DOE Front End Planning (FEP) and Project Definition Rating Index (PDRI)

G. Edward Gibson, Jr
Professor
Arizona State University
what if I could?
what if...

6 to 25%

average cost savings through effective front end planning

6 to 39%

average schedule savings through effective front end planning
2006 CII study

- Sample: 609 projects, $35 billion
- Good front end planning:
  - Cost: 10 percent less
  - Schedule: 7 percent shorter delivery
  - Changes: 5 percent fewer
what if...

3 - 10:1

average return through effective front end planning
what if...

I could bring 1000s of years of experience with me on each project?
at DOE?
April 2008 Root Cause Analysis Contract and Project Management

Number one issue from 143 identified:

- “DOE often does not complete front-end planning (project requirements definition) to an appropriate level before establishing project baselines.
  - Insufficient number of personnel
  - Lack of personnel with the appropriate Skills
  - Inadequate time dedicated to front-end planning
  - Reliance on the management and operating (M&O) contractor
  - Lack of defined benchmarks
  - Lack of effective interdepartmental integration
  - Insufficient planning budget resources”
April 2008 Contract and Project Management
Root Cause Analysis, Corrective Action Plan
Number one of eight corrective measures:

“Strengthen Front-End Planning: Establish and implement measures to ensure adequate project requirements definition is accomplished before a project performance baseline is established. This would include defining planning benchmarks, ensuring adequate resource allocation, and conducting third-party reviews prior to project approval, additional funding authorization, and project execution.”
“Improved front-end planning by: requiring sufficient design maturity prior to establishing performance baselines; using industry standard practices such as .....**Project Definition Rating Index (PDRI) tools** to determine projects readiness for baselining; and dividing large programs/projects into smaller, stand alone projects, as appropriate.”
4th Quarter Performance Metrics for Construction Projects

- **Capital Asset Project Success:**
  Complete 90% of capital asset projects at original scope and within 110% of CD-2 TPC.

- **Corrective Action Plan**

- **Target**

- **Graph**
  - % Construction
  - % PDRI Use

- **Data**
  - Successful Projects – 3 year rolling average
DOE projects greater than $10 million - pre CD-2

General Plant Projects Reported in the DOE Facility Information Management System 2006-2016

reported cost $13.9B
average reported project cost $491,800
Approximately 1,300 facilities improved / established
Approximately 15,000 projects
current DOE PDRI Guide and tools are dated
do not align to current research and commercial best practices
planning is not new
“Plan for what is difficult while it is easy, do what is great while it is small. The most difficult things in the world must be done while they are still easy, the greatest things in the world must be done while they are still small. For this reason, sages never do what is great, and this is why they can achieve that greatness.”

- Sun Tzu, *The Art of War*

1000 B.C.E
26 years of front end planning (FEP) research
Construction Industry Institute...

front end planning gated process

0  Feasibility  1  Concept  2  Detailed Scope  3  Design and Construction

Generally
30% Design
Effort
Complete
Planning for a major baseline change needs good front end planning too!
industry sectors studied with front end planning research
>280

organizations contributing to research
$108B 1250

total dollar value and number of projects researched
examples
example project

Nuclear power plant project to meet plant water discharge standards (regulatory). $6.4 million baseline

• The front end planning process was performed internally by the owner
• Inexperienced team
• Poor definition
• Lack of owner leadership
• High turnover rate of personnel
• Poor alignment with contractor
• Budget overrun of 300%, schedule overrun of 100 percent
example project

Government project, institutional facility with three key tenants. Around $50 million baseline.

• Poor alignment
• Poor front end planning effort
• Inexperienced architect
• Little constructability
• 90 percent schedule slippage and 20 percent over baseline
example project

Expansion of existing petro-chemical facility. Copy of another existing facility. Baseline of $50 million, private owner.

- Good front end planning after some early missteps
- Strong leadership once the project was identified as heading the wrong way
- Evaluated twice with the PDRI
- Good stakeholder involvement and alignment
- Early estimate adjusted to reflect reality prior to baselining
- Completed under budget and accelerated
par·a·digm

"a typical example or pattern of something; a pattern or model”
—Oxford English Dictionary

“the set of practices that define a scientific discipline at any particular period of time”
—Thomas Kuhn
3

big ideas
build the right project
scope
the right
things
set the stage for successful execution
1.5 - 5%

average cost of effective front end planning depending on type and complexity
nine rules of the game

1. defined front end planning process
2. use of scope definition tools
3. existing conditions definition
4. correct contracting strategy
nine rules of the game

5. team and organizational alignment
6. familiarity with project type, technology or location
7. practice team building
8. experienced and capable personnel
the most important rule of all…
“Leadership at all Levels”

9. leadership:
   • executive
   • project
     – Owner (DOE)
     – contractor
how to improve
number of front end planning decision support tools
A Suite of Management Tools Available
most recent, sep 2015, oct 2016

< $10 million

< $20 million
5

PDRI Tools
>6,000

years of industry experience in the individuals involved in development of the five PDRIs
## Definition Levels

- **0** = Not Applicable
- **1** = Complete Definition
- **2** = Minor Deficiencies
- **3** = Some Deficiencies
- **4** = Major Deficiencies
- **5** = Incomplete or Poor Definition

### Weighted Score Sheet (Example)

#### A. MANUFACTURING OBJECTIVES CRITERIA (Maximum Score = 45)

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition Level</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability Philosophy</td>
<td>0 1 5 9 14 20</td>
<td></td>
</tr>
<tr>
<td>Maintenance Philosophy</td>
<td>0 1 3 5 7 9</td>
<td></td>
</tr>
<tr>
<td>Operating Philosophy</td>
<td>0 1 4 7 12 16</td>
<td></td>
</tr>
</tbody>
</table>

#### B. BUSINESS OBJECTIVES (Maximum Score = 213)

#### D. PROJECT SCOPE (Maximum Score = 120)

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition Level</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Objectives Statement</td>
<td>0 2 8 14 19 25</td>
<td></td>
</tr>
<tr>
<td>Project Design Criteria</td>
<td>0 3 6 11 16 22</td>
<td></td>
</tr>
<tr>
<td>Site Characteristics Available vs. Req’d</td>
<td>0 2 9 16 22 29</td>
<td></td>
</tr>
<tr>
<td>Dismantling and Demolition Req’nts</td>
<td>0 2 5 8 12 15</td>
<td></td>
</tr>
<tr>
<td>Lead/Discipline Scope of Work</td>
<td>0 1 4 7 10 13</td>
<td></td>
</tr>
<tr>
<td>Project Schedule</td>
<td>0 2 6 9 13 16</td>
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</tr>
</tbody>
</table>

#### E. VALUE ENGINEERING (Maximum Score = 27)

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition Level</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>Process Simplification</td>
<td>0 0 2 4 6 8</td>
<td></td>
</tr>
<tr>
<td>Design &amp; Material Altis. Considered/Rejected</td>
<td>0 0 2 4 5 7</td>
<td></td>
</tr>
<tr>
<td>Design For Constructability Analysis</td>
<td>0 0 3 5 8 12</td>
<td></td>
</tr>
</tbody>
</table>

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**Section I Maximum Score = 499**

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**SECTION I TOTAL**
A2. Maintenance Philosophy

A list of the general design principles to be considered to achieve dependable operating performance from the unit/facility or upgrades instituted for this project. Evaluation criteria should include:

- Justification of spare equipment
- Control, alarm, security and safety systems redundancy, and access control
- Extent of providing surge and intermediate storage capacity to permit independent shutdown of portions of the plant
- Mechanical/structural integrity of components (metallurgy, seals, types of couplings, bearing selection)
- Identify critical equipment and measures to be taken to prevent loss due to sabotage or natural disaster
- Other

Additional items to consider for Renovation & Revamp projects

- Maintenance impact of renovation projects
- Common/ spare parts (repair vs. replace existing components)
- Interruptions to existing and adjacent facilities during R&R work
- Compatibility of maintenance philosophy for new systems and equipment with existing use and maintenance philosophy
- Coordination of the project with any maintenance projects
<table>
<thead>
<tr>
<th>CATEGORY Element</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Score</th>
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<tbody>
<tr>
<td>Not Applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPLETE Definition</td>
<td>No further work required</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MINOR Deficiencies</td>
<td>No further work required prior to Phase Gate 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOME Deficiencies</td>
<td>Needs more work prior to Phase Gate 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAJOR Deficiencies</td>
<td>Needs a lot more work prior to Phase Gate 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INCOMPLETE or POOR Definition</td>
<td>Little or nothing known</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
understanding how CII established PDRI Scores

LOWER IS BETTER!!

1000 Points

70 Points
### PDRI 3 - Low Definition Items

<table>
<thead>
<tr>
<th>Section</th>
<th>Element</th>
<th>Element Description</th>
<th>Level</th>
<th>Score</th>
<th>Comments</th>
<th>Additional Comments</th>
<th>Additional Comments</th>
<th>Assigned Target Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>I A.1</td>
<td>Reliability Philosophy</td>
<td>Level 3</td>
<td>9</td>
<td>Air receiver and knockout. Using same compressor specification; spare parts and maintenance for reliability. Two 500 cfs units. Electrical systems information not received from client; share information.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I A.2</td>
<td>Maintenance Philosophy</td>
<td>Level 3</td>
<td>5</td>
<td>firm up shutdown frequencies and durations with documents as well as who will do the work. Maintenance equipment weight and size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I A.3</td>
<td>Operating Philosophy</td>
<td>Level 4</td>
<td>12</td>
<td>Philosophy of how to operate from an electrical perspective; Some work done by design contractor, not written or decided upon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I D.5</td>
<td>Lead/Discipline Scope of Work</td>
<td>Level 4</td>
<td>10</td>
<td>Electrical contractor scope and interface; Designer needs to be defined. Other areas need work as well to coordinated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I D.6</td>
<td>Project Schedule</td>
<td>Level 3</td>
<td>9</td>
<td>engineering deliverables; verify procurement dates</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I E.3</td>
<td>Design for Constructability Analysis</td>
<td>Level 3</td>
<td>5</td>
<td>Address constructability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II F.6</td>
<td>Fire Protection &amp; Safety Considerations</td>
<td>Level 3</td>
<td>4</td>
<td>need to work on this entire element</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>II G.3</td>
<td>Piping and Instrumentation Diagrams (P&amp;IDs)</td>
<td>Level 3</td>
<td>15</td>
<td>Finalize P&amp;IDs</td>
<td></td>
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<tr>
<td>II G.4</td>
<td>Process Safety Management (PSM)</td>
<td>Level 4</td>
<td>6</td>
<td>needs significant attention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Additional Comments**

- A.4 Electrical Area Classification: Level 3, verify design package from engineers.
- B.1 Deletables Defined: Level 3, PSM stuff.
- B.2 Distribution Matrix: Level 4, need to work this hard.
- B.3 Risk Analysis: Level 4, put this in place.
- B.4 Owner Approval Requirements: Level 3, much work to do in this element.
- B.5 Draft Swarm/Storm Around Requirements: Level 4, much work to do in this element.
- B.6 Pre-Commissioning Turnaround Sequence Requirements: Level 4, much work to do in this element.
- B.7 Startup Requirements: Level 4, much work to do in this element.
- B.8.6 Training Requirements: Level 4, much work to do in this element.
DOE Order 413.3B process map—PDRI usage

PDRI Use

- Request PED Funds
- Operating Funds

PDRI Analysis / Review During the External Independent Review

1. PED Funds
2. Construction Funds
3. Operating Funds

Critical Decision
- CD-0 Approve Mission Need
- CD-1 Approve Alternative Selection and Cost Range
- CD-2 Approve Performance Baseline (PB)
- CD-3 Approve Start of Construction or Execution
- CD-4 Approve Start of Operations or Project Completion

TPC

Projects Report Earned Value ≥ $20M

PARS II Reporting for Projects ≥ $10M

NOTES:
1. Operating Funds may be used prior to CD-4 for transition, startup, and training costs.
2. PED funds can be used after CD-3 for design.
current CII study on maturity and accuracy of FEED
Maturity - Accuracy Quadrants, Cost Change (%)

Numbers represent Cost Change %

22 percent above budget

7 percent above budget

2 percent below budget

High Maturity
Low Accuracy

Low Maturity
Low Accuracy

High Maturity
High Accuracy

Low Maturity
High Accuracy

22 percent above budget

Numbers represent Cost Change %

7 percent above budget

2 percent below budget
## Top nine industrial project maturity elements

<table>
<thead>
<tr>
<th>Rank</th>
<th>PDRI Element</th>
<th>Element Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B1</td>
<td>Products</td>
</tr>
<tr>
<td>2</td>
<td>B5</td>
<td>Capacities</td>
</tr>
<tr>
<td>3</td>
<td>C1</td>
<td>Technology</td>
</tr>
<tr>
<td>4</td>
<td>C2</td>
<td>Processes</td>
</tr>
<tr>
<td>5</td>
<td>G1</td>
<td>Process Flow Sheets</td>
</tr>
<tr>
<td>6</td>
<td>G3</td>
<td>Piping and Instrumentation Diagrams (P&amp;ID’s)</td>
</tr>
<tr>
<td>7</td>
<td>D3</td>
<td>Site Characteristics Available vs. Req’d</td>
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<tr>
<td>8</td>
<td>G2</td>
<td>Heat and Materials Balances</td>
</tr>
<tr>
<td>9</td>
<td>D2</td>
<td>Project Design Criteria</td>
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</tbody>
</table>
Top five industrial project accuracy factors

<table>
<thead>
<tr>
<th>Rank</th>
<th>Factor</th>
<th>Factor Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2a</td>
<td>Technical capability and relevant training/certification of the execution team</td>
</tr>
<tr>
<td>2</td>
<td>1a</td>
<td>Leadership team’s previous experience planning, designing, and executing a project of similar size, scope, and/or location including FEED</td>
</tr>
<tr>
<td>3</td>
<td>1b</td>
<td>Stakeholders are appropriately represented on the project leadership team</td>
</tr>
<tr>
<td>4</td>
<td>2b</td>
<td>Contractor/Engineer’s team experience with the location, with similar projects, and with the FEED process</td>
</tr>
<tr>
<td>5</td>
<td>4a</td>
<td>Commitment of key personnel on the project team</td>
</tr>
</tbody>
</table>
par·a·digm

“a typical example or pattern of something; a pattern or model”
–Oxford English Dictionary

“the set of practices that define a scientific discipline at any particular period of time”
–Thomas Kuhn
in the 2010’s

our projects are different; we don’t have the time or resources to put into effective front end planning; we’ll fix it on the fly.

Result: Bad projects and broken careers are a norm
today?

effective front end planning processes are still critical, but it is all about people and execution.

Result: Owners, designers and contractors need to foster and invest in front end planning capabilities
DOE WILL PROVIDE BETTER TAILORED TOOLS to IPTs for FRONT END PLANNING

• DOE Office of Project Management Oversight and Assessments is undertaking an effort to update the current guide, align with commercial best practices, and provide a better array of tools as a member of Construction Industry Institute – March to September 2017

• Establish Certified PDRI Facilitators at DOE – June 2017

• Develop and Pilot an Front End Planning / PDRI course for FPDs and IPTs. Evaluate for inclusion in PMCDP – Fall 2017

• Present Final Products and Results to the Project Management Risk Committee, EFCOG, Certification Review Board, and next year’s PM Workshop

March 2017

2017 DOE Project Management Workshop
See you at the 5:00-6:30 pm social for questions

26 years of front end planning (FEP) research