Lightweight Plywood Construction Assembly

A lightweight approach to the elegant utilitarian form

by

Edmund Ming Yip Kwong
Honours B.A. Architectural Studies
University of Toronto 2002

Submitted to the Department of Architecture on in partial fulfillment of the requirements for the degree of Master of Architecture at the Massachusetts Institute of Technology June, 2009

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Abstract

What will be the fundamental aspect and concern of today's good design?

As global energy reserves deplete over the coming decades, a strategy of reduced consumption will be essential to the production of furniture and architecture, alike. A lightweight design strategy is a way for designers to participate in reducing the environmental footprint of everyday objects. We are witnessing a Paradigm shift in design and the decorative arts of a magnitude not seen since the Modernist movement in the early 20th century. A design style embraces the combination of sustainability with building production. Today we recognize that our resources are finite and that careful consideration should be given to the building process. Since ecological concern of materials become one of the foremost issues of today's building industry, I developed a lightweight and low-cost framing system that is collapsible and easy to assemble. My goal is to create compelling designs in the hope they will inspire people to choose sustainable design over safer and more traditional designs.

Making building from thin bent plywood yields 9-10 times more usable wood from a log than making a building from hardwood lumber. During the production of plywood, only 15 percent of the wood from a log is lost to waste. On the other hand, the average waste it takes to make a finished solid wood frame building is 1.5 times more wood than is used in the building itself!

Bent plywood has been utilized by a mere handful of designer, most notably Alvar Aalto and Charles and Ray Eames, but the application of this material remained in furniture scale. Since the creative potential of this material is still largely unexplored. My motivation is to extend the application of this very particular thin material-plywood.

Thesis Supervisor: Yung-Ho Chang
Title: Professor of Architecture and Department Head
Warmest thanks to my committee for their patient guidance throughout my thesis semester
# LIGHTWEIGHT ASSEMBLY
Instruction Manual

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Overview: Guidelines and Constraints

Before you get started - Read the following simple guidelines to using Semi-Permanent building technique:

1) **Think big** (but not too big!) - the CNC (computer controlled) machine takes a maximum sized sheet of 4ft x 8ft, so no single element can be bigger than this.

2) **Think module** - use a standard width for components of 2ft wide by 8ft - this will mean the least amount of waste (save those trees!)

3) **Wood is Good** - 1/4inch thick plywood which is flexible enough for bending

4) **Smaller rather than larger elements** - any module that is made up of more than a full sheets of 1/4 in. plywood gets heavy and difficult to man-handle.

5) **Keep it easy and clean** - no nails, use screws, bolts or wooden pegs.
Life cycle assessment of wood assembly and construction
Life cycle inventory analysis

RAW MATERIAL ACQUISITION
(Harvest)

MANUFACTURING

FOREST MANAGEMENT
(Regeneration)

BUILDING CONSTRUCTION

RECYCLE / WASTE MANAGEMENT

USE / MAINTENANCE
Lightening the load

Building modules potentially need to be transported great distances; therefore, weight is a major design constraint for the plywood assembly. The lighter a project can be made the cheaper it will be to transport. (source: Kieran and Timberlake, p. 167)
For several millennia, the methods and materials of construction were relatively limited. Local materials readily found in nature were the norm. In the midnineteenth century, however, technological developments in transportation and materials science expanded the available choices exponentially. (source: Kieran and Timberlake, p.32)
The rapid development of materials and products over the last 150 years has been exponential. Unfortunately, their incorporation into architecture has been relatively slow. (source: Kieran and Timberlake, p.120)
Imported Plywood to US (kg) 2007

FINLAND: 31,609,275 KG
CANADA: 857,719,275 KG
MALAYSIA: 428,802,700 KG
INDONESIA: 240,887,775 KG
ECUADOR: 68,352,300 KG
CHINA: 1,890,514,350 KG
RUSSIA: 233,884,175 KG

(source: APA The Engineered Wood Association)
North America and China wood trade

Since the mid-1990s, China has developed a large export-focused wooden furniture-manufacturing sector, half of whose output is destined for the United States. China supplies a third of North America’s wooden furniture imports. A significant proportion of China’s growing supply of imported timber is exported to the United States. Therefore, an increasing share of China’s timber supply can be assigned to the forest footprint of the United States. Finally, an increasing share of the wood imported into China will probably be re-exported as value-added products. Chinese manufacturers will thus need to respond to the environmental sensitivities in their export markets. (source: CHINA’S WOOD MARKET, TRADE AND THE ENVIRONMENT By Zhu Chunquan, Rodney Taylor, Feng Guoqiang, Science Press)
Research Process

![Diagram showing the research process with approved concepts and prototypes.]

- Concept
  - Prototype
- Revised Concept
- Revised Prototype
- Revised Concept
- Revised Prototype
- Revised Concept
- Revised Prototype

![Diagram showing the research process with stages involving idea, drawings, renderings, models, and prototypes.]

- Idea
  - Drawing
  - Renderings
  - Models
  - Prototypes
Research Loop

Hypothesis

Prototype

Instructions
The Evolution of Design from 1890s - 2010

1890

1920

1950

1980

2010
Looking beyond the building industry
Issey Miyake - APOC (a piece of cloth)

The designer has not only listened to the lesson of technology available in the fashion industry but has also extended the parameters of fashion and reengineered its tools, challenging the very definition of the industry. Redefining relationships between cloth and clothing with ideas about mass-customization, he is developing lines of cloths that are not cut from patterns but are instead woven into their forms from the start. APOC not only changes the production process, but introduces new practices and forms. The goal is not to be more extreme in terms of haute couture but to bring ideas of mass customization to consumers at all price points.
Looking beyond the building industry
Ferran Adria (El Bulli) - Molecular Gastronomy

The technique-concept search was Adria’s main creative pillar, without abandoning other styles and methods, and this gave rise to new pasta, new ravioli, the frozen savoury world, new caramelisation, and so on. Technique-concept creativity almost certainly marks the most important difference between a cuisine that is merely creative and one that is constantly evolving.

Serpentine Gallery has each year commissioned an internationally acclaimed architect to design a temporary pavilion that is sited on its lawn during summer months. The building has a multi-purpose function, as a coffee shop in the day and a space for lectures, meetings and entertainment in the evening. This brief remains constant, as does the site; however, the range of variations in response to how the site is used and the form of the building is dramatically diverse. The fact this is a temporary pavilion (though each building has subsequently been made available for re-siting as a more permanent structure) provides the designers with freedom to seek expression for its loose function and also response to external factors that engage with experimental design concerns.
Idelological Pavilion Precedents


The building consisted of distorted rectangular wooden grid that formed a curving dome supported on slanting grid walls on four sides. The primary impression was of a bending, tensioned structure crouching on the ground. Loose, light, movable furniture, designed by Siza, complemented the impression of a space that was ephemeral and changeable.

Hadid is giving people a glimpse of another world, and enthuse them, make them excited about ideas. The architecture is intuitive, radical, international and dynamic. The idea is to construct buildings that evoke original experiences, a kind of strangeness and newness that is comparable to the experience of going to a new country. The Mobile Art Pavilion for Chanel follows these principles of inspiration.
Canopy is a temporary structure in the P.S.1’s courtyard, built out of bamboo poles. The project relies on a singular tectonic system to bind together provisions for overhead shade, structure and varying atmospheres, resulting in what the architects envisage as deep landscape that affects the entire depth of the courtyard.

The installation is constructed using paper-thin wood laminates, scored with a laser and folded along the curved seam into wedges. It explores the coupling of potentially conflicting constructional logics – the pure compression of a vault with an ultra-light sheet material. Voussoirs, the wedge shaped masonry blocks that make up an arch, are redefined in Voussoir Cloud using a system of three-dimensional modules formed by folding paper thin wood laminate along curved seams. The curvature produces a form that relies on the internal surface tension to hold its shape and allows for a structural porosity within the constraints of sheet material.
Charles and Ray Eames, Case Study House, California, 2008.

The house demonstrates the possibilities of designing with a finite palette of prefabricated parts: every element was ordered by catalogue or purchased from an industrial manufacturer, including the structure’s steel beams and trusses, siding of various materials and colors, glass, asbestos, and Cements board, all laid out on a grid that made concern over tolerances obsolete. Charles Eames had asked himself three determinate questions before designing the project: How cheap is space? How industrial is our building industry? How light is steel? To Eamess, the value of the domicile had less to do with fine finishes and luxurious amenities than with the sheer volume of space one could obtain with the least amount of cash, with the price per cubic foot costing a mere eight dollars adjusted for inflation.
There are two key ideas that Asplund wanted to achieve in this project. The first was material minimalism, that building should be designed like boats or planes to achieve maximum strength with minimum weight. The Transport Pavilion is a case in point, with its thin, light roof rising over the sailboats and planes below. The other idea is that implied by the advertising mast, suggesting an architecture that had no material, of light only, of pure transparency, in which materials have not so much been minimized as transformed into energy.
Prouve designed the Tropical House in 1949 as a prototype for inexpensive, readily assembled housing that could be easily transported to France's African colonies. Fabricated in Prouve's French workshops, the components for two houses were completed in 1951 and were flown disassembled to Africa in the cargo hold of an airplane. The houses were erected in the town of Brazzaville, Congo, where they remained for nearly 50 years. In 1999, the Tropical House was disassembled and shipped back to France for restoration. By the end of the 1990s, the Civil War in Congo had taken its toll on the two Tropical Houses. A team was dispatched from Paris to Brazzaville to acquire the houses. Under armed guard, each piece was numbered and matched to drawings made on the fly. The houses arrived in France in 2001. The smaller of the two, which weighs about 8 tons, was transported to Presles, France, to be repaired and reconstructed. The house sits on a simple one-meter grid system with fork-shaped portico support of bent steel. All but the largest structural elements are aluminum. No piece is longer than 13 feet, which corresponds to the capacity of the rolling machine, or heavier than 220 pounds, for easy handling by two men. To deal with the extremes of the tropical climate, the outer light-reflecting skin, consisting of brises soleils that shielded the structure from direct sunlight, was separated from the inner insulated skin of sliding doors and fixed panels. The floor was suspended above a one-story base, made locally in Brazzaville, to control humidity, and warm air was drawn up through a ventilation chimney in the center.
Idelological Pavilion Precedents

Alvar Aalto, Finnish Pavilion at the new york world fair, 1938-39

The 15 meter tall pavilion comprised of 4 floors each showing photographs of different elements of finland. the fourth being photos of the Finnish landscape, the third photos of the finnishpeople the second photos of industry, and on the ground floor the results of the above three factors- the products. When asked about the project aalto had said 'It was no easy work-composing the individual elements into one symphony.' The pavilion is generally considered the crowning achievement of his work for the latter half of the 30s. Altao conceived the design as a dramatic undulating space (the working title of his competition entry was "Northern Lights"). The concept inter grated the architectural space with the exhibits of photographs, objects and industrial products, forming a single symphonic entity that evoked that spatial flow and dense rhythms of a Nordic forest. The Pavilion impressed Frank Lloyd Wright so deeply that he declared Aalto a genius.
Modular Precedents

Habitat, Montreal, 1967.

The project was constructed entirely of interlocking modules, and each unit, clad in precast concrete panels, had small yet comfortable private quarters with access to a spacious private garden and harbor and city view exposure on at least three sides. Unlike the work of the Metabolists, Safdie proposed a very different system in which no megastructure was necessary. Rather than "plugged-in" prefabricated units, modules were interlocked and woven primarily in a horizontal direction. With the exception of necessary vertical circulation cores, the project's focus was entirely upon the unit rather than global structure.
Alvar Aalto, Paimio (model 41) armchair, 1931

The Paimio (Model 41) armchair, consists of two closed loops of laminated birch, supporting an undulating plane of plywood attached to a birch frame at the two curved ends of plywood shell. While the functional goal was to produce a pliant seat, the result was the first modern chair that liberated the plywood element to become an unfurling plane, hovering within its laminated frame. The thin ply as a “unit” and its build-up through lamination were ideas that Aalto pursued.
Thonet, 1859.

Thonet was the first one who applied an industrial process to bending wood. Before Thonet bentwood in furniture was still the result of handcraft, each piece individually made, making it as labor intensive and costly as traditional woodwork. Thonet wanted to improve on the handcrafted, one of a kind or made to order system of producing furniture and saw the mass-production possibilities of bentwood.
Charles and Ray Eames, LCM chair.

Eames recognized that constraints only helped to create a better design. "Design depends largely on constraints," Charles Eames stated, and design constraints "usually include an ethic." Material economy became part of the Eameses' design ethic in the postwar period, as the end of the war did not end the shortage of materials. The designers' new goals extended beyond discovering molded plywood's technological limits: Designs also needed to economize materials, minimize parts, and reduce costs, in addition to maximizing comfort, functionality, and flexibility.
Assembly, not Construction
1/8"-1-1/2" Hex Bolt and nut

1/8 in. plywood strip

1/8 in. Polycarbonate sheet

3M Double Sided Tape

5/8" x 24" Solid Steel Rod

1/4" Steel Plate Footing
Study Model
Study Model
Study Model
Study Model
Study Model
Collapsible building study model
Prototype

Constraint

1. Weak material strength of the 1/4" thin plywood
2. No piece is longer than 8 feet, which corresponds to the largest dimension of the plywood (4’ x 8’)
3. Module weight should not exceed 60lb, for easy handling by two people
4. Collapsible and store away during the winter
1st Prototype

Issues:
1. Weakness of the graded C plywood. Failure at joint

![Joint Image]

1. joint
2nd Prototype

Issues: 2. Less bending at joint
25' Structure

Plan

Vacuum Formed 3mm Aircraft Plywood Panels (Clip on to the daiphram)

Section

Collapsible Diaphragm Structure

Perspective
40’ Structure

Main Archs support the edge condition

Top view

Axonometric Drawing

Section

Perspective
Lasercut patterns - 1/16" Aircraft plywood

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32% of waste material

12"

24"
CNC patterns - 1/4" Baltic Birch Plywood

20% of Material is lost to waste
Designing a uniformly loaded Arch

\[ W = 2,300 \text{ lb} \]

- Funicular Polygon
  - 8 ft
- Force Polygon
  - 1000 lb
  - 10 ft
  - 20 ft
10 loads @ 230lb each

A → B → C → D → E → F → G → H → I → J → K

Funicular Polygon

Force Polygon

8ft

1000lb
Designing a uniformly loaded Arch

A parabolically shaped arch has a span $L = 40$ ft and a maximum height $h_{\text{max}} = 10$ ft. Assume that $w$ dead + live = 576 lb/ft. Determine the maximum force in the arch, the thrust it exerts on its foundation if buttresses are used, and, alternatively, the forces that would be developed if a tie-rod system were used.

Loadings:
Assume roof live load = 30 lbs/ft$^2$
Assume roof dead load = 6 lbs/ft$^2$

Plywood (per inch of thickness) = 3.0 psf

Total roof load = 36 lbs/ft$^2$

Loadings on a typical arch: Assume a horizontal projection Total load/foot acting downward
- 36 lbs/ft$^2$ x 1.6 ft = 576 lbs/ft

Total load acting downwardly on arch: 576 lbs/ft$^2$ x 40 ft = 2304 lb

Solution:

Vertical reactions: $R_A_{\text{vertical}} = \frac{w \cdot L}{2} = \frac{(576)(40)}{2} = 1152$ lb

Horizontal reactions: $R_A_{\text{horizontal}} = \frac{w \cdot L^2}{8h_{\text{max}}} = \frac{(576)(40^2)}{8(10)} = 1152$ lb

Maximum internal arch force and thrust exerted on foundations:

$C_{\text{max}} = \sqrt{R_A^{2}_{\text{vertical}} + R_A^{2}_{\text{horizontal}}} = \sqrt{1152^2 + 1152^2} = 1629$ lb

If a tie-rod system were used, we would have

Force in tie-rod = 1152 lb
Vertical force on foundation = 1152 lb
Furnicular shape for uniformly distributed loading condition

L = 40ft

RA horizontal = 1,152 lb

Cmax = 1,629 lb

RA vertical = 1,152 lb

Design considerations

Lateral stability can be a problem

Lateral buckling due to high internal forces can be a problem

Lateral buckling can be solved by laterally bracing arches with other members. This cross bracing connection is needed to assure lateral stability
Sizing the plywood member

A plywood member carries a concentrated load of $P$ at midspan. Assume the dimensions of the beam are: $b = 2$ in., $h = 14$ in., and $L = 40$ ft. Assume also that $P = 2304$ lb. If the allowable stress in bending for the Baltic birch plywood used is $F_b = 2000$ lb/in$^2$ (APA The Engineered Wood Association).

**Maximum bending moment:**

$$M = \frac{W \times (L^2)}{32} = \frac{(48 \text{lbs/ft})(40\text{ft})^2}{32} = 2400 \text{ ft-lb} = 28800 \text{ in.-lb}$$

**Moment of inertia:**

$$I = \frac{bh^3}{12} = \frac{(1.0 \text{ in.})(10 \text{ in.})^3}{12} = 83.3 \text{ in.}^4$$

**Maximum bending stress** $= f_b$ at $y = c$

$$f_b = \frac{Mc}{I} = \frac{(28800 \text{ in.-lb})(10\text{in.}/2)}{83.3 \text{ in.}^4} = 1729 \text{ lb/in.}^2$$

The actual stress developed is less than the allowable stress $f_b = 1729 \text{ lb/in.}^2 \leq F_b = 2000$
Construction
Permanently Fixed

- Balloon Frame 2" x 4"
- Skill labour required to construct
- Steel Nails

Assembly
Temporarily Held

- 1/4" Baltic Birch plywood (Offsite Pre-Cut)
- Bolt
- Pre-Drilled Hole
- Numbered for Mass customization
Cladding System

Three layers system

- 1/8 in. plywood strip
- 1/8 in. Polycarbonate sheet
- 3M Double Sided Tape
Section
Stackable components and Modularity

The pavilion can be transported and stored with a Standard UPS L11 container.
Next Day Shipping

Shipping of building modules can be very efficient. All the components are categorized, codified and package for shipping.
Building Cost - 1,320 sq.ft

Total Building Cost = Material costs + Cladding (~20% of the material costs) + Labour (2 person working 24hrs @ 15 dollars/hr)

= $5,584 + $1,116 + $720 = $7,420

*an average American home costs $130/sq.ft
Lightweight Plywood Construction
A lightweight approach to the elegant utilitarian form

'The very heart of modernism is embodied by the processes that evolved from this combination of human art and industrial wood-forming technique.' (Perry 1942, 32) Molding and bending plywood is an experience of pure optimism. It can be seen as combining human engineering and a common material repurposed into an elegant utilitarian form. The spirit of modernism is contained in Thonet's (German-Austrian cabinet maker) first steam-bent beech cafe chair and Aalto's laminated birch armchair. What is it about bent plywood that makes it seem so profoundly timeless? It is the creative act of taking a basic natural material and transforming it into great product, giving it a new identity and spirit. "Molding plywood is no different than other metamorphic processes, such as firing raw clay to turn it into porcelain or fusing sand into molten material to make blown glass. Heat and human engineering combined to create something the world did not know it was missing." (Pfeiffer and Ngo 2003, P.28). In the last decade, this material and process has been the playground for architects and their obsession with correct structure; and this combination of art and technology has been the foundation of good modern design.

1 Perry Thomas, Modern Plywood, Pitman Publishing Corporation, New York, 1942 pp.32-40
What will be the fundamental aspect and concern of today's good design? As global energy reserves deplete over the coming decades, a strategy of reduced consumption will be essential to the production of furniture and architecture, alike. A lightweight design strategy is a way for me to participate in reducing the environmental footprint of everyday objects. Since ecological concern of materials have become one of the foremost issues of today's building industry, I have developed a novel way to build a lightweight chair which focuses on improving the application of this very particular material. The premise is simple: if designers reduce the weight of the things, there will be a reduction in materials processing and a reduction in carbon dioxide emission that occurs during shipping. By using a unique technique of plywood molding, this material creates not just a beautiful undulating surface but a surface that is compounded and three dimensional, molded plywood becomes stronger than conventional one. Consequently, the plywood can be made thinner without sacrificing any of its strength. Manipulation of molding plywood exploit and enhance the very essence of texture, and natural imperfections, simply and honestly.

**Fabricating Lightness**

New software and digital fabrication are changing how we use wood. Composite materials, parametric design, and automated fabrication technologies are explored, illustrating new design tools, custom manufacturing and advanced assembly methods. Spatial concepts are informed by the logic of fabrication and methods of assembly. A strong relationship between technology, space and locale suggests that the introduction of new technology coincides with new spatial concepts. Concurrently, new technologies
necessitate new buildings to house new machines effectively. The case of early industrial building in the nineteenth century serves as an example of the correlation of new technologies, means of production and building wherein ‘individual types of construction ... represented the various technical achievements of their time’ and ‘new machines with their extensive space requirements demanded ... progressive change in the specifically industrial architecture’.3

Frederic Lasserre’s (First director of the UBC school of architecture) definition of modern architecture from the 1940’s as “a process of design molded by physical, economic, technological, and cultural function, but also as a process distinguished by the subjective drama and excitement produced by the introduction of new forms and the association of new materials”4 is relevant to this argument. Lasserre perceived a conceptual shift in perception of form and space that anticipated a range of contemporary dynamic and flexible systems. Digital fabrication tools such as CNC routers, laser cutters and 3-D printers provide a direct link between computer-aided modeling and physical form. These devices allow for the direct translation of conceptual models into built form and promote evolution of practical aspects of traditional wood building methods. I aim to minimize the use of materials and energy, to integrate transport and habitation, while creating a tighter fit between architecture and product design. The project uses extreme economy of materials relying on technology to provide the strength that previously would have come from large and heavier sections. Reducing dimension and weight has the effect of reducing the quantities of materials used, the energy consumed in their production and transport, the amount of material required physically to support this process.

"Form is the responsibility of the architect." (Kieran and Timberlake, 2004, p.119)

The first three quarters of the 20th century, however, reminds us that new materials may indeed suggest new tectonics and new forms. The architecture of the last quarter of the century reestablished the understanding that there is no necessary relation between material and form. "The impact of new materials and processes on a building at the turn of the twentieth century has been well chronicled by Siegfried Gideon and others. The introduction of steel and elevator allowed the tall building to develop, since heavy masonry was no longer required to transfer load to the ground and the number of stories in a building was no longer limited by the number of flights a person could reasonably be expected to climb. Compared with the new steel, heavy masonry walls were counterproductive and uneconomic. Similarly, Gideon famously described ways in which the balloon frame – a new method of assembly, not a new material-transformed residential architectural in the United States." (Kieran and Timberlake, 2004, p.119)

The rate at which new materials have been introduced into architecture has been slow. Stone, clay, wood, glass and masonry are the tradition building materials. Many centuries later, concrete was invented. Still later metals were added, first as reinforcements and fasteners. The use of iron as a structural element has been widespread in nineteenth century. Architects have just begun to speculate upon the uses of new materials in architecture. In most cases, tradition materials have relatively low ratio strength to density. A significant amount of material is needed to yield relatively low strength and sometimes materials are oversized in some places.

5 Kieran, Steven and Timberlake, James, Refabricating Architecture, McGraw Hill, 2004 pp.119-211
In Kieran and Timberlake’s Refabricating Architecture, they stated the rapid development of materials and products over the past 150 years has been exponential. The structural properties of the recent invented materials invert this relationship. Relatively little materials yields significantly greater strength than do comparable quantities do traditional materials.

Lightweight Approach

All constructions are related to transportation in one way or another. Every single functional object that we make evolves from a process that turns material into a functional shape. There is no shape without material and effort. The more we value lightness and minimum energy consumption, the more critical it becomes. ‘There are no kites made out of concrete, because up until now nobody has come up with a process that can provide concrete with a shape that can be flown on a piece of string.’ Still the implication of the building lightweight is not that light objects should be made out of lightest possible material. There are indeed concrete sailing boats and although aluminum may have proved a suitable material for constructing airplanes, it is not the material with the lowest density. What matters is that it is light metal that can be shaped to perform as an airplane. Apart from the choice of materials, construction have to be efficient in order to be light, Building efficient constructions puts the issue of constructing economically in a different perspective. For economic reasons most objects are standardized, such as sheet, bars and beams,

6 Beukers, Adriaan, Hinte, Ed van, Building Lightness, 010 publishers, Rotterdam, 2005 pp.23-27
7 Beukers, Adriaan, Hinte, Ed van, Building Lightness, 010 publishers, Rotterdam, 2005 pp.25-27
that have been worked to fit specific applications. As these materials possess standard qualities and measures, they are generally oversized in some places. An aluminum plane would be lighter if skin thickness were not dictated by availability on the market, but by the strength and stiffness. The most obvious implication of composing efficiently is that construction should not suffer under the burden of their own weight. Materials should be able to transfer as much energy as possible relative to their density.

Material Performance
Craft + Building

While timber formed by natural growth retain a place in today’s building industry, monolithic sawn wood stocks are increasingly being replaced by composites, stranded and laminated components. New digital wood fabrication methods promote sustainable architecture and make complex timber structures more efficient and affordable. In the past century architects produced replication of identical parts, new wood processing technologies challenge conventional notions of economies of scale that assume mass production of unified, standardized building elements. “Wood structures are no longer limited to repetitive structure of equal parts and repeated connection details. These new technology offer components with improved performance and result in designs that change the way wood is conceived. Moving beyond standardization, new geometries offer formal and spatial flexibility and adaptability.”

8 Neumann, Oliver, Future Wood: Innovation in Building Design and Manufacturing. Canada, 2007 P.15
Looking beyond the building industry very often helps designer understand new approaches to their work. A good analogous industry is that of textile and fashion manufacture and design. Clothing is volumetric in its relationship to the body but it has historically been produced from flat stock. Issey Miyake (a world renowned fashion designer) has not only listened to the lesson of technology available in the fashion industry but has also extended the parameters of fashion and reengineered its tools, challenging the very definition of the industry. Redefining relationships between cloth and clothing with ideas about mass-customization, he is developing lines of cloths that are not cut from patterns but are instead woven into their forms from the start. Additionally, the cloth can be cut anywhere and will not unravel, meaning that a customer can change the size simply, with a pair of scissors. The product is called APOC (a piece of cloth). APOC not only changes the production process, but introduces new practices and forms. The goal is not to be more extreme in terms of haute couture but to bring ideas of mass customization to consumers at all price points.

Learning directly from fabricators, tools and other industries, my project will attempt to utilize these technology and ideas. Given the widespread dispersion of CNC technology, there is no reason that the tool should be used exclusively for the construction of large and expensive buildings. In this case, initial tests at the scale if furniture produce work with broader implications and larger questions. A lightweight plywood building takes large scale CNC fabrication technologies as a starting point for innovative wood construction.

methods. The broader aim is to promote sustainable wood building designs through efficiency of material and assembly. My project will demonstrate the progression of research interests and fabrication strategies that link wood construction with parametric thinking. The simple premise of the project is that 3D form emerges from 2D parts. Given the small budgets and tight construction timeframes, milling large chunks of materials is avoided as it is expensive, time consuming and wasteful. Rather than glue together blocks of material to then produce expressive form, clothing is taken as inspiration where flat material yields complex form.

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