DESIGN ENGAGEMENT

Building the Team and Managing the Design

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Big breakthroughs happen when what is suddenly possible meets what is desperately necessary.

Thomas Friedman
Construction productivity 1950-2012
Real productivity (GDP value-add per employee) by industry in the US
Indexed; 1950 = 1.0

SOURCE: Bureau of Economic Analysis (BEA), Hideyuki (2011)
A Challenged History:

**Built-in Inefficiency**
- Weather-based delays and shutdowns
- Linear Process
- Raw materials to finished product under difficult conditions

**Skill Degradation**
- Extreme personnel turnover rates (20%-60%)
- Majority of workers have minimal education
- Lack of education, skills & attitude for new demands
- Minimal or zero requirements

**Poor Quality**
- Buildings are the most defective products consumers purchase.
- 15% - 80% serious defect rate
- Decades-long industry culture of accepted compromise
CHALLENGES:

Field Labor
- Availability
- Skill
- Cost
- Productivity

Construction Materials
- Cost
- Availability
- Sustainability
SOLUTIONS:

Fully “Digitized“ Structure
• Model based survey & layout
• Subtrade Coordination
• Machine Files
• Off-site fabrication

Collaborative Delivery
• Design team buy-in
• Contractor buy-in
• Early trade partners
• All elements modeled
• Early and continuous planning

• 2014, Portland, OR
• Fully digitized concrete structure
• 100% prefab facade without the possibility of field verification
Other Industries Get It

Cruise ship bathroom pod

Subassemblies built in a controlled environment
Learn From Everywhere

DIGITAL DESIGN | BUILD

SCANDINAVIA
- Optimization
- Most Off-Site
- Construction Appropriate Technology
- Best Energy Standard Building
- Science
- Montage Design

NEW ENGLAND
- TF Legacy Building
- Off-site Benefits and Skills
- 3D Modeling Value
- Discipline of Connections
- Site Efficiency
- Tools & Logistics
- Discipline & Skills

GERMANY | AUSTRIA | SWITZERLAND
- CNC Tools
- Software Lead
- Technology Adaptation
- Modern Manufacturing
- Advanced Education for Trades
- Durable Building Standard

HOLLAND
- Open Building
- Lives Must Prevail
- Rational Design & Building
- Time based organization
- Sustainability through Adaptability
- Dimensional Coordination

JAPAN
- Lean Manufacturing
- Kaizen
- Precision
- Power of Modularity
- Tradition of Perfection

FRANCE
- Pride in Craft/Training
- Craft Knowledge
- Personal Discipline
- Humility
- Historical Perspective
Elsewhere: European Mass Timber

Hermann Blumer, Timber Engineer, Switzerland

Models are an extension of their design and carpentry expertise.
Everything Modeled

Plan, Deliver, and LEAD

THE POWER OF BIM

• Design = simulated building
• Automated PM information - costs, supply chain, shipping, etc.
• Automated cutting and shaping machine code

North Adams, MA
Bensonwood, Randall Walter, Architect
Models now drive woodworking tools and off-site fabrication - from cheese boards, to shear walls, to facade panels.
BIM to CNC
Our Tireless Workers

Bensonwood • Walpole, NH
Bensonwood • Keene, NH
THE MODEL BECOMES THE BUILDING

• The shared work space for all contributors & team members
• First built in the model, and then assembled in the field
• Machine files are as close as we can get to 3D printing
Layout, cutting & optimization

Bensonwood
Keene, NH
Material Handling

Automated inventory management

Bensonwood
Keene, NH
Case Studies & Examples

Rocking Shearwalls – Shop installation

Boundary Anchorage and Energy Dissipation System

Corvallis, OR
If part of the building, it MUST be included in the model.

• What is the source of the model?
• Interface surfaces
• Un-modeled elements lead to issues
• Appropriately timed coordination is the key
• Figure out the MEP strategy along with the structural frame
Engagement of Team for System Decisions

• Project Goals
• Code Constraints
  ▪ Building Type
  ▪ 1 or 2 hour frame?
  ▪ Allowable Height
• Energy performance
• Carbon Sequestration
• Third party certifications

• Lateral system selection
  ▪ Braced frames
  ▪ Concrete cores
  ▪ CLT shear walls
• All timber structure
• Composite structure
• Bay layout & beam orientation
• Preferred details
• Schedule
Case Studies & Examples

MEP routing designed WITH the framing layout design.

Utility gap and beam-free colonnade.

District Office, HACKER - Portland, OR
Case Studies & Examples

Design/Build Mass Plywood Stair
Portland, OR

1. BIG IDEA
2. Sketch
3. Model
4. Review
5. Correct
6. Final Review
7. Final Check
8. Prepare Machine Files
9. Fabricate
10. Install
Model snapshot of the machine files
Stair stringer prototype. (Wrong thickness.)

All components factory cut...
Bath & Mechanical Room Pods

Bensonwood
Walpole, NH
Bathroom Pods Montage

Bensonwood Walpole, NH
Cartridge assembly

On-Site

Cartridge Installation

Bensonwood • Walpole, NH
An integrated design phase = EFFICIENT CONSTRUCTION

- Productivity
- Reduced site impact
- Less waste
Site Assembly

North Adams, MA
Early digital collaboration mean better decisions...

EXPOSED STRUCTURE STRATEGY
MECHANICAL SYSTEM SELECTION
SYSTEMS DISTRIBUTION STRATEGY
  ▪ Vertical risers
  ▪ Horizontal Distribution
CONSTRUCTABILITY
  ▪ Timber connection details
  ▪ Moisture Mitigation Planning

ASSIGNED SYSTEM PATHWAYS
  ▪ Sprinklers
  ▪ Vertical Electrical
  ▪ Horizontal Electrical
  ▪ Plumbing
  ▪ Fire alarm and electrical
Important Differences

ON-SITE
- Schedule allows for field changes
- Each step adjusts to previous dimension and (in)accuracy

OFF-SITE
- Less design flexibility
- Accuracy is paramount - site portion affect install fit
- Cost may or may not be higher, however time=$
- Anticipate need to protect installed finish materials
- Design the schedule and share extensively

VS
How to Get Started

NEED SITE SPACE
• Deliveries
• Boom truck or crane
• Evaluate Access

PARTNERS
• Build a team
• Decide where info will live

DECISION MAKING & COMMITMENT
• Get everything in model early
• Work the model
• Rely on model
Concluding Thoughts:

What is each mass timber project?

- A unique prototype…
- With design and execution as isolated activities…
- Where hard lessons are learned…
- And, poor choices cannot be corrected?

- OR -

An opportunity to deliver inspired design…
In a context of collaboration…
Where decisions are reviewed and optimized early, and often.
With the right combination of design and execution expertise.
Thank you for your participation.

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