

Larry Sass

Design Fabrication

Larry is a faculty researcher at MIT working to solve the problem of unaffordable construction. He believes his computer generated snap-fit construction systems can help builders produce thousands of homes of every size, scale, and style every day. Since he published and exhibited this system in 2005, construction companies in the US and UK have adopted snap-fit construction in their workflow's and products. He is currently working on a constructive language of building construction across scales.



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Design, Fabrication, Family

Lawrence Fitchue

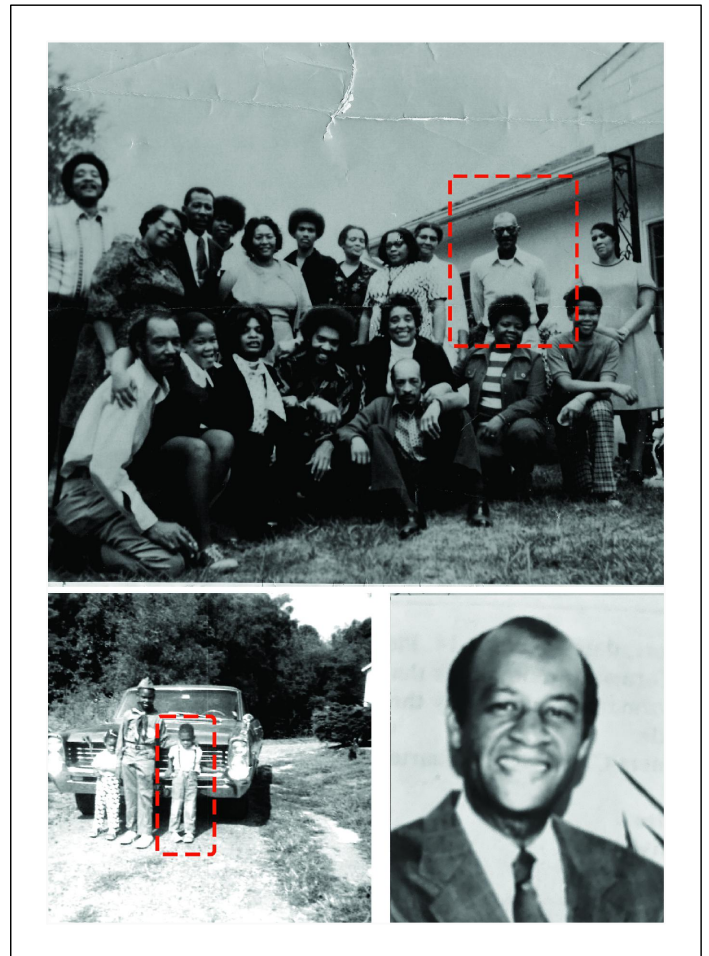
My grandfather was my greatest influence. He was the son of enslaved people in the south, a builder and a force to be feared and loved. Best his legal name was Lawrence as well, people called him Fitchue. I loved him for what he stood for as a family man and a builder. He was someone who produce structures of all types from my mom's childhood home to barns and dog houses. He built so much from so little. My mother was ashamed to say that only completed six years of school. Despite that he loved looking at pictures in the newspaper without understanding the words. He waited for television news to learn about events from newsprint. I recall spending many lack luster summers at his house in Basset Virginia the 1960's and 1970' in his presence. As little black child, playing in the dirt in baggy blue jeans, supported by plaid suspenders I loved watching him build almost anything. I watched in amazement as he built a very large barn one summer for the family car. A week later he built a new house for the dog. The week after a smoke house for tendering meat. Design was not his motive. He was moved to create shelter of all types across all scales for everyone.

Lawrence

My uncle Lawrence, his child and junior, was quite the opposite in manner. He did not possess my grandfather's ability to be physically industrious. My uncle worked as a designer in lower Manhattan for a graphics arts company, creating logos and typesetting magazine covers. They called it pasteup in the 1980's. For my uncle, the work was more than a mechanical exercise. He possessed an eye for modern design and a love of classical architecture. He believed the work should always be designed. I loved spending nights as a teenager hanging out in his Mad Man like office in lower Manhattan. He wore tight clothes, had a Harry Belafonte like smile and aspired to always speak the queens English. He opened my eyes to the world of design through his presence. He showed me that any home can of any size could serve one soul like a mansion.

Larry

I am motivated to design and build like my family. However, my life includes the formality of architecture and a mode of production that comes with computing. On the one hand my life has been mental reconstruction of many summers past watching my grandfather build. On the other, my desire to design is a repeat of the many nights in lower Manhattan watching my uncle sketch. Design Fabrication is more than a concatenation of my past and integration of today's advances in computation and fabrication. Design fabrication is a system and a language that I have developed for anyone interested in creative design production with machines and computers. I believe that my system can help anyone physically design and build almost anything of any-size, anywhere.



Upper Photo Grandfather, Lower left, Larry (me) as a child at grandfather's farm, Uncle Lawrence (lower left)

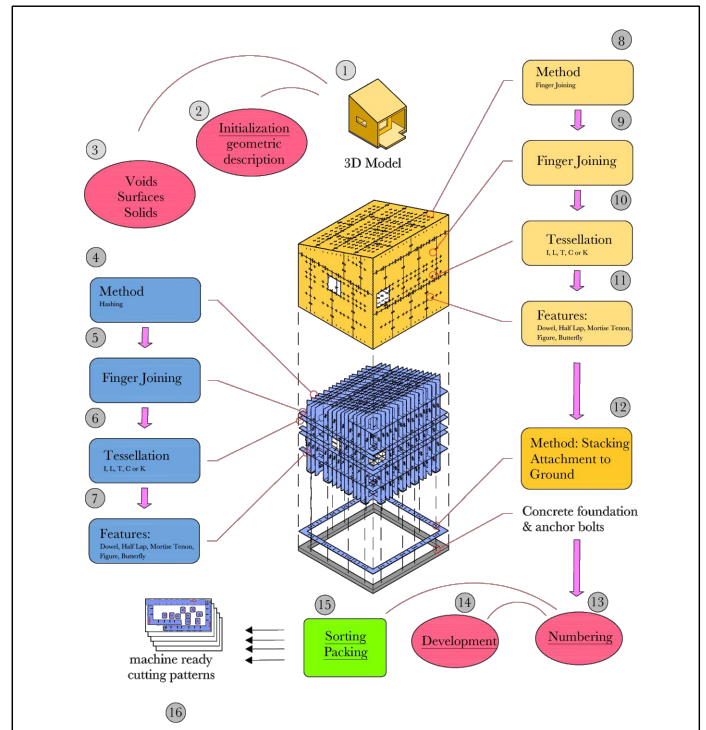
Plane Design

I conduct research by critical observation and physical production of small building with computers and machines. Digital fabrication is the future of home production. Unfortunately, CAD tools that intend to bridge the gap between what we see and machines that make are not useful for design. My research group investigates this problem with the belief that a physical language of production will bridge the gap between the virtual and physical world. So far publications of projects and processes have impacted the field of digital fabrication for home production as seen by professional companies like Facit Homes, Wiki-House, Pulp Homes, and U-Build.

The challenge has been discovery of new methods to decompose 3D models (solid & BIM) into a collection of functional, interlocking building elements. The common expectation is that large-scale 3D printing will solve the housing problem. This is not true. Instead we are feverishly working to build a planar system of design, opposed to a printing system, that will automatically generate 2D geometry across many axes and functions from 3D designs. The benefit of such a system will be a fast, scalable and sharable platform of building construction for all, not just experts.

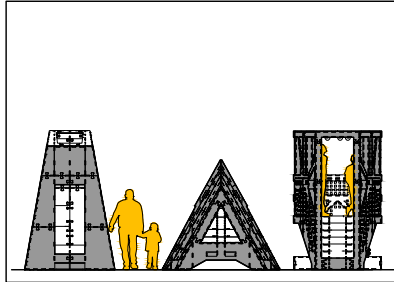
The work is to build a new language of design. It is complicated. We write rule sets for the computer that decompose our 3D forms to 2D drawings. Larger forms, such houses and shelters require as many as 12-15 rules sets. The Digitally Fabricated House for New Orleans and H22 Shelters, for example, were generated using all 15 rule sets. So far, we have had some success programming our rule sets in form of a software demonstrator called LuBan 3D. This magical tool is automation four of our core rule sets. The software is used by novice and experts alike posting designs on Facebook and IG.

All Photos Property of Prof. Lawrence Sass

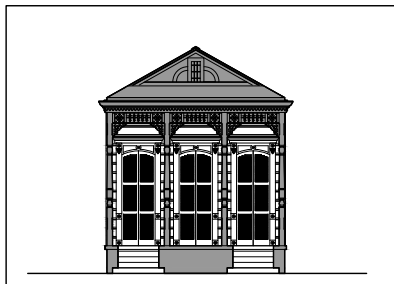


Rules sets used to decompose a 3D model (form) into a finished collection of elements

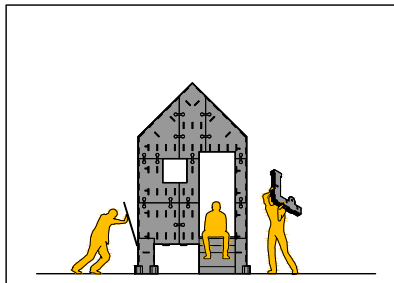
Projects



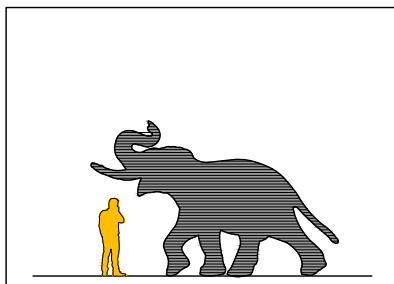
H22
Sweden
[2022]



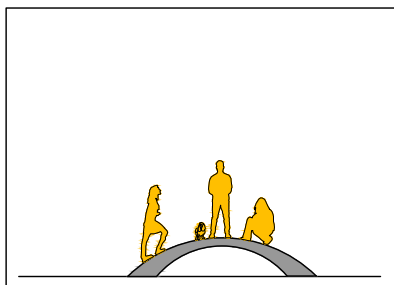
House for
New Orleans
MoMA
[2008]



Instant Cabins
MIT
[2005]



LuBan Software
Singapore
[2019]



Instant Artifacts
MIT
[2012-2022]

H22

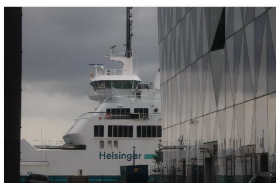
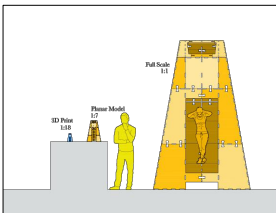
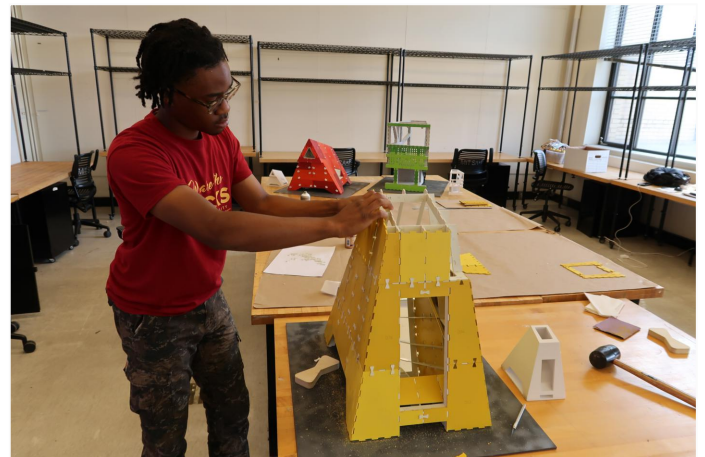
Ikea, Helsingborg Sweden 2022

This commission for three small shelters intends to evoke childhood feelings of curiosity and excitement through physical engagement. The shelters were designed to be part of the H22 festival in Helsingborg, Sweden summer 2022, sponsored by IKEA. Each shelter encourages the user to notice and reflect on their surroundings in the forest by engaging the body, the eye and the mind. The shelters were fabricated from thick interlocking plywood components, data used to fabricate elements followed the Planar Design System developed by the group.

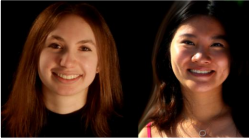
Assembly in Sweden was done with clamps, mallets and crowbars. No power tools were used to assemble the shelters on site. This page chronicles the project's development from conception to final assembly in Helsingborg.

Each shelter was designed, prototyped and assembled by two students as part of a two-semester research course. They were responsible for design functioning, forming and a user experience. After prototyping, we use the full suite of 16 planar rule functions to generate machine tool paths. Parts were fabricated by CNC machine in Poland, then delivered to Helsingborg just days before the opening of the exhibition. The assembly was a complete success!!

The shelters were on exhibit for four months.







Designers Nicole Teichner + Stephanie Li



Experience, Function & Form



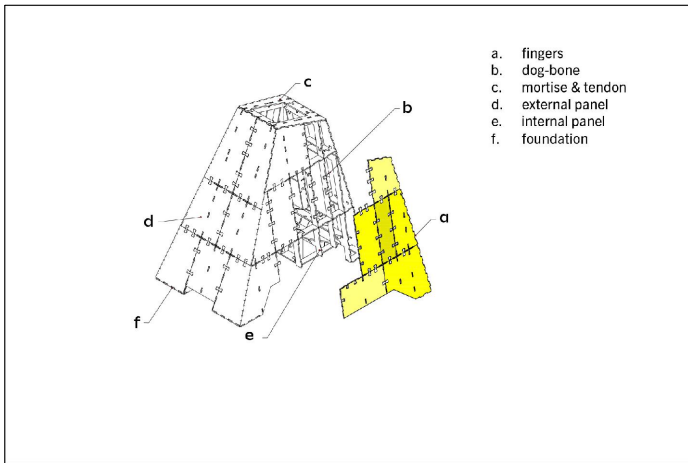
3D Printing & Form Checking



Plane Design & Prototyping 1:7



Plane Design & Prototyping



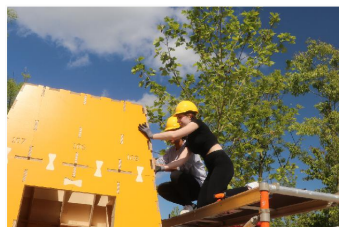
Fabrication Scale Plane Design



Finished Shelter 1



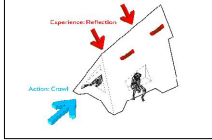
Component assembly in Sweden



Final Assembly



Designers Nina Huttenmann + Isabel Waitz



Experience, Function & Form



3D Printing & Form Checking



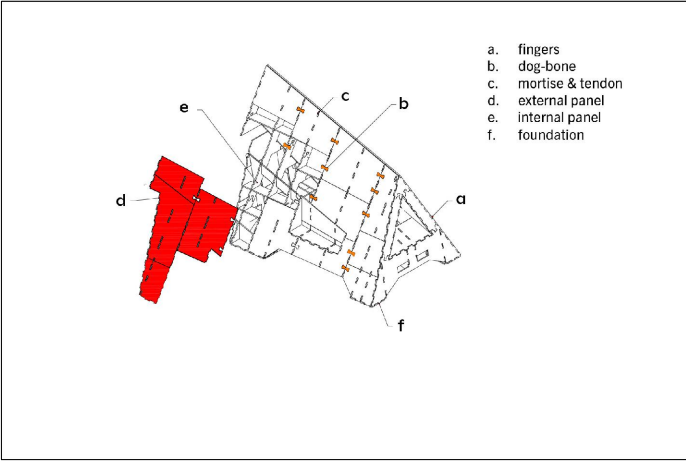
Plane Design & Prototyping 1:7



Interior of shelter with reflected surfaces



Finished Shelter 2



Fabrication Scale Plane Design



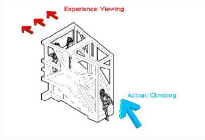
Component assembly in Sweden



Final Assembly



Designers Seif Eses + Erica Liu



Experience, Function & Form



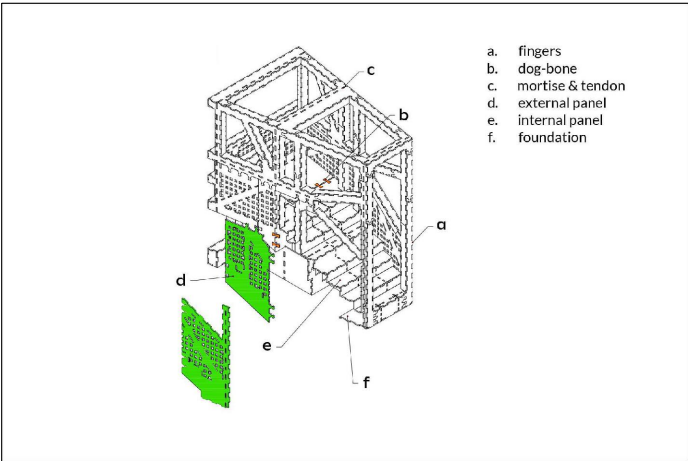
3D Printing & Form Checking



Plane Design & Prototyping 1:7



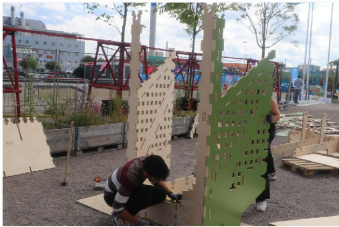
Plane Design & Prototyping



Fabrication Scale Plane Design



Finished Shelter 3



Component assembly in Sweden

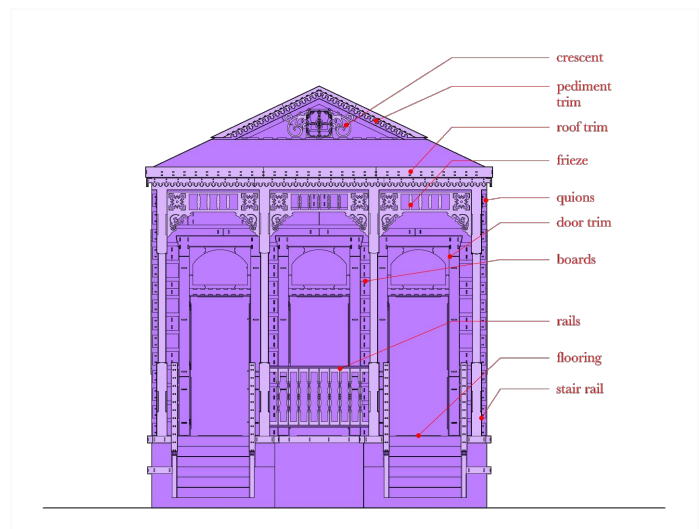


Final Assembly

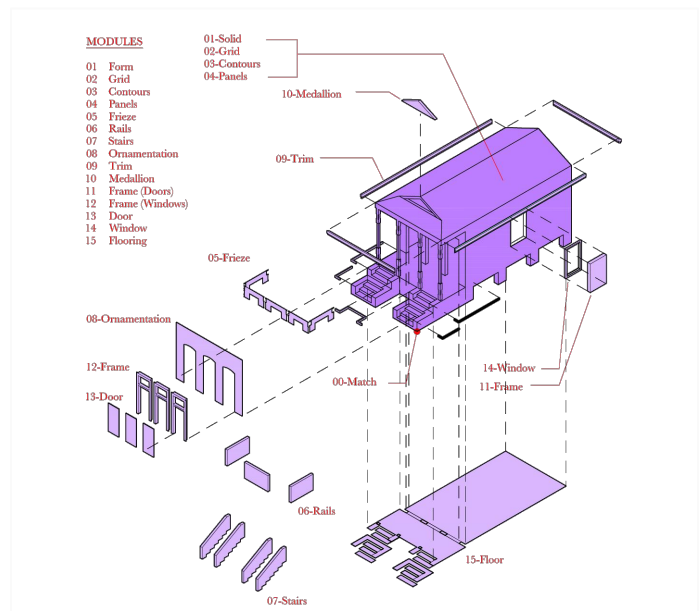
Digitally Fabricated House for New Orleans

Museum of Modern Art
2008

The Digitally Fabricated House for New Orleans was a commission from the Museum of Modern Art in 2008, to build an exhibit structure illustrating emerging technologies for home delivery. In this case digital design and manufacturing machines were used to support the concept of mass customized housing, post hurricane Katrina. The house was demonstration of a new method of home production and design. The show entitled Home Delivery, exhibited a variety of projects inside and outside the museum. Interior galleries displayed a mockup of the Lustron house, built in the 1940s as well as models and drawings of homes built in the 1950s as innovations of the time. The show also exhibited complex abstract designs that could be fabricated digitally in the future and alternative materials for homes such as recycled material and 3D printed plastic. The Digitally Fabricated House for New Orleans was one of five full-scale projects on display outside the museum in an open lot. The structure was on display July 1 to Oct 1, 2008, specifically between 54th and 55th streets.



Front facade in detail



Modulation and abstract of ornamentation supports modeling as a distributed enterprise.



Designing the house was inspired by Duane Zyborsky's "Louisiana Speaks Town Planning Guide". Here 3D prints were built as design alternatives for the project



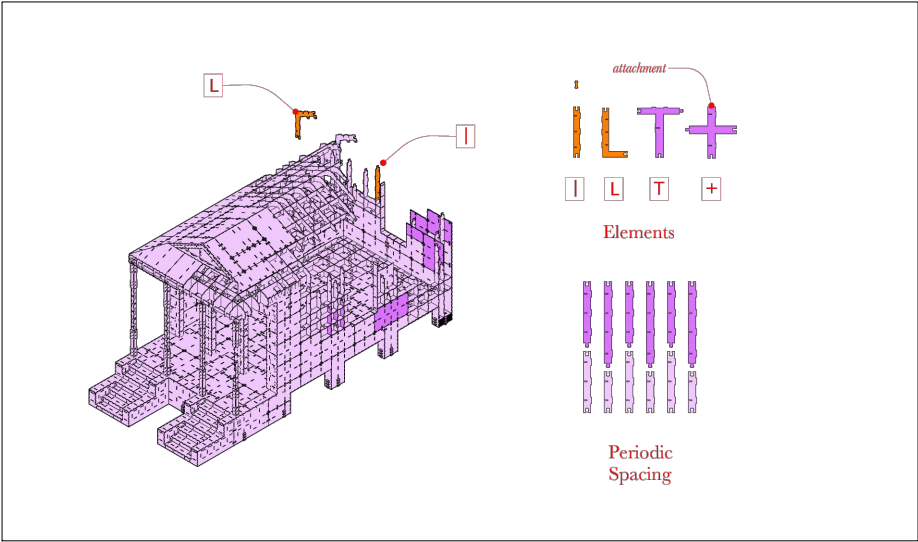
Digital manufacturing in Virginia. Elements were flatpacked for transportation



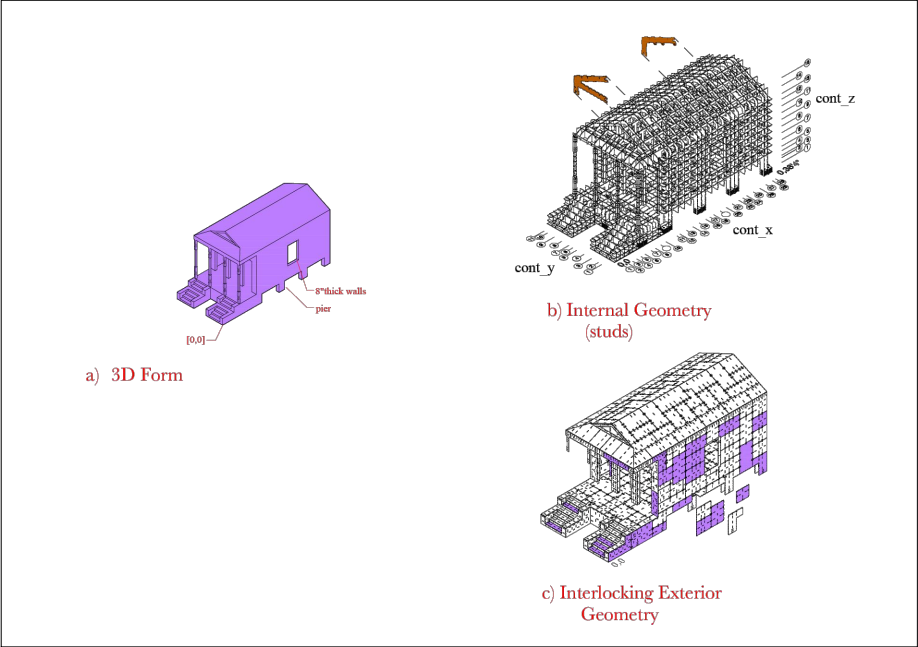
Only four tools were used to assemble the house; Rubber mallets, sledge hammer, clamps, handheld routers



Crane free job site



Principle Rule: Decomposition stopping point element discovery; Characterized to "I, L, T, +"



Principle Rule: Form Decomposition



Project Coordinator & Designers
Dan Smithwick, Larry Sass & Dennis Michaud



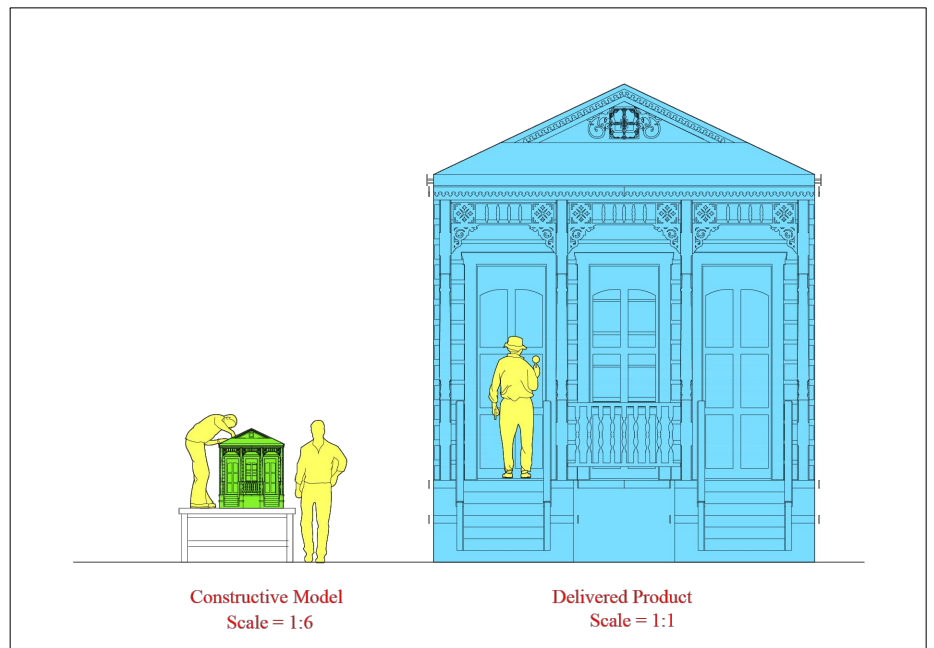
Error detection and correction model



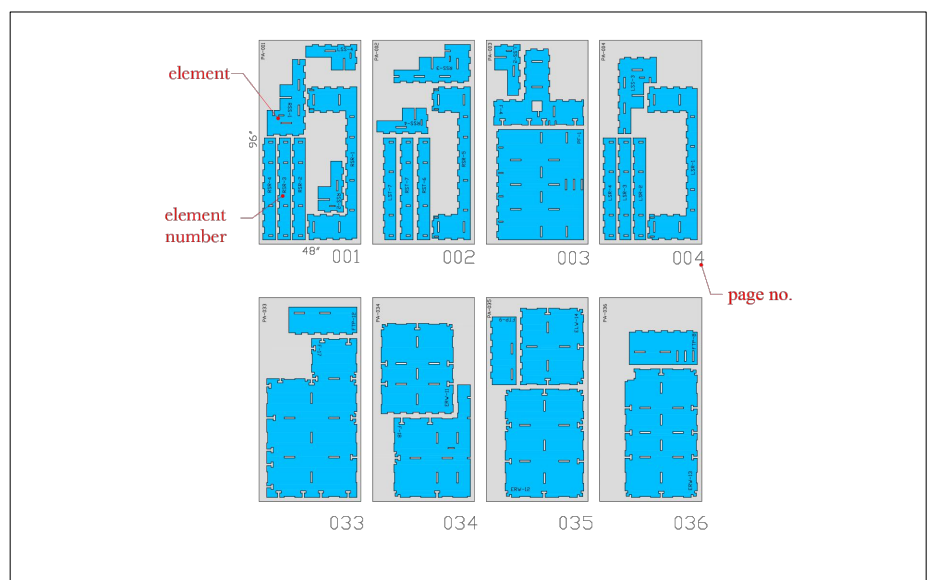
Numbered components support novice assembly



Assembly of ornamentation



Principle Rule: Scaling is used to detect and correct errors in 3D models



Principle Rule: Development, Packing & Sorting of elements within a bound surface



5000 CNC manufactured, interlocking elements



House interior including the last error detection & correction model



Grand Opening including the four other participants



Instant Cabin

MIT Campus
2005

The Instant Cabin was the first digitally fabricated wooden structure. As a research project it set the stage for future ideas related to digital fabrication for small structures. The Instant Cabin has impacted the work of others in particular projects such as WikiHouse, Facit Homes and U-Build. These are companies that were started soon after the Instant Cabin was published. The Instant Cabin, built in 2006 was an experimental structure that served as first of many examples of the potential of digital fabrication as a delivery system for houses. It is CAD/CAM manufacturing of flat, interlocking elements used to create an enclosure.

The goal of the systems was design and application of a Lego-like system of interlocking elements generated by computer modeling. This project demonstrated how digital fabrication could be a new yet efficient approach to building delivery. Unlike traditional construction, each element within the structure differs in shape, size and patterning. These differences in size and shape create strength and simplify assembly. This project was the start of our interest in rule building and rule application with modeling. Best of all this system of design and construction is measurable.

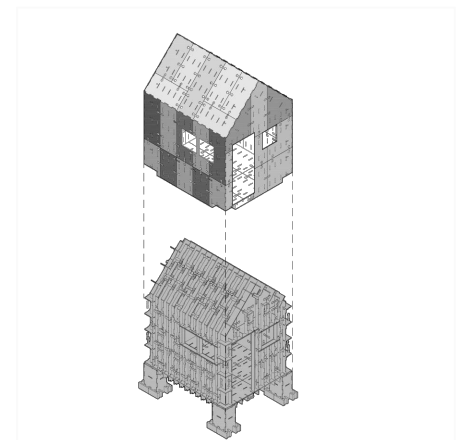
Sass, L. "A wood frame grammar: A generative system for digital fabrication." *International Journal of Architectural Computing*, Vol. 4, No. 1, 51–67, 2005.

Sass, L., Botha, M. "Instant House: A model of design production with digital fabrication." *International Journal of Architectural Computing*, Vol. 4, No. 4, 109–123, 2006.

Sass, L. "Synthesis of design production with integrated digital fabrication." *Automation in Construction*, Vol. 16, No. 3, 298–310, 2007.



Student assembly



3D CAD model



Hand guided assembly



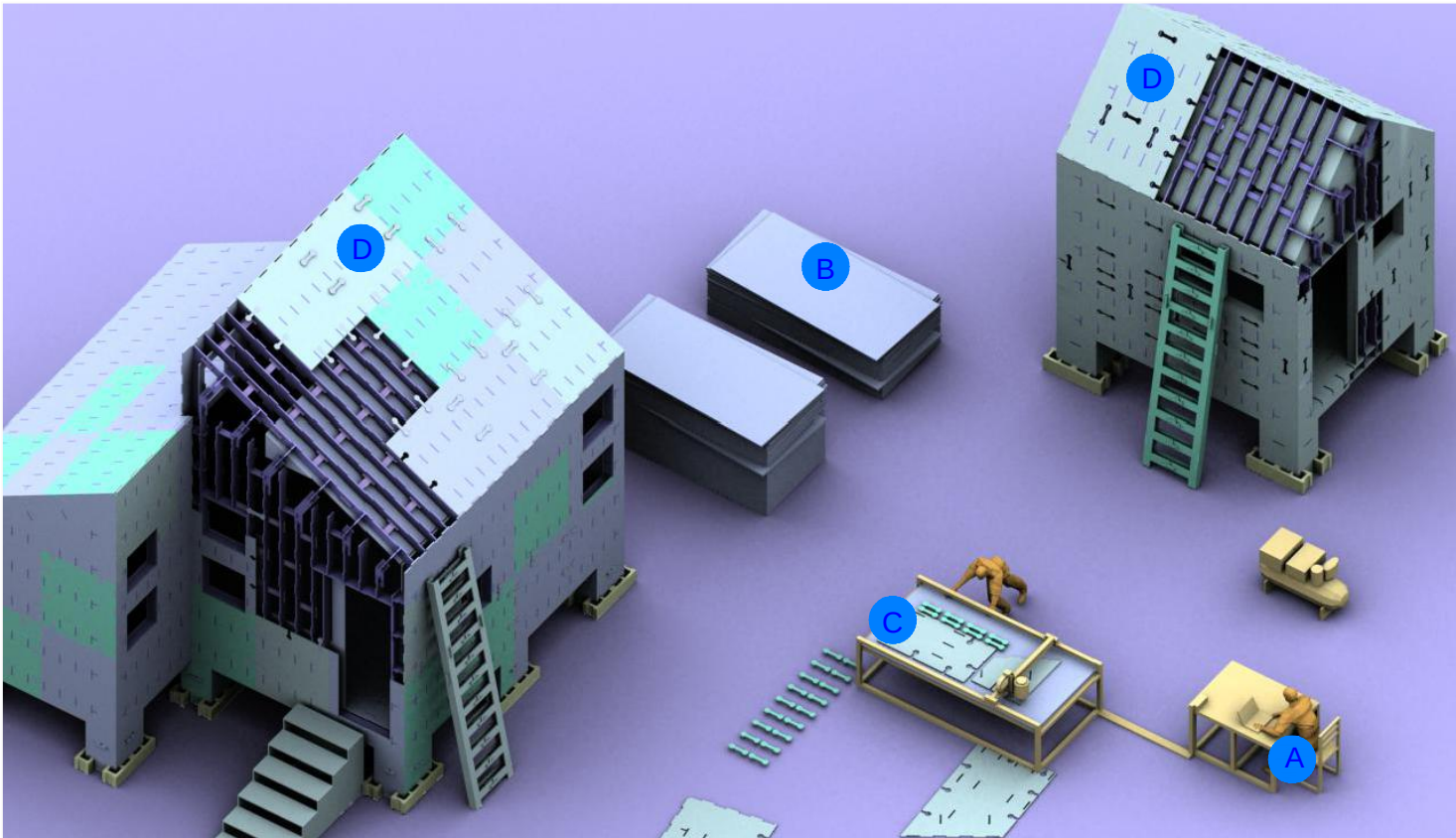
Discovery of scalable assembly; smaller model constructed of .09mm thick sheet goods & larger model constructed of 3mm thick sheet goods



20mm numbered elements



Roof assembly



Plane Design and Fabrication;

- A-Designer
- B-Sheet Goods
- C-Fabricator
- D- Assembly of Cabins



Cabin interior of shelving and desk fabricated after the cabin exterior was assembled



Entry stair added after manufacture and assembly of the cabin



Students who designed, fabricated and assembled the cabin



Larry Sass, Maggie Nelson, Diana Nee, Amanda Lee, Marcel Botha, Nic Rader

Project LuBan

Singapore University of Technology and Design
2019-Present

Project LuBan is demonstration that software can empower novice to physically construct their ideas.

A major challenge for designers of all types is physical manufacture of their designs at full scale. This is particularly true for very large artifacts, such as furniture and small structures. Common machines cannot print objects larger than a standard shoe box. Project LuBan is a software demonstrator that decomposes a 3D form in CAD, to interlocking, 3D and 2D puzzle like geometry ready for laser cutting, CNC cutting or 3D Printing. LuBan is great for prototyping models and manufacturing of final products greater than one meter square. The software is direct result of many years of Plane Design Research. It has helped thousands of users to physically produce their ideas since 2019. LuBan is automation of four (of sixteen) of our major decomposition rules/functions:

- Stacking: Also referred to as contouring, mostly used for 3D Printing
- Hashing: Also referred to as egg crating
- Plate Forming: Decomposes a model
- Modulation: Cuts models in to uniform parts and includes a positive-negative joinery. This is used for 3D printing.

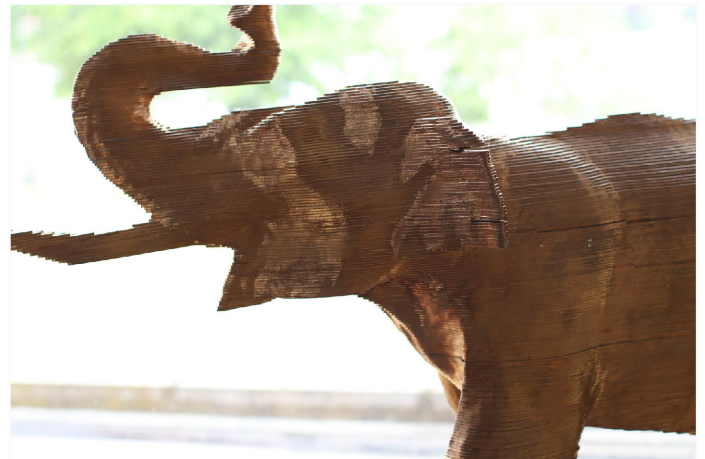
Luban 3D <https://www.luban3d.com/>

Su, Z., Chen, L., He, X., Yang, F., & Sass, L. (2018). Planar structures with automatically generated bevel joints. *Computers & Graphics*, 72, 98-105.

Chen, Lujie, and Lawrence Sass, (2017) "Generative computer-aided design: multi-modality large-scale direct physical production" *Computer-Aided Design and Applications*, Vol. 14, Iss. 1, 2017, 83-94.

Chen, Lujie, and Lawrence Sass. "Fresh Press Modeler: A generative system for physically based low fidelity prototyping." *Computers & Graphics* 54 (2016): 157-165.

Sass, Lawrence, Lujie Chen, and Woong Ki Sung. "Embodied prototyping: exploration of a design-fabrication framework for large-scale model manufacturing." *Computer-Aided Design and Applications* Vol. 13 Iss.1, 2016 124-137.

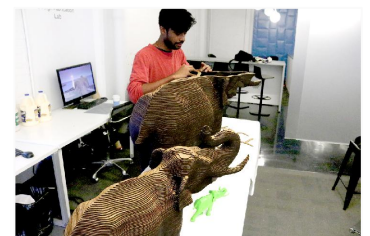


Project: Plane Elephants

LuBan Elephant model constructed from layers of laser cut painted masonite

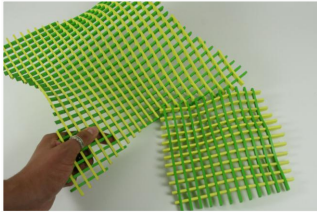
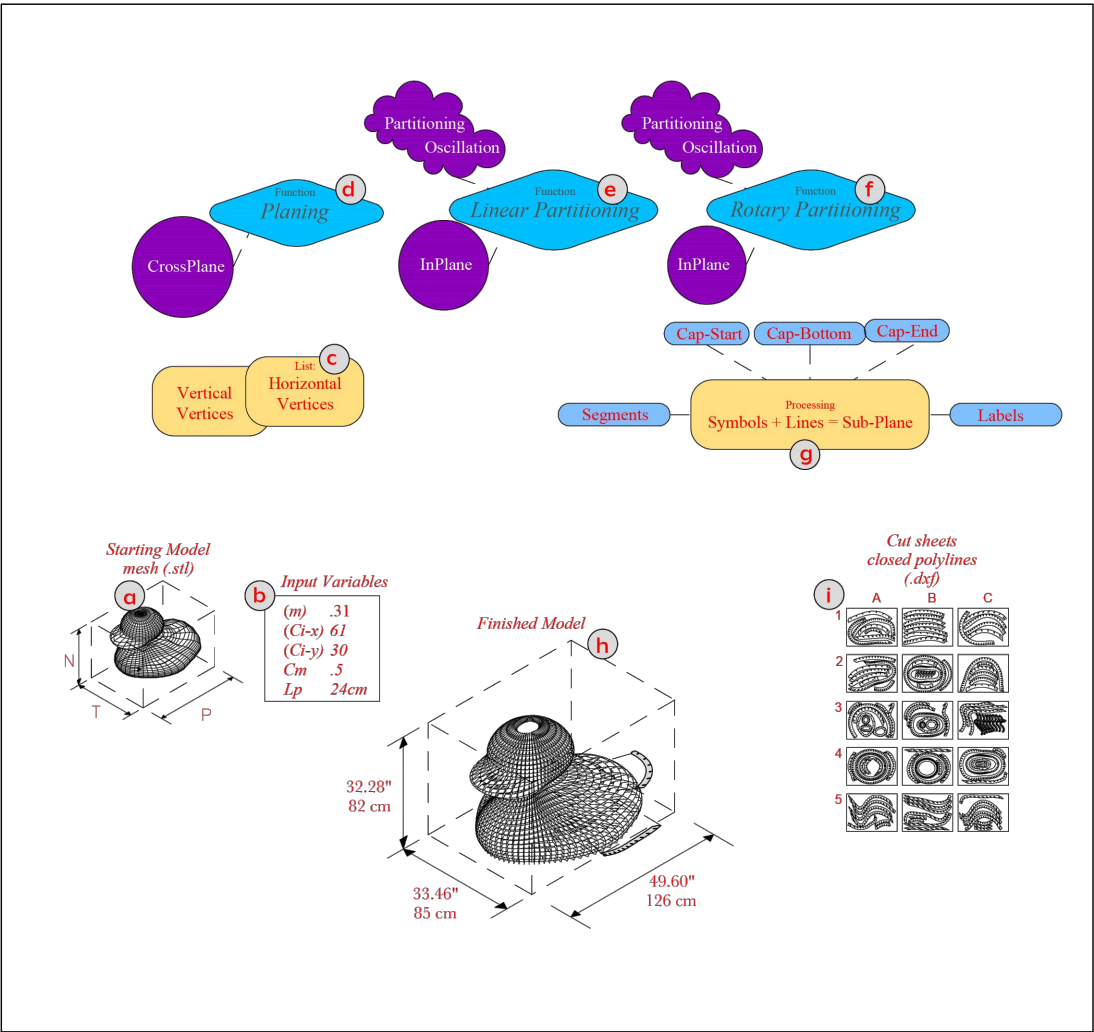


LuBan Co-Founders - Prof. Lujie Chen & Prof. Larry Sass



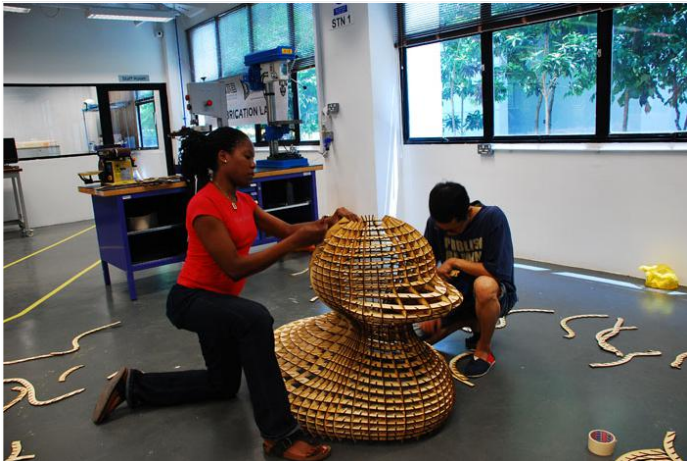
Assembly of elephant models by graduate student Ankur Podder

Project: Programming Planes
Ki Woong, Vernelle Noel, Prof.
Lujie Chen

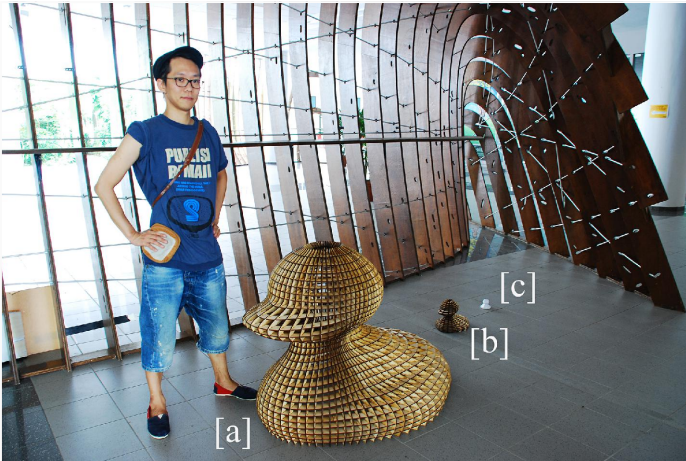


Initial laser cut hash models

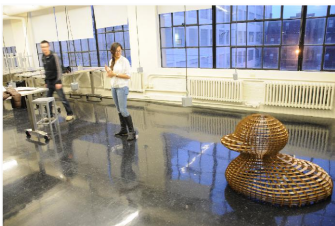
Early stage diagramming of the LuBan - Hash - algorithm



Model generation, laser cut manufacturing and assembly in Singapore

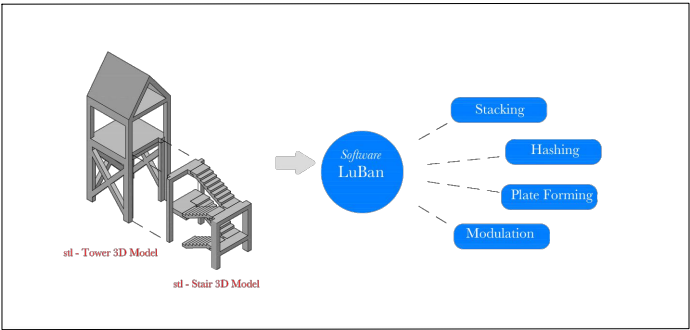


MIT graduate student Ki Woong, demonstrating how the Hash Algorithm supports physical scaling from the same initial 3D starting geometry

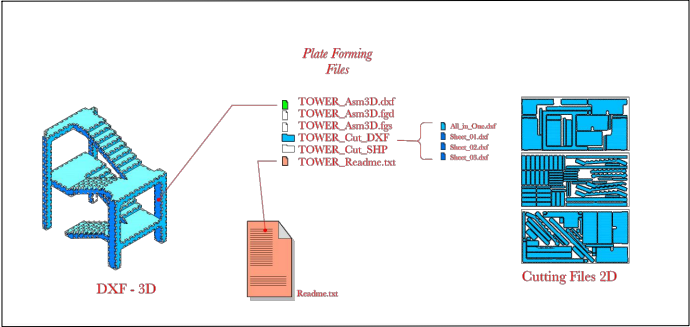


Model generation, laser cut manufacturing and assembly at MIT

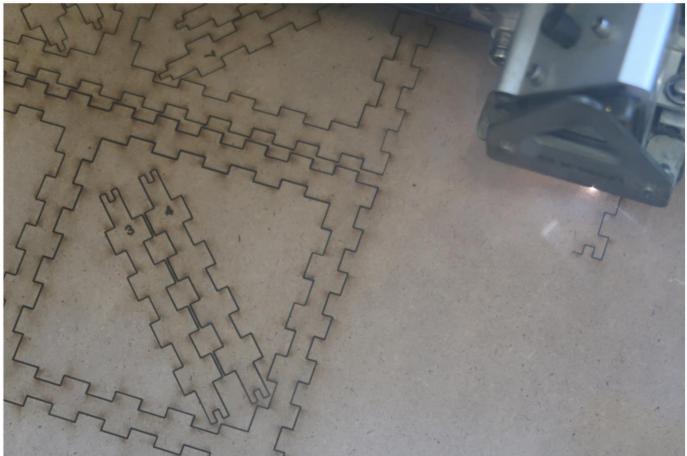
Project: Challenging LuBan
 Bolade Richardson & Marcel Walker



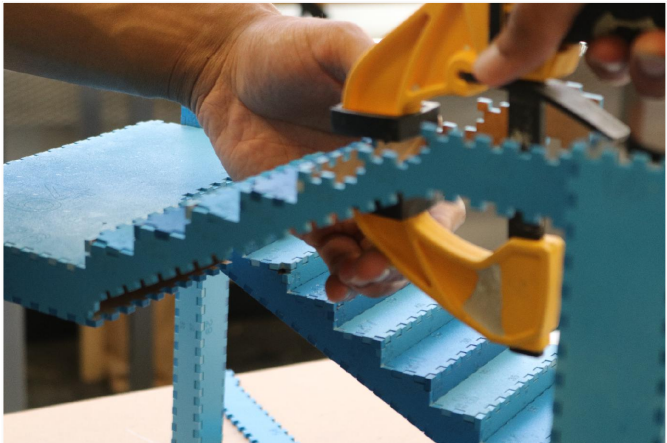
Step 1. Load CAD file into LuBan, then select a decomposition rule: Stacking, Hashing, Plate Forming or Modulation



Step 2. File management. LuBan generates multiple file types including a readme file of builder data.



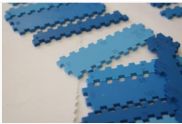
Step 3. Laser cutting numbered elements



Step 4. Hand guided assembly



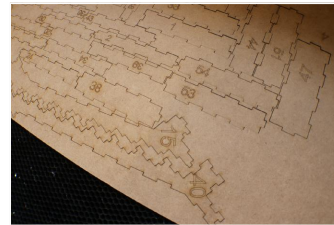
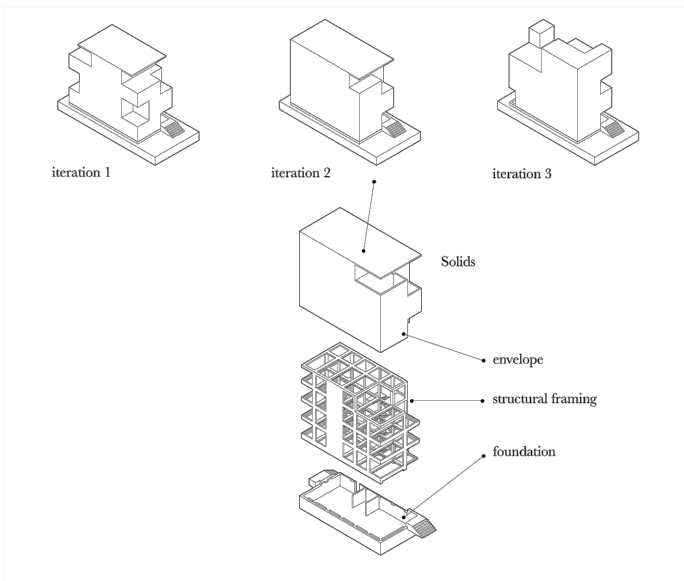
Assembled Plate Forming model with finger joints by a visiting student from Tuskegee University (2018)



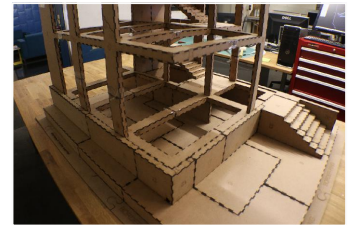
Research Project: Digitally Fabricated Three Decker
Ankur Podder, Daniel Garcia, Ai Bui, Michelle Xie, Megan
Ochalek, Laura Y Li



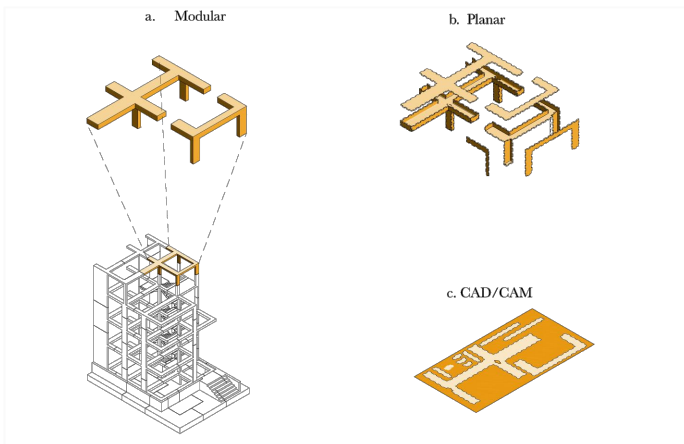
Conceptual model of digitally fabricated envelope and framing



Element laser cutting



Modules and plates



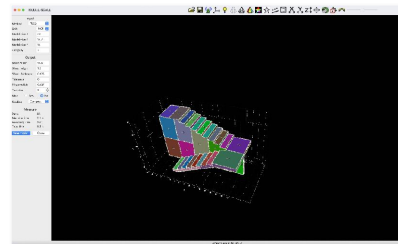
This project is design to fabrication process exploring digital fabrication of three story apartment building. This part of the study challenged the idea of a digitally fabricated framing system upon which we would apply a digitally fabricated skin.



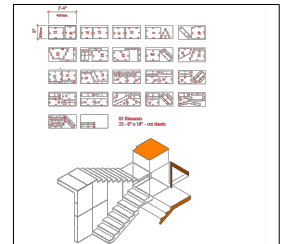
Finished assembly of modules

LuBan in the Classroom

Students challenge the system demonstrator in the classroom by physical assembly of precut elements. A typical class of 12 students assembles 4 models of the three different description types; Stacked, Hash, Hash Radial & Plate. The homework assignment was a social challenge between three to five students



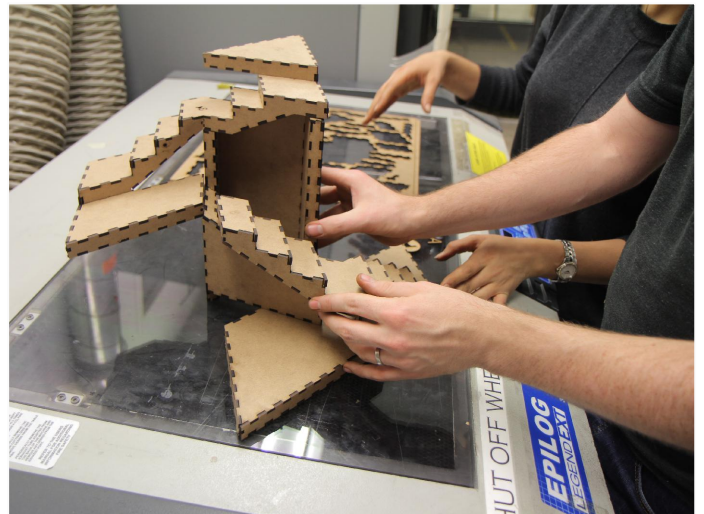
LuBan Interface and automated decomposition of a 3D model into elements



Cutting patterns and model of interlocking elements



Student in the classroom learning the extent of 3D modeling, decomposition and assembly



Homework assignment as a group of three to four students who formed and fabricated a laser cut model using LuBan

Instant Artifacts

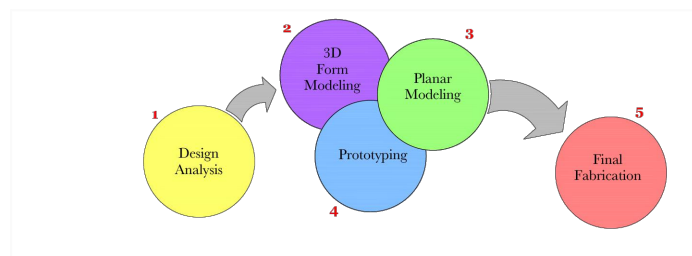
Courses 2012-2023

We learn design by "Doing". It is a form of self-actualization and freedom (Bell Hooks)

This section is demonstration of two exciting classes at MIT in the Department of Architecture aimed at learning digital design and delivery. Most of us have yet to notice the transformation in furniture manufacturing from hand tooled products to digitally fabricated mostly two-dimensional assemblies. In the U.S., furniture that was once produced by master carpenters in local factories is now designed on the computer and manufactured by computer-controlled machines.

For the past decade both undergraduate and graduate students in my Design Fabrication courses at MIT have participated in the production of many wonderful designs almost ready for prime-time production. They generate and manufacture these products in less than five weeks with basic CAD software and access to three types of CAD/CAM machines. The aim behind both of my courses is design, digital representation and physical production of functional chairs and bridges.

Production includes the same five stage system of digital delivery taken from my research and design projects. Chair and Bridge designs start by forming, followed by scalable prototyping and final 1:1 fabrication from finished sheet goods. The difference here is that student input is based on an analysis of an existing products. Also output of finished artifact must be functional as a chair or a bridge.



Five stages of design, development and product delivery in my courses

2019





2022: Students in 4.500, an undergraduate course aimed at learning Design Computation by seeing and making



1:4 Scale prototypes







2023

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