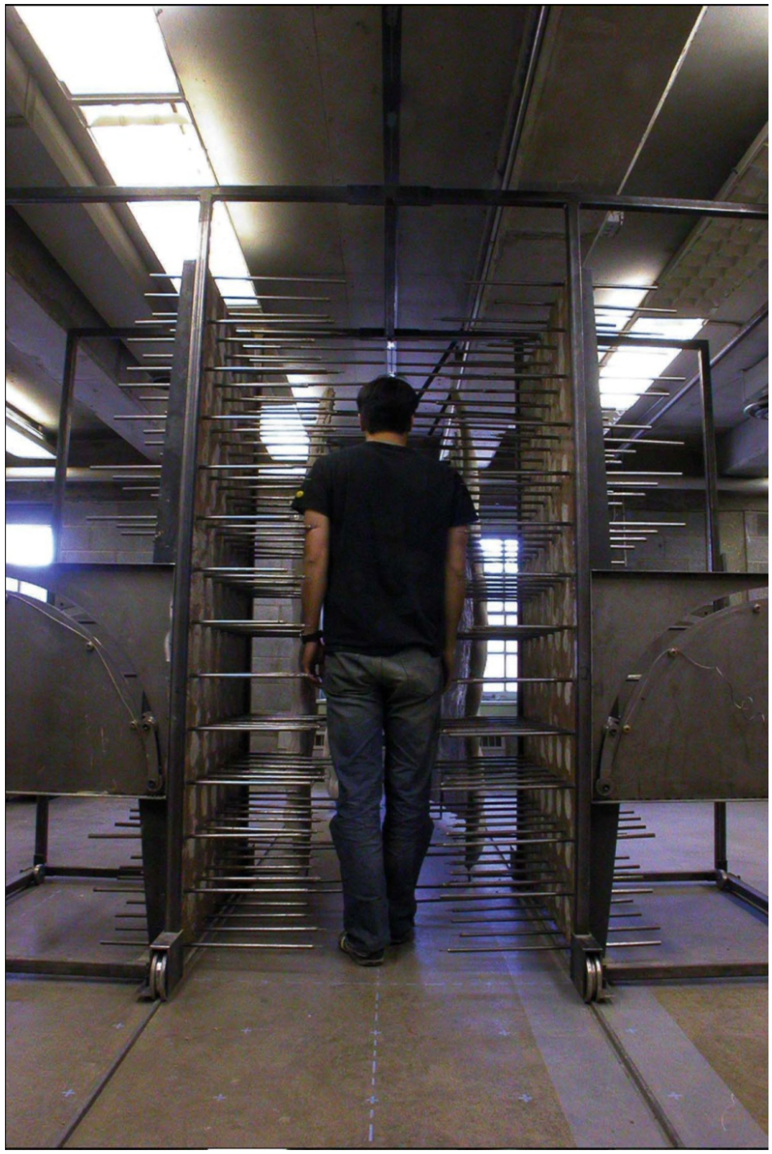

Fig. 4(Chang) Photograph of the interaction between machine and body by Chang, 2005

Chang then decided to record the events within the space. This gave rise to a series of photographic studies which utilized a technique called motioncapture photography; this method of documentation was pioneered and popularized by Eadweard Muybridge.[9] Chang took these techniques and merged them with modern technology in the form of digital cameras and using programs such as Photoshop to digitally stitch the photos to "record and map how the body began to occupy the interstitial space through the performance of events". Jose Chang describes a portion of his thesis called "BODY: scale.movement.photography" as follows:

> *"The first idea was to prescribe the form by examining the composite pictures and breaking the pictures of the body into a series of points and lines that defined each of the limbs and joints. These movement drawings began to and surfaces that can be translated right onto a fabric formwork and cast out of concrete. This method, however, brought up questions concerning representation and the high degree of separation between the body, the event and the cast."* [10]

Chang later goes on to describe the methods by which he determined to narrow the disparity of the human body and space. He determines that within his project he is missing a crucial gap within the dynamics of body and space. Chang describes this step as follows:

> *"In order to close the gap between the body, the event and the cast, it was decided that a machine would be fabricated to allow the body to directly map its movement through a series of positions in the interstitial space onto the machine. The*

[9] Chang, Jose. *Dynamic Concrete FORM[WORK]*
[10] Chang, Jose. *Dynamic Concrete FORM[WORK]*

interstitial space had to be occupied by the body. Each one of the machine's operations was defined by a specific set of actions. This requirement set forth a series of decisions that further defined the mechanics and theory behind the machine and the user." [11]

Chang's project sparked the interest in exploring the relationships between human being and space. This relationship is a dynamic one of human scale. The fundamentals of human scale which is the space surrounding the person, the space within direct proximity to that of our bodily figure. His development and fabrication of a machine to bridge and close the gap between the modified space, which is constrained by the machine, and that of the human body, became an influential process to the realization of the experiment phase of this thesis.

The second literal and tangible precedent study was that of the sculptural works of Richard Serra. Serra's works have been influential in the process of understanding the constraints and effects of tangible creations of space at the human scale. (Fig. 4-5) The human scale that I am describing is smaller than a building, but still occupied space at the scale of the human figure. Richard Serra's sculpture is an example

[11] Chang, Jose. *Dynamic Concrete FORM[WORK]*

of formulated occupiable space which has a significant effect on the human psyche.

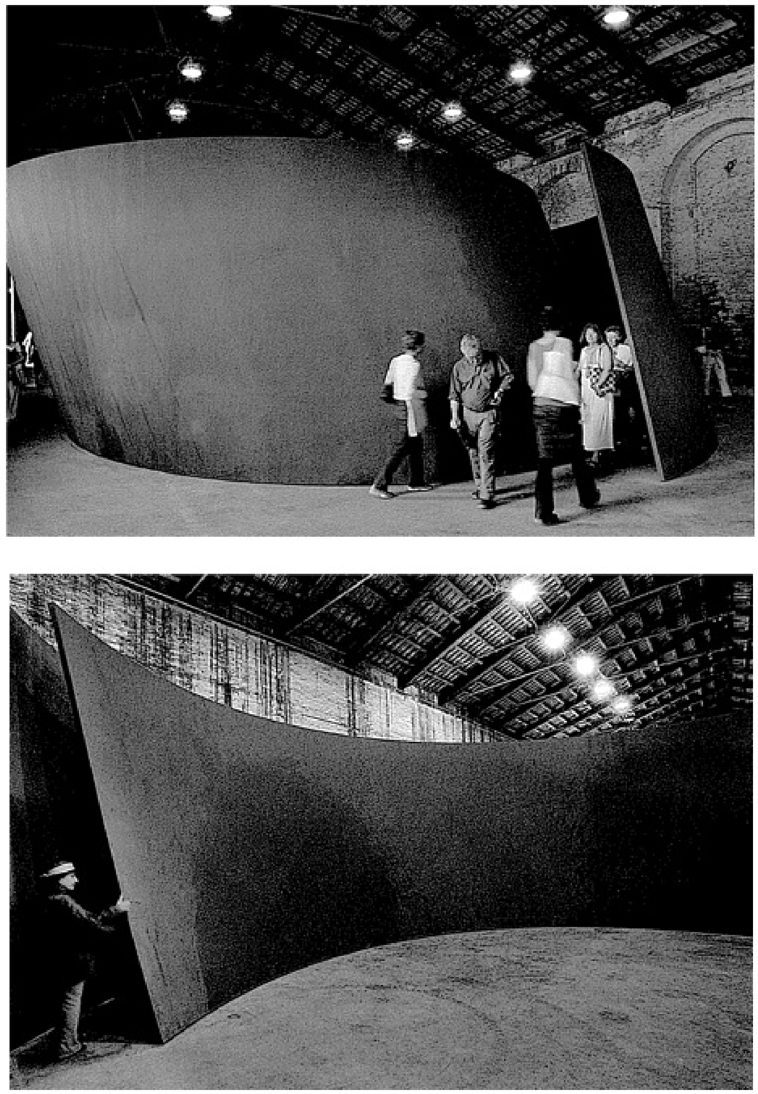

Fig. 5(Serra) Photographs of Richard Serra's sculptural installations

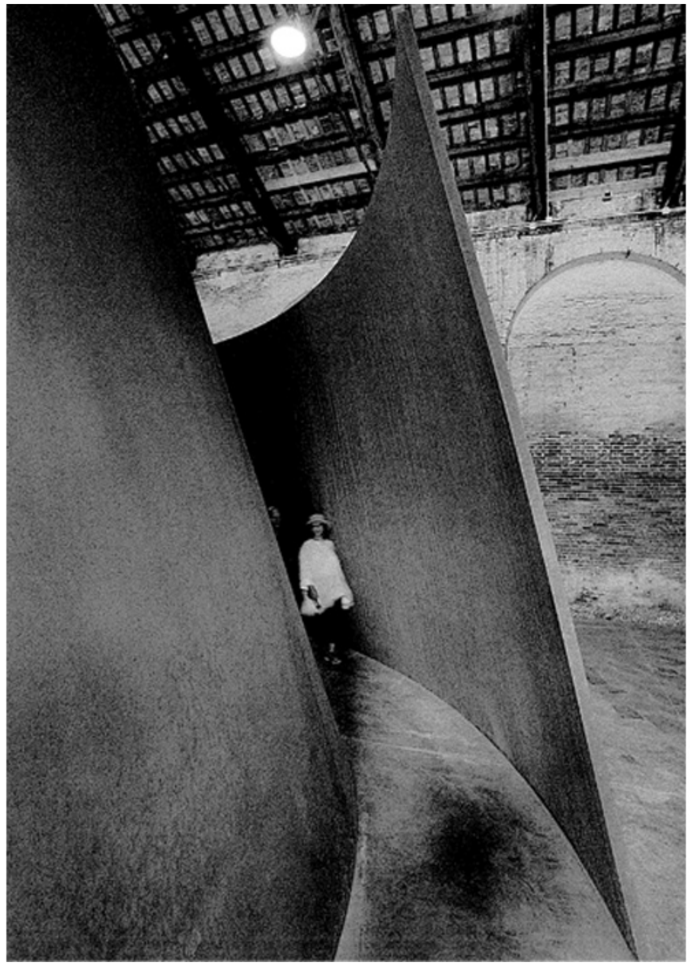

Fig. 6(Serra) Photographs of Richard Serra sculptural installations

Many people describe the occupation of Serra's sculptures as an exhilarating experience. (Fig. 6) Many claim to be either very uncomfortable in certain situations within a Serra piece while conversely exuding a feeling of excitement in a similar yet contrasting situation.[12]

[12] Serra, Richard. *Writings, Interviews*. Chicago: University of Chicago Press, 1994. p.120

In an essay titled *Torques and Toruses*, found as a prelude in the Gagosian Gallery collection, *Richard Serra: Torques Spirals, Toruses and Spheres*, Hal Foster states that "Serra has put our perception of things in tension with our conception of them: he invites our bodies, informed by materials and structures, to do the thinking, 'to think on our feet'." He goes on to speak of Serra's sculptural language and how its focus was on the body and the body's movement through space, space which Serra carved out by sculpture.[13] Foster describes the basic phenomenological principle as "the work exists in primary relation to a situated body, not as its representation but as its activation, in all its senses, all its gaugings of weight and measure, size and scale."

Serra's work can be characterized as structurally transparent. His work demonstrates how it is constructed. Serra himself agrees, stating, "In all my work, the construction process is revealed. Material, formal, contextual decisions are self-evident." Some may disagree with this but Foster argues, agreeing with Serra, that to know how a piece

[13] Serra, Richard, Hal Foster, Dirk Reinartz, and Gagosian Gallery. *Richard Serra : Torqued Spirals, Toruses and Spheres*. New York: Gagosian Gallery, 2001. p8

is configured differs from being able to see how a piece is constructed. Foster goes on explaining what Serra means by this.

> *"Just as Serra exploited the felt tension between perception and conception in his early work, so he often plays on the felt discrepancy between construction and configuration in his later work. This is best understood in architectural terms: the "elevation" of a recent Serra sculpture (i.e., the diagrammatic view en face) rarely reveals the "plan" of the work (i.e., the diagrammatic view from above), and vice versa; neither conveys the identity of the other, let alone of the sculpture as a whole. This discrepancy implies a critique of architectural protocols (a persistent aspect of his work); more intrinsically, it prevents any reduction of sculptural physicality to pictorial image."* [14]

Serra would agree with such an analogy of the architecture plan versus elevation. He says in regards to his Torqued Ellipse's, "their outside is totally different from their inside..." He describes the act of view of the Ellipse's from the outside in comparison to viewing them from the inside as, "You don't know the form even if you walk around it several times. When you walk inside the piece, you become caught

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[14] Serra, Richard, Hal Foster, Dirk Reinartz, and Gagosian Gallery. *Richard Serra : Torqued Spirals, Toruses and Spheres*. New York: Gagosian Gallery, 2001.

up in the movement of the surface and your movement in relation to its movement..."

Giving a description of the experience of viewing one of Serra's Torqued Spirals is a difficult task. The viewer/occupant feels a pinch and opening of space around them. A tightening at the head in instances, while taking a few steps the inverse may occur with the space widening at one's head and squeezing at the feet. Meanwhile, the impending thought of the size and scale of the piece lingers in thought; being five plates of two inch thick steel each weighing toward twenty tons. Foster gives a notable description of this experience.

> *"One feels continuously dislocated - even more so with the spirals, which, unlike the ellipses, do not have a common center and are not sensed as two discrete forms. Again, even more with the spirals, one feels that each new step produces a new space, a new sculpture, even a new body. Sometimes, as the walls pinch in, you feel the weight press down - not only of your body but also of the five plates, each 20 tons, which make up each spiral. But then, as the walls open up again, this weight is somehow eased; it seems to be funneled up and away from you. Suddenly both your body and the structure feel almost weightless..."* [15]

Foster's description of occupying the torqued spirals alludes to the effects a space like this can have upon the human

[15] Serra, Richard, Hal Foster, Dirk Reinartz, and Gagosian Gallery. *Richard Serra : Torqued Spirals, Toruses and Spheres*.

psyche. Gaining responses to the effects of similarly configured spaces is a goal of the later experiment.

Process Timeline

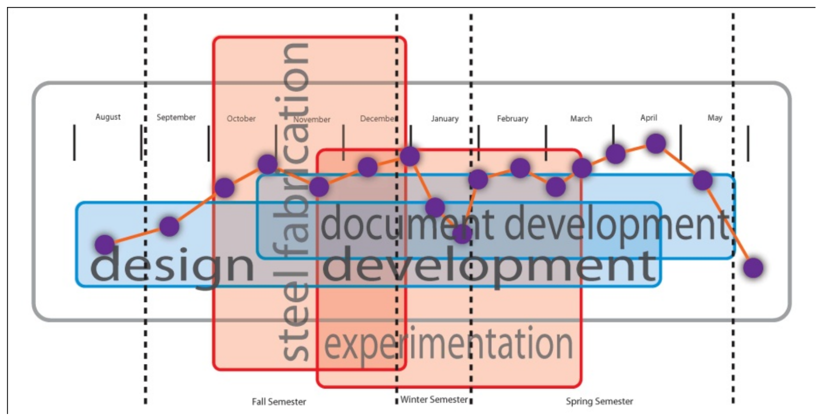


Fig. 7 (Faulkner) Diagram timeline of Thesis Process and Calendar

Design Process

The design process of this thesis consists of six steps. Those steps are: 1) The Questions, 2) The Machine, 3) The Experiment, 4) The Site(s), 5) Data Collection, and 6) The Analysis. These steps are somewhat chronological and connected to the organization of the scientific method.

The Questions

The questions within the design process are an elaboration of the general question, how does the space we design (as designers of space) affect its occupants? This question is quite broad from a basis stand point. However it is the beginning.

To elaborate on this question we refer back to our background research. We begin to think of spatial qualities. Is space is large or small? Is the space's surface rough or smooth? Is the configuration of those surfaces rectilinear or does it have curvature? This is the method which begins to test and inform the understanding of space, but in order to accomplish this, physically creating space is necessary.

By creating a new space we could determine and address some of these thoughts directly. This space is to be scaled to the human. It is designed to have the ability to be manipulated so its configuration could be changed from being rectilinear to having curvature. Its surface could be changed to reflect that of a smooth surface or a rough surface.

The Machine _ design process

The design and development of the machine was to create a relationship between the human body and a small scale space.

The idea of creating a machine was sparked from the thought of the possibility to merge the precedent of Jose Chang's thesis and that of a Richard Serra sculpture. (Fig. 4-5) Could one create the maneuverability and adaptability of Chang's machine while simultaneously creating spatial qualities similar to that of a Richard Serra sculpture? If so, would that space be one that could test the spatial and psychological relationship between the human and occupiable space.

With notes and design iterations from Chang's machine and Richard Serra's sculptures, the development of a new machine, which could create a transformative space, had begun.

> *"**Transformative** is defined by Merriam-Webster Dictionary as 1) to change in composition, 2) To change in character or condition"*

With maneuverability, the machine can transform on a day-to-day basis. Yet this maneuverability allowed for the mimicking of space similar to those experienced when occupying a Torqued Spiral by Richard Serra.

The design of this machine also has similarities to the children's toy "Image Capture" or "Pin Art". (Fig. 8 and 8a) This toy is a pin screen that lets you create fascinating patterns. The design of this machine resembled a large scale pin toy. However, rather than the interior of the space be a field of points from the tips of the pins, a flexible surface would be applied in order to create a singular surface.

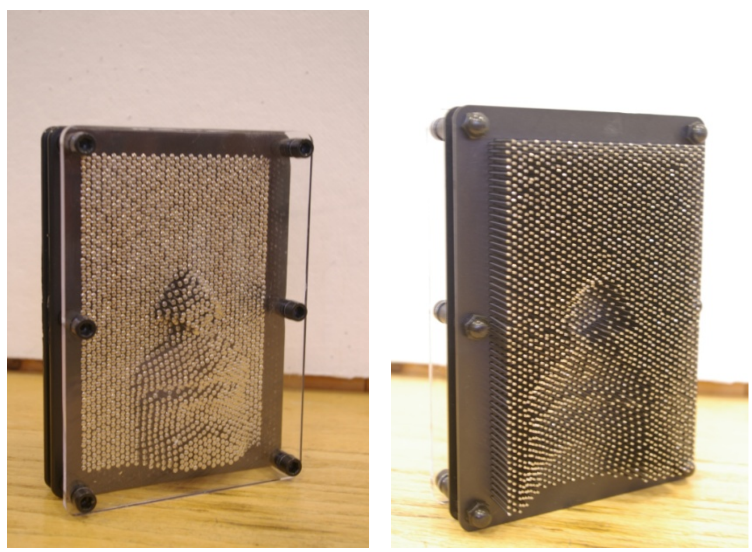


Fig. 8 and 8a (Faulkner) Image of Pin Art, Photographs by Author

The Machine _ fabrication

The parameters of the machine are based off of the minimum walking distances in which people can experience physical transitions. The machine is twelve feet in length, eight feet in width and eight feet in height. The twelve feet in length was a decision made by walking distances and based upon a length in which is long to be experienced as a transition. The eight feet in width is a dimension that will allow the passage of multiple people through it, yet allow for enough deviation where it can be as narrow as three feet when in full extension of manipulation and still allow a 36” width to meet code for disabled persons. The eight feet in height was determined to have enough height to be taller than a person passing through it, yet remain at a tangible scale of the human. The height also allows it to be sizable to fit in many interior spaces as well as to be setup outside. The size of 12’x8’x8’ also allowed the machine to be within a buildable size and formed in a panel system allowing it to be assembled and disassembled.

Fig. 9(Faulkner) Image of study model 1″=1′, Photograph by Author

The machine in total is the assembly of twelve 4'x4' panels with a 3' depth. Each panel begins with the fabrication of two square frames made out of 1 1/2" angle iron. The angle iron was cut using a horizontal band saw and a grinder with a cutting wheel, then welded together at the seams. These square frames are then connected together by welding a 1' length of the same angle iron between the two frames to create a three dimensional rectangle; essentially a squat cube. (Fig. 10 and 11)

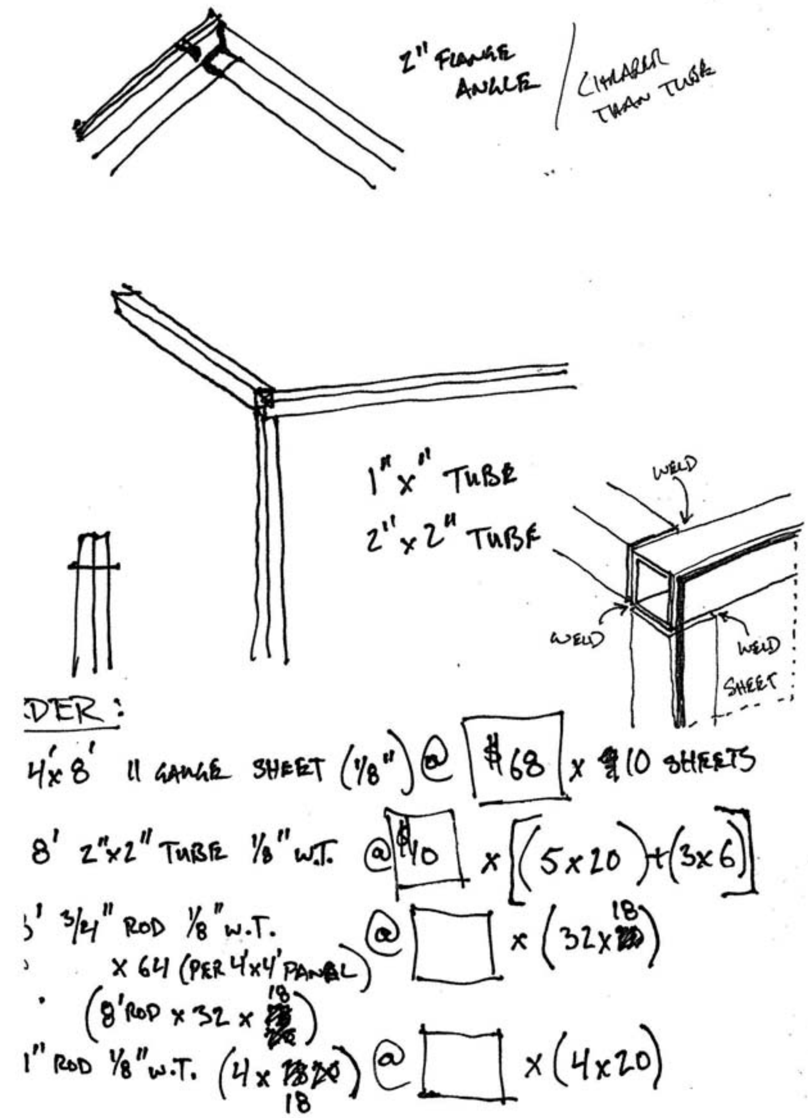


Fig. 10 (Faulkner) Process Design Sketches and Notes

Following the completion of the twelve frames, six 4'x8' sheets of 12 gauge steel (approx. 1/8" thick) where plasma cut into 4'x4' sheets. These 4'x4' sheets of steel were then mounted to one side of each frame to give a solid surface. The sheets of steel where marked with a 25 point grid (5x5 grid) at each intersection or point, and a 1/2" hole was plasma cut. This now leaves you with a 4'x4'x1' frame with one 4'x4' face clad with a steel sheet perforated 25 hole grid.

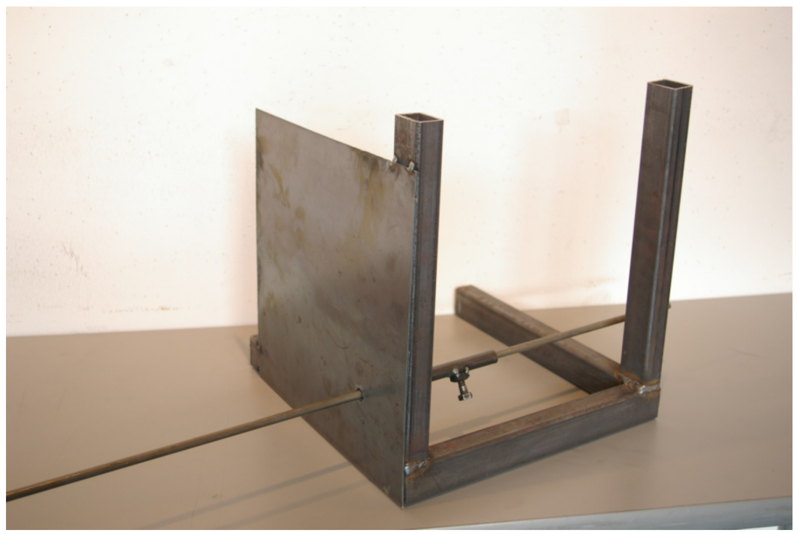


Fig. 11(Faulkner) Photograph of Fabrication Study Model

The 25 holes on each of the 12 panels were then filed with a 9" long 1/4" schedule 40 pipe (5/16" ID, 1/2" OD). The pipe was fabricated with a lock down bolt 2" from one end. The lock down nut was incorporated by drilling a 3/16" hole in the pipe and then threading the hole with a die so a 1/4" bolt could be screwed into it. The pipe was then welded to the sheet steel through each of the 25 holes with 3 inches of the pipe protruding on the sheet side of the panel and 6 inches of the pipe with the lock down bolt protruding on the frame side of the panel.

Following the insertion of the pipe, 3' lengths of 5/16" cold rolled round bar (1/4" OD) were cut. The round bar was then guided inside the pipe and tightened to a certain depth by the lock down bolt. This is the completion of a single panel. At this point you essentially have a 4'x4' pin art toy. (Fig. 12 and 13)

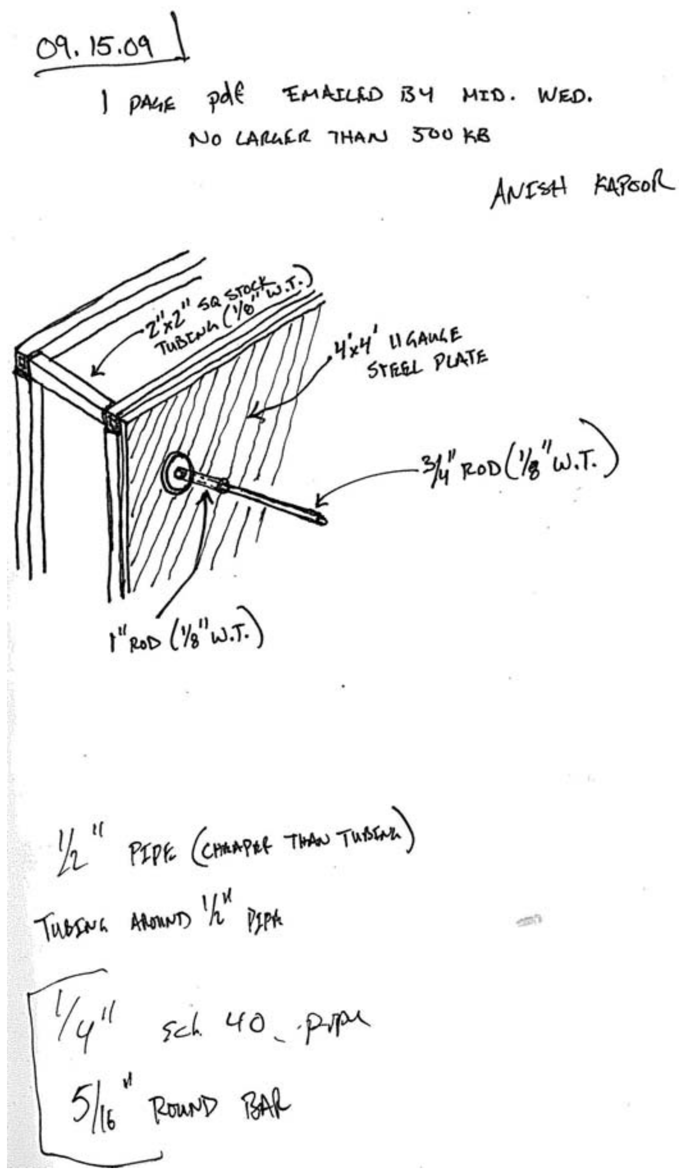


Fig. 12(Faulkner) Process Design Sketches and Notes

Once the twelve panels were completed, they were assembled together with six panels to a side, three long and two high. Each panel was fastened to another with a series of nuts and bolts. The two sides where then placed parallel 8' away from each other and the two sides were fastened together with 1 1/2" angle iron spanning across the top of the two sides to create a frame. You now have the equivalent to a 12' long hallway of a pin art toy.

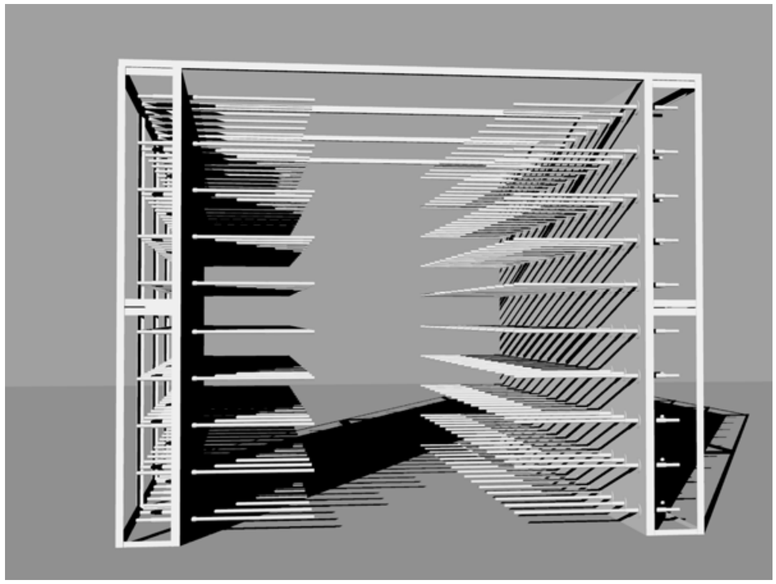


Fig. 13 (Faulkner) Perspective of Preliminary 3D Model

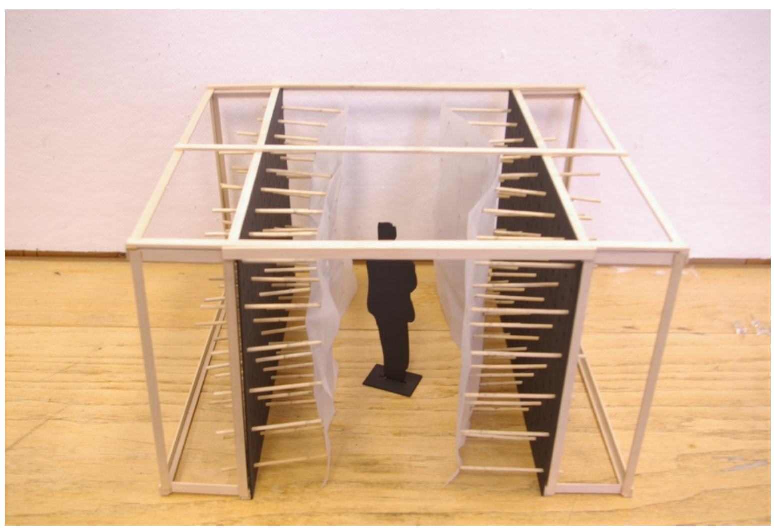


Fig. 14 (Faulkner) Arial view of study model, 1″=1′, Photograph by Author

Following the assembly of the panels there was the application of a surface to the interior of the machine. Two 12'x8' pieces of high quality spandex were equipped with 150 rare earth magnets in a grid to match that of the round bar rods of each panel (25 rods per panel x 6 panels = 150 total rods). The two spandex panels were then applied to the rods via the magnets to create a singular surface on each side of the interior of the machine.

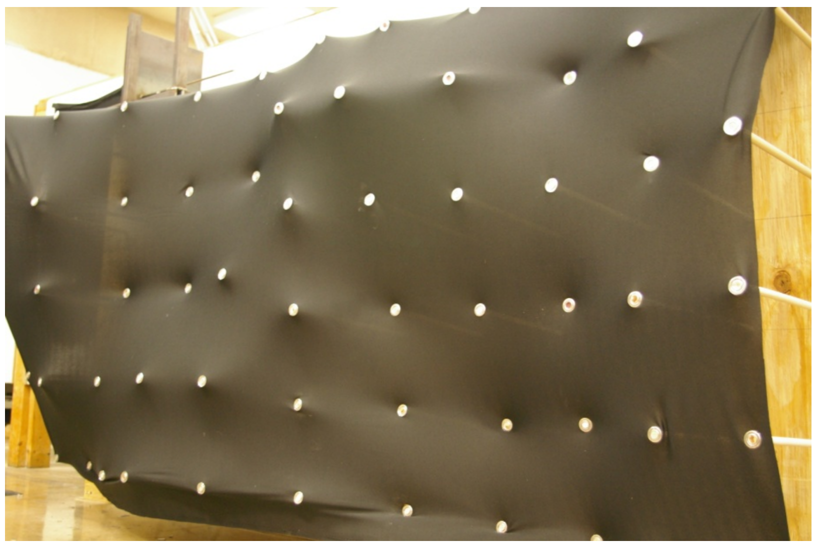


Fig. 15 (Faulkner) Photograph of Surface Study Model

The Experiment

The experiment, or series of experiments, called for the testing of human subjects. In order for this to become part of the thesis research, approval through the Institutional Review Board (IRB) was necessary. This was an ongoing process through the fabrication process. This was also crucial to the development of the machine, because this allowed for the physical construct to develop and adapt along with the development of the experiment. With the guidance and review of Dr. Thomas Carlson, a Professor in the University Of Maryland School Of Psychology, there was the development and design of a research experiment. Once the experiment had been designed, the application for human testing was submitted.

The experiment is essentially an installation which will be set up in two sites on the University of Maryland College Park Campus, and the subjects will be daily occupants of the campus. The installation will be setup in a situation which will suggest the participants pass through the space, however there will be alternate route to bypass the installation if an occupant chooses not to enter the space.

This research will study the path of movement taken by people as they pass through the hallway situation in various configurations. (Fig. 16, 17 and 18) In particular, we seek to gain a better understanding of how and why people move through certain configurations of space.

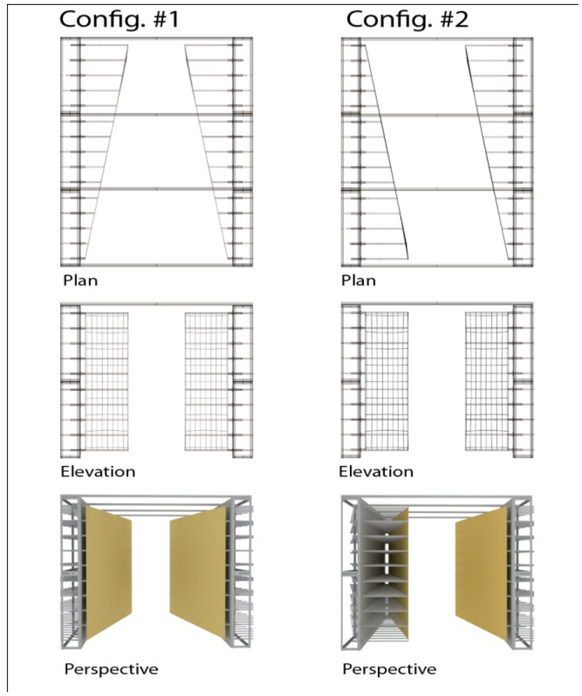


Fig. 16 (Faulkner) Machine Positions 1 and 2: Plan, Elevation, and Perspective

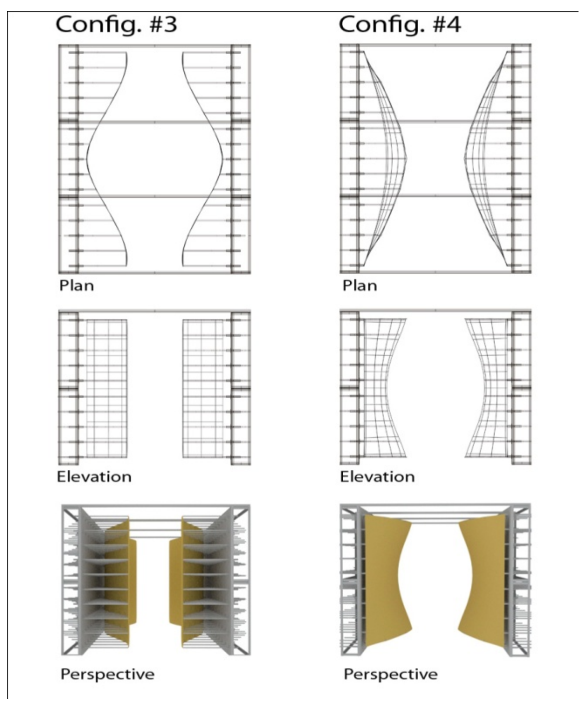


Fig. 17 (Faulkner) Machine Positions 3 and 4: Plan, Elevation, and Perspective

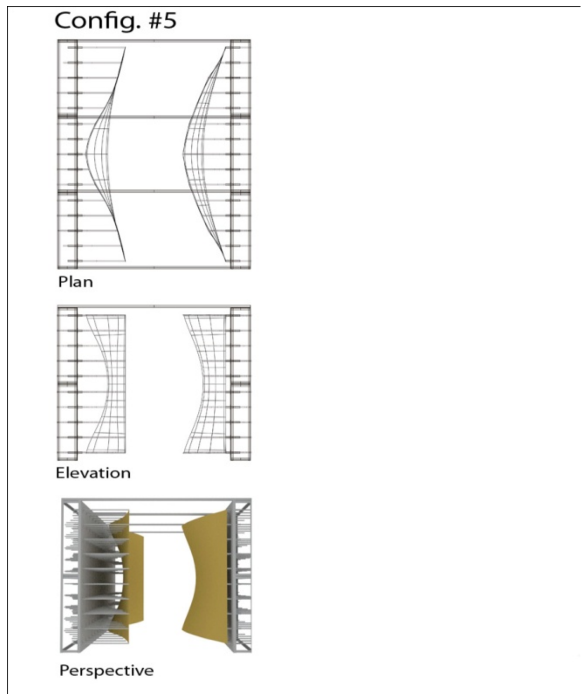


Fig. 18 (Faulkner) Machine Positions 5: Plan, Elevation, and Perspective

Nightly the configuration of the installation will be changed, remaining in a single position for a period of one day. Each day there will be an optional and anonymous questionnaire which will be marked by date. (Fig. 19) The questionnaire remains the same throughout the running of the experiment. This is in hope that different configurations may lead to different tendencies in responses.

Questionnaire:

Date: 01.25.10

1. Have you previously experienced a similar or contrasting encounter and if so what?
2. Please describe your experience in the form of a metaphor?
3. Please sketch your experience?
4. Did the experience make you think of something in particular and if so what?
5. Did the experience have any effect upon you and if so what? Circle one.
   a. Calming
   b. Exciting
   c. Irritating
   d. Other ____________________

Fig. 19 (Faulkner) Copy of typical questionnaire

Subjects for this study will be participating at their own discretion. The installation will be setup and positioned in a way that you may walk through it or around it. The anticipated subject pool for this study will include students, faculty and university employees. There may also be individuals not affiliated with the university that wish to participate in this study.

The design of the experiment was based around the hope of determining some answers and explanations to the questions previously stated. The hopes of the experiments are to gain insight into the relationship between the human psyche and perception of space.

The Site

Due to the limitations of the installation of the machine, the size and accessibility for transportation of the machine, allocated a strict range of placement within the UMD College Park campus and for that much within a reasonable vicinity of the School of Architecture, Planning and Preservation (Building 145) as well as that of the Department of Art Building (Building 146). The Department of Art Building is the building to the North on the Nolli Plans and the School of

Architecture, Planning and Preservation is the building to the South on the Nolli Plans. (Fig. 20-21)

These two buildings are located on the West end of the UMD College Park campus near the Adelphi Road and Campus Drive entrance to campus. They are located adjacent to one another with Campus Drive passing between them just as you enter campus. To the north of the Department of Art Building is Talbot Hall. To the south of the School of Architecture, Planning and Preservation is the Smith School of Business.

Fig. 20 (Faulkner) Nolli Plan at 1:50 with possible areas of installation positioning

Fig. 21 (Faulkner) Nolli Plan at 1:50 with possible areas of installation positioning selected

Site Selection

The installation of the machine was to happen in two locations for the development and collection of data through the process of this being an experiment. After reviewing and narrowing the scope of movement between sites for convenience of transporting the machine the decision was made to be located in the atrium space of the Department of Art Building and on the Smith School of Business lawn, adjacent to the School of Architecture. The machine was to be set at each site for a one week period of time to run the experiment. Each day the configuration of the machine will change. However due to inclement weather conditions and time constraints the second installation site was abandoned.

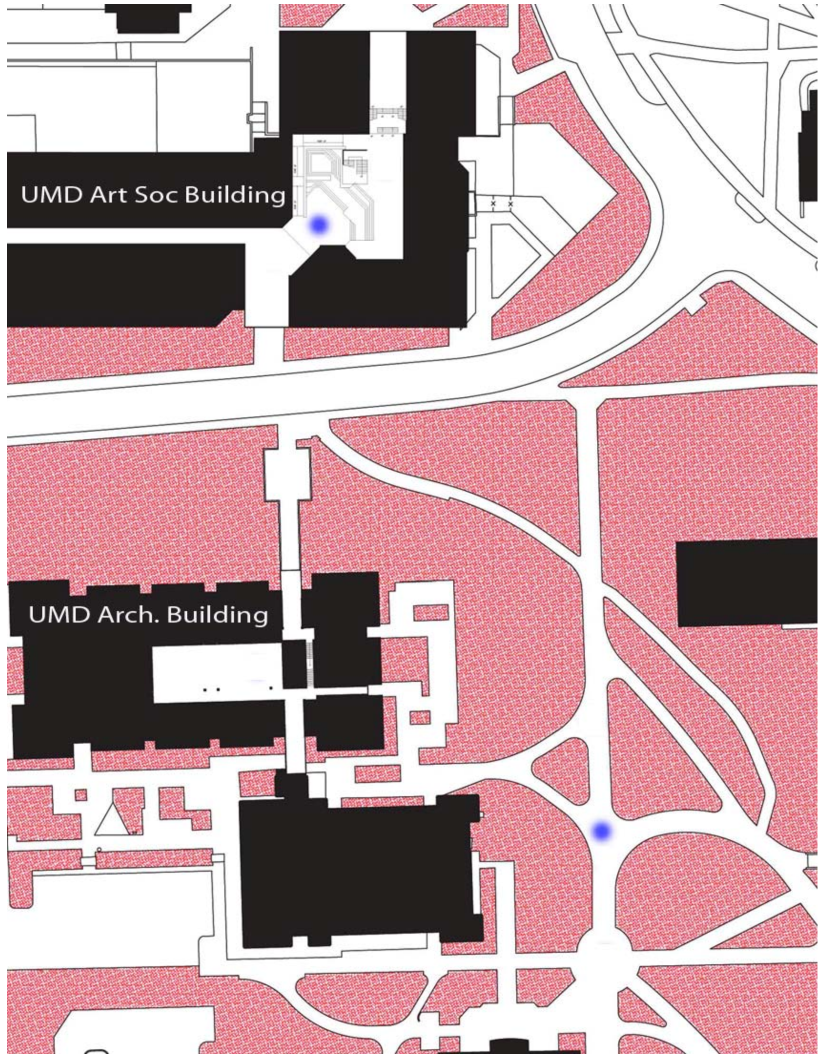


Fig. 22 (Faulkner) Nolli Plan of Locations 1 and 2

Site 1

The first portion of the study will take place in an indoor setting, Area 1: the atrium in the University of Maryland Art and Sociology Building (146), for a one week period of time with its configuration changing daily. (Fig. 23)

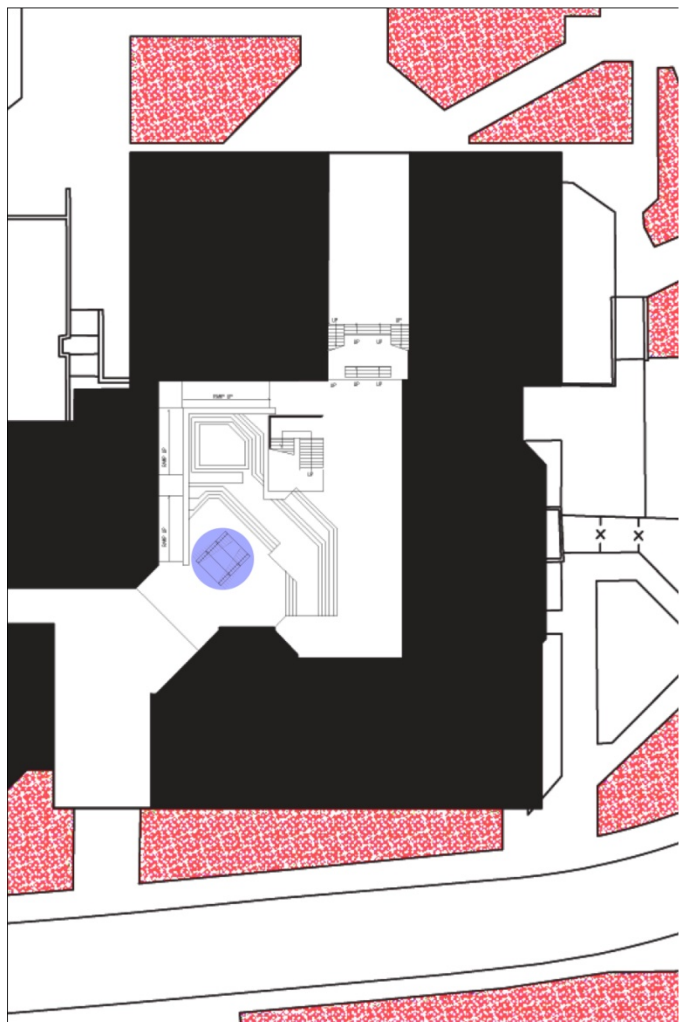


Fig. 23 (Faulkner) Nolli Plan at 1/8″=1′ with position 1

Site 1 _ analysis

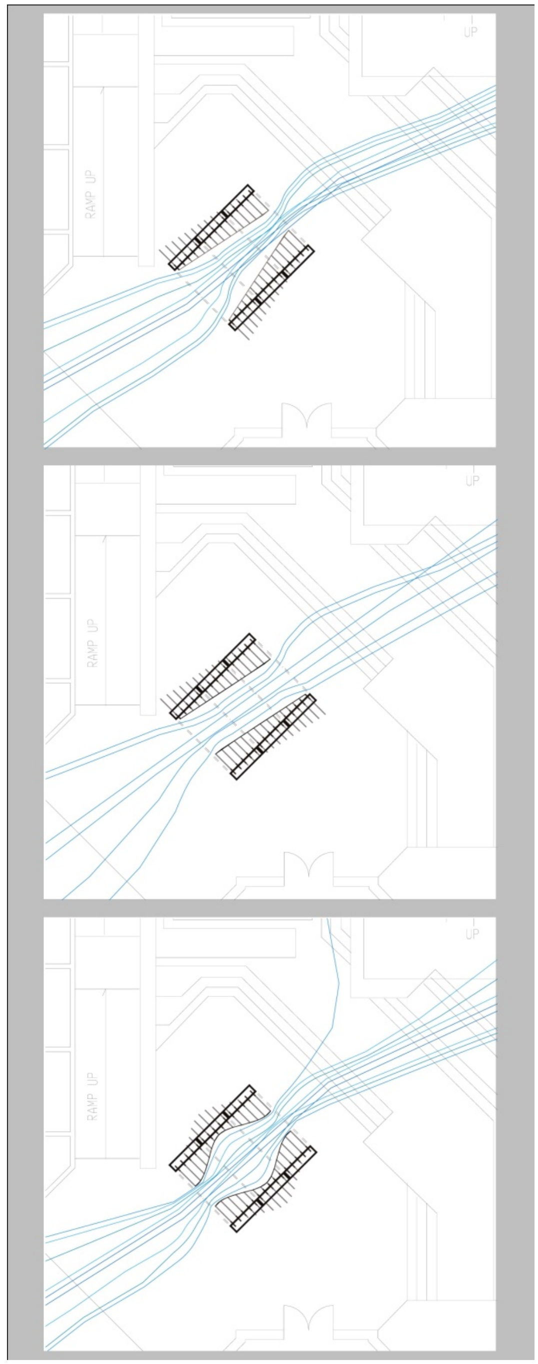


Fig. 24 (Faulkner) Movement Path Diagrams of position 1, configurations 1, 2 and 3

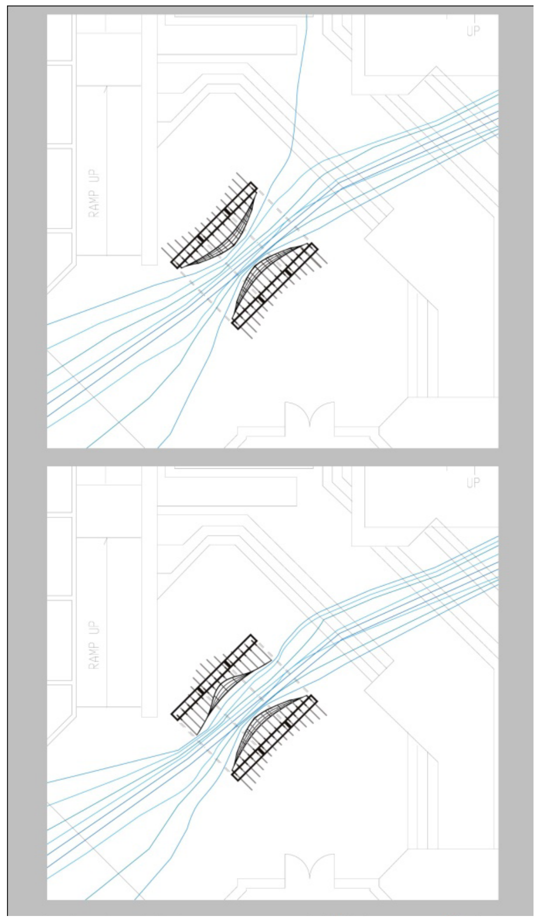


Fig. 25 (Faulkner) Movement Path Diagrams of position 1, configurations 4, 5 and 6

Data Collection

For the collection of data the five configurations are video recorded each day and in each location with the hopes of gathering information as to the path that people may take through the installation and the possible variations that may come from those recordings. The installation is video recorded from three vantage points. One camera at each end of the machine, totaling two, and one placed above showing a top down view.

The camera placed in the above position is to get a plan view of the installation. The goal of this view is to capture the direct path that people take through the installation. This is in hope of getting various paths taken despite the maintained 3' straight path through the installation at all times. The addition of the optional questionnaire is to gather further insight into the occupant's thoughts and actions/reactions to the installation.

The purpose of the two cameras placed at each end of the machine is to get an elevation view of the installation from both sides. There was the need for a camera at both ends of the installation because it is a multi-directional space. The goal of the elevation view is to capture the movement of the body itself. This view anticipates capturing any movements or changes in the occupant's posture or vertical positioning.

Data Analysis

The video recordings will then be digitized and analyzed to interpret the path and the way in which people pass/move through each configuration of space as well as the body movement of the individuals. This will determine if there are any differentials in movement.

The analysis is done by converting the recordings to digital files so they can be split into individual frames. The individual frames are then analyzed in relation to each other and using vector software such as AutoCAD and vector drawings are made.

Vector drawings are developed, from the plan view recordings, mapping the paths the occupants take within the apparatus. This is done for each configuration and then the drawings are analyzed to pick out any tendencies. (Fig. 26)

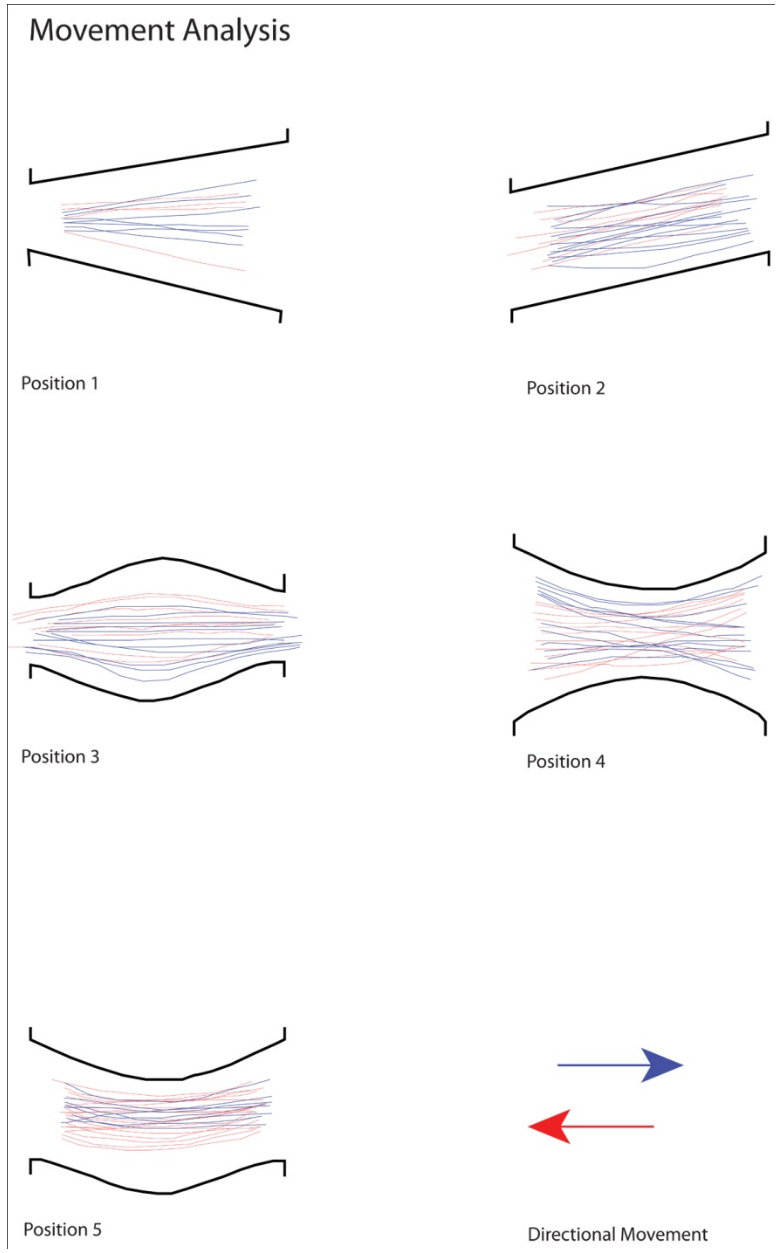


Fig. 26 (Faulkner) Movement Analysis of five spatial configurations, derived from video recordings

Fig. 27 (Faulkner) Photographs of apparatus in 4 of five configurations

Data Conclusions

From the data collected, the experiment and apparatus had clear limitations. The design of the experiment and apparatus viewed the space as a constant by setting the apparatus as a spatial defining device in a certain configuration and recording the human response. Which then viewed the occupants movement as the variable to be analyzed for data.

Despite these preconceptions in the design process as limitations there were three conclusions that could be drawn from the data collected in the form of video recordings of human's occupying each configuration as well as a questionnaire occupants responded to. The first two conclusions were explicitly visible through the video recordings. The first is that there is a clear limit to the distance an occupant will get to a wall surface. From my research, people's comfortable range of distance away from a wall surface is approximately 6-10 inches. This distance is measured from the closest vertical surface point to the person. This distance holds true regardless of whether the point is near the occupant's feet, waist or head.

The second observation gathered from the videos was the disregard to the cultural norm to walk to the right side of a space unless there was another occupant passing in the opposite direction. This comes from visual analysis of occupants' passage with the set configurations.

The third observation comes directly from the occupants responses on the questionnaire. Numerous participants commented on the questionnaire that the wall surfaces of the apparatus seemed to be taller than their actual height. This was apparent due to the lack of a direct ceiling plane which gave a false perception of height.

Installation vs. Application

To this point the research portion of this thesis has focused on setting a configuration of space and analyzing the occupants' response to that spatial configuration. Now the knowledge gained from the data collection and data analysis is applied to design choices where an existing movement-oriented site will be transformed. This second phase is geared to further speculate and reflect on the relation between a designer's choice and the effects that choice has upon the inhabitant's senses. In order to take what was learned from Part 1 and apply it, the search for a suitable site for transformation began. The chosen site for this study is the pedestrian connection of the 6th Avenue L train stop to the 7th Avenue 123 stop in New York City. What made this site suitable for exploration was its sole function of providing passage for pedestrians and its complete lack of interaction or response to its occupants.

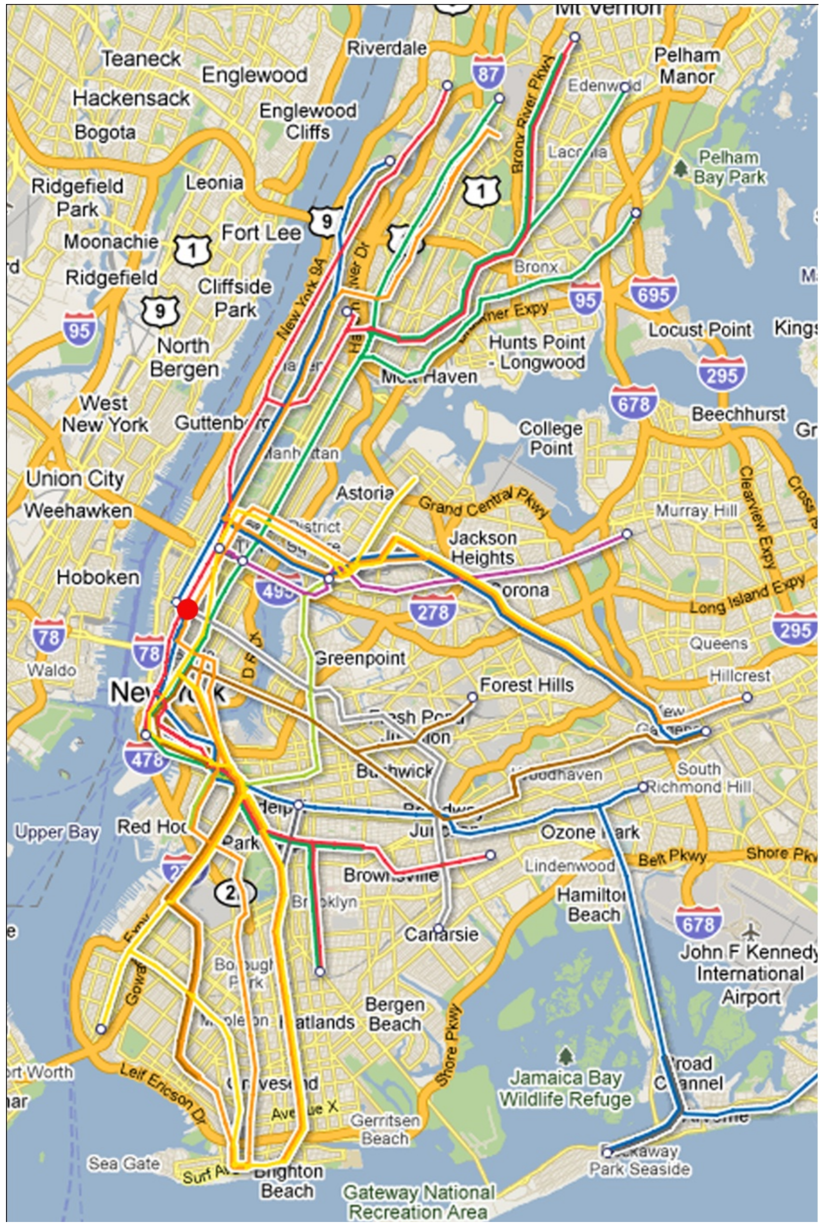


Fig. 28 (Faulkner) Google Image modified to show MTA Subway Lines

Application Site

The 6th Ave. L train station was the original termination point for the L line (Canarsie line from 1924) until the 8th Ave. station was opened in 1931. This station is approximately 40 feet below street level and has connection to the FV (IND 6th Avenue line) and the 123 (IRT West Site/7th Avenue line). The connection to the FV is narrow winding stair and the connection to the 123 is a long corridor. The long corridor connection to the 123 is Site 1.

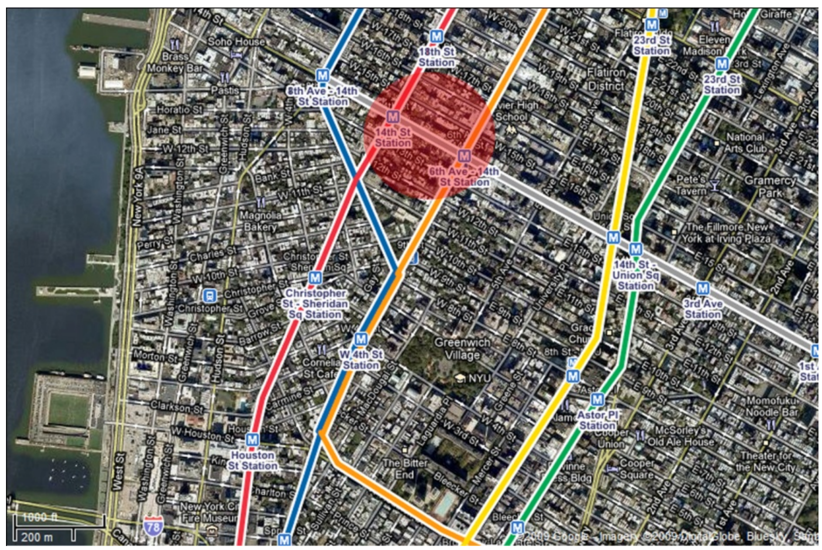


Fig. 29 (Faulkner) Google Image modified to highlight 6th Ave L stop

This underground corridor is located 32 feet below the surface of 14th Street in Manhattan between 6th and 7th Avenues. It is 15 feet wide, 8 feet tall from floor to bottom of beam, and 750 feet long. The connection has a concrete floor surface, tiled walls, and a ceiling plane defined by beams every four feet on center.

Fig. 30 (Faulkner) top to bottom: collage perspective looking south at 6th Ave; collage perspective looking south at 7th Ave; montage ariel view of 14th street looking south

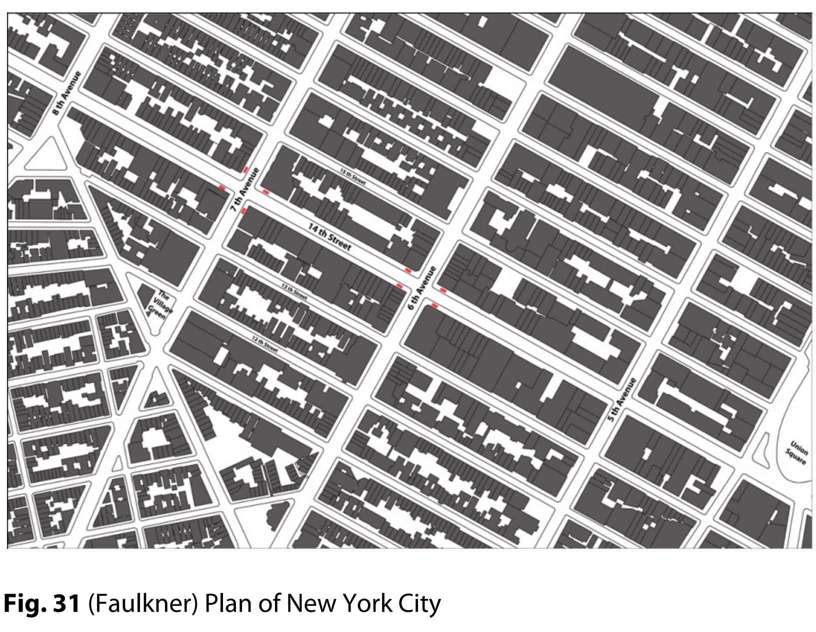


Fig. 31 (Faulkner) Plan of New York City

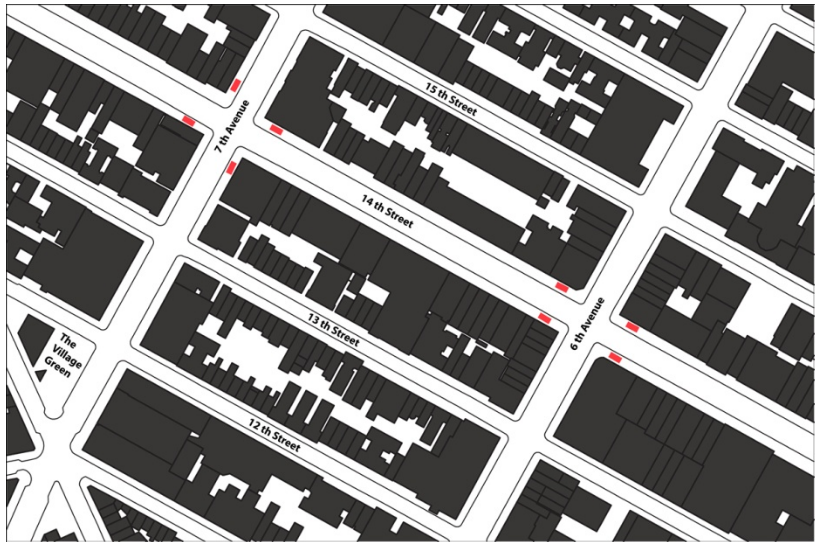


Fig. 32 (Faulkner) Plan of 14th St. NYC between 6th and 7th Avenues

Fig. 33 (Faulkner) Photograph of corridor connection between the 6th Ave. L stop and the 14th St. 123 stop

Fig. 34 (Faulkner) Photograph of corridor connection between the 6th Ave. L stop and the 14th St. 123 stop

Fig. 35 (Faulkner) Existing Site Section and Site Plan

Application Design Process

In designing the transformation of this site I took what I had learned from the participants' responses to the experiment and looked at applying them to the corridor. These are the three conclusions that were made from the collected data. While considering the site and the attributes of experiment based around the human response to space it became apparent to me that I could not solely design to make the occupants respond to the space. I needed to design the space to respond to the occupants based on what I had learned. Hopefully the occupants would in turn respond to the space.

To do this I began to explore how to make a space responsive and how attributes that define space can be responsive to their occupants. Now this begins to break down the site into surfaces. The four surfaces of the site are that of the floor, the ceiling, and the two walls. I began to understand this space to work as two corresponding entities, the floor and ceiling acting as a pair and the two wall surfaces acting as a pair. This happens due to the perceptual confinements of the site, with a height of only eight feet the floor and ceiling must work in tandem to conclude with cohesion. This holds true for the wall surfaces as well, the right and left walls must work together to provide a visual and perceptual unity.

This unity has been created by designing this space with four attributes that work in the pairing of floor/ceiling and right/left walls. Each of these attributes look at precedents and their relationship to spatial qualities. They also have a direct correlation to the relationships of body, space and time.

Wall Surfaces

The first two are used to define the wall surfaces. They are inert walls and re-active walls. The inert walls are surfaces that are visually animate due to their surface curvature and quality as light reflects off of the shell. They are derived from looking at and studying the qualities of Mark Goulthorpe's aluminum screen project for the Glaphyros Apartment, which can be found in his book *The Possibility of (an) Architecture.* (Fig.36)

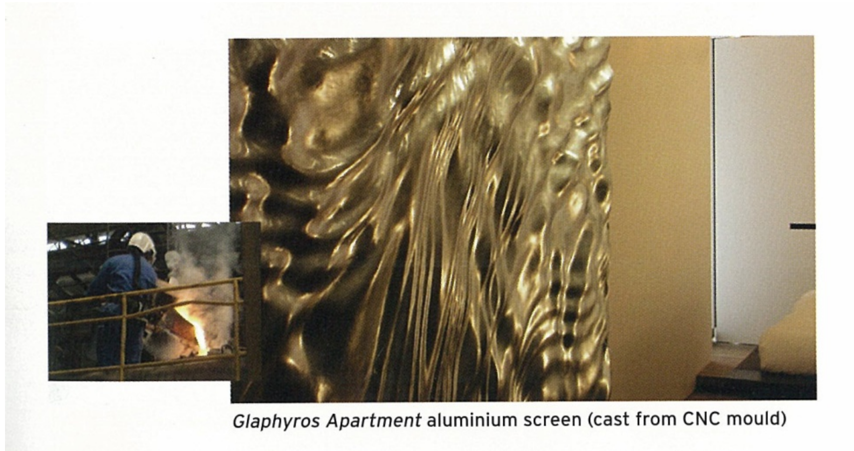


Fig. 36 (Goulthorpe) Glaphyros Apartment aluminum screen

The animate qualities of the surface come to light as one walks in through the space. A person's oblique view of the wall surface changes due to their movement. The animate behavior is then seen due to the wall's curvilinear nature as static form. The changing oblique in conjunction with the reflection of the light on the surface gives a false perception of a static wall having animate qualities.

The inert walls are 4'x8' panels which get assembled in a linear fashion connecting to each other and the existing wall behind. They are 1/2" think recycled cast aluminum with a brushed finish. A rubber seal transitions the connection between consecutive panels. The inert walls are limited in form to not exceed protruding into the space more than two feet into the space.

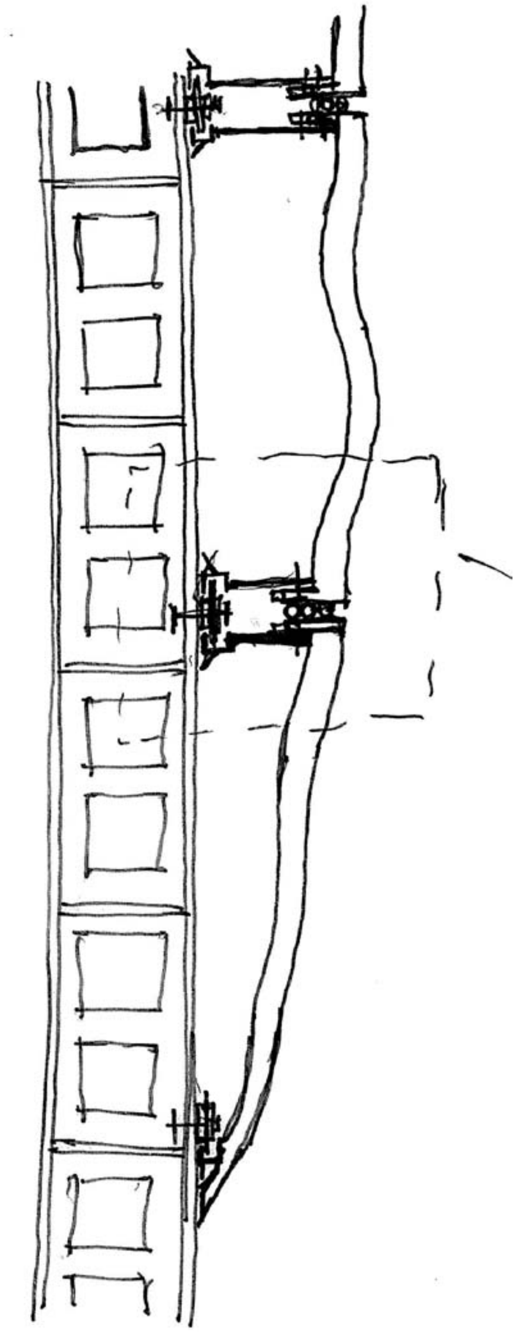


Fig. 37 (Faulkner) Sketch of Inert Wall Mount

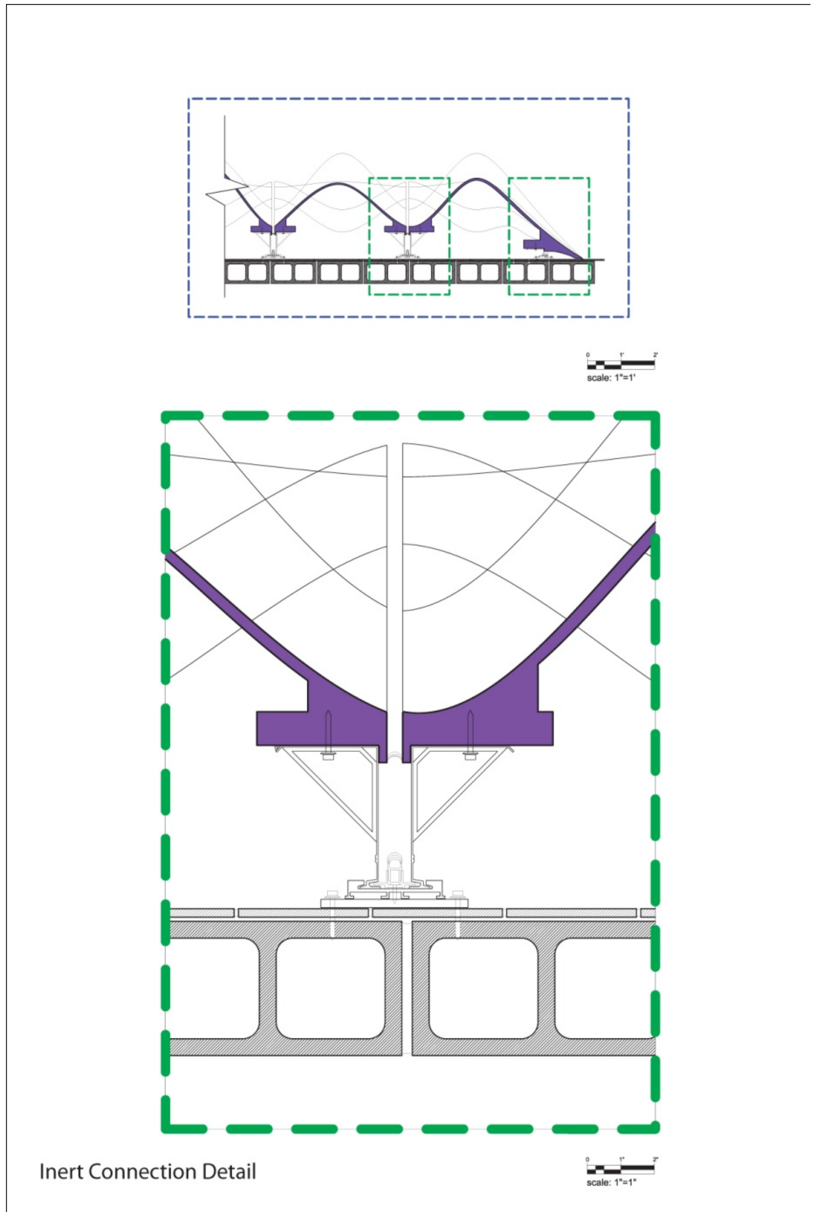


Fig. 38 (Faulkner) Inert Panel Connection Detail

The second attribute of the wall surfaces is the re-active walls. These walls are animated surfaces based on a pneumatic actuation system which is responsive to the movement of the occupants within the space. This system looks at the project *Hyposurface*, another Mark Goulthorpe piece, which is also a pneumatic actuation system. (Fig. 40)

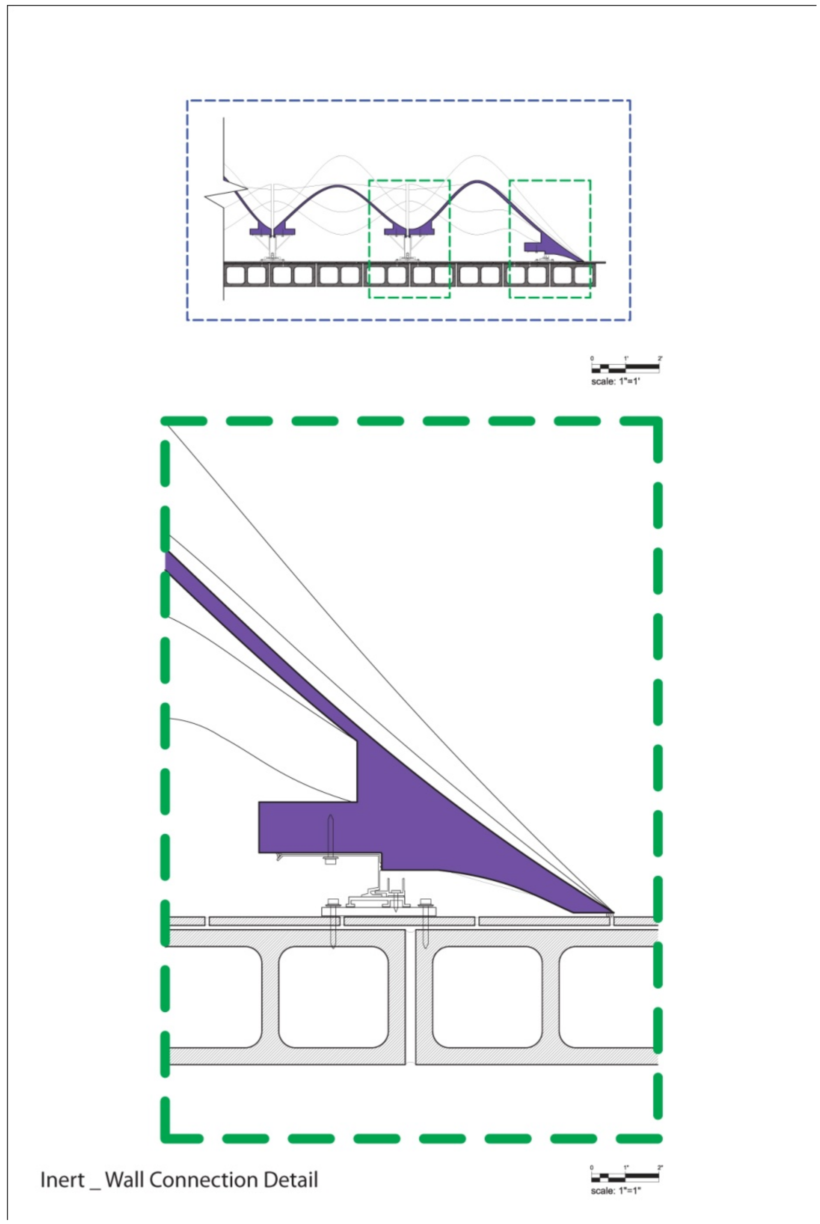
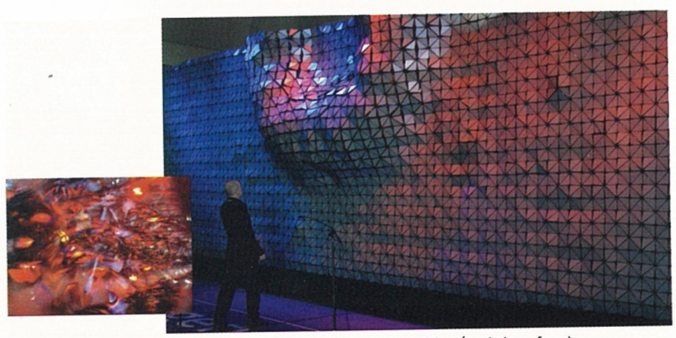


Fig. 39 (Faulkner) Inert to Wall Connection Detail

Aegis Hyposurface (articulated rubber/metal surface)

Aegis Hyposurface (pneumatic actuators)



Aegis Hyposurface (articulated rubber/metal surface)

Fig. 40 (Goulthorpe) Hyposurface Project

The re-active wall is designed as a 4'x4' panel system with a 1' frame. Two panels are stacked on top of each other to fulfill the 8' height of the site and then another two panels are mounted to add to the length. This occurs until that segment of re-active wall reaches its specified length. Each panel consists of 25 pneumatic actuators, spaced in a 9 1/2 inch centered grid, which are attached to bi-polar metal triangular panels, that create the surface of the wall, with rubber fittings. The stretch to the rubber fitting and the dimension of the triangular panel limit the tangential difference two adjacent actuators can protrude or depress. The metal triangles are then outfitted with OLED attachments that have the ability for a curator to organize and display digital imagery for a period of time. This display could be used for visual art, public service, or advertised and many other possibilities.

The design of the re-active wall is controlled by the response to the Part One research and the conclusion of the proximity distance of the 6-10 inches a person will get to a wall surface. So the re-active wall responds to the occupants passing by it and protrudes or depresses to remain 6-10 inches from the occupant. This is of course constrained by the frame of the system as a limit of depression, and has been designed with a protrusion limit of two feet. These limits are to control the amount of intrusion on the already narrow site.

The inert and re-active walls work in concert with each other to define the wall surfaces. This happens by them alternating sides of the space so at all times there is an inert wall to one side of the occupant and a re-active wall to the other side. As the occupant moves further through the space this condition would alternate, having the respective walls on the opposite sides on the occupant. The two elements are limited to not intrude on the existing width of the space more than a combined distance of four feet in order to maintain a minimum width of eleven feet within the site.

Where the inert wall meets up with the re-active wall they maintain a seamless transition between surfaces. This occurs with the detailing of the connection between the two elements. When the two meet they are attached to one another with a rubber seal. The re-active wall then holds the form of the inert wall surface for the duration of two columns of actuators. The third actuator then begins to respond to the movement of the occupants.

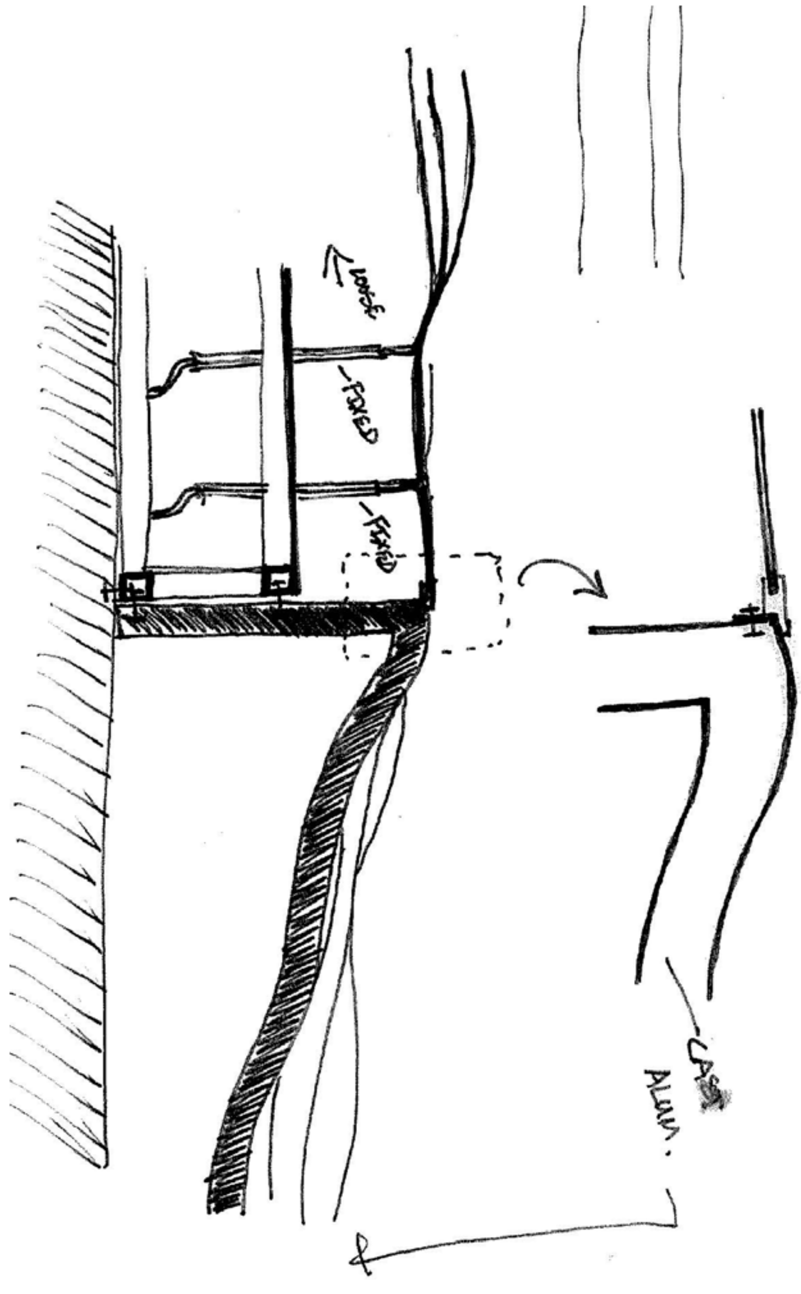


Fig. 41 (Faulkner) Inert and Re-active wall Connection Detail Sketch

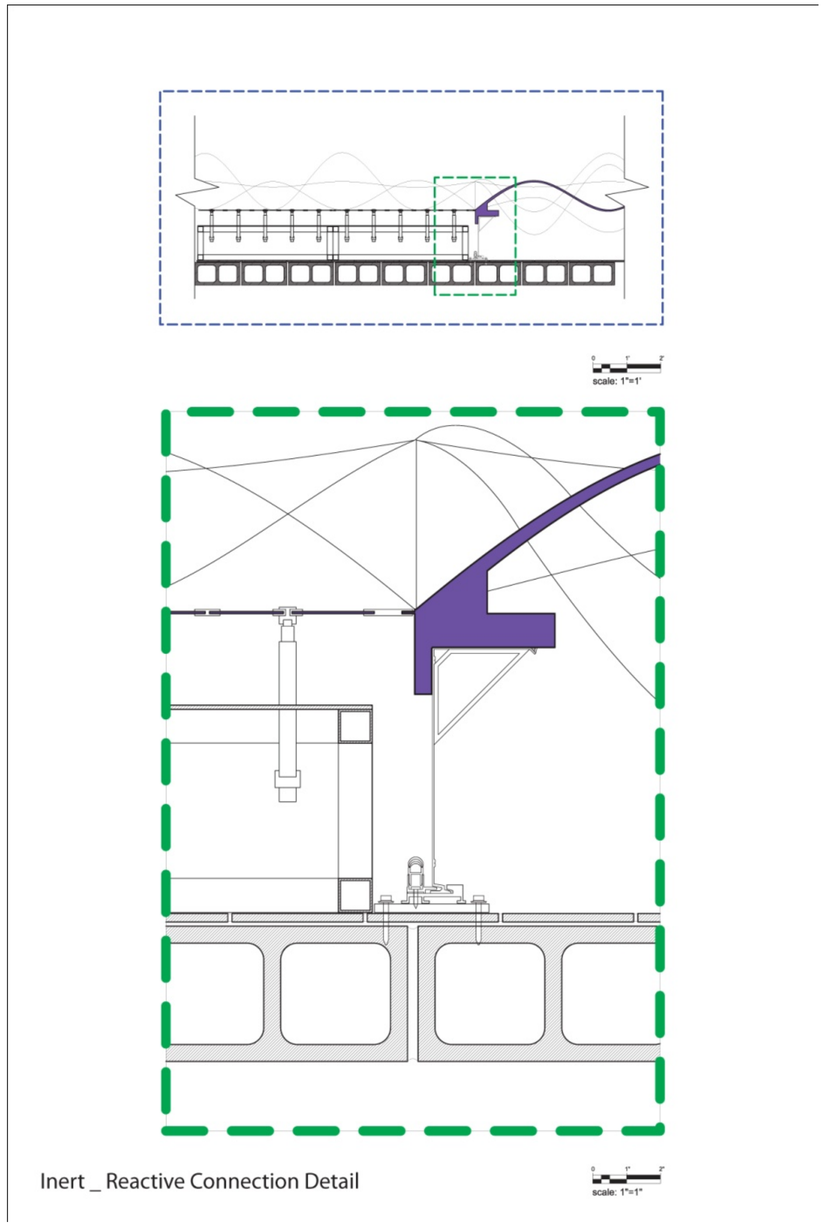


Fig. 42 (Faulkner) Inert and Re-active Wall Connection Detail

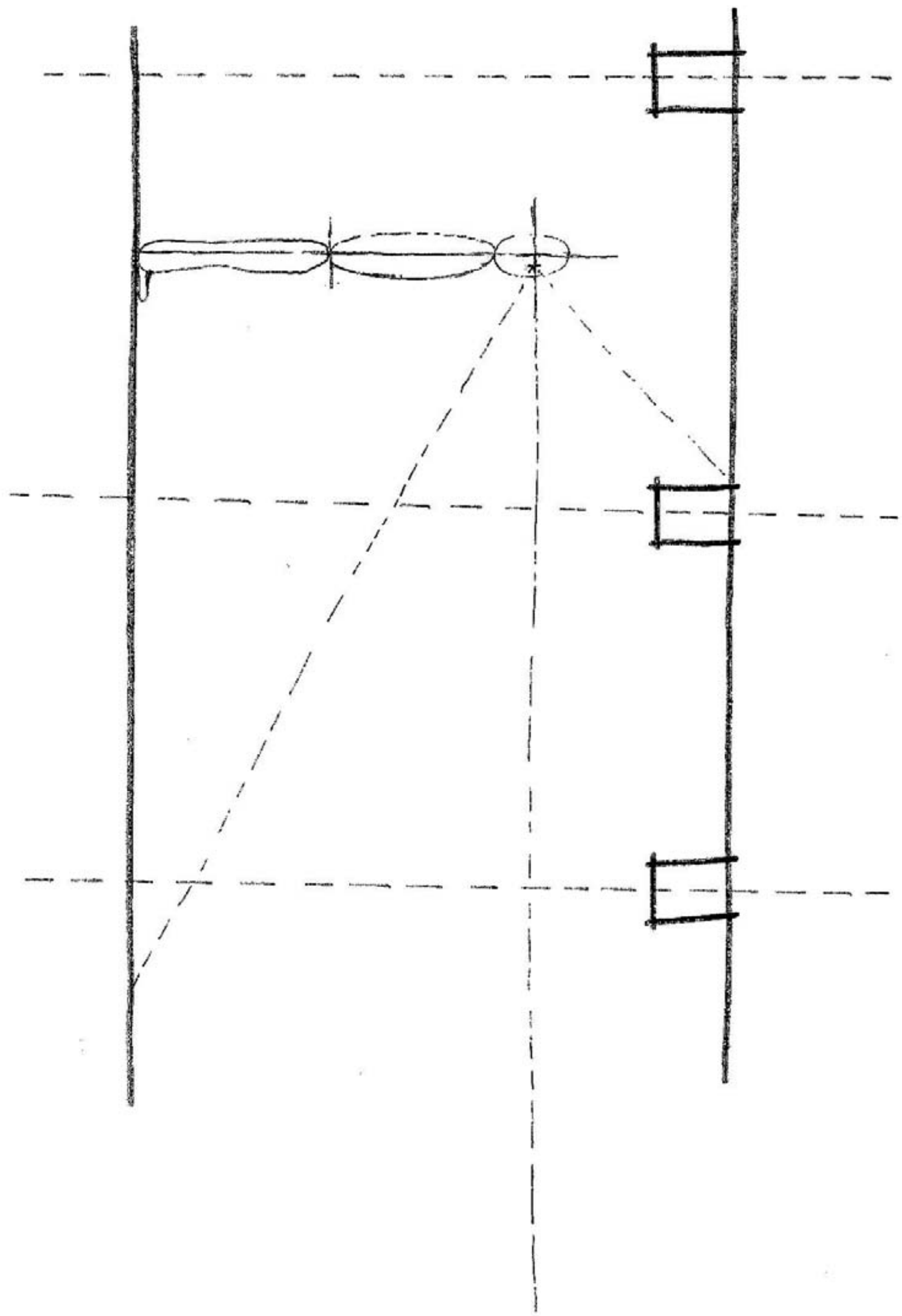


Fig. 43 (Faulkner) Visual Diagram Sketch, Floor and Ceiling Relationship

Floor and Ceiling Surfaces

The third and fourth attributes work in concert with each other to help define the notions of body, space and time. They do this by relating the occupant to the layered conditions of the site. As stated in the site description, the connection corridor is located below 14th Street between 6th and 7th Avenues. The site is sandwiched between the L train which travels East/West directly below the corridor and 14th street. The street surface of 14th Street is 32 feet above the floor surface of the site; this corresponds to there being 22 feet of ground between roof of the corridor and street surface. The third and fourth attributes of this design look to provide the occupant with a sense of place by hinting to the conditions which happen above and below.

The third attribute looks to provide a perceptual illusion of being a taller space than it is. This comes from the Part One conclusion to provide a false sense of a ceiling plane to make the height of the space perceptually elongated. It looks indirectly at the project *555 Kubik* by Urbanscreen. (Fig. 44) This project uses animation applied to a flat surface of a building façade to give the illusion of depth and movement.

Fig. 44 (UrbanScreen) 555 Kubik Project

The third attribute is the application of LED panels to the ceiling plane. The LED screens are mounted between the existing beams of the site recessed a dimension of two inches as to create a reveal to the existing conditions of the beams in the site. This also manages the size of the LED screens and maintains the consistency of the rhythm of the beams

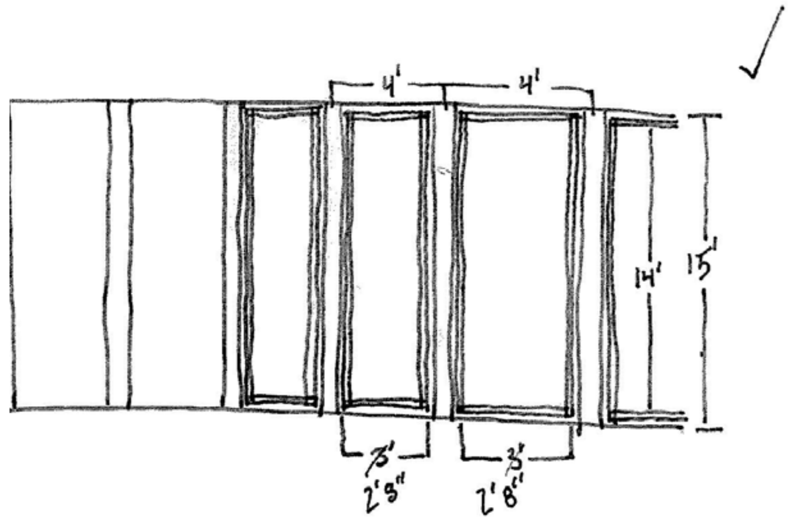


Fig. 45 (Faulkner) Ceiling Plan Sketch

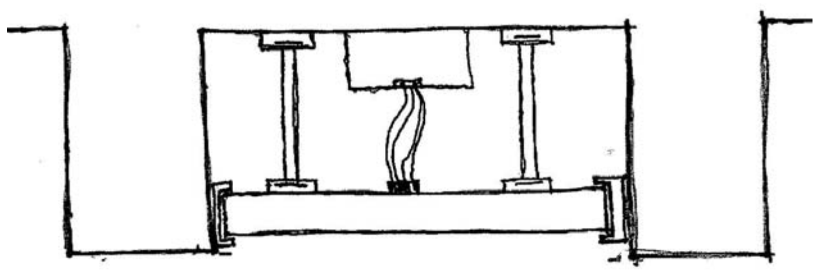


Fig. 46 (Faulkner) LED Ceiling Section Detail Sketch

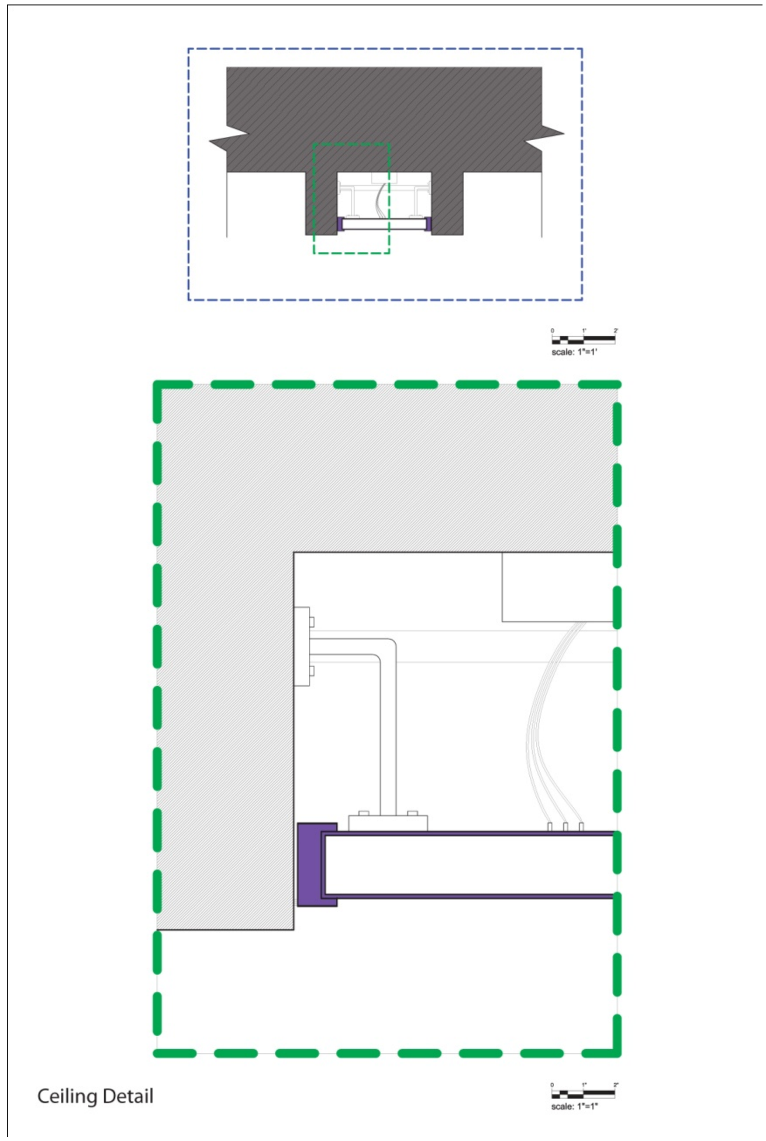


Fig. 47 (Faulkner) Ceiling Section Detail

The LED screens are programmed to work in conjunction with one another as well as being responsive to atmospheric conditions outside. They become a representation of the sky outside providing a false sense of an elongated height to the space. They can also be programmed to represent street conditions at rush hour and a special event which may be going on in Manhattan.

The fourth is the application looks at using the mass of people who pass through this site everyday as a source of creating energy while connecting those users to the conditions below. The connection to below creates a visual connection to the passing trains below the corridor.

This occurs through the introduction of the Piezoelectric Power Leap flooring system into the site. (Fig. 48 & 49) This attribute has less of a perceptual connection to the body than the others. However, this flooring system takes the thousands of people passing through this space on a daily basis and turns their foot traffic into energy to provide power for the applications within this space.

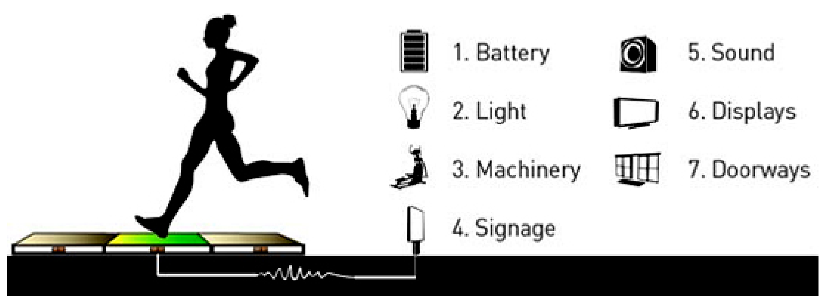


Fig. 48 (PowerLeap) PowerLeap Flooring System Diagram

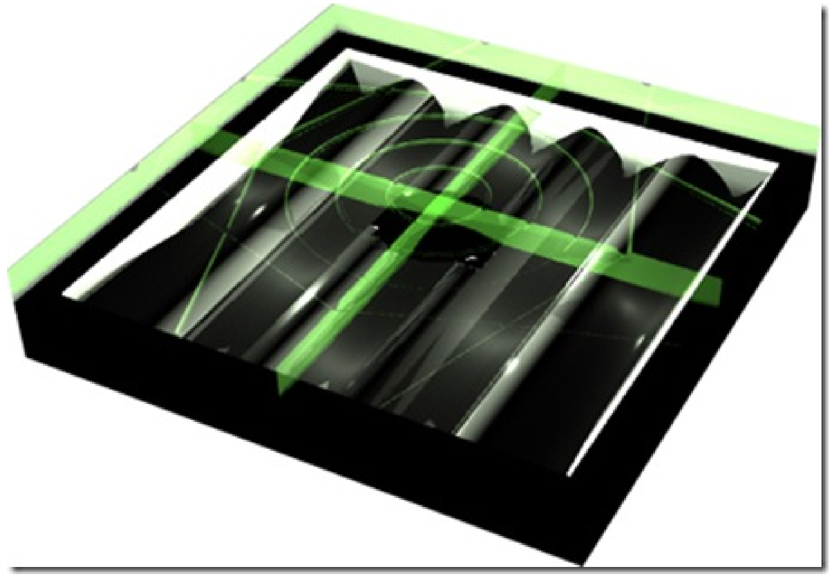


Fig. 49 (PowerLeap) PowerLeap Flooring System Panel Detail Rendering

The system does this by using piezoelectric technology and the weight of the people walking on the panels to generate energy. A single person walking the length of the site (750 feet) will generate an average of 25 watts/hr. This may seem minuscule until you multiply that number by the average of 50,000 occupants daily, some occupants passing through this space multiple times a day.

The flooring system is equipped with LED lights spaced in a 5x5 grid which can provide light to the space from the floor surface. The LED lights are programmed to be responsive to the L trains passing below the corridor. This provides the occupants with a sense of place and time relating them to the movement and timing of train traffic below. As a train passes below the floor panels LED's will light up tracking the speed and distance of train travel. The lights are programmed to be color specific to the direction the passing train is traveling. A train traveling East will be represented by the illumination of red lights, while a train traveling West will be represented by the illumination of blue lights. Now this is flexible due to the nature of the flooring systems programmability.

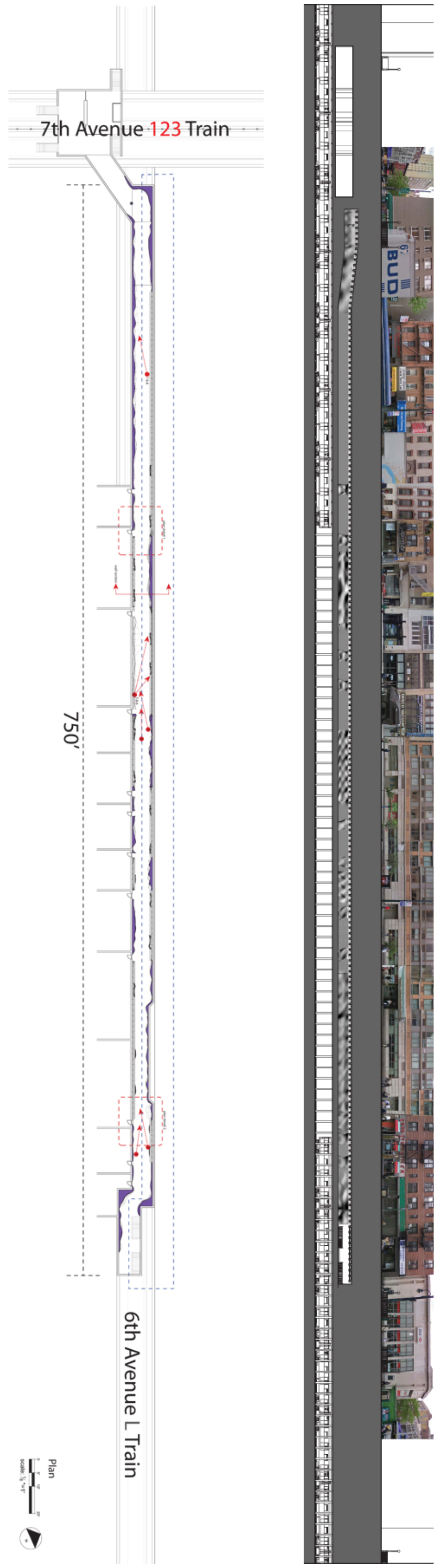


Fig. 50 (Faulkner) Proposed Plan and Section

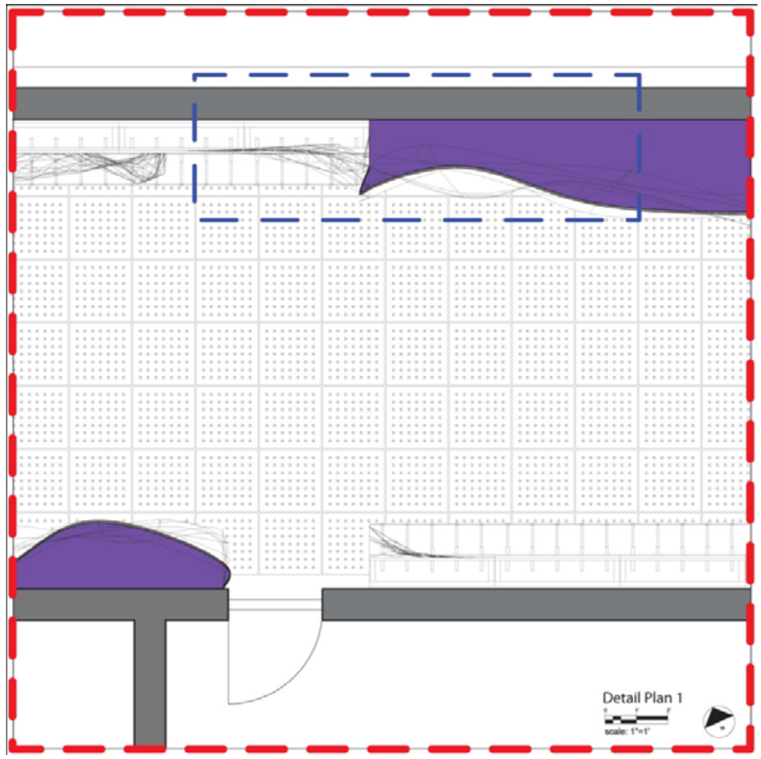


Fig. 51 (Faulkner) Plan Detail 1

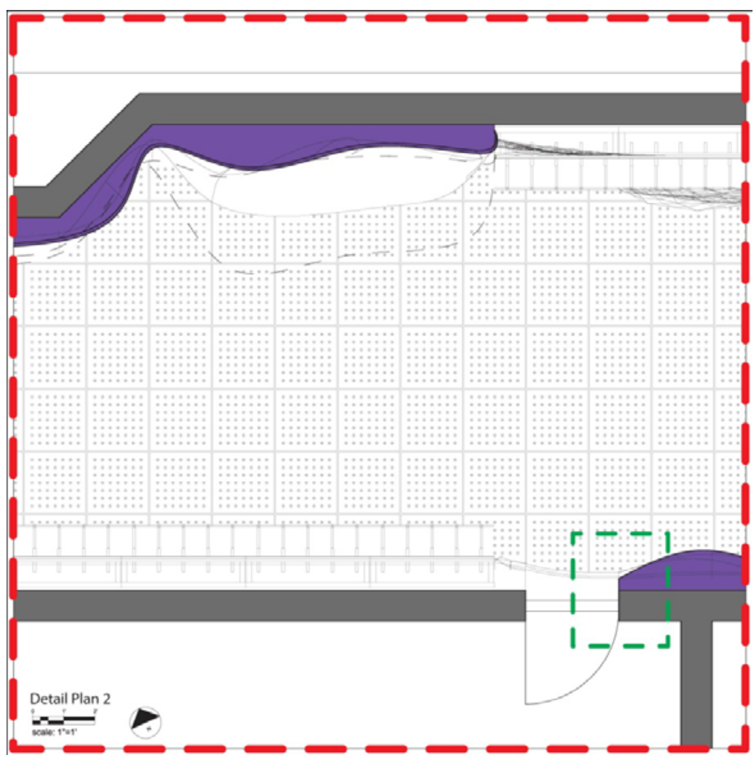


Fig. 52 (Faulkner) Plan Detail 2

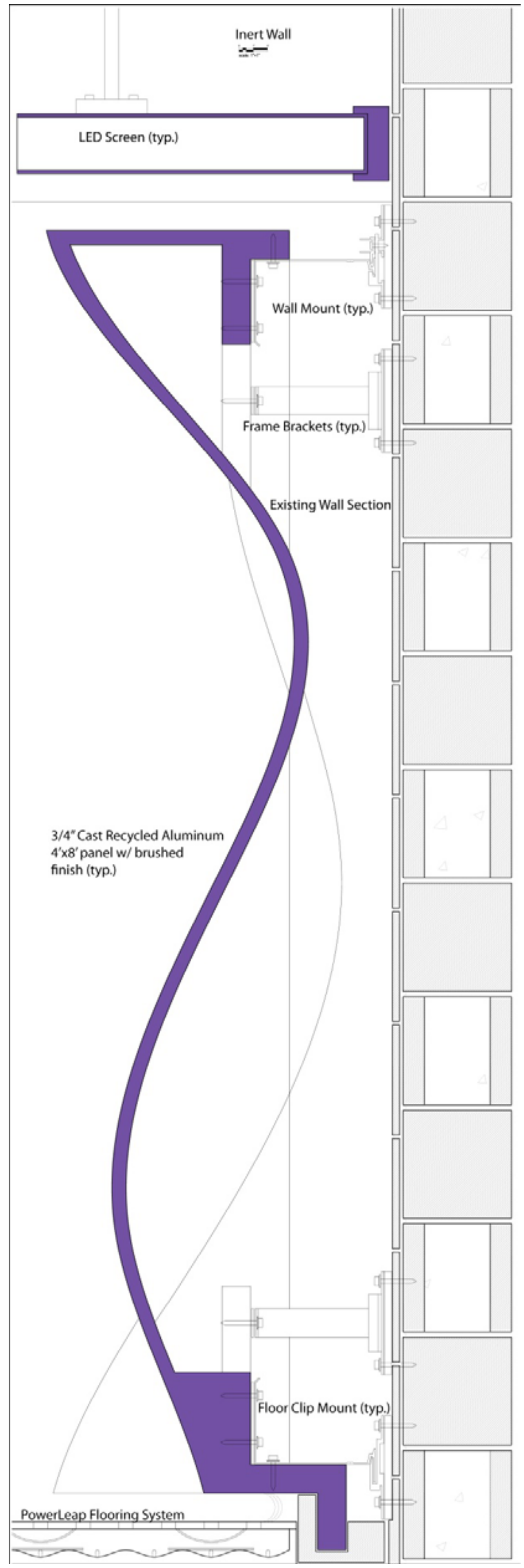


Fig. 53(Faulkner) Inert Wall Section Detail

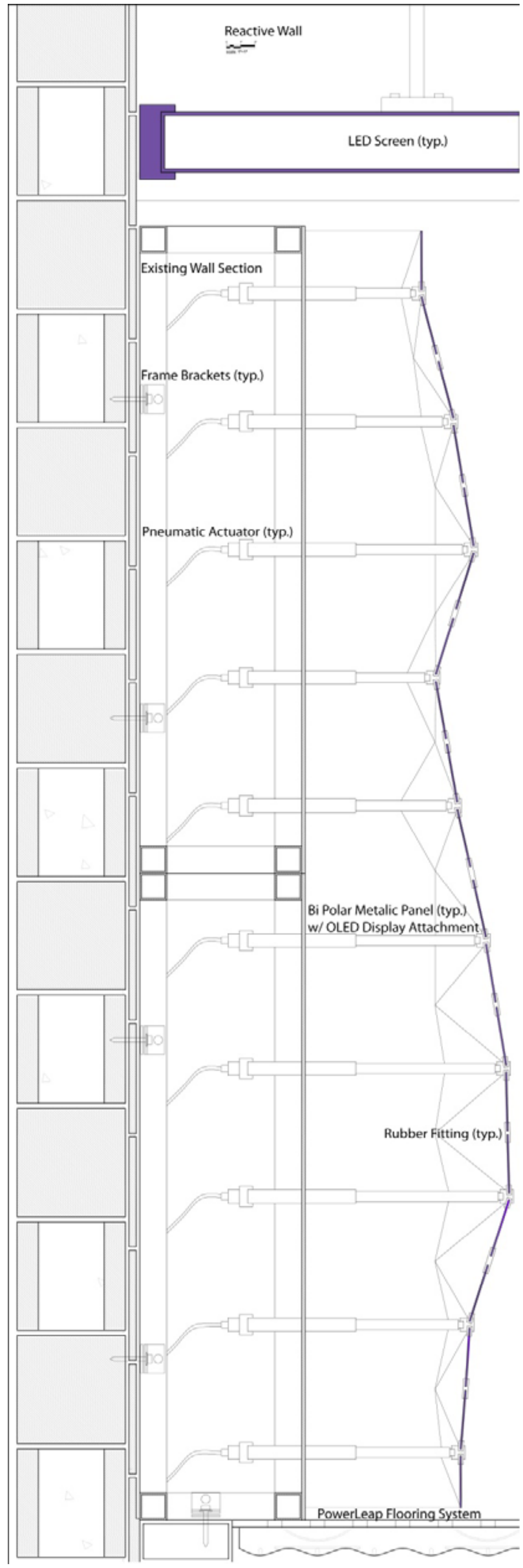


Fig. 54 (Faulkner) Re-active Wall Section Detail

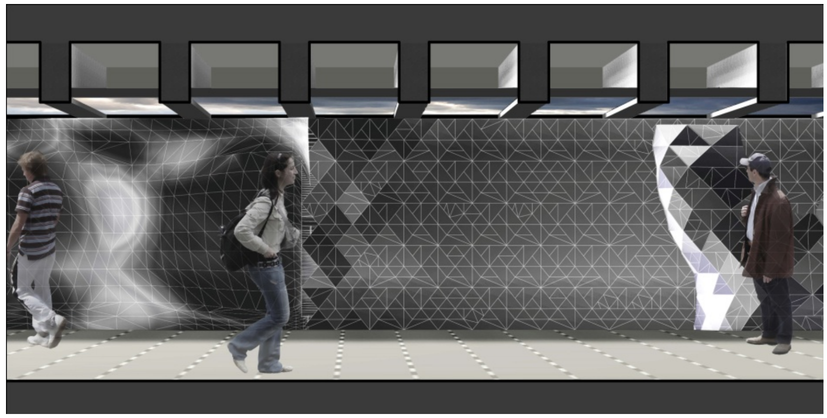


Fig. 55 (Faulkner) Longitudinal Section Perspective

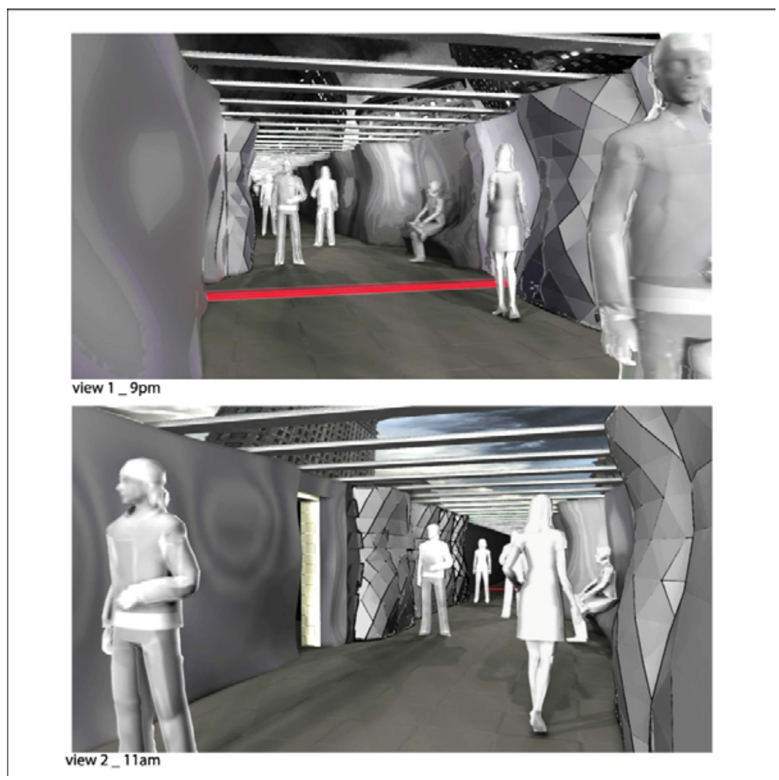


Fig. 56 (Faulkner) Interior Perspectives 1 and 2

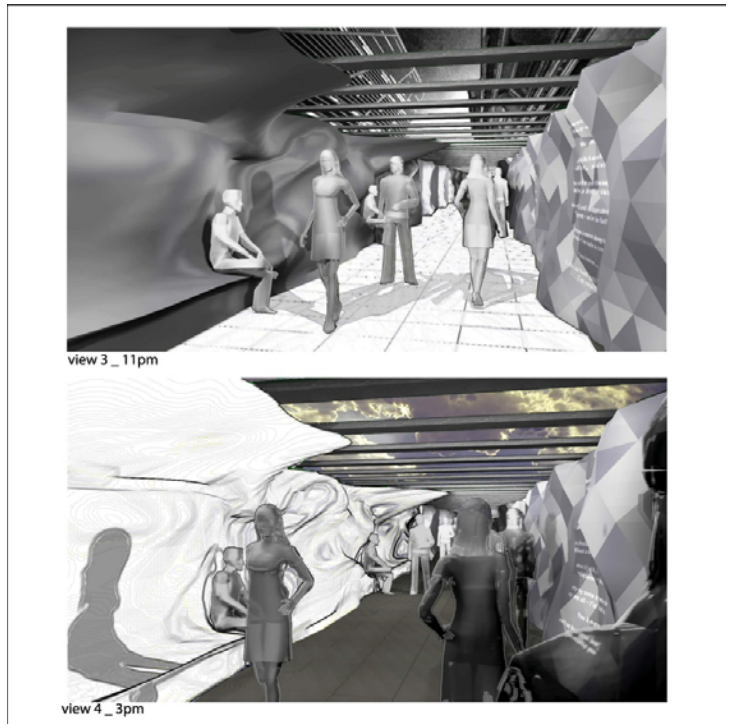


Fig. 57 (Faulkner) Interior Perspectives 3 and 4

Fig. 58 (Faulkner) Interior Perspectives 5 and 6

Fig. 59 (Faulkner) Interior Perspectives 7 and 8

Conclusion

This thesis was evolved out of two related areas of interest. First, the love and respect for making and the knowledge that comes from the tangible qualities of making. The second was a curiosity about the intersection between our bodies, our movements, and our perceptions of the spaces we inhabit.

It was structured as a two part process. The first part was based around the design and fabrication of a full scale apparatus for gathering information from others about these relationships of body, movement, space and perception. A site in New York City was selected to continue exploration of and to test the conclusions gleaned from part one.

Three questions jump started this thesis. First and foremost, how might we design spaces that are interactive and responsive to its occupants? Second, how can a dynamic, ever-changing space participate/alter relationships between body, space and time? Finally, how do we begin to understand spatial configurations and their effects on us?"

In response to this questions I developed an experiment that I hoped would reward me with insight. I designed and built an apparatus that could be reconfigured to shape the space it defined. As participants walked through this shaped passage their movement were video recorded and they were asked to fill out a questionnaire.

While there were limitations to the apparatus and the experiment, there were three conclusions that were developed from the data collected. First, there is a limit to the distance an occupant will get to a wall surface. Second the cultural norm of staying to the right of a space is disregarded, unless there is another occupant travelling in the opposite direction. Third the existence or lack of a ceiling plane affects our perception of height.

So, up to this point the experiment focused on establishing a configuration of space and analyzing the occupants' response to that space.

Now, in order to take what I have learned from this experiment and apply it, I began to searching for a suitable site. I chose the underground pedestrian connection between the 6th Ave. L train stop and the 7th Ave. 123 stop in New York City. What made this suitable for exploration was its sole function of providing passage for pedestrians and its complete lack of acknowledgement for interaction or response to its occupants. This underground corridor is located 32 feet below the surface of 14th Street in Manhattan between 6th and 7th Avenues. It is 15 feet wide, 8 feet tall from floor to bottom of beam, and 750 feet long.

In designing the transformation of this site I took what I had learned from the participants' responses to the experiment and looked at applying them to the corridor. While considering the site it became apparent to me that I could not solely create a design to make the occupants respond to the space. Rather, I needed to design the space to respond to the occupants based on what I had learned in the hope that the occupants would in turn respond to the space.

To do this I explored how to make a space responsive and how attributes that define a space can be responsive to its occupants. I have done this by designing this space with four attributes. The first two are used to define the wall surfaces. They are the inert walls and the re-active walls. The third attribute is the application of led panels to the ceiling which are responsive to atmospheric conditions outside while the illusion of the sky above provides a false sense of an elongated height to the space. The fourth is the application of Piezoelectric Power Leap flooring system. This takes the energy produced by those who pass through the space to power the applications within the space.

In conclusion this thesis provides not only a frame work for contemporary thinking towards an interactive and responsive architecture but it also provides a site specific solution utilizing this frame work. It opens up an understanding into the relationships between body, space and time and how these attributes of the human perception can relate directly and indirectly with transformative space.

It does this while looking to utilize the modern technology which is available to contemporary designers to transform an existing site with less than attractive attributes. This frame work introduces the usage of interactive and responsive technologies to create environments that have the ability to take the human senses and relate them to the space we inhabit. When thinking about our senses and the effects they have on our memories we can begin to relate specific memories to sensory attributes. These sensory attributes provide us with a frame of mind, which may be different for everyone, as well as remembering certain events, or even transcending us to another time or place within our memories.

The relationship between our senses and our perceptions are directly correlated with our understanding of body, space and time. What is meant by this is that our understanding of our bodily movements, the spaces we have been and the time that we occupy is all theoretically based on our memories and our memories are developed and relived through our senses and our perceptions of what we remember.

Now the culmination of this thesis in transforming the chosen site with interactive and responsive technologies is for sure site specific. The transformation and design of the interactive and responsive nature of the underground connection in New York City is still based on this notion of body, space and time, however these three attributes have a specificity to them based on the site. The design looks at the human body as it moves through this space as a transitional element, from one train to another train. It utilizes the placement of the site below ground to create a sense of place and allow the occupants to create their own relationship to the space. The design also makes use of the sites placement between street and train to relate the occupant to a sense of time.

However, one hope is that utilizing these attributes will provide the occupant with an escape from the mundane task of traveling through this passage. The interactivity and responsiveness is hoped to allow the occupant to engage with the environment. This engagement is anticipated to utilize ones senses to create memories and supply a participant with a transcendence of body, space and time while traveling within this new interactive and responsive environment.

This suggests that many similar sites, with less than attractive attributes, that society may think are unchangeable can be retro-fitted with contemporary technologies to create interactive, responsive, and engaging pieces of work.

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