Is Post-Heroic Management Possible in Construction?

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I have to thank John Kunz, Executive Director Emeritus, CIFE, for introducing me to the idea of post-heroic management.
• 100% funded by industry
  • Building owners
  • Design and construction companies
  • Software and hardware vendors
• 1988-2000 BIM
• 2000-2010 VDC
• 2010+ Optimize Facility Performance
Virtual Design and Construction Certificate Program Graduation Ceremony
Hosted by Kruse Smith in Sola on September 11, 2017
Key technology and management developments

Mobile
• from just-in-case to just-the-right information

Cloud
• anytime (push and pull, bi-directional, “unlimited”)

Parallelization
• fast

Location / dimensional measurement
• accuracy, dimensional control, off-site / on-site

Machine learning, AI
• experience and data

Robotics, additive manufacturing
• virtual ↔ real, safety, environmental impact

Internet of Things (IoT)
• virtual ↔ real

Virtual Environments
• test!

Collaboration
• concurrent knowledge

Lean
• lower uncertainty, lower risk, customer, pull, purpose → value

The combination of these developments creates significant opportunities and dramatic change.
You must decide how to allocate your firm’s resources when you get back to your office.

Strategy Diamond Framework

Four strategic implications

- Product vs. Service
- Projects vs. Corporate
- Partners
- Staff Development
Every CEO is proud of their people!
The Simple Framework for IPD

Measurable Value → Production Management → Collaboration Colocation → Simulation Visualization

High Performing Building ← Integrated Systems ← Integrated Processes ← Integrated Organization ← Integrated Information

Agreement/ Framework

Sooner or later someone will pay for integration.
INTEGRATION IS THE KEY STRATEGY TO CREATING HIGH-PERFORMING BUILDINGS

<table>
<thead>
<tr>
<th>PROJECTS</th>
<th>EXAMPLES</th>
<th>FIGURES</th>
<th>FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>123</td>
<td>189</td>
<td>33</td>
</tr>
</tbody>
</table>
The Simple Framework for IPD

Measurable Value
Production Management
Collaboration Colocation
Simulation Visualization

High Performing Building
Integrated Systems
Process Integration
Integrated Organization
Integrated Information

Agreement/Framework

©2017 CIFE
Sooner or later someone will pay for integration.
Visualize the future you want to create

Maximize daylight

Integrate underground parking structure

©2017
Vision
A future I would like to make happen

Every workhour
builds the right product
safely and productively

Definition of Vision by Robert Burgelman, GSB, Stanford
Building the **right** product (building)
<table>
<thead>
<tr>
<th>Equipment standardization for MEP infrastructure</th>
<th>Flexibility of utility space to support growth or reconfiguration</th>
<th>Highly reliable building</th>
<th>Efficient building layout</th>
<th>Building/Systems are properly started-up and de-bugged prior to handover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider long term operational impacts and costs</td>
<td>Ability to clean building</td>
<td>Indoor Air Quality</td>
<td>Use smart design of code</td>
<td>Educate users / stakeholders on what they are receiving</td>
</tr>
</tbody>
</table>

Specific Metrics have been identified for each of these Conditions of Satisfaction.
Delivering the Gigafactory in Tesla Time Using HD BIM

Tim Schrotenboer, SE
GPLA
5 Buildings, 3.8 million sq ft, 2 floors and roof, all composite steel & concrete on deck. Gravity and lateral framing uncoupled to accelerate mill order and fabrication for 90% of steel. First use of innovative fused strongback BRB seismic system. Schedule: start design April 15, 2016, order steel May 5, start steel fab June 6, start steel erection July 6, complete steel erection November 15, release to process March 2017.
Case Study – Tesla Gigafactory, Sparks, Nevada, 2016 - 2017

Rocking Fused Strongback Frame

Field Bolted Frame

Rocking Strongback Frame

Krawinkler Fuse

September 20, 2017
Case Study – Tesla Gigafactory, Sparks, Nevada, 2016 - 2017

Gigafactory Top Out November 7, 2016
5 Buildings
3.5 million Square Feet
32,000 tons of structural steel
2500 tons of rebar
All steel and rebar shop drawings from GPLA HD BIM model
7 months from first phone call
“Incomplete design is the source of many of the problems in our industry. In light of the potential offered by the digital revolution, the traditional design process is an anachronism that we can no longer afford.”

“My job is to create a high-performing building.”

“It is not to create a model or a set of drawings.” Greg Luth, Structural Engineer
What does Corporate do? What do Projects do?

Also illustrating
“building ... safely and productively”
Two weeks ago, in the offices of a General Contractor on the East Coast ....

Meet Jake
• Experienced construction manager
• Scheduling projects for 10 years
• Tools: Primavera, MS Project

Jake won a building project!
• 38-story high-rise
• Cast-in-Place concrete

• Jake used P6 to schedule his project.
• Total duration: **567 days**!

“I’m wondering how correct my P6 schedule is though...

Why not run some AI to see what I come up with!”
2. Construction Information Model (CIM)

- Jake’s architect gave him a Building Information Model (BIM) to use for his AI scheduling efforts.
- The BIM was unnecessarily detailed for Jake’s scheduling purposes with ~5,000 elements.
- Jake went to his automation team and explained the scheduling scope.
- **2 days later** he received a Construction Information Model (CIM) with 1,440 elements!
3. Step 1 – Run P6 with AI

- CIM Setup: 2 days
- Construction model set up: 2 days
- Run simulation: 2 mins

- Same crew mix & numbers as in P6
- Total duration: 622 days
- “Ugh... Looks like my P6 schedule was a little optimistic. Let's see what I can do.”

High Rise Building Schedule results

<table>
<thead>
<tr>
<th>Method</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>P6</td>
<td>567 days</td>
</tr>
<tr>
<td>P6 with AI</td>
<td>622 days</td>
</tr>
</tbody>
</table>

Cost x $1000 vs Time in Days

- CPM Duration: 567 days
- Duration: 622 days
4. Step 2 – Resequencing

- CIM Updates: Split Ext wall: 4 hrs
- Construction model set up: 4 hrs
- Run simulation: 2 mins

- Changed crew workflow from clockwise to crisscross
- Total duration: 610 days
- “Hmm... I am saving a few days, but it’s not enough!”

High Rise Building Schedule results

Duration 610 days

Cost x $1000

Time in Days
4.1. 4D snapshot – day 120

Exterior walls are split into 4 pieces per level; therefore, the resequencing option allows for the skin to get placed faster.
5. Phase 3 – Max crews

- CIM Updates: 0 mins
- Construction model set up: 1 min
- Run simulation: 2 mins

- Changed crew mix to 15 crews of each type
- Total duration: 549 days
- “That’s cool! But let’s find out how many crews I actually need to get the same result…”

High Rise Building Schedule results

- P6: 549 days
- P6 AI: 549 days
- Resequencing: 549 days
- 15 crews: 549 days

Cost X $1,000

Time in Days
Labor abundance of the 15-crews option allows for more concurrent work to occur. Costs are high due to high crew idle time on site.
6. Phase 4 – Balance crew mix

- CIM Updates: 0 mins
- Construction model set up: 1 min
- Run simulation: 2 mins

- Increased only Carpenter crews to 6 – all other crews remain 1
- Total duration: 549 days
- “Wow! Looks like I need only 6 carpenters to get the same result... cheaper!”
Carpenter crew appeared to be the “bottleneck” for construction. In the 6 carpenter crews option, the carpenter’s work finished earlier, allowing for the rest of the crews to move more efficiently eliminating idle time on site.
Corporate? Project?

• Innovation must happen on projects.

• It’ll be too slow if you let each project manager discover and try innovations on his/her own.
Deeper partnerships, staff development
An engineer with today’s tools cannot compete with an engineer with the same tools that are connected

<table>
<thead>
<tr>
<th></th>
<th>Engineer with today’s tools</th>
<th>Engineer with connected tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total steel weight</td>
<td>2,728 mt</td>
<td>2,292 mt</td>
</tr>
<tr>
<td>Cost savings</td>
<td>$4M</td>
<td></td>
</tr>
<tr>
<td># alternatives evaluated</td>
<td>39</td>
<td>12,800</td>
</tr>
<tr>
<td>Design time per alternative</td>
<td>4 hours</td>
<td>3 seconds</td>
</tr>
<tr>
<td>Total design time</td>
<td>~200 hrs</td>
<td>~200 hrs</td>
</tr>
</tbody>
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Roof truss design for a soccer stadium in the Middle East
Work by Forest Flager and John Haymaker in collaboration with Arup Sports, London
Optimize across all cost components of a steel frame

Design Cycle Time: 8-24 weeks

<table>
<thead>
<tr>
<th></th>
<th>Original Frame</th>
<th>Value-Engineered Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Weight</td>
<td>-</td>
<td>+8%</td>
</tr>
<tr>
<td>Total Cost</td>
<td>-</td>
<td>-13%</td>
</tr>
<tr>
<td>Procurement Time</td>
<td>-</td>
<td>-20%</td>
</tr>
</tbody>
</table>

Work by Forest Flager, Pratyush Havelia, Henry Hamamji, Filippo Ranalli, Bo Peng, Thomas Trinelle
in collaboration with SOM, Herrick, Autodesk
OPTIMA CENTER CHICAGO
200 AND 220 EAST ILLINOIS

- 2 inter-connected towers
- 42-story tower
- 60-story tower
- Post tensioned concrete structures
- 850 Residential Units
- 250 Hotel Units
- 150,000 sf Commercial Space
- 2.5 Million GSF
Developer studied 13 building designs in 2 weeks in conceptual design including architecture, structure, MEP, and construction cost and schedule.
Post-heroic management in construction is possible when

- the client defines the project objectives with quantified targets
- the project team includes the disciplines required to address the objectives
- the project team designs its workflows and collaboration methods to leverage the visualization, information integration, and automation potential of BIM
- mechanisms for learning on and across projects are in place
Who will do what next week? (And beyond.)

Strategy Diamond Framework

Four strategic implications

- Product vs. Service
- Projects vs. Corporate
- Partners
- Staff Development
I have made all my generals out of mud.

Napoleon