Creating Value through the Benchmarking of Capital Projects

Measuring the relationships between

what you do

and..

what you get

IPA
Purpose of the Discussion

- Discuss the progress of the process industries in capital effectiveness
- Explore primary drivers of project excellence
- Bring data to some contentious issues
Basis for the Discussion

Each year Independent Project Analysis (IPA) conducts about 600 project evaluations for the process industries:

- oil (upstream and down)
- chemicals
- pharmaceuticals
- minerals
- consumer products
- power

We now have databases containing over 5000 major projects and 1400 small projects.
Characteristics of the Databases

Data for each project are quite detailed: over 1500 variables describe the projects from inception to completion.

All data were obtained through face-to-face interviews with the project teams and sponsors in addition to the documentation.

All data are normalized to a common time and place and external factors are removed.

We then develop statistical models to create indexes for cost, schedule, operability, etc.
Outline

* Progress in capital effectiveness
  * Keys to improvement
  * The role of contracting strategies
    * Is fixed-price best?
    * Do incentives work?
Progress

- The cost of facilities has improved by about 12 percent in real terms over the past 5 years.
- Execution schedules have improved nearly 30 percent over the past decade.
- Construction safety has improved dramatically.
- Operability has held steady.
Cost Performance Is Improving

The graph shows the relative cost index over time from 1989 to 1997. The relative cost index is plotted on the y-axis, which ranges from 0.8 to 1.2. The x-axis represents the year of authorization, marked from 89 to 97. The line chart compares the cost performance of the industry (red dashed line) and the top quartile (blue line). The top quartile shows an increasing trend, indicating improving cost performance over the years.
Schedules Are Improving

Execution Schedule Index vs. Year of Authorization

- Red dashed line: Industry
- Blue solid line: Top Quartile
Operability Shows No Change

Operability Index vs Year of Authorization

- Industry
- Top Quartile

Year of Authorization:
89 90 91 92 93 94 95 96 97
Safety Performance is Improving

Lost Time

Authorization Year

Total Recordables

Authorization Year

*Using all PES database projects authorized after 1992.
Top Quartile Performance Can Increase IRR by 5%

**Cost**
- Top adds 2.5% IRR over Industry
- Top adds 3.9% IRR 1998 vs. 1989

**Schedule**
- Top adds 0% IRR over Industry
- Top adds 0.6% IRR 1998 vs. 1989

**Operability**
- Top adds 0.5% IRR over Industry
- Top adds 0% IRR 1998 vs. 1989

- Top adds 3% IRR over Industry
- Top adds 5% IRR 1998 vs. 1989
Outline

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Elements of Capital Effectiveness

Business Strategy
- Technology Strategy
- Business Case Development
- Team Integration
- Leading Technology
- Front-End Loading
- Use of Value Imp. Practices

Optimal Scope for Business Need
- Executed with minimum change
- Discipline
- Timely Involvement of Contractors/Vendors

Key Leading Indicators

Low Cost
- Fast Cycle Time
- Excellent Operability

SAFETY

BETTER ROI

Key Performance Indicators

IPA
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- SAFETY
- BETTER ROI
- Key Leading Indicators
- Key Performance Indicators

IPA
Integrated Project Teams

Definition of an Integrated Project Team

An Integrated Project Team is a team of full or part-time representatives of the following areas (but are not limited to):

- Business
- Engineering
- Construction
- Maintenance
- Operations/Production
- Health and Safety
- Environmental (if needed)
- Contractor (if appropriate)

These representatives are identified prior to project authorization and have specific responsibilities that are defined and understood by all team members.

These representatives have authority to make decisions for the function they are representing and provide functional input to the project manager.
Integrated Teams Result in Better FEL and Therefore Better Performance

Integrated Teams

Non-Integrated Teams

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IPA
Integrated Teams Even Help Projects With Poor FEL

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Elements of Capital Effectiveness

Key Leading Indicators:
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IP A
Components of Front-End Loading

Site Factors
- Local labor cost and productivity
- Materials availability
- Equipment layout
- Soils data
- Environmental requirements
- Health & safety requirements

Engineering Definition
- Engineering tasks
  - Detailed scope
  - Feedstock/product properties
  - PFDs
  - H&MBs
  - P&IDs
  - One-line elec. diagrams
  - Major equipment specs
  - Cost Estimate
- Participation/buy-in of:
  - Operations
  - Maintenance
  - Business

Project Execution Plan
- Contracting strategy
  - Who
  - How
- Team participants & roles
- Integrated schedule
  - Critical path items
  - Identification of shut-downs for tie-ins
  - Resource requirements
  - Overtime requirements
- Plans
  - Commissioning
  - Startup
  - Operation
  - Quality assurance
- Cost/schedule controls

FEL Index
FEL is Improving Slowly

Year of Authorization

FEL Index

Best Systems
Industry

Best
Systems

Industry
Better Front-End Loading Saves Money

- More than industry average
- Less than industry average

Front-End Loading Score

Actual Cost/Industry Average Cost

Pre 1990
Post 1990

Undefined Good Fair Poor Best Practical
Better Front-End Loading Saves Construction Time

Front-End Loading Score

Actual Months/Industry Average Months

More than industry average
Less than industry average

Undefined  Poor  Fair  Good  Best Practical
Elements of Capital Effectiveness

Key Leading Indicators:
- Business Strategy
- Technology Strategy
- Business Case Development
- Team Integration
- Leading Technology
- Front-End Loading
- Use of Value Imp. Practices

Key Performance Indicators:
- Optimized Scope for Business Need
- Executed with minimum change
- Discipline
- Timely Involvement of Contractors/Vendors

BETTER ROI
- Low Cost
- Fast Cycle Time
- Excellent Operability

SAFETY

IPA
The Value-Improving Practices

Potential to Impact Value

- Technology Selection
- Process Simplification (Value Analysis)
- Classes of Facility Quality
- Waste Minimization
- Energy Optimization
- Process Reliability Modeling
- Customized Standards & Specs
- Predictive Maintenance
- Design-to-Capacity
- Value Engineering
- Integrated 3D CAD
- Constructability Reviews

Project Phase

R&D  Front-End Loading  Detailed Design  Construction  Startup

Authorization
Which VIPs are Most Commonly Used

- Constructability
- Technology Selection
- Customizing Stds.
- Value Engineering
- Design-to-Capacity
- Process Simp.
- Waste Min.
- Predictive Maint.
- Classes of Fac. Qual
- Reliability modeling
- Energy Optimization

% Opportunities Used

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VIPs that Drive Cost Performance

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VIPs Use is Increasing

The graph shows the percentage of VIP opportunities used from 1990 to 1997. The graph includes data for Best Systems and Industry. The percentage of VIP opportunities used increases from 20% in 1990 to 40% in 1997 for Best Systems, and from 10% in 1990 to 30% in 1997 for Industry.

IPA
Lack of FEL Results in Changes

*Using all PES database projects authorized after 1992*
Few Projects Meet All Objectives

% Projects Meeting Performance Objectives

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Why is Capital Effectiveness So Difficult?

In capital intensive businesses, capital effectiveness is an avenue to success

- low cost producers have some volume, margin, and market share control
- cycles provide opportunities as well as headaches

Yet many commodity businesses waste large amount of capital, because...

- work process is inadequate
- accountability is poor
- cross-functional cooperation is lacking
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- Key Leading Indicators

Key Performance Indicators

- BETTER ROI
- IPA
- SAFeETY
- Low Cost
- Fast Cycle Time
- Excellent Operability
The Contracting Strategy Problem

- There are strongly held, diametrically opposed beliefs about the relative merits of different contracting approaches.
- In general, these beliefs are unsupported by systematic data.
- The contracting problem is also confused by the inability of many to distinguish between predictability and effectiveness.
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Contract Approaches Examined

- **EPC Lump-sum**: detailed engineering, procurement and construction performed on a fixed price basis by same firm or consortium.

- **Reimbursable**: all work performed on a cost-plus fee or cost-plus incentive fee basis.

- **Mixed**: engineering & procurement performed on a reimbursable basis with predominantly fixed-price construction.

- **Results are controlled** for definition; poorly defined EPC-lump sums have very large penalty.
Contracting Strategy and Project Results

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- Mixed
- Reimbursable
- EPC
- Lump-Sum
- Reimbursable & Reimb.
Contracting Strategy Results

- EPC Lump-sum is on average significantly more expensive than average.
- Reimbursable engineering followed by any form of fixed price construction (the "mixed strategy") is the most cost-effective approach.
- Although Mixed strategy execution time is longer, the cycle time is shortest.
- EPC Lump-sum carries a heavy operability penalty.
- On average the Mixed strategy appears best and EPC lump-sum worst.
Why are EPC Lump-sums more Costly?

- This contract form seeks to shift risk to the contractor.
- Theory is that because contracts lead execution, they should be better able to control risk.
- However, contractors are not well-capitalized and cannot bear equity risks at low cost.
- Therefore, contractors will normally bid on a higher than 50/50 basis.
- The larger the project relative to contractor, the higher the risk premium.
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The Role of Incentives

- **Engineering incentives** were amounts paid to the engineering contractor according to a formula for results versus targets.

- **Construction incentives** were paid to the construction contractor.

- "Both" are projects in which incentives were provided to both the engineering and construction contractors or to a single EPC contractor for overall cost and schedule results.

- Too few contracts had meaningful provisions for operability incentives to be examined.
Contract Incentives and Project Results
(Non EPC-Lump Sum Only)

Cost Index

Schedule Index

Cycle Time

Operability Index

NO EFFECT ON COST

NO EFFECT ON SCHEDULE

NO EFFECT ON CYCLE TIME

ENGINEERING INCENTIVES

IPA
Conclusions about Incentives

- The use of incentive contracting has no reliable effects on cost, execution time, or cycle time.
- Directionally the results are poorer rather than better with incentives.
- The use of incentives for engineering is strongly associated with *poorer* operability of facilities.
- This conclusion holds for all types of projects we have examined.
- The use of incentives as currently practiced should be reconsidered.
- Contractors are better at this than owners.
If You Incentivize, Ask...

- Exactly, whose behavior are you seeking to change? How will the change mechanism work?

- Will engineers withhold good ideas unless their firm receives an incentive?

- Are there ways that the incentive can be "gamed", e.g. high estimates?

- Are there potential unintended consequences, e.g. managing to the incentives rather than the project?