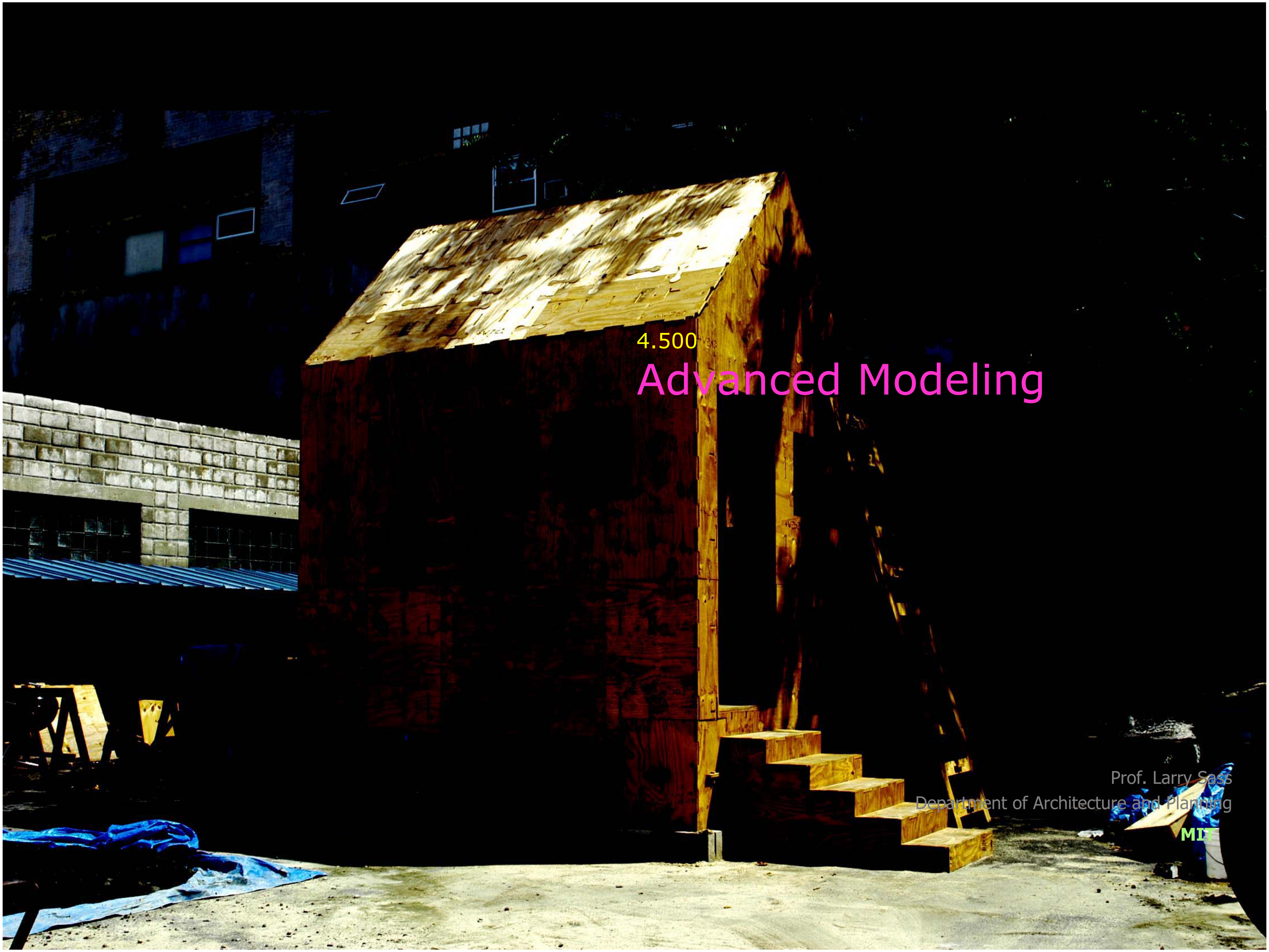
4.500 Introduction to Design Computing
Fall 2008


4.500
Advanced Modeling
Prof. Larry Sass
Department of Architecture and Planning
MIT

Scientific Research

- Publications
- Exhibits
- Lab Group – DDFG
- Teach 3 Fabrication Courses

Theory

Any 3D *(S)* shape can be converted to 2D shapes (fab) for manufacture with a construction grammar (Rules) and digital fabrication devices at any scale. Results are high quality structures.

Larry Sass

$$S \rightarrow \mathit{Rules}_{(fab)} = \mathit{Artifact}$$


a
b
c

Impact of Digital Fabrication on Design

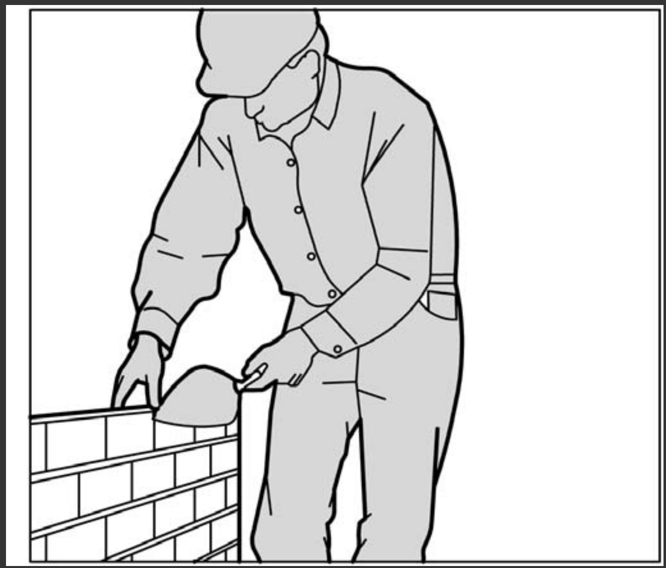
- CAD becomes important – BIM (building information modeling)
- Architects extend fees into the construction of buildings
- Takes advantage of low skilled labor
- Cost control by removing specialties in manufacturing
- Designers can manufacture complex designs with controlled costs

Problem

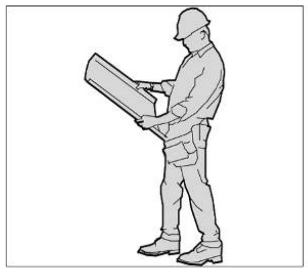
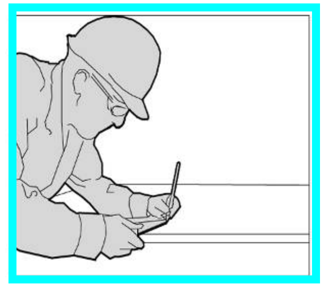
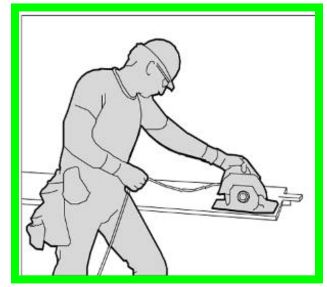
Error in Construction

Imprecise Measures

Cost per square foot



The Cutting Edge of Home Design


- Factory based construction
- Hand Operations
- High Energy
- Imprecise measuring
- Imprecise cutting
- Imprecise assembly



Materialization

Advances in digital fabrication

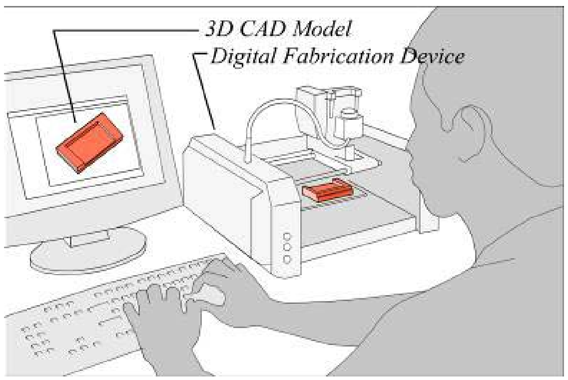
- Assembly Only Construction Sites
- **Impact:** Increased quality of building production in local communities with limited resources and developing countries
- **Challenges:** Development of new software systems
- **Vision:** Toyota of Housing – **Affordable Design**

Vision of Materialization

[1]
CAD

[2]
machine & material

[3]
assembly



Machine
Measuring
(MIT)

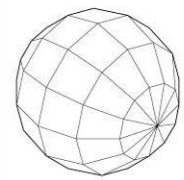
Machine
Cut or Build

Machine
Assembled
(ETH)

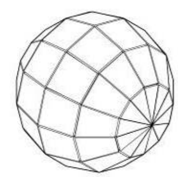
Materialization Process

Current Research

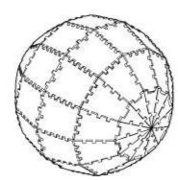
- Step 1 – Generate a design/model in any CAD software (Google Sketchup).



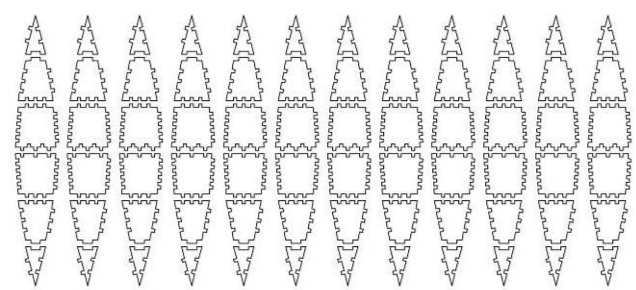
- Step 2 – Surface subdivision (under development)
  - Limits of objects based on machine
  - Structural testing
  - Energy testing
  - Materials quantity testing



- Step 3 – Construction Modeling (under development)
  - Assemblies modeling
  - Materials modeling



- Step 4 – CAM Cutsheets (under development)
  - Materials and machine data



Materialization Process

Current Research

- Scaleable data
  - No need for new measuring
- Precise Data
  - Supports good communication
- Rapid Manufacturing
  - One machine
- Distributed Manufacturing

Materialization

Advances in digital fabrication

[1] [2] [3] [4] [5]

Shape → *Shape Analysis* → *Subdivision of Geometry* → *Manufacturing* → *Self Guided Assembly*

- CASES
- **Chair**
- **Plywood Cabin**
- **Digitally Fabricated House for New Orleans**

Chair Design

MIT Spring 2006
Initial Designer

Design a Chair Shape

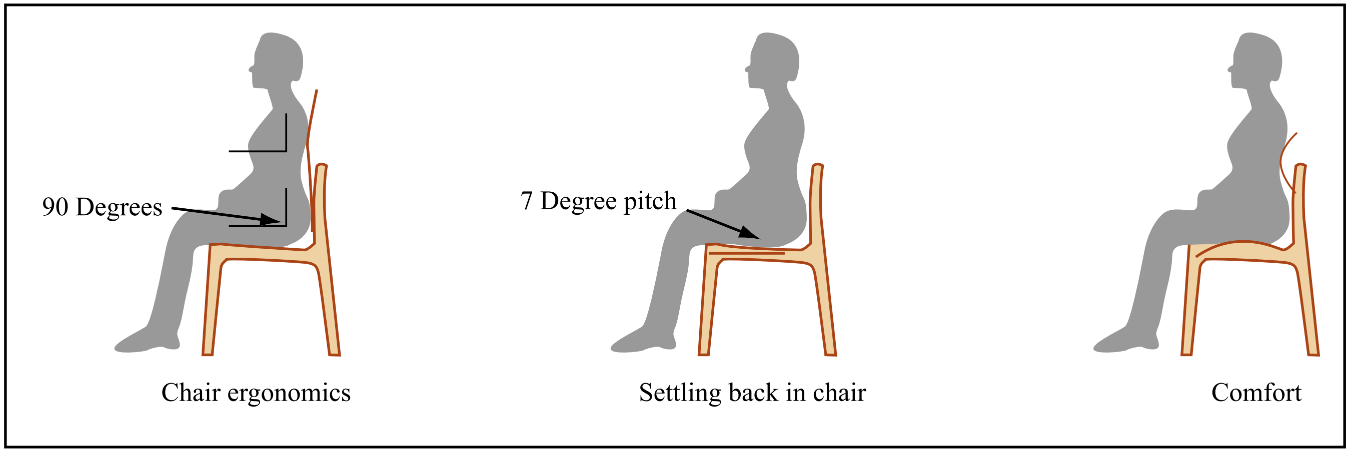
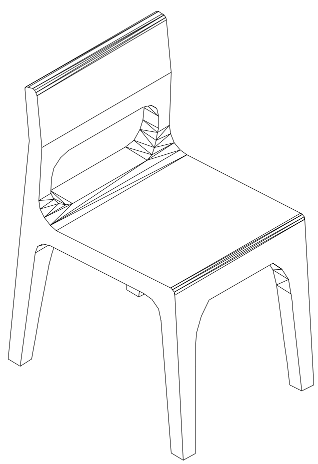
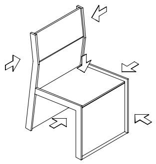
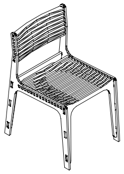
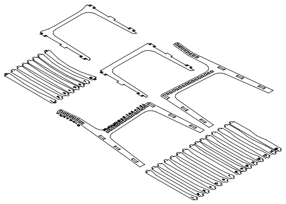
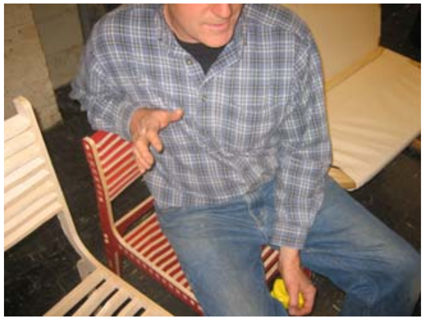


Figure by MIT OpenCourseWare.





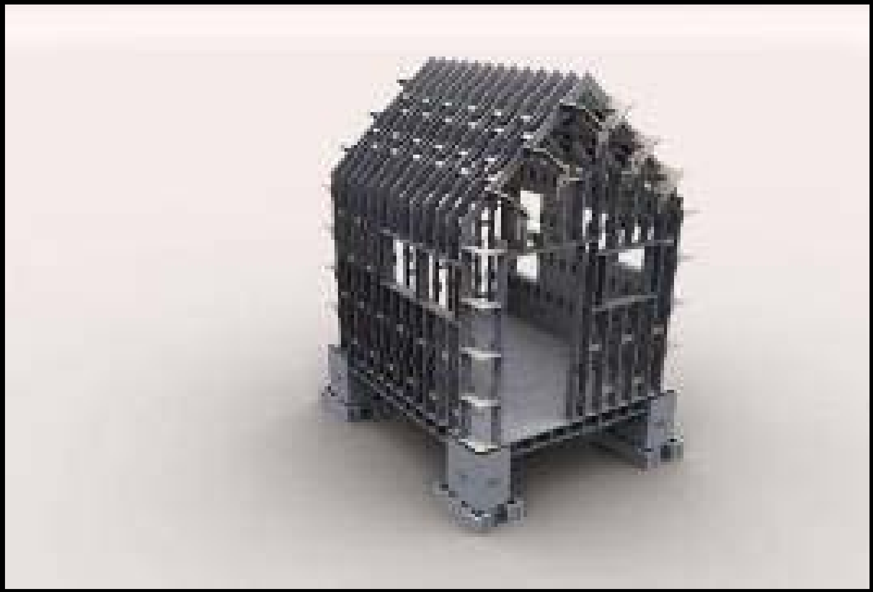
Step 1:

CAD - Design Model

Step 2 & 3:

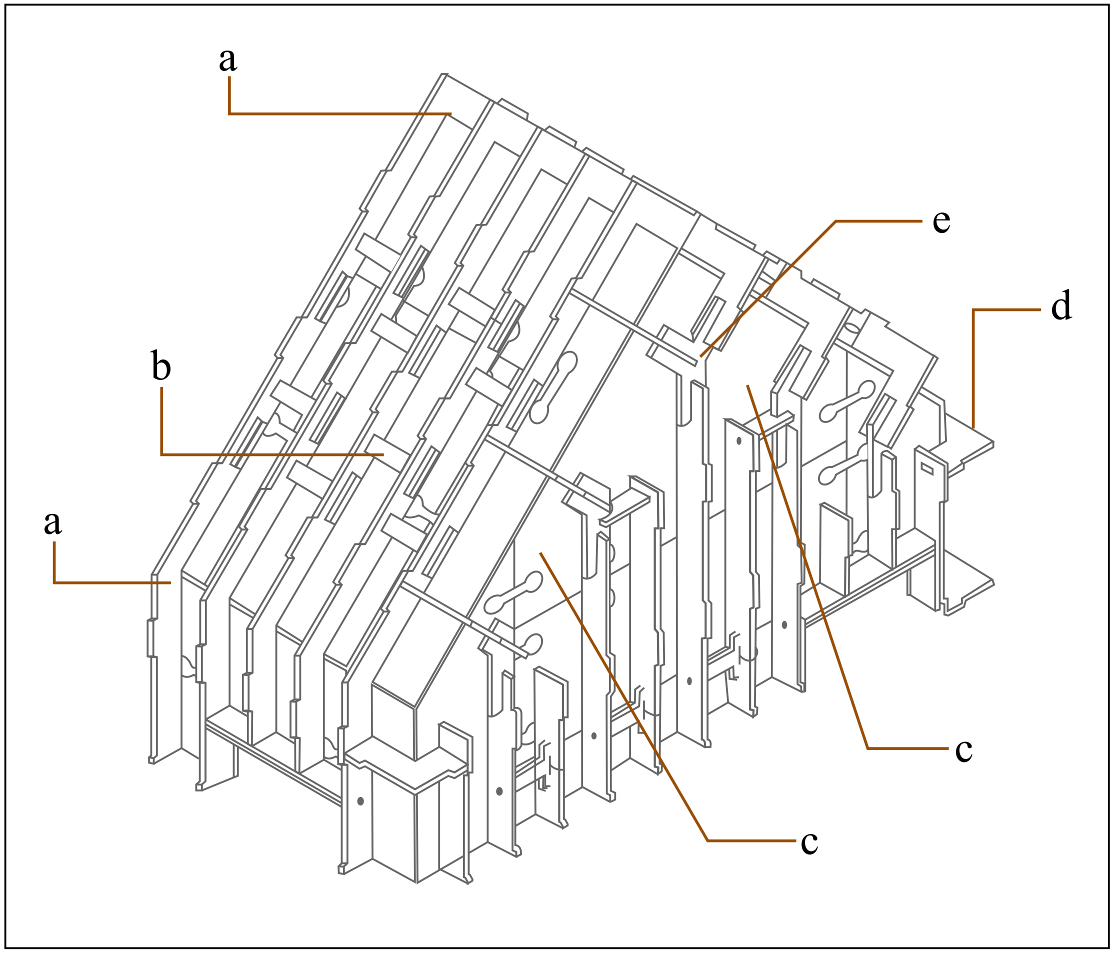
CAD – Component design & analysis

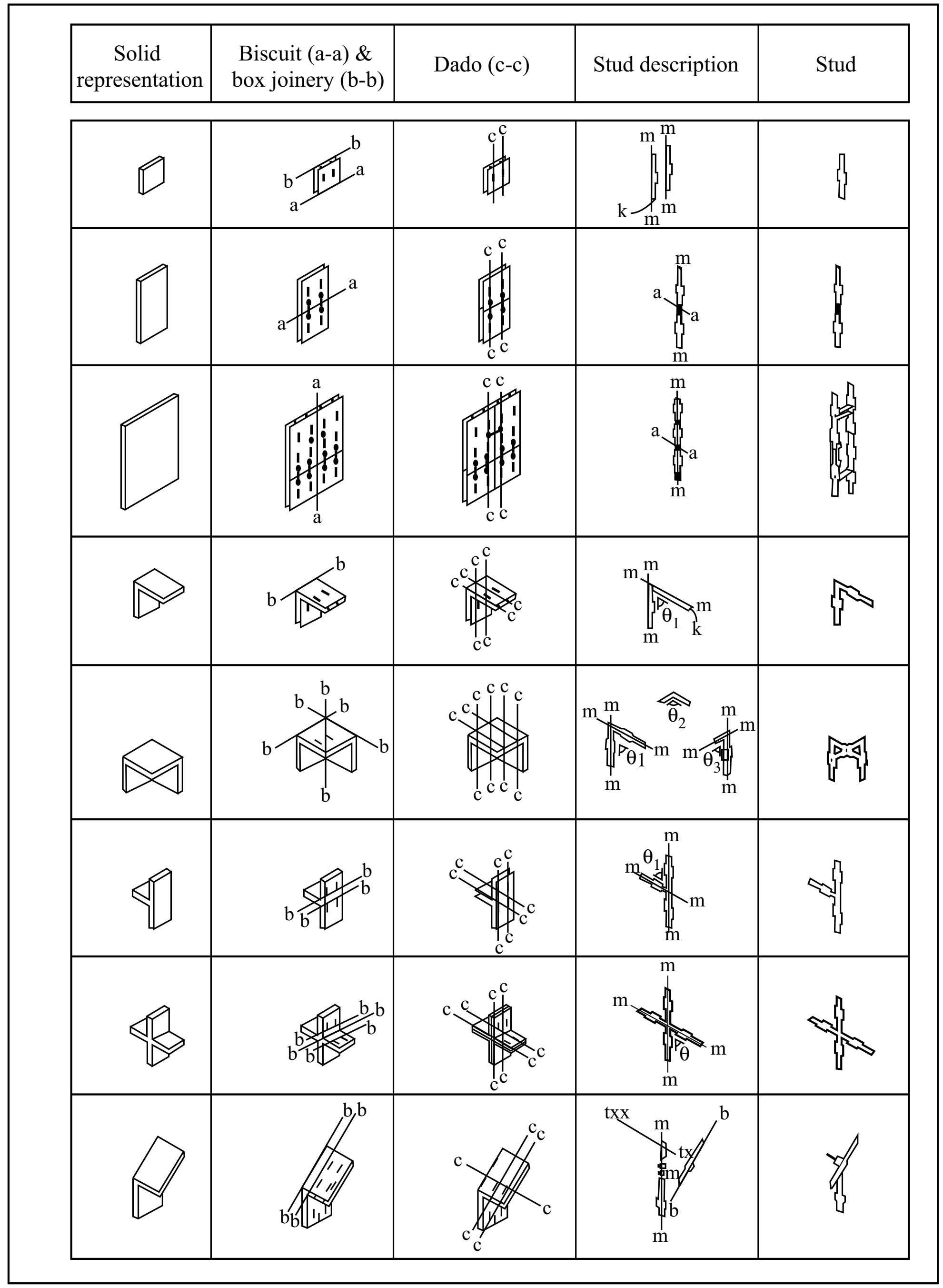
- One Room with Furniture
- 114 Sheets of Plywood
- **984** components
- Approximate Cost $2,500
- Translate design model into construction components and fabricate in one month
- 3 Days to assemble model



Step 2:

CAD – Component design and analysis





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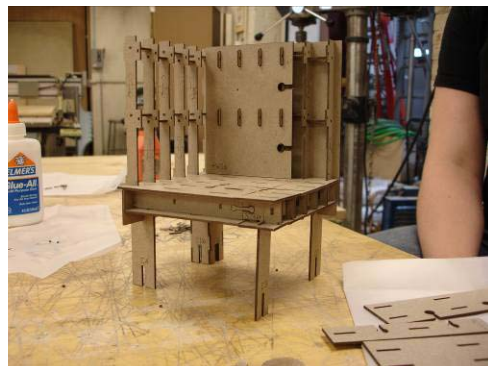
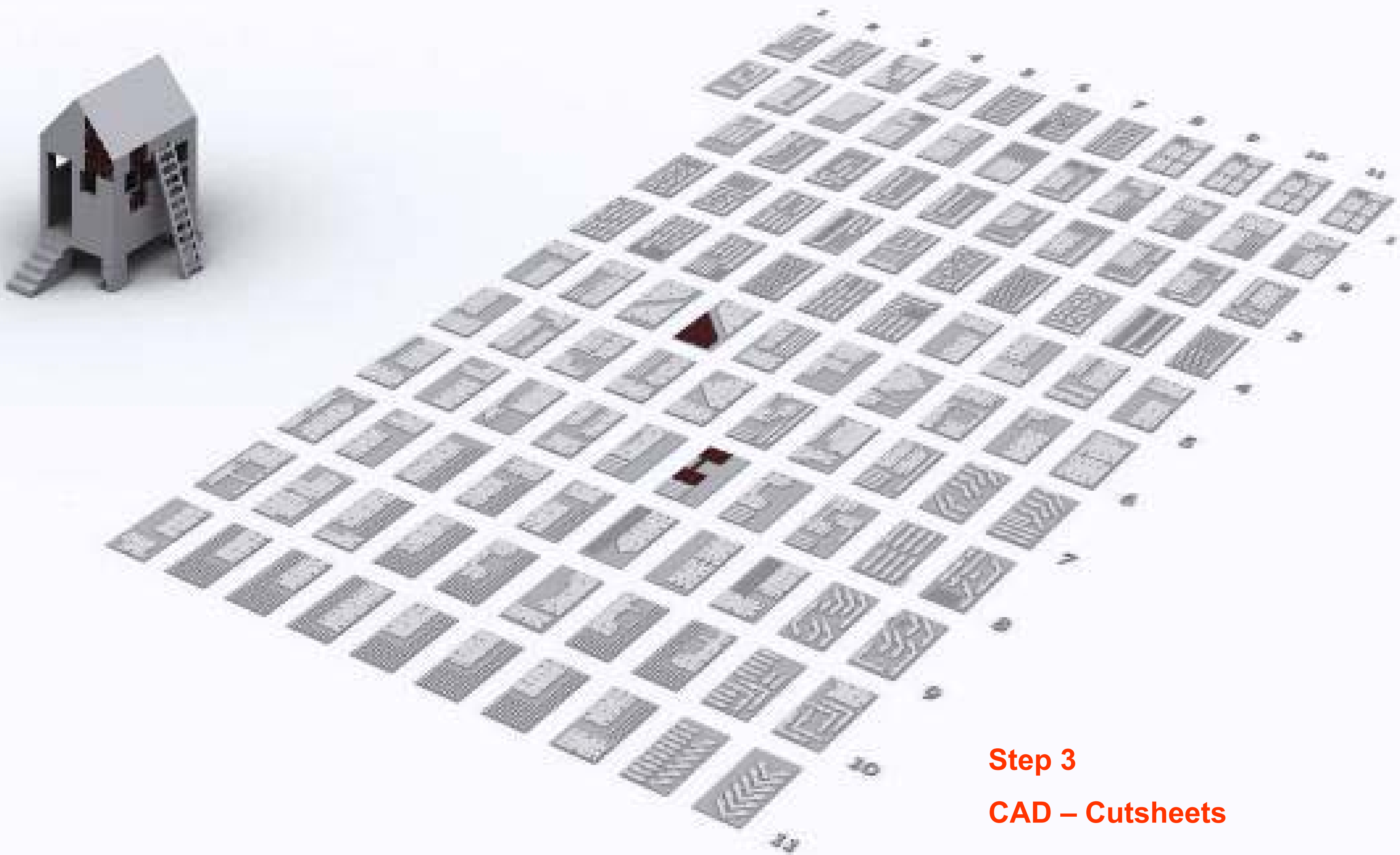
Design System

Integral Assemblies
(Plywood)
Summer 2005

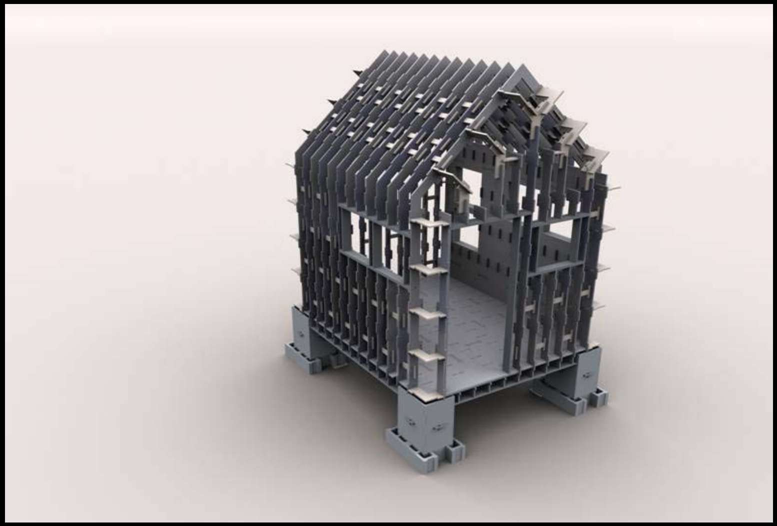
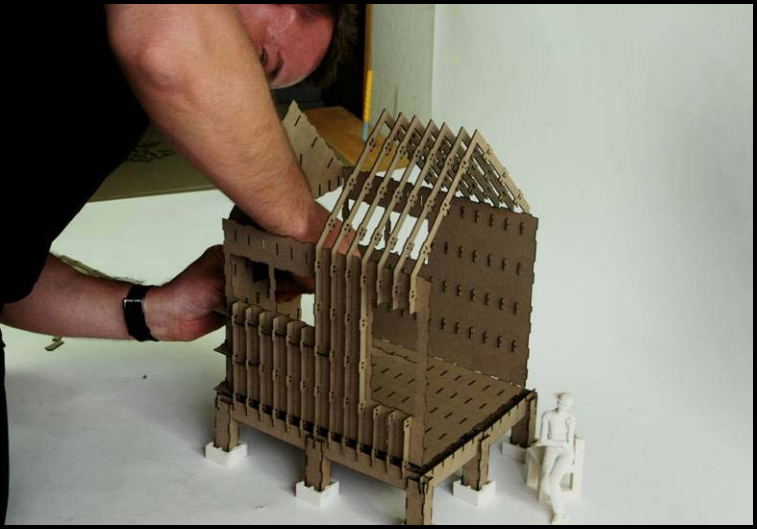
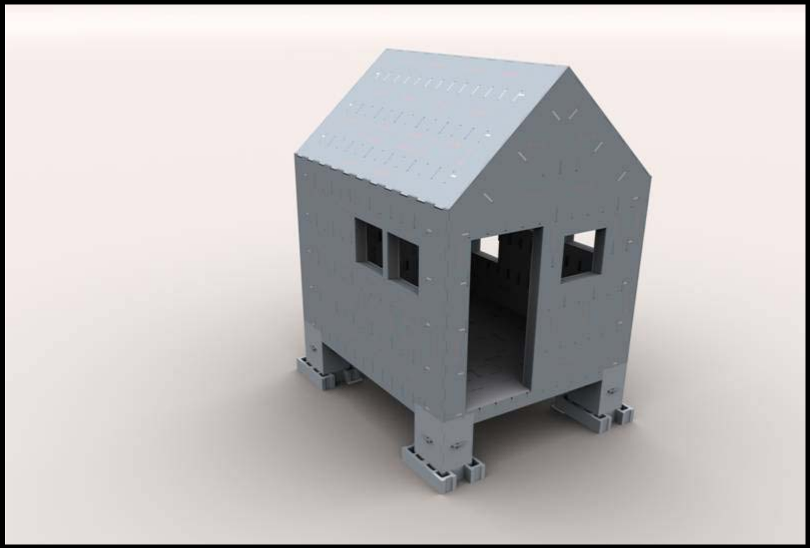




Step 3

CAD – Cutsheets





-W4b4
W4b2