4.510 Digital Design Fabrication
Fall 2008

Lecture 1

Materializing Design

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How does Digital Fabrication Work for architects?

- *Method - Materializing Design*
- *Generating Results - Artifacts*

Digital Fabrication

(Systems)

Design

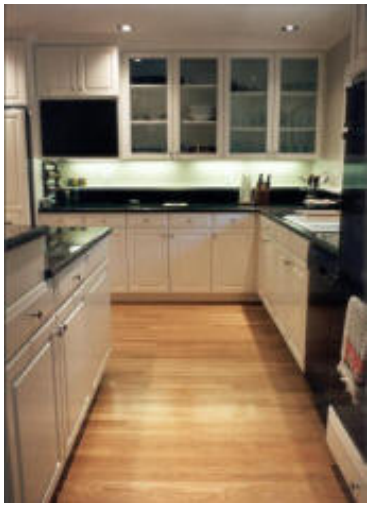
Rapid Prototyping

Construction

CNC Fabrication

Artifacts

(something created by humans usually for a practical purpose)



Vision of Digital Fabrication

Stephen Kieran & James Timberlake

- Increase the quality of the built environment
- Lower building cost
- Integration of building trades

Image of book cover removed due to copyright restrictions.

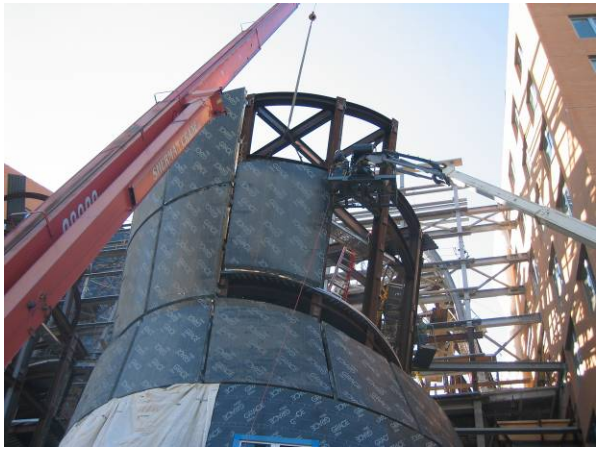
Kieran, Stephen, and James Timberlake. *Refabricating Architecture: How Manufacturing Methodologies are Poised to Transform Building Construction*. New York, NY: McGraw-Hill, 2003. ISBN: 9780071433211.

How is a Design Materialized?

- Materializing a design is transformation of a virtual artifact to a physical artifact

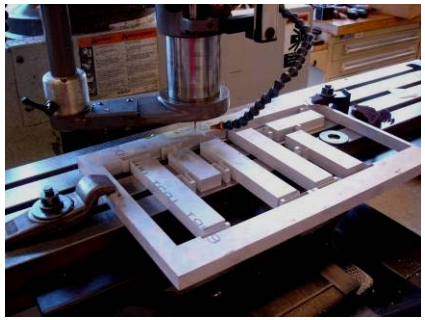
- In theory digital design and digital manufacturing methods will facilitate all forms of constructions

- 2D drafting will be substituted with representations in 3D for fabrication.



Ways to materialize an artifact

- Subtractive
  - Laser cutting
  - Waterjet cutting
  - CAD/CAM cutting



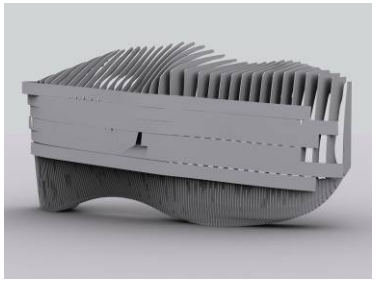
- Additive
  - Layered Manufacturing
  - Mold making

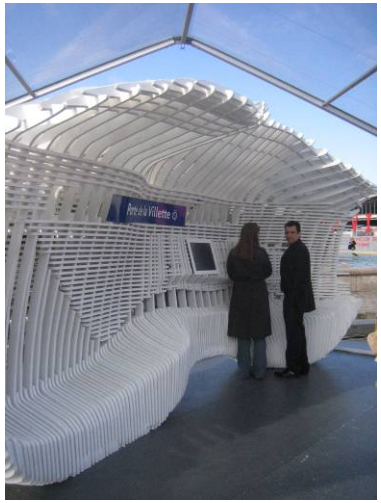
Integrated thinking?

- Benefits of digital fabrication
  - Concept to Construction processing
  - Fewer physical tools
  - Integration of design and manufacturing

- Integration of four sub-fields

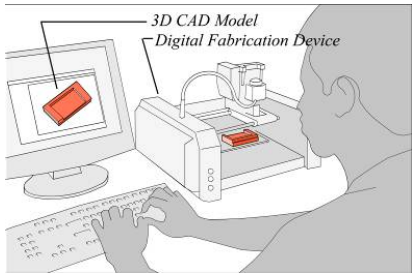
  1. Material/Structure
  2. Assembly
  3. Machining
  4. Modeling





How is a Design Materialized?

[1]
modeling



Measure

[2]
machine & material

Cut or Build

[3]
assembly

Assemble

Process

- Translation of a virtual artifact to physical artifact
- Design Language
- Constraints

Physical	***Visual***
Structural	Form
Assembly	Spatial
Material	Ornamental
Machine	Style

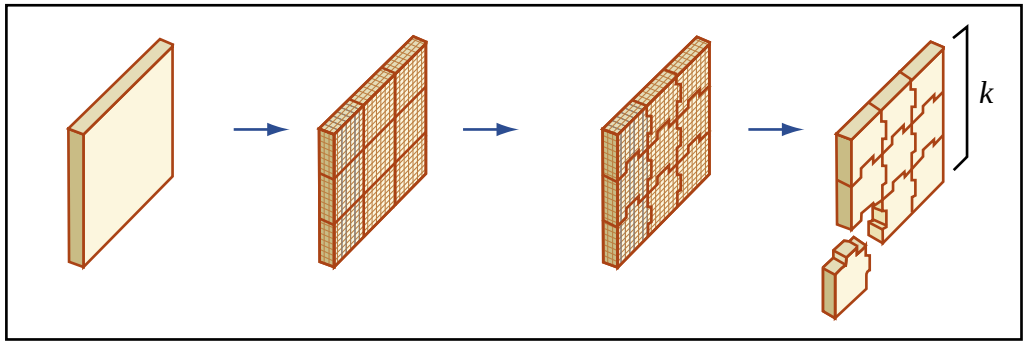
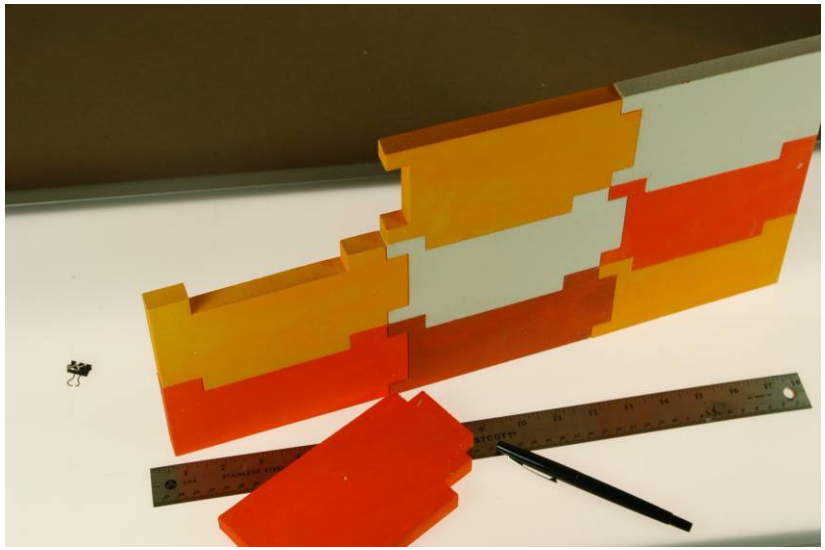


Figure by MIT OpenCourseWare.

a

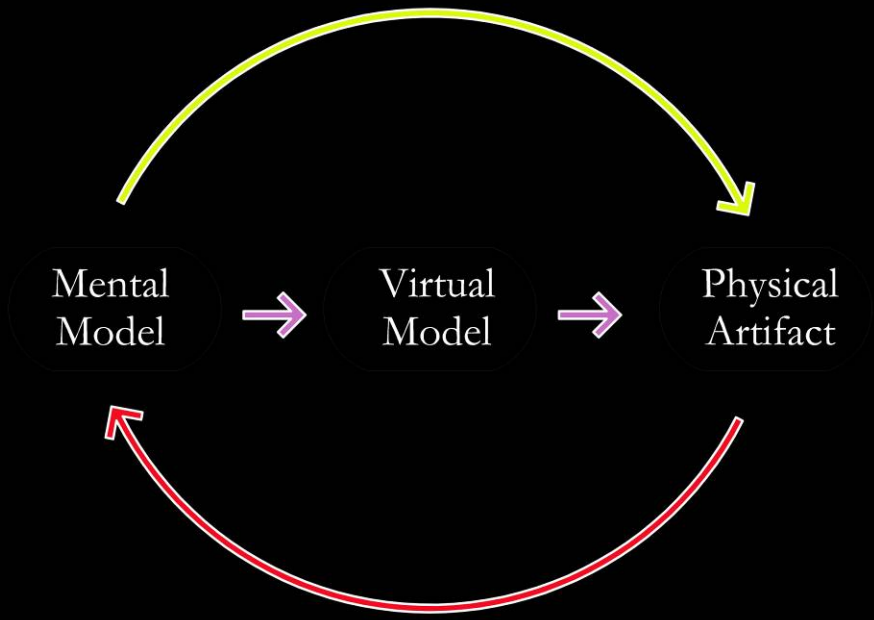
b



c

Integrated Thinking

1. Modeling/CAD
2. Assembly
3. Machining
4. Material/Structure

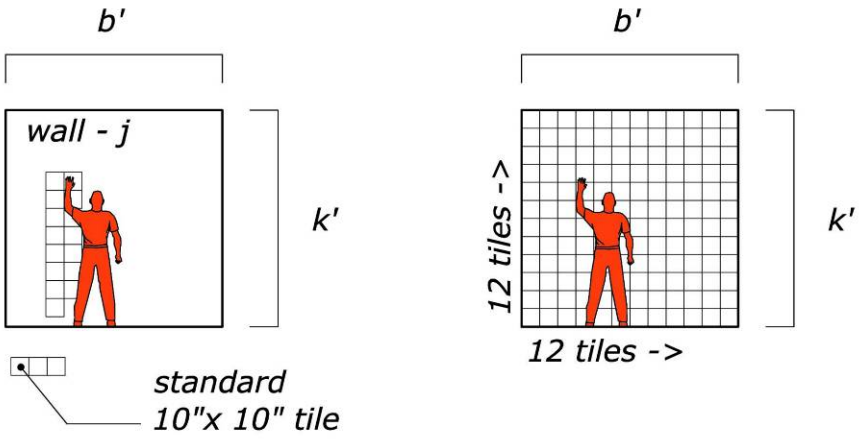


Error in Fabrication

- Error Correction and Redirection is found in Telecommunications – Ability to detect errors in data transmission across a noisy channel
- What is an architectural Error
- Patterns – Interior & Exterior Finishes
- Error is unpredictable & costly

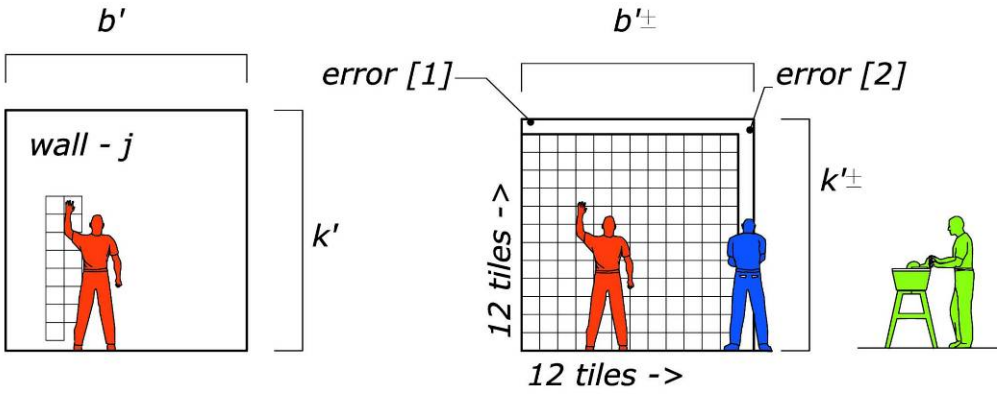
WALL [A]

144 tiles x a = cost



WALL [B]

144 + (25 tiles x a (m & c)) = cost



Cost of Error

Wall [A] = - Assembly only

Wall [B] = Assembly + Measure+ Cut

HouseCostTime = (*nWalls* x [A]) + (nWalls x [B])

Solutions

Error in fabrication is reduced by

1. cutting or building components with precise machinery

2. Reduction in the number of parts in construction

3. By guiding assembly through smarter components

Results = lower cost, faster construction, higher quality buildings

Methods

Frank Gehry

Kieran/Timberlake

Berhard Cache

Legacy Home Delivery Systems

- Low precision
  - Hand cut parts
- Slow Production
  - Production = (m + c + a) num_parts
- Each cut part is unique
- Most finishes are hand cut on site
- High cost

Stick build

Factory build

Digital Home Delivery Systems

Benefits

- High precision
- Fast fabrication (machine made)
- Reproducible
- High variety
- Low cost
- Safe construction

limitations

Digitally fabricated homes

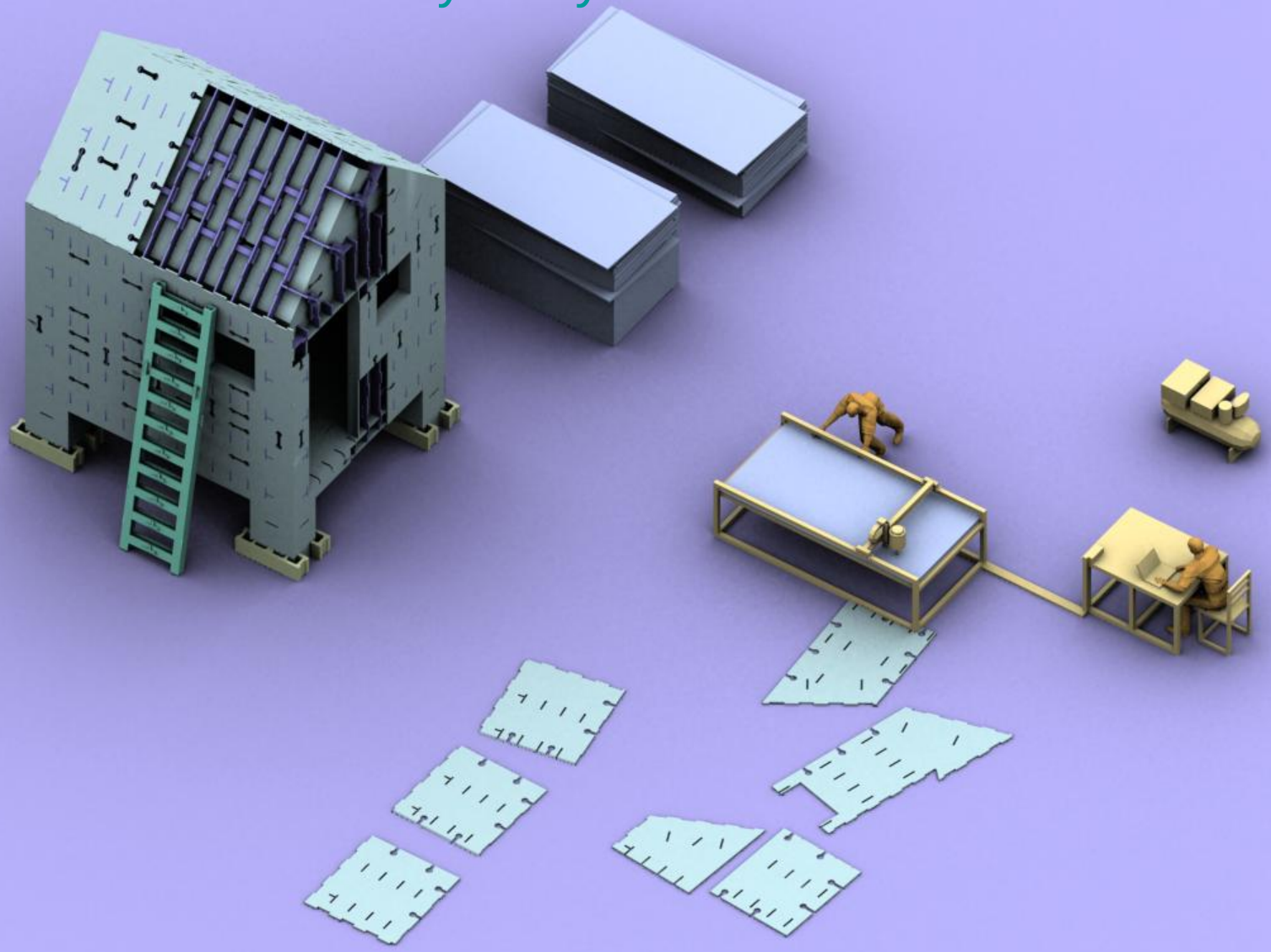
1. Material waste

2. Few proven systems

3. Labor intensive in design (Building Information Modeling)

Materializing Design @MIT

by Larry Sass

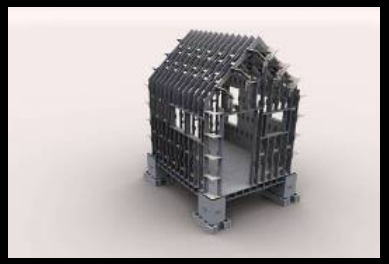


Project Data

- 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

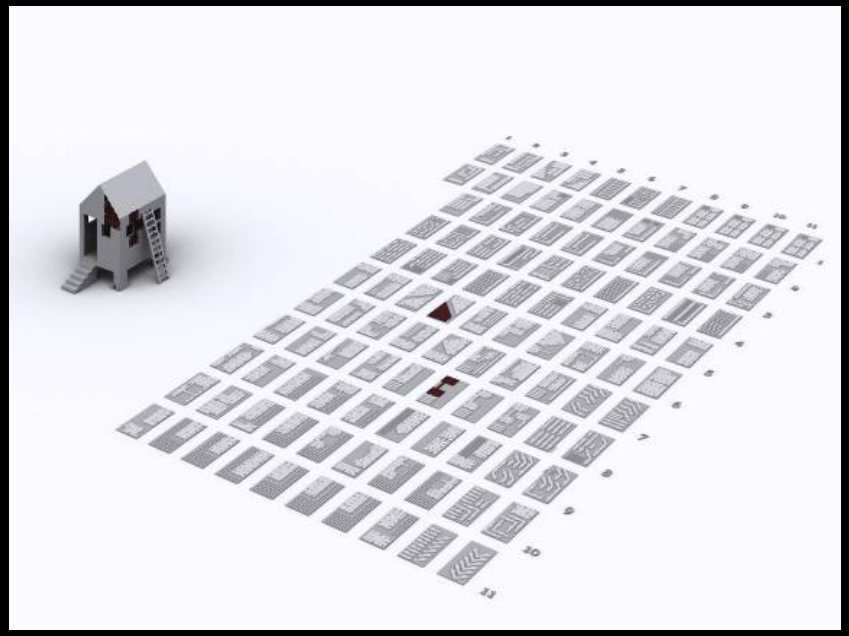
Generating Compliant Descriptions

Design Model



Construction Model

Cut sheet



Compliance

Computational (measurable)

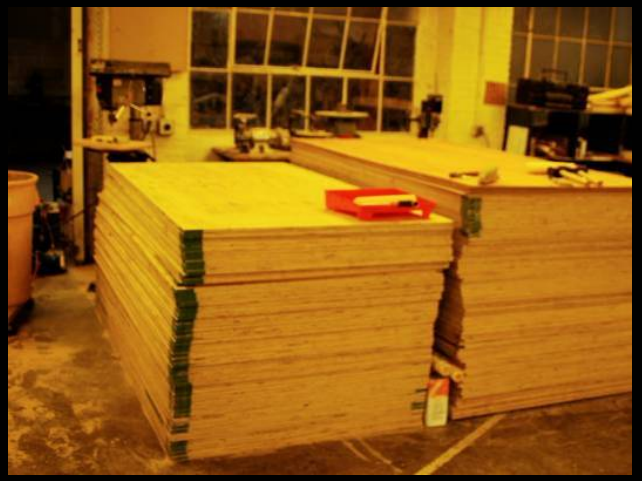
Physical

Structural
Assembly
Material
Machine

Visual

Form
Spatial (Floor plan)
Ornamentation
Style

Start
CNC Machine



Material Stock
114 Sheets of
Plywood

Assembly with a
rubber
mallet only

Summary

- How does Digital Fabrication Work for architects
  - *Skills*
    - CAD
    - Machines
    - Materials
  - *Method*
    - Materializing Design
  - *Results Complaint Artifacts*