Industrialized Construction & Lean Manufacturing
Where the ecosystem needs to be

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Head of Industrialized Construction Strategy and Evangelism

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
Amy Marks

Head of Industrialized Construction Strategy and Evangelism – Autodesk

#QueenofPrefab

• Formerly CEO of XSite Modular
• Industry thought leader on Industrialized Construction
• Alumna of Harvard Business School and a graduate of the UF
• Ambassador of Advancing Prefabrication Conference – January
• Trainer Mechanical Contractors Association of America (MCAA)
• Singapore Govt. Panel of Experts on Construction and Productivity
• Worked on six of the seven continents consulting on large scale projects to optimize Industrialized Construction
Gorilla Factory
Pods
DfMA
Rising Factory
Factory
Built
Offsite Construction
Prefabrication
Prefab
Racks
Flying Factory
Industrialized Construction
Offsite Manufacturing
Skids
Modular
Offsite
Modules
Industrialized Construction: The application of manufacturing techniques in the built environment
INDUSTRIALIZED CONSTRUCTION

Prefabrication Continuum

PROCESS ENABLERS
- DfMA
- BIM
- Lean MFG

TECHNOLOGY ENABLERS
- Cloud
- Big Data & Analytics
- IOT

Advanced Building Products
Single Trade Assemblies
Multi Trade Assemblies
Volumetric Modular
Robotics & Automation
Additive Manufacturing

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Single Trade Assemblies
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Volumetric Modular
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Industriized Construction Process Enablers
- Technology Enablers
  - Cloud
  - Big Data & Analytics
  - IOT
- Process Enablers
  - DfMA
  - BIM
  - Lean MFG

Prefabrication Continuum
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- Advanced Building Products
- Single Trade Assemblies
- Multi Trade Assemblies
- Volumetric Modular
Over next 15 years

- **45%** of AEC value will shift away from traditional processes

- Prefabrication will increase to **~30%** of construction revenue

Increasing Pressure to Adopt IC Across Ecosystem

“Serial” owners asking for it

Government requirements & incentives

Global proof points (hype projects)

Architects / Engineers

General Contractors

Subcontractors recognizing value

Successful prefab product mfg (e.g. Blox)

Lowering Barriers to Adoption
Increasing Pressure to Adopt IC Across Ecosystem

- "Serial" owners asking for it
- Government requirements & incentives
- Global proof points (hype projects)
- Successful prefab product mfg (e.g. Blox)
- Lowering Barriers to Adoption
- Subcontractors recognizing value
- Architects / Engineers
- General Contractors

COVID-19

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DfM and DfA

**Design for Manufacturing (DfM)**
- Method of design for ease of manufacturing for a collection of parts that form the product/element
- Optimization of the manufacturing process through design choices

**Design for Assembly (DfA)**
- Method of design of the product/element for ease of assembly
- Design principles used by the design teams in the design of products/elements focusing on the number of parts to assemble, shipping, handling and ease of assembly (integration on site)
Design for Manufacturing and Assembly (DfMA)

Definition: A **design methodology** to enable and optimize prefabrication using a **set of design choices (principles)**
DfMA Enables Industrialized Construction

MOVING MAKE & OPERATE INTO DESIGN

DESIGN

ASSEMBLE

INSTALL

OPERATE

DfMA

INDUSTRIALIZED SUPPLY CHAIN

LIFECYCLE DATA

INDUSTRIALIZED CONSTRUCTION ECOSYSTEM
<table>
<thead>
<tr>
<th>DfMA - Generic Principles</th>
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</thead>
<tbody>
<tr>
<td>Design for ease of fabrication – Element specific</td>
</tr>
<tr>
<td>Maximize multi-trade elements when adjacencies exist</td>
</tr>
<tr>
<td>Use of standard components</td>
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<tr>
<td>Design for ease of assembly and minimized handling/logistics</td>
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<tr>
<td>Design it once, use it many times</td>
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<tr>
<td>Use of advanced building products</td>
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<tr>
<td>Modular (not volumetric box modular) design</td>
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<tr>
<td>Design parts for multi-use</td>
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<tr>
<td>Safety in design</td>
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<tr>
<td>Balance ease of fabrication vs. ease of assembly</td>
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**DfMA – Element Specific**

**Element specific DfMA** is a particular set of instructions that apply to one type of element and include the proprietary rules of each manufacturer – because there are few standards.
DfMA – Element Specific

- One proprietary precast panel system can have 45 DfM and 10 DfA principles
- Multiply by number of elements
- Multiply by proprietary systems
Target Value Design
Target value design – trade centric

- Owner’s program and needs defined
- Benchmark and historical cost reviewed
- Preliminary design concepts
- Preliminary cost review and validation
- Review expected cost and set target costs
- Track cost drivers to target costs

- Electrical
- Plumbing
- HVAC
- Structure
- Carpentry
- Finishes
Target value design – trade centric

T-shirt + Sock = T-shirt
**TVD Element-Centric vs Trade Centric**

- Focuses on performance-based specifications vs. prescriptive specifications

- Places focus on sharing costs as part of the design criteria

- Requires target costs for element-based solutions vs. trade focus

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**Conventional Bathroom:**

**Required Trades: 9**

Carpenter, Plumber, Mech, Elec, Drywall, Door, Fire Protection, Tiler, Painter

**Bathroom Pod:**

**Required Trades: 1**

Bathroom Pod Manufacturer
Define Elements, identify products and supply chain partners, understand remaining scope
Constraint Log Creation & Resolution

- I CAN do “prefabricated element”, IF this criterion is met

- Team focus is on removing constraints and collaborating on solutions
Prefab Pitfalls

- Late engagement
- The "apples to oranges" comparison
- Conventional procurement process
- Lack of Alignment – Why are we doing this?
- Single Element Focus
- Project-Centricity
Autodesk IC Strategy
Autodesk IC Strategy

MAKE DfMA AND PREFABRICATION EASIER

CONNECT AUTODESK PLATFORM WITH THE IC ECOSYSTEM

CREATE A COLLABORATIVE IC COMMUNITY
Map Ideal Pathways

Map processes for 5 major prefabricated elements

- Pods (e.g. bathroom)
- Precast Concrete
- Multi-trade Headwall
- MEP Racks
- MEP Structural Module

Assess for each element

- Pains/gains
- Value mapping
- Tasks/tools/data
- People/personas
- Define idealized workflow
Deliver Connected Solution through Functional Data

AUTODESK PLATFORM CAPABILITIES

- DfMA
- BOM/BOP
- CDE
- Generative
- Carbon
- Costs
- Schedule
- Labor
- Inspection
- Availability

Content Library

Manufacturing

Supply Chain
Product Mindset Enables IC Optimization

From project-centric to product-led

Optimized
Managed
Defined
Repeatable
Initial / Ad Hoc

Increasing certainty & productivity

Product unlocks new benefits

Project-centric metrics prevent embracing the learning curve

CMMI – Maturity Framework
‘New Possible’ Roles

**TRADITIONAL PERSONAS**
- Owners
- A&E
- GCs
- Subs
- MFGs
- BPMs

**BUSINESS MODEL CONVERGENCE**
- Vertical Integrators
- Serial Owners
- Super Subs

**FUTURE STATE ACTIVITIES**
- Ecosystem Influencers
- Empowered Designers
- Systems Integrators
- Product Makers

**AUTODESK**
- Platform provider