Construction Productivity: Advances and Opportunities for Improvement

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Agenda

- Construction Productivity – The Measurement Challenge
- Improvements through Technical Change
- The Need for Process Improvement
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Productivity Measures and Industry Policies

Construction Price Indices

Industry Labor Productivity = Real Output ($) ÷ Total Work Hours

Raw Output ($) → Price Index → Real Output ($)
Single-Family Houses Index
Hedonic Regression Models

1970s Home
Modern Home
Case Study: New Home Construction in Bowling Green, Kentucky

- Bowling Green, KY
- Population: 54,000
- Local Economy: Health Care, University, Manufacturing, and Agriculture.

Used new home sales data for 2005 to 2007 from Multiple Listing Service to develop “New” Price Index for Bowling Green, Kentucky.
Case Study: New Home Construction in Bowling Green, Kentucky

Data Source: Multiple Listing Service New Home Sales Data
Evidence of Productivity Improvement among Construction Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>1976</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitework</td>
<td>51.5% (1.5%)</td>
<td>51.5% (1.5%)</td>
</tr>
<tr>
<td>Doors &amp; Windows</td>
<td>28.6% (0.9%)</td>
<td>28.6% (0.9%)</td>
</tr>
<tr>
<td>Finishes</td>
<td>20.6% (0.7%)</td>
<td>20.6% (0.7%)</td>
</tr>
<tr>
<td>Masonry</td>
<td>20.4% (0.7%)</td>
<td>20.4% (0.7%)</td>
</tr>
<tr>
<td>Concrete</td>
<td>15.5% (0.5%)</td>
<td>15.5% (0.5%)</td>
</tr>
<tr>
<td>Thermal Protection</td>
<td>10.8% (0.4%)</td>
<td>10.8% (0.4%)</td>
</tr>
<tr>
<td>Wood &amp; Plastic</td>
<td>10.0% (0.3%)</td>
<td>10.0% (0.3%)</td>
</tr>
<tr>
<td>Metals</td>
<td>6.2% (0.2%)</td>
<td>6.2% (0.2%)</td>
</tr>
</tbody>
</table>

Note: (Annual Improvement Rate) Data Source: RS Means

CII RT-240: Leveraging Technology to Improve Construction Productivity
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Technology Impact: A 25 Year Perspective

- **More Power**
  - Contributes to 1.5% Annual Compound Productivity Improvement in Site work

- **Advanced Modularity**
  - Contributes to 0.5% Annual Compound Productivity Improvement in Concrete

- **Advanced Function**
  - Contributes to 0.7% Annual Compound Productivity Improvement in Finishes

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Problem: Site Materials Tracking on Large Industrial Projects

- Typical Characteristics
  - Thousands of engineered components
  - Long storage periods
  - Material movement
  - Sequenced erection
  - Remote yards
  - Inclement weather

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Carl Haas (Univ. of Waterloo) and Carlos Caldas (Univ. of Texas at Austin)
Reliable Material Tracking

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One Result of Leveraging Technology: Total Labor-Time per Component Located

Manual Tracking

Automated Tracking

36.8 minutes per component  4.6 minutes per component

Improvement Ratio ~ 8.1:1

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Productivity Analysis / Installation Area

Based on:

- Project controls data (work hours)
- Foreman daily 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

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Best Processes for **Electrical** Productivity

![Bar chart showing normalized labor productivity for various processes]

- Integration
- Safety
- Material Management
- Automation
- Constructability
- Team Building

Note: A lower labor productivity measure is better.
** denotes significance at 0.01 level.
* denotes significance at 0.05 level.

CII RT-252: Craft Productivity Program
Best Productivity Practices Implementation Index

- **Materials Management**
  - Materials Management System
  - Receipt and Inspection of Materials
  - Procurement Management

- **Equipment Logistics**
  - Site Tool Management
  - Machinery Availability

- **Craft Information Systems**
  - Short Interval Planning
  - Work Face Planning
  - Constructability Review

- **Human Resource Management**
  - Training and Development
  - Behavior
  - Organizational Structure
  - Employment

- **Construction Methods**
  - Sequence and Scheduling of Work
  - Start-up, Commission, and Turnover Plan
  - New Product Investigation
  - Site Layout Plan

- **Environmental Safety and Health**
  - Job Safety
  - Substance Abuse Programs
  - Safety Training and Orientation

CII RT-252: Craft Productivity Program
Future Tasks – BPPII Model

- Weight BPPII elements based on their relative impact on productivity
- Validate and test
- Develop Implementation Resource (Roadmap)

CII RT-252: Craft Productivity Program
Conclusion

- The challenge of accurately measuring construction productivity at the industry level remains.
- Technology has had a positive impact on construction productivity.
  - …but the swing has to match the club.
- There is significant variation in construction productivity from project to project.
- Mapping the processes to control productivity should help reduce the variation and potentially improve it on a macro scale as well.