Automating Field Material Tracking Processes
A CII Research Team 240 Study

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Field Material Tracking
In The Laydown Yard

• Construction Industry Institute Research Team 240, and FIATECH
• RFID improved productivity AND
• Improved predictability and reliability of material availability
• Rockdale, Texas and Toronto Field Trials
Research Team

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Research Questions

1. Does technology really have an impact on construction labor productivity, and if so, how much?

2. Are there some good examples? Show me a couple.
1. Does Technology Have an Impact on Labor Productivity?
# Equipment and Material Technology

<table>
<thead>
<tr>
<th>Technology Factors</th>
<th>Change in Labor Productivity</th>
<th>Statistically Significant?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment Technology Factor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>36.2%</td>
<td>Yes</td>
</tr>
<tr>
<td>Control</td>
<td>31.7%</td>
<td>Yes</td>
</tr>
<tr>
<td>Functional Range</td>
<td>38.3%</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Material Technology Factor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modularization</td>
<td>16.1%</td>
<td>Yes</td>
</tr>
<tr>
<td>Reduction in Unit Weight</td>
<td>38.2%</td>
<td>Yes</td>
</tr>
<tr>
<td>Installation Flexibility</td>
<td>14.4%</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Data Sources:
Technology Impact of IT

Projects with higher Automation and Integration of IT had 31% to 45% better productivity.

Data Source:
- CII Benchmarking and Metrics
2. Is there a good example . . .
Maybe something that would help me track my materials better?
Target: Field Materials Tracking Processes on Large Industrial Sites

• Typical Characteristics
  – Thousands of engineered components
  – Long storage periods
  – Material movement
  – Deliveries in large batches at early stages
  – Remote projects
  – Inclement weather
1. Rockdale Field Trial

The project:

• 565 MWatts power plant, Rockdale, TX
• $750 million
• Open shop / direct hire
• Two identical boiler-support steel structures
Field Trial Methodology

MANUAL TRACKING PROCESS
BOILER A

LAY DOWN YARD

COLLECT RECORDS

STAGING AREA

COMPARE

AUTOMATED TRACKING PROCESS
BOILER B

LAY DOWN YARD

COLLECT RECORDS

STAGING AREA

400 STEEL COMPONENTS FROM IDENTICAL INSTALLATION SEQUENCES
Lay Down Yard

• Storage of pre-fabricated components
• 25 acres lay down yard
• Divided in smaller grids of 50ft x 100ft
• Posts uniquely marked the center of each grid for worker navigation purposes
Manual Process – Data Collection

Manually list

• Component piece mark and grid reference
Automated Process – Data Collection

• A rover equipped with positioning and identification sensors facilitates the data collection process
• Tagged components are identified around the rover

Tagged Steel Component
Active Identification Tag
Identification Reader & Omnidirectional Antenna
Positioning Reader & Antenna
Automated Process – Data Collection (ii)
Improved Accuracy and Precision

(a) 300 ft Accuracy

(b) 10 ft Accuracy

Tagged Component

RFID Read Range

Improved Localization

Rover Position

Rover Position
Localization Methodology–Navigation Maps
Total Labor-Time per Component Located

Manual Tracking
36.8 minutes per component

Automated Tracking
4.6 minutes per component

Improvement Ratio ~ 8.1:1
% of Components Not-Immediately-Found

Manual Tracking

Automated Tracking

9.52%

0.54%

Improvement Ratio ~ 17.5:1
Staging area

- Pre-assembly and installation of steel components
- Small, crowded, dynamic
- Minimal storage capacity
Productivity Analysis / Staging area

Based on:
- Project controls data (work hours)
- Foreman delay surveys (idle work time)
- Engineering data (Tons of installed steel)

Focus on the erection of installed components:
- Including the efficiency of erection crews for installing steel components
- Not including bolting, torquing, plumbing, painting, and inspection tasks

4.2% increment in steel erection productivity
Cost Benefit Analysis

• Assuming that all 9,670 steel components had been tagged, a 2:1 benefit-to-cost ratio would have been achieved for this particular project.

• Re-using the tags would increase this benefit to cost ratio.
2. Portlands Field Trial

- Partnership between OPG and Transcanada Energy
- 550 megawatt, natural gas fired, combined cycle, generation facility
- Union labor
Portlands Field Trial

- Focus on tracking the following components:
  - 224 pipe spools
  - 22 safety valves
  - 100 globe valves
Materials Tracking Technologies

- RFID reader
- Omni-Directional Antenna
- RFID Tag
- Bluetooth GPS
- Handheld PC
Reliable Materials Tracking
Flow of Pipe Spools

Week of August 20th
Port – 89 North - 13
South - 44

Week of August 27th
Port – 89 North-13 South-
44

Week of September 3rd
Port-18 North- 69 South-
89

Week of November 9th
Port – 0 North – 59 South
- 67
Pipe Spools – Typical Case

3 pipe spools were not immediately found

<table>
<thead>
<tr>
<th>Manual process (&gt;$5,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two workers for 5 hours searching (&gt; $1,250)</td>
</tr>
<tr>
<td>Redirecting other crew members (&gt; $1000)</td>
</tr>
<tr>
<td>Further search and further disruption (&gt; $2000)</td>
</tr>
<tr>
<td>Risk of reordering the materials (&gt; $1000)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Automated Process (&lt; $45)</th>
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<tr>
<td>Spools were found within 20 minutes (&lt;$45)</td>
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</tbody>
</table>
Strong Positive Feedback from Contractors

- Overall feedback from contractors was very strong and positive
- Immediately recognized benefit in terms of time and cost savings
- General foreman was able to reduce initial crew size from 18 to 12 workers
Summary

- Changes in equipment, materials, and the automation and integration of project work functions are related to significant improvements in productivity.

- Automated materials identification and localization technologies significantly improve field materials management.
Acknowledgments

• Construction Industry Institute
• FIATECH
• Bechtel
• Ontario Power Generation
• Transcanada Energy
• Identec
More details on this project and also the measurement tools to do predictive analysis of the technology value in construction can be found on the FIATECH website at

Business Case for Leveraging Technology