BIM from an Architect’s Perspective

Lean Processes and Lessons from Other Industries

Tom VanLandingham and Tomislav Zigo
What we will discuss

• BIM as a means of eliminating waste (lean process)
  – An example of organizing content
  – Elimination of duplication
  – Non-conventional organization of work sets

• Organizing the BIM Execution Plan (BEXP)
  – Why a BEXP and what does it contain?
  – Moving out of silos and into the model
  – How is BIM optimized for design/build?

• BIM and technology transfer
  – Organizational best practices from other industries
  – Defying the adoption paradigm

• Case Studies
What is waste?
<table>
<thead>
<tr>
<th>Definition of waste...</th>
<th>in manufacturing</th>
<th>in design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overproduction</td>
<td>Making more than is needed</td>
<td>Details and drawings that aren't useful. More than can be afforded</td>
</tr>
<tr>
<td>Waiting</td>
<td>No value added when people or goods are idle</td>
<td>“I haven’t got the information/answers, etc. that I need.”</td>
</tr>
<tr>
<td>Transport</td>
<td>While people or goods are moving, no value is added</td>
<td>Information passing through a chain of command.</td>
</tr>
<tr>
<td>Inventory</td>
<td>Inventory is material that is not immediately useful</td>
<td>Submittals long before they are needed</td>
</tr>
<tr>
<td>Overprocessing</td>
<td>Effort that does not add value</td>
<td>Repetition of requirements in drawings, details and specs.</td>
</tr>
<tr>
<td>Motion</td>
<td>Excess movement of product or people only consumes resources</td>
<td>Too many people on the team too early.</td>
</tr>
<tr>
<td>Correction</td>
<td>Defects, rework and scrap</td>
<td>Errors and omissions</td>
</tr>
</tbody>
</table>
...differs from industry to industry.

<table>
<thead>
<tr>
<th>Waste is...</th>
<th>in manufacturing</th>
<th>in design</th>
<th>in construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overproduction</td>
<td>Making more than is needed</td>
<td>Designing more than can be afforded</td>
<td>“Yes, I’m working time and materials. Why do you ask?”</td>
</tr>
<tr>
<td>Waiting</td>
<td>No value added when people or goods are idle</td>
<td>“I haven’t got the information/answers, etc. that I need.”</td>
<td>“I haven’t got the information/answers/material/people that I need.”</td>
</tr>
<tr>
<td>Transport</td>
<td>While people or goods are moving, no value is added</td>
<td>Information passing through a chain of command.</td>
<td>Information/material/labor sent here and there.</td>
</tr>
<tr>
<td>Inventory</td>
<td>Inventory is material that is not immediately useful</td>
<td>Submittals received long before they are needed</td>
<td>Material delivered too early.</td>
</tr>
<tr>
<td>Overprocessing</td>
<td>Effort that does not add value</td>
<td>Repetition of requirements in drawings, details and specs.</td>
<td>Do contractors ever overdo anything?</td>
</tr>
<tr>
<td>Motion</td>
<td>Excess movement of product or people only consumes resources</td>
<td>Too many people on the team too early.</td>
<td>Pile of drywall in the middle of each room.</td>
</tr>
<tr>
<td>Correction</td>
<td>Defects, rework and scrap</td>
<td>Errors and omissions</td>
<td>Punch list</td>
</tr>
</tbody>
</table>
Who draws what?  (A lean lesson from the pre-BIM era.)

Background

• CGCMC Phase 2 project
• NICU and Surgery are complex, technically difficult spaces
• Intergrated Delivery contract allowed team to optimize effort
• Focused on reducing calendar time and eliminating duplicate labor of documentation
Defining the handoff

• Eliminate duplicate work
• Designers retained responsibility for:
  – Complying with owner program
  – Code compliance
  – Configuration decisions
  – Capacity and sizing
What did we learn?

• MEPFP can have surprisingly early handoffs
• General construction handoffs limited to casework, doors, hardware
• Early handoffs make coordination a bit easier
  – Layouts and relationships easier to modify if they are not “too cooked”
  – Subcontractors got to move onto their preferred software platforms
• An unintentional way of avoiding construction document scope creep.

• Architects and engineers find it is really hard to let go.
How does this relate?

- *Organized*, early handoffs do save duplication.
- Hand offs can be a *rolling event*.
- When participants can work in parallel, a better level of optimization is *possible*.
- BIM provides the opportunity for *many participants* to work in the same “model.”

*Each of these is a two-edged sword.*
Extending these lean “lessons learned with BIM
Dispersing BIM myths
Dispersing BIM myths

Ratios of hours worked to hours paid of production workers by NAICS supersector, 1979-2010
Looking for process validation!
Similarities

• Shipbuilding not fully integrated.
• Integration of an extreme high number of products and technologies, and one-of-a-kind production are currently not sufficient.
• While modularisation has increased in other industrial sectors, ships are still constructed in a traditional way with much outfitting work done onboard the ship.
• Commissioning, procurement and logistics bear considerable potentials, not yet exploited.
Shipbuilding – The change is here

- Integrated collaborative working environment and web.
- Conceptual design and space management.
- First principle design methods and tools such as:
  - rules to CAD for quick generation of production information
  - cost-estimation tools for hull production
  - tools for shell plate optimization
  - simulation tools for space management and production lines
  - concepts for risk-based design of commercial ships.
- Knowledge management PDM tools.
- Integration of production know-how.
- Pre fabrication and modularization
- Application and network mobility.
- Shipbuilding e-trading and e-procurement systems.
Differences and similarities

CONCURRENT ENGINEERING (CE)

= =

INTEGRATED DELIVERY METHODS
DB, IPD

VALUE

TRUST

COLLABORATION

BUILDERS

DESIGNERS

BUILDING OWNERS

ELECTRONIC PRODUCT DEFINITION (EPD)

= =

VIRTUAL DESIGN AND CONSTRUCTION (VDC)
Established Process—Concurrent Engineering

- Work in parallel, controlled manner
- Early involvement – ‘righter’ first time
- Early use of corporate knowledge to influence design
- Invest time and resource in early design phase
- Sharing information – common source of data

SOURCES:
ULJANIK SHIPYARD
WONDERMAR II – PUBLIC WORKSHOP 2004
Established Process– Concurrent Engineering

<table>
<thead>
<tr>
<th>Prerequisites</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collocated organization</td>
<td>Excellent collaboration</td>
</tr>
<tr>
<td>Formal goal metrics</td>
<td>Extremely low latency period</td>
</tr>
<tr>
<td>Knowledge network</td>
<td>Good for SD and DD phases</td>
</tr>
<tr>
<td>Informal process and culture</td>
<td>Everyone is on the same page</td>
</tr>
<tr>
<td>Excellent technical infrastructure</td>
<td>You can’t manage what you can’t measure</td>
</tr>
</tbody>
</table>
Established Methodology
Electronic Product Definition

Collaboration

– Product and process data stored electronically on one database
– Total Product Modelling (TPM)
– Virtual Product Development (VPD)
– Virtual Manufacturing

Control

– Who sees information?
– When is it available?
– What form is the information in?

...to create, control, exchange and reuse all the product data through its lifecycle, from the initial conception to the exploitation.
PREFAB & MODULARIZATION

• The right idea
• The right tool
• The right process
• The right market
• The right long view intention
Are we there?
10 years after…
What is missing?
IIS – Integrated Information Systems

- Better tools – Faster Development
- Simplified Maintenance
- Reduced system complexity
- Fewer integration points
- Comprehensive reporting

Technology Modernization

PRICELESS!

40 Million $ over 5 years
Technology Transfer – Through Numbers

<table>
<thead>
<tr>
<th>Industry</th>
<th>Revenue</th>
<th>Lifespan</th>
<th>Employment</th>
<th>R&amp;D Share of Business Expenditure 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Shipbuilding</td>
<td>$19,051M</td>
<td>15-30 yrs</td>
<td>87,300</td>
<td>2.8%</td>
</tr>
<tr>
<td>Car Manufacturing</td>
<td>$76,664M</td>
<td>6-8 yrs</td>
<td>58,000</td>
<td>7.5%</td>
</tr>
<tr>
<td>Commercial Construction</td>
<td>$133,657M</td>
<td>15-30 yrs</td>
<td>220,000</td>
<td>0.7%</td>
</tr>
<tr>
<td>Aircraft Manufacturing</td>
<td>$131,757M</td>
<td>10-20 yrs</td>
<td>281,000</td>
<td>6.3%</td>
</tr>
</tbody>
</table>

Sources: Booz and Co, IBIS World, National Science Board
BEXP – BIM Execution Plan

• Why do we need one?
  – Documenting roles and responsibilities.
  – Defining process, technology and coordination objectives.
  – Monitoring progress and fine-tuning implementation.

• Where to start?
  – Documenting roles and responsibilities.
  – Defining process, technology and coordination objectives.
  – Monitoring progress and fine-tuning implementation.
Value, Goals, Process, Infrastructure
### Model Progress Specification – Who Models What and When

<table>
<thead>
<tr>
<th>Description</th>
<th>LOD 100 - PIF/S</th>
<th>LOD 200 - SD</th>
<th>LOD 300 - 3D</th>
<th>LOD 400 - CD</th>
<th>LOD 500 - CONSTRUCT/OP</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOD 400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

**LOD 500**

**Constructed Assemblies Actual and Accurate in Terms of Size, Shape, Location, Quantity, and Orientation.**

Assemblies that are Accurate in Terms of Size, Shape, Location, Quantity, and Orientation with Fabrication, Assembly, and Information.

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**Generalized Systems or Assemblies with Approximate Quantities, Size, Shape, Location, and Orientation.**

**Specific Assemblies That are Accurate in Terms of Size, Shape, Location, Quantity, and Orientation.**

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**Overall Building Metrics Indicative of Area, Height, Volume, Location, and Orientation.**

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**Innovate Systems or Assemblies with Approximate Quantities, Size, Shape, Location, and Orientation.**

---

**Specific Assemblies That are Accurate in Terms of Size, Shape, Location, Quantity, and Orientation.**

---

**Fabrication, Assembly, and Information.**

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The question

We offer three kinds of service:

GOOD - CHEAP - FAST
You can pick any two

GOOD service CHEAP won’t be FAST
GOOD service FAST won’t be CHEAP
FAST service CHEAP won’t be GOOD
Defining waste
Defining waste
Case study
St. Louis County Health Clinic - 2011

Scope of execution plan: Design integration
Working within RFP scope
Analysis integration

Number of participants: 5
Design/Build*
Structural Engineer*
Mech Engr & Contractor
Elec Engr & Contractor
Lab Consultants
Active: 5*
Non active: 0

Advantages:
-Rapid design decisions
-Real time QTO and estimate verification
-Life cycle vs construction cost, project validation
-100% buy in by team members

Limitations:
-Software platforms
Case study
St. Louis County Health Clinic - 2011
BEXP – practical implementation
Case study
St. Louis County Health Clinic - 2011
MPS (AIA E 202) – practical implementation
Case study
St. Louis County Health Clinic - 2011
3D, 4D – validation
Case study
St. Louis County Health Clinic - 2011
5D – direct product of MPS
Summary

• The design and construction industries are below par in R&D spending…
  …some of the difference can be made up by drawing best practices from
  related industries.

• BIM can support more highly integrated design/construct approaches…
  …but the complexities of integrated work require thoughtful management
  and organization.

• BIM can certainly improve visualization…
• …but the most benefit will be gained by teams that manage to break
  down conventional organizational silos.