Northwest Construction Consumer Council

Independent Project Analysis, Inc.

Market Trends – A Focus on Engineering Productivity

Dean P. Findley

May 29, 2008

Purpose

- **Share information on recent market trends**
- **Discuss one area of market bottleneck: Engineering**
- **Provide recommendations for avoiding the bottleneck**

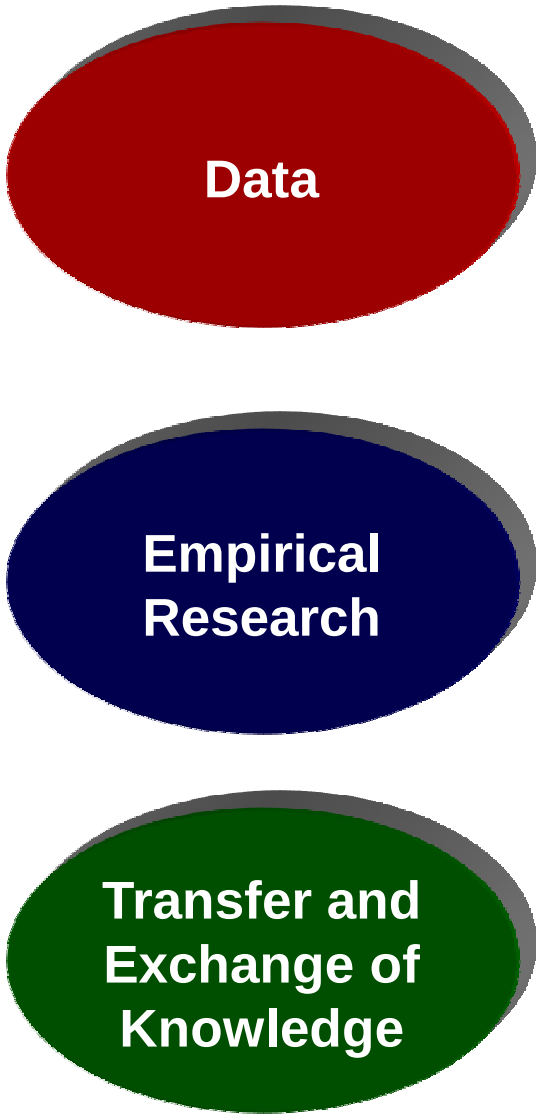
Outline

- *Introducing IPA*
- The Setting
- Market Trends
- Engineering Productivity
- Conclusions

Independent Project Analysis

- **IPA independently measures the performance of capital projects for a variety of companies**
- **Devoted to the analysis of capital projects as a field of empirical research**
- **We measure the Leading Indicators:**
  - **Front-End Loading (Project definition)**
  - **Team Effectiveness**
  - **Use of Value Improving Practices**
- **We help owners set and achieve goals**
- **IPA improves the competitiveness of its customers by helping them use capital more effectively**

How Does IPA Help Improve Capital Projects?



10,000+ Projects

- **350+ Companies**
- **Varying project types**
- **Over 2,000 Variables per project**

Statistical Analysis

- **Practices vs. Results**
- **Project research**

Performance and Plans

- **Best Practices**
- **Benchmarks**

IPA Works at Several Levels

- ***Individual projects*** **form the foundation of our work**
- **Diagnosing (benchmarking)** ***project systems*** **provides companies with the basis for improvement**
- ***Benchmarking Conferences*** **bring companies together to share practices and metrics**

Industry Benchmarking Consortium
IBC 2008 Companies

Agenda - Tuesday, April 1

9:00 a.m.-9:15 a.m.	Welcome	[Belmont Ballroom]
9:15 a.m.-10:00 a.m.	Keynote Address	[Belmont Ballroom]
10:00 a.m.-10:15 a.m.	Break	[Belmont Foyer]
10:15 a.m.-10:30 a.m.	Safety Metrics	[Belmont Ballroom]
10:30 a.m.-12:00 p.m.	Industry Metrics	[Belmont Ballroom]
12:00 p.m.-1:00 p.m.	Lunch	[Potomac Ballroom/Colvin Run]
1:00 p.m.-2:00 p.m.	Operability	[Belmont Ballroom]
2:00 p.m.-3:00 p.m.	Market Trends- Engineering Productivity	[Belmont Ballroom]
3:00 p.m.-3:15 p.m.	Break	[Belmont Ballroom]

Agenda -Wednesday, April 2

9:00 a.m.-9:15 a.m.	Agenda Overview		[Belmont Ballroom]
9:15 a.m.-10:15 a.m.	Peer Reviews and Capital Effectiveness		[Belmont Ballroom]
10:15 a.m.-10:30 a.m.	Break		[Belmont Foyer]
10:30 a.m.-11:30 a.m.	Defending the Gate: Examining Gatekeeping in a Stage-Gated Project Definition Process		[Belmont Ballroom]
11:30 a.m.-12:30 p.m.	Best and Worst IBC 2008 Projects		[Belmont Ballroom]
12:30 p.m.-1:30 p.m.	Lunch		[Potomac Ballroom/Colvin Run]
1:30 p.m.-2:30 p.m.	Presentation by Alcoa [Belmont I & II]	Presentation by EPA	[Belmont I & II]
2:30 p.m.-2:45 p.m.	Break		[Belmont Foyer]
2:45 p.m.-3:30 p.m.	Commercialization of Alternative Energy Technologies [Belmont I & II]	Company Breakouts	[As Assigned]
3:30 p.m.-4:00 p.m.	Break		[Belmont Foyer]
4:00 p.m.-4:45 p.m.	Commercialization of Alternative Energy Technologies [Belmont I & II]	Company Breakouts	[As Assigned]
4:45 p.m.-5:00 p.m.	Closing Remarks		[Belmont I, II, & III]
5:00 p.m.-6:00 p.m.	IBC Steering Committee Meeting		[Sully]
6:00 p.m.-7:00 p.m.	Reception // Welcome Small Projects and Site Systems		[Belmont Foyer]

Outline

- **Introducing IPA**
- ***The Setting***
- **Market Trends**
- **Engineering Productivity**
- **Conclusions**

The Projects Crisis

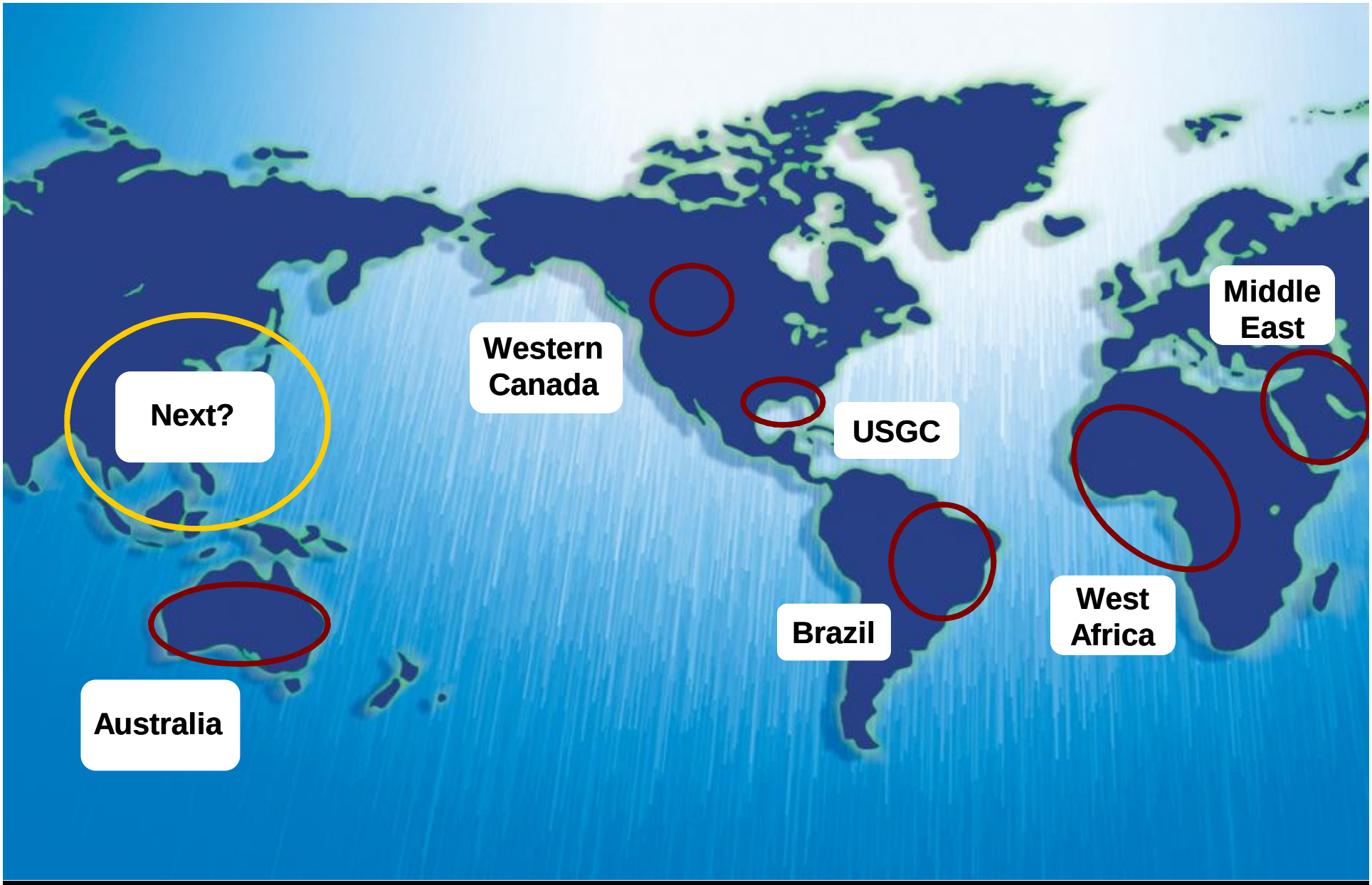
- **We are in our 5th year of the first world-wide projects crisis in the process industries**
- **Barring a global economic slowdown, the crisis has years to run**
- **On-going and near-term spending is unprecedented**
  - **$1.4 trillion in Middle East alone**
  - **55 projects> $100MM in Alberta**
  - **$400+ billion on USGC**
  - **Etc…**
- **This is no longer any fun**

Harsh Reality

The cupboard is empty:

- Many equipment items have escalated 80 percent in the past few years and delivery times have lengthened
- Engineering shortages are spreading from all of the major engineering centers to the value centers
- Lack of FEL resources is causing a dramatic slowing of project development
- Labor shortages combined with other problems have created a growing series of project “hotspots”

Regional Hotspots



Issues

- How is the crisis playing out?
- How much damage will be done to
  - projects?
  - capital project systems?
  - companies' futures?
- How will we respond?

Project Casualties are Mounting

- **More projects are spinning out of control**
- **Large projects are especially vulnerable**
- **Projects are slowing dramatically, but not by choice and therefore not by plan**
- **Quality, especially engineering quality, is suffering**

Causes of Failure

- **Most failed projects are old-fashioned business objectives and FEL failures**
- **Even relatively small errors are severely punished in the current market**
- **However, we are seeing more genuine execution failures, an expected but new result**

When Projects Fail...

The Scapegoats Must be Found!

- **Six IBC companies have replaced their heads of engineering with contractor executives *with no prior owner experience***
- **We are seeing several reorganizations**

15 years of progress is in jeopardy

What Needs to be Done?

- **At the Corporate Level?**

- **At the Project System Level?**

Corporate Level

- **Business education**
- **Trimming of the portfolio**
- **Capability assessment**

Ground Business Management in Reality

- **If your management does not understand the basics of capital projects and how business actions control capital projects, it is education time!**
- **If your management does not appreciate the state of the project markets and its implications, it is education time!**
- **If you cannot find somebody or some way of getting them to listen, dust off your résumé**

Trim the Portfolio

- **We continue to work on too many projects**
- **Trim the portfolio of:**
  - **economically marginal projects**
  - **vampire projects**
  - **projects bogged down in regulatory, political or partner problems**
  - **projects for which the technology is not ready**
- **Control of the portfolio is essential, especially in decentralize companies**

Assess Project Capabilities

- **Inventory project staffing resources across the company**
- **Account for increasing attrition**
- **Account for the (in)effectiveness of new hires**
- **Provide management with a realistic assessment of how many you can develop and execute as a function of project size and complexity**

Project System Level Actions

- **In addition to being ever more scrupulous with the fundamentals, you need to explicitly plan to cover contractor deficiencies in**
  - **Design QA/QC**
  - **Construction QA/QC**
  - **Expediting and inspection of vendor-supplied materials**
  - **Construction management**
  - **Project cost and schedule controls**
- **Suggesting that many of these are contractor responsibilities is true but a waste of time**

INDEPENDENT PROJECT ANALYSIS INC.

IBC 2008

Market Trends

A Focus on Engineering Productivity

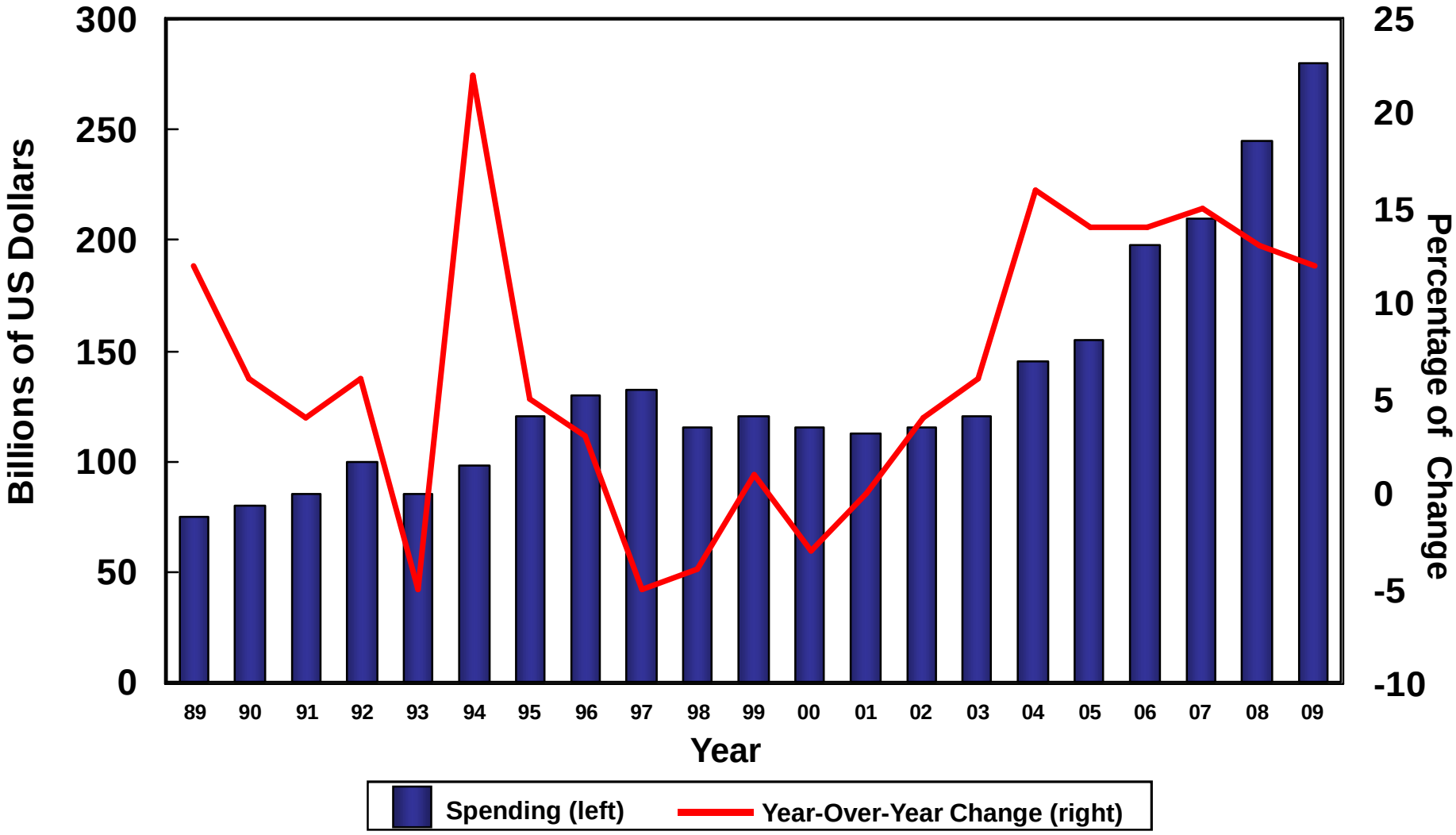
Dean P. Findley and Luke M. Wallace

Outline

- ***Market Trends***
- **Engineering Productivity Database**
- **Drivers of Engineering Productivity**
- **Time Trends and Regional Differences**
- **Conclusions**

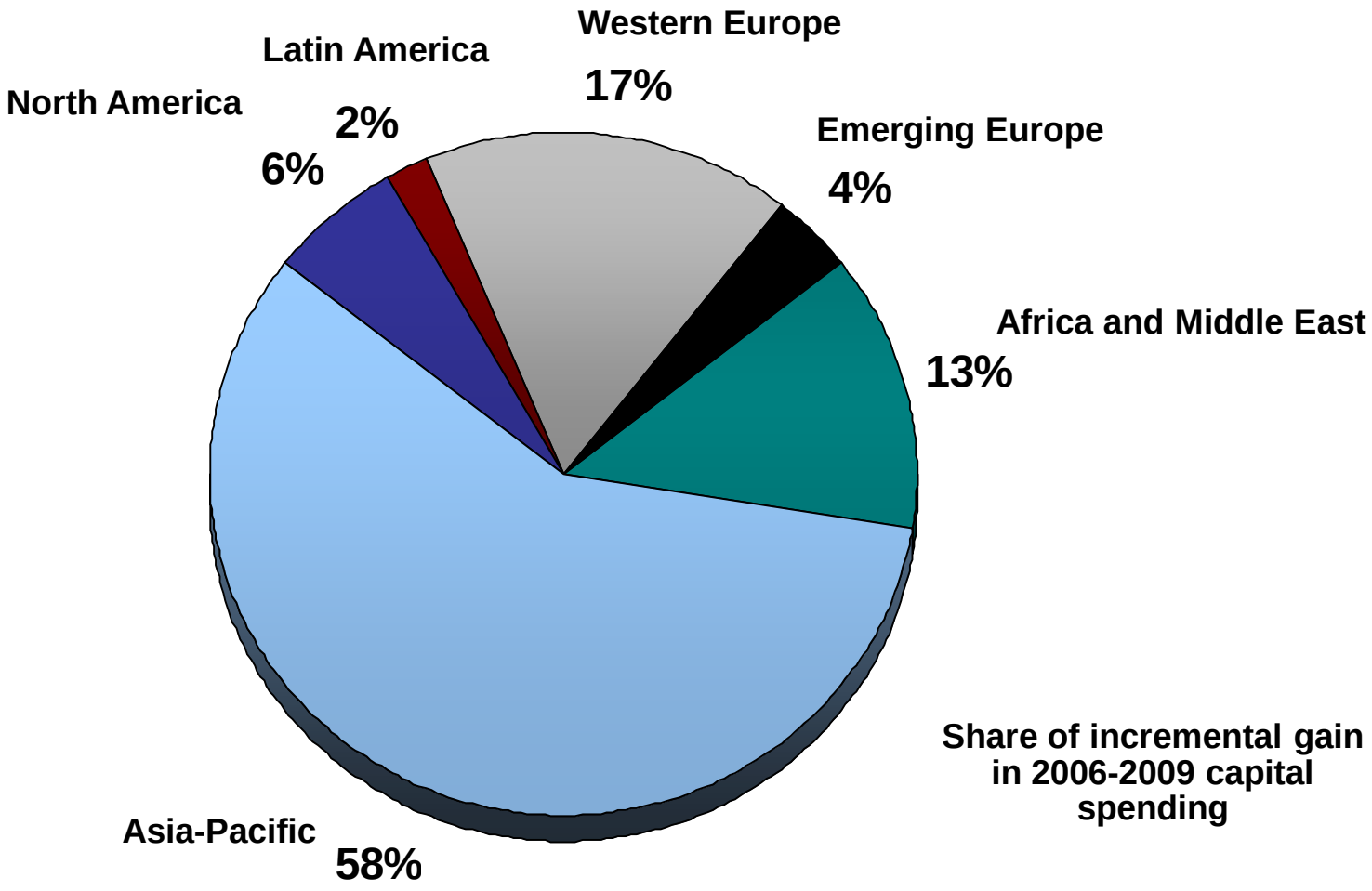
Capital Spending Has Increased in All Industries

For Example, Global Chemical Spending



Source: *Chemical Engineering*, January 2008

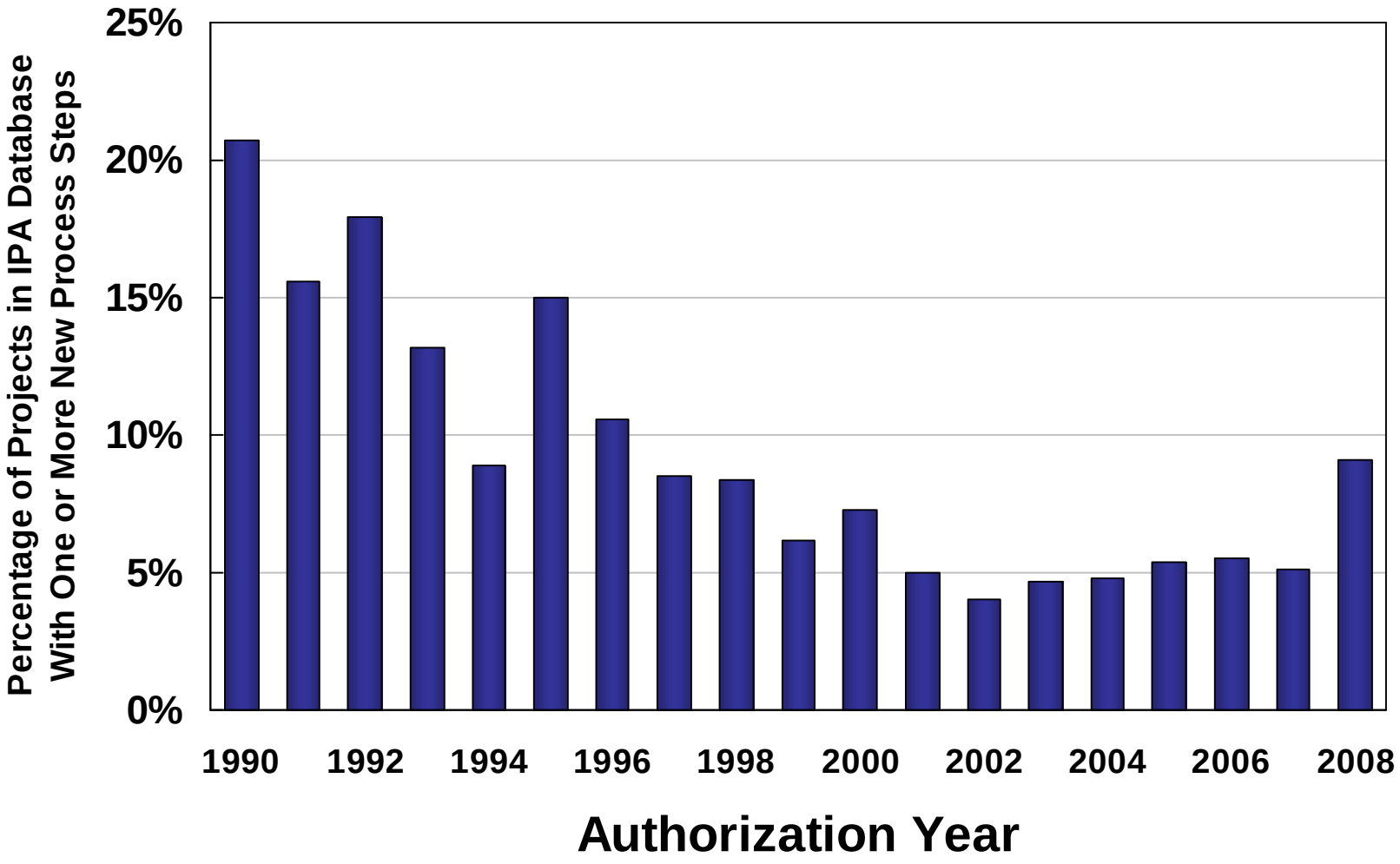
Where Is the Spending Increase Happening?
2006 to 2009 Period



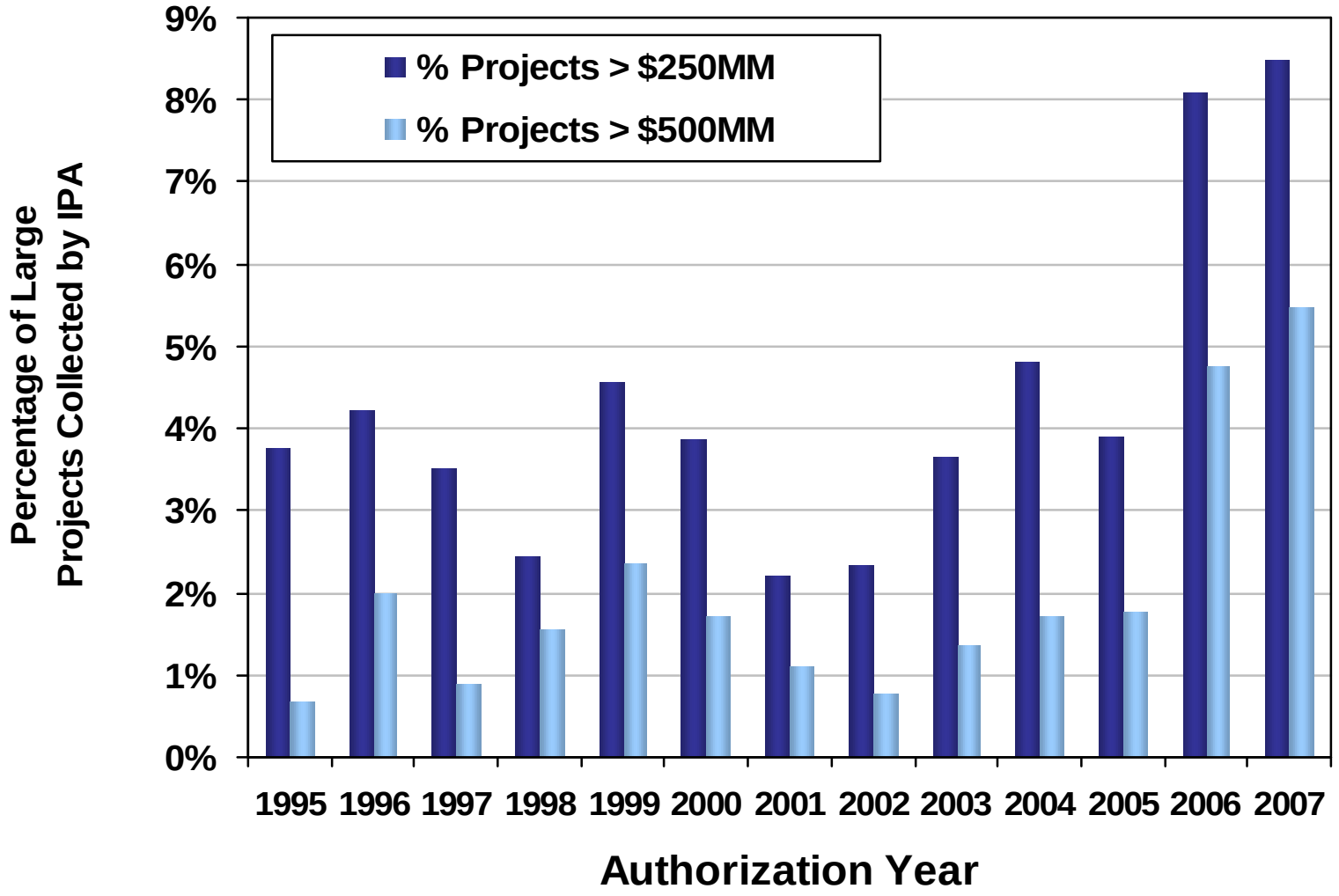
Source: *Chemical Engineering*, January 2008

New Technology Projects Have Declined

But, We Expect an Increase

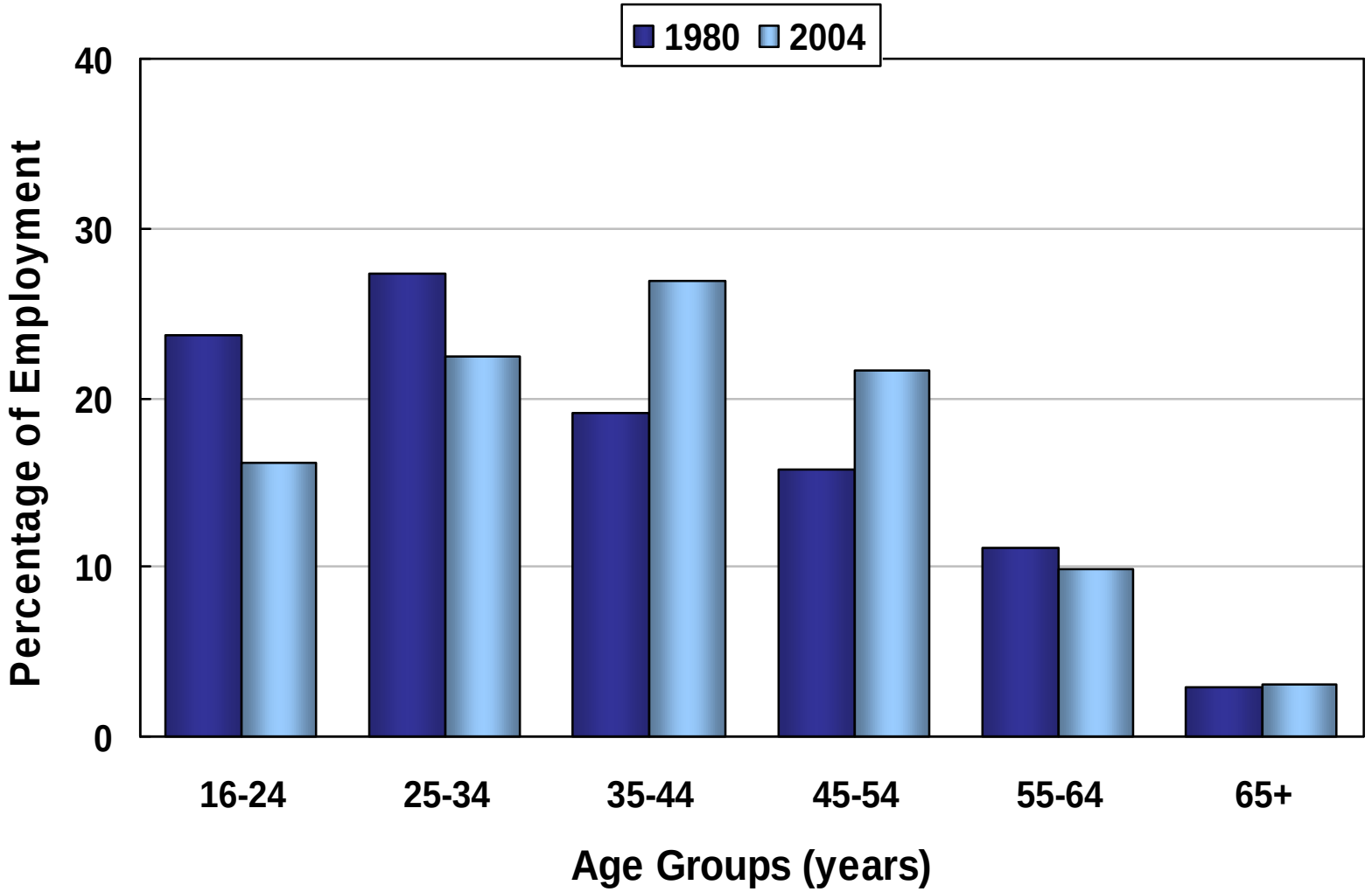


Megaproject Activity Has Significantly Increased



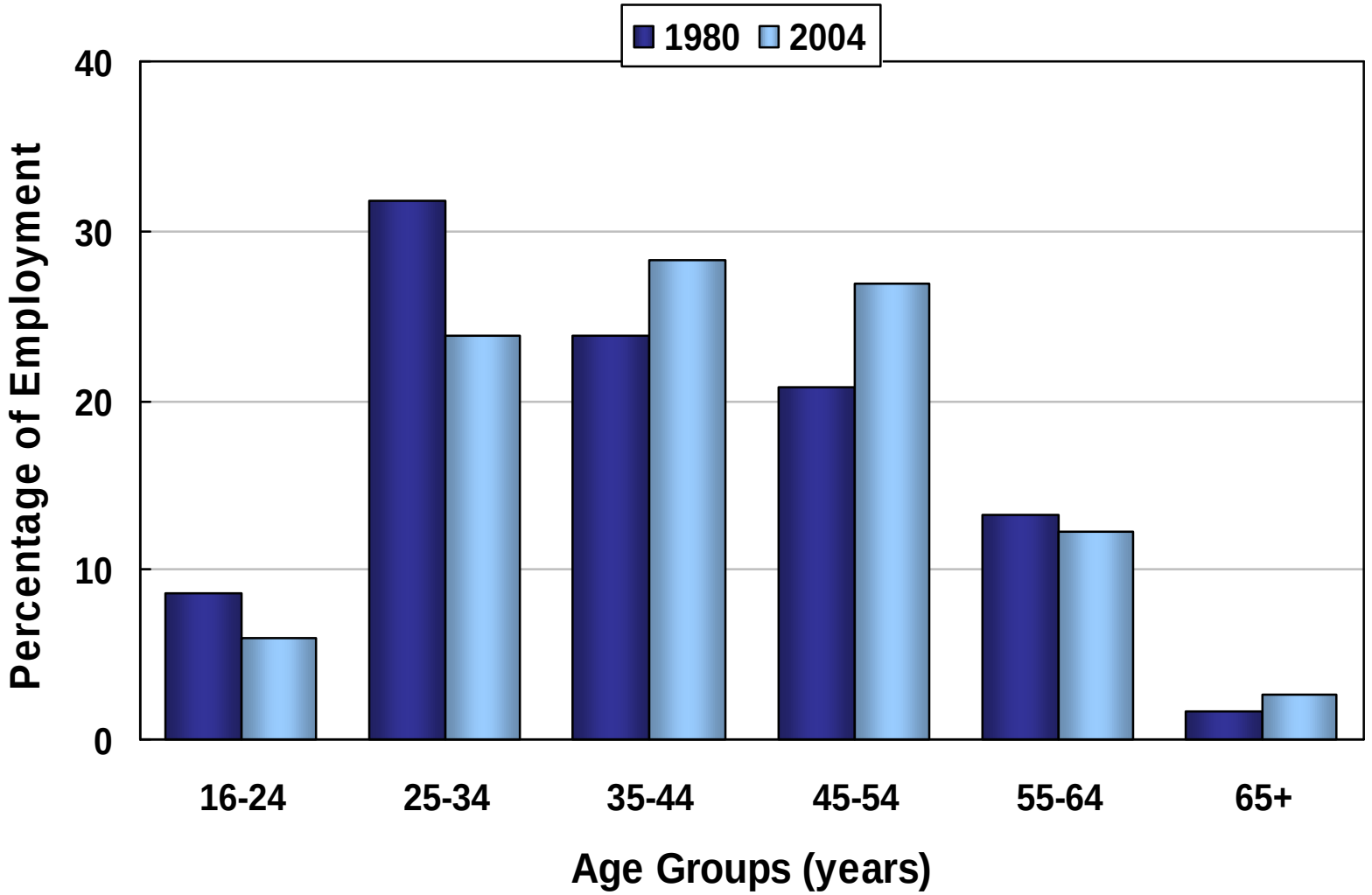
Demographic Trends

Labor Force Is Aging in Many Developed Regions



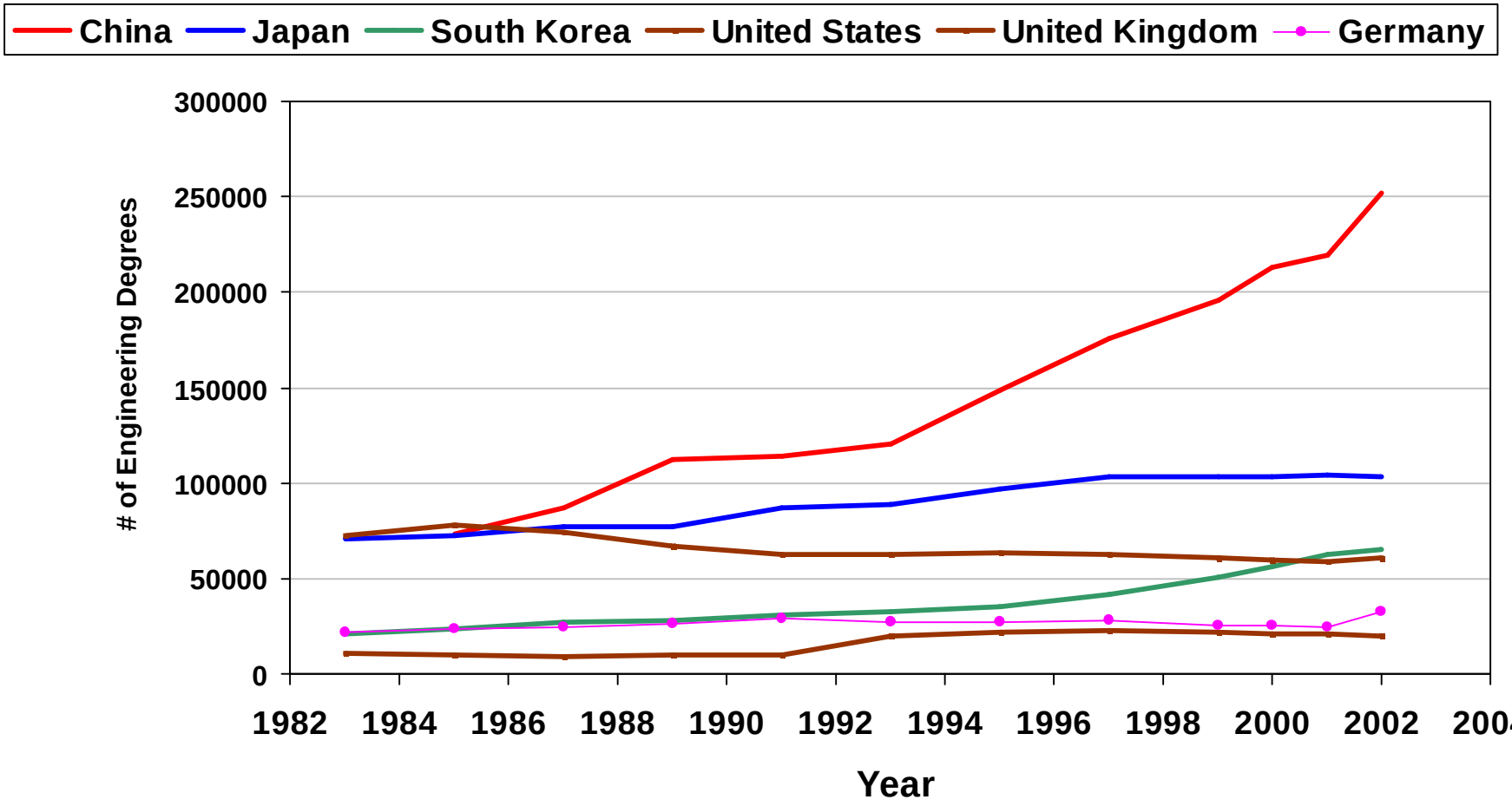
Source: U.S. Bureau of Labor Statistics

U.S. Engineers: Fewer Young People and Sharp Decline After Age 54



Source: U.S. Bureau of Labor Statistics

Engineering Degrees by Country

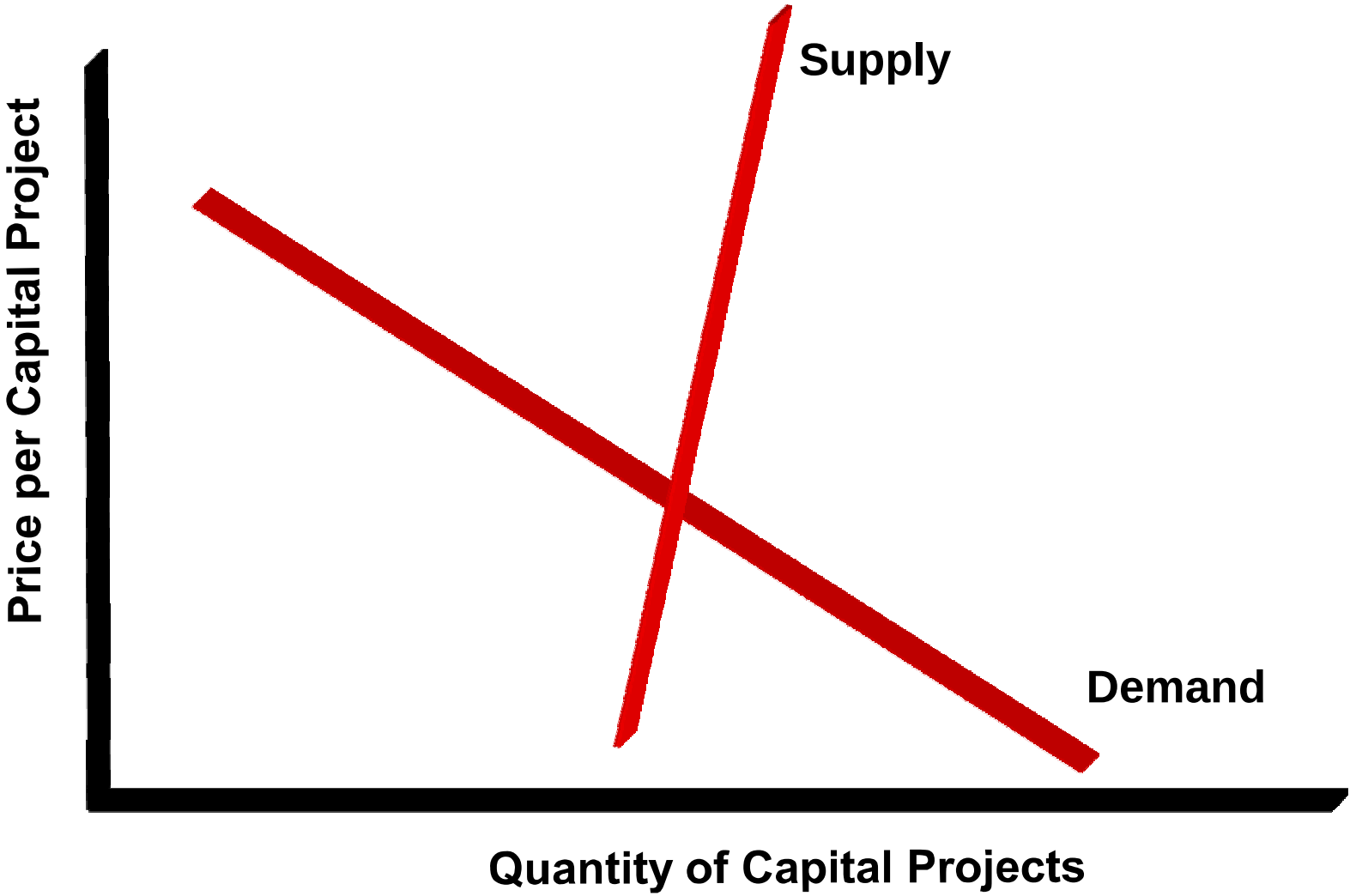


Source: National Science Foundation, Science & Engineering Indicators, 2006

Putting the Trends in Context

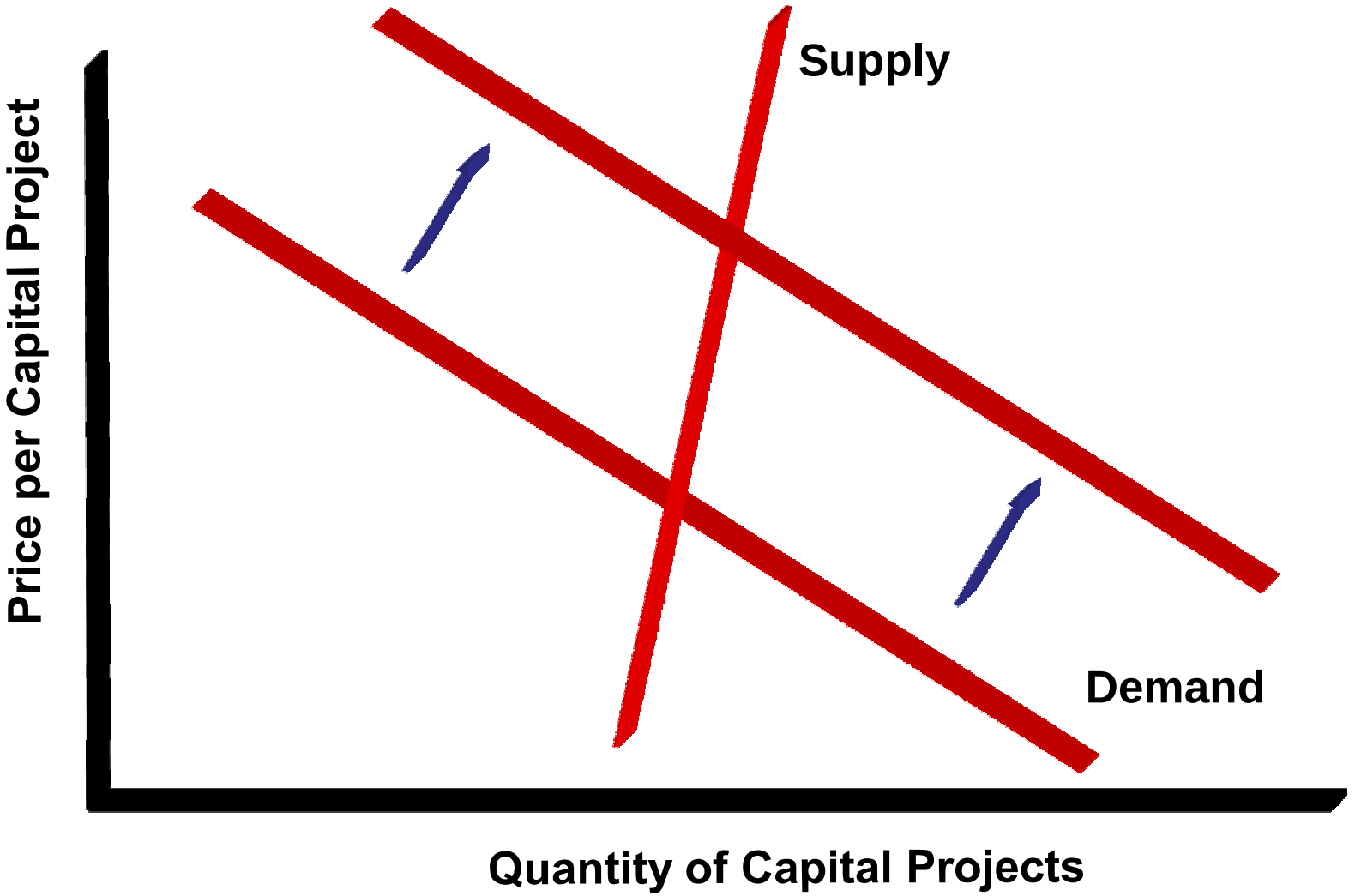
- **Demand has never been greater:**
  - **China and other developing nations are growing**
  - **Commodity prices (oil, metals, etc.) are all relatively high**
  - **More “megaprojects” to capture economies of scale**
- **Market’s ability to expand is constrained**
  - **Demographic challenges**
  - **Years of downsizing and contractor consolidation**
  - **Vendors do not quickly expand production**
  - **Construction labor reflects the region (e.g., Alberta versus China)**

Supply and Demand for Capital Projects
The Market Cannot Respond Quickly



Supply and Demand for Capital Projects

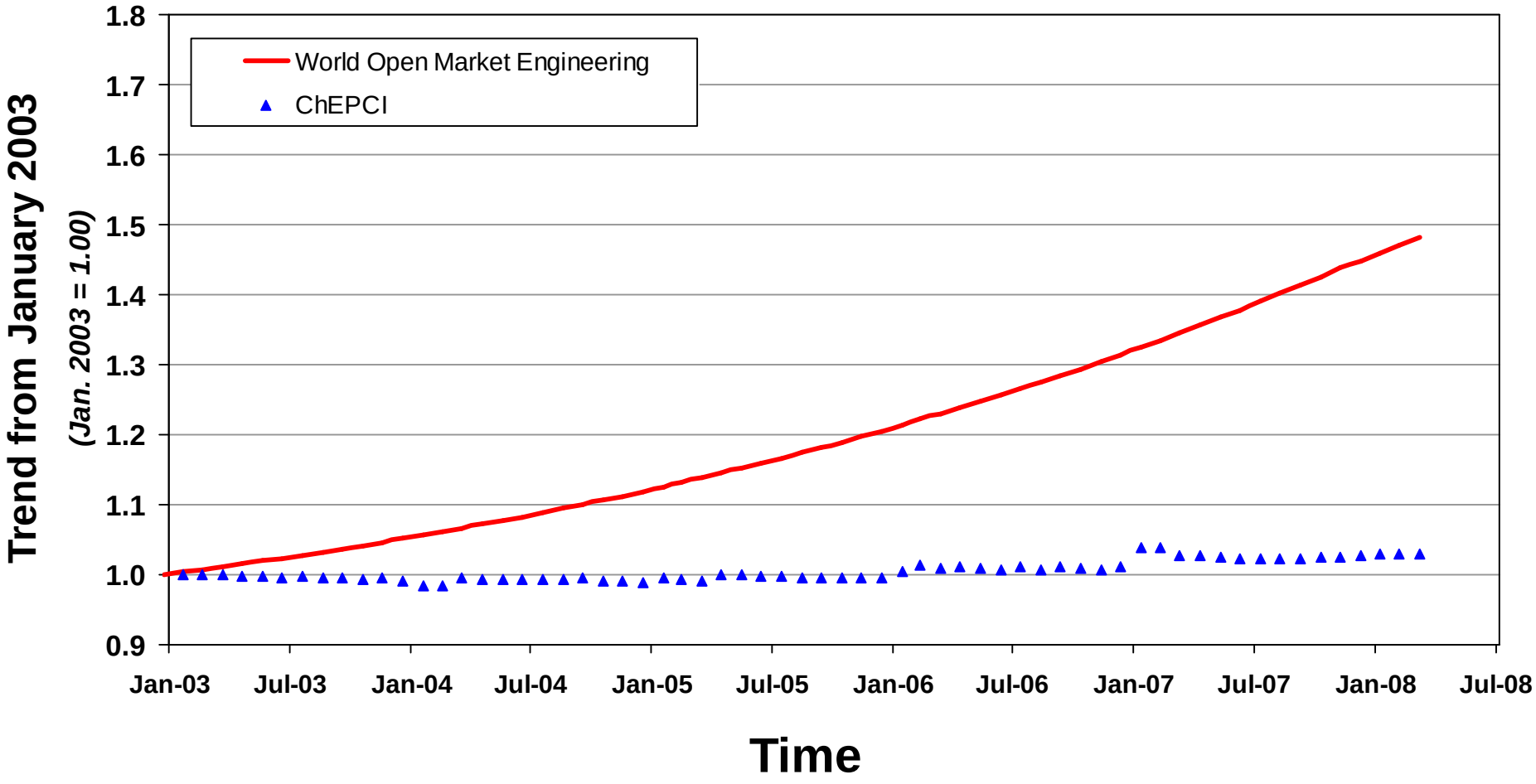
A Short-Run View of the Problem



Prices Have Increased A LOT !!

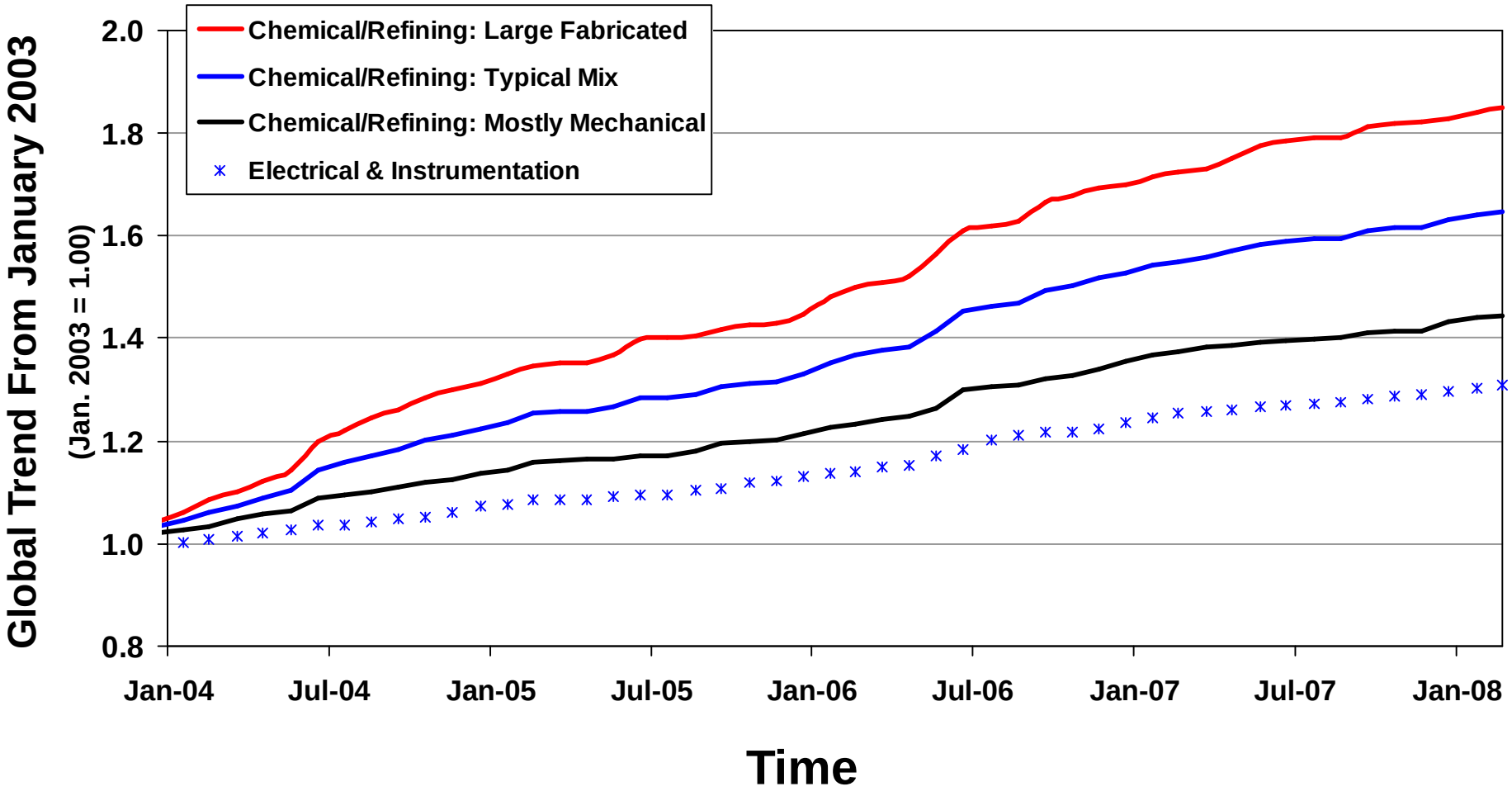
- **Varies by cost element**
- **Varies by project type**
- **Varies by location**
- **Not just the increase—the volatility**

Engineering Escalation Comparison



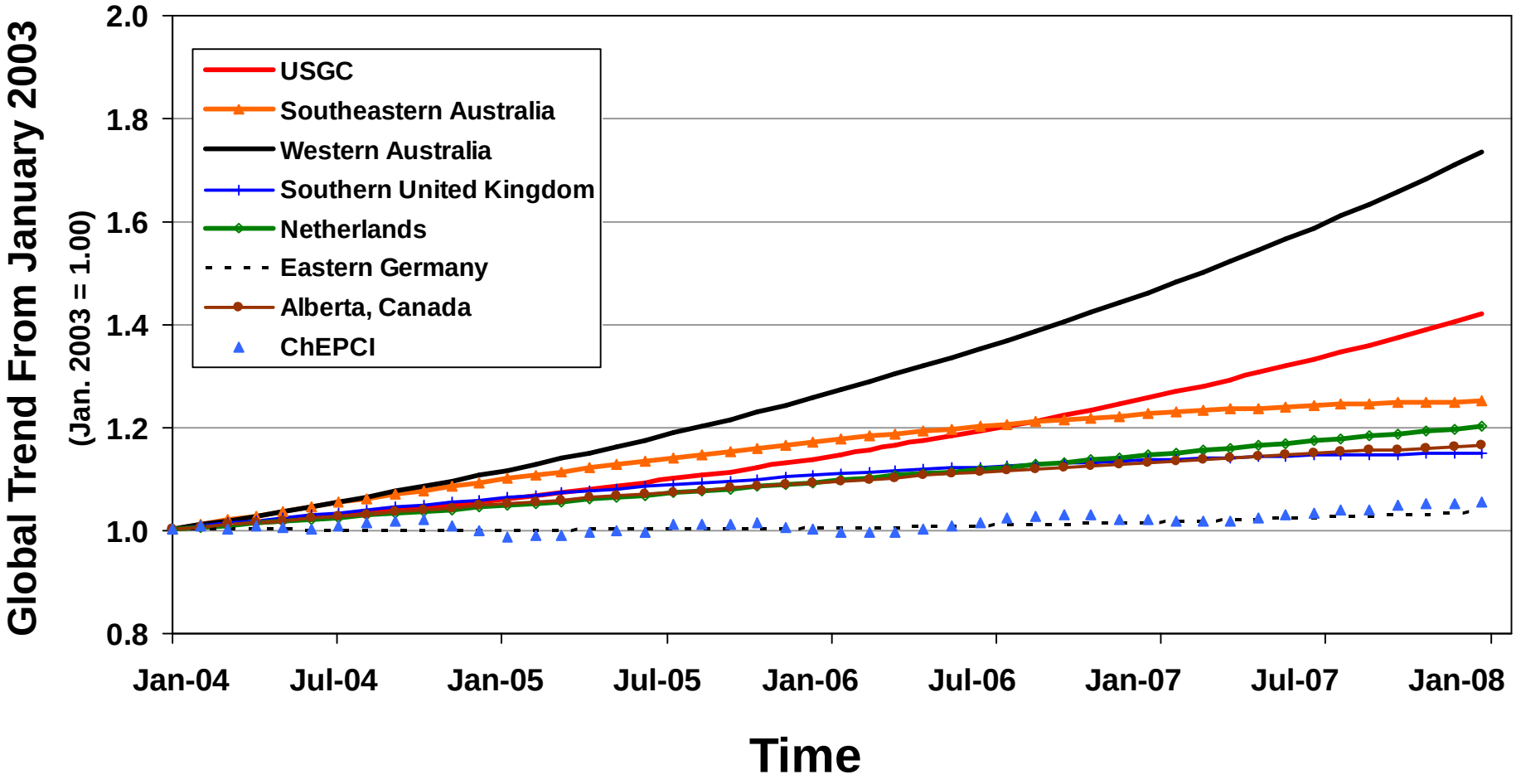
Cost escalation trends are displayed in US dollars.

Major Equipment Cost Escalation Varies by Type of Equipment



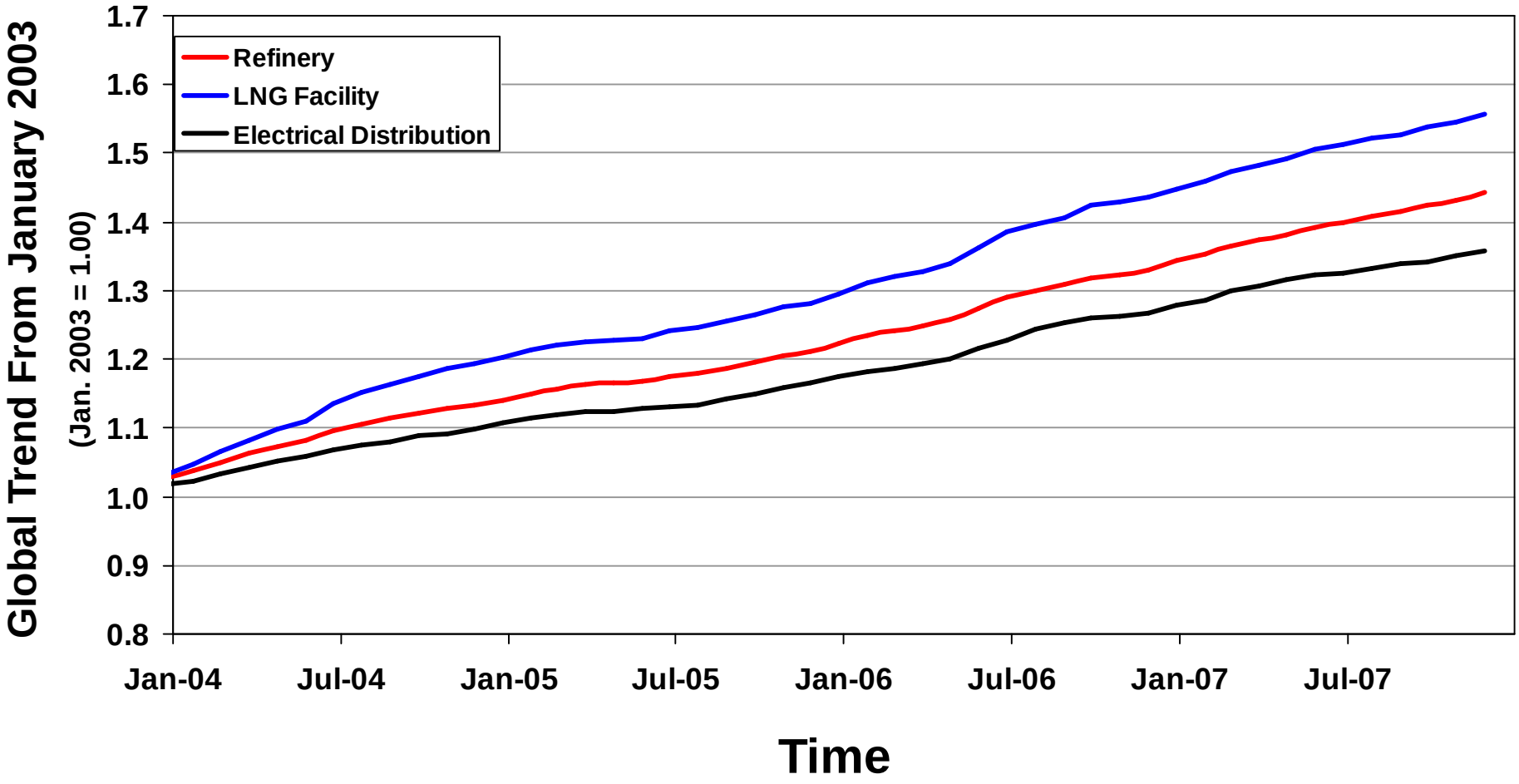
Data are a composite escalation index for various types of projects
Cost escalation trends are displayed in U.S. dollars

Construction Labor Escalation Varies by Location



Cost escalation trends are displayed in local currency

Escalation Varies by Project Type

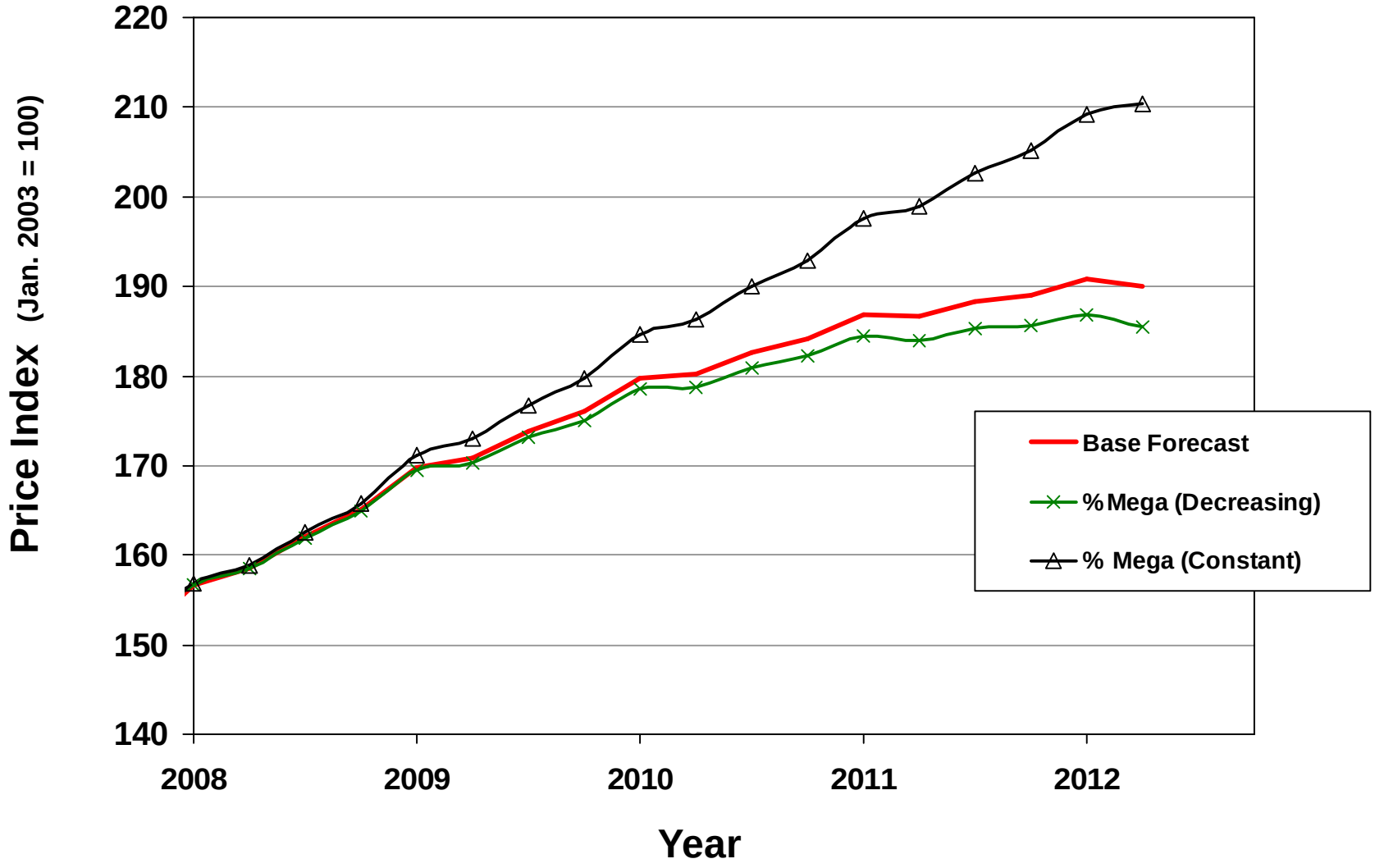


Data are a composite escalation index for various types of projects
Cost escalation trends are displayed in U.S. dollars

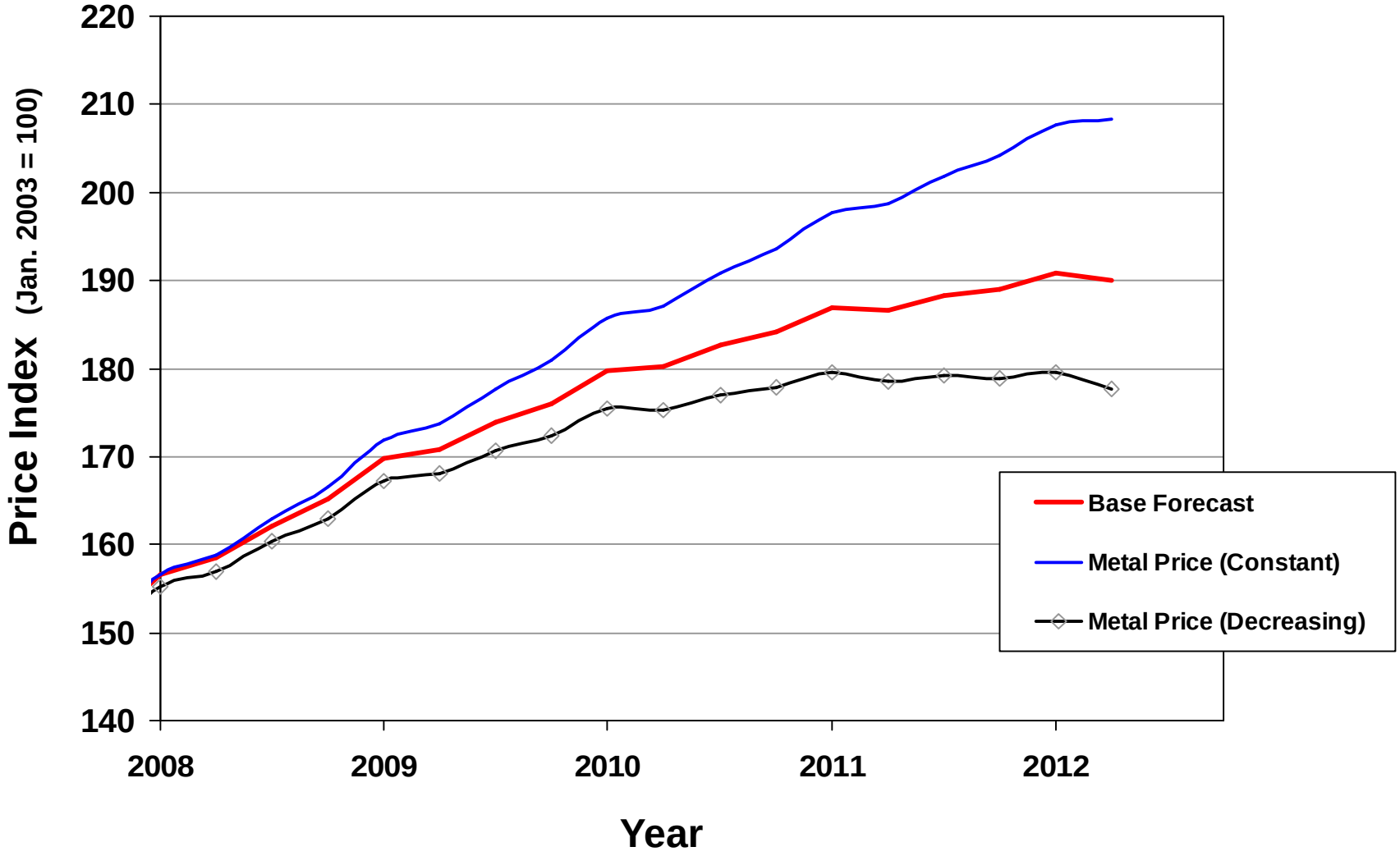
Future Market Trends
-- A Few Comments --

- **Markets do not adjust instantly**
  - **Price changes in current period are related to changes in previous period**
  - **Specific markets are affected by external events, but an adjustment lag usually occurs**
  - **Understanding the adjustment lags is basis for short-run predictions**
- **Longer term forecasts require predictions of the external events (GDP, megaprojects, oil price, etc.)**
  - **More difficult**
  - **Adds to uncertainty**

Forecast Price Sensitivity
-- An Example With Megaproject Activity --



Forecast Price Sensitivity
-- An Example With Metal Prices --



Market Trends Summary
Productive Engineers Are Critical

- **Market activity has increased – more projects, bigger projects, complex projects**
- **Costs have increased and become more volatile for many locations, project types, and cost elements**
- **The market trends are not likely to quickly change**
- **Demographic challenges are substantial, especially among the highly skilled**
- **Engineering is a bottleneck—how are we going to debottleneck the system?**

Why Should We Care?

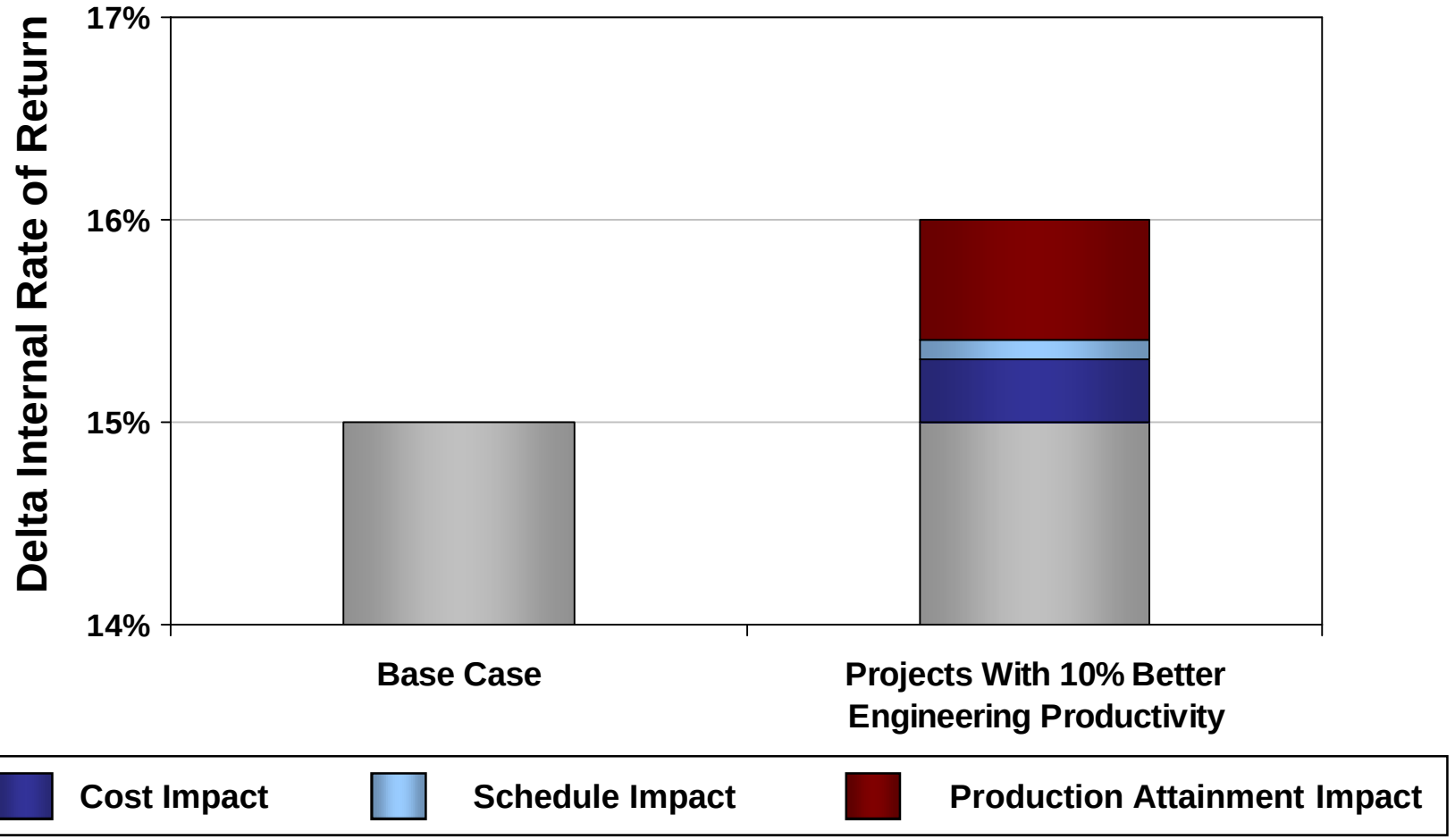
Because Engineering Is Highly Leveraging

- **Absolute Performance—Engineering services is often the category that determines overall performance**
- **Predictability—Engineering overruns by more than any other cost category (21 percent, on average)**
- **Operability—Problems executing the design are the immediate cause of field problems, delayed startups, and operability issues**

Engineering Productivity Matters

10% Improved Engineering Productivity

- ü 2% Lower Cost
- ü 3% Faster Project
- ü 5% Better Operability



Outline

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- ***Engineering Productivity Database***
- **Drivers of Engineering Productivity**
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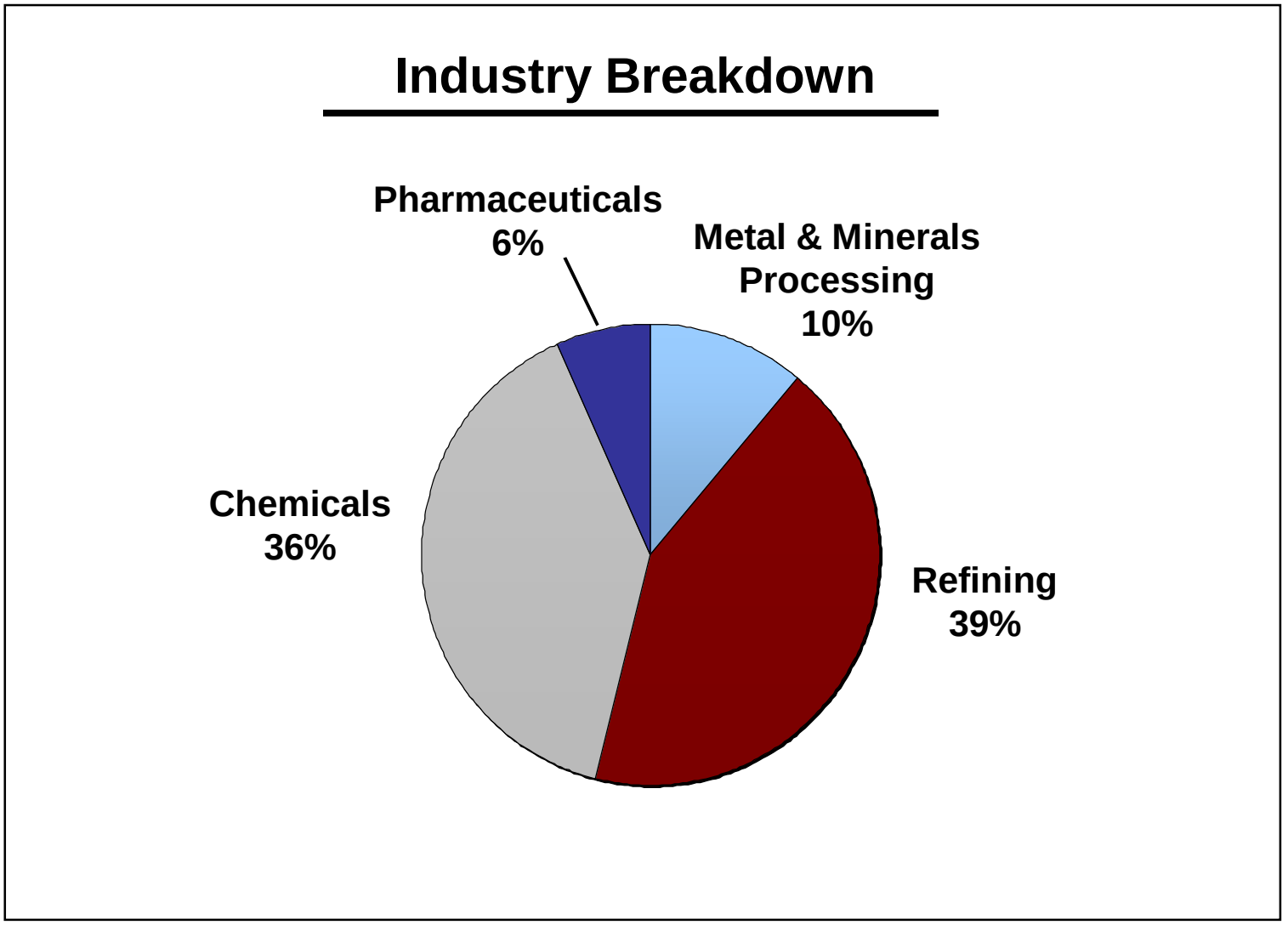
Updated Engineering Productivity Database

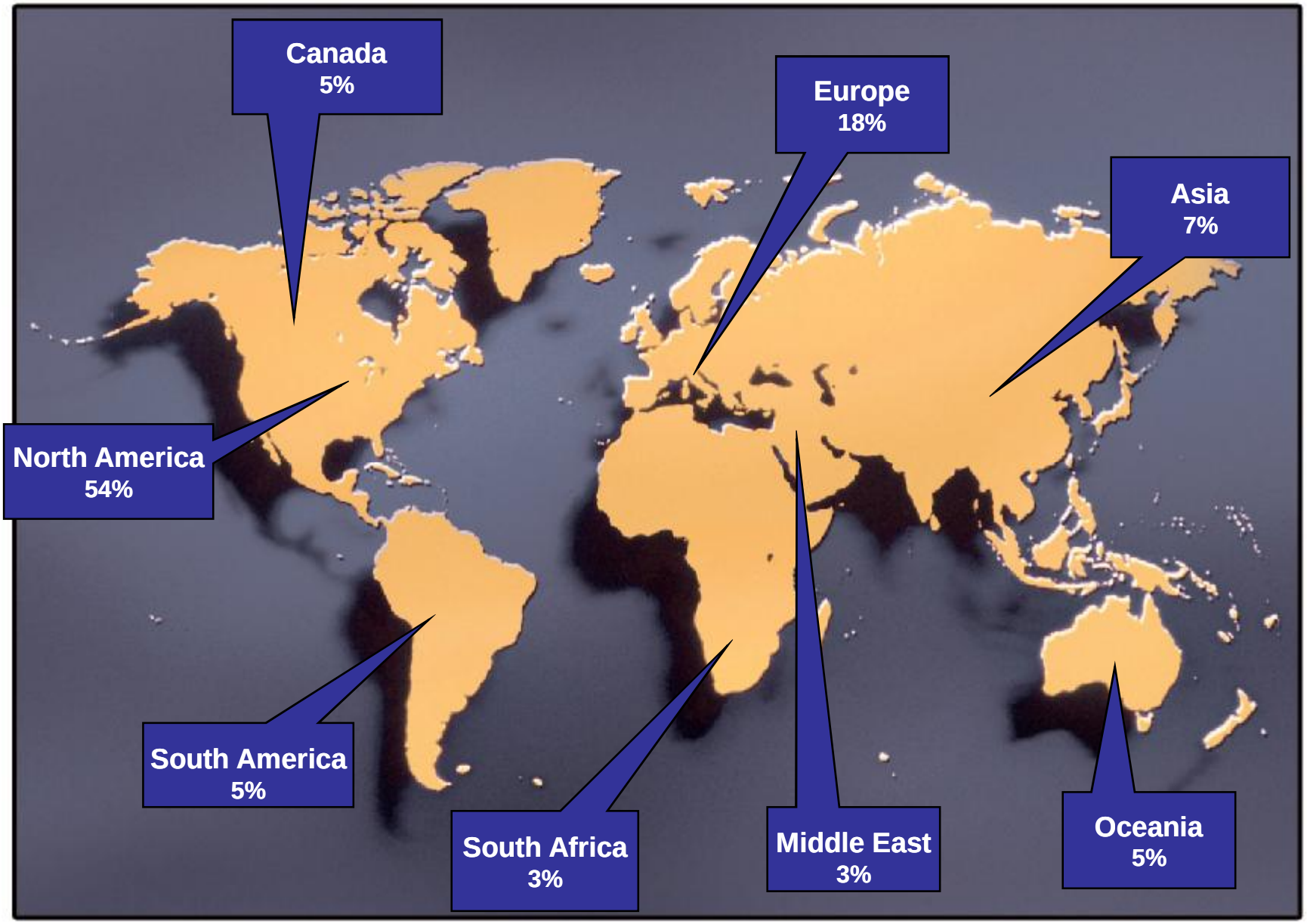
More Projects, More Current

Number of Projects	**992**
Estimated Project Cost (in millions of US$)	**$111 / $24 (mean/median)**
Range of Total Project Costs	***$4 million to $6 billion***
Average Authorization Year	**2004**
Range of Authorization Years	**1995 to 2008**
Number of Owners Represented	**132**
Number of Engineering Contractors Represented	**200+**
Percentage of Projects With New Technology	**6 percent**

Engineering Productivity Database

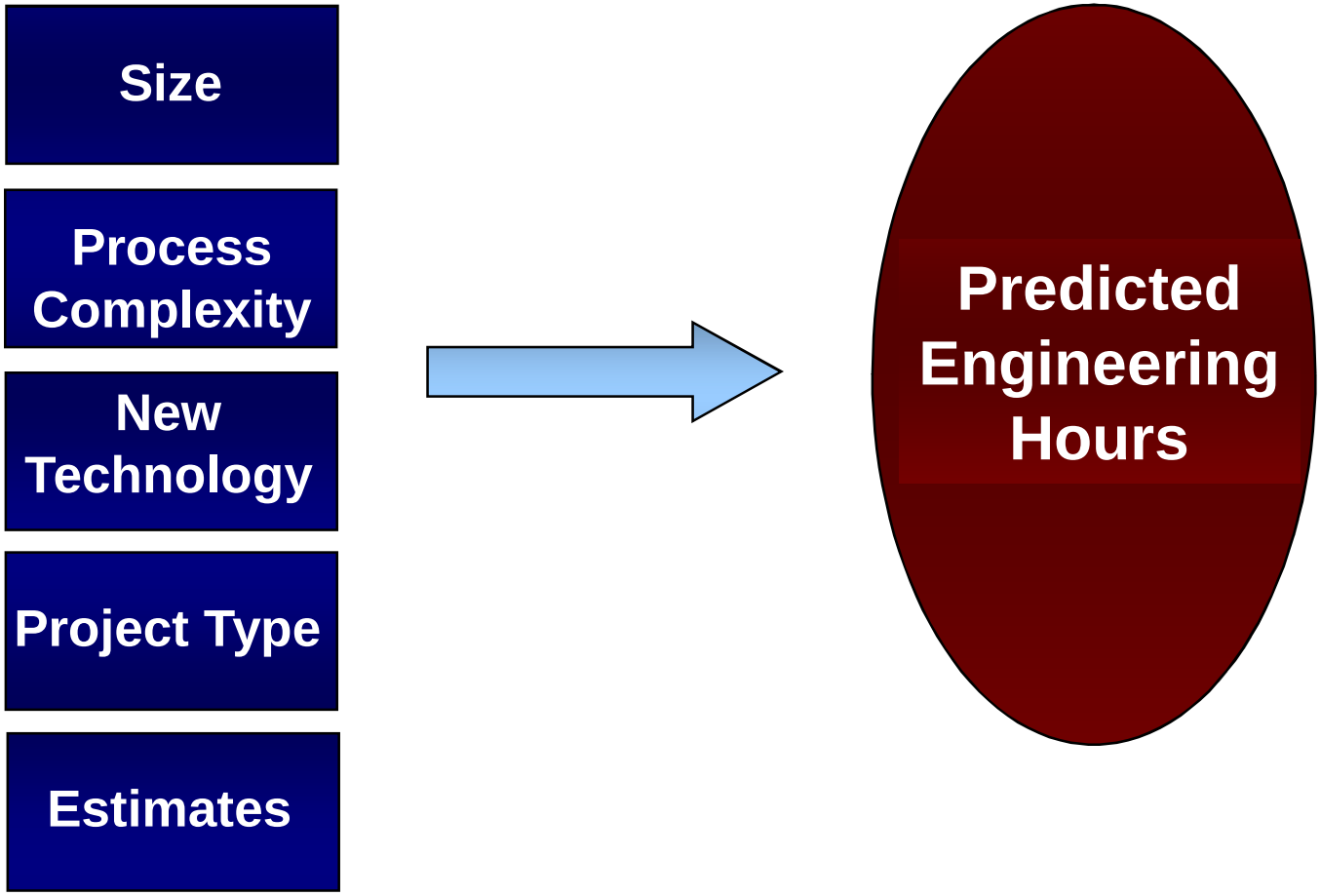


Geographical Distribution of the Projects



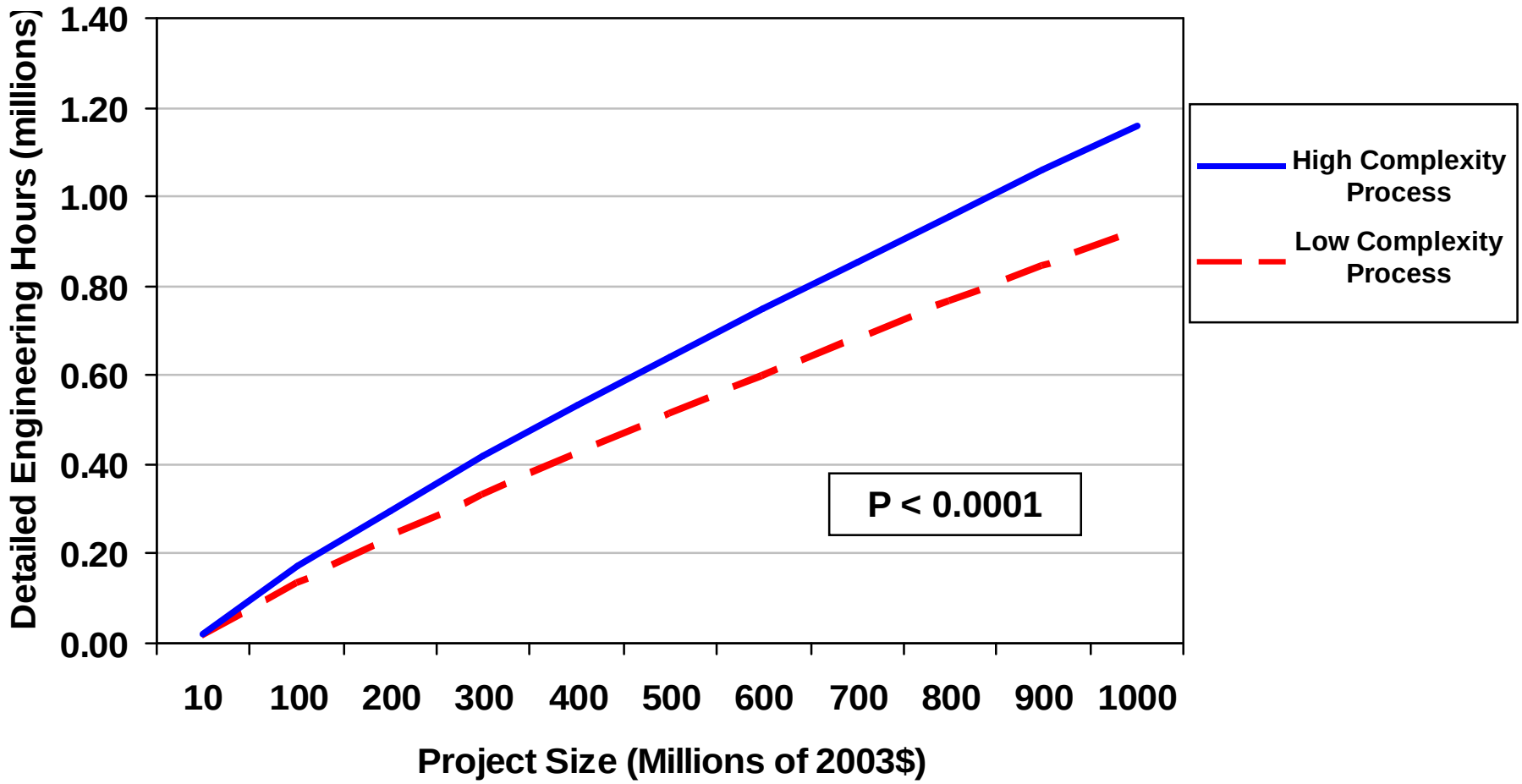
Development of an Engineering Index

Inherent Factors

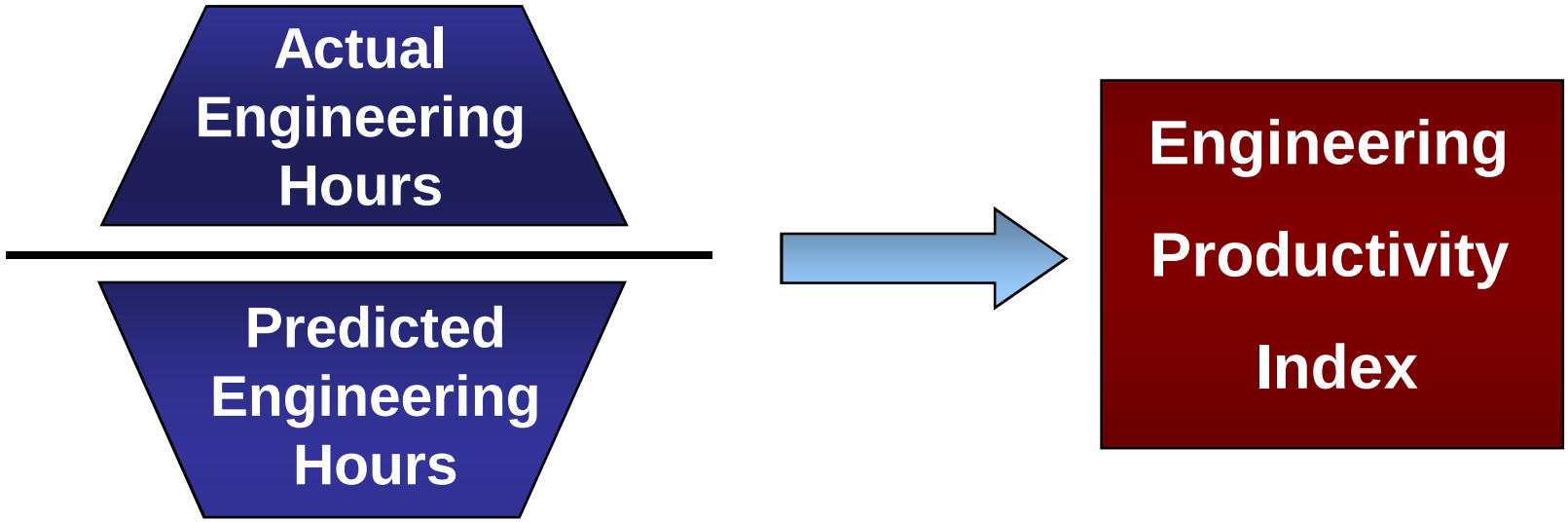


Detailed Engineering Hours

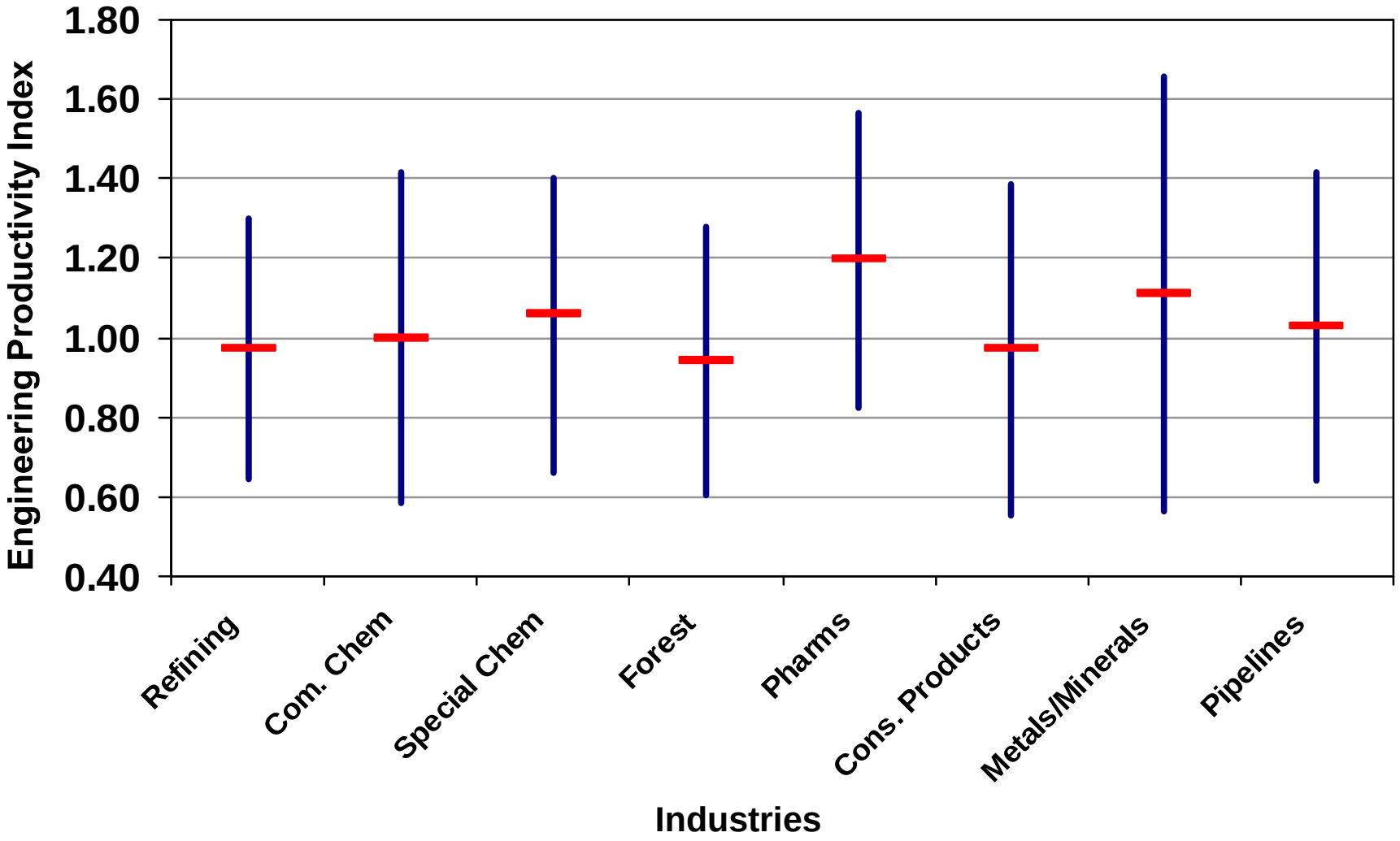
Rule of Thumb: About 1 Hour for Every $1,000



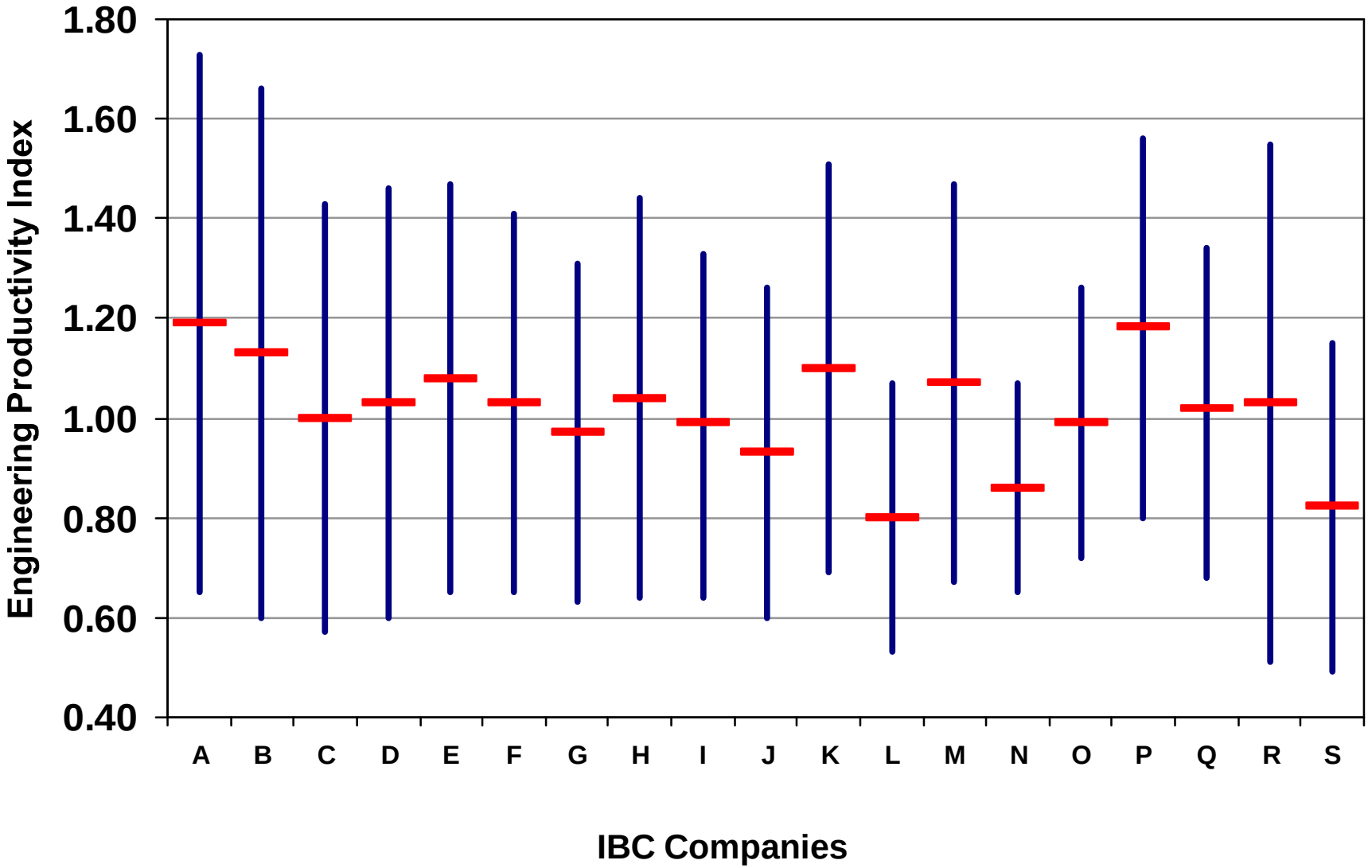
Engineering Productivity Index



Engineering Productivity Varies Within and Across Industries



Engineering Productivity Varies Within and Across Companies



Industry and Company Differences

- **Variance in engineering productivity is substantial**
- **What are the practices that improve productivity?**
- **Then we will consider regional differences and time trends**

Outline

- **Market Trends**
- **Engineering Productivity Database**
- ***Drivers of Engineering Productivity***
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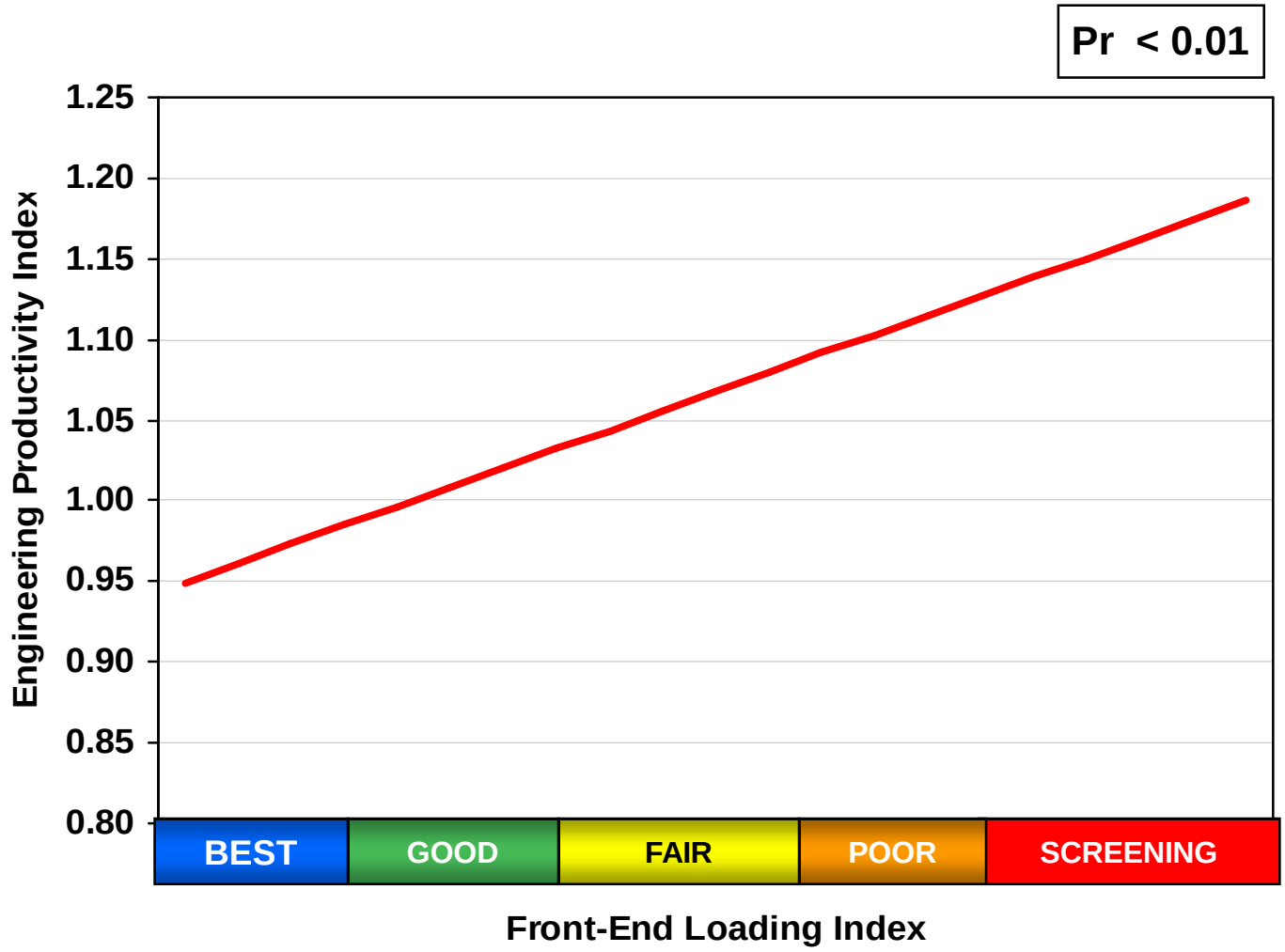
Front-End Loading (FEL) Improves Productivity

DRIVERS OF PRODUCTIVITY

- ***FEL Strategies***
- **Schedule Strategies**
- **Teams & Other**



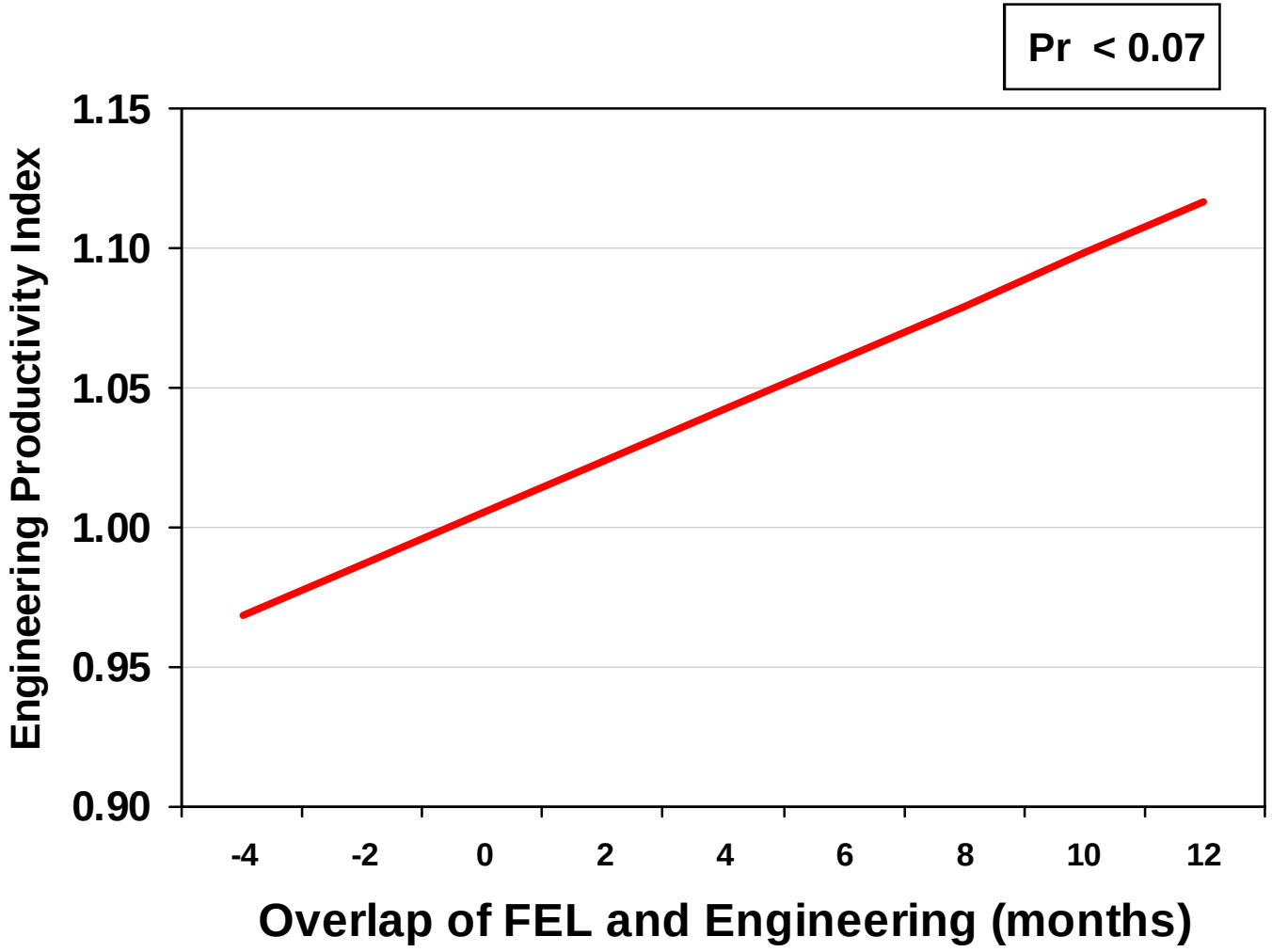
FEL Components

- **A few specific FEL items are disproportionately important to engineering productivity**
  - **Basic data items, such as heat and material balances (H&MBs), process control strategy, and instrumentation requirements**
  - **Site-related issues**
    - > **Various environmental requirements**
    - > **Utilities, especially waste treatment needs**

Overlapping FEL and Detailed Engineering Reduces Productivity

DRIVERS OF PRODUCTIVITY

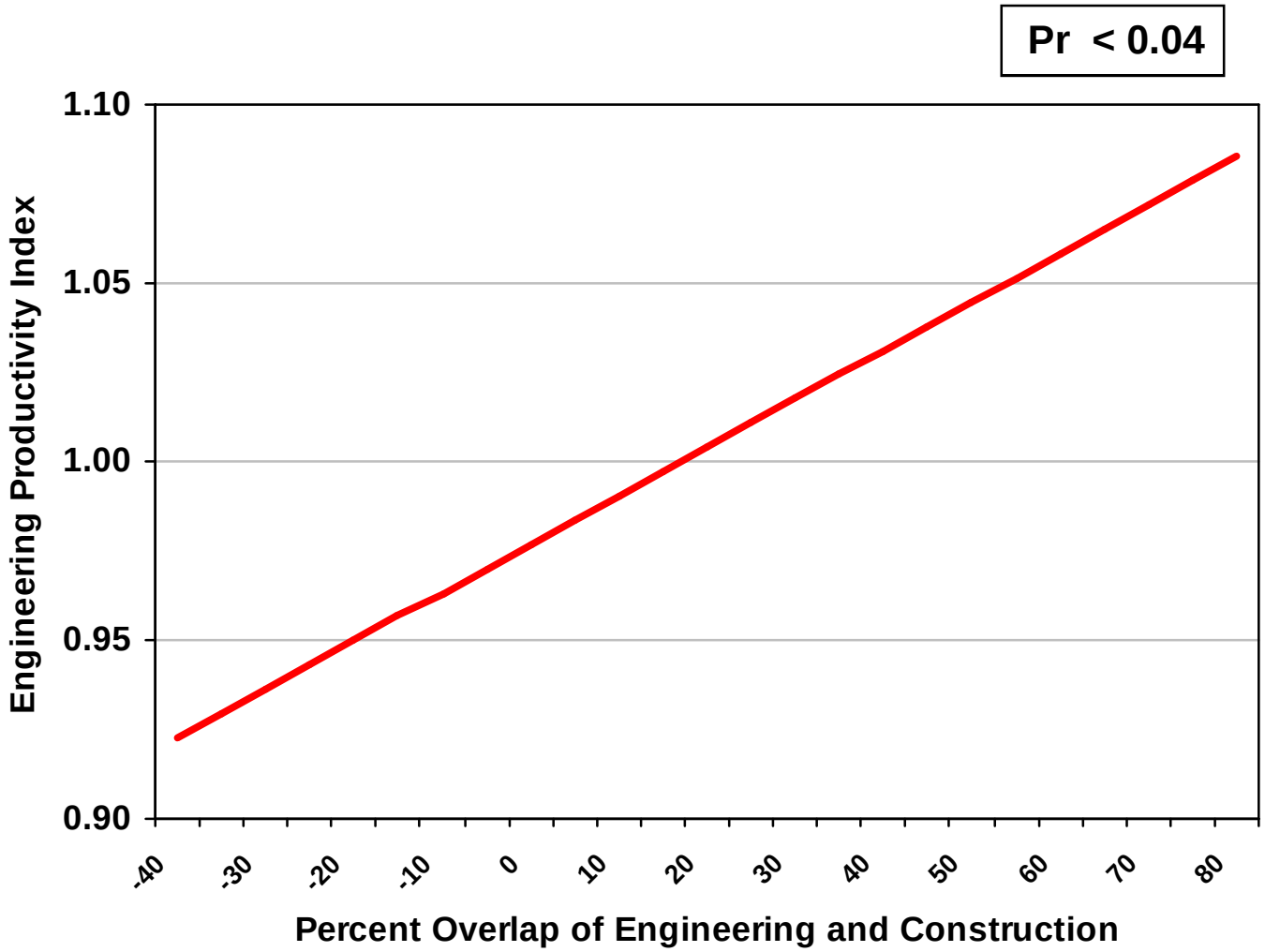
- FEL Strategies
- ***Schedule Strategies***
- Teams & Other



Overlapping Engineering and Construction Reduces Productivity

DRIVERS OF PRODUCTIVITY

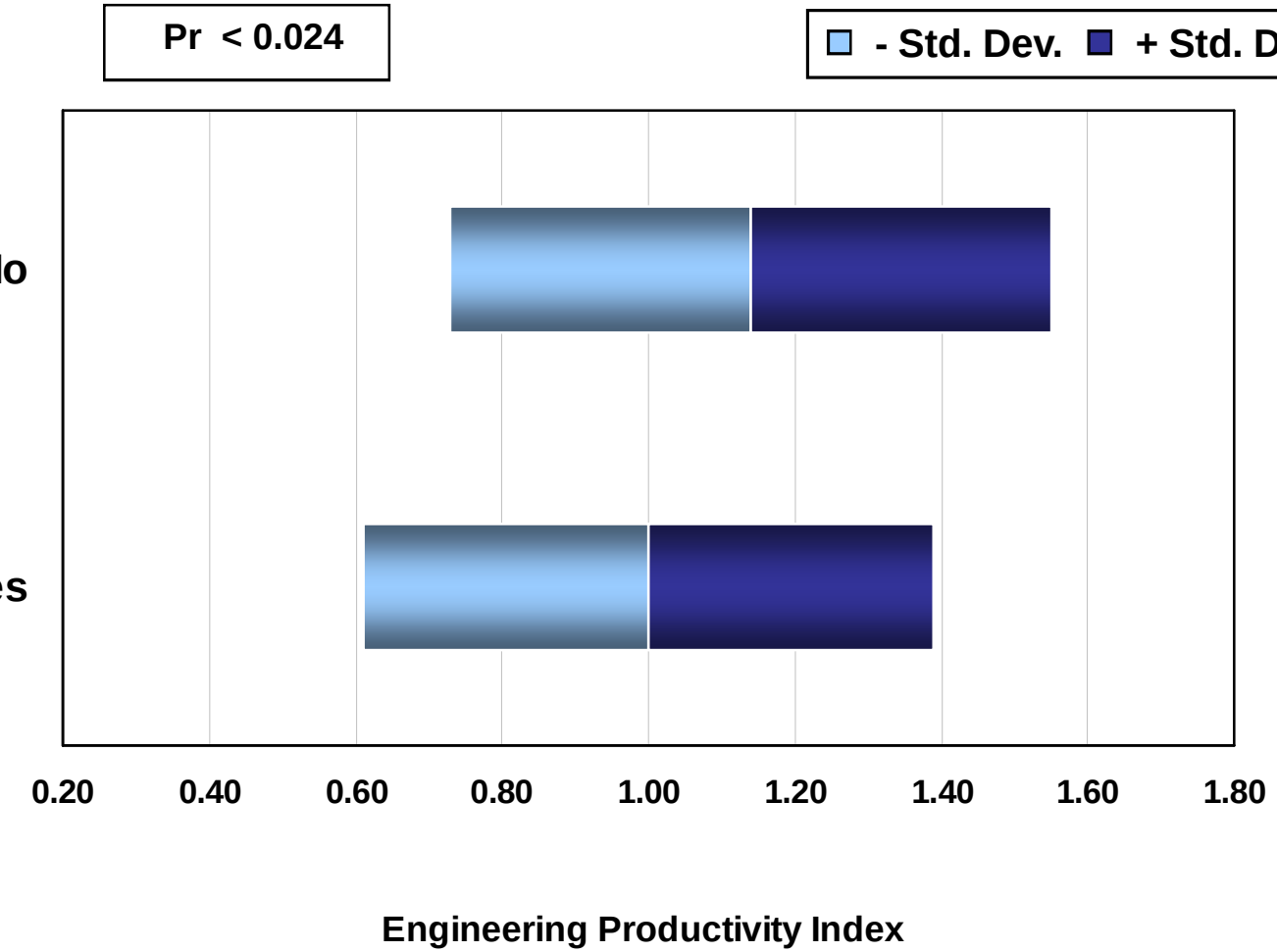
- FEL Strategies
- ***Schedule Strategies***
- Teams & Other



Formally Defined
Roles and Responsibilities Is Key

DRIVERS OF PRODUCTIVITY

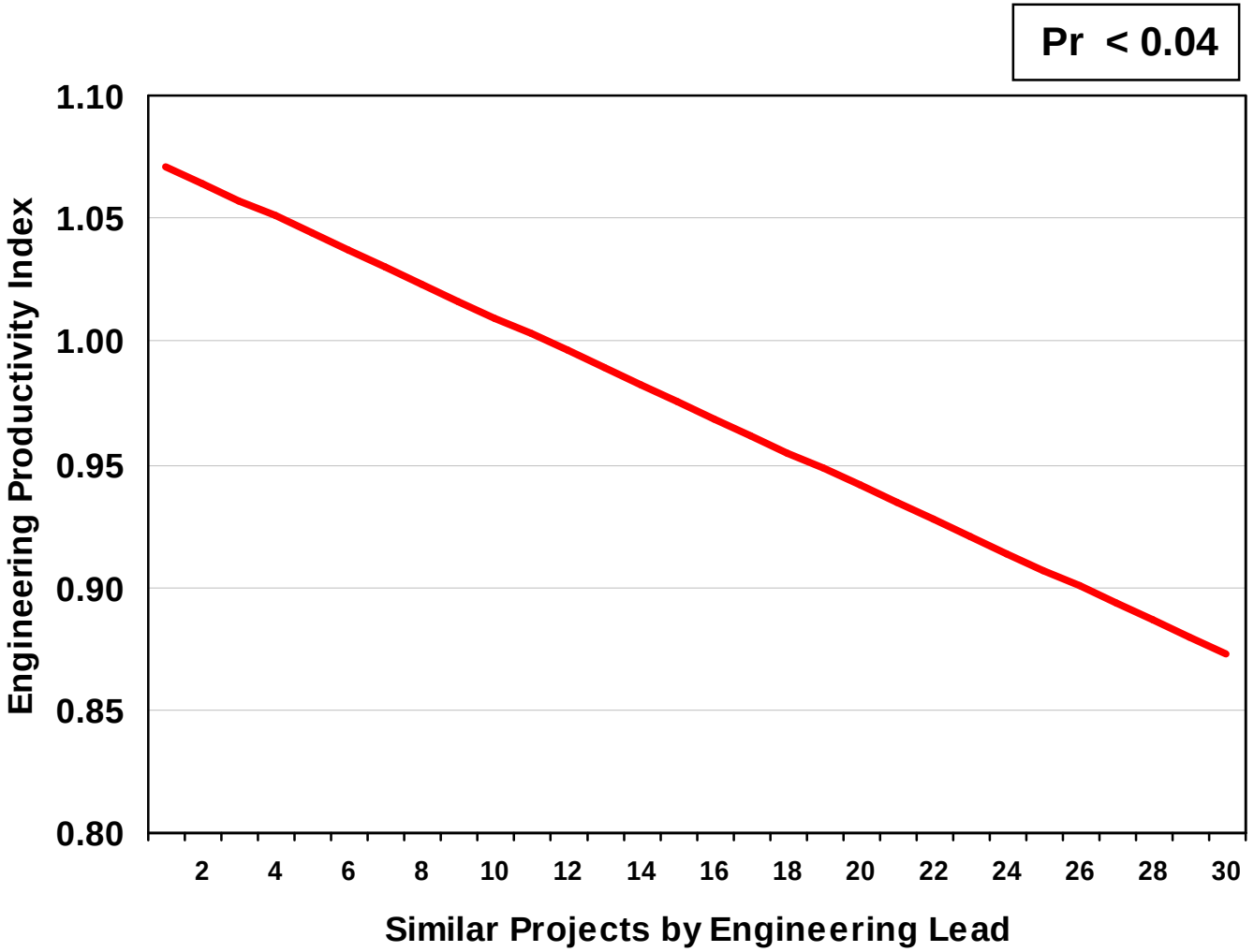
- **FEL Strategies**
- **Schedule Strategies**
- ***Teams & Other***



Project Experience Matters

DRIVERS OF PRODUCTIVITY

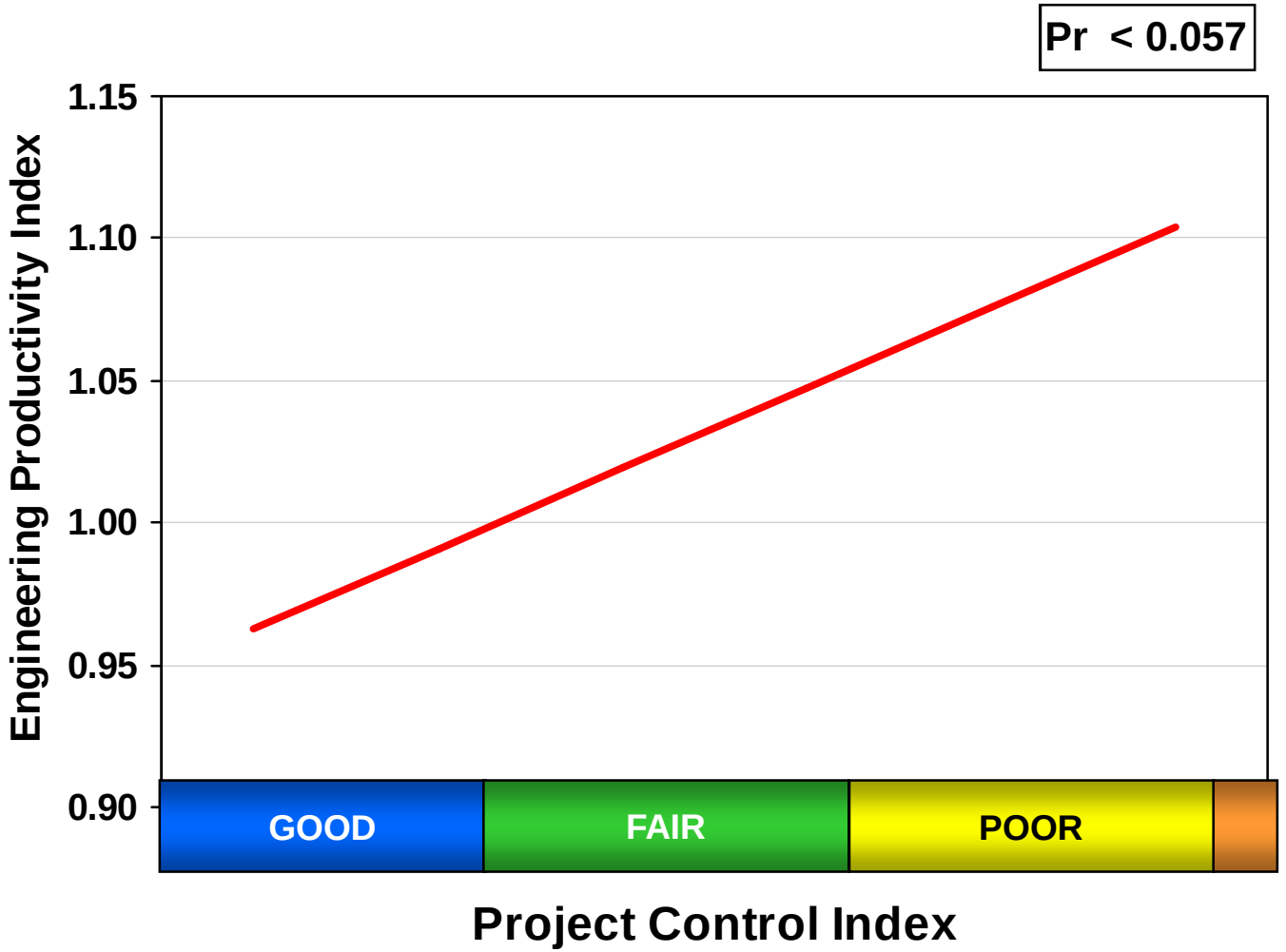
- **FEL Strategies**
- **Schedule Strategies**
- ***Teams & Other***



Good Project Control Yields Better Productivity

DRIVERS OF PRODUCTIVITY

- FEL Strategies
- Schedule Strategies
- *Teams & Other*



Key Practices Remain Fundamental

- ***Best Practical* FEL**
  - **Projects achieving *Best Practical* FEL average a 0.95 productivity index**
- **Overlap**
  - **Overlapping less than 10 percent of the execution duration results in competitive productivity**
- **Teams**
  - **Teams with formally defined roles and responsibilities are 15 percent more productive**
- **Project Controls**
  - **To achieve competitive productivity, project controls need to be at a *Good* level**

Related Issues and Previous Research
A Few Comments

- **Automated design tools**
  - **Initial use versus ongoing improvements**
- **Incentivized contracts do not work**
- **Engineering value centers**
  - **Increasing use, but generally less productive with lower wages**
  - **Direct owner connection improves total project value**
- **Thinly staffed project teams**
  - **Large owner teams set the basis for good performance**
  - **Staff key positions with owner staff**
- **Local content requirements**
  - **Increasing issue, especially in less developed regions**
  - **More on this later**

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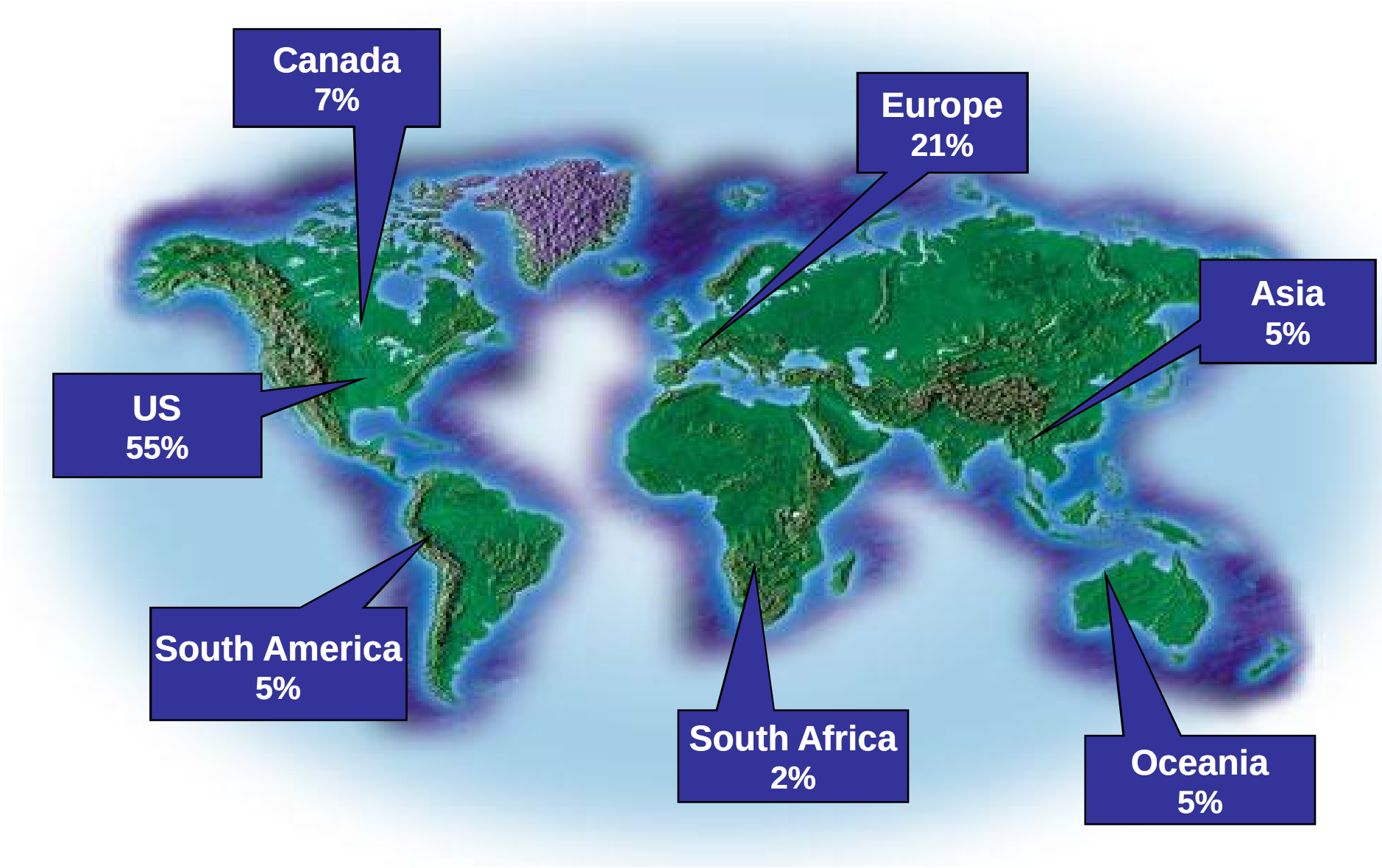
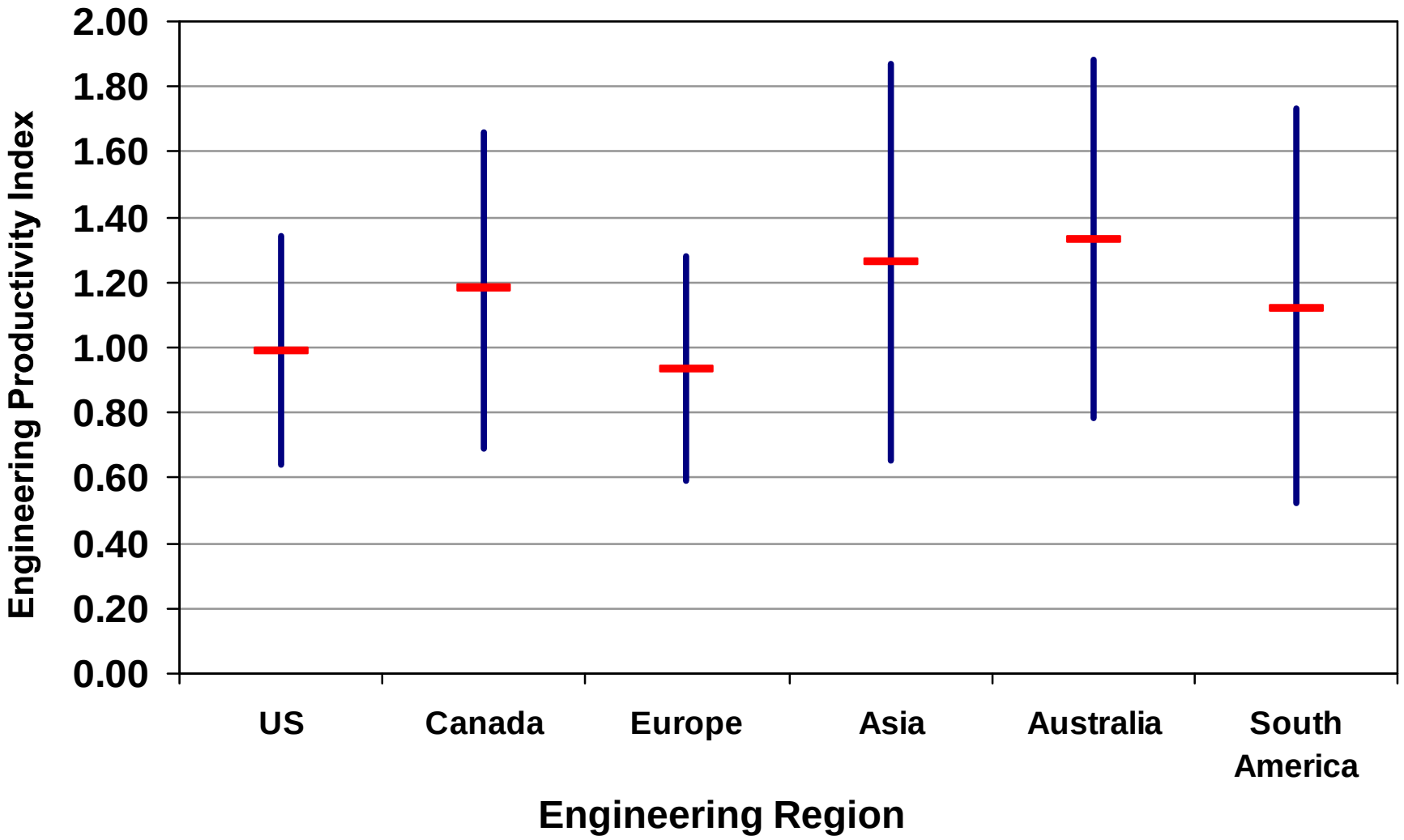
- ***Time Trends and Regional Differences***
- **Conclusions**

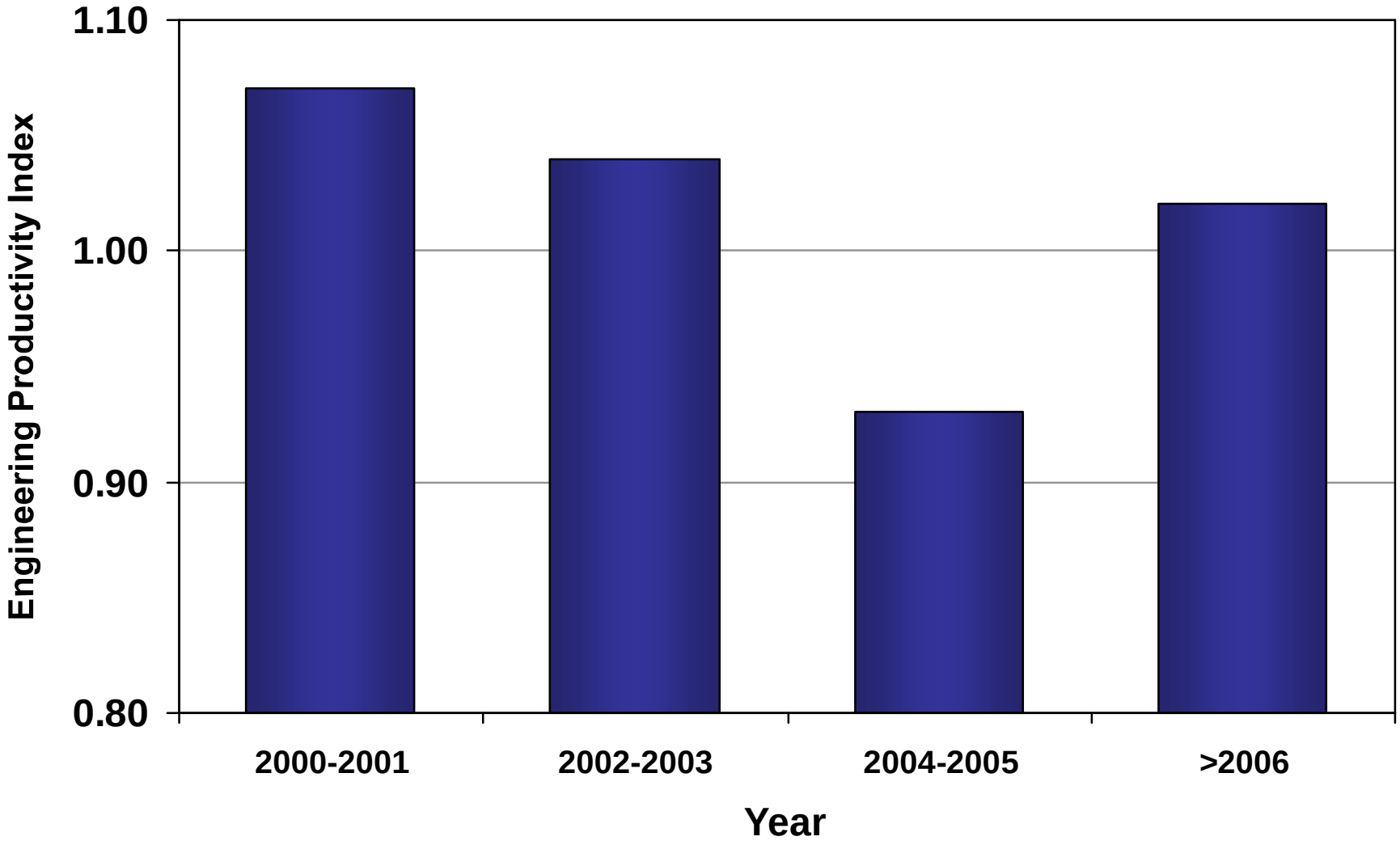
Geographical Distribution of Engineering Locations



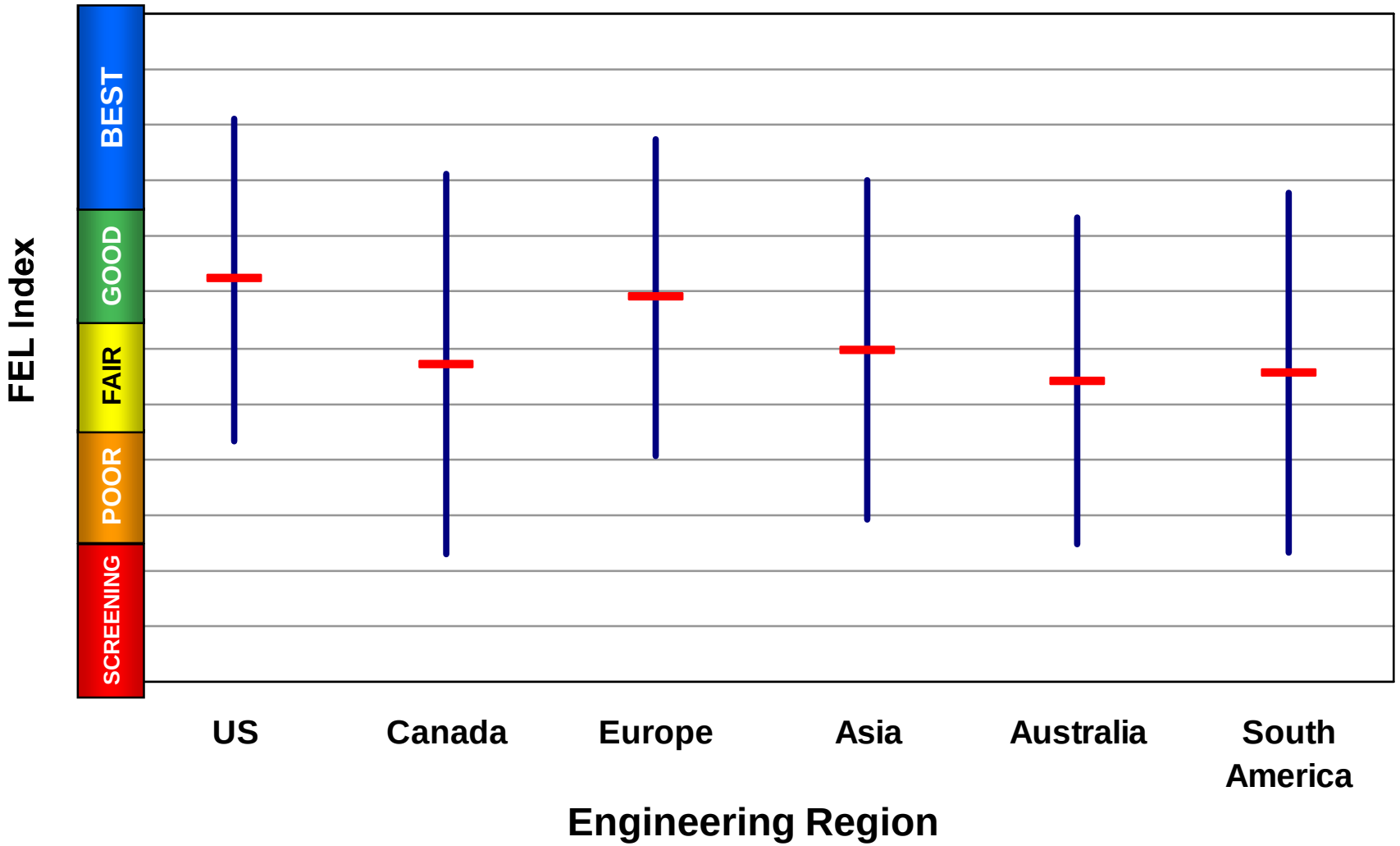
Productivity Varies by Region



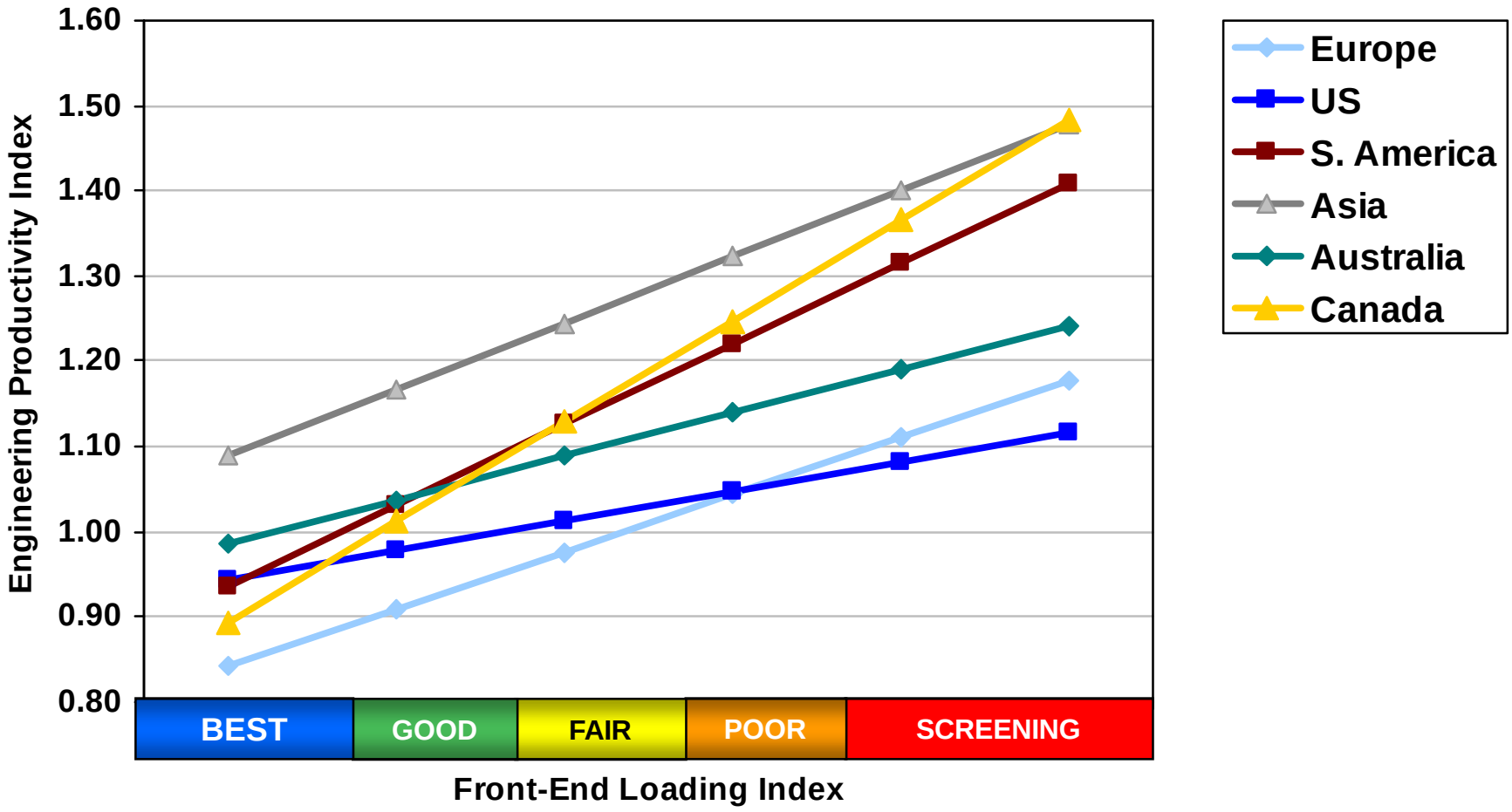
Engineering Productivity Has Recently Declined, And Is Likely Getting Even Worse



FEL Varies by Engineering Region



FEL Is More Important in “Hot Spots”



Outline

- **Market Trends**
- **Engineering Productivity Database**
- **Drivers of Engineering Productivity**
- **Time Trends and Regional Differences**
- ***Conclusions***

Conclusions—Trends and Practices

- **Market trends are not going away**
  - **Capital spending will remain high**
  - **Labor markets present the greatest challenge**
- **Engineering productivity is critical**
- **Best Practices remain essential:**
  - **FEL is a prerequisite and avoid extensive overlaps**
  - **Team alignment is important, along with experience, continuity, and project controls**

Conclusions— What About the Regions?

- **Mature Project Regions:**
  - **Strengths: Project fundamentals provide a foundation**
  - **Opportunities: Reduce the variance in applying Best Practices and recover from years of downsizing**

- **Emerging Project Regions:**
  - **Strengths: Economic growth and labor is generally available**
  - **Opportunities: Project fundamentals must be improved and training is necessary**

Recommendations
Things to Consider

We are in it for the long term!

- **Use the current market opportunity to establish and/or rebuild owner competence**
- **Locate engineering centers in favorable markets**
- **Do not authorize fundamentally weak practices**

10 percent better productivity means
10 percent fewer engineers
to achieve better outcomes !