

ARTIFACTS OF QUESTIONS ASKED

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ABSTRACT

The cyclic trajectory described here exemplifies a loosely defined, continuously evolving set of questions, results, and methodologies that have emerged during the process of design by making. Through a series of prototypical building components and assemblies this collection presents a design process that began with a top-down program-specific design process that informed the development of a unique building system and enabled a bottom up formal exploration. As the design thesis for the first professional Master of Architecture degree this exploration surrounds the design, fabrication, and deployment of a series of component-based building assemblies. One example, the SEEDS Pavilion At Hawks Ridge, serves as a remote base of operations for a local youth organization that supports field-based environmental education. The pavilion continues an investigation of user assembled construction and is based on a component group that can be assembled on-site by camp children. Each building component was manufactured using on campus fabrication laboratories and was assembled on-site by a group of supervised SEEDS camp student-volunteers during a two-day design-build workshop at the Hawk's Ridge Preserve in Floyd, Virginia. The form of the structure is derived by the limitation of component number, size, and assembly sequence and represents the conflict between a parametrically derived prescriptive shape and the forms that resulted during the bottom up exploration of the physical system itself. The component-based construction system is made possible by a series of nodal linkage assemblies designed to accommodate variations in on-site conditions using a strategic 'sloppy detail' that enables a high degree of assembly and deployment tolerance. The following collection of sequential images outlines construction of several prototypical components and assemblies and is intended to represent a continuance, not an end, to a long-term effort.

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TABLE OF CONTENTS

Abstract	ii
Acknowledgements	iv
Introduction	1
SEEDS Pavilion at Hawk's Ridge	5
Process	10
Toward User Assembled Components	16
Conclusions	112
Image Credits	114
References	115



IMPLEMENTATION OF MANUFACTURED COMPONENTS IN USER ASSEMBLED, PRE-FABRICATED BUILDING SYSTEMS

SEEDS POD: A PROTOTYPICAL PAVILION AT HAWK'S RIDGE

SEEDS (Seek, Explore, Educate, DiScover)*

It is important to the understanding of the direction chosen for the SEEDS pavilion to first introduce the SEEDS organization (client) and their mission. Rather than reinterpret this mission I have included, with permission, a description written by the founder of the organization. The following text provides some insight into the characteristics that will later help shape the thought process that resulted in a diversion from initial top-down design proposals to what became an inherently bottom-up approach to design and construction.

“SEEDS has a mission to develop future leaders as people conducting themselves with civic responsibility and accountability in a sustainable society. SEEDS is a charitable educational organization that creates inquiry-based, discovery oriented activities for everyone. SEEDS cherishes the tenet of education by complementing and supplementing existing educational programs. We facilitate a learning awareness from an ecological perspective by emphasizing life's cycles, sustainable living, civic, and cultural awareness. Through travel, study, and play, SEEDS stresses the importance of independent thought, creativity, and strengthening community by the participation of everyone involved in the process of learning.” (SEEDS 2009)

The SEEDS Educational Process

“The Founding Directors of SEEDS, Dave Deshler and Mike Rosenzweig, have over 20 years of team experience and years more of personal experience as teachers. Their careers came together as SEEDS to continue sharing and creating creative programs for children and adults alike. They care to contribute to the community by the principles of the SEEDS program. An important aspect of SEEDS is that taking people to explore the world around them “first - hand”. SEEDS believes learning is fun, there-

*For Detailed information about the good work done by Mike Rosenzweig and the SEEDS organization please visit their website. Much of the following text was provided my Mike and used to describe the organization and their pedagogical philosophy that helped guide the development of this body of work. (<http://seedsguys.org/>)

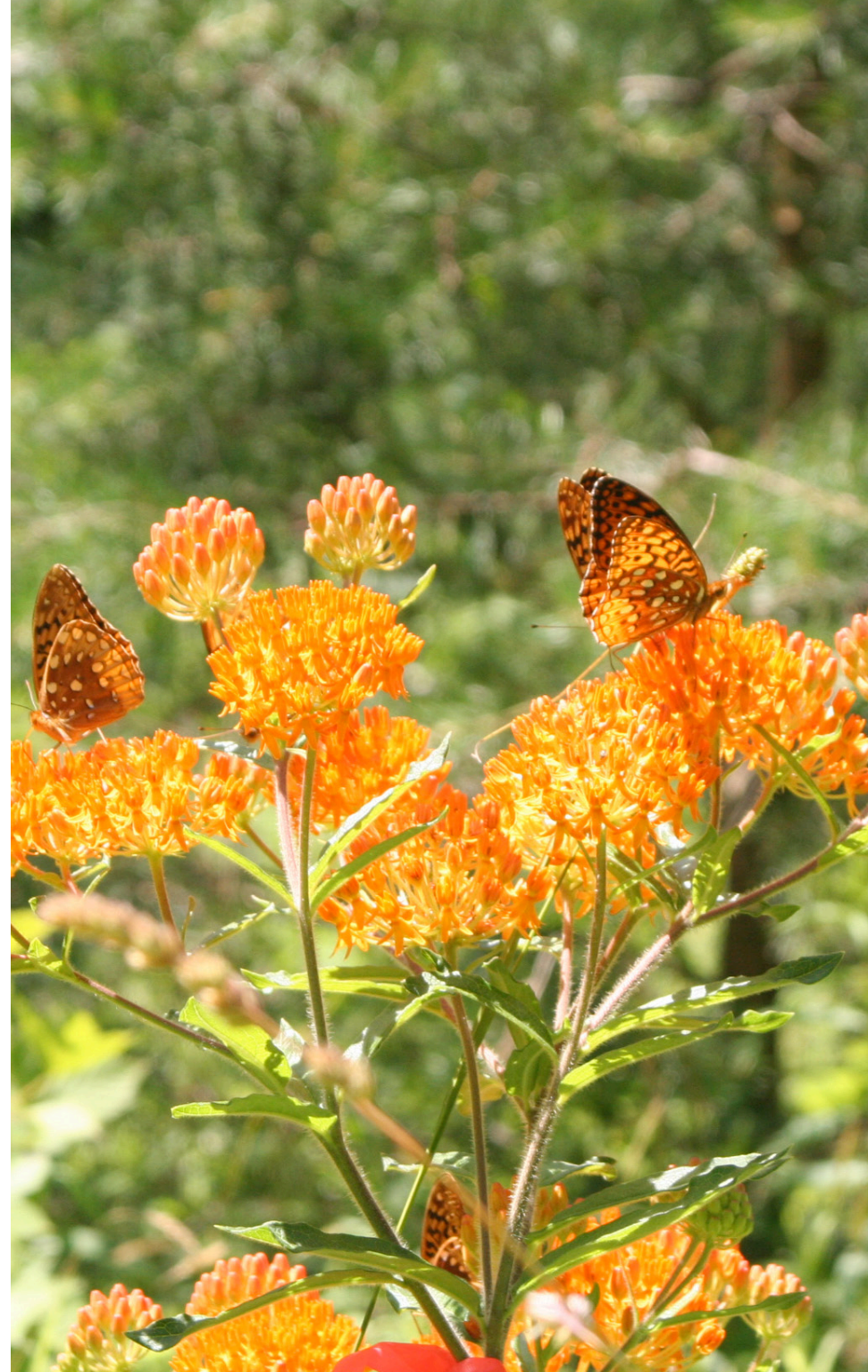
fore, teaching is fun. If learning is facilitated in a fun way, people become energized and enjoy the learning process. If they are enjoying themselves, then they are learning the way that they learn the best. The more someone enjoys the process, the more they will learn. SEEDS provides education that uses a multi-faceted approach. In this way, people are given the opportunity to search out their individual styles of learning in a challenging environment. Everybody is involved in the learning process. It is a process that includes different opinions, approaches and experiences. We live in a rapidly changing world and SEEDS acts to develop our future leaders as people conducting themselves with civic responsibility and accountability. This and an active, multi-dimensional, and fun approach to learning is what SEEDS personifies.” (SEEDS 2009)

Seeds and a Sustainable Society

“A society that manages its economy and population without doing irreversible environmental harm by exhausting the planet’s ability to replenish its resources and sustain human and other life forms is called a sustainable society. In a sustainable society, the needs of its people are supported without depleting the ecosystem services that provide resources to humans and other life forms. The issues faced by society involve all levels of citizens and includes many aspects of society including geography, ecology, history, sociology, government, law, and other arts and sciences. The work that SEEDS does in the community creates a “circle of learning” that works toward the goal of a sustainable society.” (SEEDS 2009)

Hawk’s Ridge Retreat

“Hawks Ridge Retreat is a 77 acre wildlife preserve located in Floyd county Virginia. Through collaborative work with the SEEDS organization the retreat offers educational opportunities for children during the summer





SEEDS environmental education camps. The site offers education through immersion and provides a location for field study and demonstration. Hawk's Ridge Retreat and Sanctuary has been established to provide a place of natural beauty and solitude that serves as an eco-spiritual retreat for humans and a sanctuary for native plants and wildlife. It is rich in natural beauty nestled in the Blue Ridge Mountains. Laurel Branch Creek runs through the property and there are miles of trails for hiking and bird-watching. In keeping with its purpose as a center for environmental, emotional and spiritual education, we sponsor field trips and provide a space for individual retreats. It is a space used by individuals and groups, children as well as adults." (SEEDS 2009)

SEEDS Pavilion at Hawk's Ridge

The proposed SEEDS pavilion will be located just off the banks of the Laurel Branch Creek that flows through the site from a general east to west direction. The photograph to the left shows the open field that lies at a low point between a series of ridges. The creek flows from back left to right in the image and the photograph is taken from a southeast position. The pavilion will be located to the bottom right of the photograph about six feet above the creek at a distance of twenty feet. The entrance to the structure will face north to allow views of all approach trails as well as the path leading to the waterfall about fifty yards from the specific building site. By opening toward the three trails the structure allows for visual contact throughout the site providing controlled freedom for camp counselors and participants. The south face of the structure will remain as a primary shading element to help cool the space within the pavilion and provide shade for the grounds directly in front of the structure. The shaded area in the front of the building will serve as the gathering place and will hold various meetings, meals, and discussions while maintaining a connection to the site both visually and physically. A primary function of the pavilion is to provide a 'home-base' or landmark for campers around the site. By providing a node

within a series of trails the pavilion give SEEDS counselors a vantage in all directions that enables supervised freedom for students on the site thus enhancing the goal of learning through personal discovery.

Building Typologies, Methods and Influence.

In an attempt to embody the goals of SEEDS in the physical structure, material and construction methods became a primary area of investigation. It seemed a natural reaction to begin to explore vernacular building types and methods. The influence of several iconic structures was realized as primary influence on the initial proposals. Physical development of these iconic structures grew from a specific pragmatic impetus and the material choice was a matter of availability. This emergent process is inherently local. Their form seemed to arise from utilitarian ideal of functionalism rather than a notion of aesthetic. If material choice is a matter of availability and form is derived from functional considerations then the resultant must be for a specific use in a specific place.

As an icon, the Corncrib, shown here in a larger barn like construction emerged as a stylistic influence for several reasons. The structure will be used during the warmest months of the year, often during the hottest hours of the day. Cooling and the allowance for natural ventilation is a key environmental design consideration of the simple structure. In the beginning it seemed that in the most basic terms the structure must keep the students dry in wet weather and cool in the heat. With similar goals, the corncrib's form solves for these two parameters. To enhance natural air flow through the structure ventilation is provided by slatted siding that allows heat to rise from the interior while drawing cooler





dry air from all sides of the building. Often the Corn Cribs foundation is inboard of the roof perimeter, which allows the side to slope outward. The sloping sides serve to increase the surface area of ventilation as well as protect the corn near the bottom from rooftop rainwater run off.

An additional benefit arises from the well-ventilated structure. The primary building material, wood, is somewhat resistant to rapid weathering but is susceptible to exposure over long periods of time. By elevating the structure and allowing air movement between the building components, the structure was allowed a longer life than a similar construction without these details. Understanding these considerations and adapting their use to serve the SEEDS pavilion will insure a lasting structure without the use of harmful chemical treatments. Rhythmic spatial qualities within the Corncrib emerge from the spaced siding also make the structure a compelling building typology. From the interior, the occupant is allowed selected views of the surrounding landscape while maintaining a sense of protection within the enclosure. An ability to constantly maintain connection to the environment is paramount as to venture into nature only to separate from it does nothing to further the learning of the students that use the facility. This tension between the connection and separation to nature plays a significant role in the final iteration of the project below.



PROCESS

Crib Shelter

By focusing on vernacular building methods and local materials a structure could be developed that solves the program and resembles recognizable local buildings in terms of material and type. From this research a certain common feeling began to arise in the relationship of the structure, its site, and the users. The initial proposals for the structure embraced these ideas literally and began to adopt the same style and type as the buildings researched.

Modularity

The model shown here represents a primarily wooden structure. The structure is comprised of a series of pre-fabricated components. The components make up the floor decking and the wall assemblies. All accessory elements are based on a division of this module including windows, doors, and roof trusses. The modular nature of the building systems allows for precision work to be done in the shop facilities at Virginia Tech and only the final assembly to occur on site. This capacity for modularity also helps reduce the site impact as the staging area is greatly reduced and on site construction time is minimal



Foundation

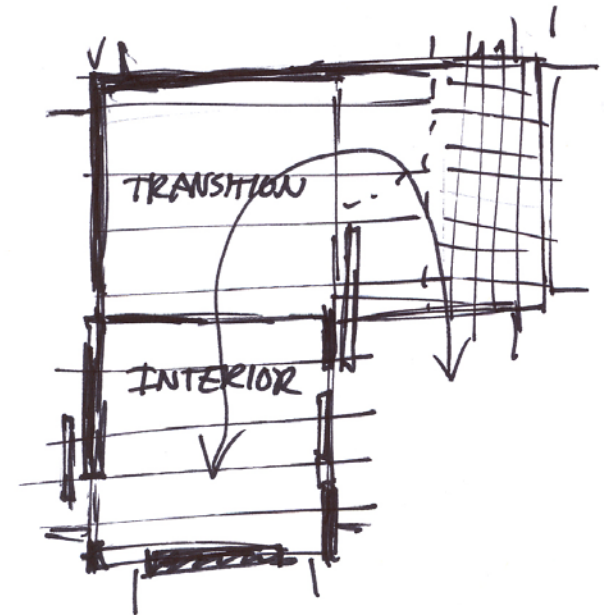
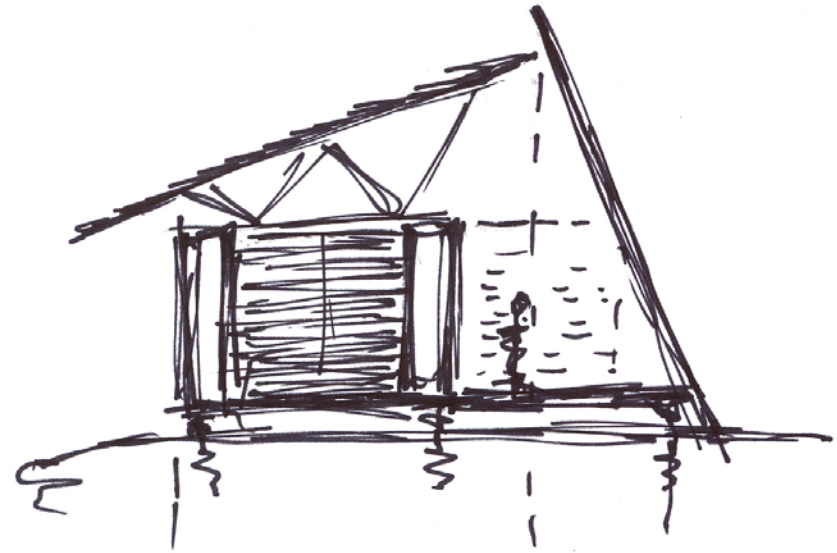
The foundation of the shelter consists of eight helical piers. The helical pier can be driven into the soil by hand and eliminates the need for massive excavation efforts surrounding a standard foundation system. The piers have been tested on site and will serve as the primary compressive support of the final structure as well as the current proposals.

Programmed, modular construction

The first proposed structure is built around three different spaces; enclosed, transitional, and covered. The plan provides a series of three squares, each housing one spatial type. The enclosed space has panels made of opaque corrugated metal roofing product and tightly laid, rough-sawn polar decking. The exterior of this space as defined by horizontal corrugations and the translucent window panels at each corner. This space can be closed from the other two spaces or opened to bleed together with them. Connection to the surrounding environment is maintained by a screened perimeter clearstory that closes the space between the roof deck and the top of the wall panels.

The transition space is denoted by a series of structural panels clad in horizontally oriented “corn crib” siding. This space can be closed from the more open porch section of the structure but maintains a sense of protected openness by blending with the surrounding environment while providing a sense of separation.

The third of the squares is primarily a covered outdoor space. The roof of this space is formed by an intersection of a large vertical shading element and the apex of the main roof structure. The change in covering material and roof type separates this space as an entrance space. When all doors and walls are open the three spaces will blend with each other to provide one continuous space.





Modular Tilt-Up A-Frame construction

The second iteration of the pavilion takes the spatial considerations given to the previous proposition and attempts to incorporate them into one space that can accommodate all of the needs of the SEEDS campers. This structure incorporates the same foundation system and building component strategy. The major difference in this construction type is the roof system. Here the roof is constructed as an A-Frame construction that allows easier assembly on site with less tooling. The roof-framing component is design to be assembled flat then raised and locked into receiving nodes that connect directly to the foundation piers. The resulting assembly is a complete roofed shelter with two simple construction steps. The sizing of the roof systems makes it possible for only a small group of volunteers to erect the structure and eliminates the need for powered construction equipment. Once erected the roof structure begins to form the walls and delineate the interior and exterior space. a portion of the roof in the front of the building is pulled up from the primary roof truss to allow the broad side of the building to open toward to the site. This gesture also covers an auxiliary deck structure that expands the covered usable space. An additional benefit to the A-Frame construction is the exaggerated height. Because the nature of the structure provides ample ventilation the roof systems will help form a stack vent that will move the heated air that collects in the space out and allow the space to naturally cool, a primary concern of the buildings program.

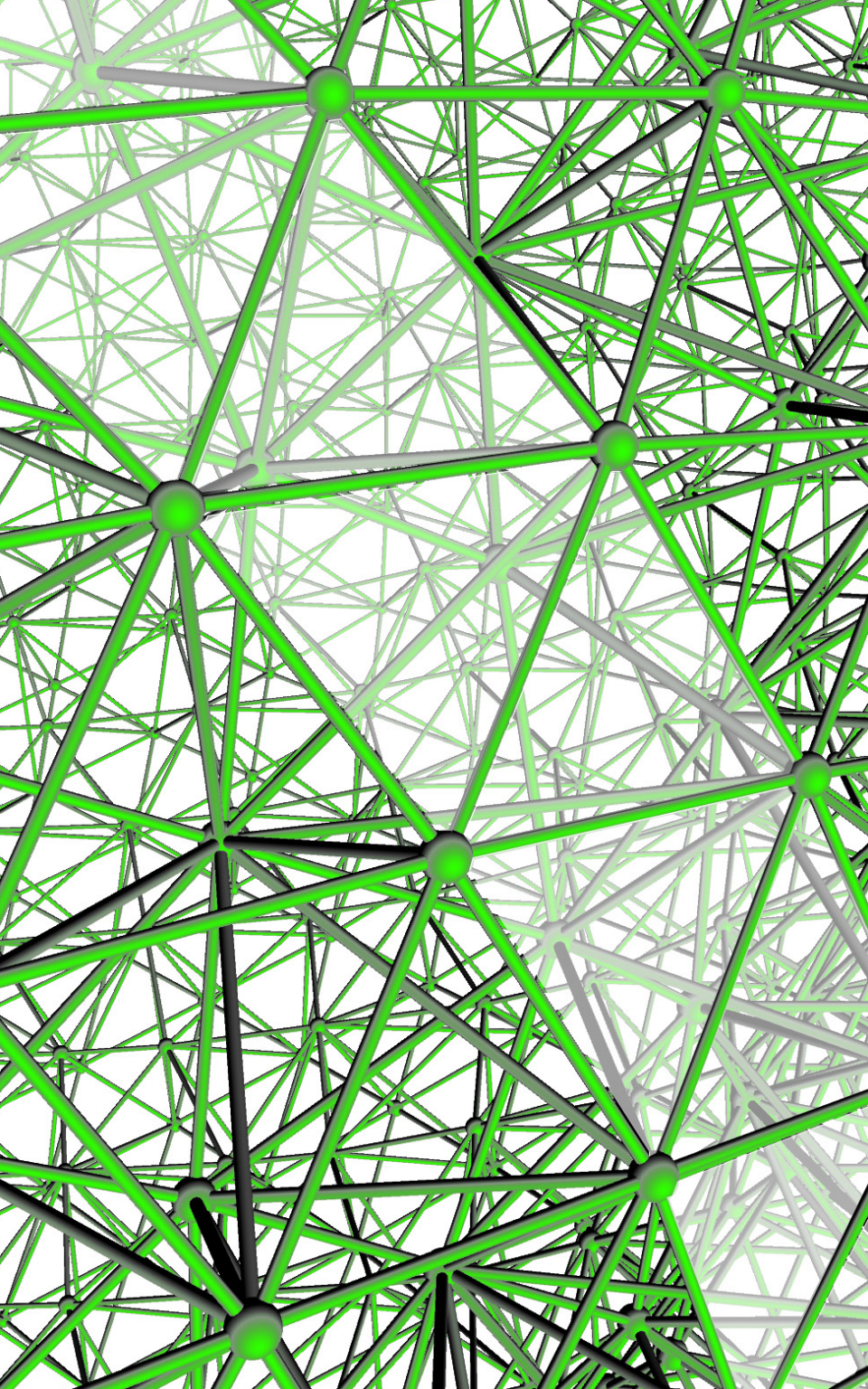


TOWARD USER ASSEMBLY

Building, a tool for learning

While evaluating the proposed Tilt-Up structure of the second iteration it struck me that a key component was missing from the project. While I had provided a building that could be assembled on site by a small group of volunteers I had eliminated a critical educational opportunity from the program. The building of the shelter is an opportunity to gather a community of volunteers including any willing SEEDS campers to work together to construct their own pavilion. To this end a user-assembled structure became the primary goal and bottom-up development process began that resulted in a novel building technology. The initial proposal was based on a modular system that would allow two adults to assemble the primary structure, the new direction allowed a group of guided children to participate in the construction of their own shelter. If each module is designed with the children in mind then the door is open for anyone to participate in its construction. With the initial research completed in terms of material and desired spatial condition the direction shifted into the investigation of module and the resulting forms. The proposed SEEDS pavilion will be made of a structural framework of small modules assembled by its primary user.





Prototype as process

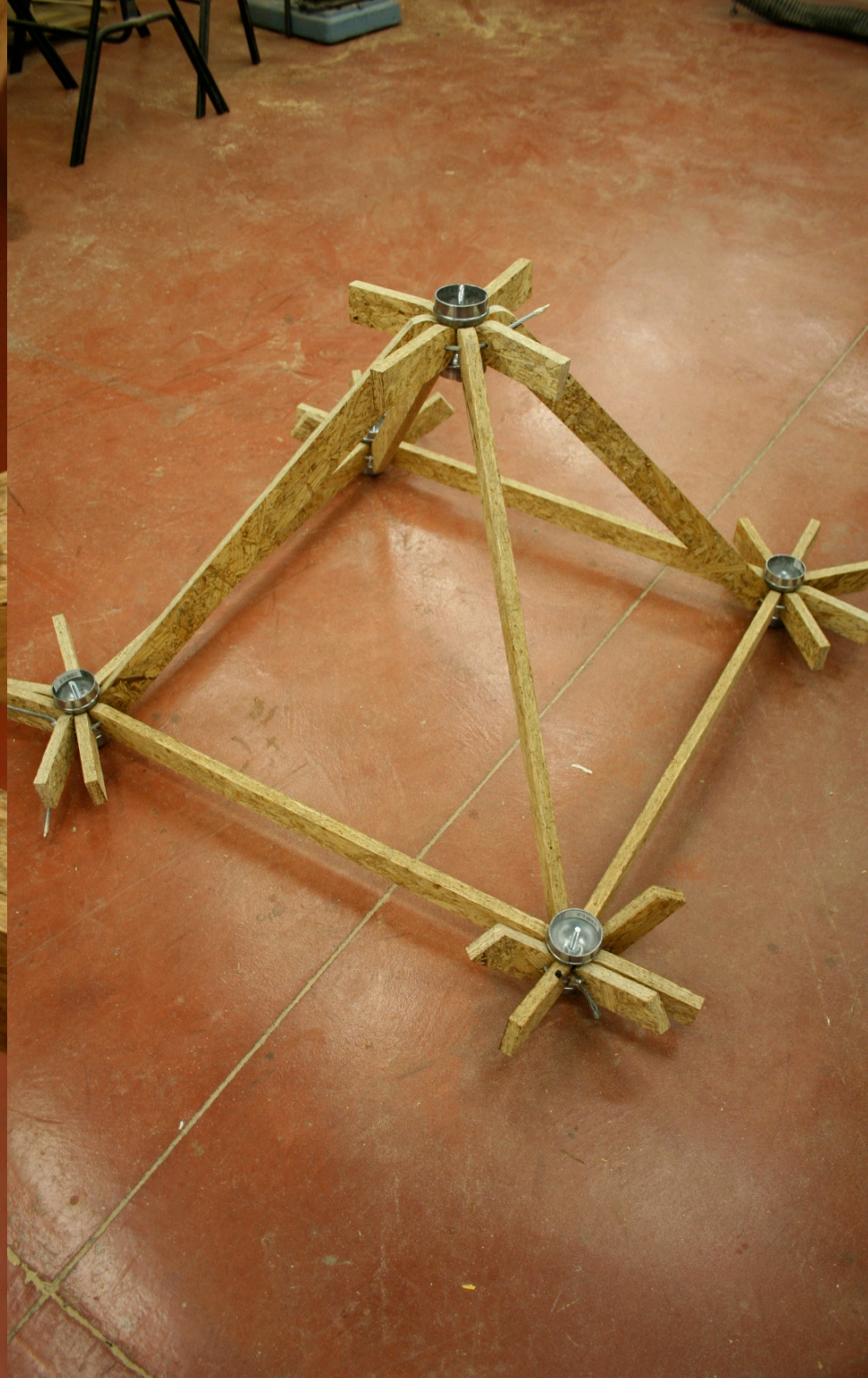
Early iterations can be characterized by a top-down design approach that addresses a modular construction system that responds to the intended architectural form. For this process, scale models can be viewed as prototypes and, in general, represent both the appearance and assembly methodology. In these cases reasonable assumptions can be made regarding materials, detailing, and fabrication because the behavior of individual parts and the resulting assembly is known. In these iterations most questions are largely answered in the model and construction could begin immediately following some detail revisions and structural calculations. In the following investigation the scale model is useful only to begin to understand the potential opportunities of a given system. In order to transition toward a user assembled building system strategic modifications to the design process must be made. Early parametric scripts were developed in a digital design environment that sought to rationalize a prescriptive shape into manageable structural units. To begin to rationalize an aggregation of user-assembled building components a complex digital algorithm was created in collaboration with a fellow student, Jonathan Grinham. The parametric discretization tool divides the surface of any given form along UV curves then instantiates a series of intersecting structural tetrahedra that result in highly individualized struts and nodal connections. This advanced but naive approach was useful in creating compelling graphics but provided very little usable data in terms of component definition, assembly, and aggregation strategy. Unlike the previously described iterations, the user-assembled system was not understood and therefore could not be assigned to a prescriptive form. Prototyping became a mechanism for understanding the behavior of the system as well as the associated parameters. The following images describe the prototyping process.

The following set of sequential images outline the development of a user assembled structural system through a series of prototypical components and assemblies. The intention is to introduce a user-assembled typology that serves as the beginning of a long term research trajectory and not a exhaustive and conclusive investigation. The result of this thesis is a beginning-not an end.











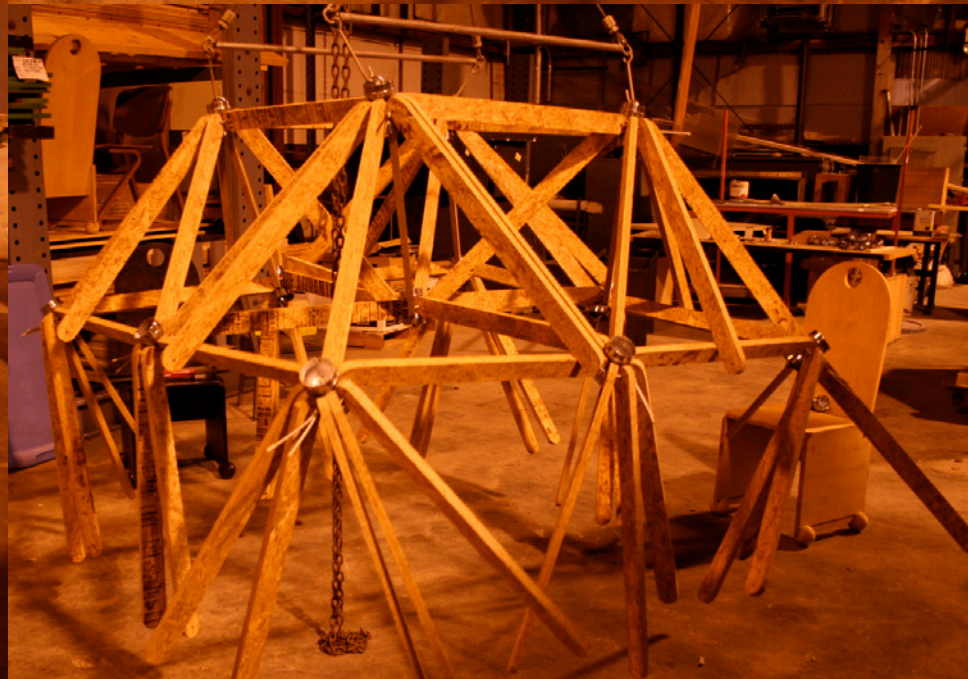
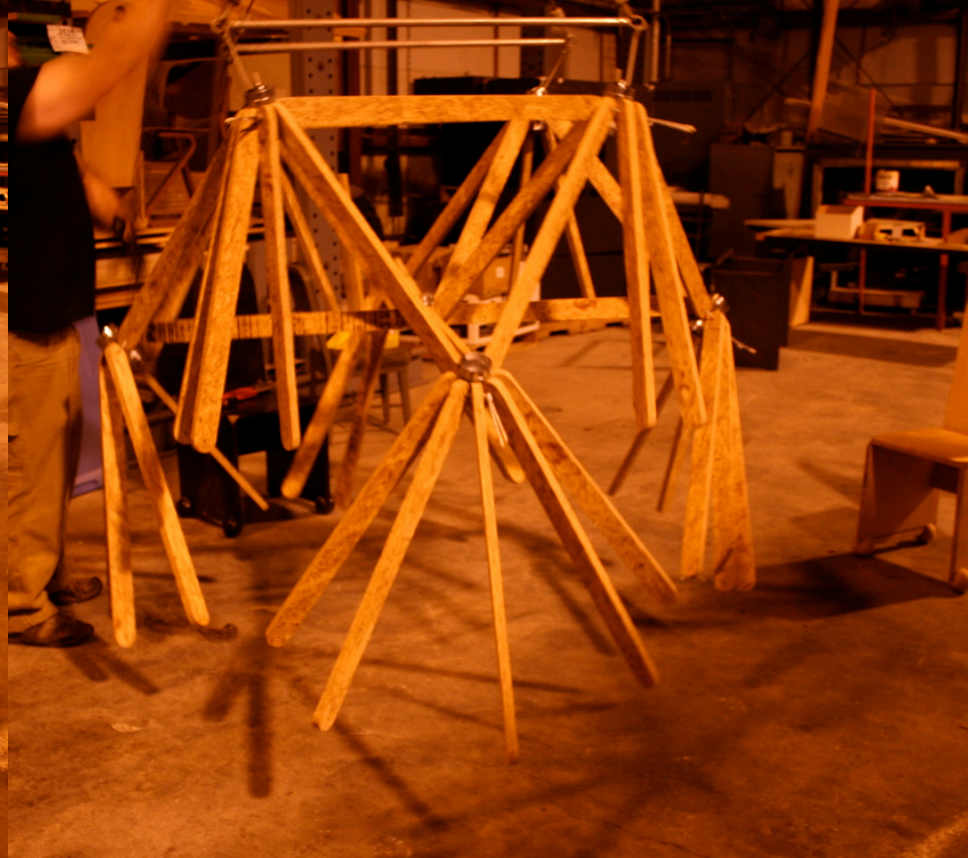


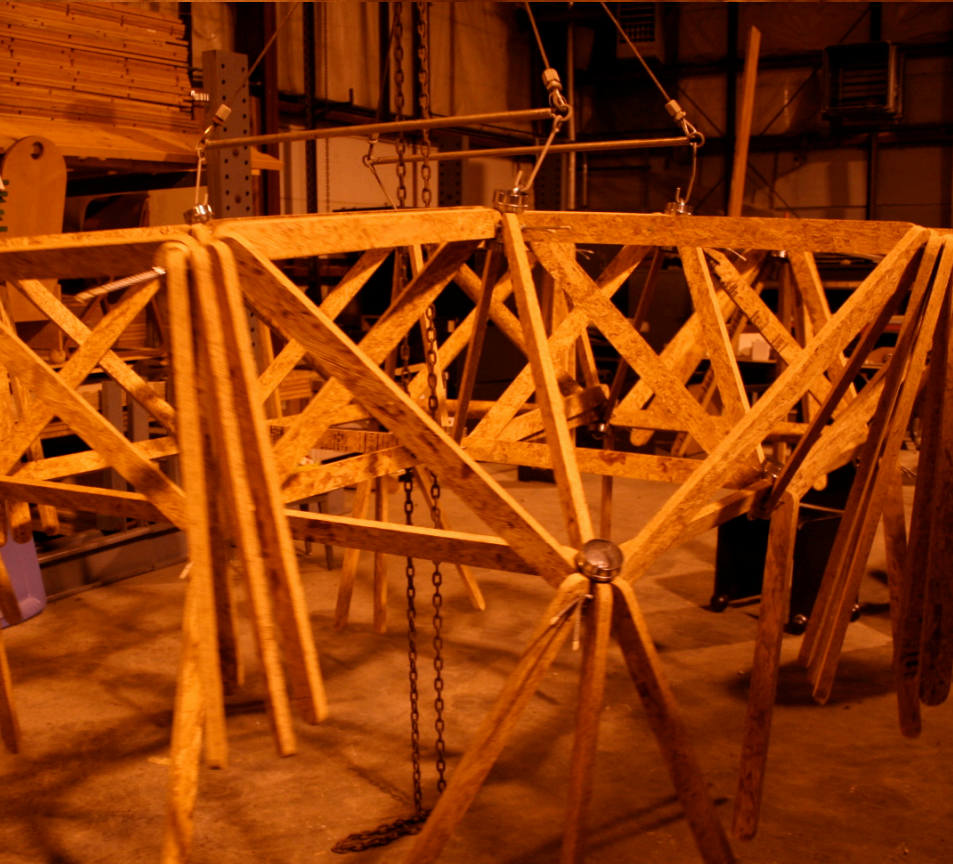
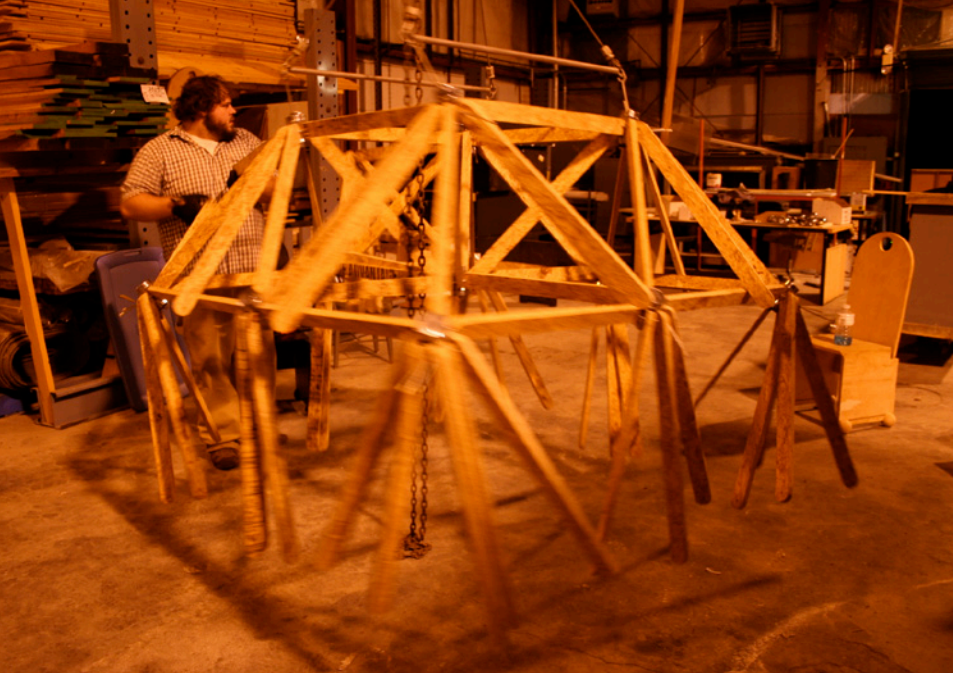


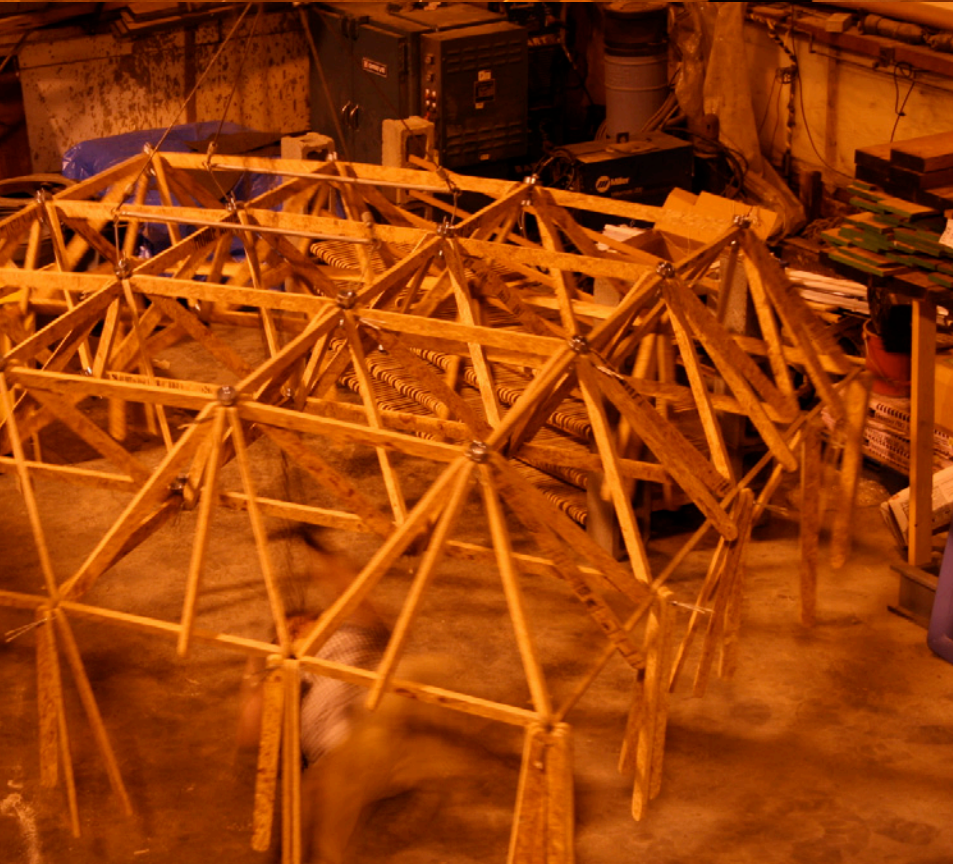
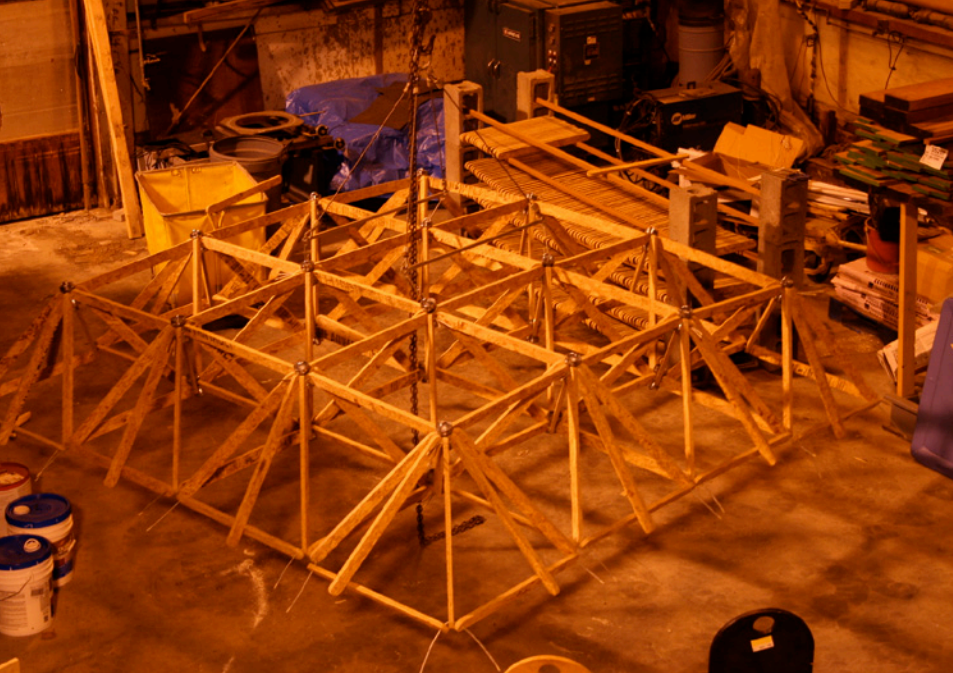


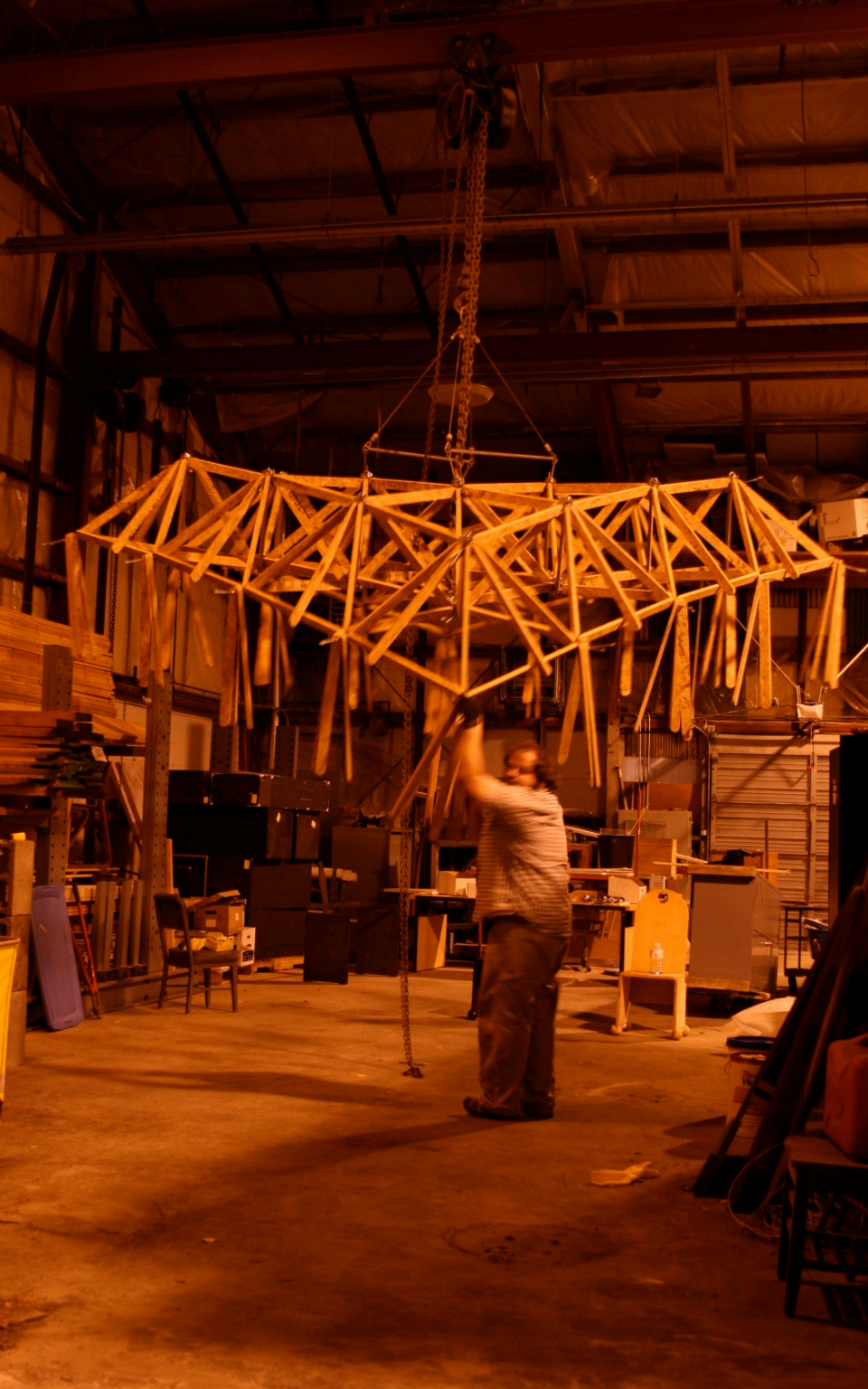


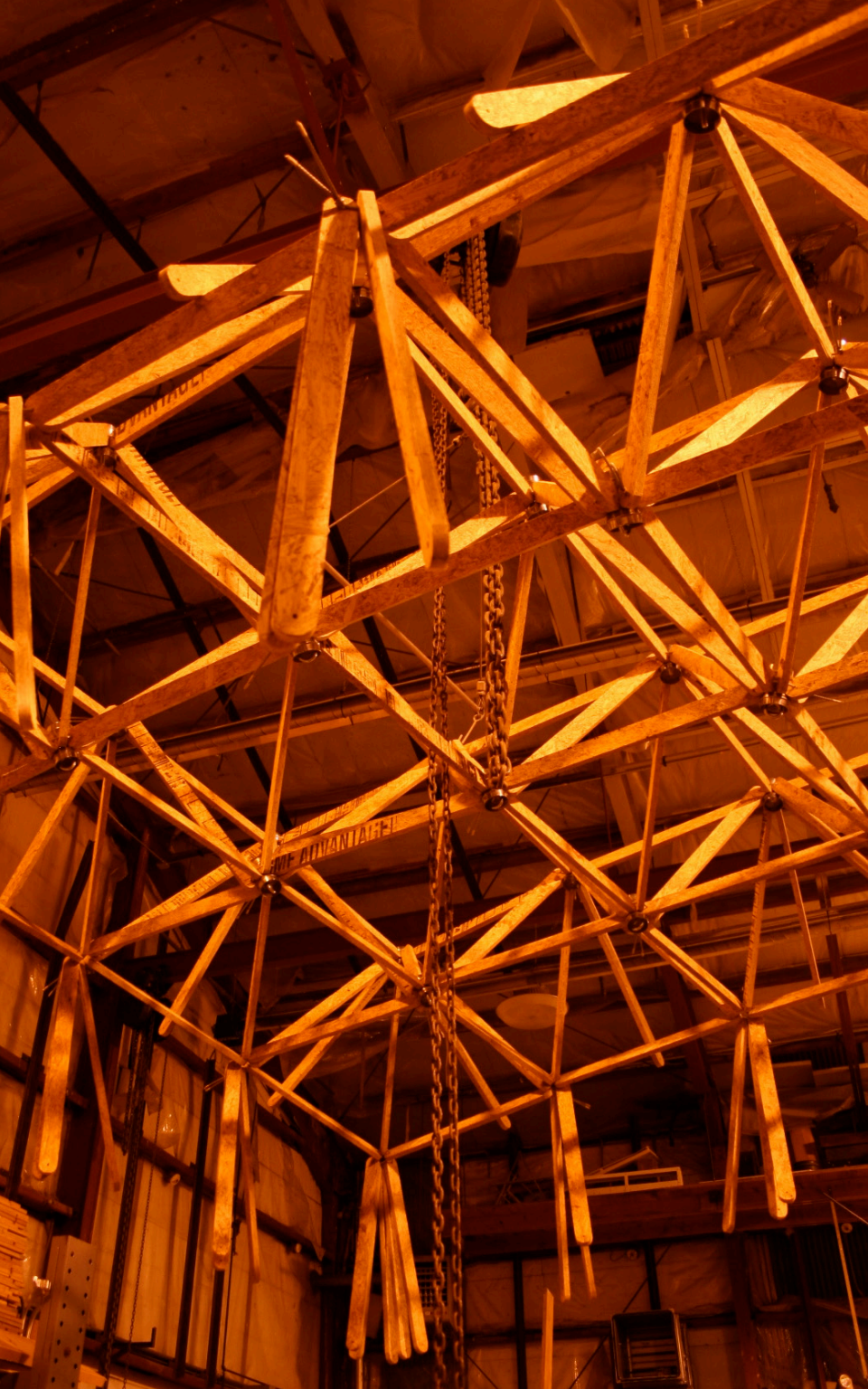


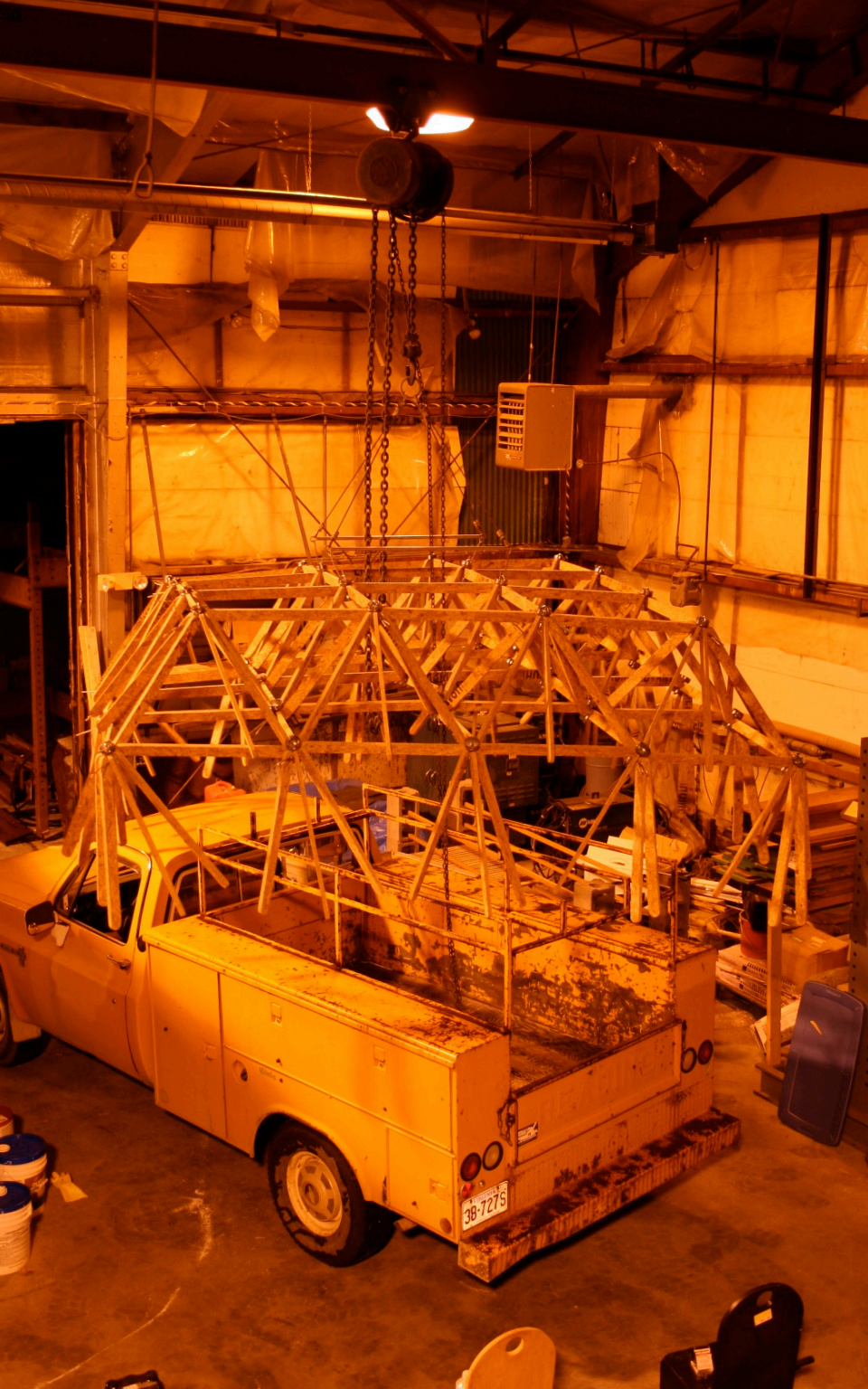












































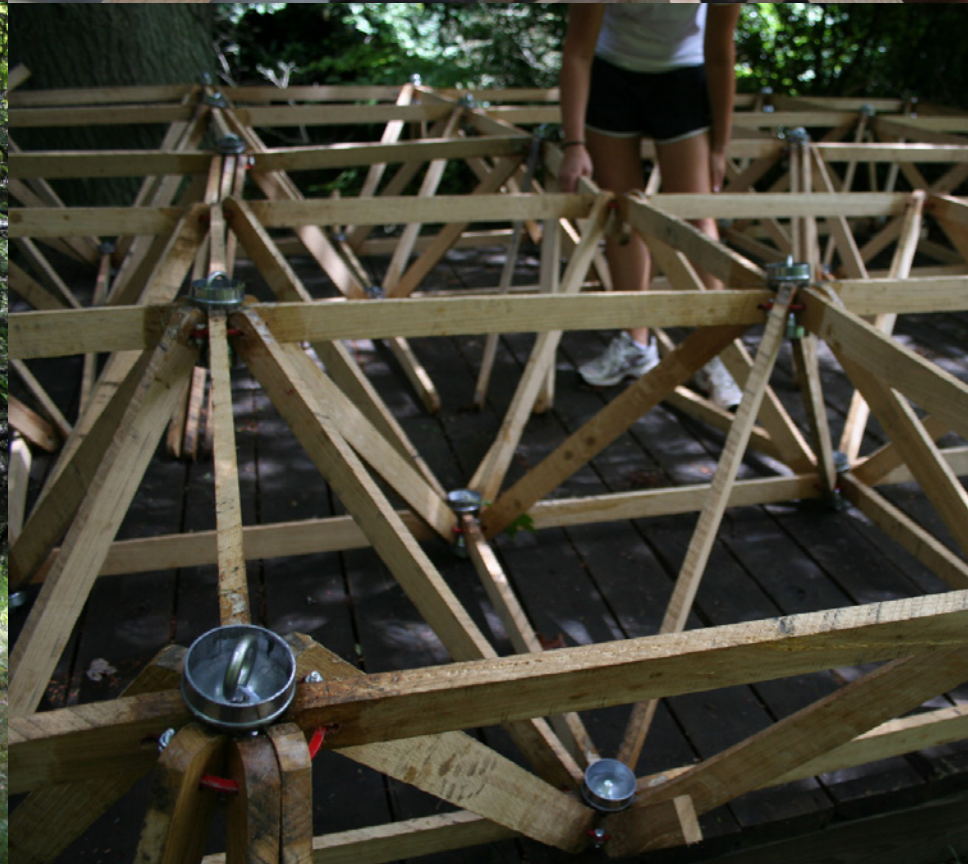










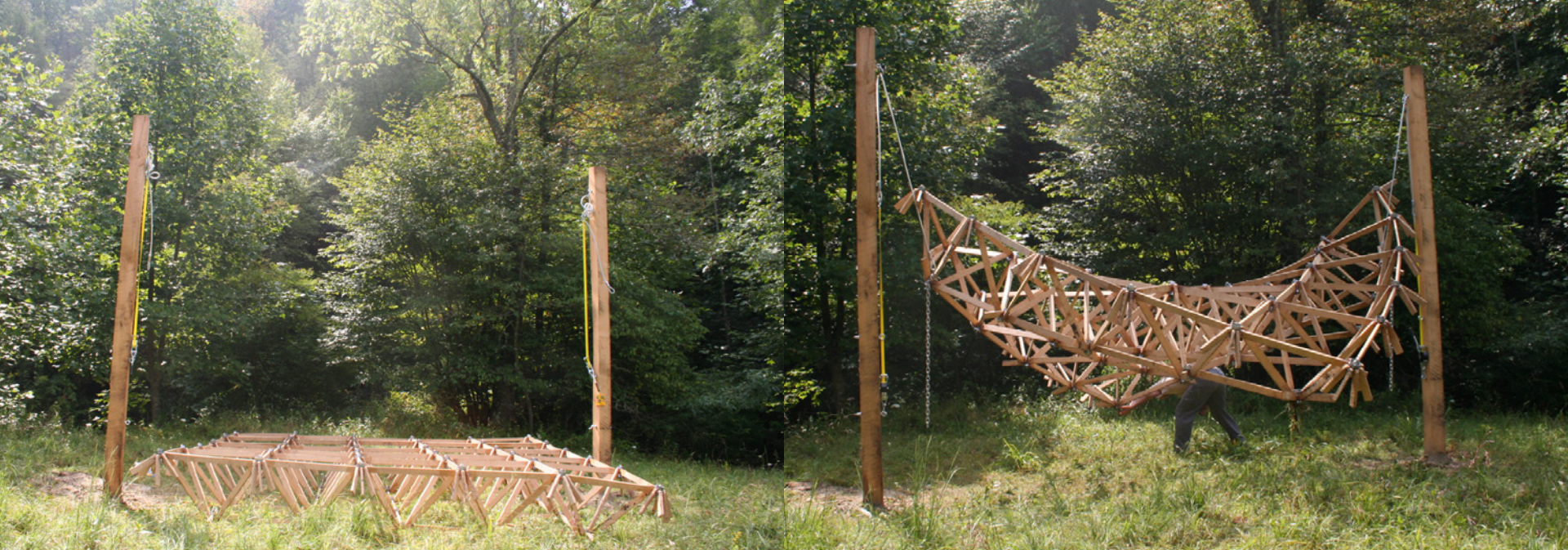




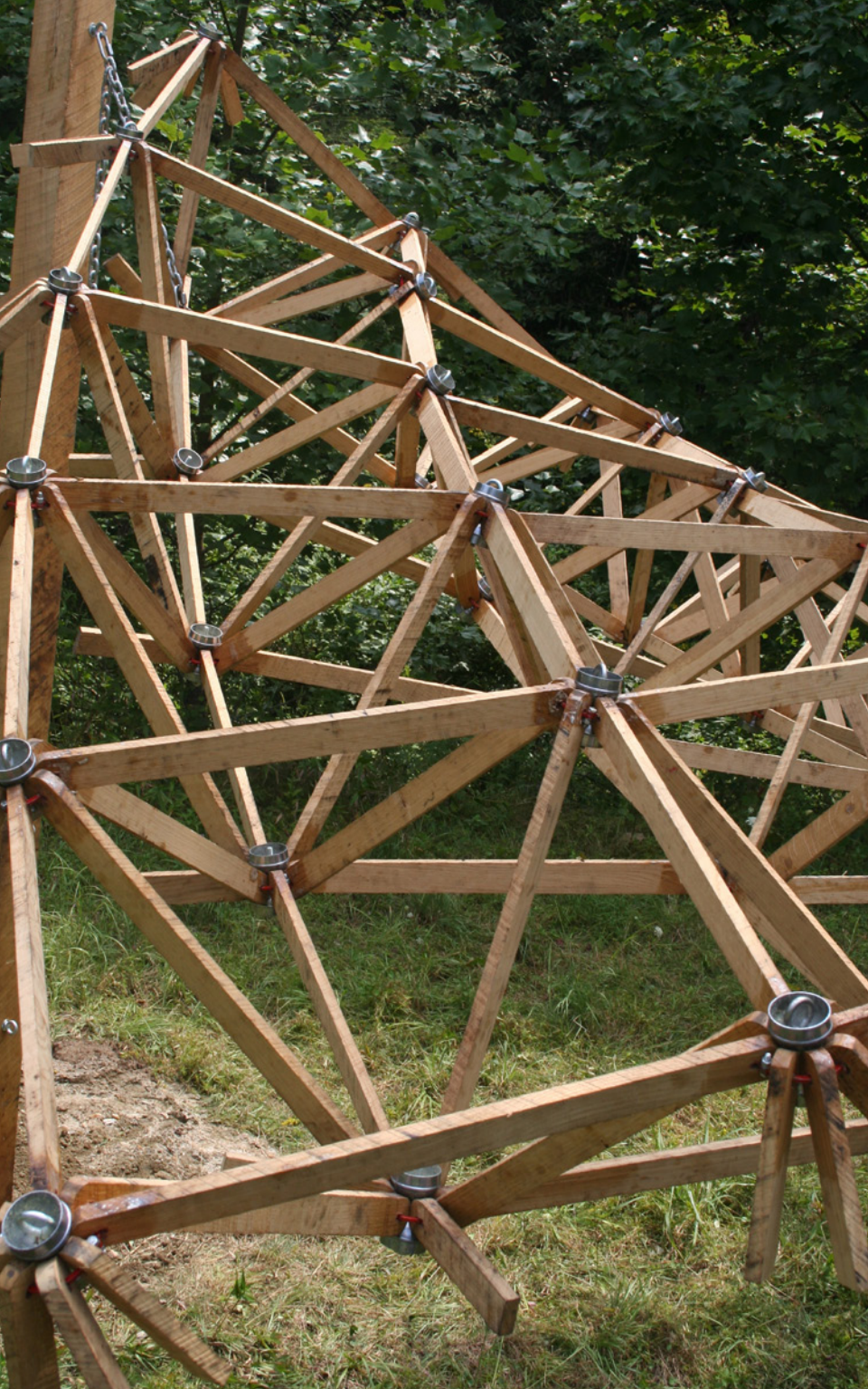


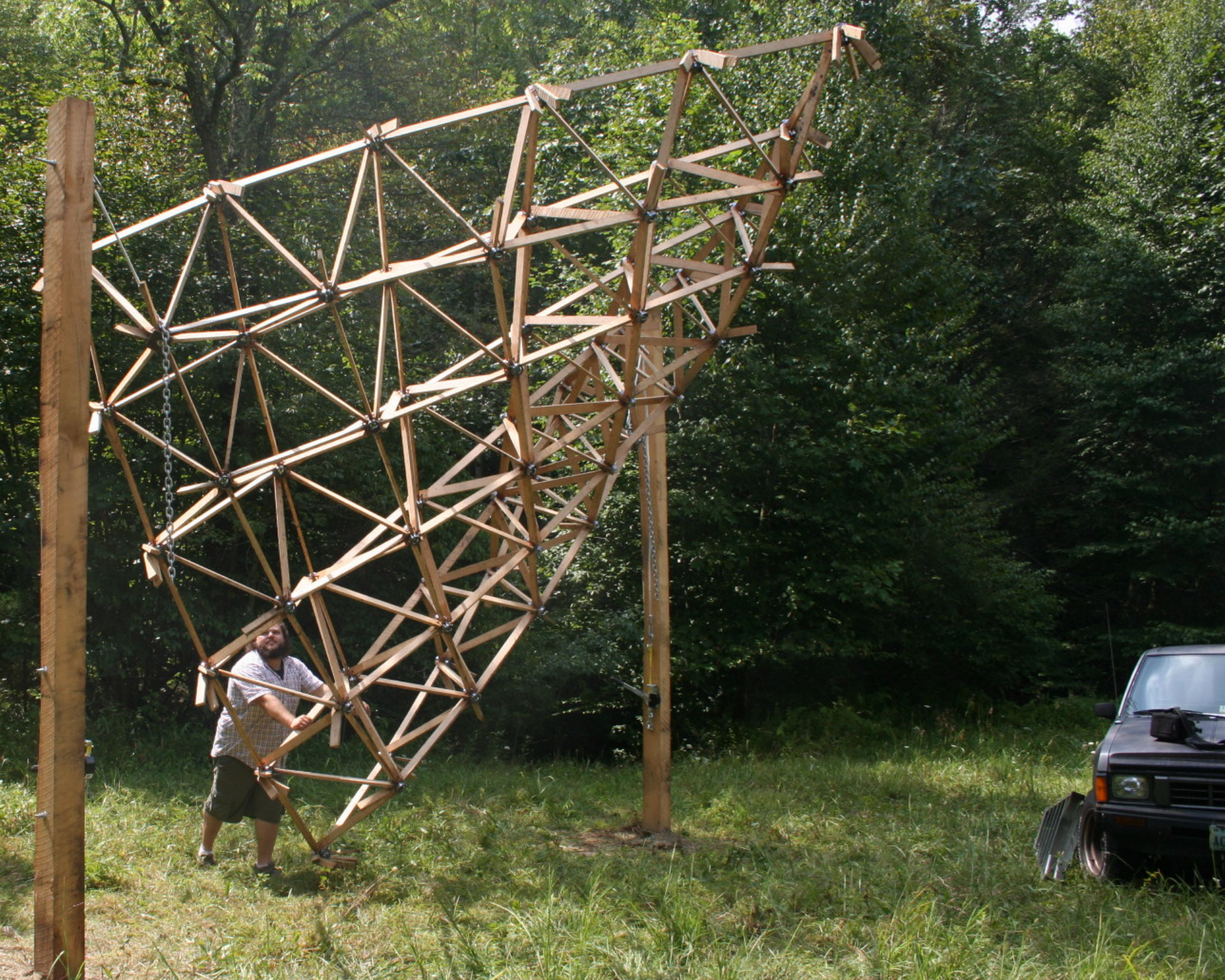












CONCLUSIONS

This document tracks, primarily through images, the development of a building system that emerged through honest programmatic evaluation. Several architectural proposals were developed that used a relatively simple modular construction to create key programmatic spaces within a formal proposition that responded to recognizable local construction typologies. Each of these shelters satisfied the goal of the proposed pavilion but did not resolve the participatory learning opportunity that the SEEDS organization strives for. To address aspects of learning-by-doing a user assembled structural system was envisioned that enables student participation in its construction.

The design process associated with system development is characterized by persistent prototypes. Two associated structural typologies were initially conceived and extensively prototyped including a novel flexible joint detail. Early user-assembled design proposals attempted to rationalize complex forms using specialized custom computational tools developed using Visual Basic (VB) scripting and complicated Grasshopper definitions within the Rhinoceros three dimensional modeling environment. While extremely powerful methods, these procedures were limited by a misunderstanding of the governing parameters of the physical assembly. During detailing of the structural assembly a unique behavior was discovered that led to a formal exploration relying on tolerance variation, rather than unit discretization, and allowed a simplified assembly process.

The first structural unit, based on the tetrahedron, was developed in response to the prescribed digital form. Prototypes proved that this typology did create a rigid structural system that could only be constructed using highly differentiated struts. A second typology, a pyramid with a four-sided base, was also considered. In this assembly, flexibility in the node enabled the creation of saddle shapes using a single strut dimension. This discovery presented the opportunity to begin to explore forms that respond to inherent variations in the homogenous system rather than those requiring hundreds of individualized units. For the SEEDS pavilion a regular structural system was used to create an

interactive surface that was constructed in the summer of 2009 by a group of students at the Hawk's Ridge Retreat. The system was hung on two supports and the shape can be modified by raising or lowering opposing corners thus allowing each subsequent group of campers to have some impact on their own pavilion.

Throughout this work prototyping was an absolutely necessary means of understanding the behavior of the proposed system. The prototype allowed a design development process that was inherently rational and constructability was no longer speculative. The decision to transition from top-down architectural proposals to the development of a user-assembled system was made based on rigorous understanding of the given architectural program. In order to resist a speculative problem solving exercise the design process became physical. Through the process of making, modifying, remaking, and evaluating, the governing parameters became clear, opportunities were realized, and a construction system was developed that enabled user assembly. The SEEDS pavilion at Hawk's Ridge can be seen as a prototypical example of the user-assembled system as well as a dynamic shape experiment that embraces tolerances and flexibility in the system. To become a viable Architectural proposition the rigorous understanding of the physical parameters must provide feedback to the digital, which in turn must support the architectural intention that responds to the given program; this thesis addresses the former.

IMAGE CREDITS

All photographs taken by the author.

REFERENCES

SEEDS: Seek Education, Explore, DiScover. “SEEDS”, Web. Accessed: 20 Apr. 2009. <www.seedsguys.org>.