House Fab

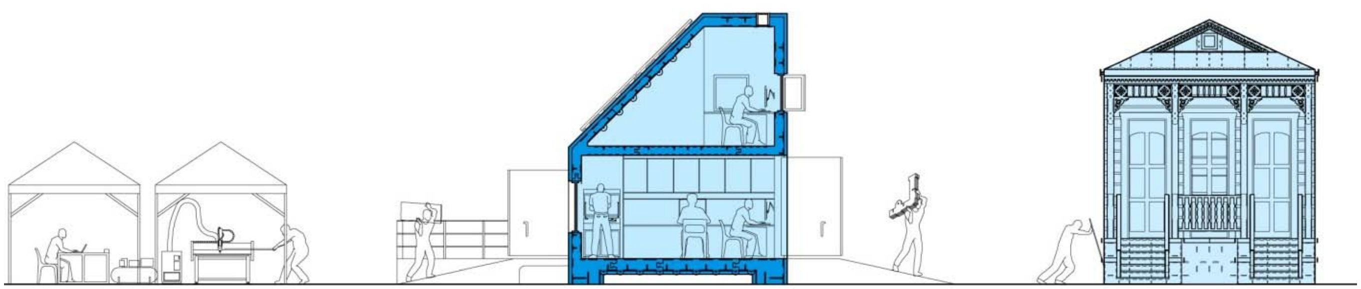
Department of Architecture, MIT

Field: Digital Fabrication

Building Kits

Digital Fabrication

1. Low cost precision manufacturing building
2. Every building should be different
3. Hundreds can be fabricated in days
4. Low skilled labor in production



(a) *Temporary Outdoor Fab*

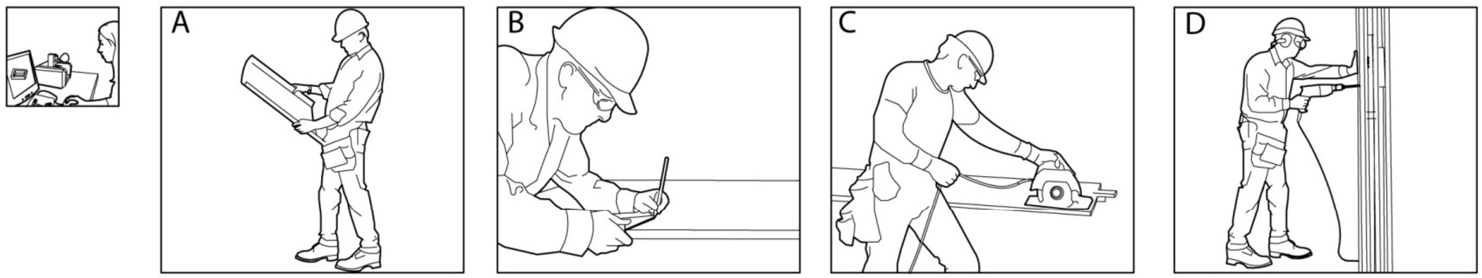
(b) *Fab Lab*

(c) *House Kit*

Village: New Orleans

Conventional Construction

The Limits



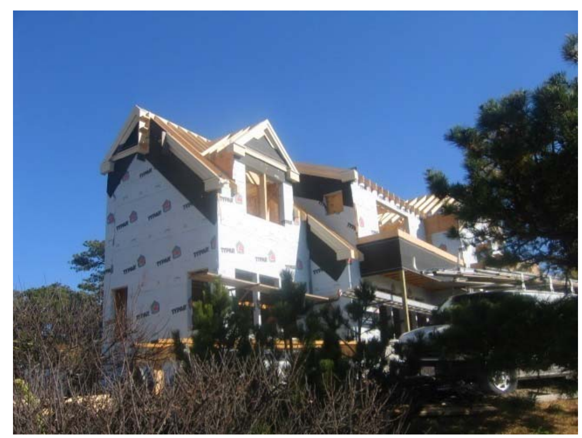
Error prone production

a) Construction workers interpret drawings (errors when interpreting drawings)

b) Transfer measurements to material (errors in measuring)

c) Manufacture components by hand (errors in manufacturing)

d) Non-Formal assembly (no assurance of quality)



Conventional Construction
High energy delivery

Prefabrication in Factories

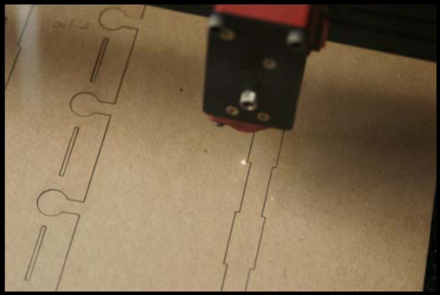
- Century old system - Method was invented by Sears & Roebuck in 1920s
- Limited designs - Finished product must be rectangular
- High energy - Requires an indoor environment to build large products
- Western environments only - Requires finished roads for delivery

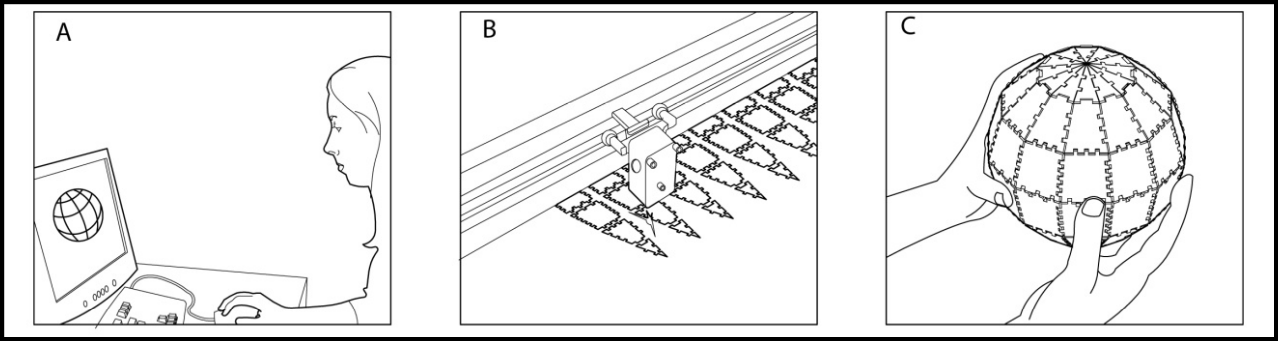
Digital Fabrication

Materializing Design

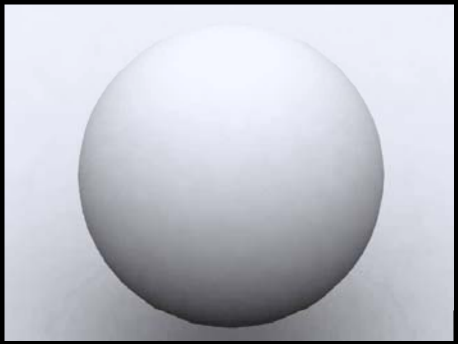
1. Build a 3D model in CAD
2. Subdivision of Geometry
3. Compute Attachment Features
4. Translates from 3D to 2D
5. Laser cut shapes
6. Assemble

Laser cutter





Process steps

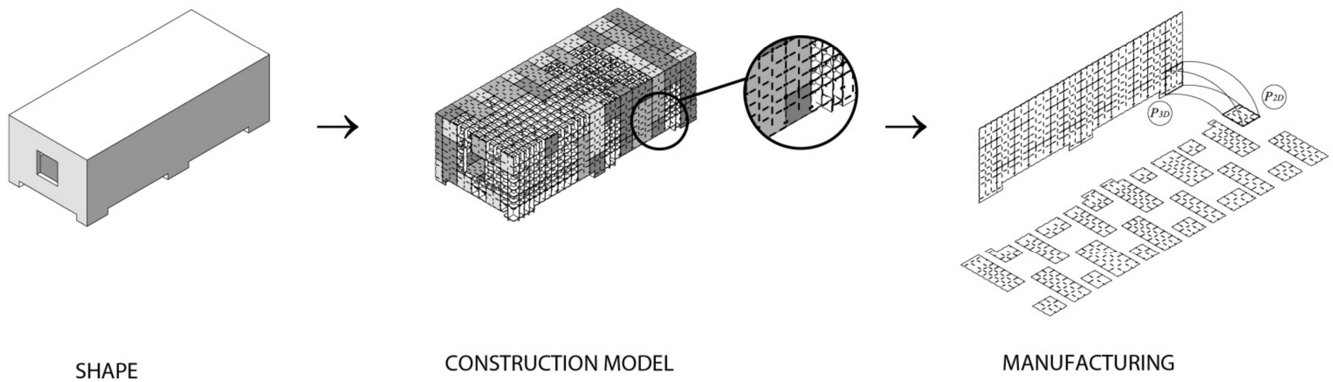


Materializing a shape

computing, manufacturing and assembly of a shape

Language of Construction

Materializing Design



General Rules

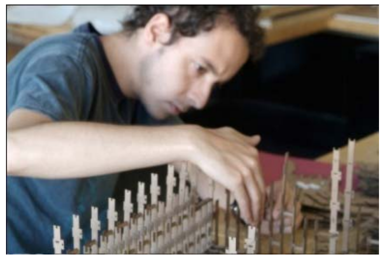
1. Designs are subdivided into elements for digital fabrication
2. Lattice & Surface
3. Each element includes and interlocking component
4. Elements are fabricated as 2D parts
5. Assembly is sustained by friction

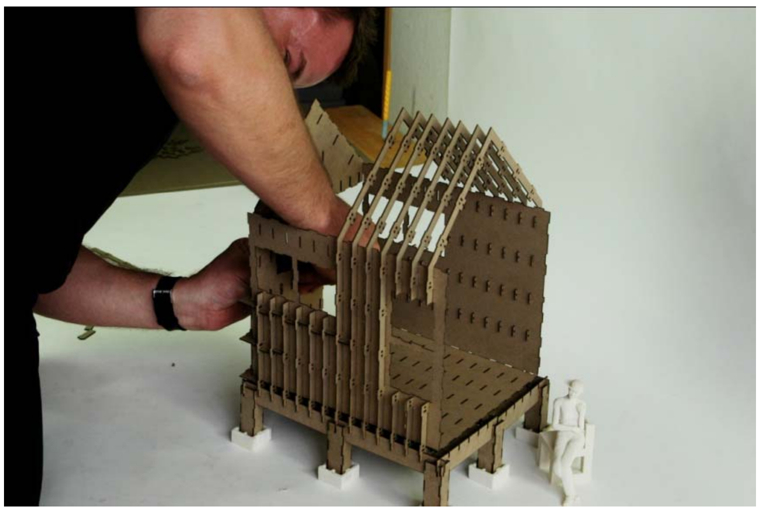
Chen, Y. Example of a mesostructure produced from a slicing algorithm

Sass, L. Example of building elements created from a construction grammar

Language of Construction

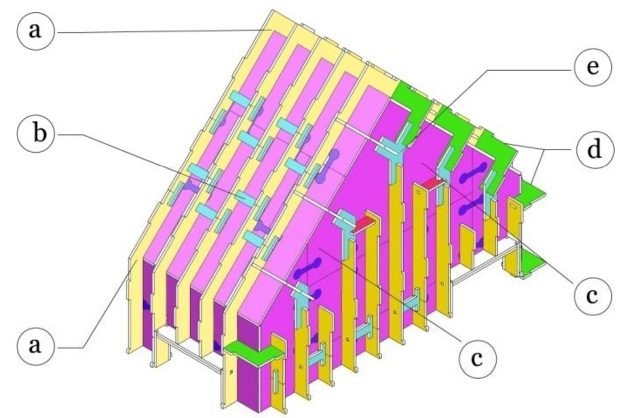
How to construct a building from the elements





Student constructing a model
from the grammar

Design from grammar
(roof)



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

Alternative Designs

Flexible design and manufacturing system

Benefits of System

- Easy to assembly components
- Easy to prototype (laser cut)
- Can build a range of building forms
- The language is computable – easy to turn into software

Design

Design

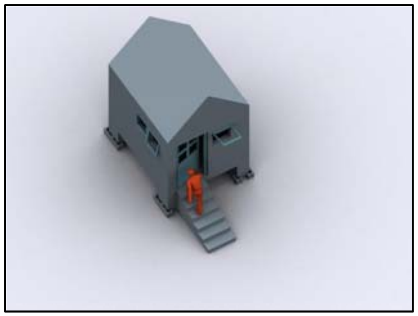
Prototype

Design

Prototype

Digitally Fabricated Buildings

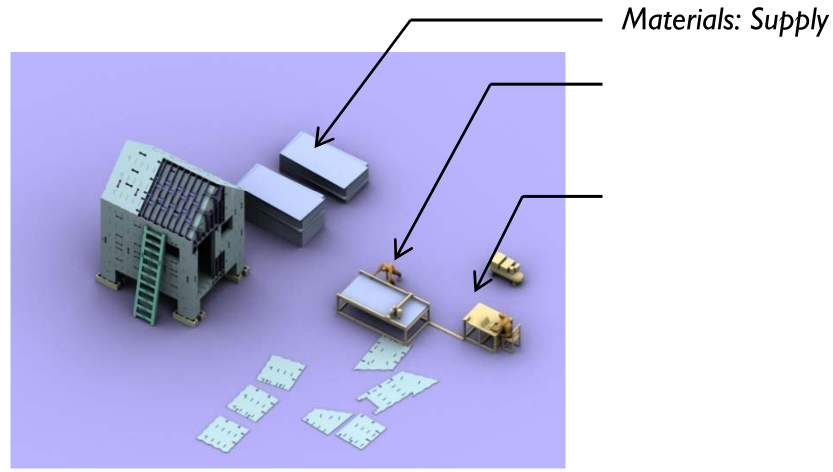
Low energy production



a) The Design

c) Digital fabrication

b) Computer used to Materialize the Design



Sass, L. "Synthesis of design production with integrated digital fabrication." *Automation in Construction,* Vol. 16, No. 3, 298–310, 2007.*Sass L. 2006*

Flexible design and manufacturing

- No Factories needed
- Supports design variety
- Quality manufacturing anywhere
- Snap together construction assures quality

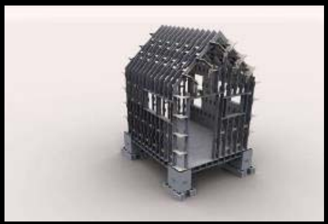
d) House Kit

Instant Cabin

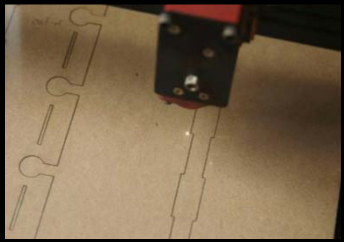
Physical production of a digitally fabricated structure

Shape Model

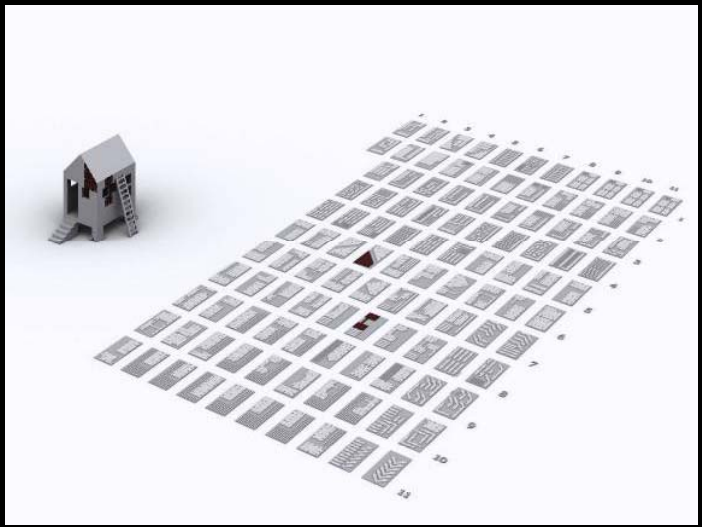
Construction Model



Laser cutting



Prototyping



Manufacturing data

Day 1

Instant Cabin

Physical production of a digitally fabricated structure

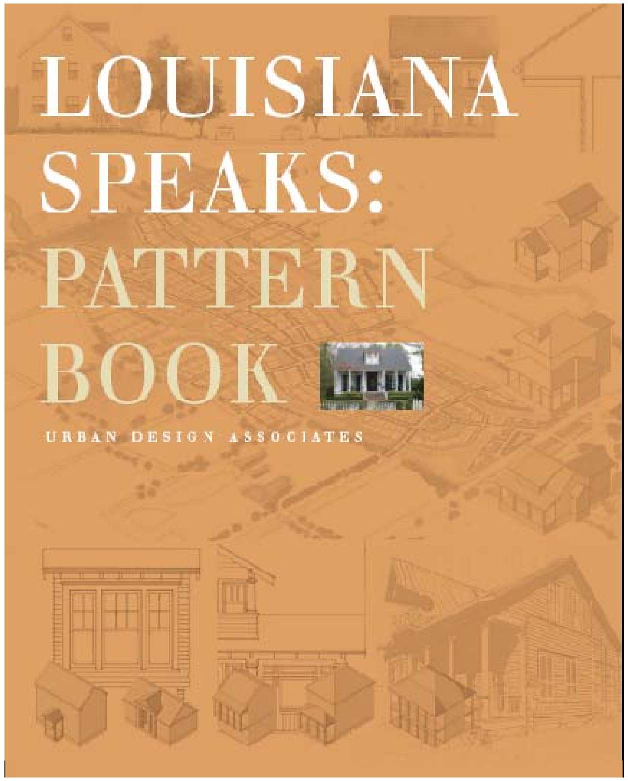
Sass, L. "Synthesis of design production with integrated digital fabrication." *Automation in Construction,* Vol. 16, No. 3, 298–310, 2007.

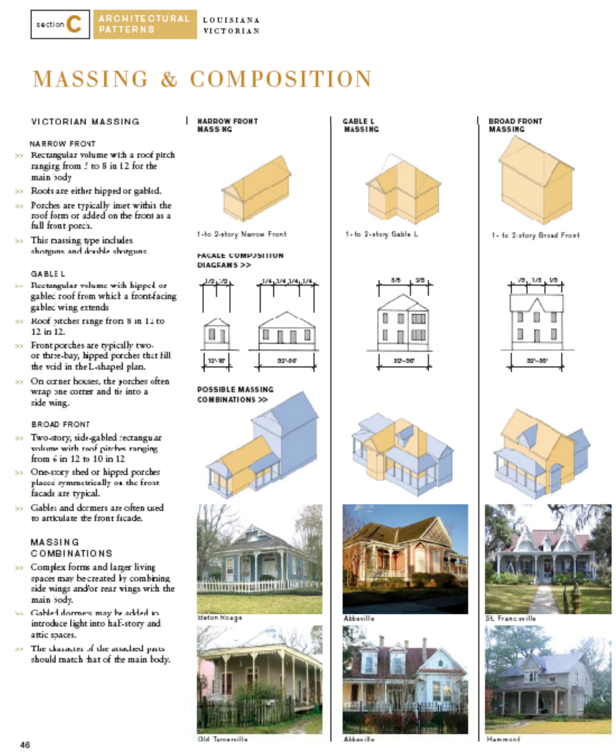
Low energy assembly

Digital Fabrication

A digitally fabricated house for New Orleans

Modern Museum of Art
Summer/Fall 2008





section C ARCHITECTURAL PATTERNS LOUISIANA VICTORIAN

MASSING & COMPOSITION

VICTORIAN MASSING

NARROW FRONT
>> Rectangular volume with a roof pitch ranging from 5 to 8 in 12 for the main body
>> Roofs are either hipped or gabled.
>> Porches are typically inset within the roof form or added on the front as a full front porch.
>> This massing type includes shotguns and double shotguns.

GABLE L
>> Rectangular volume with hipped or gabled roof from which a front-facing gabled wing extends
>> Roof pitches range from 8 in 12 to 12 in 12.
>> Front porches are typically two- or three-bay, hipped porches that fill the void in the L-shaped plan.
>> On corner houses, the porches often wrap one corner and tie into a side wing.

BROAD FRONT
>> Two-story, side-gabled rectangular volume with roof pitches ranging from 6 in 12 to 10 in 12
>> One-story shed or hipped porches placed symmetrically on the front facade are typical.
>> Gables and dormers are often used to articulate the front facade.

MASSING COMBINATIONS
>> Complex forms and larger living spaces may be created by combining side wings and/or rear wings with the main body.
>> Gabled dormers may be added to introduce light into half-story and attic spaces.
>> The character of the attached parts should match that of the main body.

NARROW FRONT MASSING

1-to 2-story Narrow Front

FACADE COMPOSITION DIAGRAMS >>

1/2 1/2 12'-18'
1/4 1/4 1/4 1/4 32'-36'

POSSIBLE MASSING COMBINATIONS >>

Baton Rouge

Old Jeanerville

GABLE L MASSING

1- to 2-story Gable L

3/5 2/5 32'-36'

Abbeville

Abbeville

BROAD FRONT MASSING

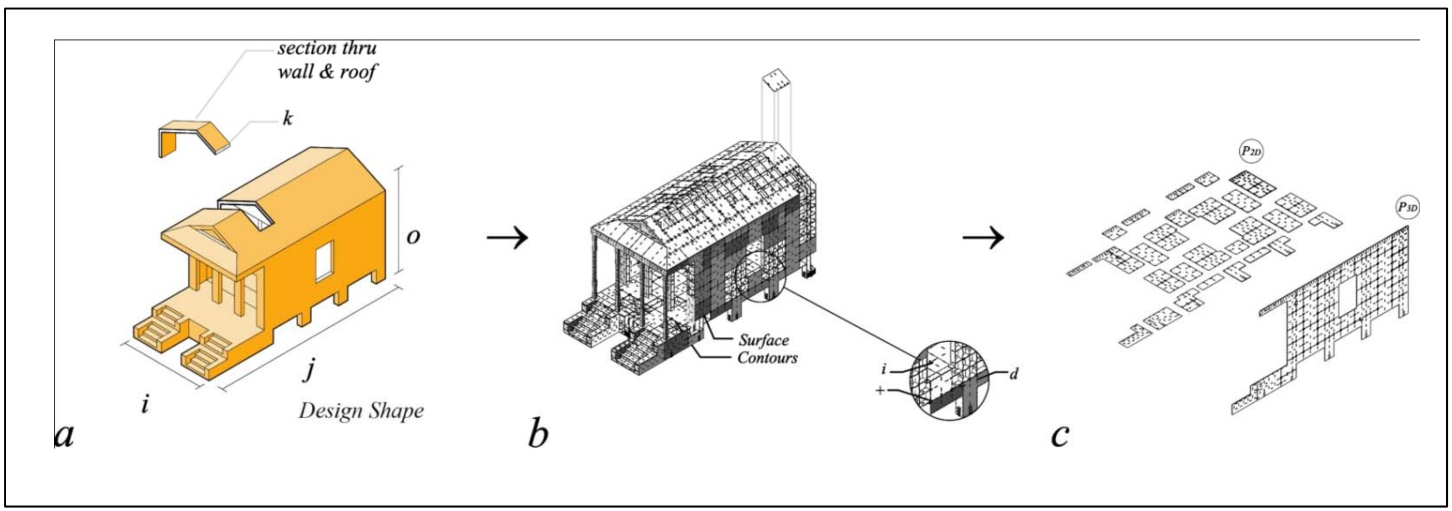
1- to 2-story Broad Front

1/3 1/3 1/3 32'-36'

St. Francisville

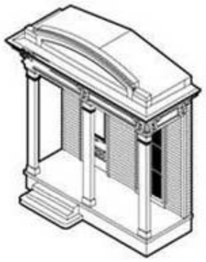
Hammond

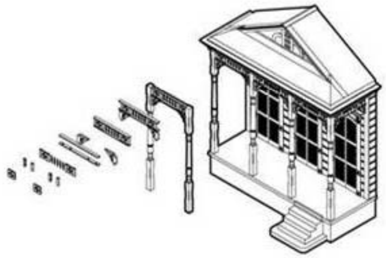
46



Initial Design Shape

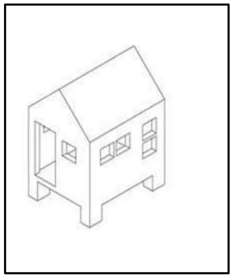
Step 1

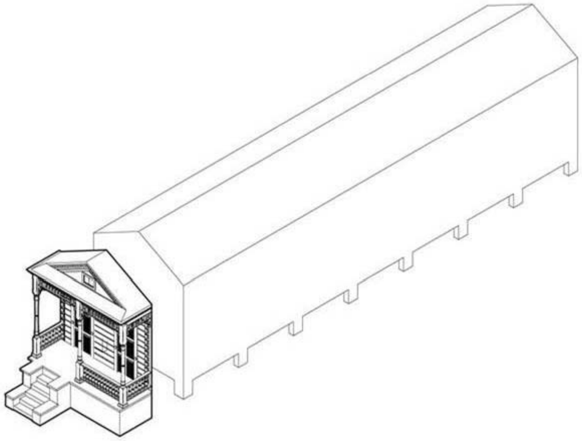


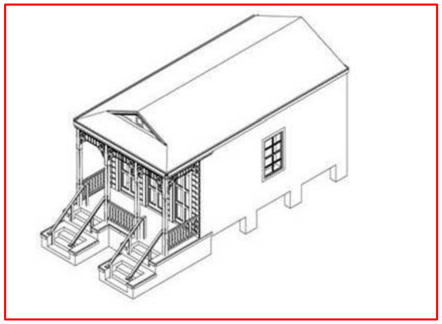


Initial Design Shape

Step 1



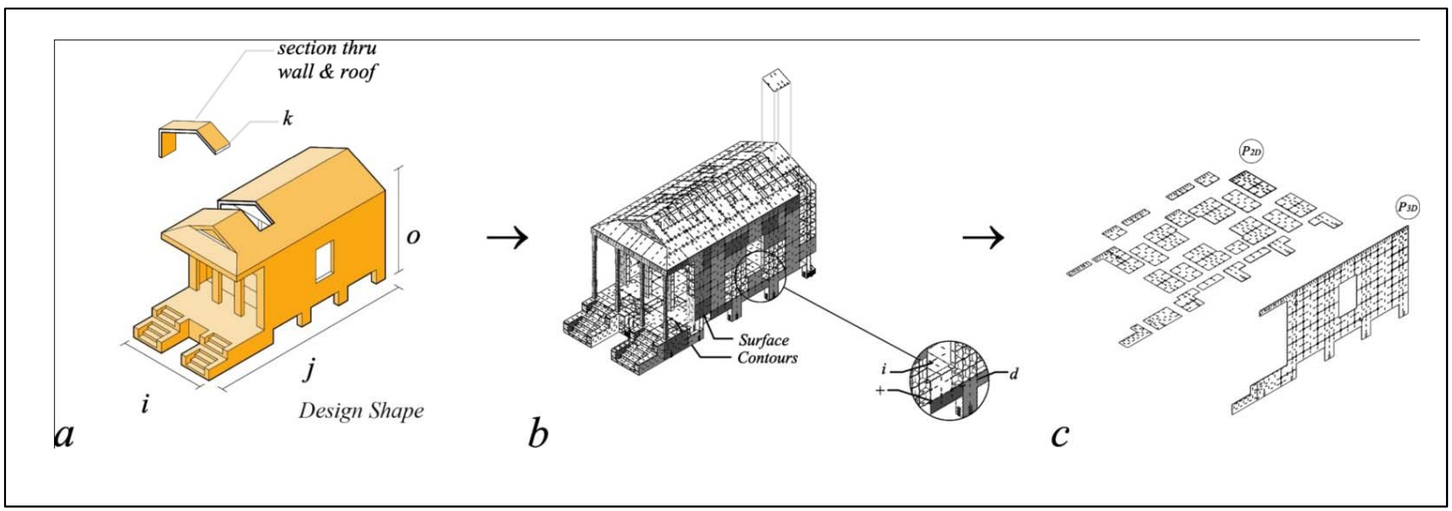




Materializing

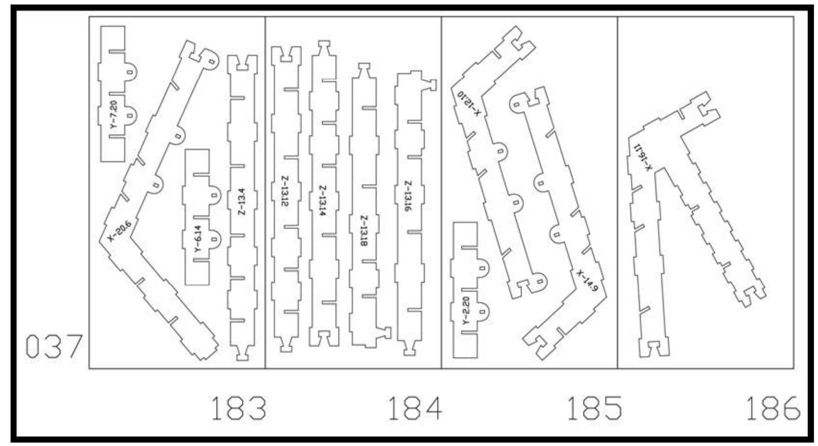
Step 2

1. Error detection modeling
2. Computing Shapes
3. Mass Customized Approach



Manufacturing

Step 3

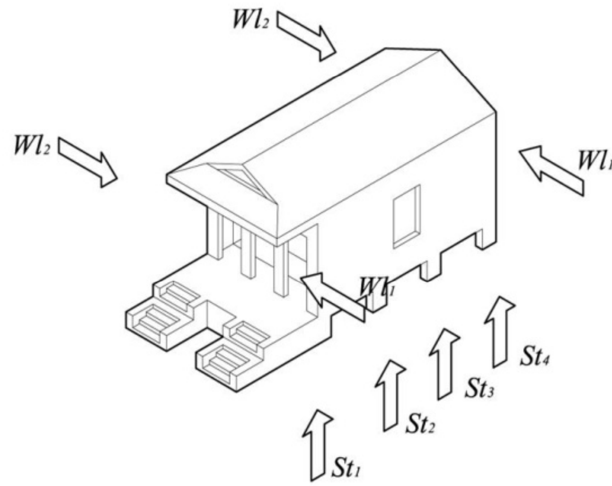


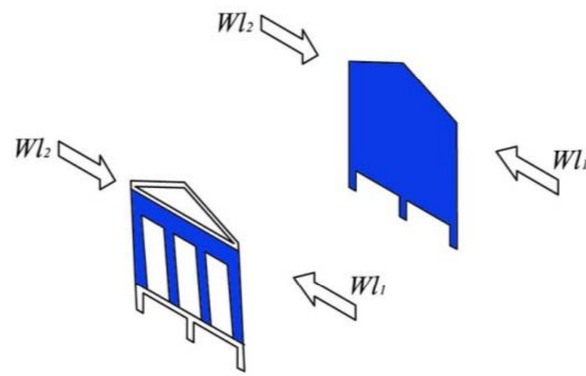
Assembly

Step 4

Assembly

Step 4





- Certified for a 75mph
- Can withstand a 140mph

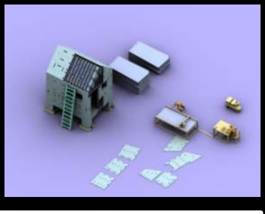
  Daniel Bonardi PE, Cambridge , MA

Interim Construction

FEMA Trailers

Tents → Permanent Buildings

5-15 years



New
Research