Successful Program Delivery Starts Long Before the Program Does – Part 2

Frank R. Parth, MS, MSSM, MBA, PMP

In part 2 of this series we follow up on the discussion of part 1 by examining the current approaches to these projects as being used by both private industry and by the academic community. We then review two common assessment approaches to determining the thoroughness of the planning and execution stages of the projects.

4. Survey of Current Approaches to Large, Complex Projects

The approach to managing these projects over the past 30 years has evolved from the "classic" waterfall approach to a much broader approach as we learned to appreciate the impacts of stakeholders and that long projects face significantly greater impacts from the outside environment.

There has been an increasing body of evidence from private organizations such as Independent Project Analysis, Inc. (IPA), from professional organizations such as the Construction Industry Institute (CII) and research sponsored by PMI, private for-profit industries such as Shell, Anglo-American Mining, Saudi Aramco, and Chevron, and academic research that the most critical decisions, the ones that are most likely to make a project successful or to fail, are made by the business decision-makers long before the design and construction stages start.

With this in mind, this Front End Development (FED) approach to stage-gating the project should begin long before the engineering design/EPC phases begin. The seeds of project success are sown in the very earliest set-up stages of a project, before the engineers ever get involved (Williams, T).

One of the first organizations to emphasize a Front End Development approach seriously was Royal Dutch Shell around the year 2000. In 2001, they revised their Project Management Guide to take into account the change in emphasis from a pure execution oriented approach towards an approach with heavier emphasis on the early stages of the project.

There has been some recent academic research to re-define when these complex projects begin and end. Sato and Chagas (Sato and Chagas) propose to "redefine" the concept of Project Lead Time (PLT) to encompass the time between the project initial idea and the moment in which success is being assessed, which can be beyond the project close-out. Unfortunately they reach no firm conclusions, ending that saying management should use whatever criteria is appropriate for the stakeholder at that moment in time.

The conventional project life cycle does not count for the long term effects of the megaproject, which can have a significant impact on the perception of success. Sat0 & Chagas' approach ignores the long period prior to EPC and just follows the definition used by IPA, where success is measured two years after the end of the project and encompasses the impact on operations of decisions made early.

There has been much written about the poor performance of megaprojects, particularly in the area of public works projects. Flyvbjerg (Flyvbjerg and Bruzelius) has published significant material in this area. For many of these projects the original justifications are based on wishful thinking regarding both the costs and the benefits of the project. Winch (Winch, G.M.) uses the Channel Fixed Link (the "Chunnel" between France and England) to emphasize that these early justifications are based on "future perfect strategizing" where risks are downplayed and the future is perfectly predicted in terms of project cost and future revenues.

4.1 Hutchinson and Wabeke

Hutchison and Wabeke (Hutchison and Wabeke) came up with a similar model for the phases of complex megaprojects. Their model has five phases: Identify and Assess, Select, Define, Execute, and Operate. They plotted the value of each phase as shown here:

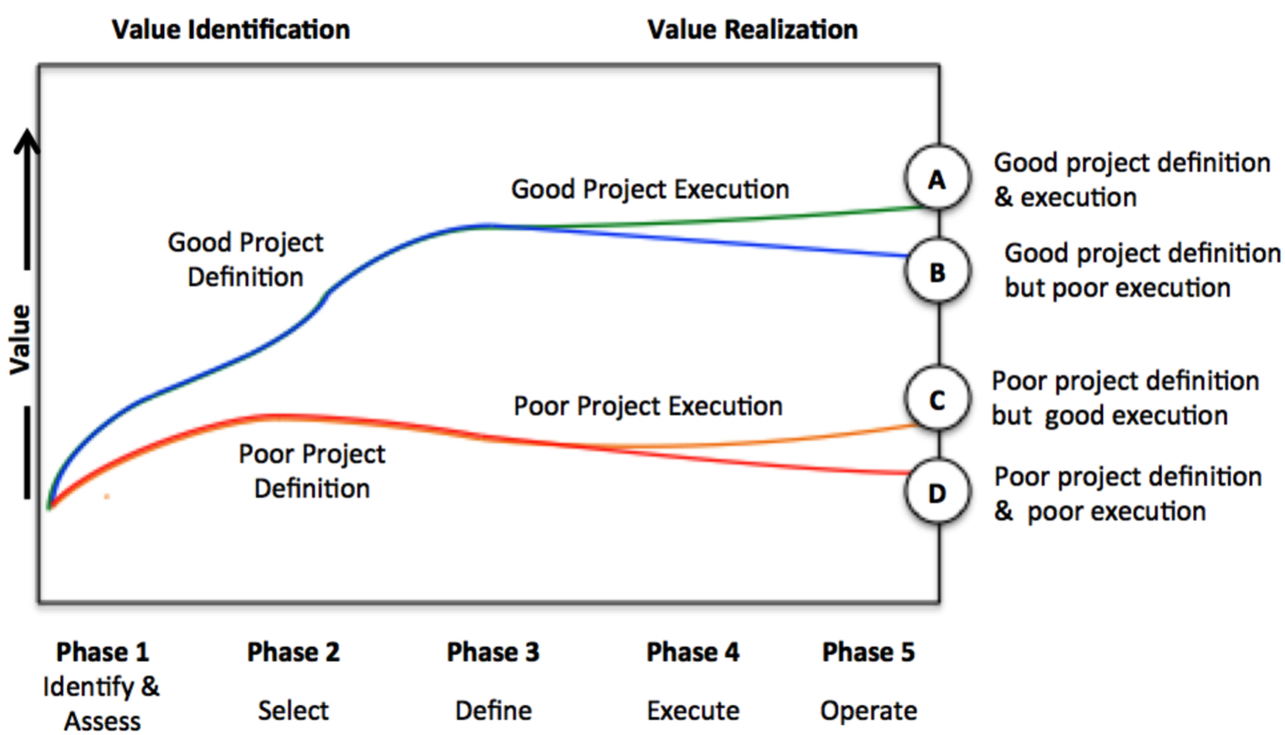

Figure 9: Impact on Value with Early Decisions

The greatest value is provided in the early, business-owned phases of Identify and assess opportunities, select the "best" opportunity for further development, develop the details of the selected opportunity, and then go through the execution phase, which includes both project planning, detailed engineering, and construction efforts. Phases 1 and 2 belong to the business, Phase 3 starts involving the engineers and some project management, Phase 4 is all project management and construction, and Phase 5 goes back to the business.

No amount of good engineering, management, and construction will provide as much value if the project was the wrong one to begin with. Conversely, even good project management will not recover all the value in a poorly-selected project. While this has been widely recognized among practitioners of complex projects, this is the first significant effort to quantify the impacts of the business decision process on project success.

4.2 Jergeas

Jergeas (Jergeas) shows a similar categorization of pre-EPC phases and adds decision points: Identify and Assess Opportunities; Select from Alternatives; Develop the Preferred Alternative; Execute; Operate and Evaluate. Each of these phases is followed by a decision gate as shown here:

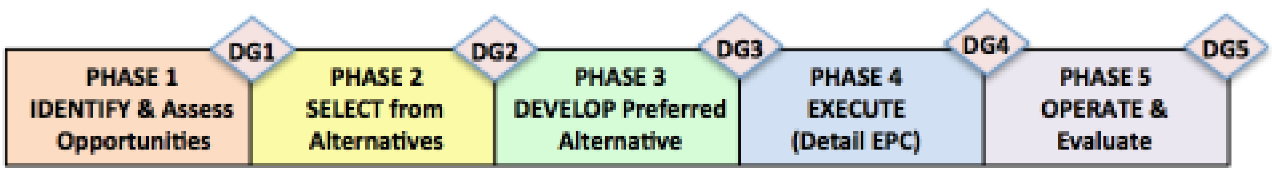

Figure 10: Jergeas Project Phases

Phase 1 Activities (typically 1% of the engineering costs of the project.):

- Clearly Frame Goal
- Test for Strategic Fit
- Preliminary Overall Plan
- Preliminary Assessment
- Develop the Phase 1 Estimate

Phase 2 Activities:

- Generate Alternatives
- Preliminary Development of Alternatives
- Develop Expected Value
- Identify Preferred Alternative
- Develop the Phase 2 Estimate

Phase 3 Activities:

- Fully Define Scope
- Develop Detailed Execution Plans
- Refine Estimate
- Submit Funding for Approval
- Phase 3 Estimates (+/- 10 % Accuracy)

These Phase 3 activities may consume up to 25% of the engineering costs. At the end of Decision Gate 3 is when the Authorization for Expenditures (AFE) is made.

Phase 4 Activities:

- Implement Execution Plan
- Minimize Changes
- Finalize Operating Plan
- Business Plan for Phase 5
- Project Review

Phase 5 (Operations) Activities:

- Operate Asset
- Monitor & Evaluate Performance
- Identify New Opportunities

While this model has been widely quoted, it is slightly inconsistent with other approaches in that in Jergeas' model a business plan for operations is not developed until after the engineering work begins. In both the CII PDRI and in IPA's research results this is much too late to develop a business plan for operations. This document should be developed much earlier in the process.

4.3 Research by Klakegg on Early Warning Signs

Klakegg et al. , on research sponsored by PMI, studied literature on complex projects to attempt to early identify indicators of future problems. They developed a model to use in comparing several complex projects across a variety of industries.

The model begins with the business development stage, where the initial decisions are made based on strategic planning goals, and identifies several major stages that must be done effectively before the engineering and construction phases begin.

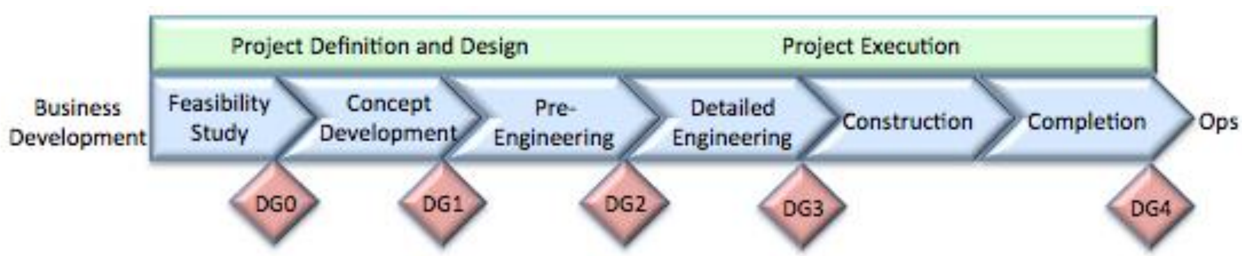

Figure 11: Klakegg Early Warning Signs

Before the project begins, and several times during the early stages, Go/No-Go decision gates are inserted into the process. The decision gates, DG0-DG4, are defined as:

DGO: Decision that the idea is formally recognized in the organization as an acceptable initiative with a person appointed as responsible for following up and spending (allocated) resources in planning the initiative up to the next decision gate.

DG1: Decision that the initiative is acceptable for further investigation and resource consumption. Further investigation will include identifying principal alternative solutions or concepts for decision makers to choose from.

DG2: Choice of concept. The decision implies that the initiative is acceptable for further planning and includes choice of the conceptual solution to be investigated in a pre-project.

DG3: Decision about financing and execution of the project. In this reference model, this gate is associated with the "Go/No-Go" decision.

DG4: Decision to accept the project's outputs/deliverables as complete and commence operations.

Of particular importance is that the most critical gates, DG0-DG3, occur before the engineering and construction phases. These gates all belong in the realm of business decisions. There is typically no project management, detailed engineering, or contractor involvement. Indeed, the model assumes that once the Go/No-Go gate at DG3 is successfully passed that there will be nothing requiring additional decision gates. Considering how extremely challenging these projects are this is a significant shortfall in the model.

4.4 Anglo-American Mining

It is often true that for-profit organizations are much better at developing efficient processes than the academics who come along later and study them. That’s true in this area also. The international mining company, Anglo-American, has for many years faced multiple, serious risks on any mining project they engage in as do all other international mining companies. Their stages and gates approach includes:

- Opportunity identification
- Concept Development and Conceptual Studies
- Analysis and Pre-feasibility studies
- Planning and Feasibility studies
- Execution/Implementation
- Commissioning/production ramp-up/handover
- Close out

There again are stage gates at appropriate points as shown here:

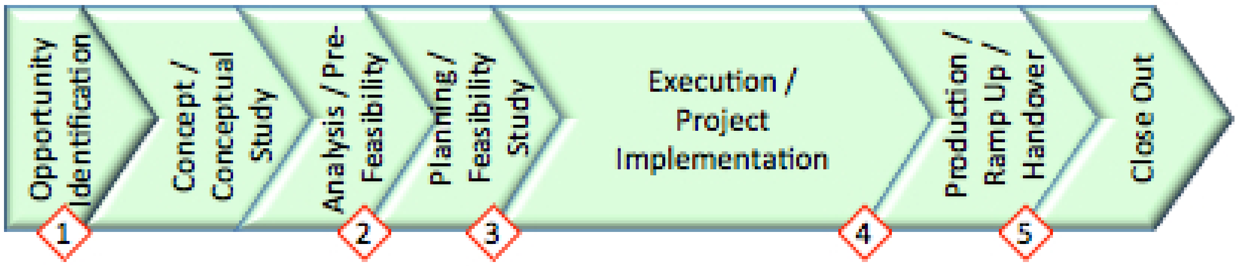

Figure 12: Anglo-American's Project Stages

The mining industry faces many of the same challenges as does the oil/gas (both upstream and downstream) industry: high regulatory burden, environmental impacts, as well as strong opposition from environmental NGOs, high profit risks, and so on.

Developing processing facilities is a multi-year effort. Without the immediate income from ore sales much of the economy collapsed due to the loss of jobs and revenue. The Indonesian government later "changed its mind" and re-permitted ore sales to recover lost revenue. But the decision had large impacts that rippled through the mining industry. Because of the high costs and high risks in mining, these early phases become highly critical to success of the mine and production facilities. Similar stages can be found in oil exploration and production companies such as Landmark.

In September 2013 Anglo (Reuter's Business Report) announced that it was pulling out of a joint venture to develop the Pebble copper/gold project in Alaska. While they walked away from the project after spending US$500 million, the predicted risks in the project outweighed the future benefits. Not too many companies have the strength to walk away after spending that much money and it shows commitment to the importance of the early stages of these major efforts.

4.5 Valero Energy Company

Valero Energy is the largest independent oil refiner in the world, with 16 refineries and a daily capacity of 2.8 million barrels per day. An extensive proportion of their corporate budget is devoted to refurbishing and maintaining existing plants (there has not been a new refinery built in the USA since 1979). One was started in 2014, but with the significant drop in oil prices it remains to be seen if it will be continued.

An analysis of their projects (Anjaneyulu) shows four different levels of these turnaround projects depending on their complexity:

Complexity Level	Average Labor Hours	Average Peak Labor	Man-hours per Day
Low	43,563	238	1,825
Medium	203,710	901	4,402
High	693,960	1,524	11,375
Mega	*1,241,648*	*2,518*	*18,338*

Megaprojects are significantly more difficult than other turnaround projects and face greater risks. The level of uncertainty in the cost and schedule planning is much higher for these projects as can be seen here:

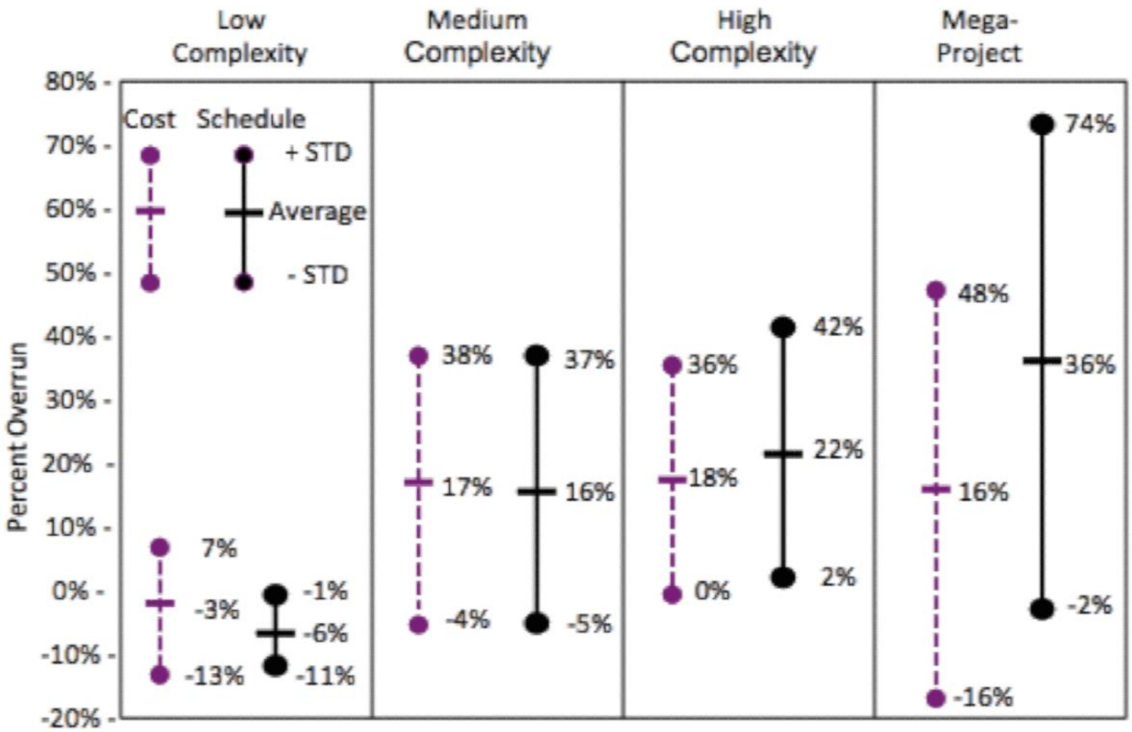

Figure 13: Valero Turnaround Uncertainty

In order to manage the risks of these massive turnaround projects, they have developed an overlapping stage-gated approach starting more than two years before the actual work (the top numbers are months):

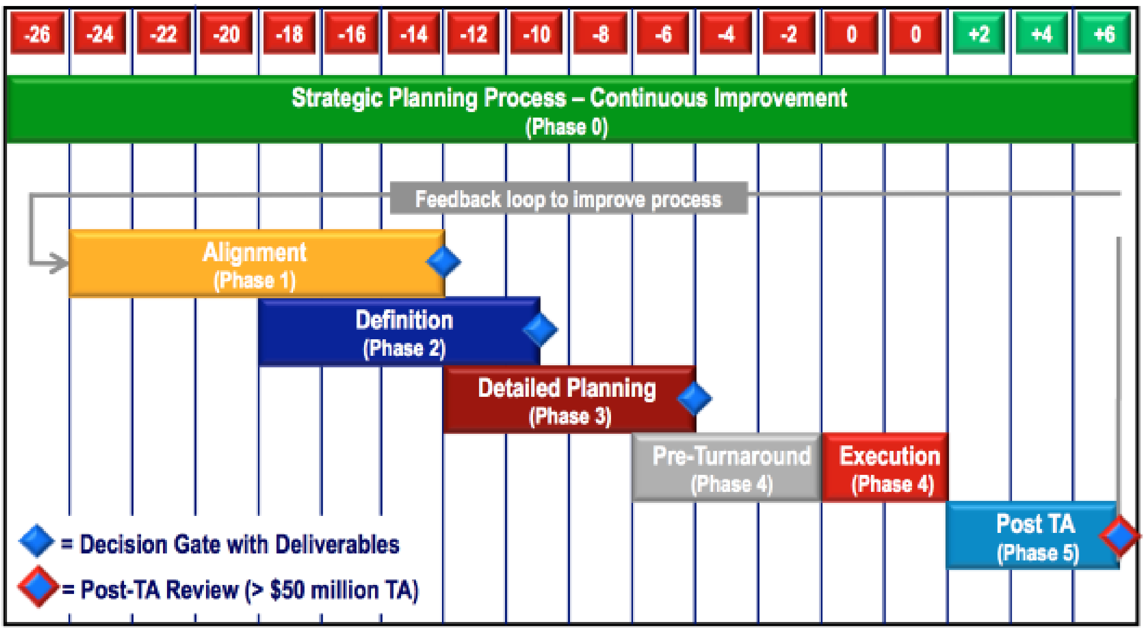

Figure 14: Valero Turnaround Planning Phases

Within each phase there is a well-defined set of activities to be done by the project team.

So both industry and academic approaches show a consistent set of activities to be done long before the EPC stage in order improve the success rate of these projects.

4.6 Saudi Aramco

Saudi Aramco is widely held to be one of the best engineering/construction firms in Saudi Arabia. Their ability to manage complex projects has won PMI's 2004 Project of the Year award and major construction contracts not related to the oil/gas industry. Even for their pipeline projects, technologically slightly less complex than full-scale refinery development, they have a multi-stage process (Al Haijri)

1. Study and Development Phase
2. Preliminary Engineering
3. Project Proposal to Expenditure Request Approval (ERA)
4. Detailed Engineering
5. Procurement
6. Construction
7. Start up

The only unusual part of their process is the early emphasis on funding analysis, done after the preliminary engineering stage. This analysis involves preparation of the expenditure requests estimate followed by an executive advisory review, a management committee review, and finally an Executive Management Committee (EXCOM) review and approval. At each review step the project can be halted or delayed.

There is a large emphasis on making these early business decisions as good as possible. Before a project is approved there are a number of steps in the Study and Development Phase before any engineering gets done. (Note: FPD is Facilities Planning Department, PS&CD is Project Support and Controls Department; DBSP is Design Basis Scoping Plan; and PMT is Project Management Team)

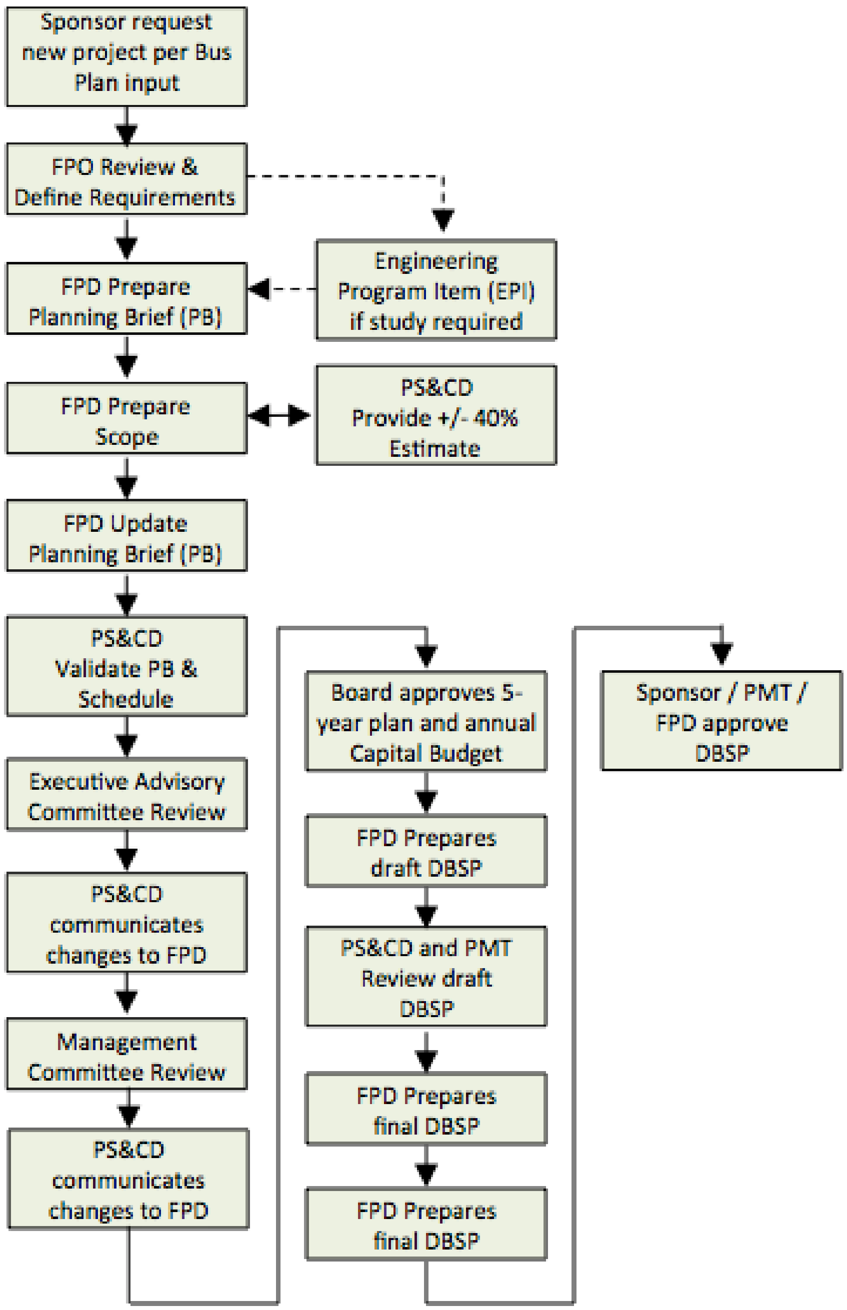

Figure 15: Aramco Pipeline Project Pre-Development Process

One of the roles of the Facilities Planning Department (FPD) is to develop and maintain the Capital Program for Saudi Aramco five-year Business Plans. At the end of November, FPD requests Business Line coordinators to submit new projects for inclusion in the Capital Program. Business Line coordinators consolidate inputs from each department in their Business Line identifying potential new projects.

Approximately four months prior to the Board's review of the Spring Business Plan, Business Line coordinators submit their new projects to FPD to include in the Capital Program based on guidelines and instructions issued by Corporate Planning. The Business Plan is reviewed by the Executive Advisory Committee, then by Management Committee and finally approved by Saudi Aramco's Board of Directors.

FPD uses the input data received from Business Line coordinators to define the preliminary scope of the new projects. Within one week, FPD submits the scope of new proposed projects for cost estimating to Project Support and Controls Department (PS&CD). Within one month PS&CD produces (+/- 40%) cost estimates for all the projects within the Business Plan. FPD enters the cost estimates as well as project execution schedules in the Capital Program database. Continuous discussions take place between FPD and representatives from all seven Business Lines regarding the cost, schedule, and justification of the newly proposed projects.

FPD then archives the Capital Program database for the Executive Advisory Committee review, which will take place approximately three weeks later. During this period, FPD further screens the new projects, ranks them among the other projects already in the Business Plan, and generates Planning Briefs for new projects. Planning Briefs give a brief description of the scope and the schedule requirements and are required for all projects included in the five-year Business Plan.

As soon as the Business Plan is archived for the Executive Advisory Committee review, PS&CD in conjunction with FPD issues the master scheduling system (MSS) report for the projects in the Business Plan for review at the Table Top meeting. Simultaneously, FPD issues the Planning Briefs to Project Management. At this meeting, the Project Management Team (PMT) and PS&CD discuss their comments/problems with the schedule of each project with FPD for further follow up with the Business Line coordinators. This meeting will also validate the planning brief and the schedule.

After the Executive Advisory Committee review, the Capital Program is revised to reflect Executive Advisory Committee changes. FPD archives again for the Management Committee review. PMT and PS&CD discuss any changes with FPD. Also, the changes from Management Committee are archived for the Board of Directors' review and approval. After the approval of the Spring Business Plan in May, the Business Plan is then updated, following a similar planning process, to be reviewed by the Board in November. This process is called the Business Plan Fall Update. In this review, the Board approves the Business Plan and the annual Capital Budget, which is a list of projects to be funded in the first year of the Business Plan. The Budget Briefs of these projects are presented to the Board for approval.

Based on the Planning brief and the project requirements, FPD develops the Design Basis Scoping Paper (DBSC) for the project following the approval of the Capital Budget by the board of directors.

The DBSC defines "what" is to be built and reflects sizing parameters, design conditions and other special operational considerations. With the DBSC as a basis, the "how" to build is developed during the project-proposal phase by the PMT. The objective of the DBSC is to establish the major design basis, while still permitting the optimization of facility design during project proposal development. After the DBSC is developed, it is reviewed by PS&CD to check the estimate and the schedule, and it is reviewed and approved by the proponent and the PMT. This is the point of time when the project is turned to the PMT and the preliminary engineering phase starts.

5. Assessment Approaches

In addition to developing stage-gating processes to better plan these projects, there are also approaches that have been developed to assess how good the planning effort is. Two of the move widely used processes are the Front-End Loading (FEL) process and the Project Definition Rating Index (PDRI).

5.1 Front End Loading (FEL)

The company Independent Project Analysis (IPA) has done research on large projects since 1987 and has accumulated a significant database of what causes projects to be successful or to fail. They have advanced the concept of pre-planning the project very early in the business cycle through a three-stage Front End Loading process.

The first stage is purely about the quality of the business data and the decisions that result from it. There are extensive questions about the thoroughness of the business case, team sponsorship and dynamics, and analysis of any alternatives. This first assessment is a business expense and does not come out of the project budget.

The second assessment is to identify the thoroughness of the scope development. The questions revolve around the site factors, the design status, and the project execution plan (PEP). The emphasis here is on the completeness and accuracy of the data that will be used in making decision to go forward or not. For an oil/gas refinery, 100% identification of the process flow diagrams (PFDs) is a go/no go gate to continue. The PFDs are normally developed during the Front End Engineering Design (FEED) process prior to the EPC phase of the project.

Assessment three is done to prepare for the Authorization for Procurement decision. Areas include again the site factors, the design status, and the PEP. This time these area should be developed in much more detail. For process plants there is a go/no go gate revolving around the Processing & Instrumentation Diagrams (PIDs) for a refinery project. If PIDs are not sufficiently detailed, the decision should be to not go further until a sufficient amount of data is available.

For comparison, the FEL process maps roughly to AACEI's estimating classes as follows:

Phase	FEL 1	FEL 2	FEL 3
FEL Goal	Business Planning	Scope Planning	Project Planning
Major Activities	Identify and assess the business opportunity	Select single project and develop scope	Define detailed scope for selected project and develop execution plans
AACEI Estimate Class (with uncertainty ranges)	Class 5 L: -25% to -50% H: +30% to +100%	Class 4 L: -15% to -30% H: +20% to +50%	Class 3 L: -10% to -20% H: +10% to +30%

The comparison is not exact because FEL is semi-customized for each organization.

FEL #1 looks at the business case, the team dynamics, and an analysis of alternatives:

- Business case:
  - Market experience
  - Competitive analysis
  - Raw Material/Feedstock costs
  - Investment and economic life
  - Legal/Regulatory framework
  - Completeness of business plan
- Team dynamics:
  - Sponsorship and leadership
  - Clear authorization and resourcing process
  - Multifunctional project team
  - Clear team goals and expectations
  - Clear, timely, effective communication
  - Effective decision- making process
  - Team stability
- Alternatives Analysis:
  - Competitive technology selection
  - Business objectives statement and charter to team
  - Capacity recommendation
  - Technical plan

This work does not come out of the project's budget but should be funded out of basic research or from overhead.

The decisions made here are at the level of middle management – managers, senior managers, and directors with input from the technical staff. They will be taking the work done by the technical people and deciding which of the alternative options should be carried forward and developed in more detail.

The emphasis here needs to be on making the "best decision possible. The decision itself is the important part of this effort, not the activities or workflows in getting there. The details of the data needed for that decision must be determined in advance and the decision criteria for a Go decision should also be determined in advance. Any really critical items (such as the Process Flow Diagrams or the Piping and Instrumentation Diagrams emphasized in the FEL process) should be clearly identified.

If some of the data are marginal for a Go decision, these become risks to the project and the project manager should give them a high priority. It would be useful for the process in getting to each decision to be defined as a project itself, with the outcome of the project gathering and analyzing the data needed for the business to make a good decision.

There is no specific schedule to be met here, the effort should take as long as necessary to produce the information needed to make an intelligent decision. For a pipeline project in Canada (Muiño, A., and Akselrad, F.) this effort took 3 months and cost about 1% of the total project budget.

FEL 2 has a different emphasis. There are three areas that are looked at in determining readiness to continue: Site-specific factors, Design status, and Project Execution Plan. This stage covers a broad effort and it is recommended to be done twice: the first to select a single project out of the options that came out of FEL 1 and the second to develop more details on the selected project.

- Site Factors:
    - Site Determined
    - Equipment Block Layout identified
    - Preliminary soils & hydrology report
    - Environmental permitting requirements & strategy identified
    - Health & safety requirements & strategy identified
    - Labor survey completed if needed
    - Local content providers reviewed

- Design Status:
    - Basic process data
        - feedstock/product properties
        - H&MBs
    - Engineering tasks

        - Written scopes
        - Single set of PFDs
        - Sized major equipment list
        - Utility, infrastructure & off-site requirements
        - Analysis of existing equipment
        - Full factored cost estimate
    - Clear business goals
    - Participation/Buy-in of
        - Operations
        - Maintenance/ turnaround
        - Business

- Project Execution Plan
    - Execution strategies (not plans)
        - Design
        - Procurement
        - Construction
        - Turnover sequences
        - Contracting
        - Team participants and roles
    - Integrated CPM schedule
        - FEL 3
        - Engineering
        - Procurement
        - Construction
        - FEL 3 plans (not strategies)
        - Contracting
        - Long-lead procurement
        - Resource requirements
    - Clear project objectives

Success data for a Go decision should be clearly defined. IPA recommends that a full set of Process Flow Diagrams (PFDs) be complete before proceeding onward. For the pipeline project in Canada cited earlier this effort took 6 months and cost about 4% of the total project budget.

Developing a schedule for this stage can be highly problematic depending on the project. For a mining project or an oil/gas project, it can take many months to do the field work and develop the site's geology report, and longer if the work is in an inhospitable area such as northern Canada, Alaska, or Siberia or in a politically unstable area such as Nigeria or Sudan.

At FEL 3 the categories of information are the same: Site-specific factors, Design status, and Project Execution Plan, but the level of detail required is much more thorough:

- Site Factors
  - Labor
  - Availability
  - Cost
  - Productivity
  - Local materials availability
  - Plot plans and arrangements
  - Soils data
  - HSE requirements
- Design Status
  - Engineering tasks
    - Detailed scopes
    - Feedstock/ product properties
    - Heat and mass balances
    - License packages
    - Piping/ Instrumentation diagrams
    - Electric single-line diagrams
    - Major equipment specs
    - Take-off based estimates
  - Full agreement/Buy-in of
    - Operations
    - Maintenance/ turnaround
    - Business
    - Other stakeholders
- Project Execution Plan
  - Contracting strategy
  - Project environment
    - Community relations
    - Regulatory liaison
    - Local content providers
  - Project organization / resources
  - Team participants and roles
  - Interface management and communications plan
  - Critical path items
    - Identification of shutdowns for tie-ins
    - Overtime requirements
  - Plans
    - Commissioning
    - Startup

    - Operations
    - Manpower
    - Quality assurance
  - Cost/Schedule controls

For the pipeline project in Canada cited earlier this effort took 6 months and cost the remaining 85% of the project budget. At the end of this stage the plan was ready for operations.

While FEL is a highly useful analysis approach, it may still underestimate project costs as shown by Ogilvie et al. Their analysis of 462 projects in the process industry shows cost estimates 70% lower than actual at FEL 1, 20% lower at FEL 2, and 10% lower at FEL 3 as shown here

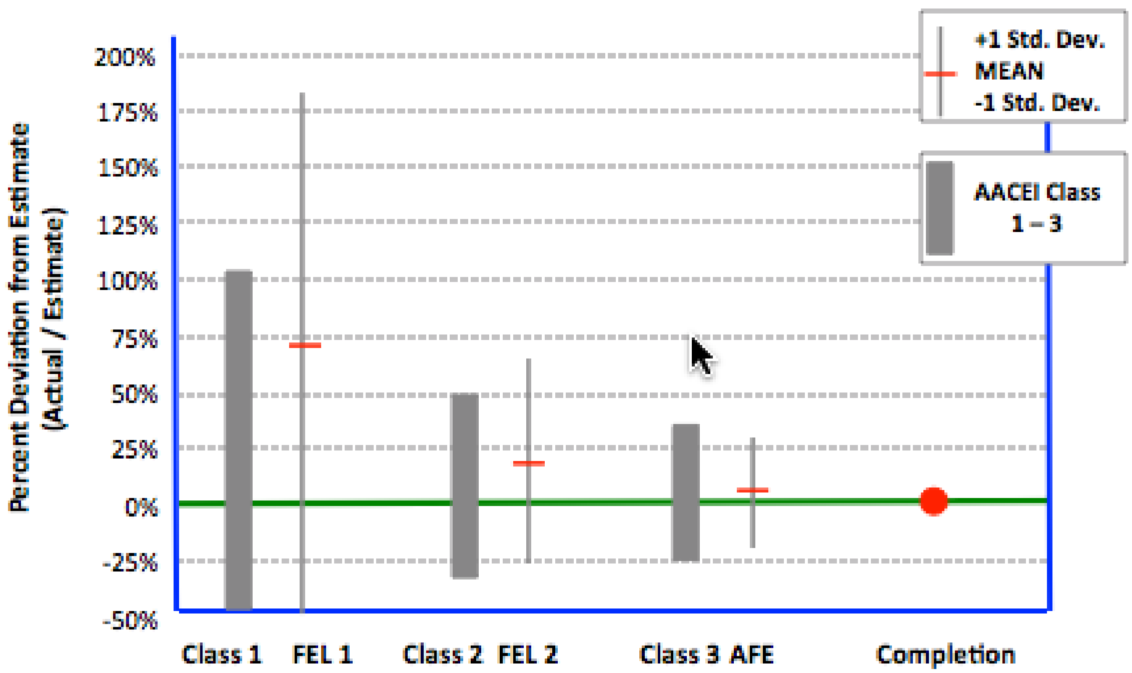

Figure 16: FEL Cost Errors

While these assessment tools are highly useful, no tool can reflect the realities of complex projects perfectly.

5.2 Project Definition Rating Index (PDRI)

The PDRI was developed by the Construction Industry Institute in the US to assess the risk of projects. It is a survey that comes in three forms: industrial projects, infrastructure projects, and building projects.

Based on feedback from participants, each question is weighted for its impact to project risk. The first set of questions, the ones that have the greatest weight in determining a project's risk are all business-oriented questions: building use, business justification, business plan, economic analysis, and owner philosophies on reliability, maintenance, operational, and design. In this respect it is similar to the FEL process because of the heavier weights given to the early business decisions.

While the emphasis is on understanding the project's risks, it gives very good information for the decision-makers to decide whether to continue the project or to stop and do further work to improve the probability of success.

Both the FEL process and the PDRI process assess the quality of the planning processes and how risky the project is. FEL assessments look at different factors than PDRI assessments do. Both show clearly the heavy impact of the pre-EPC decisions on project success. PDRI is done during the front-end planning (FEP) stages:

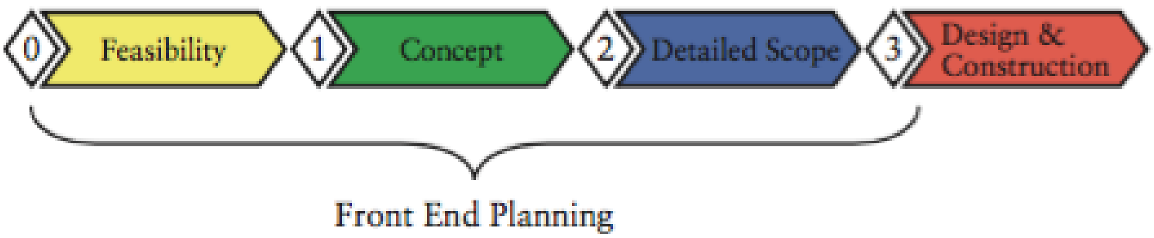

Figure 17: FEP Cycle

These FEP activities are performed up to Phase Gate 3 (the point at which the decision to fund design and construction is made) and include feasibility, concept and detailed scope definition. Please note that front end planning has many other terms associated with it, including "front end loading," "pre-project planning," "programming," "schematic design," "design development," and "sanctioning," among others.

As shown in the CII's PDRI documentation the following is a list of the ways the PDRI for Infrastructure can benefit a project:

- As a **checklist** that a project team can use to determine the necessary steps for defining project scope, for both greenfield and R&R projects.
- As a listing of **standardized scope definition terminology** for infrastructure projects.
- As an industry standard for rating the completeness of the project scope definition package to facilitate **risk assessment** and prediction of escalation potential for disputes.
- As a means to **monitor progress**—when used successively—at various stages of the front end planning effort.
- As a tool to promote **communication and alignment** between owners and design contractors by highlighting poorly defined areas in a scope definition package.
- As a means for project team participants to **reconcile differences**, when used as a

common basis for project evaluation.

- As a means by which members of a project team can **identify enabling tasks and act upon them** before the project schedule becomes delayed.
- As a **benchmarking tool** for comparing completion of scope definition on current projects against performance on past projects, both within organizations and externally, in order to predict the probability of success on future projects.

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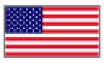
About the Author

Frank R. Parth

Rancho Santa Margarita
California, USA



Frank Parth, MS, MSSM, MBA, PMP is the President of Project Auditors LLC, a past member of PMI's Board of Directors, and is currently on the core management team for PMI's PMBOK Guide version 6. Mr. Parth brings 35 years' experience in project and program management to his teaching and consulting work.

He had a first career designing satellite systems for the US government and in 1993 he set up a consultancy and began consulting in program management and systems engineering. He has created PMOs for several Fortune 1000 companies and for companies internationally. He consults to clients in multiple industry sectors, including telecom, construction, high tech, chemical processing, utilities, government, healthcare, mining, financial services, and aerospace. He is currently supporting Saudi Arabia's Saline Water Conversion Corporation in improving their project management processes and in developing a PMO.

Mr. Parth teaches project management courses throughout the world and has taught over 4000 students worldwide in preparing for the PMP certification exam. He is a guest lecturer at USC's Marshall School of Business, the University of California, Irvine, and at the American University of Sharjah (AUS) in the UAE, is an accomplished international speaker, and does pro bono teaching of project management in Vietnam.

He has co-authored or contributed to multiple books on project management and has published numerous papers in project management and systems engineering. He is actively involved with PMI, serving on local and national committees and was PMI's Project Manager for the Standard for Program Management, 2nd edition published in 2008. Mr. Parth can be contacted at fparth@projectauditors.com.