DESIGN ENGAGEMENT

Building the Team and Managing the Design

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Mass Timber Construction Management: Design through Project Close Out

Presented by Brad Nile and Kevin Bittenbender

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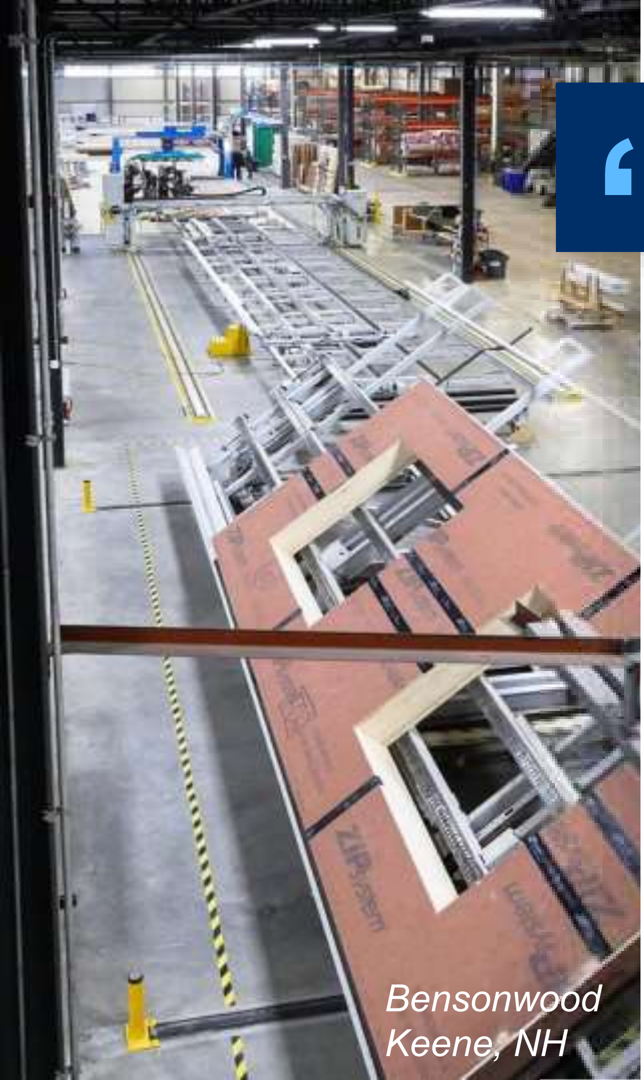
Course Description

Innovations in mass timber construction are offering new opportunities for the building industry. Products such as cross-laminated timber (CLT) and glue-laminated timber (glulam) combine multiple laminations of lumber to produce solid timber elements such as floor and wall panels, beams, and columns. These elements have high strength-to-weight ratios, allowing them to replace more traditional construction materials while providing sustainable systems that can meet code criteria for acoustics, fire-resistance, seismic performance, energy efficiency, and more. However, while design and code aspects of mass timber receive a great deal of focus, it is the construction aspects that often decide whether a project goes forward. Mass timber construction has similarities to other systems, but it also has unique attributes—and a complete understanding of the differences is key to efficient project cost estimation and efficient construction. This in-depth, multi-faceted workshop will explore mass timber from design through preconstruction, fabrication, erection, and project close-out. After setting the stage with an overview of mass timber products and sustainability attributes, discussion will focus on construction topics, including risk analysis, cost case studies design team interaction, cost optimization, scheduling, site planning, and other logistics. Intended for construction industry professionals looking to gain a deep understanding of the unique attributes of mass timber construction, this workshop will leave attendees with information they need to successfully bid and construct a mass timber project.

Learning Objectives

1. Understand the preconstruction manager's role in material procurement and coordination of trades for code-compliant mass timber projects.
2. Highlight effective methods of early design-phase cost estimation and building official interaction on code compliance topics that keep mass timber options on the table.
3. Discuss potential construction schedule savings and construction fire safety practices realized through the use of prefabricated mass timber elements.
4. Explore best practices for interaction between manufacturer, design team and preconstruction manager that can lead to cost efficiency and safety on site.


Bensonwood
Keene, NH

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

Thomas Friedman

ANDERSEN CONSTRUCTION

PORTLAND, OR • SEATTLE, WA • BOISE, ID







BENSONWOOD

KEENE, NH







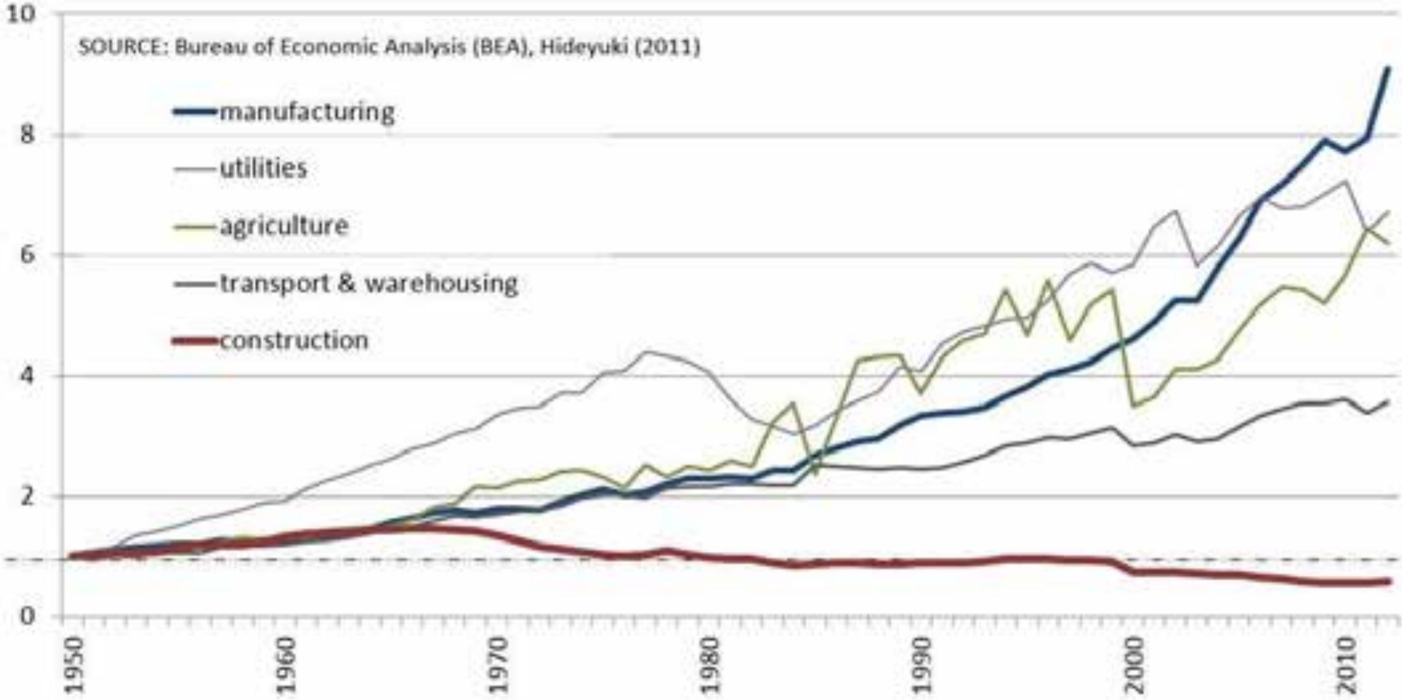
INDUSTRY CHALLENGES

What solutions can we adopt from other industries?

- What are the challenges?
- What are the solutions?

Construction productivity 1950-2012

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



[www.curt.org]

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

- *2014, Portland, OR*
- *Fully digitized concrete structure*
- *100% prefab facade without the possibility of field verification*

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

Other Industries Get It

Cruise ship bathroom pod

Subassemblies built in a controlled environment

Learn From Everywhere

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

JAPAN
Lean Manufacturing
Kaizen
Precision
Power of Modularity
Tradition of Perfection

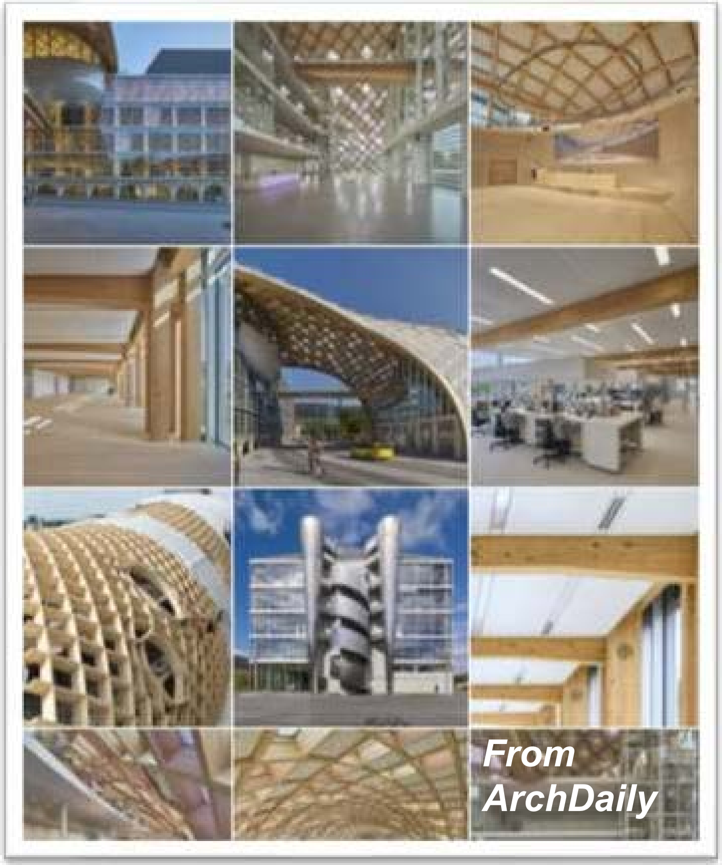
HOLLAND
Open Building
Lives Must Prevail
Rational Design &
Building
Time based organization
Sustainability through
Adaptability
Dimensional Coordination

FRANCE
Pride in Craft/Training
Craft Knowledge
Personal Discipline
Humility
Historical Perspective

Elsewhere: European Mass Timber

Models are an extension of their design and carpentry expertise.

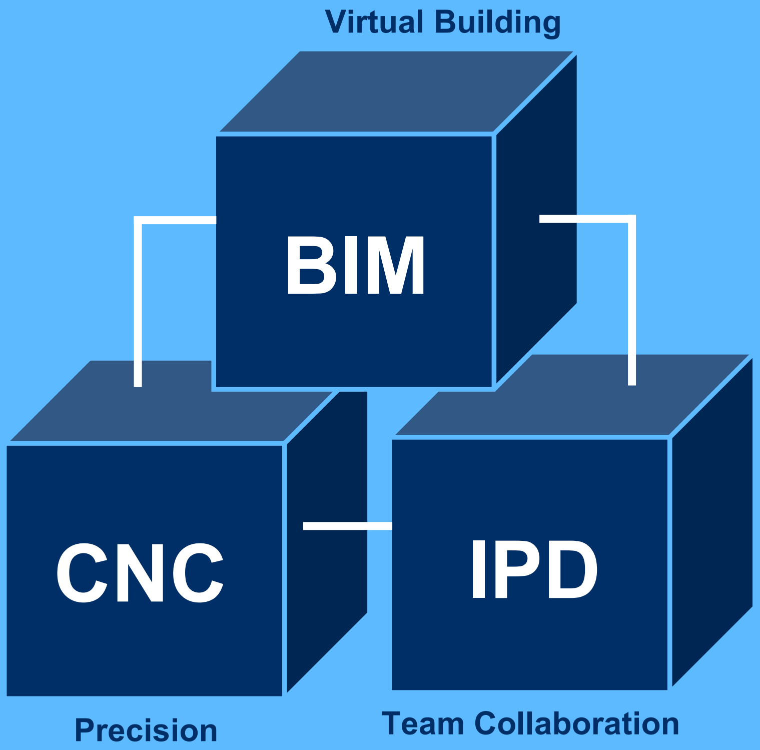
Blumer-Lehmann
Swatch Omega timber in the shop…
Gossau, Switzerland

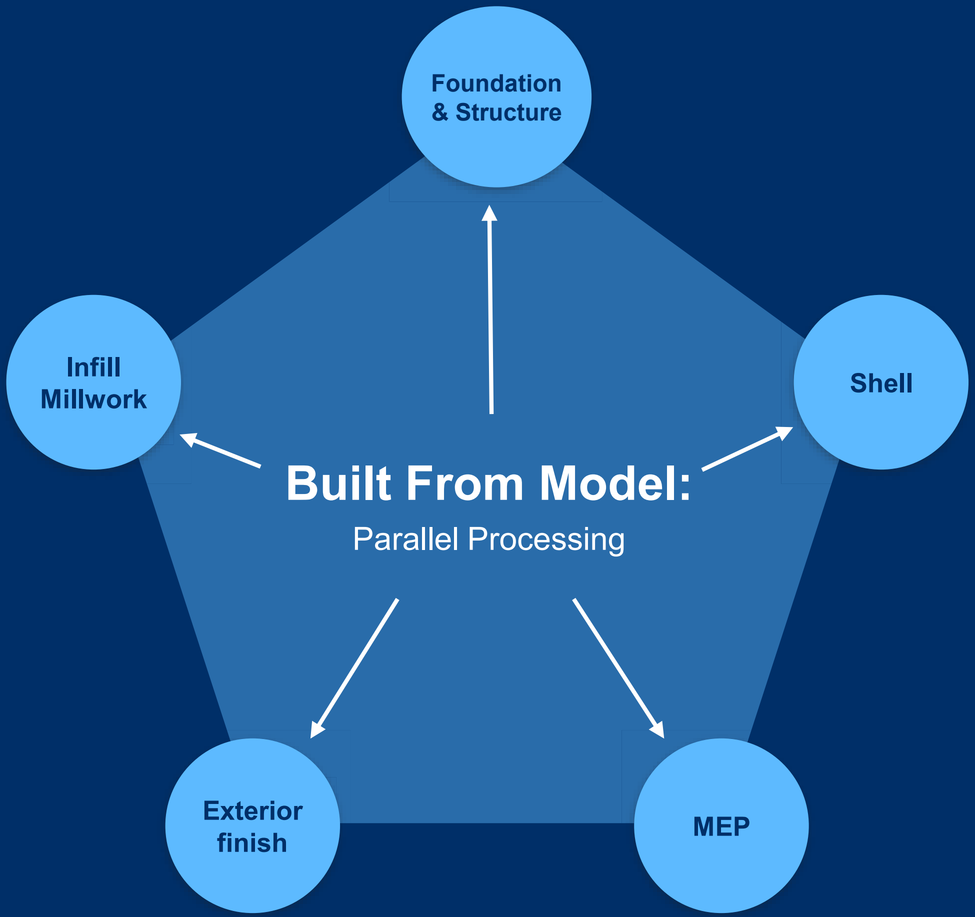


Swatch Omega Headquarters
Shigeru Ban Architect
Biel, Switzerland

Intersection of Strategies

Design | Build | Deliver | Digital Fabrication | Offsite





VS

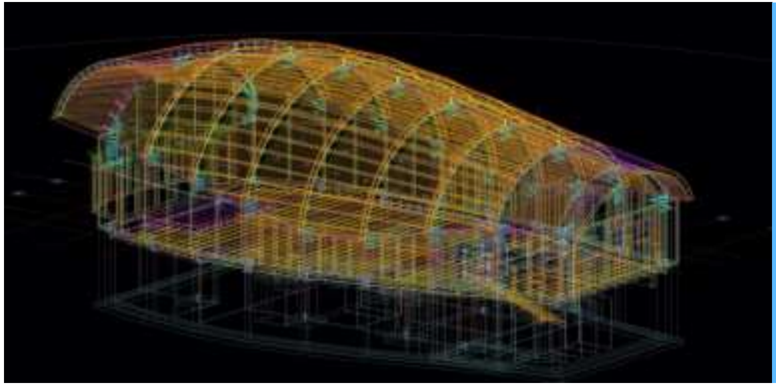
Site Process

1. Layout from plans
2. Cut
3. Attach
4. Measure
5. Order
6. Wait
7. Install
8. Measure
9. Cut
10. Fit
11. Repeat…

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,

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




Model based timber designs - Northern Italy

Layout, cutting & optimization

Bensonwood
Keene, NH

Material Handling

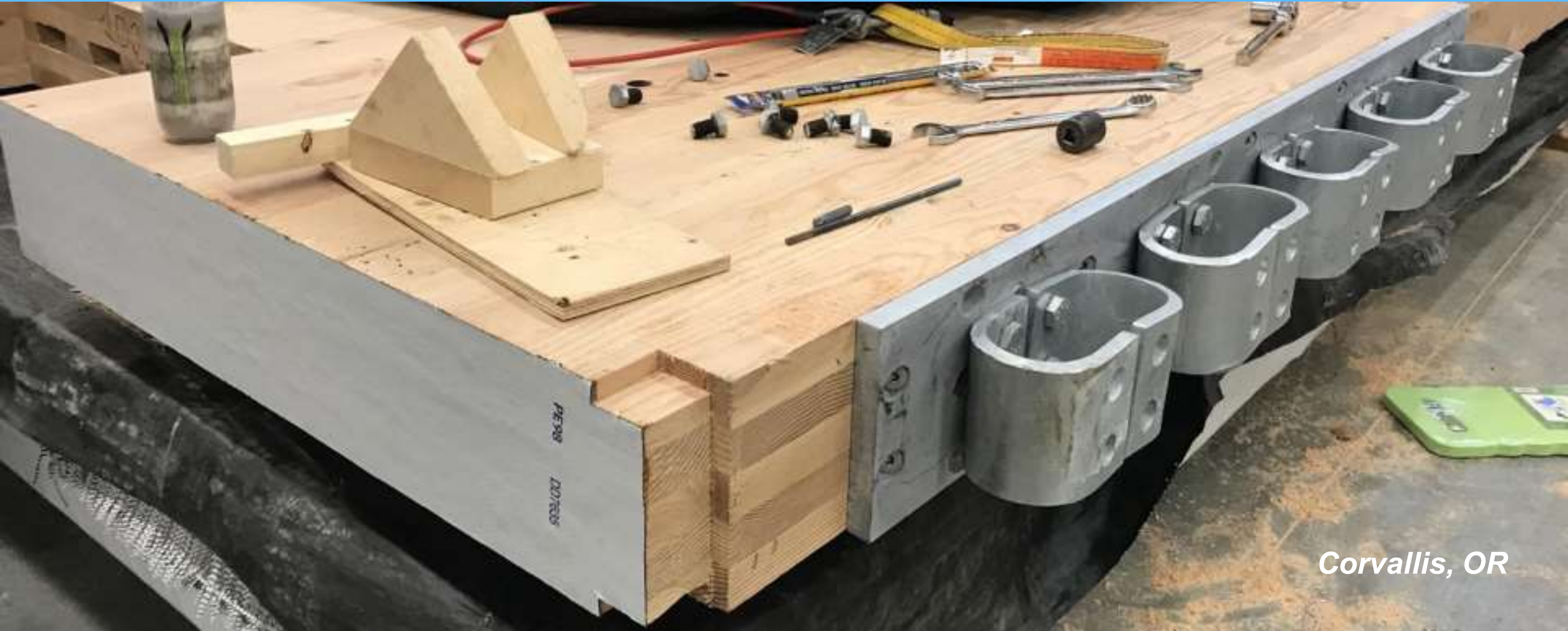
Automated inventory management

Bensonwood
Keene, NH

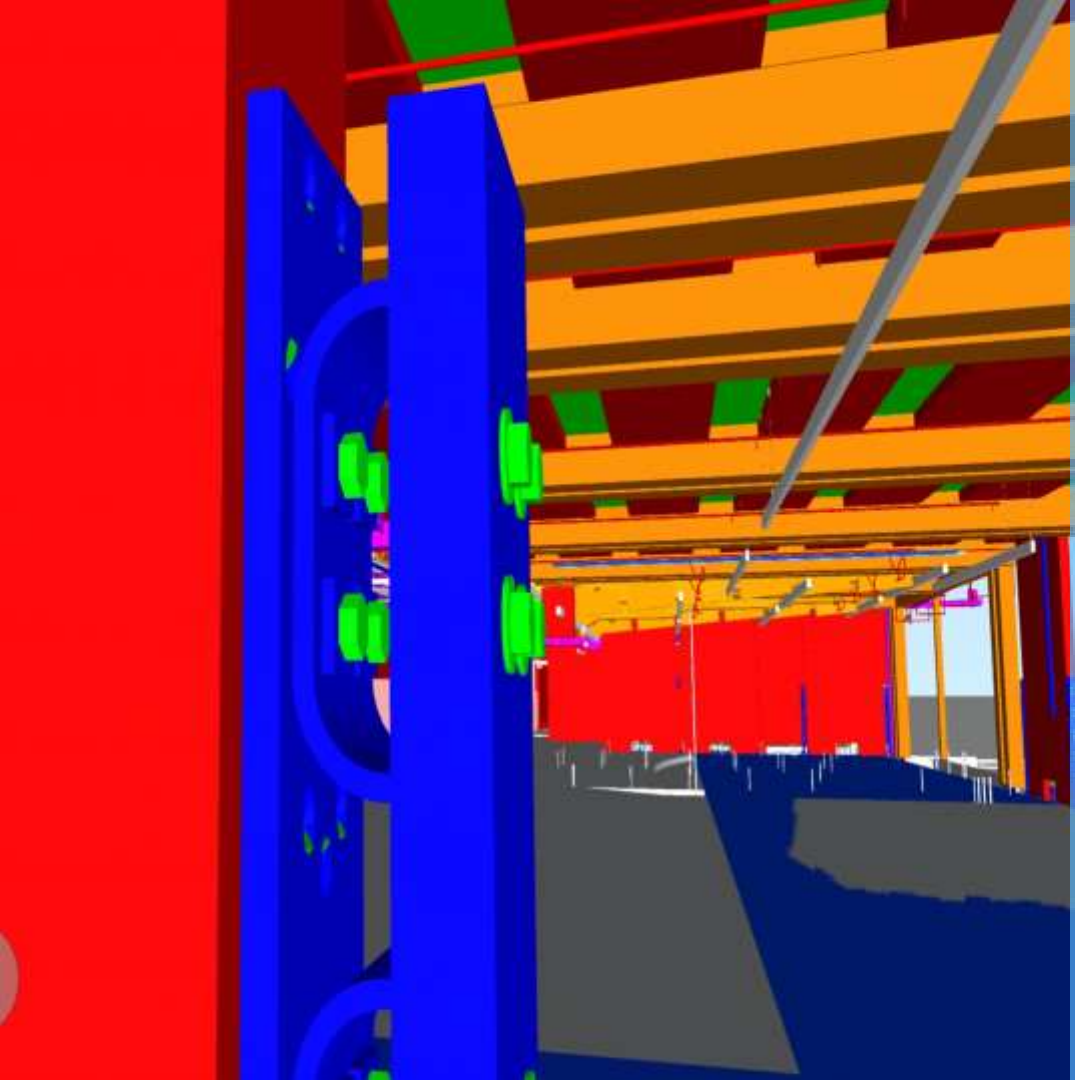
Case Studies & Examples

Rocking Shearwalls – Shop installation

Boundary Anchorage and Energy Dissipation System



Corvallis, OR

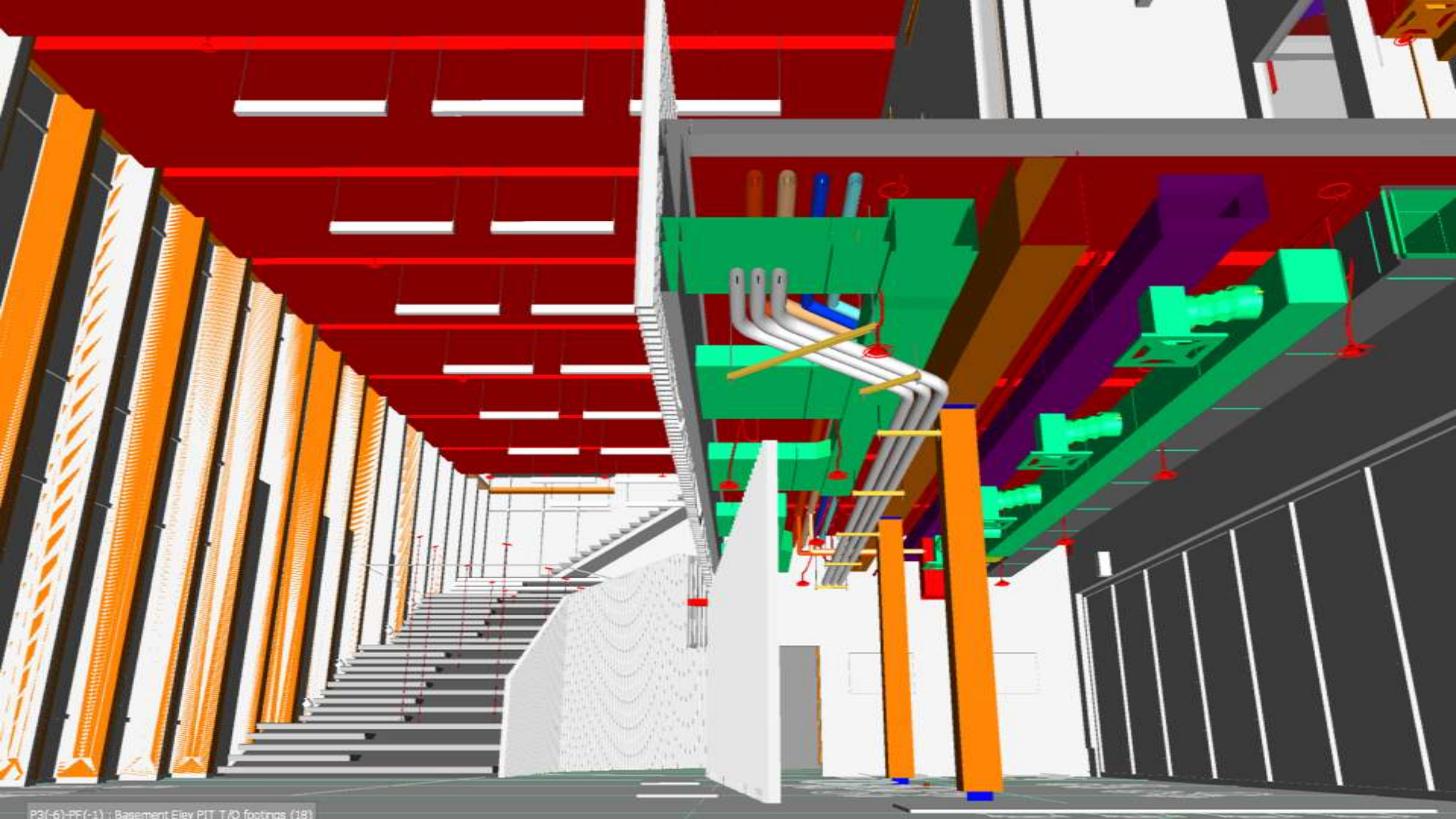


Corvallis, OR

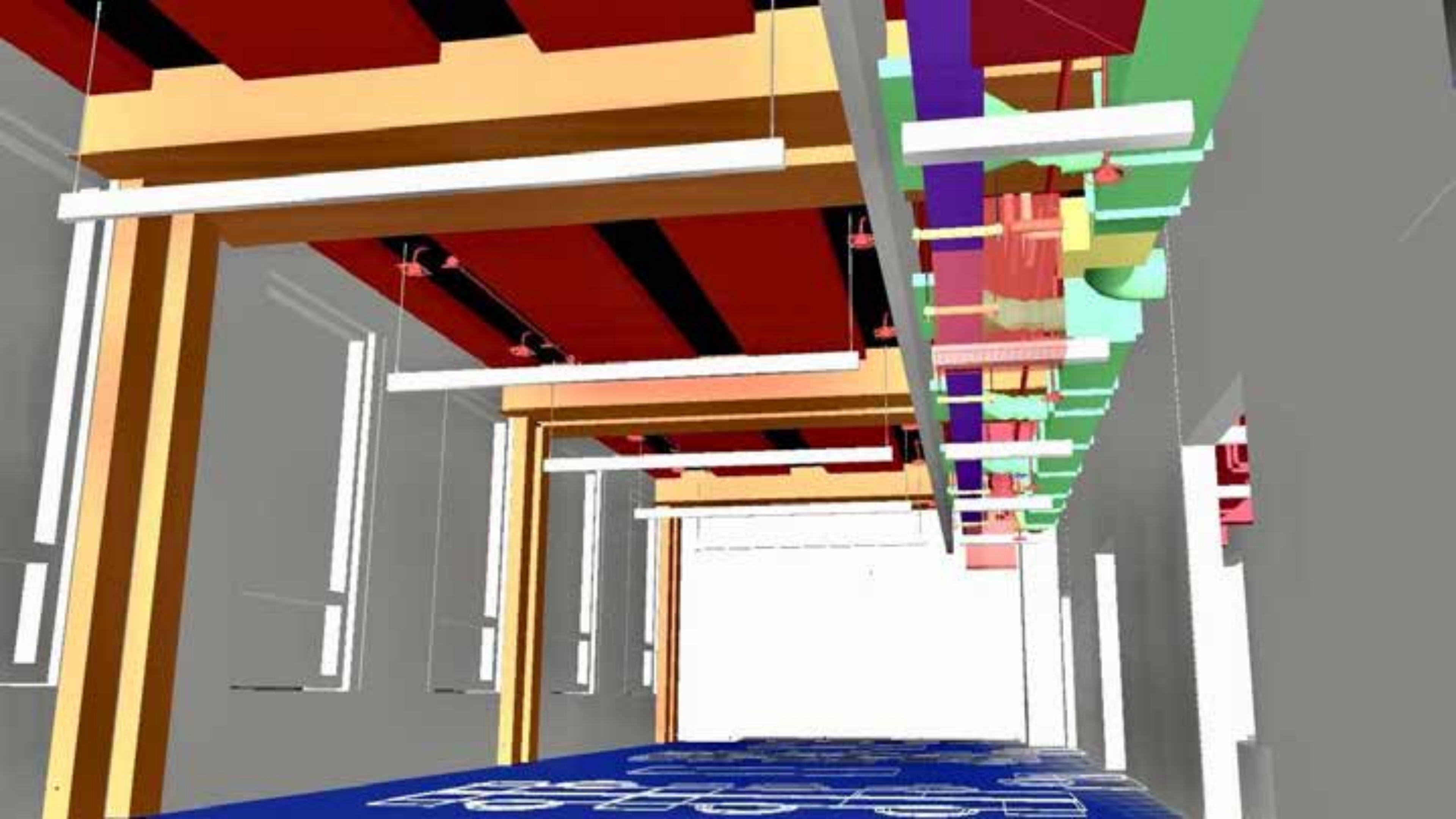

WL1-1103

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
- Components of light weight
- Appropriately timed coordination is the key
- Figure out the MEP strategy along with the structural frame


P3(-6)-PF(-1) : Basement Elev PIT T/O footings (18)


Oregon State University • Corvallis, OR




CAUTION
Oregon State University • Corvallis, OR

Oregon State University • Corvallis, OR


Oregon State University • Corvallis, OR

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



Portland, OR

Early digital collaboration mean better decisions…

EXPOSED STRUCTURE STRATEGY

MECHANICAL SYSTEM SELECTION

SYSTEMS DISTRIBUTION STRATEGY

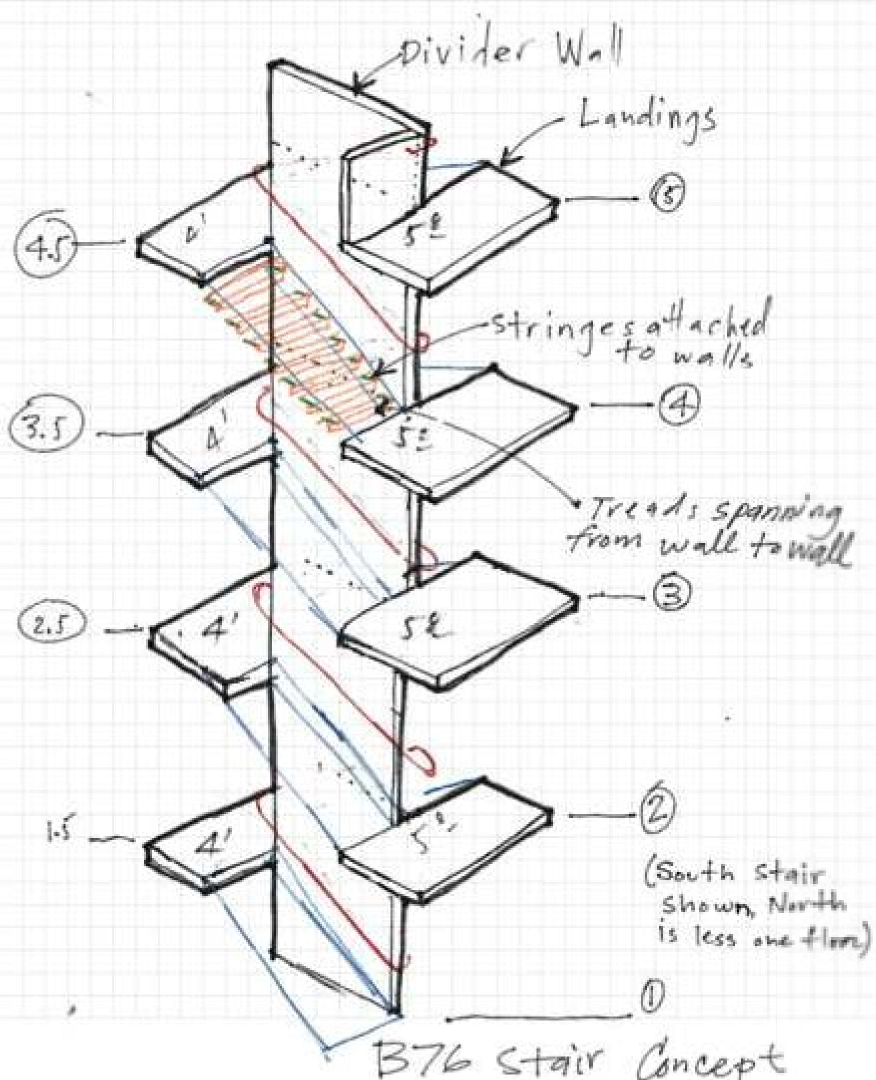
- Vertical risers
- Horizontal Distribution

CONSTRUCTABILITY

- Timber connection details
- Moisture Mitigation Planning

ASSIGNED SYSTEM PATHWAYS

- Sprinklers
- Vertical Electrical
- Horizontal Electrical
- Plumbing
- Fire alarm and electrical

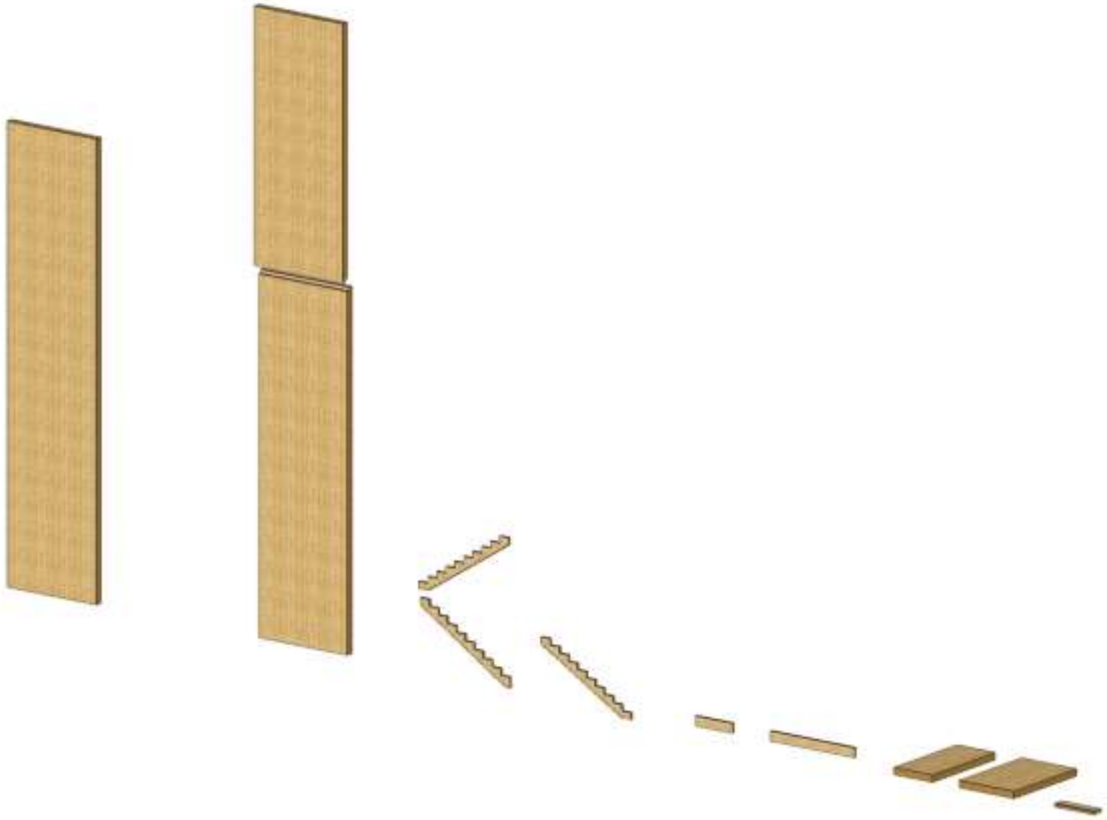


Case Studies & Examples

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

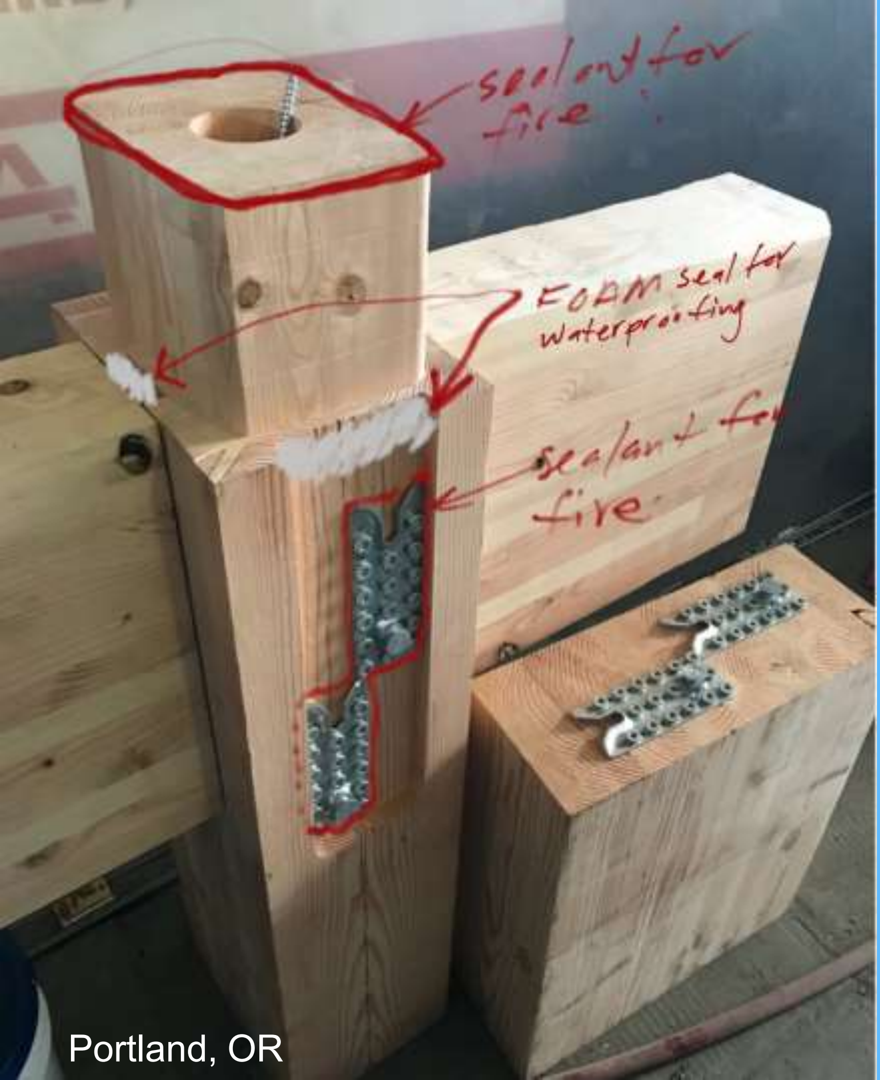
All components factory cut…

Prototype Development

- First-time Components
- Engineering Verification
- Machine and material limitations

Feature Stair HACKER Portland, OR

Freres Plywood, Lyons OR



Prototype Development

Detailed mock from the final model

Objectives:

1. Validate connector fire protection.
2. Further the team understanding.
3. Fit and finish confirmation.

Bath & Mechanical Room Pods

Bensonwood
Walpole, NH

Bathroom Pods Montage

Bensonwood
Walpole, NH

Cartridge assembly

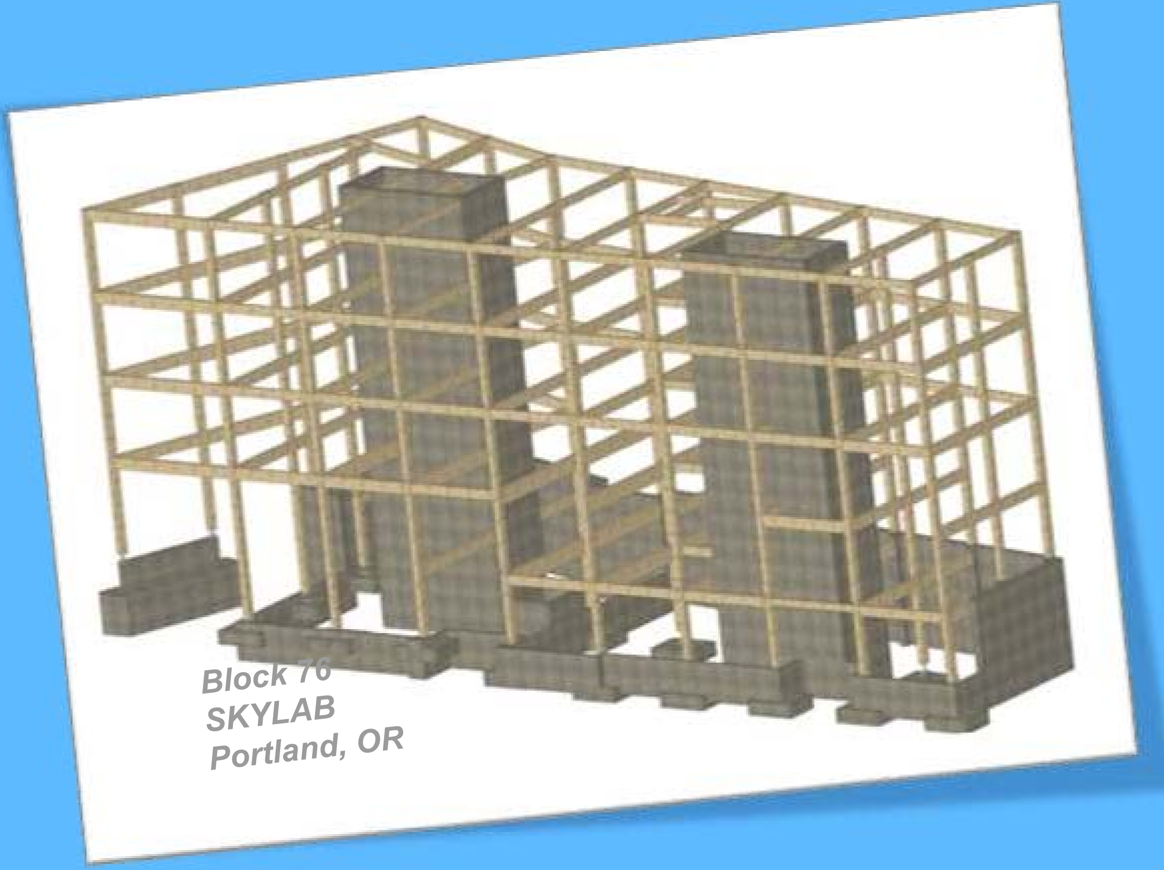
On-Site

Cartridge Installation

Bensonwood • Walpole, NH

An integrated design phase = EFFICENT CONSTRUCTION

- Productivity
- Reduced site impact
- Less waste



Portland, OR

Portland, OR

Portland, OR


Site Assembly

Bensonwood
North Adams, MA


North Adams, MA

North Adams, MA


EXIT

Important Differences

ON-SITE

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

VS

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

Concluding Thoughts:

1. Assemble and integrated project team.
2. Get the code designation right.
3. Solve the long spans first.
4. Examine bay spacing for efficiency.
5. Model everything!
6. Integrate MEPS.
7. Uniform, efficient details.
8. Orchestrate the schedule.
9. Plan ahead for stain prevention and moisture management.

Thank you for your participation.

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