Industrialized Construction & Lean Manufacturing
Where the ecosystem needs to be

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Amy Marks
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#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
Industrialized Construction: The application of manufacturing techniques in the built environment
Prefabrication Continuum

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)

COVID-19

Subcontractors recognizing value

Successful prefab product mfg (e.g. Blox)

Lowering Barriers to Adoption

Architects / Engineers

General Contractors
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
DfMA - Generic Principles

- Design for ease of fabrication – Element specific
- Design for ease of assembly and minimized handling/logistics
- Modular (not volumetric box modular) design
- Maximize multi-trade elements when adjacencies exist
- Design it once, use it many times
- Design parts for multi-use
- Use of standard components
- Use of advanced building products
- Safety in design

Balance ease of fabrication vs. ease of assembly
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

\[\text{shirt} + \text{sock} = \text{shirt}\]
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

Conventional Bathroom:

Required Trades: 9
Carpenter, Plumber, Mech, Elec, Drywall, Door, Fire Protection, Tiler, Painter

Bathroom Pod:

Required Trades: 1
Bathroom Pod Manufacturer
Target value design – trade centric

- Define Elements, identify products and supply chain partners, understand remaining scope

1. Owner’s Program and Needs Defined
2. Benchmark and Historical Cost Reviewed
3. Preliminary Design Concepts
4. Preliminary Cost Review and Validation
5. Review Expected Cost and Set Target Costs
6. Track Cost Drivers to Target Costs
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
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
- CDE
- Generative
- Schedule
- Costs
- Labor
- Inspection
- Availability
- BOM/BOP
- Carbon
- Content Library
- Manufacturing
- Supply Chain
Product Mindset Enables IC Optimization

From project-centric to product-led

- Initial / Ad Hoc
- Repeatable
- Defined
- Managed
- Optimized

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
- Platform provider

AUTODESK
- Platform provider