

DIGITACTILITY

by

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College of Architecture

Charlotte

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## ABSTRACT

NICHOLAS WADE AULT.

Digitactility.

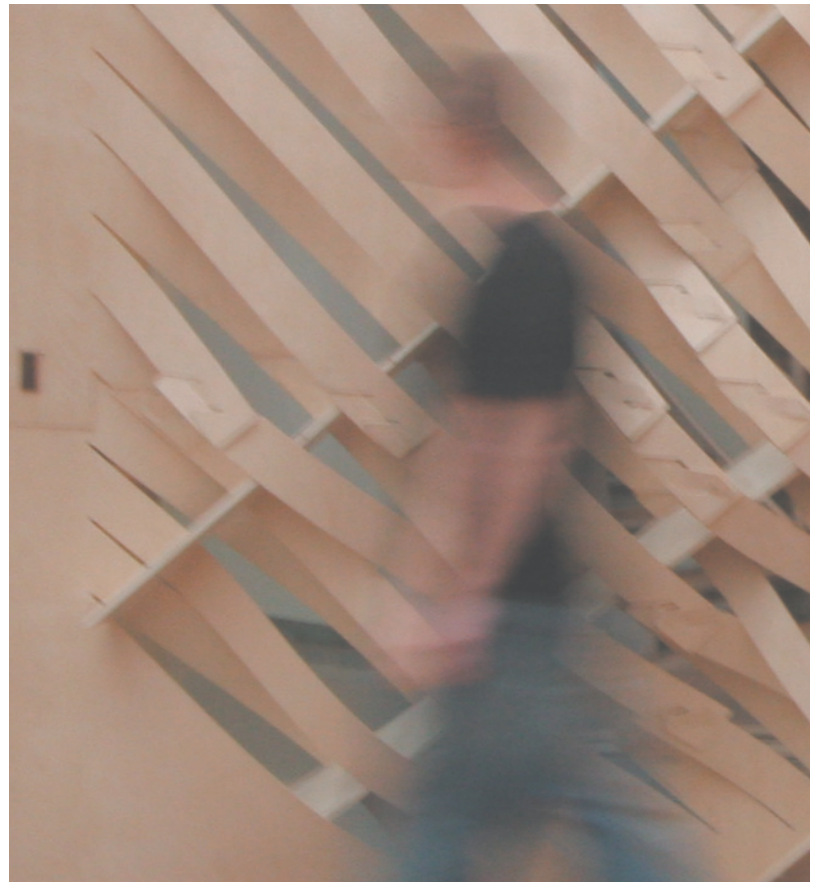
Professor Eric Sauda

Through an investigation into material phenomenology and digital fabrication a codependent relationship evolved revealing the possibilities that these new technologies can have with respect to integrating the architect more fully in the construction and fabrication of architecture. These studies used a digital and analog generative design process as an approach to reveal the characteristics and possibilities that lie within this relationship.






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“The time frame assigned to architectural production has been continually compressed, and the distance between design and fabrication is narrowing. At the same time, we are losing contact in both social interaction and the material fabrication process.”

Toshiko Mori



Every touching experience of architecture is multi-sensory; qualities of matter, space and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton and muscle. Architecture strengthens the existential experience, one's sense of being in the world, essentially giving rise to a strengthened experience of self. Instead of mere vision, or the five classical senses, architecture involves several realms of sensory experience which interact and fuse into each other. 1

-Juhani Pallasmaa

The architecture that surrounds us influences us in immeasurable ways, each element coalescing with the others to create a spatial experience unique to the moment. Through our senses we experience the materials, their warmth, articulation and detailing, all of which, in unison, add to the overall experience of space. Materials have properties that identify with the architectural space as well as the intimacy we gain through our bodily contact with the materials; each material speaking in conversation with our bodies and the surrounding architectural space. Materials reveal themselves to the individual, they tell a tale of their history, articulation, and fabrication. Wood tells of flood and drought through the intricacies of its grain explaining its history and it tells of articulation through the shadow lines of detailing. Through the advancement and emergence of digital fabrication technologies in architecture, wood is able to express new methods of usage and articulation. The relationship between digital-material investigation is set to take a step forward in order to investigate the phenomenal possibilities that lie within the materials and technology.

Phenomenology deals with the intuitive experience of phenomena, primarily experienced through the senses. The study of phenomenology in architecture relies on perception, memory and imagination within the individual. The architecture can only suggest how one could inhabit the space and how to create a condition that is 'common' to all that experience the space. This experience relies on every element converging and informing one another to create a space that encourages all of the senses to become immersed in architectural space.

Our senses have become modified by technology in the past few thousand years but more so in the past 100 years as technology has been driven by the mass distribution of the printed word, the television and most recently the computer. The invention is an idea of thought, discovery and growth. The invention of printed language shifted the sensory balance to make humans ocularcentric by nature. This technological shift has pushed us away from our environment and each other; there is no longer a need for histories and ideas to be passed down in an oral-audible exchange through storytelling. We, with the evolution of the written word, have created a way for us to distance ourselves from one another and remove ourselves from time and place; although this was not the original intent it has allowed our histories to be shared by a larger audience and over a greater time. This innovation, while dramatically accelerating the advancement of technology itself, prioritizes our sense of sight over our other senses, causing a disconnect between ourselves and our environment. The architecture and writing of Steven Holl, Rick Joy and Glenn Murcutt, among others, are drawing our senses together

once again by creating rich spaces which engage us in conversation.

There is some sense that are more easily relate to architecture; the sense of sight being the most easily engaged because light is the primary creator of architectural space. Light and its counterpart shadow, give life to the built environment; give depth to our spaces, brings forth the subtle qualities of materials and spills sharply across carefully textured walls explaining the geometry and intricacies of space in a language that is representative and easily distinguishable.

The quality of light in architecture accents the elements within a space but also accentuates geometry of the space. The power of light and shadow articulate the spaces in such a way that they draw us further into the space. This phenomenological quality creates a bridge to an understanding of space and materiality through our sensory perception. These powers are most readily understood through our sense of sight but, without our other senses a full understanding is impossible.

This power of light to accentuate and articulate space can easily be understood, but its power over materials is one that is more subtle, and when carefully considered can be much more powerful. Materials have character, a quality of expression that gives rise to the power of space. Natural materials – stone, brick and wood – allow our vision to penetrate their surfaces and enable us to read the veracity of matter. Materials and architecture are inseparable; they join together and release the hidden power of the architecture. The architect has a responsibility to understand, to covet the expression of the ancient, elemental knowledge about man’s use of materials and at the same time to expose the very essence of these materials which is beyond all culturally conveyed meaning. The tangibility of architecture lies primarily in the materials and their expression of space. Materials produce a psychological effect such that mental processes, feelings, and desires are evoked. They stimulate the sense beyond acute sight, towards tactility. In the perception of details, colors and texture, psychological and physiological phenomena intertwine. Phenomena that can be “sensed” in the material and detail of an environment exist beyond that which can be intellectually transmitted.

3

The wide variety and language that is spoken in that materiality is a complex and subtle language that lies in the understanding of individual materials, and the voice that each communicates with has a variety of tones. The articulation of material language comes to rest in its treatment, but the language of materiality falls directly on the space. The haptic qualities of each material must carefully be understood and considered for each specific condition. The relationship between materiality and space is co-dependent the loss of sensitivity and articulation of either will result in failure.

Hapticity also has a play in spatial awareness. Materials not only have close up haptic details but also have a large-scale impact on a space. Concrete and masonry spaces have a much different haptic feeling than does a wooden space, much of this has to do with the temperatures that each material has ingrained in its elemental properties. These temperature differences are felt through our skin, the sensitivity that our bodies hold in the sense of touch are astonishing and critical to

the spatial understanding that we are able to gain when we inhabit a space. The characteristics of materials are ingrained deep within our psyche, creating experiential memories and associations that give us the ability to experience materials and understand how they will feel on our skin.

The collection of senses guides us throughout our lives, but in an architectural sense tend to be neglected, of the visual appeal that is easily achievable in architecture. The visual aspect of architecture is primarily the sense that gets, perhaps, fully explored but, an architecture that completely involves the sense is far more powerful than one that neglects any one. The exploration of sensory response to architectural element is one that begins to speak of the total immersion of the occupant. The space of architecture, always elusive and mysterious, is the space in which we may perceive ourselves, if only for a moment, as a whole; it is the "event" (space/time) that may change our lives through this recognition.<sup>4</sup>

Natural materials, specifically wood, are of special interest because we are given the opportunity to work in concert with nature. Wood has a psychological appeal that links it into our psyche, we are able to identify with it, wood has character and unique imperfections that speak to us. Wood begs to be worked; it is warm to the touch, compared to stone and steel, readily available and can dramatically influence our spaces through its richness.

Wood has an ability to bring out the designer in all of us. It is accessible and easy to manipulate; it cries out to be shaped, carved, scratched, sanded and nailed. Many of us have sawn, cut or hammered into a chunk of wood as children, turning rough, abandoned pieces into all manner of toys.<sup>5</sup> This type of familiarity with a material gives us an understanding and appreciation for wood that can influence our future perception of space.

Wood is a material that is readily understood and utilized in vast amounts nearly world wide. Although incredibly diverse and cultural, wood is a universal building material that takes many forms and serves many uses. Wood is so common in our lives that it has become a sort of datum to our daily activities and has lost some of the reverence that it should be given.

Wood is a material whose poetics in manufacture can also be remarkable. Rotary cut plywood and veneer expresses the history of the material. The log is pinned the center and a knife peels the log into thin layers that reveals an ever deepening history of the tree with each revolution. This poetics through manufacture is a testament to the natural beauty and history that wood can encapsulate simply through an understanding of the material.

This phenomena of material language and articulation is coming upon a revolution, reminiscent of the struggle between hand crafted and machine crafted products fought by architects such as Walter Gropius and Adolf Loos. This new battle is currently being fought with digital technology. Digital technology has the power to articulate and calculate geometries of unforeseen complexity. This new technology is beginning to infiltrate the design processes and construction methodologies of architecture. Many architects throughout the world are fighting at the forefront of this battle pushing



further towards and entirely digital architecture. Architects such as Asymptote, ShoP, NOX and others are using advanced computer programs to push the limits of what architecture can be, separating themselves from more 'traditional' practitioners. This separation is creating a 'digital-divide' from those who are exploring advancing traditional design processes from those concentrating their focus on a typologically new architecture.

Digital technologies grant designers the power to explore wood through their speed, geometrical, precision and generative capabilities. An in depth knowledge of wood is integral to the success because the machine has no understanding of the phenomenological properties; it is merely a machine for fabricating the realized components the designer has intended. The designer therefore must work simultaneously through the material and the machine to achieve the final objective through the articulated material. This marriage of fabrication and traditional materials will reinforce the phenomenological properties of architectural materials.

The new "Digital Architecture" typology may be worthwhile by breaking away from the dogmas that architecture has been struggling with since Modernism simplified that architectural form. These sculptural forms rely on the computer to create their complex geometries but the computer is a tool, not a partner; an instrument for catching the curve, not for inventing it.<sup>6</sup> Using the computer as a tool to create new possibilities in architecture is a method that needs to be embedded deeper into architectural practice especially in the realm of material fabrication. The means by which computerized technologies can accelerate and enhance architecture currently is through innovations in design, fabrication and construction. Although computer assisted fabrication has become mainstream in a variety of fields over the past two decades the architectural community is just beginning to recognize the possible benefits that can arise from integrating advanced fabrication techniques into the construction of buildings. The relationship between the computer technology and design can also be exploited the experience of virtual space, this new technology enables us to rapidly explore space and create and architectural experience before construction and even design has been finalized.

Materials also play a role in determining the involvement of computerized fabrication. Materials traditionally speak the language of the craftsman, with computerized fabrication there is no language for the material to speak. These tides are turning. The understanding of computer technologies has reached a point where materials can begin to express themselves further through digital technologies, essentially creating a new dialect of material language. We are beginning to see this evolution, Frank Gehry brought new life to metals as an exterior surfacing material with the Guggenheim Museum in Bilbao, and ShoP (Sharples Hold Pasquarelli) infused the inexpensive material MDF (Medium Density Fiberboard) into a new and expressive space in their Virgin Atlantic Lounge. These projects are not formally expressive but also expressive as material experiments. Digital fabrication plays an important role in the realization of these projects. These projects may not have been possible, feasible or eventually realized without the utilization of digital fabrication.



The aim is not necessarily to create a "different" form of architecture, but to create a newly articulated material language rendering new componentry form materials. Digital fabrication technologies have the benefit of learning from the past but also looking forward to the future where mass-customization is finally becoming a reality. The ability of these machines to create infinite 'one off' products and giving architects the ability to create spaces independent of any predetermined parts list, in essence they are only limited by their imagination. We can easily despair. As in the time of (John) Ruskin, we could yearn romantically – and in vain – for a more innocent work. Or we can strive for a future with more appealing technology more justly applied. 7 The aim is not to take the human hand out of materials and fabrication, rather to take advantage of the new tools in a way that will bridge the gap between the concept of architecture and the construction/fabrication process in architecture. These technologies ingrain the human hand in the process of architecture from design through fabrication; we are able to exploit the benefits of such a relationship through an intimate understanding of these processes and of the newest technologies.

The properties of wood can be dramatically altered through infusion with digital fabrication techniques. This relationship is one that can emphasize and alter the preconceptions that are conveyed through wood. Plywood is a material that through its material manufacturing technique has alternating layering and grain patterns, this is a characteristic that can be exploited through digital fabrication, by cutting, carving and making interventions between the layers of material can alter the characteristics of the material. The investigations into the possibilities of plywood will enable it to create designed geometries. The geometries will be controlled through the articulation of the plywood, the layer manipulations will generate points of weakness that will bend to create an architectural installation. This installation will take advantage of the variability of plywood but also exploit the physical, historical, haptic, experiential, aesthetic, phenomenological and psychological characteristics of the material.

The relationship created between a digital-material investigation is set to take a step forward to investigate the phenomenological possibilities that lie within the materials and the technology. Through the simultaneous investigation of wood and various digital fabrication techniques, an exploration or material fabrication will evolve, developing a material language accentuated through the use of digital technologies. These studies will inform, through the fabrication technique, material characteristics, and phenomenological qualities, a space that can prompt the inhabitant to further investigate the spatial possibilities of architecture.




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2. Zumthor, Peter. Thinking Architecture. Baden, Switzerland: Lars Muller Publishers, 1998.
3. Holl, Steven, The Haptic Realm.
4. Holl, Steven. Parallax. Basel; Boston: Birkhauser-Publishers for Architecture; Princeton Architectural Press, 2000.
5. Lefteri, Chris. Wood: Materials for Inspirational Design. East Essex, UK. Rotovision SA. 2003
6. Gehry, Frank O. Gehry Talks: architecture and process. New York: Universe Publishing. 2002.
7. McCullough, Malcolm. Abstracting Craft: The Practiced Digital Hand. Cambridge, Mass.: MIT Press. 1996.



END NOTES





“By understanding materials basic properties, pushing their limits for greater performance, and at the same time being aware of their aesthetic values and psychological effects, an essential role can be regained and expanded.”

Toshiko Mori



## **An Exploration in Material Phenomenology through Digital Fabrication Processes**

"What all crafts share is not just technique, or hard work on form, but also a probing of their medium's capacity, a passion for practice, and moral value as an activity independent of what is produced. Is there any reason to expect these in the electronic realm? We must make them our goal."

Malcolm McCullough

"Every touching experience of architecture is multi-sensory; qualities of matter, space and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton and muscle. Architecture strengthens the existential experience, one's sense of being in the world, essentially giving rise to a strengthened experience of self."

Juhani Pallasmaa

"Materials interlock with the senses to move the perceiver beyond acute sight to tactility. From linearity, concavity, and transparency to hardness, elasticity, and dampness, the haptic realm opens. Through making, we realize that an idea is a seed to be grown into phenomena. The hope is to unite intellect with feeling, and precision with soul."

Steven Holl

### **Premise**

The course concentrates on the investigation of materials wood; it's physical, historical, haptic, experiential, aesthetic, phenomenological and psychological characteristics. The exploration will center on the 7 characteristics of wood at differing scales; from the scale of the hand, the relationship to the body and the spatial qualities that can be elicited.

These investigations will utilize digital design and fabrication technologies to extract, expand, enhance and discover the qualities of wood. An in-depth understanding of wood characteristics as well as an understanding of a variety of manufacturing, construction, and fabrication techniques is critical to the final success of the investigations.

The research will manifest itself in scale mock-ups and full scale experiential pieces. This project intends to explore the notions of architectural materiality and fabrication techniques in order to explore new spatial lexicons that could enhance the phenomenological properties of architectural space and the burgeoning reinterpretation of wood and materiality.

### **Definition of Terms**

**Wood:** wood<sup>1</sup> (w<sup>oo</sup>d)

1. A natural material derived from the consumption and processing of trees and various other plants such as bamboo
2. Any material made from, consisting of or resulting from a wood process; including veneer, dimensional lumber, rough sawn lumber, plywood, Medium Density Fiberboard, Paper, etc.

**Aesthetic** (ěs-thět 'īk)

1. Relating to the philosophy or theories of aesthetics.
2. Of or concerning the appreciation of beauty or good taste: the aesthetic faculties.
3. Characterized by a heightened sensitivity to beauty.
4. Artistic: The play was an aesthetic success.
5. Informal. Conforming to accepted notions of good taste.
6. Relating to the sensations.
7. Relating to esthetics.

**Experiential (experience)** (īk-spēr ē-əns)

n.

1. The feeling of emotions and sensations as opposed to thinking; involvement in what is happening rather than abstract reflection on an event.

**Space**

(spās)

n.

1. Mathematics. A set of elements or points satisfying specified geometric postulates: non-Euclidean space.
  - a. The infinite extension of the three-dimensional region in which all matter exists.
2.
  - a. An extent or expanse of a surface or three-dimensional area: Water covered a large space at the end of the valley.
  - b. A blank or empty area: the spaces between words.
  - c. An area provided for a particular purpose: a parking space.
3.
  - a. A period or interval of time.
  - b. A little while: Let's rest for a space.
4. Sufficient freedom from external pressure to develop or explore one's needs, interests, and individuality: "The need for personal space inevitably asserts itself" (Maggie Scarf).



5. Music. One of the intervals between the lines of a staff.
6. Printing. One of the blank pieces of type or other means used for separating words or characters.
7. One of the intervals during the telegraphic transmission of a message when the key is open or not in contact.
8. Blank sections in printed material or broadcast time available for use by advertisers.

**Material:**

(mā-tīr'ē-ə)

n.

**1. The substance or substances out of which a thing is or can be made.**

**2. Something, such as an idea or information, that is to be refined and made or incorporated into a finished effort:** material for a comedy.

**3. materials** Tools or apparatus for the performance of a given task: writing materials.

4. Yard goods or cloth.

5. A person who is qualified or suited for a position or activity: The members of the board felt that she was vice-presidential material.

adj.

**1. Of, relating to, or composed of matter.**

**2. Of, relating to, or affecting physical well-being; bodily:** "the moral and material welfare of all good citizens" (Theodore Roosevelt).

**3. Of or concerned with the physical as distinct from the intellectual or spiritual:** "Great men are they who see that spiritual is stronger than any material force, that thoughts rule the world" (Ralph Waldo Emerson).

**4. Being both relevant and consequential; crucial:** testimony material to the inquiry

**5. Philosophy. Of or relating to the matter of reasoning, rather than the form.**

**Physical:** phys·i·cal (fīz'ī-kəl)

1. Relating to the surrounding world of material object; the physical environment
2. The properties of an object specifically its measurable characteristics; the physical environment

**Historical:** his·tor·ic (hī-stôr'īk, -stŏr')

1. Refers to an importance within history often shows importance because of associations with persons

**Haptic:** hap·tic (hăp'tĭk)  
Of or relating to the sense of touch

**Phenomenological:** phe·nom·e·nol·o·gy

(fĭ-nŏm'ē-nŏl'ə-jē)

1. An architectural condition that engages the senses in a certain and specific manner
2. A philosophy or method of inquiry based on the premise that reality consists of objects and events as they are perceived or understood in human consciousness and not of anything independent of human consciousness.

**Psychological:** psy·cho·log·i·cal (sĭkə-lŏj'ĭ-kəl)

1. Influencing or intended to influence the mind or emotions: psychological warfare.
2. Unexplainable physical qualities that elicit a human response unique to the individual

### **Content**

This course will utilize reading and experiments into the material of wood along with digital design and fabrication technologies to open wood to new material possibilities. Through an in-depth understanding of wood and the technologies the investigations reveal an experiential nature of wood that will manifest itself in a full scale architectural installation.

Through these investigations research into the material of wood, its physical, historical, haptic, experiential, aesthetic, phenomenological and psychological characteristics will be explored and manipulated through digital design and technology.

### **Method**

The semester shall be broken into two separate portions:

- 1) Discovery
- 2) Realization

During the Discovery portion of the semester, I will explore specific types of wood and exploit a material characteristic in a new way in order to continually gain a new understanding. This material investigation will incorporate explorations in digital fabrication as an integral role to the design process. These processes should not necessarily be limited to the equipment at the CoA.

The Realization assignment will consist of a final material experiment that will evolve from the information gathered throughout the semester and should reflect the level of understanding and interaction developed with the specific wood chosen

## **Objectives**

Upon completion of this course a student will be able to:

- To create a dialogue with wood and gain an understanding of the material, its possibilities, limitations and the interaction that it can have in an architectural context
- Develop a critical understanding about materiality and digital fabrication techniques
- Respond to materiality and its relationship with space
- Employ alternative fabrication techniques to extract material properties
- Challenge traditional material properties and preconceptions

## **Evaluation**

Work ethic, intellectual rigor, and product are expected to be at the level commensurate with professionally executed work. As in all other courses in the CoA, work completed for this course must comply with the UNCC Code of Academic Integrity. Grades will conform to the university grading scale and will be based on progress as well as produce. The following grade scale will apply:

## **Graduate Grading**

A Outstanding – meets or exceeds stated requirements of the course; exhibits significant improvement in understanding and/or execution over the course of the semester; exhibits strong self-motivation and time management skills; participates meaningfully in class discussions and activities.

B Satisfactory – meets stated requirements of the course (all work complete & on time); exhibits improvement in understanding and/or execution over the course of the semester; exhibits good self-motivation and time management skills

C Marginal – fails to meet stated requirements of the course (work incomplete and/or late); OR exhibits little or no improvement in understanding and/or execution over the course of the semester OR exhibits inadequate self-motivation and/or minimal participation in class discussions and activities; OR fails to sufficiently understand and/or execute the concepts and skills required for the course

U Unsatisfactory – fails to meet stated requirements of the course (work significantly incomplete and/or late); OR exhibits little or no self-motivation and/or minimal participation in class discussions and activities; OR fails to sufficiently understand and/or execute the concepts and skills required for the class

In addition to the scheduled class times, there are specific lectures and/or field trips that you will be required to attend.

## **Documentation**

I will document my work rigorously throughout the semester from process through final product. The documentation will include high resolution digital scans of process and final drawings, as well as digital photos of material investigations, the fabrication process, and final fabrications. I will also document the making process, from working in the shops to final installations. The documentation will be assembled at the end of each stage and at the culmination of the semester.

## **Required Readings**

This list including but not limited to:

Pallasmaa, Juhani. Eyes of the Skin: Architecture and the Senses. London: Academy Group LTD, 1996.

Zumthor, Peter. Thinking Architecture. Baden, Switzerland: Lars Muller Publishers, 1998

**Mori, Toshiko. Immaterial/Ultramaterial : Architecture, Design, and Materials**. Cambridge, Mass.: Harvard Design School, 2002.

Mori, Toshiko. Materials, Fabrication and Performance. Buffalo, NY. School of Architecture and Planning University at Buffalo, The State University of New York. 2003.

McCullough, Malcolm. Abstracting Craft: The Practiced Digital Hand. Cambridge, Massachusetts: The MIT Press. 1998.


Kieran, Stephen and James Timberlake. refabricating Architecture: How Manufacturing Methodologies Are Poised to Transform Building Construction. New York: McGraw-Hill. 2004

Lefteri, Chris. Materials for Inspirational Design: Wood. East Sussex, UK: RotoVision SA. 2003.

Hoadley, R. Bruce. Understanding Wood: A Craftsman's Guide to Wood Technology. Newtown, Conn: The Taunton Press. 2000.

Callicott, Nick. Computer Aided Manufacture in Architecture – A Pursuit of Novelty. Architectural Press. 2001.





"The exploration of sensory response to architectural element is one that begins to speak of the total immersion of the occupant. The space of architecture, always elusive and mysterious, if only for a moment, as a whole; it is the 'event' (space/time) that may change our lives through this recognition."

Steven Holl



## **Assignment 1.0**

### **Discover**

“Historically speaking, the discovery and utilization of materials such as concrete and steel changed the course of architecture. In considering applications of new materials, we soon realized that research on innovative methods will have a profound impact on conventional design methodologies, general conceptions of form, and modes of production.”

-Toshiko Mori

Immaterial Ultramaterial

### **Objective**

The objective of this series of investigations is to explore wood in a new way to gain a greater understanding of the material, its physical, historical, haptic, experiential, aesthetic, phenomenological and psychological characteristics. Through these investigations, both in the material and in the fabrication technology, I will approach wood as a material scientist, designer and fabricator. Through each exploration I will press further the possibilities of wood as an architectural material.

### **Method**

I will investigate wood and research the properties that are typically associated with its product life cycle, typical usage, innovative application (if any), and finally a property that I feel can be exploited in new and interesting ways. This research will lead into studies and investigations that will make architectural installations expressing new material properties through digital fabrication techniques expressing the materials possibilities.

### **Schedule**

This project consists of a long-term material investigation that is continually evolving through the exploration of the wood material. These assignments should work in such a way as to exhaust a characteristic which will in turn lead to a continuing of the investigation in a type of wood that is able to capitalize on the failure points of the prior material.



DISCOVER



## **Assignment 2 Realization**

"The ideal advanced material is lasting, flexible, resistant to corrosion or wear, noninvasive, and reusable. Its sensible application may incorporate the old within the new, making good use of past conceptual and technical achievements...Design can be described as the attempt to achieve a goal (an ideal object) using the available means (materials and techniques). The new, mutable character of materials, as expressive as it is functional, has generated new forms as well as a more experimental approach toward design."

-Paola Antonelli

Mutant Materials in Contemporary Design

### **Objective**

The objective of this final project is to draw upon the discoveries in digital fabrication technologies and the material characteristics of wood and to make a final articulated architectural installation that expresses newly discovered, articulated or realized material characteristics. This project should build upon the preceding set of projects and either display the discoveries or explore a new characteristic possibility.

### **Method**

Through the selection and research of a material and subsequent investigation the properties that are typically associated with wood, its product life cycle, typical usage, innovative application (if any), and finally a property that can be exploited will be explored and fabricated. This research will evolve through studies and investigations that will make an architectural installation(s) expressing new material properties and/or new digital fabrication techniques.


### **Schedule**

This project will take place over the remainder of the semester, and will result in a full scale architectural installation fabricated with the actual material(s).



REALIZATION

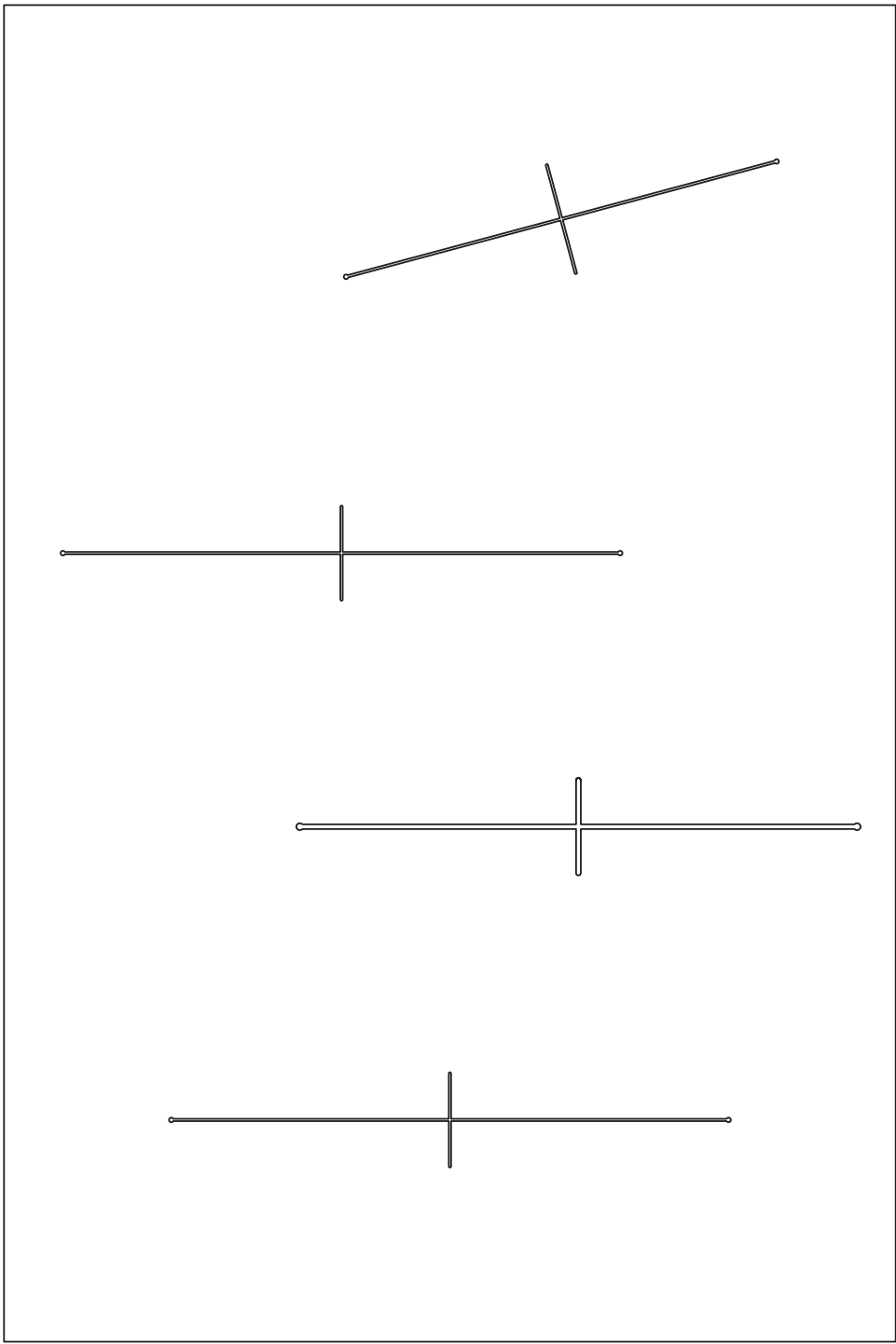




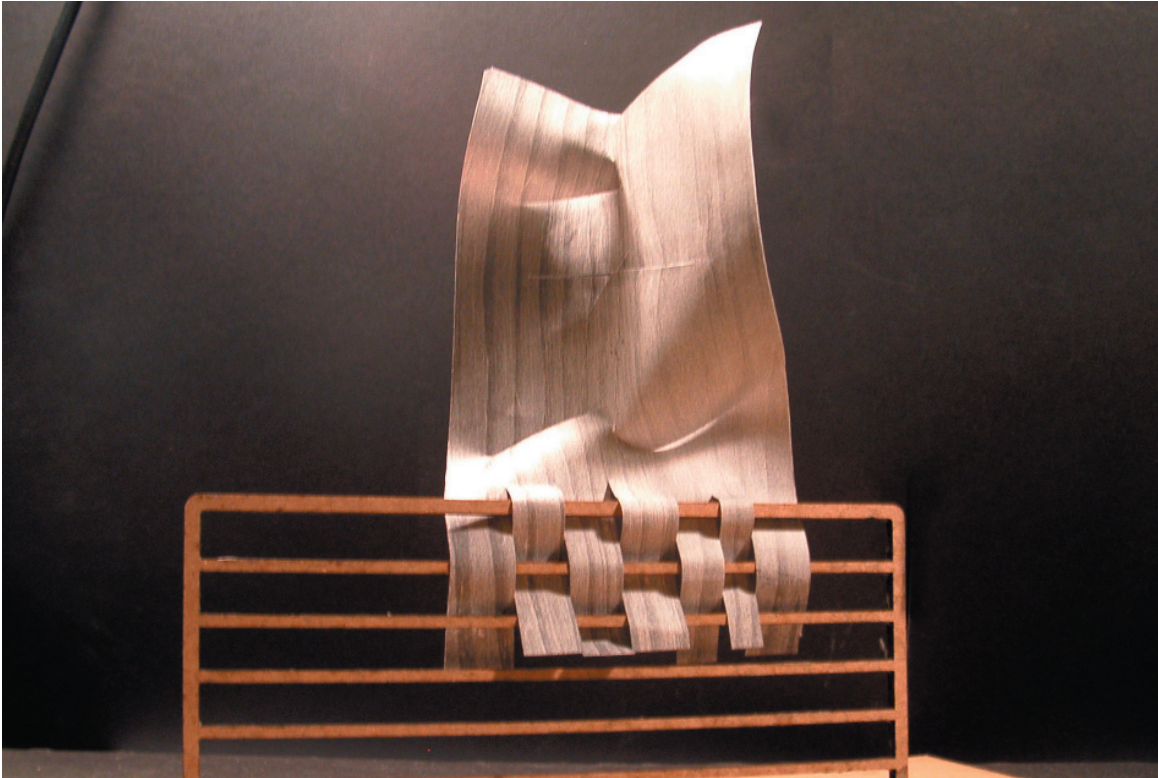
“Materials interlock with the senses to move the perceiver beyond acute sight to tactility. From linearity, concavity and transparency to hardness, elasticity, and dampness, the haptic realm opens. Through making, we realize that an idea is a seed to be grown into phenomena. The hope is to unite intellect with feeling, and precision with soul.”

Steven Holl





FINAL DRAWING OF  
VENEER ESQUISSE



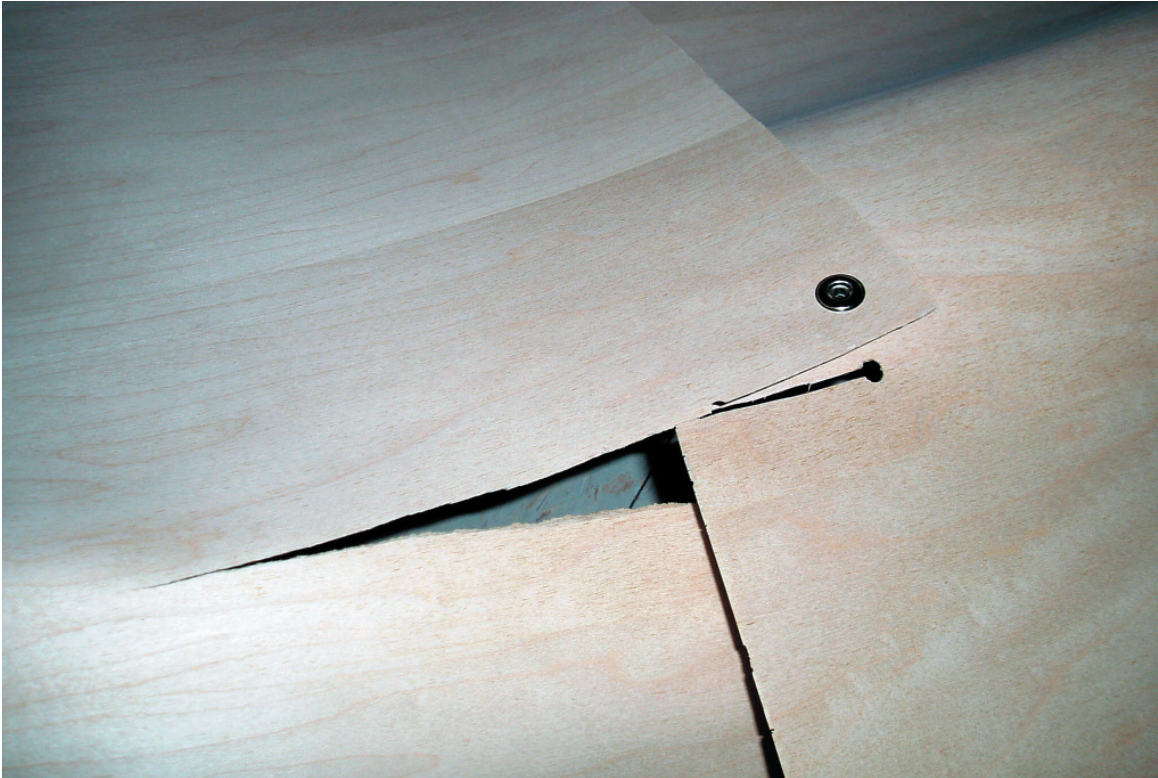
## DESIGN INTENT

The initial esquisse of this project was to create a stable three-dimensional geometry from a very thin, 0.010", maple veneer panel. This project was investigated primarily from small paper models that were initially approximated to have similar properties at scale as the maple veneer.



INSTALLING  
VENEER PANEL





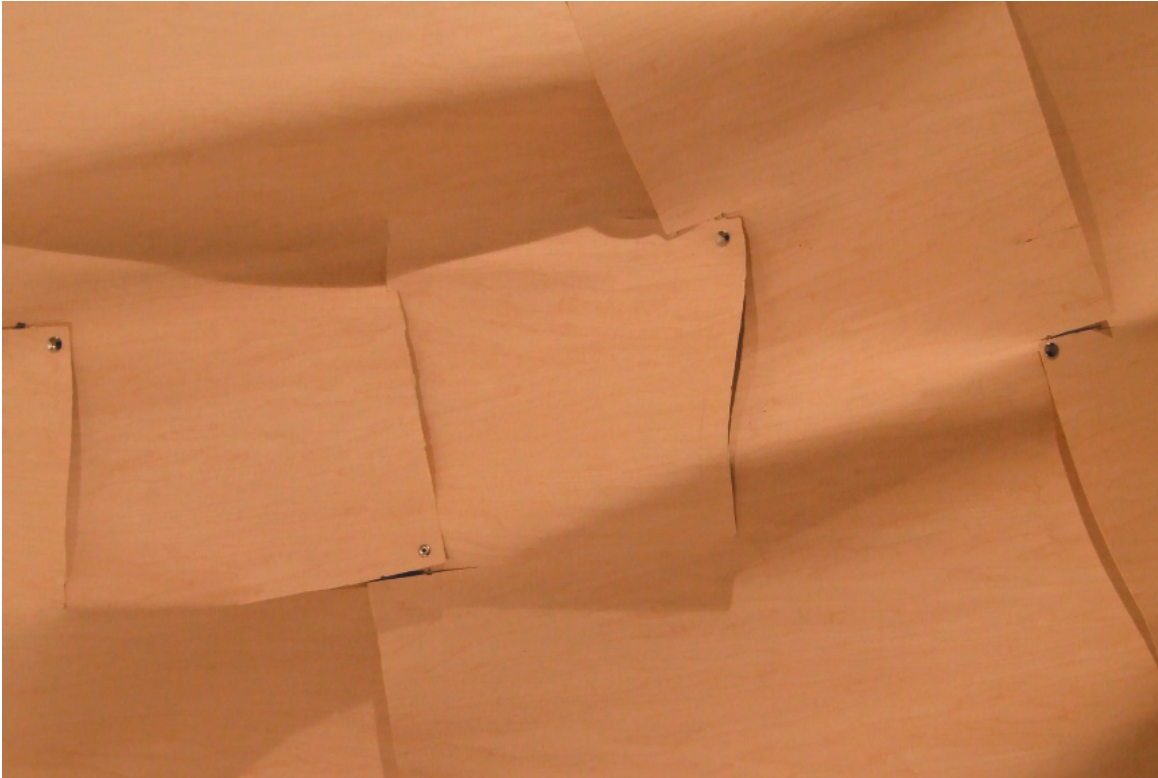
## FABRICATION

Throughout the installation process the fragile material revealed that the stresses created by the articulated geometry, attachment technique and material techniques exceeded those capable of being handled by the material itself. Although this installation was not able to be fully completed the investigation was itself a success because an incite into the limitations of the material were discovered.






VENEER INSTALLATION




## RESULT

Although the final installation was not able to be presented as initially set out the fabrication proved to be a very relevant study and a successful study in geometry as well as an interesting interpretation and investigation in light and shadow.





“The selection of material ends up being very personal and private. I don’t want to be at the receiving end of the standardized use of material. I would like to be able to use material to invent forms that haven’t been invented before. And I’d like to try to make something that I don’t know anything about, that is a new condition to me. If you can take your material, whatever it is , and apply it to that need, then possibly you can make the material do something it hasn’t done before. In terms of forming, these pieces probably look more plastic than anything you have ever seen in steel.”

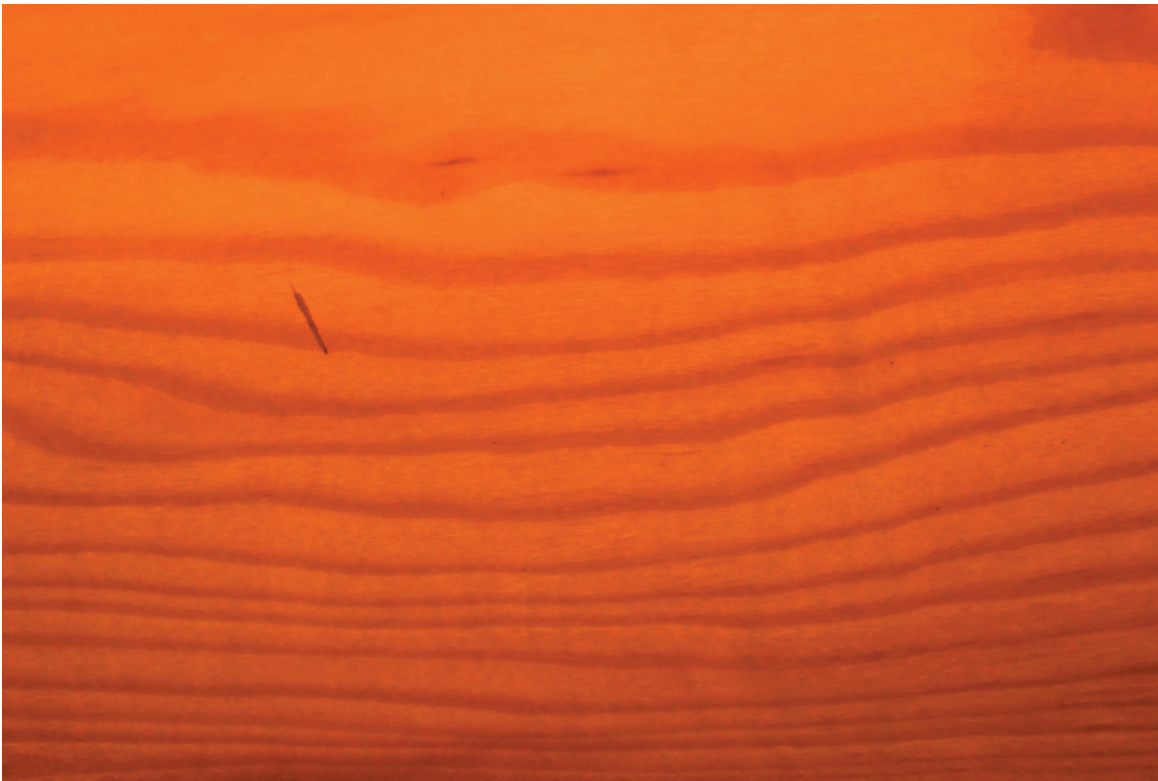


Richard Serra  
...on his material choice for the  
Torqued Ellipses series



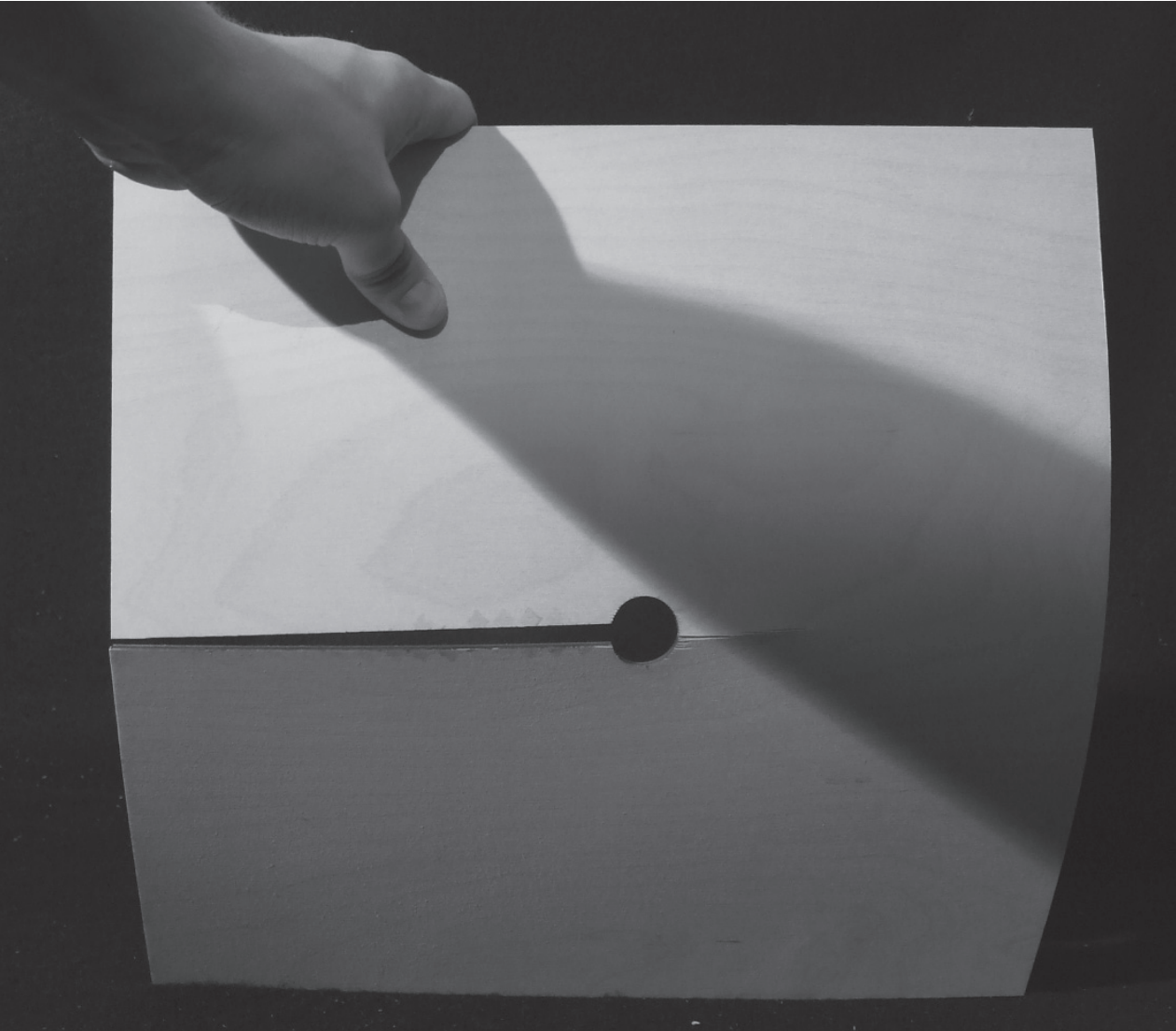


NADER TEHRANI  
"EDGE"



## MATERIAL STUDY

- EXPLORE MATERIALITY
- UNDERSTAND THE CHARACTERISTICS OF A MATERIAL
- INVESTIGATE PROPERTIES AND DISCOVER OPPORTUNITY FOR INTERVENTION
- DISCOVER/APPLY MATERIAL TO AN ARCHITECTURAL SETTING



CROSS GRAIN  
MATERIAL STUDY





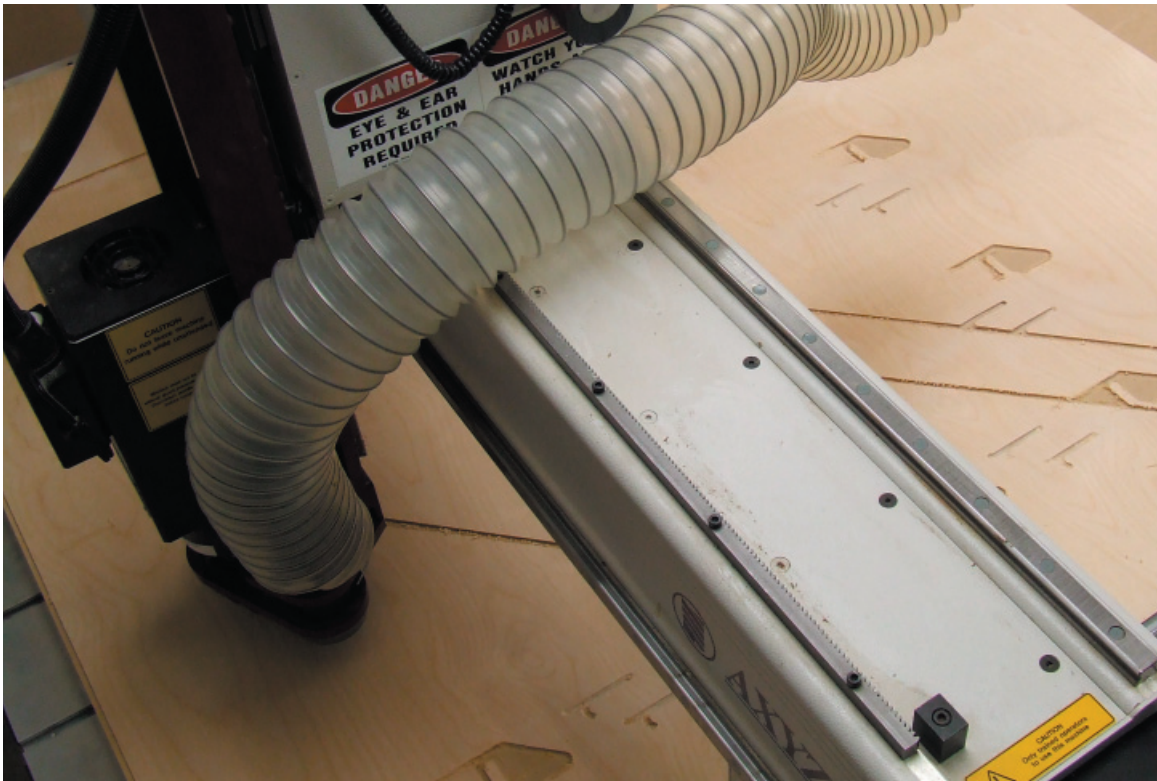
## MATERIAL STUDY

The primary investigation throughout the course of the study was to delve into the material qualities of wood. As a course of study basic geometric studies were utilized that would yield very basic properties and provide an understanding of the physical characteristics of 1/8" Baltic Birch plywood. Throughout these investigation connection and connectivity became a key issue. These issues also revolved around a nearly fetishised drive to pursue a high level of "material honesty."



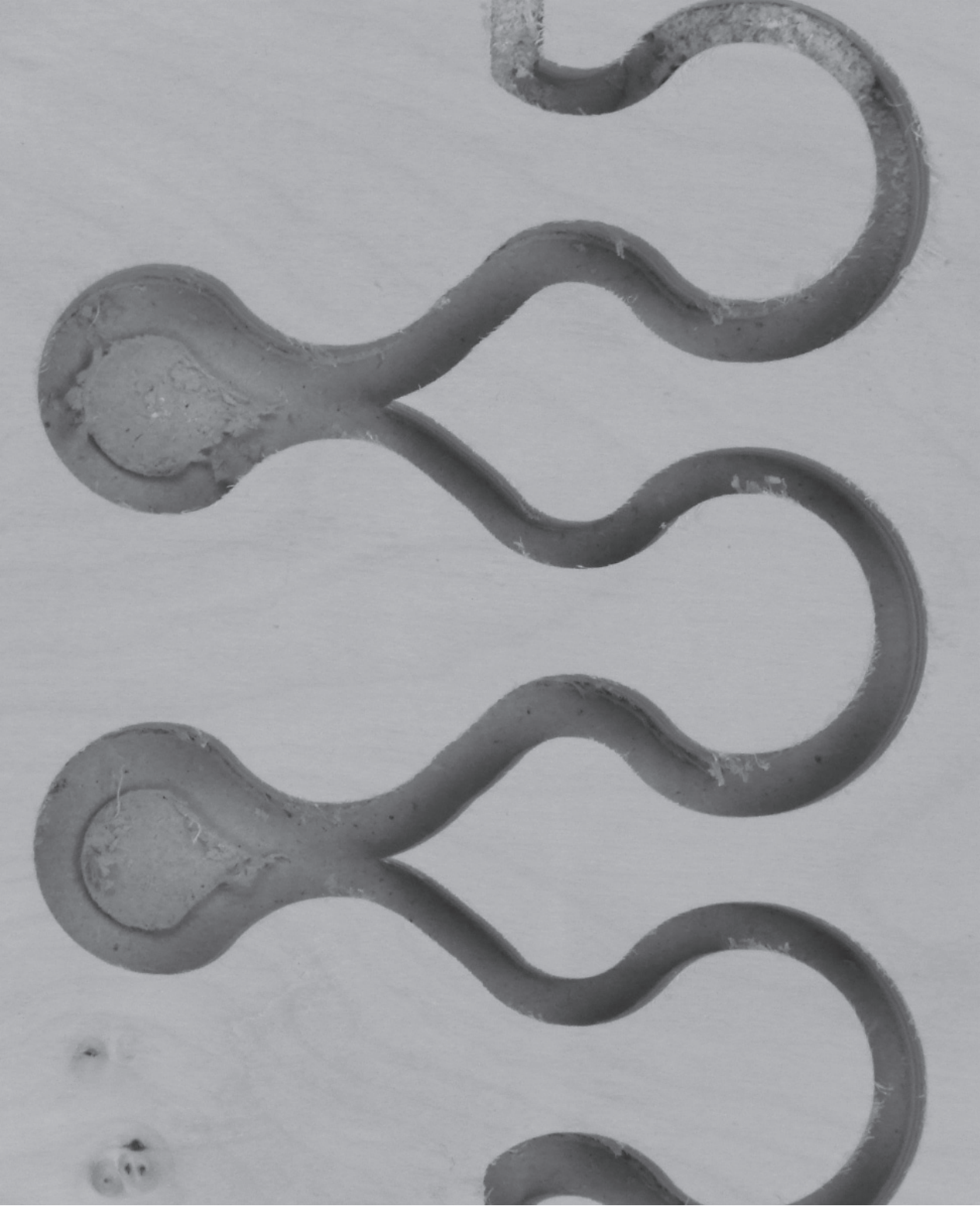


GREG LYNN  
"EMBRYOLOGICAL  
HOUSE"

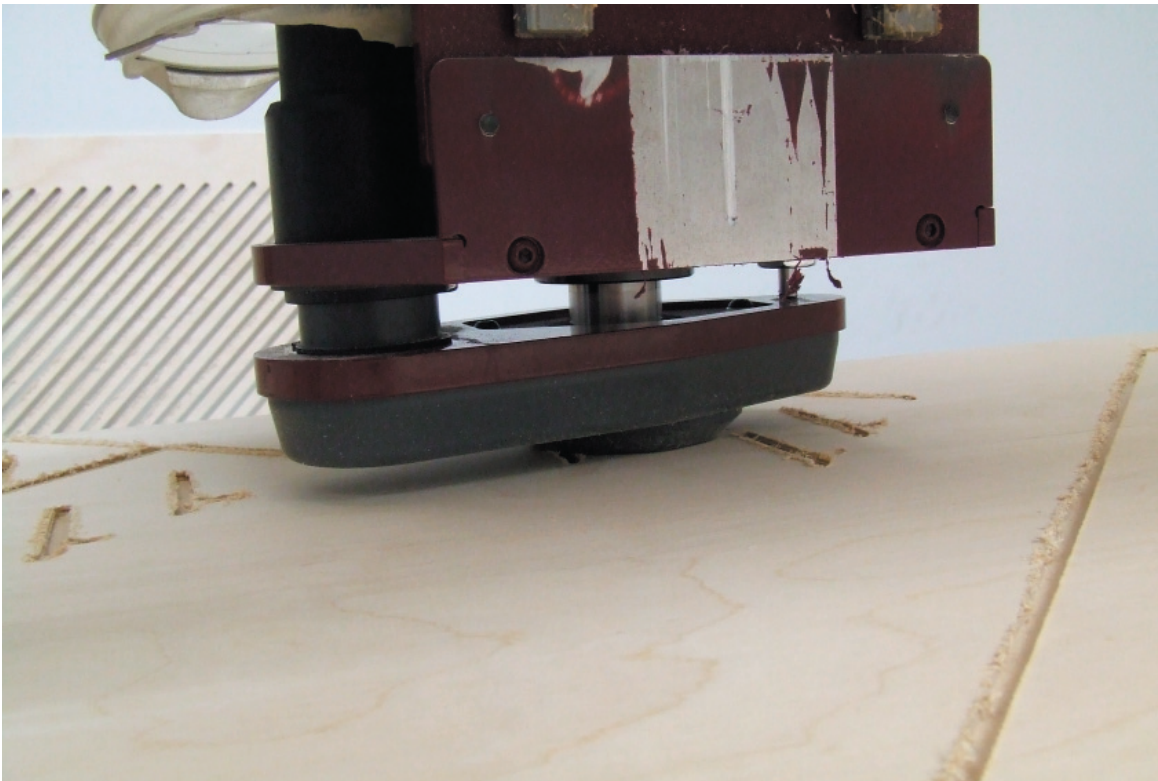


## DIGITAL FABRICATION

- LEARN A LANGUAGE OF DIGITAL FABRICATION
- INTERACT AND BECOME FAMILIAR WITH DIGITAL FABRICATION TECHNIQUES
- UTILIZE DIGITAL FABRICATION TECHNIQUES TO ARTICULATE MATERIAL EITHER IN NEW WAYS AND/OR WITH A HIGH AMOUNT OF EFFICIENCY
- TO BRING THE DESIGNERS/ARTISTS HAND INTO DIGITAL FABRICATION
- DEVELOP A TACTILE/OPERATIONAL RELATIONSHIP BETWEEN DESIGNER AND FABRICATION PROCESS



PUZZLE PIECE  
SPINE CONNECTION



## DIGITAL FABRICATION

Digital fabrication techniques are capable of allowing a new craft to pervade Architecture and bring the architect back into the building process. As this technology advances and architects begin to take advantage of these computer technologies the digital hand can evolve and digitally fabricated building components will be able to have a highly developed level of craft. The idea of the architect as a master builder may be a thing of the past but the architect should be more integrated into the construction and fabrication processes, this technology can provide an integration of design and fabrication and more closely relate the architect with this process.





RICHARD SERRA  
"TORQUED ELLIPSES"



## SPATIAL PHENOMENOLOGY

- TO STUDY THE IMPACT THAT MATERIALS HAVE ON SPACE
- TO ENGAGE THE OCCUPANT IN A HAPTIC ENVIRONMENT
- CREATE A DYNAMIC SPACE DERIVED FROM MATERIAL STUDY



LARGE SCALE  
INSTALLATION






## SPATIAL PHENOMENOLOGY

Every space that we occupy engages all of our senses, the amount to which each is involved depends on the level of articulation and the materiality of the space. This haptic environment has evolved to have an occularcentric focus and has relegated the other senses to become secondary when observing architecture. Throughout this investigation the concept of an encompassing space will be investigated in relation to materiality and its impact on our senses.



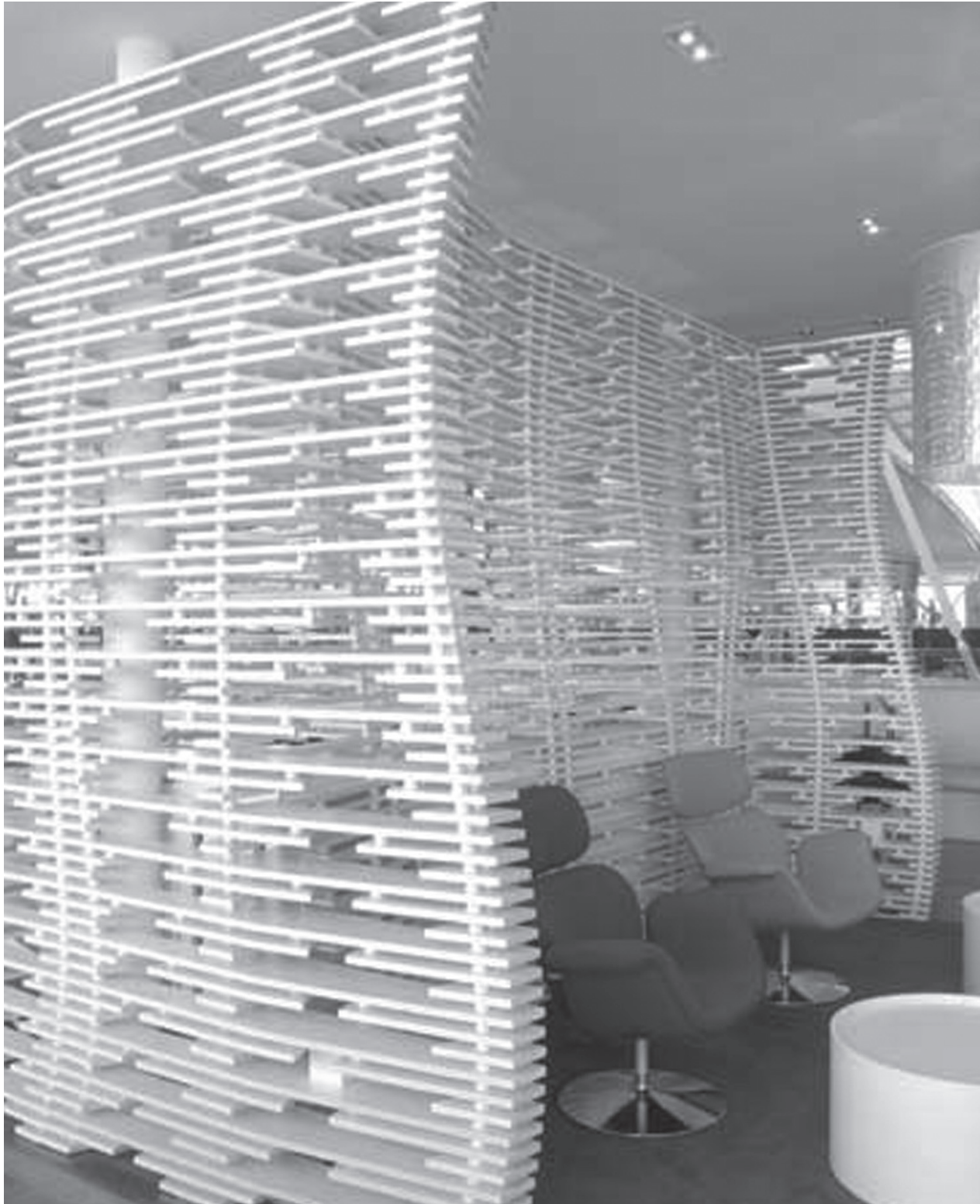




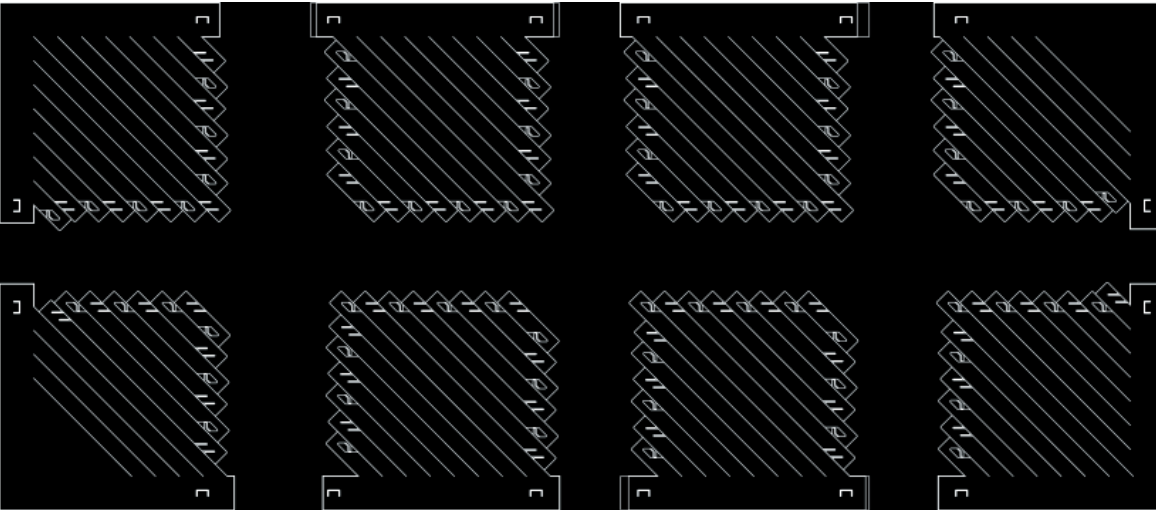
“What all crafts share is not just technique, or hard work on form, but also a probing of their medium’s capacity, a passion for practice, and moral value as an activity independent of what is produced. Is there any reason to expect these in the electronic realm? We must make them our goal.”

Malcolm McCullough



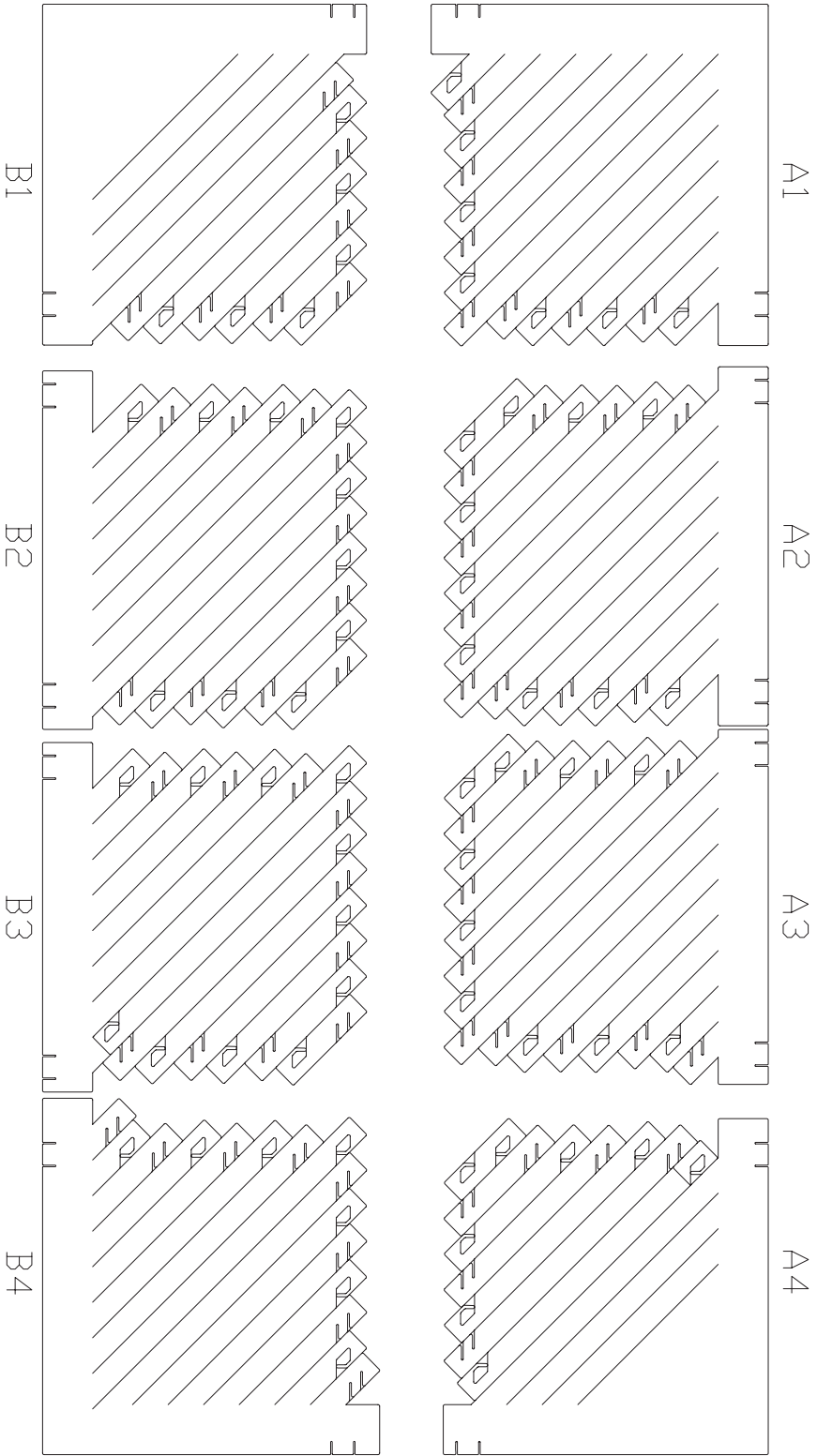


SHoP  
"VIRGIN ATLANTIC  
CLUBHOUSE"

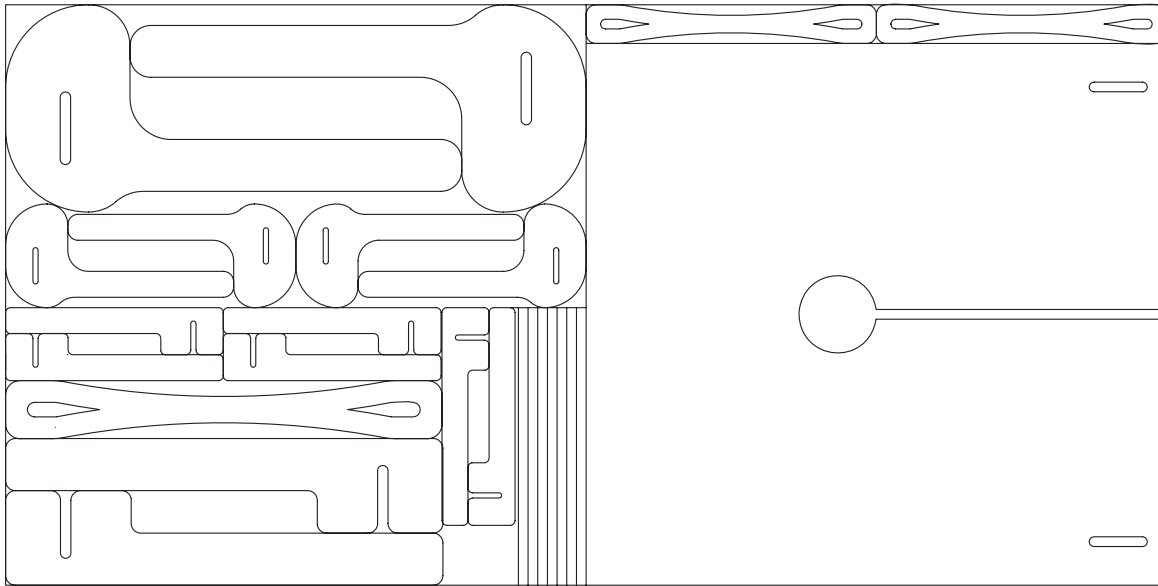


## FABRICATION TECHNIQUES

- COMPUTER MODELING SOFTWARE (MAYA, RHINOCEROS, 3DS MAX, SKETCHUP)
- CAD/CAM SOFTWARE (AUTOCAD, TOOLPATH)
- COMPUTER NUMERICALLY CONTROLLED ROUTER
- LASER CUTTER



PANELIZED  
FABRICATION DESIGN  
DRAWING



## FABRICATION TECHNIQUES

Through the use of a diverse set of design and fabrication techniques including three dimensional modeling programs and computer controlled manufacturing techniques a process of digital and analog generative iteration was utilized to provide a myriad of possibilities. This kit of tools informed the design process and helped to create a geometric explorations that created an aesthetic matrix of digitally designed and fabricated objects. This investigation evolved in materiality, connection and scale throughout the process finally yielding a digitally fabricated installation that created and informed space at an architectural scale.



EARLY  
INSTALLATION  
PERSPECTIVE





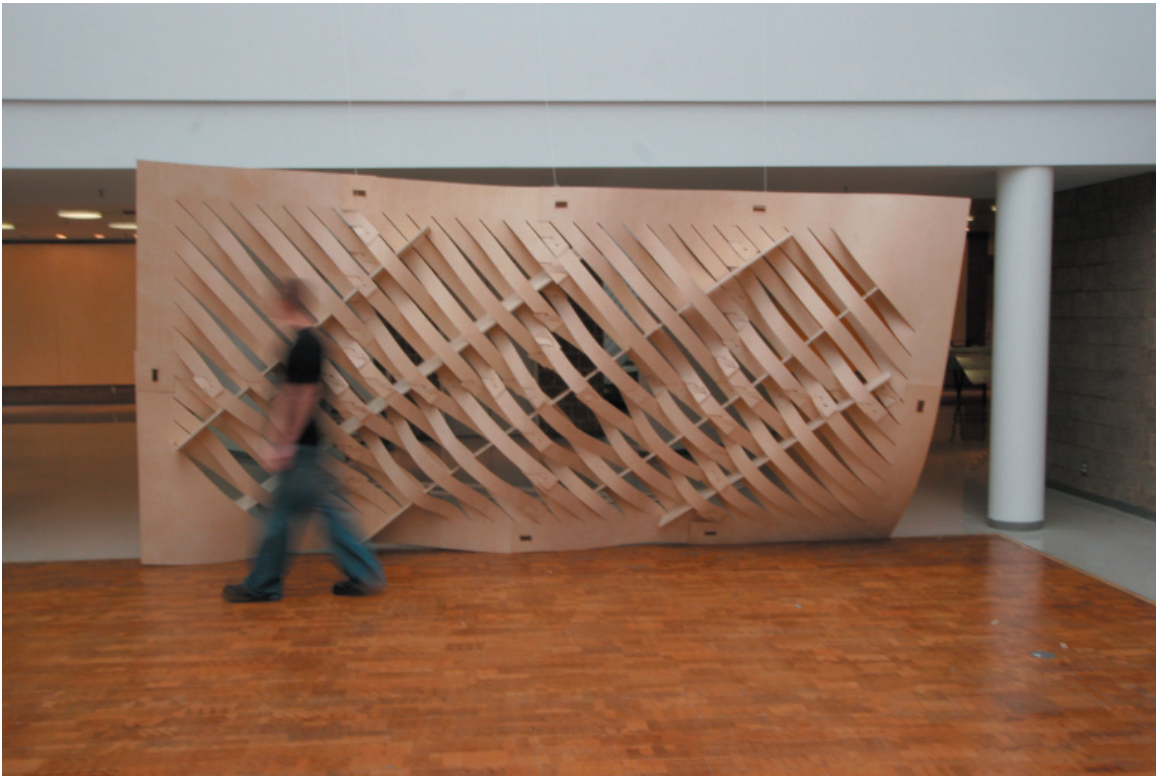
## MATERIAL RELATIONSHIP

- INVESTIGATE THE RELATIONSHIP BETWEEN ANALOG AND DIGITAL MODELING TECHNIQUES
- CULTIVATE THE LANGUAGE OF DIGITAL FABRICATION TECHNIQUES AND MATERIALS
- DESIGN ARCHITECTURAL INTERVENTION THAT HONESTLY REPRESENTS THE MATERIAL AND ITS PROPERTIES AS WELL AS UTILIZES DIGITAL FABRICATION TECHNIQUES AND THEIR CAPACITY TO EXPRESS THE DESIGNERS HAND






FINAL INSTALLATION  
PERSPECTIVE



## MATERIAL RELATIONSHIP


Through investigations in digital fabrication a co-dependent relationship emerged. The language between material and fabrication techniques became a major area of study that was responsible for much of the design of connections and also responsible for much of the material consumption and panelization decisions that came about. This relationship is unique because it has a life both in the digital and physical worlds and will always remain so, through the understanding and evolution of this relationship the designer can begin to exploit this language.





“The real problem is not to adapt machine production to the aesthetics of handicraft, but to think out new aesthetic standards for new methods of production.”

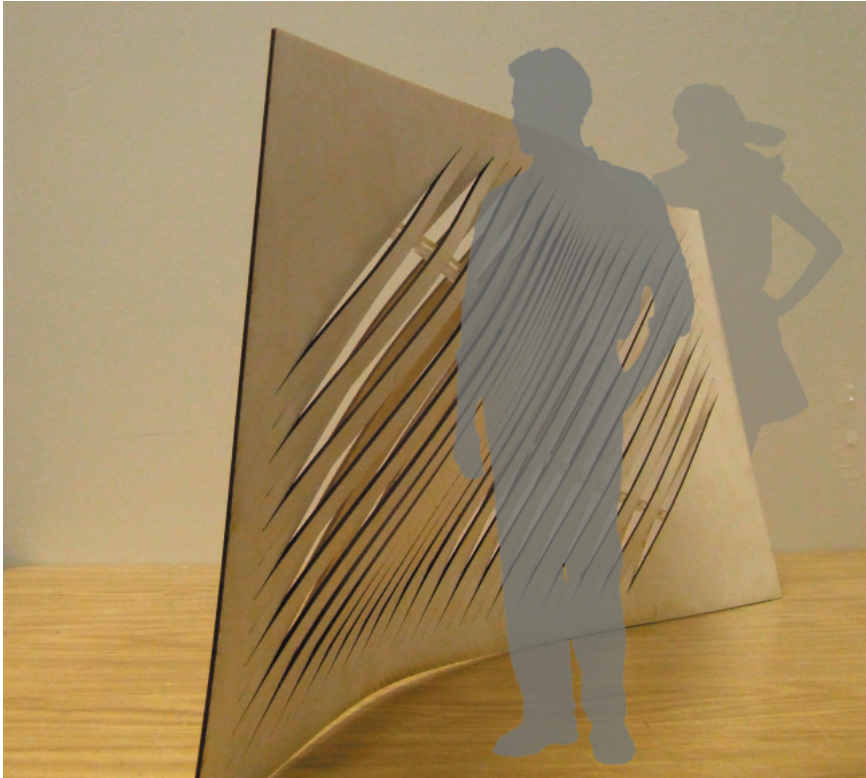
Herbert Read  
1936







RICK JOY  
"CATALINA HOUSE"



## SPATIAL INFLUENCE

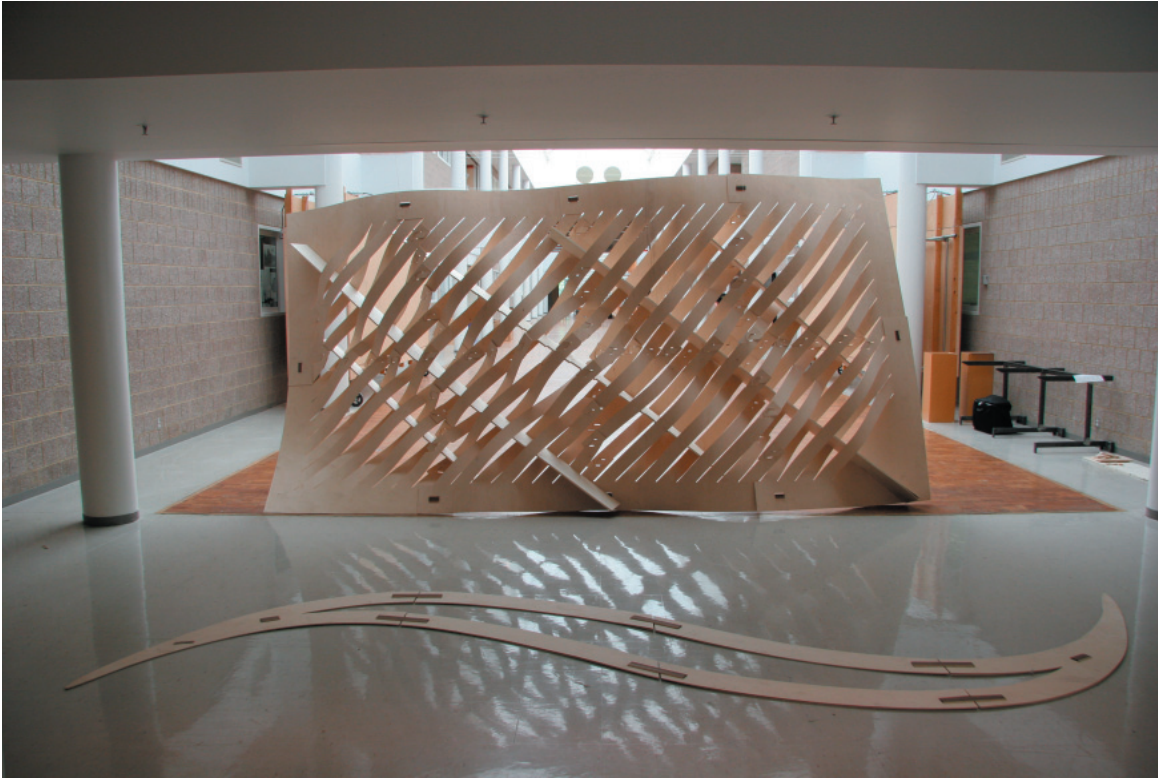
- STUDY HAPTIC QUALITIES OF MATERIALITY IN SPACE
- CREATE A DYNAMIC SPATIAL QUALITY UTILIZING GENERATIVE DESIGN METHODS





VRud et wis nonseniat.  
Ut nos non utet augait  
vulla consequam, quiscin






## SPATIAL INFLUENCE

The phenomenological qualities of this study revolved around utilizing the haptic characteristics of wood and our familiarity with the material to more fully engage the occupant within an articulated architectural space. This study yielded results that, though not fully engaging the occupant, began to grant an understanding of what this type of space should be able to convey to the individual. This haptic environment is one that is and will continue to be difficult to simulate digitally and relies heavily on an understanding of space and materiality to achieve this all haptic environment.

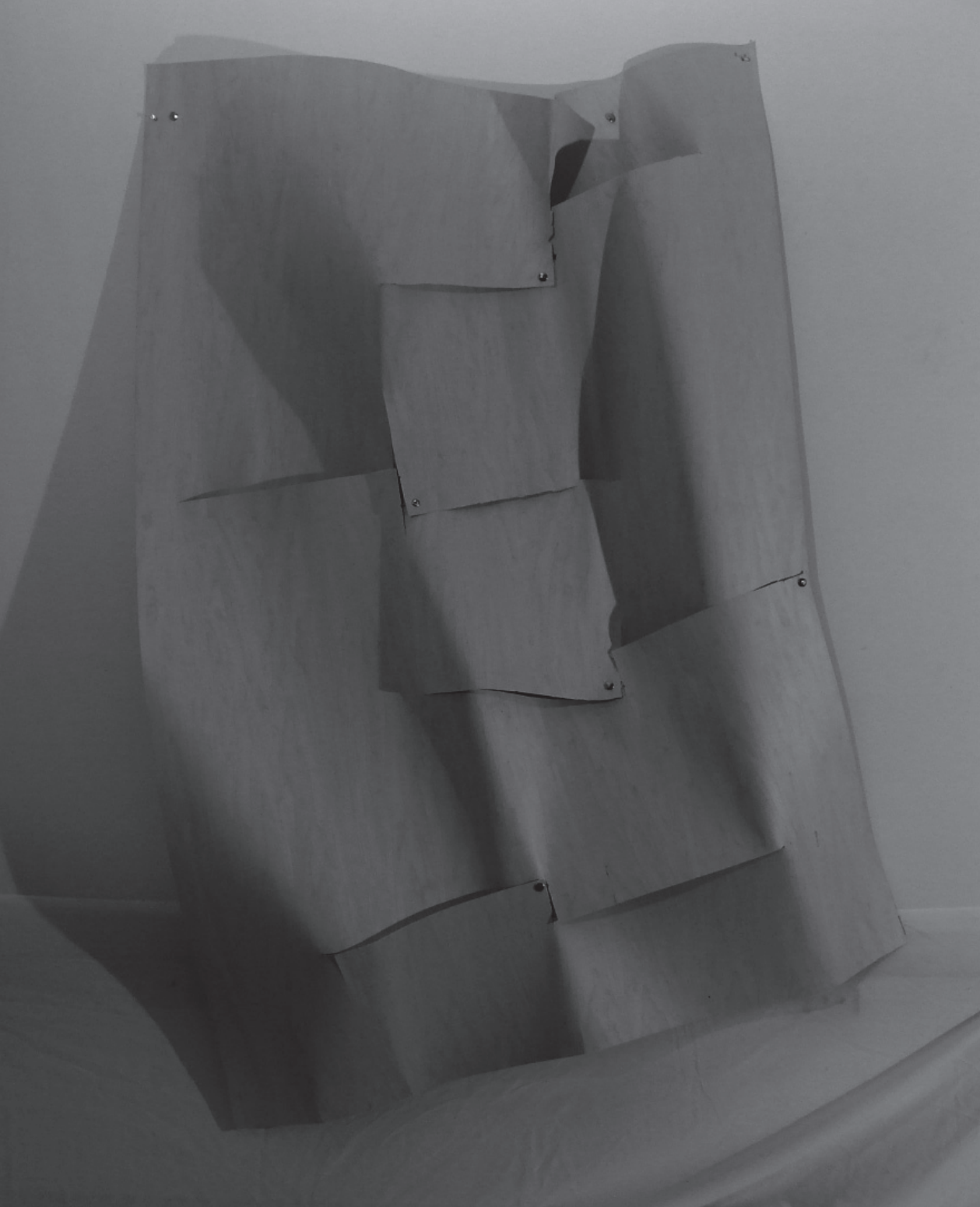




"The space of architecture, always elusive and mysterious, is the space in which we may perceive ourselves, if only for a moment, as whole; it is the 'event' that may change our lives through this recognition."

Alberto Perez-Gomez





PAPERBACK VENEER  
DESIGN ESQUISSE



## SELECTION

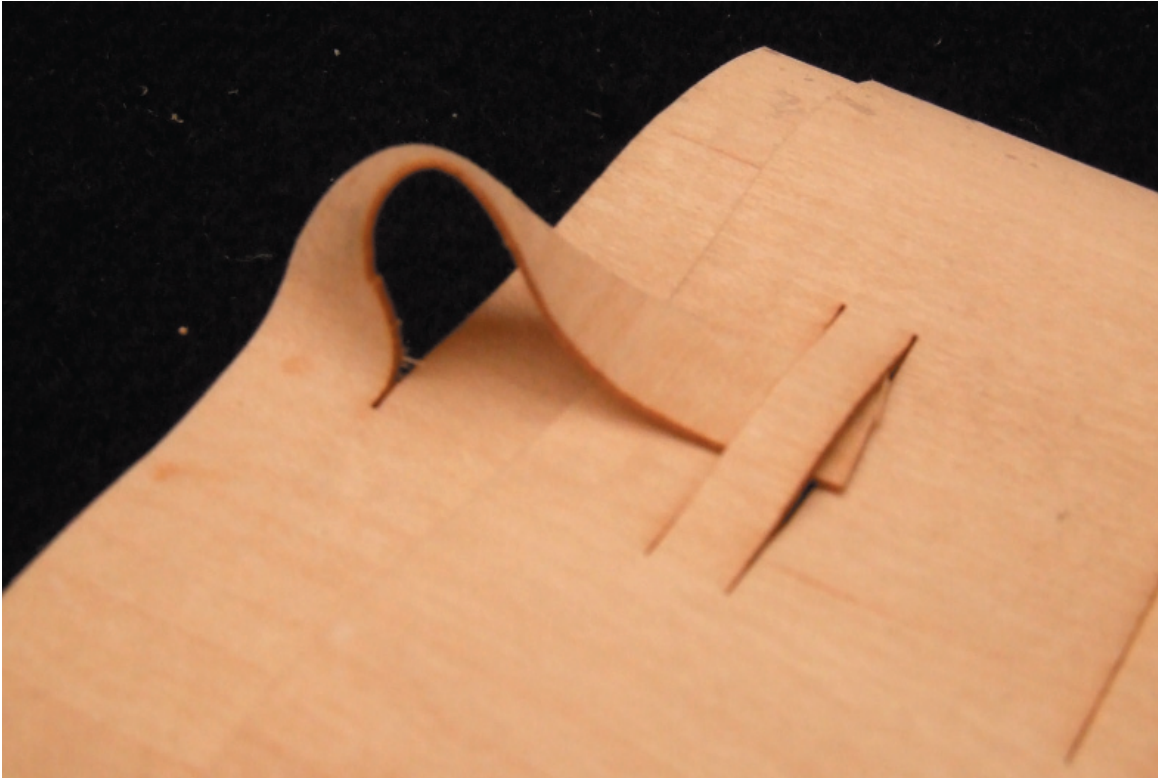
- INVESTIGATIONS
  - 0.010" PAPERBACK MAPLE VENEER
    - GRAIN QUALITIES
    - RELATIVE FLEXIBILITY
    - GEOMETRY
    - CHEMICAL TREATMENT POSSIBILITIES
    - INITIAL CONNECTION INVESTIGATIONS





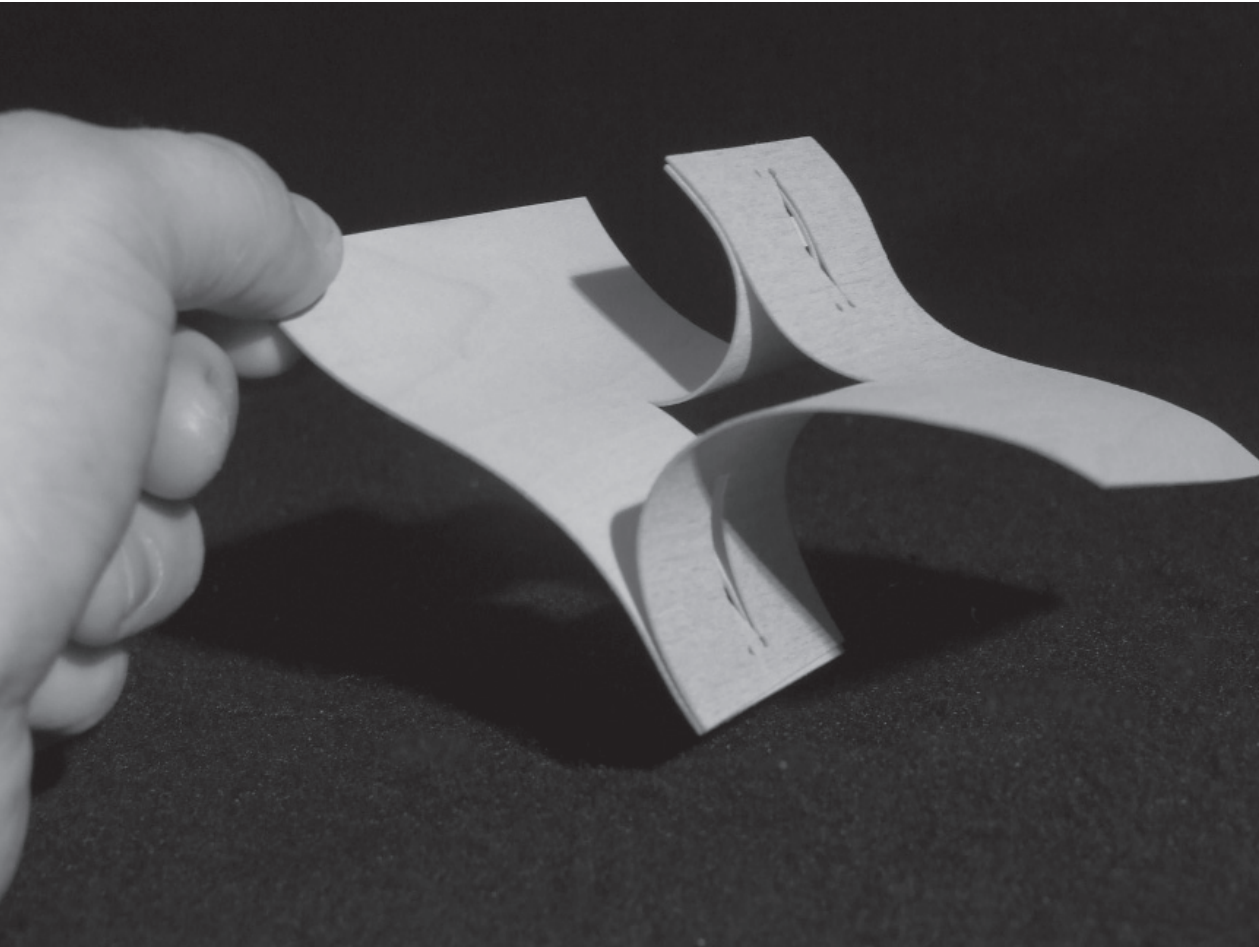
IDEA MODEL FOR  
EXPANDABLE PLANE



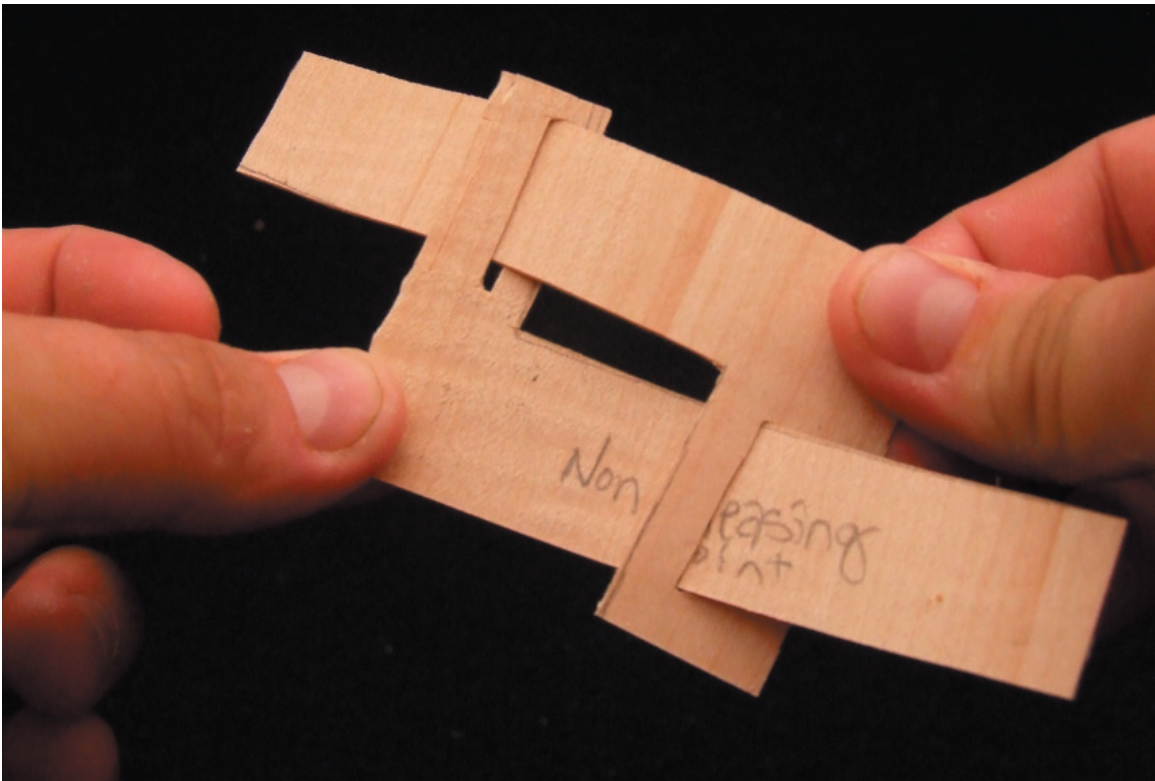


## SELECTION

- INVESTIGATIONS
  - 0.030" MAPLE VENEER
    - GRAIN QUALITIES
    - RELATIVE FLEXIBILITY
    - GEOMETRY
    - CONNECTIONS
    - INVESTIGATIONS INTO UNFOLDING PLANAR GEOMETRY

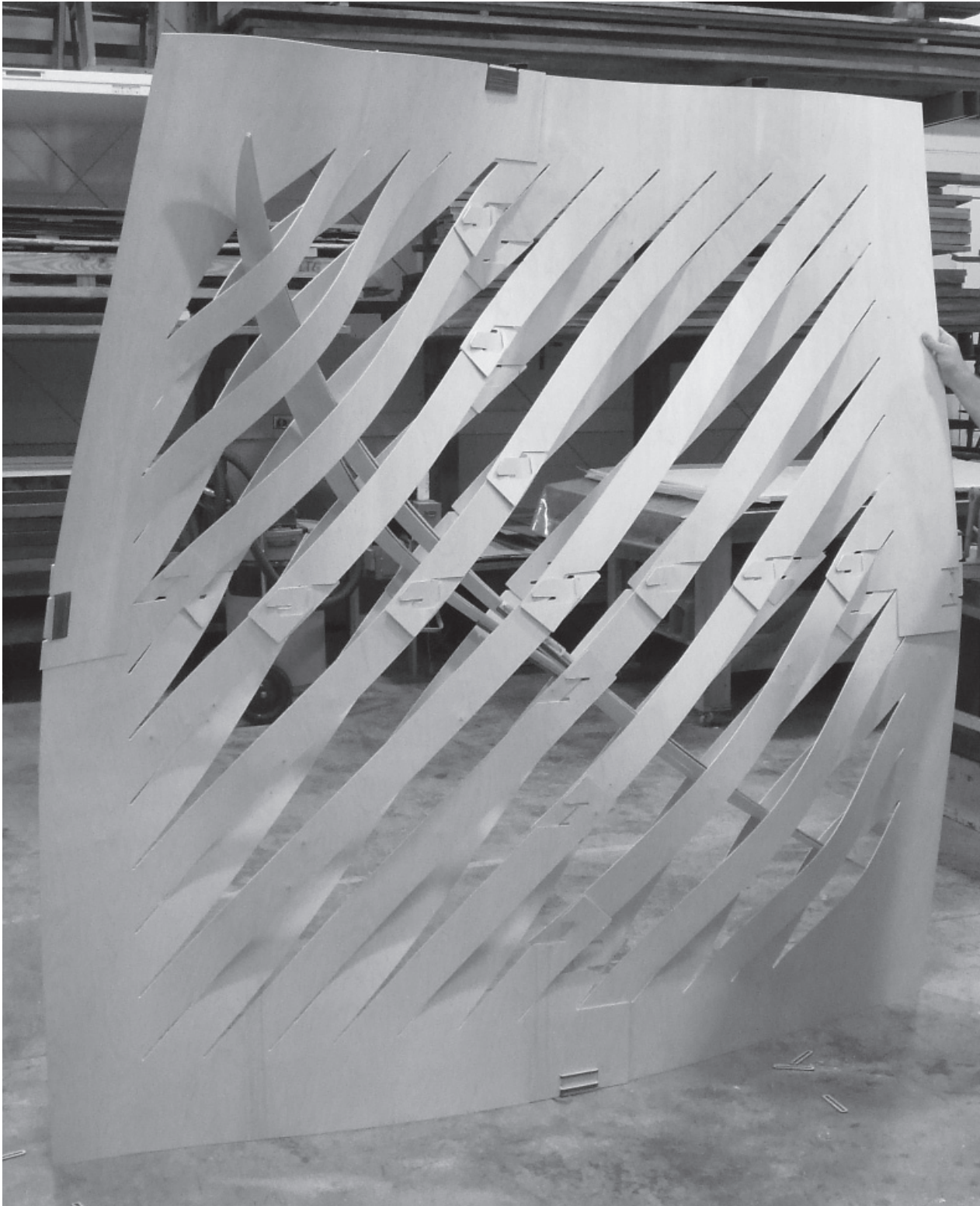


GEOMETRIC &  
CONNECTION  
STUDY



## SELECTION

Through the investigation of this very thin, very brittle material many of the basic material properties of wood became relevant, such as grain patterning, connection and geometry possibilities and issues with scale. This series of investigations proved a fantastic basis for the continued evolution of the study as the material qualities realized at this stage of the project proved relevant throughout the remainder of the investigation.



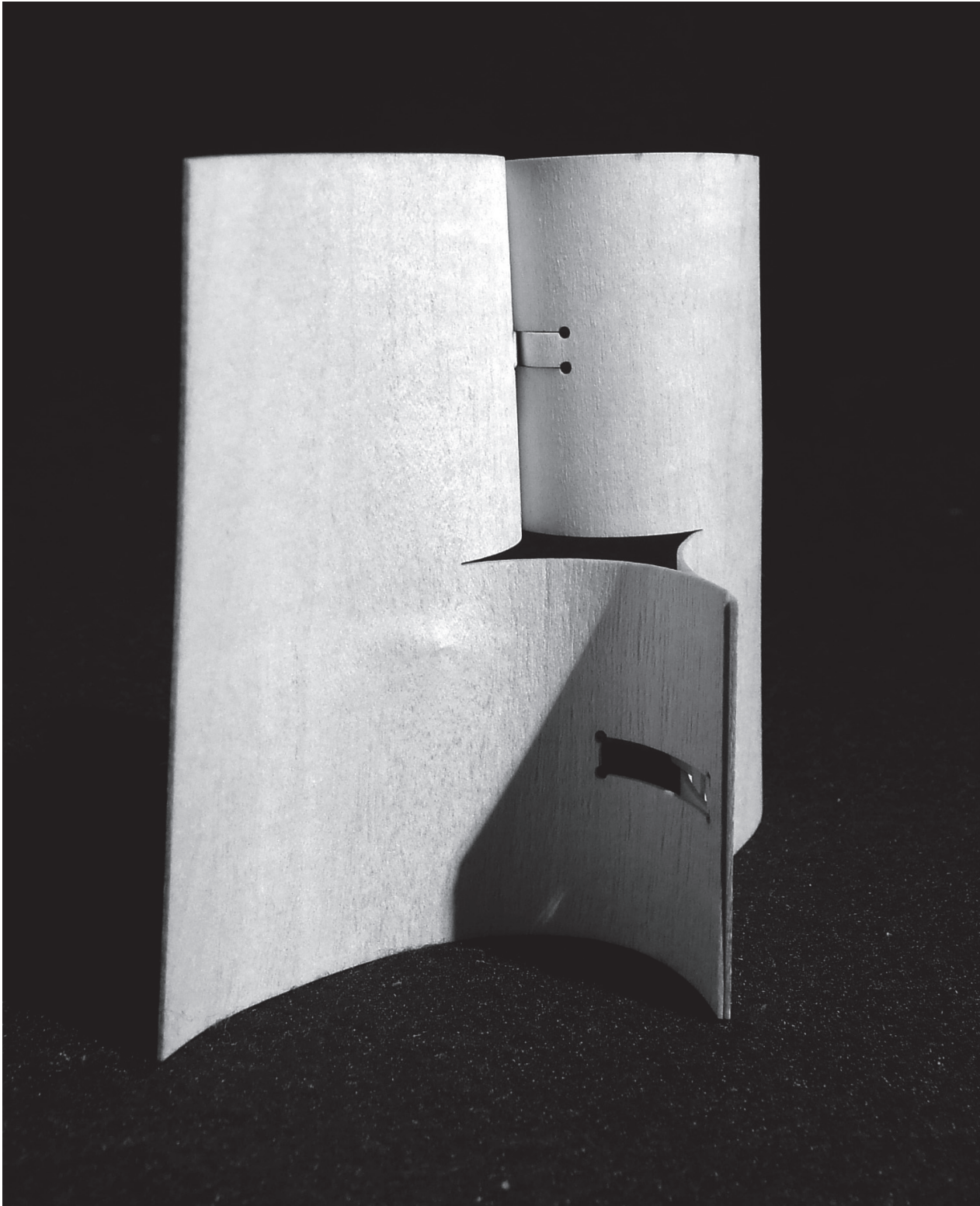
FIRST LARGE SCALE  
ITERATION





## SELECTION

- INVESTIGATION
  - 1/8" BALTIC BIRCH PLYWOOD
    - GRAIN QUALITIES
    - RELATIVE FLEXIBILITY
    - ABILITY TO ACHIEVE GEOMETRY
    - PRESCRIPTIVE GEOMETRY
    - UNFOLDING OF PLANAR GEOMETRY



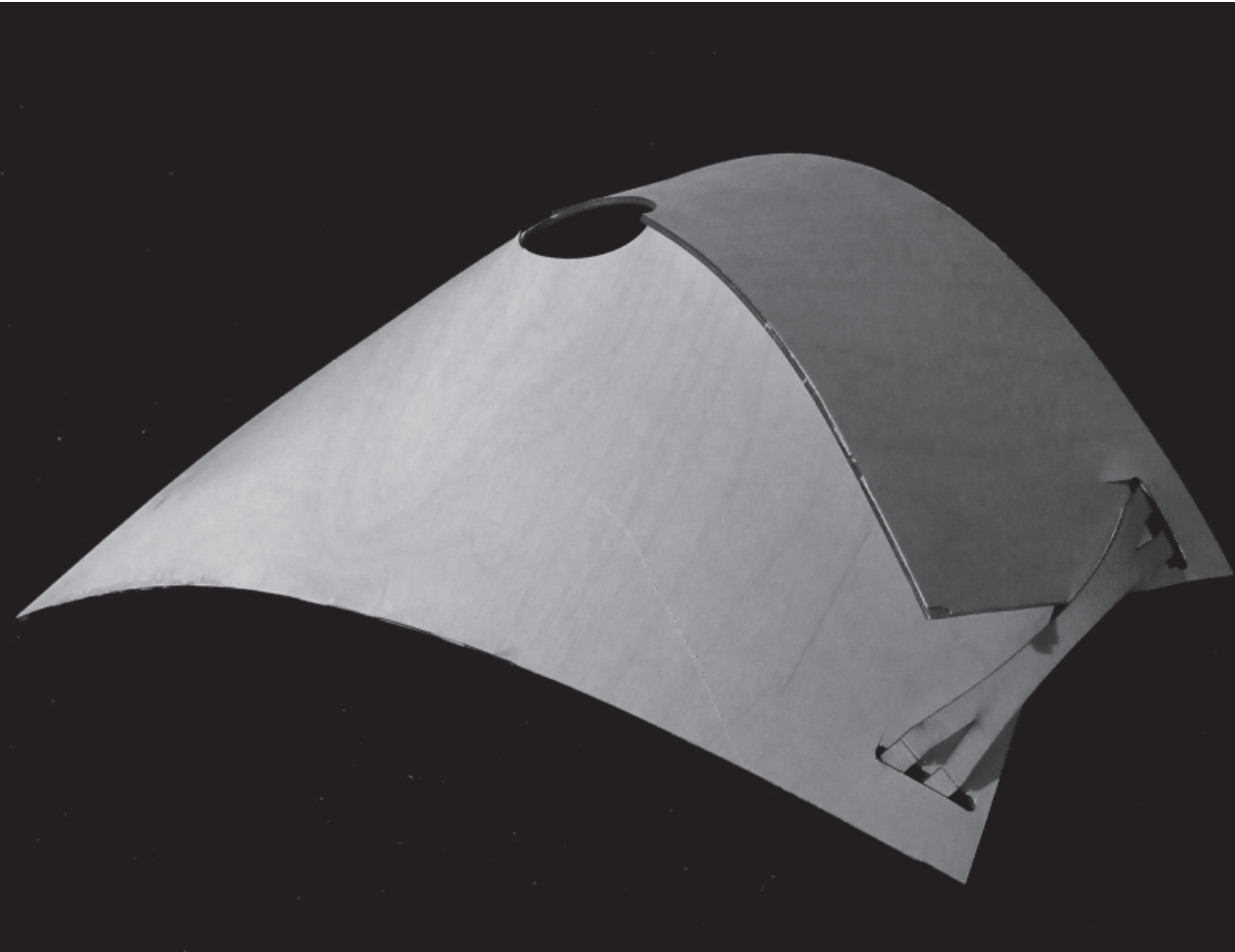
EARLY STUDY OF  
STABLE VENEER  
GEOMETRY



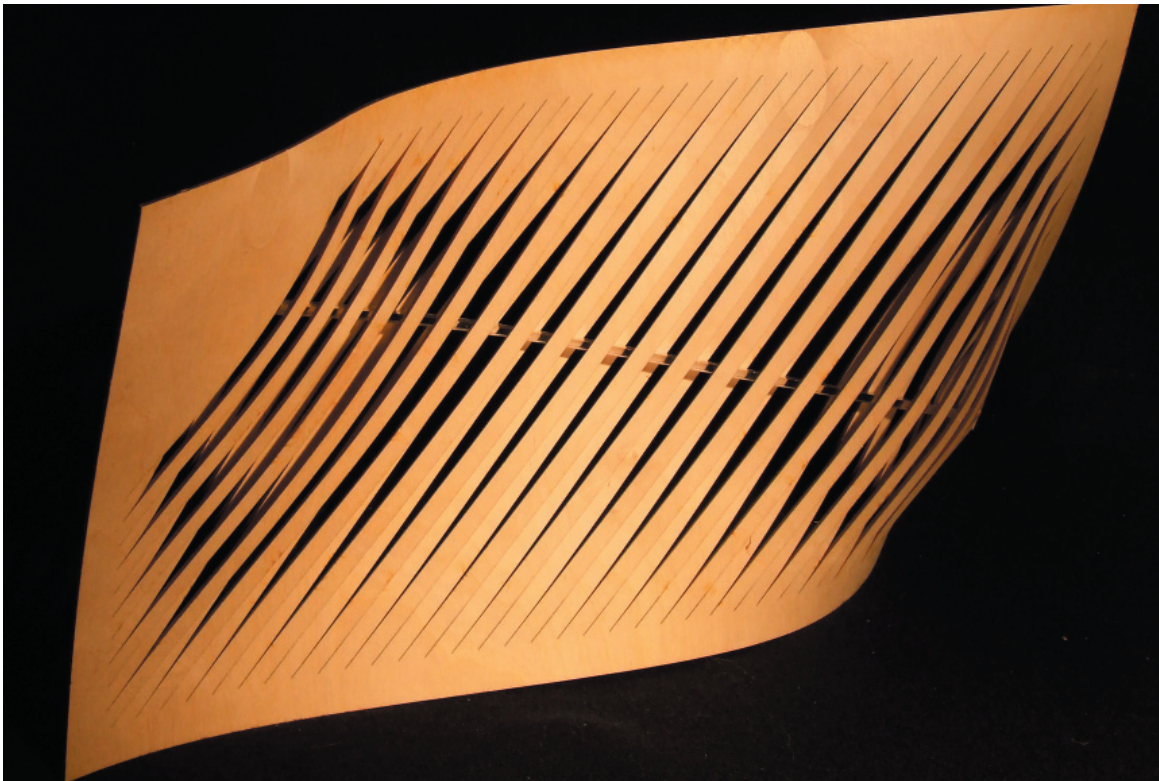


## EVOLUTION

- VENEER STUDIES
  - YIELDED AN UNDERSTANDING OF MOST BASIC PRINCIPLES OF MATERIAL
  - BEGAN TO DISCOVER PANELIZATION WOULD BE NECESSARY TO ACHIEVE A SCALE THAT WOULD BE REPRESENTATIVE OF THE ULTIMATE SCALE OF THE PROJECT
  - PROVED DIFFICULT TO OBTAIN ARCHITECTURAL SCALE FROM SUCH THIN MATERIAL

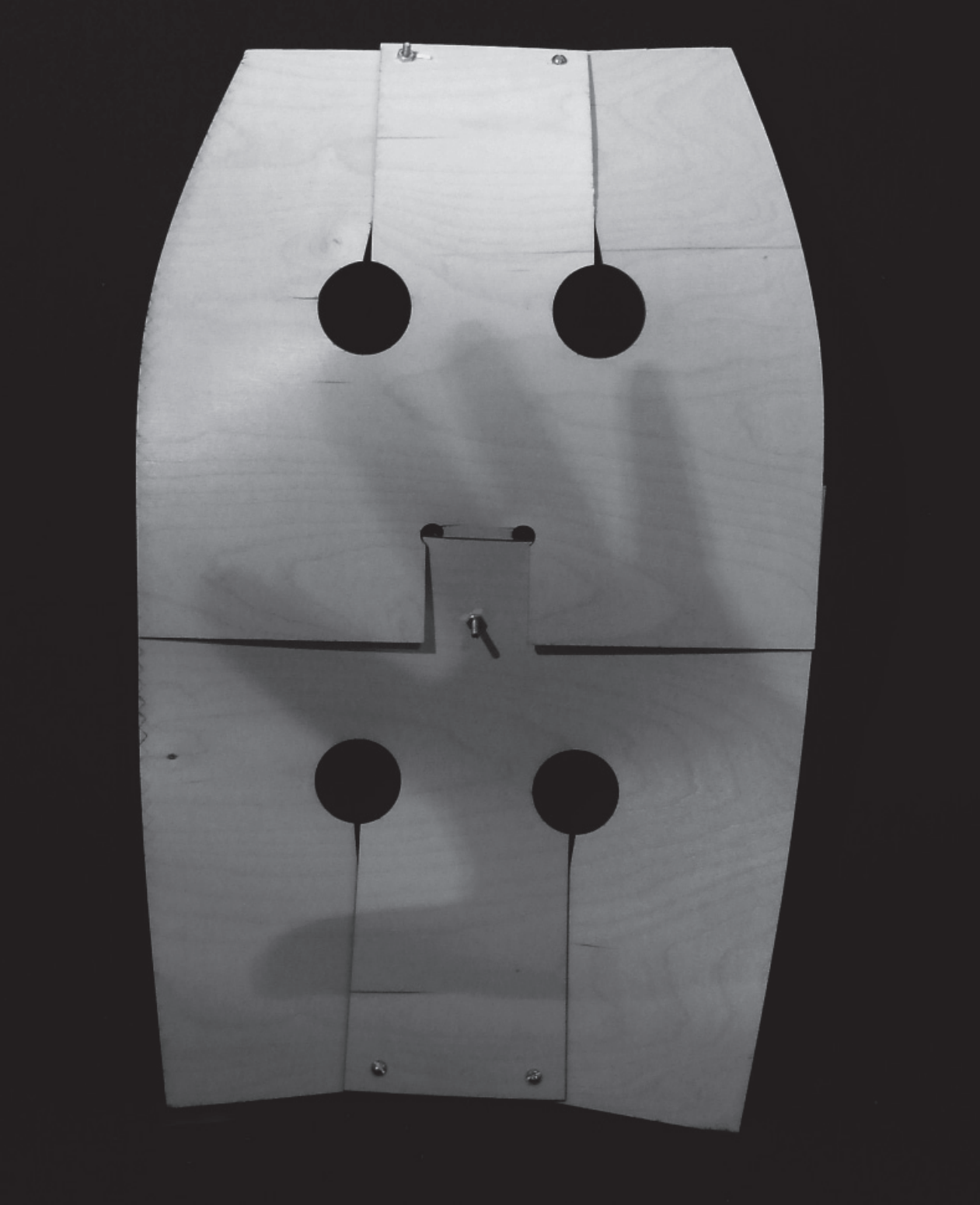


EARLY STUDY OF  
WOODEN CONNECTION



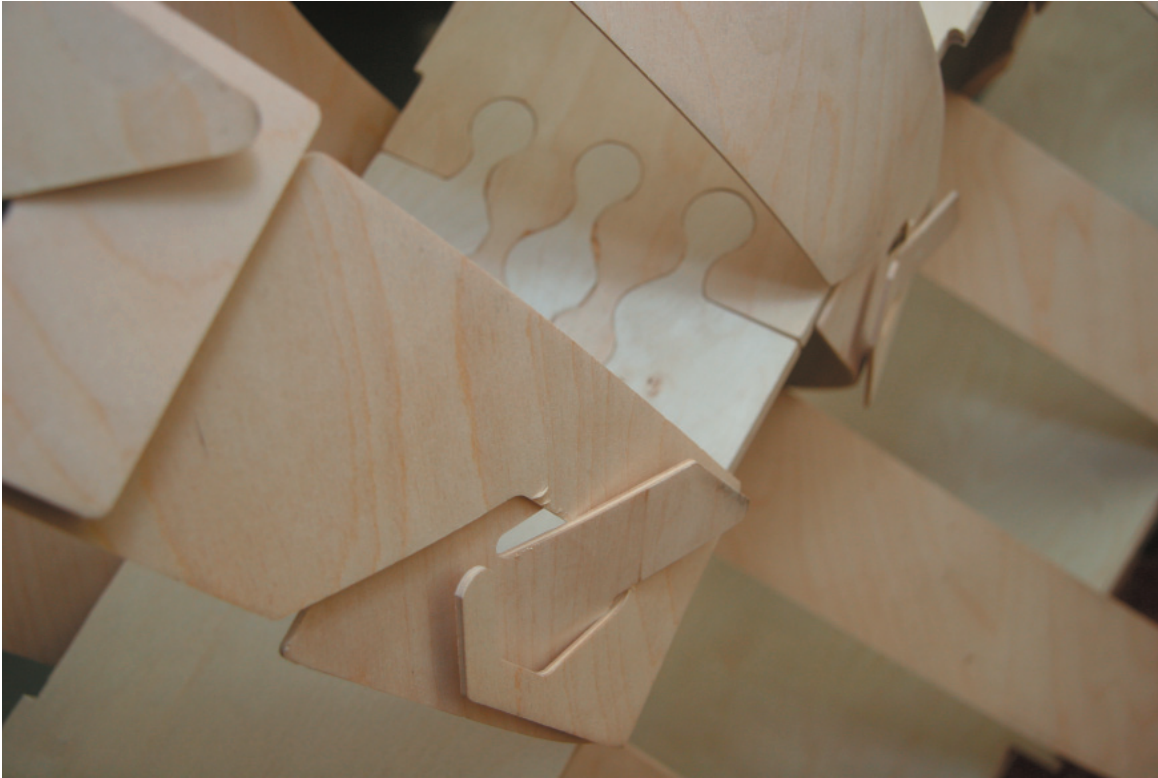
## EVOLUTION

- PLYWOOD
  - UTILIZED THE UNDERSTANDING GAINED FROM VENEER STUDIES BUT ALSO REQUIRED AN UNDERSTANDING OF THE PROCESS OF PLYWOOD MANUFACTURE, IT TECHNIQUES, METHODS, AND MATERIAL PROPERTIES
  - MATERIAL IS STRONG ENOUGH, YET FLEXIBLE ENOUGH, TO ENABLE CONNECTIONS TO BE MADE OF THE SAME MATERIAL (1/8" BALTIC BIRCH PLYWOOD)
  - UNFOLDED SURFACE BECOMES DESIGN TOPIC OF INVESTIGATION



WOOD PANELIZATION  
ASSEMBLY





## EVOLUTION

The evolution of the investigation took a unique turn when the idea of introducing an articulated spine; this discovery resulted in a series of investigation in geometry, stability aesthetics and material strength. The spine coupled with 45 degree cut, which maximize the strength of the three-ply plywood; and a curvilinear spine woven through the angled slats enabled the panel to curve simultaneously in two directions and inform a space that surrounds the panel itself.



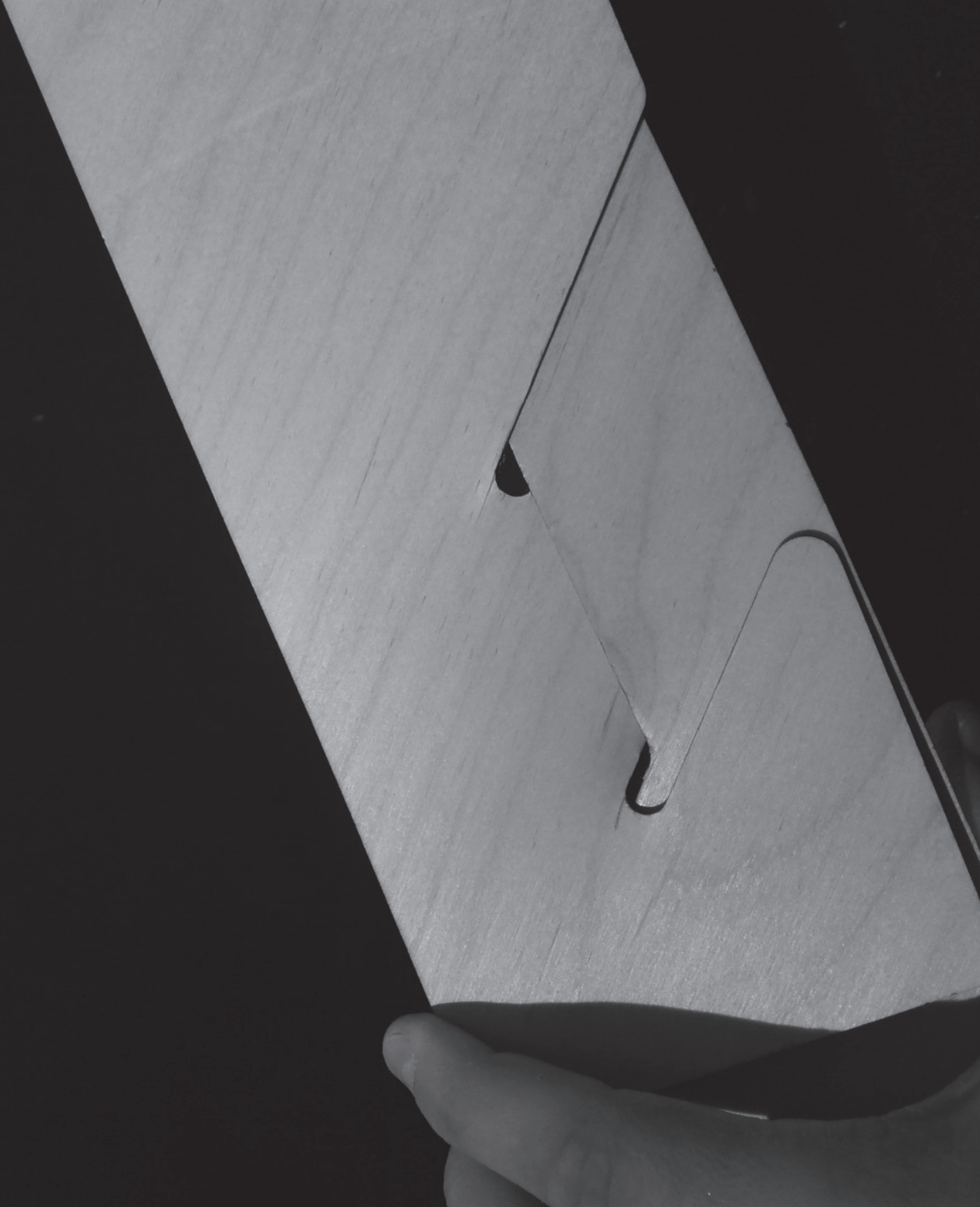
FINAL ITERATION OF  
WOODEN CONNECTOR





## PANELIZATION

- DUE TO SIZE LIMITATION OF SINGLE PANEL, A PANELIZED SYSTEM WAS NECESSARY TO CREATE THE DESIRED SPATIAL QUALITIES
- ALLOWED FOR MULTIPLE PIECES OF MATERIAL TO BE JOINED TOGETHER AND REFERENCE AN ARCHITECTURAL SPACE
- EVOLUTION OF CONNECTIONS ALLOWED FOR DIRECTIONAL CONNECTION THAT IS BOTH FUNCTIONAL AND REFERENCES FABRICATION TECHNIQUES




PANEL CONNECTION



## PANELIZATION

The panelization of a series of smaller units due to the material size that was available as well as the size of the CNC router. The method of panelization needed to be flexible, functional and feasible to be fabricated with the machines at the college. Two separate connections were devised and became another exercise in exploring materiality and its ability to withstand bending and tension forces.



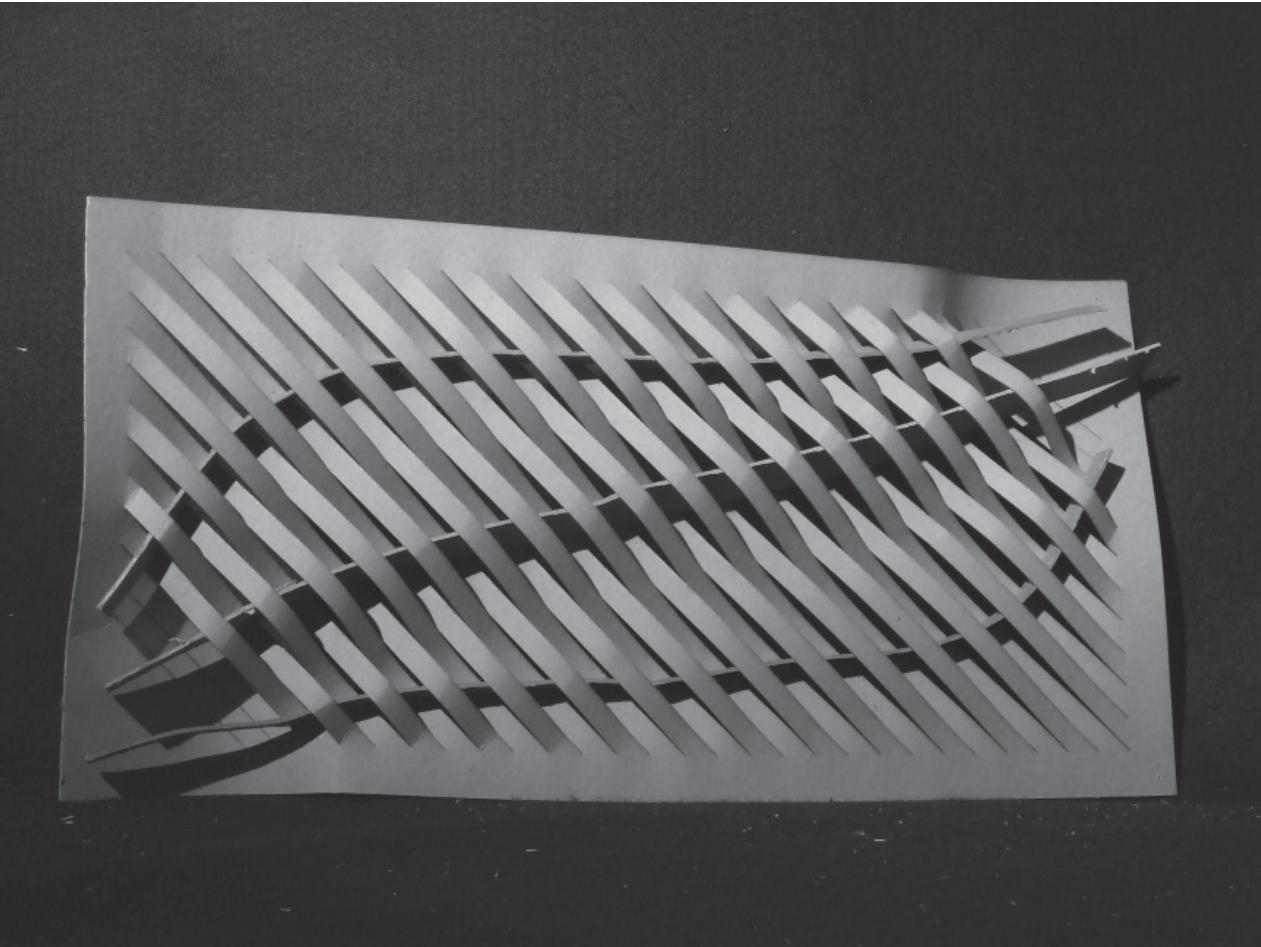


Plastic can be hip, glass can be cool, but wood commands too much respect to be in or out of fashion.

Chris Lefteri

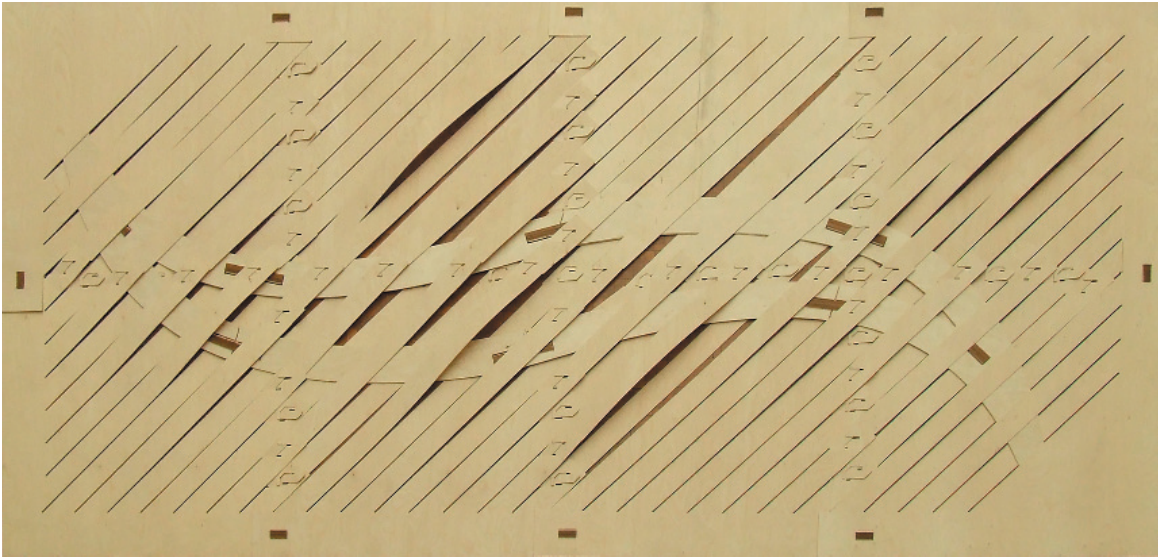






VIEW OF PANEL  
SYSTEM SUPPORTED  
VERTICALLY





## GEOMETRY

- CURVILINEAR SPINE PROVIDES GEOMETRY TO ALLOW PANEL TO STAND FREELY
- SHALLOW ANGLE ALLOWS CURVATURE TO INFLUENCE PANEL GEOMETRY BOTH VERTICALLY AND HORIZONTALLY
- LARGE SCALE SPINE FAILED DUE TO THE WEAKNESS OF THE 1/8" PLYWOOD, THE MATERIAL WAS UNABLE TO SUPPORT ITS OWN WEIGHT AT FULL SCALE



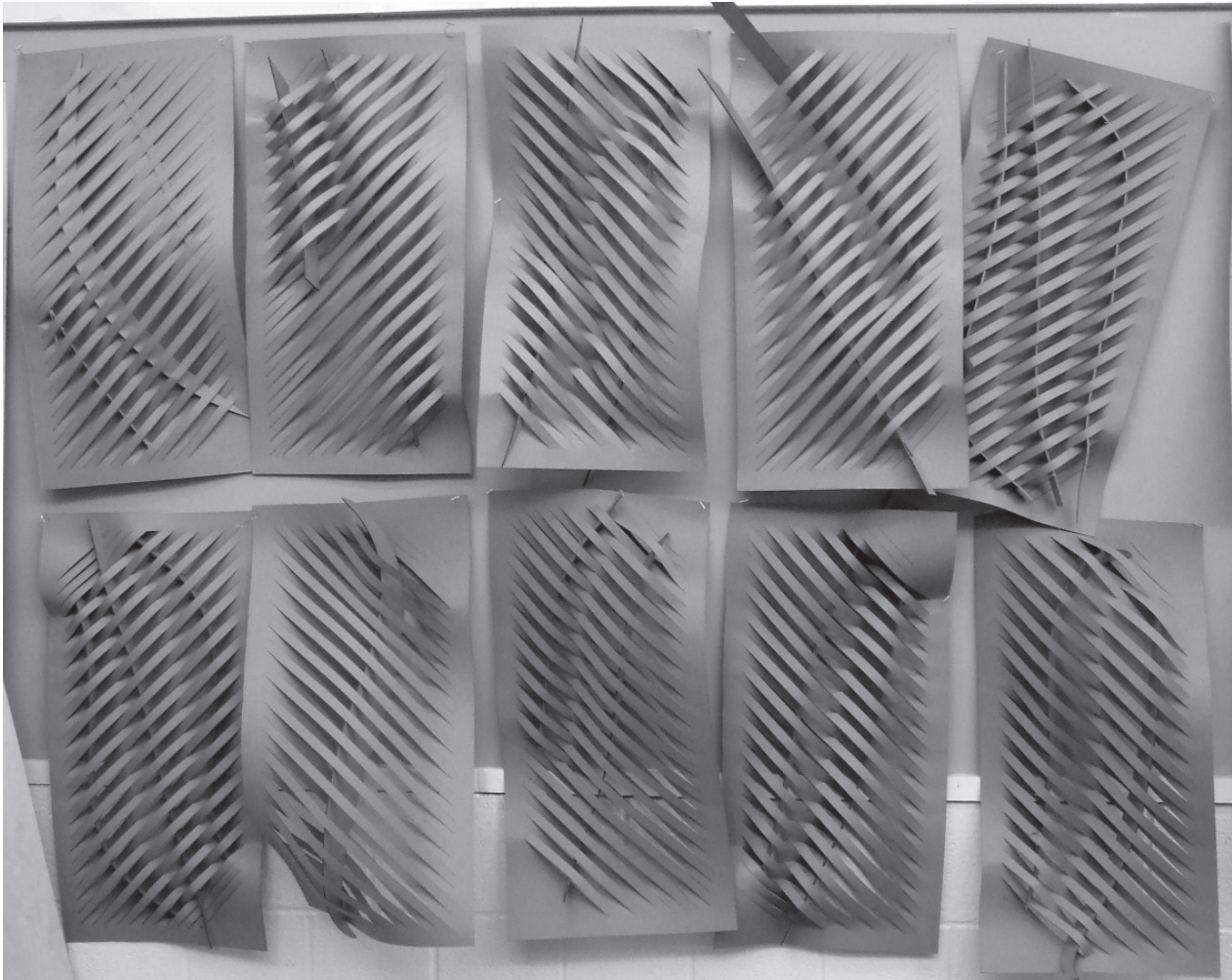
PUZZLE PIECE  
CONNECTOR IN  
LINEAR SPINE



## GEOMETRY

Although a curvilinear spine geometry was concentrated on throughout the investigation it proved very difficult to replicate the results achieved at a small scale. This led to the investigation of a linear geometry for the panel so that it could be more easily calibrated to the correct dimension at this stage of the project.



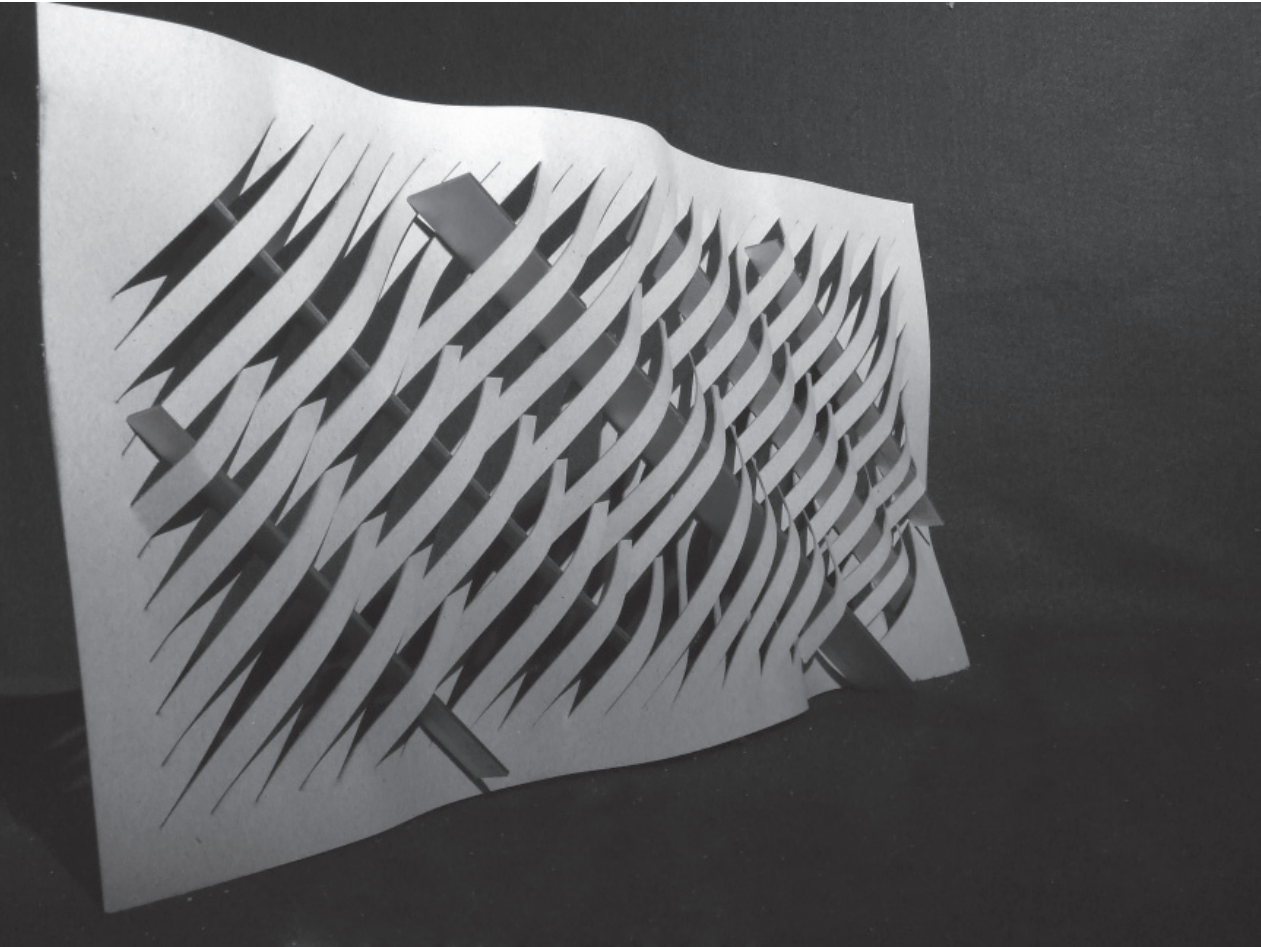


PORTION OF  
GEOMETRIC SPINE  
STUDIES



## INVESTIGATION

- THE INTRODUCTION OF ADDITIONAL LINEAR SPINES HELPS TO TIGHTEN AND STRENGTHEN THE PANEL
- THE INSERTION OF SLOTS INTO THE SPINES ALLOWS THE FLAT RIBS TO FIND THEIR PLACE AND TO CONTROL THE CHAOS OF THE FLIMSY RIBS



SCALE MODEL OF  
FINAL INSTALLATION






## INVESTIGATION

After the initial failure of a curvilinear spine which was unable to properly tension the panelized assembly a series of investigations to explore the possibilities of multiple spines. Throughout these explorations five straight spines running perpendicular to the pattern of cuts on the panel were decided upon. This number of spines was far more capable of providing a high level of tension within the panel, which is required to properly control geometry.





"We must remain open and experimental and, perhaps, marginal. The realization of one inspired idea in turn inspires others. Phenomenal experience, worth the fight, is answered without words - the silent response is the joy radiated in the light space and materials of architecture."

Steven Holl



When reflecting back on a process that one is ingrained deeply in there is plenty of opportunity for reflection and finding areas that one probably should have been able to foresee during the investigation, however, this is most likely not the case. An investigation of this type is about process and gaining a further understanding at differing levels, each posing a separate and equally important part of a larger whole. These investigations hinged on being able to understand and foster a relationship between materiality and digital fabrication techniques while investigating the possibilities of articulating a haptic environment.

When looking into the material study itself it became apparent that a basic understanding of the material would not suffice in the scope of this investigation. This study required an intimate understanding of wood and the associated digital fabrication techniques. Plywood is a material whose many uses can be taken for granted but also has historically been deeply explored. From the plywood furniture of Charles and Ray Eames to the flooring most likely under our feet this material has both played a mundane role in our daily lives and become an artifact of high design. The material of choice in this investigation was 1/8" Baltic Birch Plywood which consists of three alternating ply's. This imported material is solid, this differs from much of the material manufactured in the United States because it has a particle board core which makes the material very stable but destroys the honest behavior of wood, which is very important for the purposes of this study.

The digital fabrication portion of the investigation revolved around having knowledge of the techniques that can be utilized and are available here at UNCC. These techniques were primarily concentrated around a three-axis numerically controlled router and a two dimensional laser cutter. These technologies were chosen as they are both readily able to work with selected plywood and perform complex operations with a high amount of speed and efficiency in ways that would neither be possible nor feasible through traditional handicraft techniques.

The relationship between the material study and the digital fabrication techniques employed in this investigation have become the main area of study and of interest. This relationship is one of interdependence, with each being equally dependent on the other. Throughout the evolution of the project this relational articulation has become one of the main areas of study and interest. Being able to articulate ideas through the fabrication machines has become much easier as an understanding of this relationship between machine and material has built throughout the year. This evolution is one that once an understanding has become realized the architect is in position to exploit and serves a building block to further press themselves as a designer and the larger field of architecture.

These material and fabrication investigations have traditionally been pursued under the premise that this understanding would lead toward another investigation into a study of the phenomenological impact that architecture of this type can have on space. This idea of discovering a newly articulated way of incorporating the senses into the perception of space has been under addressed in this process, partially due to the complications of enlarging the scale of the investigation. Although this method of architectural analysis has been addressed in many ways throughout the study it has almost entirely been investigated at the scale of the hand held object.

Throughout the exploration, and through reflection of the process, many byproducts and instances of intervention have become apparently clear. These points of interest range from possibilities to investigate the graphic possibilities of the fabrication drawing to the possible investigations of ideas that were initially cast aside. This series of byproducts is set to further develop the evolution of the process because at this time reflection has become one of the key investigations and will potentially form the next portion of investigation into the relationship between digital fabrication, materiality and phenomenology.

Although the latest fabrication portion of this investigation yielded an intervention that is not necessarily beautiful, in the traditional sense, the process that has led to this final intervention has allowed beauty to pervade the process. This process has become, almost by accident, the area of highest interest. It has brought about very fundamental questions such as: what is a plane, how strong can corners be, how much can I bend this or that, how can light and shadow inform and articulate geometry, and it has brought these questions to rather sophisticated digital fabrication equipment.<sup>1</sup> This investigation has come to utilize equipment that is viewed as “highly polished” final product and has been utilized this same technology to question some of the basic element and effects of architecture.

Throughout this research study there have been points of excitement where a great amount of potential could be seen and low points to where a near dead end was perceived. However the project continually pressed forward and as a basis for this continuum continually questioned the current modality of these technologies. This has become the basis for the continual exploration of this work and has already begun to inform the evolution and growth of my personal design process.

**(Footnotes)**

<sup>1</sup> Morris, Mark. [mmorris1@email.uncc.edu](mailto:mmorris1@email.uncc.edu). May 9, 2006. RE: Thesis Epilogue.

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