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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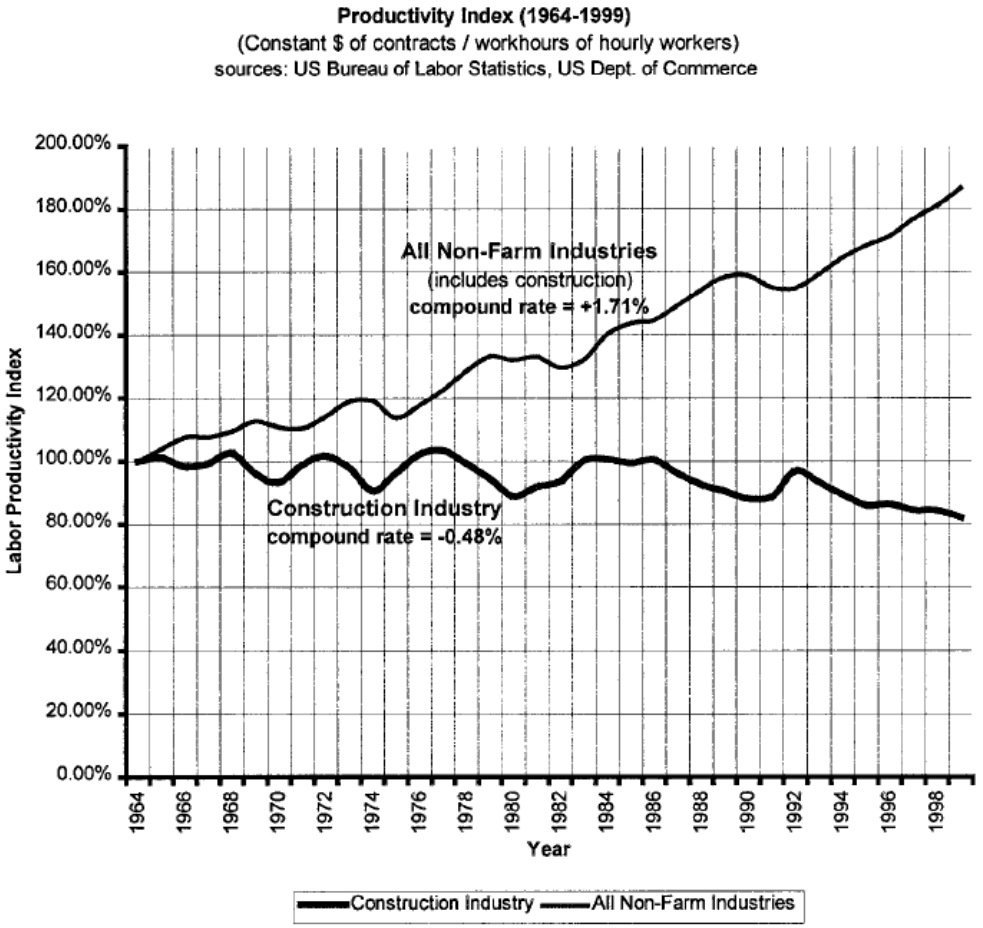
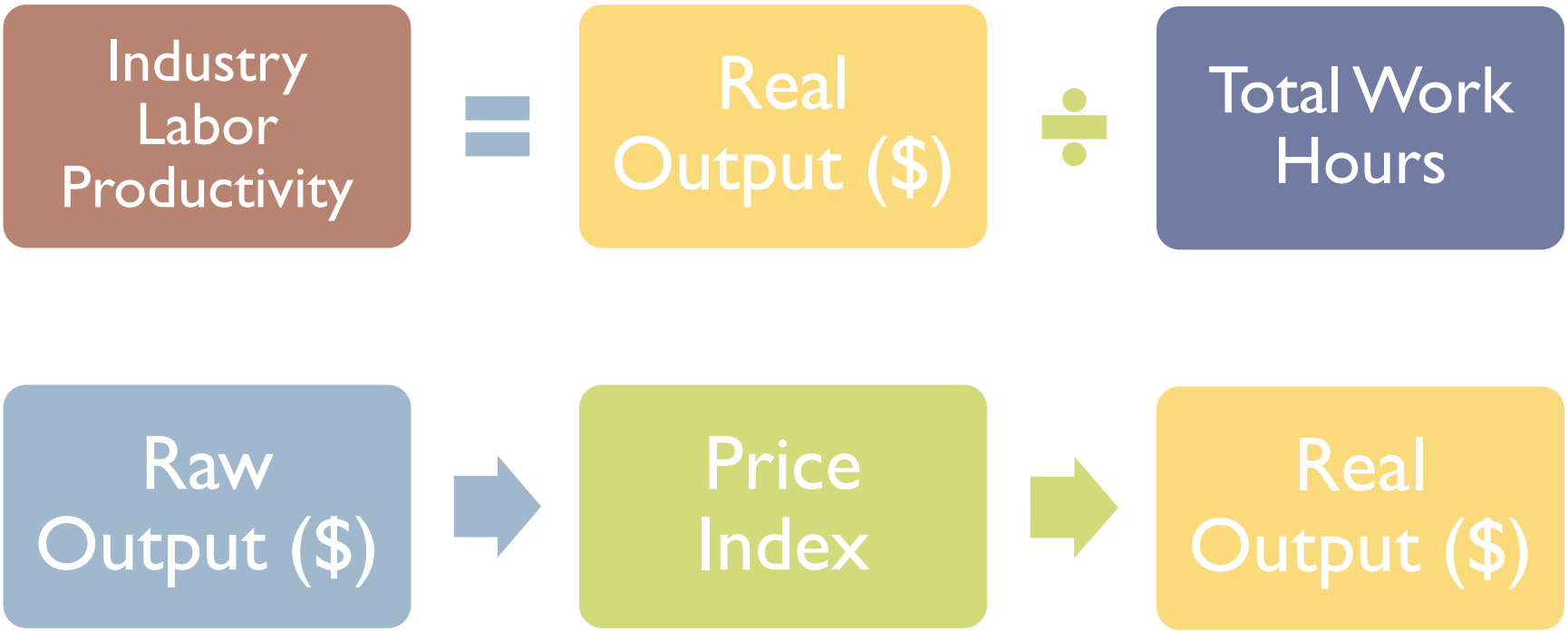
Productivity Measures and Industry Policies



Ref: Teicholtz, P. (2001). “U.S. Construction Labor Productivity Trends, 1970-1998”. ASCE J. Const. Engr. & Mngmt.

Construction Price Indices

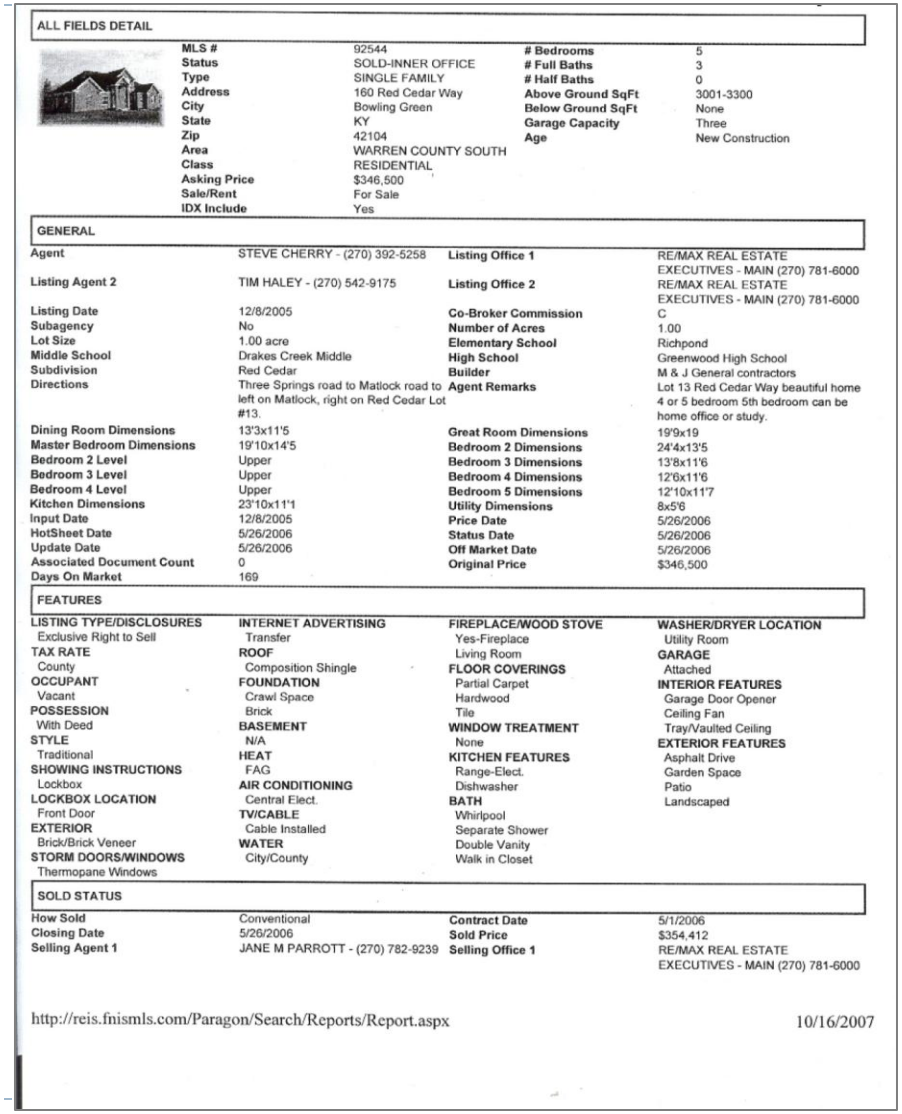


Single-Family Houses Index Hedonic Regression Models

1970s ern 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.



ALL FIELDS DETAIL

MLS #	92544	**# Bedrooms**	5
Status	SOLD-INNER OFFICE	**# Full Baths**	3
Type	SINGLE FAMILY	**# Half Baths**	0
Address	160 Red Cedar Way	**Above Ground SqFt**	3001-3300
City	Bowling Green	**Below Ground SqFt**	None
State	KY	**Garage Capacity**	Three
Zip	42104	**Age**	New Construction
Area	WARREN COUNTY SOUTH		
Class	RESIDENTIAL		
Asking Price	$346,500		
Sale/Rent	For Sale		
IDX Include	Yes		

GENERAL

Agent	STEVE CHERRY - (270) 392-5258	**Listing Office 1**	RE/MAX REAL ESTATE EXECUTIVES - MAIN (270) 781-6000
Listing Agent 2	TIM HALEY - (270) 542-9175	**Listing Office 2**	RE/MAX REAL ESTATE EXECUTIVES - MAIN (270) 781-6000
Listing Date	12/8/2005	**Co-Broker Commission**	C
Subagency	No	**Number of Acres**	1.00
Lot Size	1.00 acre	**Elementary School**	Richpond
Middle School	Drakes Creek Middle	**High School**	Greenwood High School
Subdivision	Red Cedar	**Builder**	M & J General contractors
Directions	Three Springs road to Matlock road to left on Matlock, right on Red Cedar Lot #13.	**Agent Remarks**	Lot 13 Red Cedar Way beautiful home 4 or 5 bedroom 5th bedroom can be home office or study.
Dining Room Dimensions	13'3x11'5	**Great Room Dimensions**	19'9x19
Master Bedroom Dimensions	19'10x14'5	**Bedroom 2 Dimensions**	24'4x13'5
Bedroom 2 Level	Upper	**Bedroom 3 Dimensions**	13'8x11'6
Bedroom 3 Level	Upper	**Bedroom 4 Dimensions**	12'6x11'6
Bedroom 4 Level	Upper	**Bedroom 5 Dimensions**	12'10x11'7
Kitchen Dimensions	23'10x11'1	**Utility Dimensions**	8x5'6
Input Date	12/8/2005	**Price Date**	5/26/2006
HotSheet Date	5/26/2006	**Status Date**	5/26/2006
Update Date	5/26/2006	**Off Market Date**	5/26/2006
Associated Document Count	0	**Original Price**	$346,500
Days On Market	169		

FEATURES

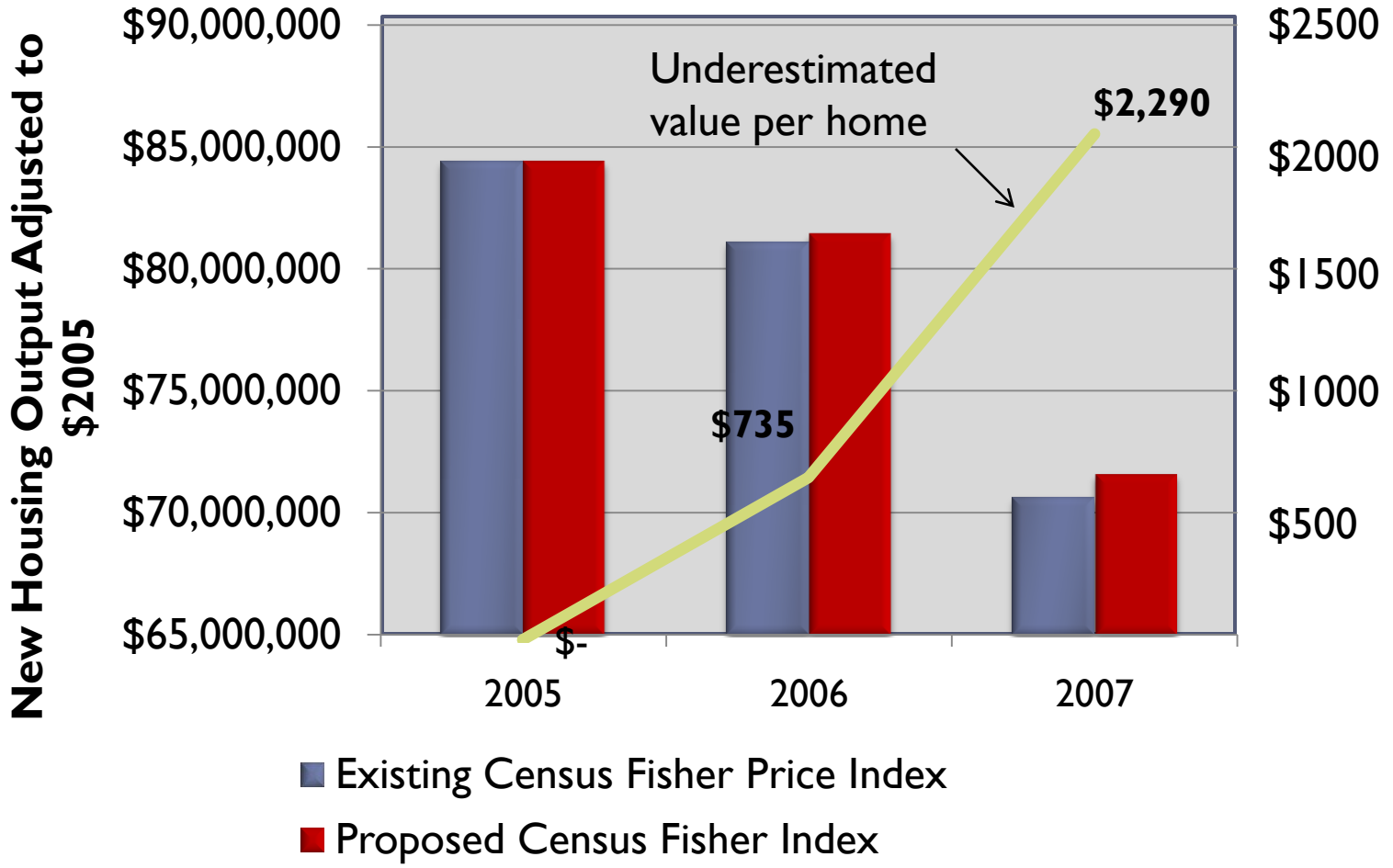
LISTING TYPE/DISCLOSURES	**INTERNET ADVERTISING**	**FIREPLACE/WOOD STOVE**	**WASHER/DRYER LOCATION**
Exclusive Right to Sell	Transfer	Yes-Fireplace	Utility Room
TAX RATE	**ROOF**	Living Room	**GARAGE**
County	Composition Shingle	**FLOOR COVERINGS**	Attached
OCCUPANT	**FOUNDATION**	Partial Carpet	**INTERIOR FEATURES**
Vacant	Crawl Space	Hardwood	Garage Door Opener
POSSESSION	Brick	Tile	Ceiling Fan
With Deed	**BASEMENT**	**WINDOW TREATMENT**	Tray/Vaulted Ceiling
STYLE	N/A	None	**EXTERIOR FEATURES**
Traditional	**HEAT**	**KITCHEN FEATURES**	Asphalt Drive
SHOWING INSTRUCTIONS	FAG	Range-Elect.	Garden Space
Lockbox	**AIR CONDITIONING**	Dishwasher	Patio
LOCKBOX LOCATION	Central Elect.	**BATH**	Landscaped
Front Door	**TV/CABLE**	Whirlpool	
EXTERIOR	Cable Installed	Separate Shower	
Brick/Brick Veneer	**WATER**	Double Vanity	
STORM DOORS/WINDOWS	City/County	Walk in Closet	
Thermopane Windows			

SOLD STATUS

How Sold	Conventional	**Contract Date**	5/1/2006
Closing Date	5/26/2006	**Sold Price**	$354,412
Selling Agent 1	JANE M PARROTT - (270) 782-9239	**Selling Office 1**	RE/MAX REAL ESTATE EXECUTIVES - MAIN (270) 781-6000

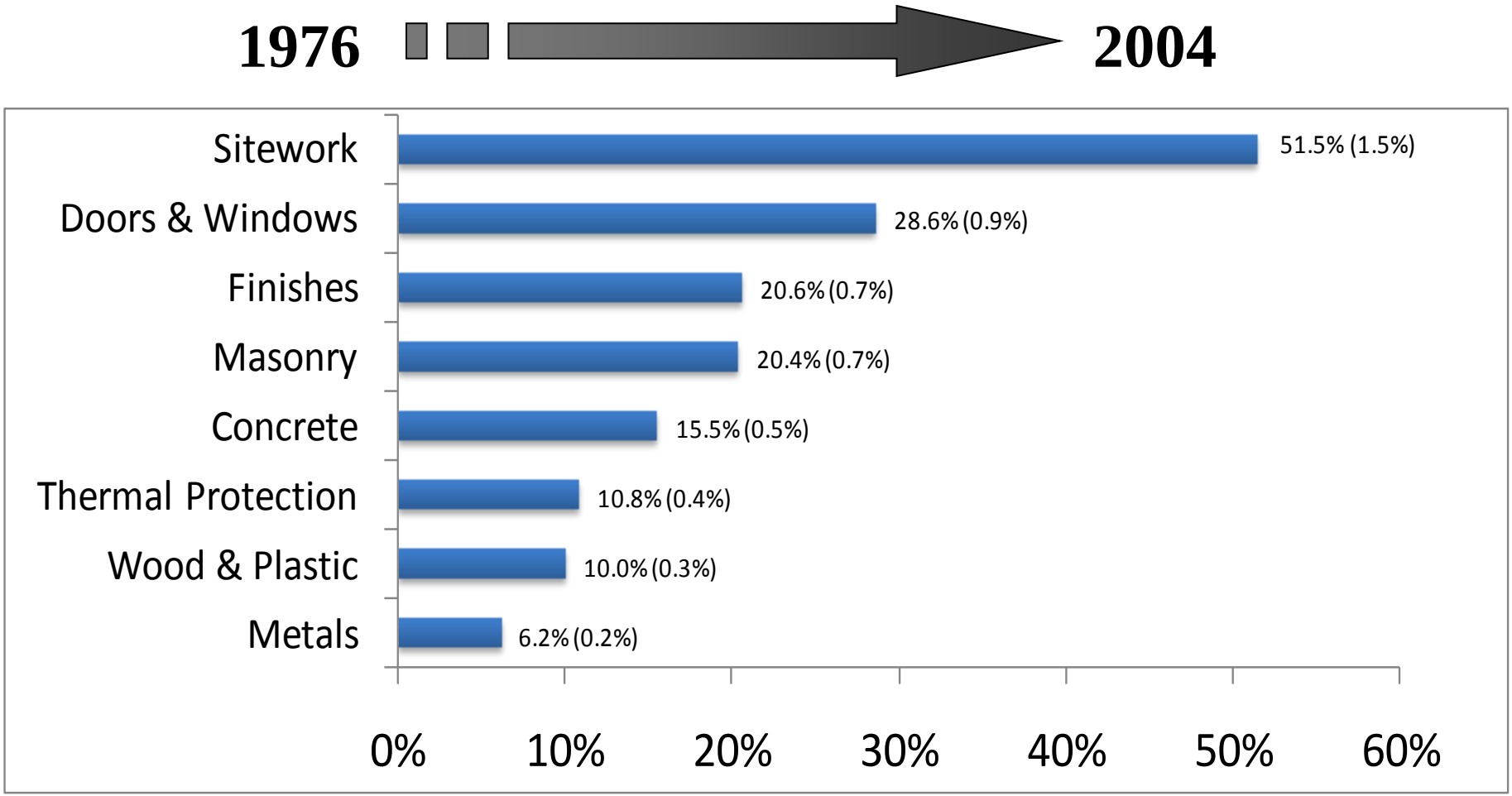
http://reis.fnismls.com/Paragon/Search/Reports/Report.aspx 10/16/2007

Case Study: New Home Construction in Bowling Green, Kentucky



- Scope of Study: New Home Sales in Bowling Green, KY 2005-2007.
  Data Source: Multiple Listing Service New Home Sales Data

Evidence of Productivity Improvement among Construction Activities



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

CII RT-240: Leveraging Technology to Improve Construction Productivity

Agenda

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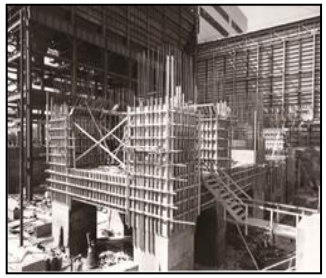
Technology Impact: A 25 Year Perspective

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 →

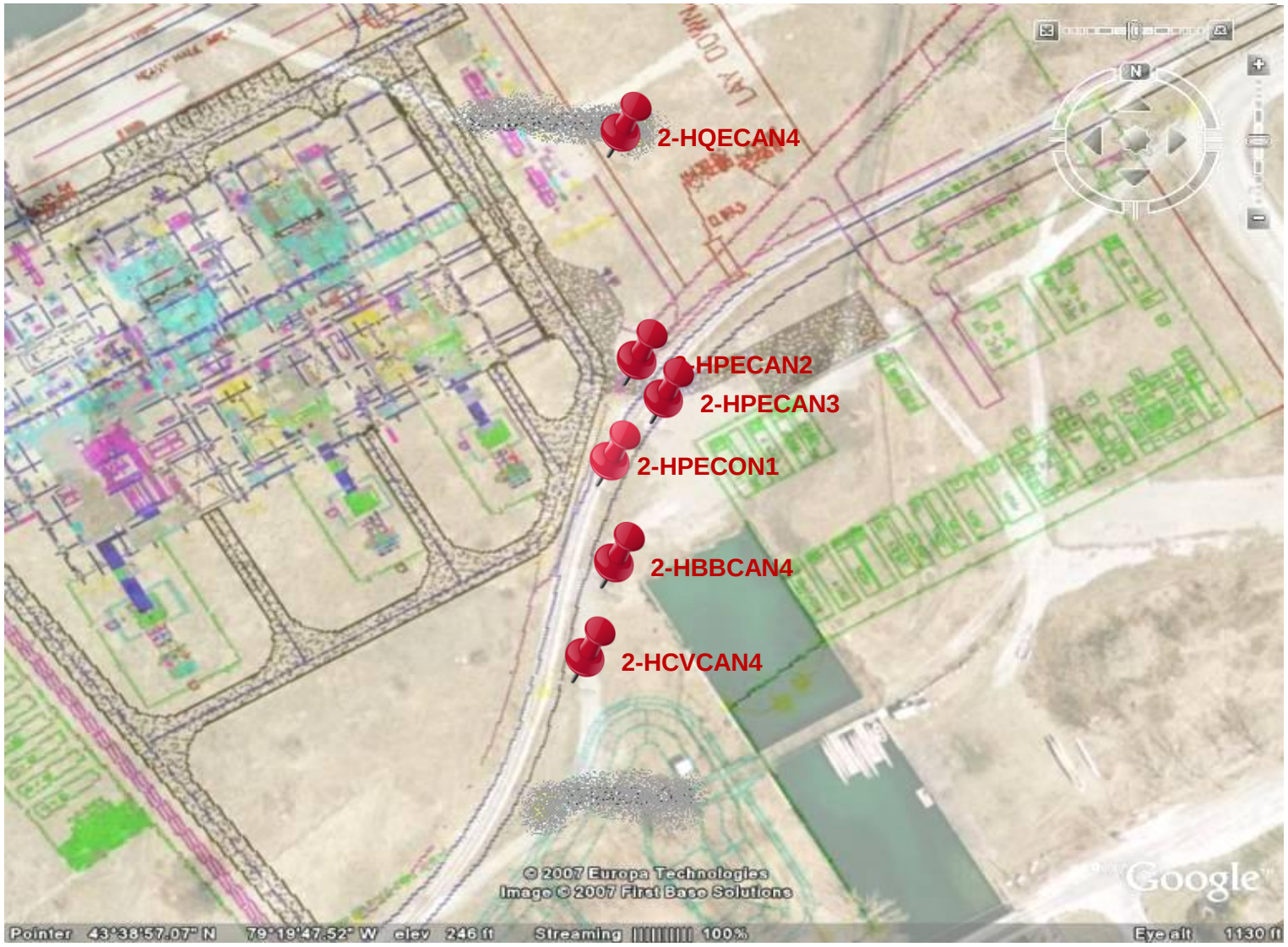
Contributes to →

0.7% Annual Compound Productivity Improvement in **Finishes**

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

Reliable Material Tracking



One Result of Leveraging Technology: 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

CII RT-240: Leveraging Technology to Improve Construction Productivity
Carl Haas (Univ. of Waterloo) and Carlos Caldas (Univ. of Texas at Austin)

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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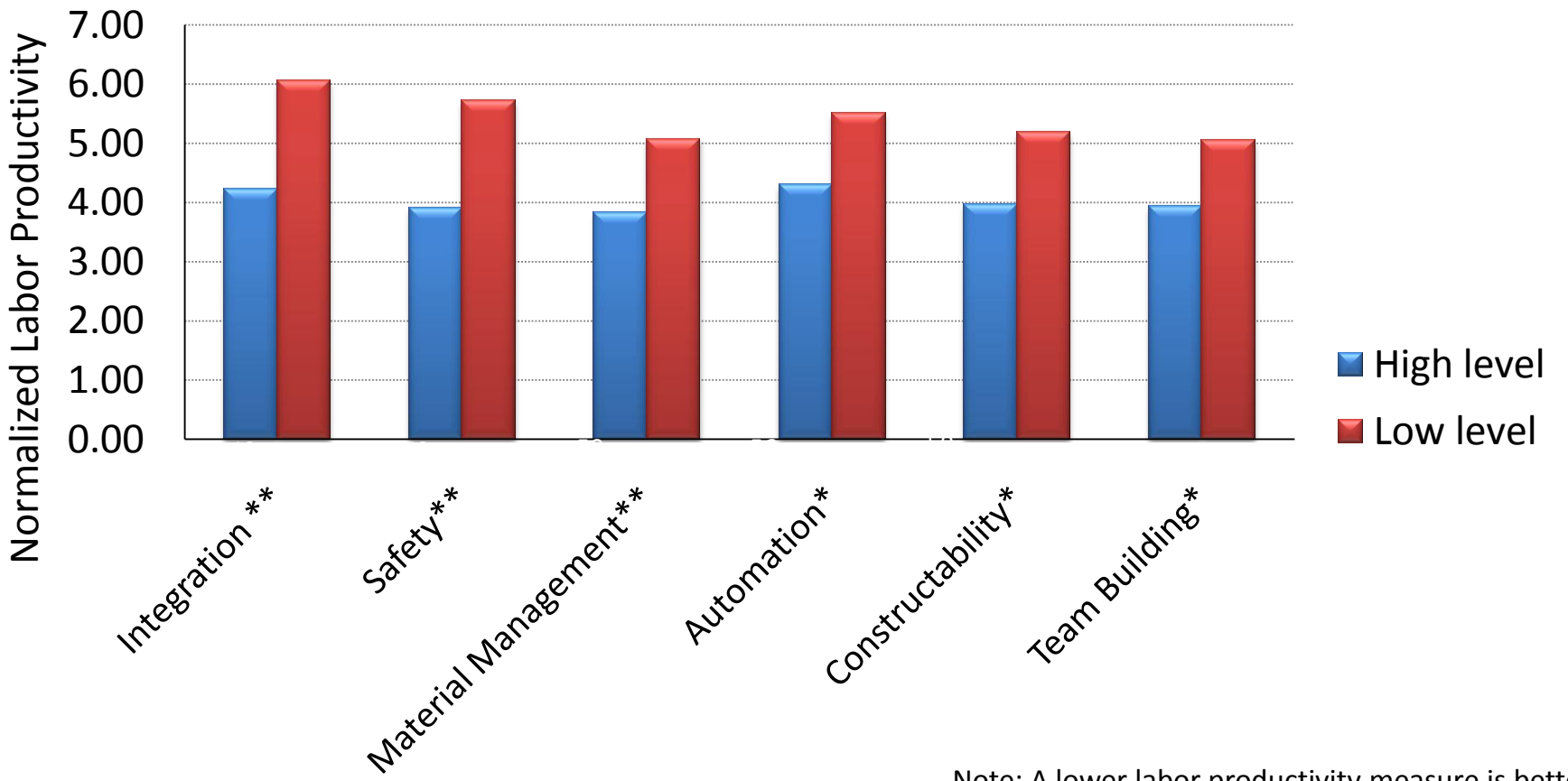
Craft Productivity Improvement Program

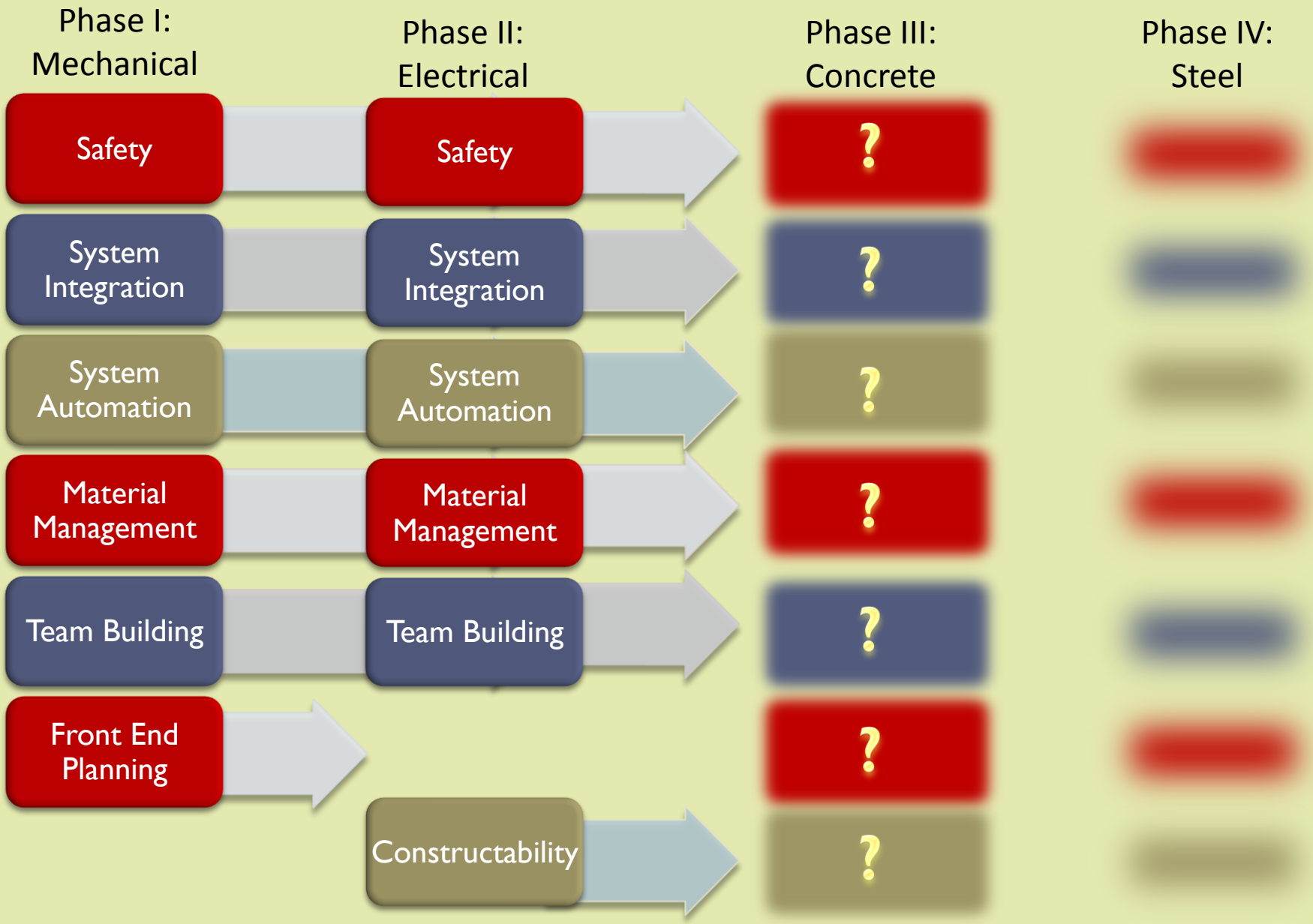
	2009	2010	2011	2012	2013
Innovations	Pipe Support Study Laser Scanning Case Study Weldless Pipe Joining Case Study Scaffolding Systems Case Study Eliminating Cut Length on Pipe Modules Case Study	Activity Analysis Guide Rework Reduction Tool Modular Formwork Case Study Self Consolidation Concrete Case Study	Workforce Development Index New Case Studies TBD	New Case Studies TBD	Report Out
Benchmarking & Metrics Data Analysis	Mechanical •Safety •System Integration •System Automation •Material Management •Team Building •Front End Planning	Electrical •Safety •System Integration •System Automation •Material Management •Team Building •Constructability	Concrete •Best Practices to be determined	Steel •Best Practices to be determined	Report Out
Best Productivity Practices	Synthesize BPPII Framework Weight Index	Validation of Best Productivity Practice Implementation Index (BPPII)			Finalize Roadmap

Best Processes for **Electrical** Productivity



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

Emerging Productivity Practices



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

Future Tasks – BPPII Model

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

Best Productivity Practices Implementation Index								
CATEGORY	Planning and Implementation Level							
Section	0	1	2	3	4	5	Level	Score
I - MATERIALS MANAGEMENT								
A. Materials Management Systems								
B. Receipt and Inspection of Materials								
II - EQUIPMENT LOGISTICS								
A. Site Tool Management								
B. Machinery Availability								
III - CRAFT INFORMATION SYSTEMS								
A. Work Packaging								
B. Work Face Planning								
D.Constructability Review								
IV - HUMAN RESOURCE MANAGEMENT								
A. Training and Development								
B. Behavior								
C. Organizational Structure								
D. Employment								
V - CONSTRUCTION METHODS								
A. Sequence and Scheduling of Work								
B. Start-Up, Commission, and Turnover Plan								
C. New Technology Investigation								
D. Site Layout Plan								
VI - ENVIRONMENTAL SAFETY AND HEALTH								
A. Job Safety								
B. Substance Abuse Programs								
C. Safety Training and Orientation								

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.