The Future of Construction

Digital Project Delivery Workshop
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Ted Blackmon
So What Does the Future Hold?
What?

US Labour Productivity - Construction versus All Other Industries 1964 - 2008

Labour Productivity Construction
Labour Productivity Non-Farm Industries
What?

US Labour Productivity - Construction versus All Other Industries 1964 - 2008

Predict a Step Change in Productivity, then Followed by Incremental Improvements
Why?
$3T USD  Annual Global Construction Spending
50%  Non-Residential Construction
40%  Typical Percent of Labor Budget on Project
80%  Construction Labor (vs Engineering Labor)
25%  Improved Productivity (Conservative)

$120 B USD  Now That's A Lot of Wasted Money!

The Payback
How?
“You can't know where you are going until you know where you have been.”
The History of Construction
Neolithic Age

Circa 11000 BC
Göbekli Tepe is a stone-age mountain sanctuary in Turkey dated near 11000 BC. It remains unknown how a force large enough to construct and maintain such a substantial complex was mobilized and compensated or fed in the conditions of pre-sedentary society.

Circa 3180 BC
Skara Brae, built from 3180 BC, includes structures constructed using dry-stone-walling techniques.

Circa 10000-9000 BC
Tell es-Sultan in Jericho with the first known use of mud bricks formed with the hand, circa 10,000 BC.

Circa 3000-2000 BC
Stonehenge, built anywhere from 3000 BC to 2000 BC, likely using Neolithic technology as basic as shear legs.
2584 BC
The Great Pyramids of Giza, started in 2584 BC, were constructed over a 10-20 year period, with a labor force of 10,000 workers.

Circa 1000 BC
Petra in Jordan was built around 1000 BC, with the quarrymen using ladders, ropes and slots to reach the working level.

70-80 AD
The Roman Colosseum (70-80 AD) used the invention of concrete, enabling this massive building to be built quickly, efficiently and to great effect.

Circa 2100 BC
The remains of the Ziggurat of Ur from Sumeria (circa 2100 BC) consist of mud brick lined with burnt bricks set in bitumen.

448-432 BC
The Parthenon in Athens was built between 448-432 BC by the master builders Iktinos and Callicrates.

Circa 200-300 AD
By the third century AD, Rome had 11 aqueducts, representing the dawn of cross country infrastructure projects.

Ancient Civilizations
Thru the Age of Enlightenment

Circa 500 AD
The Parthenon in Athens was built around 490 BC as a temple dedicated to Athena.

Circa 1130 AD
Angkor Wat in Cambodia (circa 1130 AD) was built by a combination of elephants, oxen, ropes, pulleys, and bamboo scaffolding, placing stones tightly laid without mortar.

Circa 1200 AD
Old wooden stave church in Heddal Norway, constructed at the beginning of 13th century, according to legend in 5 days.

Circa 1386 to 1812 AD
Duomo di Milano was built over six centuries, starting in 1386, with numerous leading master builders.

Circa 1450 AD
Machu Picchu was built around 1450, at the height of the Inca Empire, with blocks of stone cut to fit together so tightly without mortar, not even a blade of grass fits between the stones.

Circa 800 AD
The Buddhist temple Borobudur in Java was constructed around 800 AD as a massive step pyramid structure that represents a three-dimensional mandala (spiritual universe).
The Industrial Revolution

- **1856**: In 1856 the first oil refinery in the world was built by a Polish petroleum industry pioneer Jan Józef Ignacy Łukasiewicz.
- **1884**: Started in 1884, Eiffel's tower was completed in a matter of months with a small labor force of 300 on-site workers.
- **1931**: Completed in 1931, the Empire State Building was the first commercial construction project to employ the technique of fast-track construction, and became a model of efficiency.
- **1933**: Starting in 1933, the construction of the Golden Gate Bridge completed ahead of schedule and under budget, while also innovating the use of movable safety netting.
- **1934**: The Hoover Dam, built by a TVA-celled the Big Companies, Inc., hired large numbers of workers, with more than $200,000 on the payroll by 1933, and peaking at 15,000 personnel in July 1934.

Established in 1935, the M. E. Baker, Sr. School of Building Construction at the University of Florida is the oldest construction management program in the country.
The Information Age
Disappearance of the Master Builder

The Delta Shift
CPM Scheduling was the discovery of M.R. Walker of DuPont and J.E. Kelly of Remington Rand, circa 1957, with the computation designed on a UNIVAC-1 computer.
Spark of Innovation

1957

Industry Adoption

1983
Sketchpad' is invented as the first interactive computer graphics system by Ivan Sutherland as part of his Ph.D. Thesis at MIT in 1963, who later goes on to co-found Evans & Sutherland in 1968.
Construction Automation Tools

- Estimating / Cost
- Geomatic Systems
- Building Information Modeling

Project Management

- Construction ERP
- Quality Control / Commissioning
- Asset / Operations Management

Construction Automation Tools
How?
Industry Fragmentation
Mis-alignment of Economic Motivation

Benefits are Not Clear
Lack of R&D Budgets Within Contractors

Project-Driven Industry
Shark-Tank Mentality of GCs

Not Wise to Dictate Means & Methods
Cannot Trust Data Provided to Us

Must Compete on Cost to Win Bids
Shark-Tank Mentality of GCs

High Risk to Bid Projects on Innovative Methods
Payback Window Into Operations is Too Long
## Advanced Work Packaging - Information Mapping

### Level 1 Swim Lane Diagram

<table>
<thead>
<tr>
<th>Stage I - Preliminary Planning &amp; Design</th>
<th>Stage II - Detailed Engineering</th>
<th>Stage III - Construction</th>
<th>Stage IV - Completion</th>
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</thead>
<tbody>
<tr>
<td><strong>Engineering</strong></td>
<td><strong>Detailed Engineering</strong></td>
<td><strong>Construction</strong></td>
<td><strong>Completion</strong></td>
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<tr>
<td>Produce Design by EWP's</td>
<td>Detail Engineering &amp; Release EWP's</td>
<td>Expedit RFI's from Field</td>
<td>Produce As-Builts for STPs</td>
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<tr>
<td>Manage Project Data Deliverables</td>
<td></td>
<td>Deliver Eng Rfs with Change Report at BOQ/MTO Level</td>
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<td>AIM Input</td>
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<tr>
<td><strong>Procurement &amp; Materials</strong></td>
<td><strong>Equipment Detailing &amp; Fabrication</strong></td>
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<tr>
<td>AIM Input</td>
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<tr>
<td>AIM Input</td>
<td><strong>Completion</strong></td>
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<tr>
<td>Define Path-of-Construction &amp; CWP Release Plan</td>
<td><strong>Completion</strong></td>
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<tr>
<td>AIM Input</td>
<td>Load WIP System(s)</td>
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<tr>
<td>AIM Input</td>
<td>Monitor &amp; Expedite Consistencies</td>
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<tr>
<td>AIM Input</td>
<td>Load &amp; Release CWP's</td>
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<tr>
<td>AIM Input</td>
<td>Develop &amp; Release CWP's</td>
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<tr>
<td>AIM Input</td>
<td>Validate Systems and Final Start-Up Sequence</td>
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<tr>
<td>AIM Input</td>
<td>Develop System Turnover Packages (STPs)</td>
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<tr>
<td>AIM Input</td>
<td>Execute Work</td>
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<tr>
<td>AIM Input</td>
<td>Execute Test Packs</td>
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<tr>
<td>AIM Input</td>
<td>Walk-Down Systems for Turnover</td>
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<tr>
<td>AIM Input</td>
<td>Add-on &amp; Sign-off on STPs</td>
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</tbody>
</table>

### Relationships

1. **AIM**
2. **NCS**
3. **BIM steel**
4. **OmniClass**
5. **COBie**
6. **BIM Guide**
7. **MOMA**
8. **iRING Tools**
9. **CIS/2**
10. **fitters.org**
Advanced Work Packaging
Information Mapping (AIM)
AIM Motivation

Industry Best Practice
CII Implementation Resource

Potential ROI
1. Up to 25% Productivity
2. Reduction in TIC of 4-10%
3. Predictability / Visibility
4. Safety Benefits

Identified Barrier
Challenge with Data Provisioning
Current Approaches to AWP

- Project Mandates Contractors Perform AWP
- Project Considers Use of IT Tool to Support AWP
- Information Reqs & IT Systems Arch Are Not Clear
- Project Resorts to Manual Dev of Work Packs

Results are Sub-Optimal and Potential ROI Not Achieved
Current Approaches to AWP

Project Mandates Contractors Implement AWP with technology

Automation Tool to Support AWP is Selected

Project Data Deliverables are Not Clarified in Contracts

Work Packs Are Developed But Likely Remain Highly Static

Expectations of AWP Implementation May Not be Met
AIM Approach to AWP

AWP & Project Data
Contracts Specify AWP and Requisite Project Data As Deliverables

People, Work Process and Technology are Aligned for AWP

Consolidated and Validated BOM/MTO is Fed to IT Tools to Support AWP

Works Packs Remain Agile and Sync’ed with Engineering Revisions

AWP is Reliable with Improved Safety, Productivity, Predictability
Thank You!

Ted Blackmon
CEO
Construct-X

ted@construct-x.com
www.construct-x.com