

Keep Projects on Track: Improve Communication During Estimating

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Introduction

In the energy and chemicals industries, project costs have risen faster than the rate that CAPEX increases (in comparable industries) and faster than the rate of inflation. Engineering, procurement and construction companies (EPCs) argue that owners do not effectively freeze, define and communicate project scope and requirements at the beginning of the bidding process, as well as into the front-end engineering design (FEED). As the project definition creeps, EPCs must employ significant manpower to react and make adjustments, which results in a spiral of cost and schedule changes throughout the project.

The estimate is a key FEED deliverable and communication mechanism. Traditional estimating approaches, which are very dependent on manpower to do the work of obtaining individual quotes and enumerating quantities, capture this intensive data collection in spreadsheets, and do not provide the agility to quickly react to scope changes. This can lead to projects being delayed and going over budget. A 2014 EY analysis showed as many as 64% of megaprojects were over budget and as many as 73% were behind schedule. Both EPCs and owners know that better transparency regarding project scope and estimates is needed during bidding to improve this situation and change the trend.

In addition to communicating scope and project intent, many owners are not equipped to evaluate, analyze and manage contractors' costs. Without insight, at the very front end, into appropriate project CAPEX, owners are operating blind. For owners to gain control over bid estimates, downstream detailed cost estimates and project performance of contractors, they must employ a system that can validate the accuracy of early conceptual estimates from contractors. At the same time, owners must balance the need to minimize CAPEX with smarter investments in design that can optimize energy use, maintainability and future uptime (i.e. OPEX) to avoid spending additional CAPEX shortly after the asset is put into service. The use of one common economic evaluation solution across the lifecycle, which is closely integrated with the process development tasks at the project outset, can be a key optimization and management weapon in that journey.

Inefficiency of the Estimating Lifecycle

The bidding and estimating process in most companies today offers many opportunities for improvement. Based on years of engineering tradition, business processes are characterized by a manual handover of data and information, “siloeed” engineering disciplines without collaboration between departments and a razor-sharp focus on the client’s end deliverable. Figure 1 provides an overview of the workflow and data interrelationship between different engineering functions and activities. The green circles (A-E) represent the biggest targets for improvement.

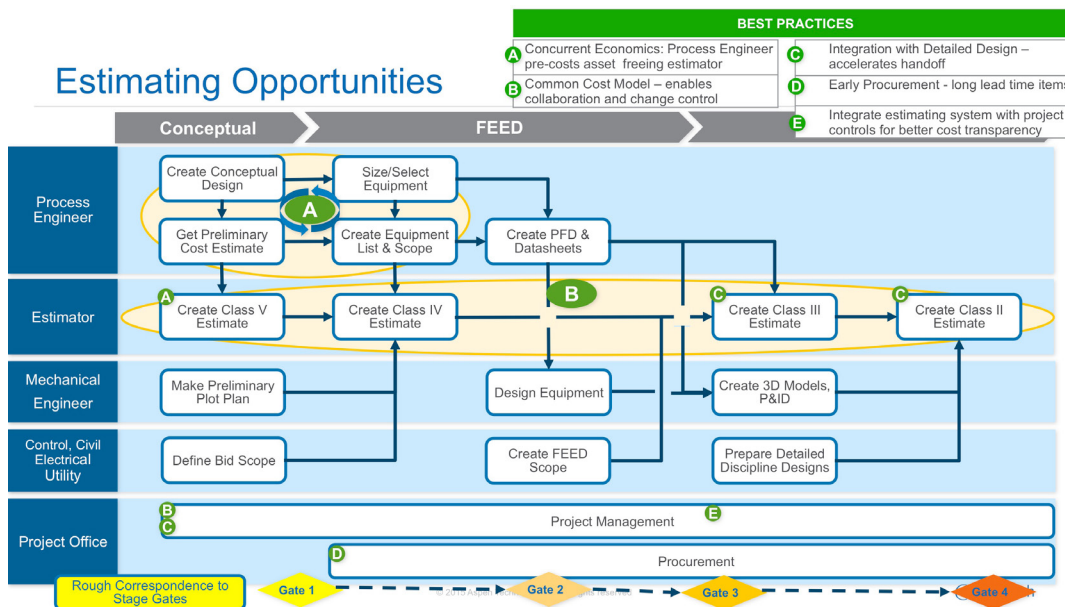


Figure 1: Estimating lifecycle for a typical capital project.

Aspen Capital Cost Estimator™ as the Backbone of the Estimating Lifecycle

Many owners struggle with projects coming in over budget and behind schedule, and find themselves with capital costs that are spiraling out of control. The model-based conceptual estimating system, Aspen Capital Cost Estimator (ACCE), provides a unique capability to rapidly evaluate project scope and costs throughout the estimating lifecycle in one view. Figure 2 provides an overview of how ACCE fits the workflow and the data interrelationship between different engineering functions, activities and software platforms. ACCE also supports robust integration between the different work stages.

ACCE Integrated in the Asset Creation Workflow Achieving Project Cost and Project Execution Effectiveness

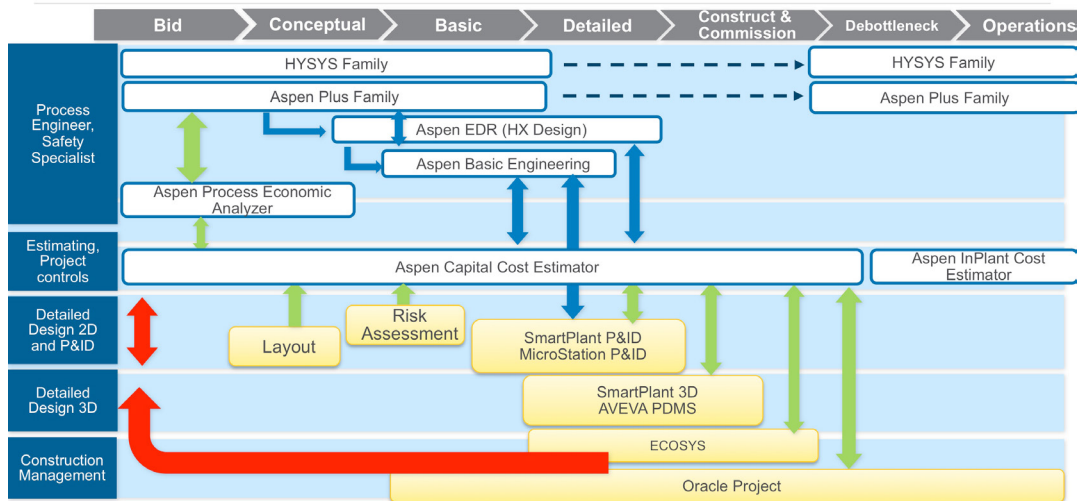


Figure 2: ACCE as the backbone of the estimating lifecycle.

Some of the key integration points are:

- Process models (in Aspen HYSYS® or Aspen Plus®) are integrated with Aspen Process Economic Analyzer™ (APEA).** This intelligent integration extracts the heat and material balance and process flow diagram from Aspen HYSYS, and sizes and maps equipment that correspond to process schema elements. The sizing can be customized to incorporate sizing rules that are general to the owner or EPC's engineering standards for projects, or specific to technology types or specific projects.
- Define the plot plan in ACCE.** The plot plan can be defined within ACCE or can be integrated from AutoCAD or SmartPlant. This establishes an early scope for bulk items, and on offshore projects. The size and weight limitations are defined within ACCE.
- Easily export P&ID and 3D models to ACCE.** The capability to export from SmartPlant P&ID, AutoCAD and AVEVA P&ID is currently provided by Strategic Estimating Systems' (SES) add-on applications, while AspenTech provides the capability to export from SmartPlant 3D to ACCE. AspenTech plans to provide further integration to support detailed estimating (+/- 10% accuracy).
- ACCE estimates can be exported to project management tools (such as Oracle Project) and to construction management/project controls (such as EcoSys).** This automates the handover of equipment, materials and resource loading.

Communication Between the Owner and Contractor

Both EPCs and owners know that better transparency regarding project scope and estimates is needed during bidding. Owners with an in-house conceptual estimating solution have much greater visibility into contractors' bids and can overcome challenges in communicating scope and FEED basis.

ACCE creates that visibility and enables better communication between owners and contractors. This section will describe some of the modes in which that is accomplished. (See Figure 3.)

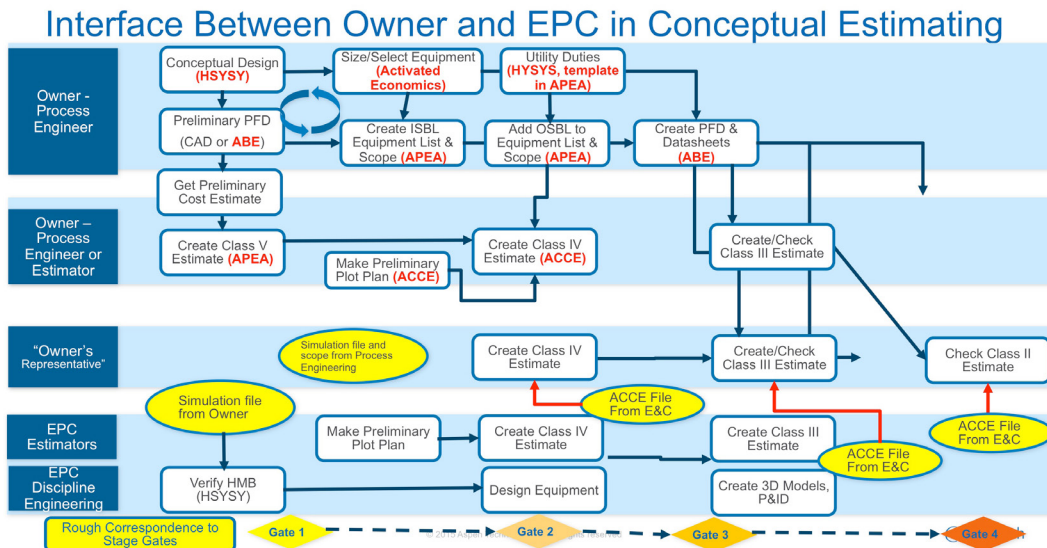


Figure 3: Some typical contractor/owner integration points during the estimating lifecycle.

Several recent industry studies (including studies by EY Consulting, IPA and R.J. Long) point to a lack of definition and communication of front-end loading (FEL) and FEED as primary costs of capital project overruns. Therefore, in terms of capital project performance, it will benefit the owner to define the process performance, process scope, capital costs and construction/fabrication strategy as early in the project as possible.

Scope and Early Estimates by Owner

Owners need a way of improving the accuracy of their early conceptual estimates, starting at the beginning of the project lifecycle, and in reducing the uncertainties which can lead to better decisions regarding the use of capital and capital spending.

Aspen HYSYS integrated with Aspen Process Economic Analyzer (APEA) provides process schema, heat and material balance and process scope. To complete the scope, outside battery limit (OSBL) scope needs to be added to the preliminary process scope so that it can be generated in an automated way from the process model. This includes heating and cooling utilities, substations and buildings, in particular. This scope can be entered in APEA directly by trained process engineers or estimators, or can be entered by a process engineer by the use of a template.

Company or project-specific parameters that increase the estimate accuracy, such as labor efficiency rates by categories, indirect rates and regional cost factors and indexing, can be performed in ACCE. A template can be generated for use by process engineers in APEA to apply the appropriate parameters.

Handover of Scope to EPC or FEED Contractor

When the owner delivers the process modeling file (from Aspen HYSYS or Aspen Plus) to the contractor, it provides an efficient way to communicate the conceptual design and the proposed project performance parameters. If the contractor has not provided the electronic file, they will usually have to recreate the model, which introduces additional project costs and inefficiencies.

The owner can provide the contractor with the APEA file or the APEA equipment lists; however, often from a business point of view, it is better to provide the simulation file and have the contractor develop the estimate, so that they take ownership of the process.

Use of Common Systems and Handover of Estimate from Contractor to Owner

The primary element of communication between owner and contractor is through the use of common systems. There are a number of published examples of owners who employ ACCE as a common system. In other words, they either encourage or require FEED and EPC contractors to prepare estimates in ACCE and to provide estimates electronically in the ACCE electronic format (the “.IZP” file). Examples include Saudi Aramco, ConocoPhillips (Phillips66), Koch Industries, LyondellBasell Chemicals, The Dow Chemical Company, DuPont, Nova Chemicals and Reliance Industries.

ACCE can support communication between the owner and operator in a number of ways:

- 1. Handover of electronic files (as described above) from selected contractor to owner.**
The owner can then review the project scope and estimate in ACCE.
- 2. Contractor can mask the project indexing and cost basis before providing the file to the owner.** This is appropriate in instances where the contractor feels that the project cost basis is a competitive bidding and project execution advantage.
- 3. Use of owner's reporting structures, material codes and other customizations by contractors.**
In some cases, owners provide contractors with pre-configured systems so that the estimates can be effectively reviewed in the context of the owner's engineering standards and systems. In other instances, cost-basis templates can be provided.

Rolling up multiple project participants into one estimate is a best practice when developing megaprojects. In the case of large megaprojects, different EPCs may be awarded different portions of a project that involve particular sections of a large facility or different systems. With ACCE, the individual contractor estimates for parts of a project can be rolled up into one overall estimate for the project, creating powerful visibility into these large and complex projects. (This requires agreement on the use of one common project cost basis for each of the individual component estimates.) This approach was used on the SADARA project, where KBR and The Dow Chemical Company's engineering team acted as lead engineers with multiple EPCs working on individual parts of this \$30B USD project. By using ACCE on the SADARA project, many of the traditional megaproject challenges described above were overcome.

Industry Examples of Best Practices

There are many examples of the strong benefits achieved by owners who are using economic evaluation software by AspenTech in various contexts. Here are some of the advantages of using ACCE and requiring contractors to submit estimates in ACCE:

- Faster and cheaper estimate creation process
- Consistency in bid submissions from EPCs
- Easier bid analysis and comparison
- Support for value engineering and scope reduction exercises
- Rapid comparison of construction strategies using the same base costs (i.e. stick built v.s. modularization, configurations of storage systems, materials of construction, etc.)
- Transparency with cost control
- Improvement in estimate accuracy and end-of-job cost performance
- Unit rate and change notice basis for contractor negotiations
- The ability to rapidly evaluate process alternatives to select those that meet CAPEX, OPEX and operability tradeoffs

Saudi Aramco: Saudi Aramco requires contractors to develop and submit estimates in ACCE. This is used for contractor selection and to understand and manage project progress and costs.

Phillips66: ConocoPhillips (Phillips66) requires EPCs to provide estimates in ACCE. Phillips66 employs ACCE to (a) compare contractor bids and ensure the scope requested by the owner is included in those bids and (b) use the estimate and the generated resource loads to monitor progress on projects and identify early warning signs that projects are trending over budget.

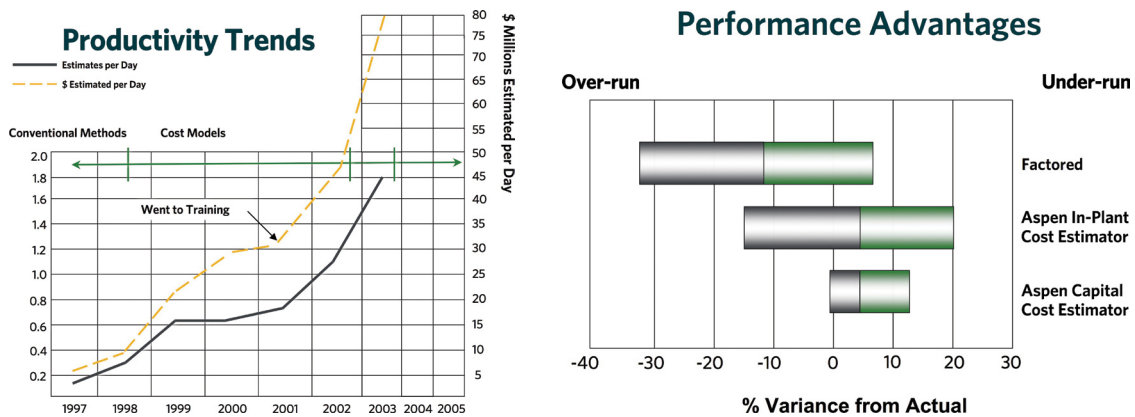


Figure 4: Improved accuracy and productivity measured by Phillips66 after adoption of ACCE.

PEMEX: PEMEX employs Aspen HYSYS, APEA and ACCE in an integrated workflow, as described below, to define project scope and estimated costs early in the engineering cycle. Additionally, PEMEX makes use of integration with Crystal Ball for risk and uncertainty analysis, and with Oracle Project for project control.

CASE STUDY: PEMEX
Consistently Exceeding Industry Benchmarks on Estimating



Business Challenge & Objective		Results & Benefits	
<ul style="list-style-type: none"> Meet and exceed estimating accuracy targets to support PEMEX and Mexican federal budgeting processes Manage risk Improve project execution 	<ul style="list-style-type: none"> Estimated over 30 major capital projects with APEA and ACCE Consistently achieved accuracy better than +/- 21% for Class IV estimates Achieved +/- 8-16% for Class III estimates 		
Solution Overview			
<ul style="list-style-type: none"> Use HYSYS with APEA for improved project workflow Use ACCE for Class IV, III estimating Use Crystal Ball with ACCE for risk assessment Integrate ACCE with Primavera 			

Proj. No.	Project Name	Estimate	Contract	Delta	Accuracy
1	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
2	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
3	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
4	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
5	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
6	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
7	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
8	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
9	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
10	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
11	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
12	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
13	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%
14	Proyecto de Construcción de una Refinería de Petróleo en el Estado de Veracruz	1000	1000	0	0%

Consistently Exceeding Industry Benchmarks on Estimating

Eni / Polimeri Europa: Eni employs the integration between Aspen HYSYS and APEA/ACCE to evaluate alternative process schemas and achieve substantial capital cost savings by rapidly optimizing process, capital and OPEX alternatives.

Polimeri Europa (eni)
Achieving better capital decisions at the right time

Challenge	Solution	Result
<ul style="list-style-type: none"> Aspen Capital Cost Estimator Calibrated with historical cost information from prior projects Used ACCE to accurately estimate installation as well as equipment costs No vendor quotes or detailed engineering required 		<p>Case 2: Less equipment but bigger, lower cost or higher?</p> <p>Ref: Antonio Maganzani, Aspen Global Conference, June 2011.</p>

To summarize the broad usage of ACCE across the process industries, the list below is representative of the leading engineering and construction firms and owner/operator companies that have used the software to increase profitability. ACCE has been used to achieve good results in 35+ countries and 1,300 locations.

E&Cs – Americas, Europe, MENA

- Fluor Corporation
- Jacobs Engineering Company
- KBR
- Burns & McDonnell
- S&B Engineering
- Black and Veatch
- CH2M Hill
- AMEC Foster Wheeler
- Aker Solutions
- ABB
- Siemens
- Technip (USA and Stone and Webster Process Technology)
- SNC Lavalin
- Honeywell - UOP
- AECOM (URS Washington Group)
- Wood Group (PSN and Mustang)
- Linde Engineering
- Strategic Estimating Systems
- Audubon Engineering
- Technimont

E&Cs – Asia Pacific

- SK E&C
- Daewoo Engineering
- Daelim E&C
- Samsung Engineering
- Samsung Heavy Industries
- JGC Corporation
- Chiyoda Corporation
- Kawasaki Heavy Industries
- Petro China Engineering
- Sinopec Engineering (SEI)
- WorleyParsons
- Thyssen Krupp Australia
- Essar Projects
- EIL

OWNER/OPERATORS

- Saudi Aramco (Downstream, Upstream)
- KNPC
- ExxonMobil (Upstream, LNG)
- SABIC (Chemicals)
- PEMEX (Downstream, Offshore)
- Pertamina (Up and downstream)
- Petronas (Up and downstream)

OWNER/OPERATORS

- Nova Chemicals
- PDO (Oman)
- OMV
- Anadarko Petroleum
- The Dow Chemical Company (Chemicals)
- Reliance Industries (Downstream)
- ConocoPhillips (Downstream)
- Petrobras (Downstream)
- PDVSA/Hovensa/CITGO (Upstream, Downstream)
- Statoil (Downstream)
- Suncor Energy (Mining, Upgrading)
- Husky Energy (Upstream, Pipelines)
- PetroCanada (Downstream)
- MOL Group (Downstream)
- Chevron (Downstream)
- Flint Hills Resources (Koch) (Downstream)
- Koch Pipelines
- Shell (Downstream)
- DuPont (Chemical, Biochemicals)
- Lyondell Basell (Chemicals)
- Air Liquide
- Praxair

Conclusion

Today's business conditions require the analysis of many asset alternatives, in terms of location, size and scope, products, tradeoffs between CAPEX and OPEX, sustainability and more. The business owner needs to make complex and dynamic choices between business objectives, capital constraints and business opportunities when making CAPEX decisions. Lean organizations and inadequate tools limit the ability of companies to optimize their projects.

The integrated engineering workflow, with Aspen HYSYS and Aspen Capital Cost Estimator at its core, includes best practices to achieve better capital decision-making through faster, more accurate estimating and better communication between the owner and contractor.

Aspen Capital Cost Estimator uniquely enables a +/- 20% estimate with only 5-10% of the engineering work completed. This provides the owner with a powerful management tool for controlling the CAPEX of projects and for improved collaborative working relationships with contractors.

AspenTech is a leading supplier of software that optimizes process manufacturing — for energy, chemicals, engineering and construction, and other industries that manufacture and produce products from a chemical process. With integrated aspenONE® solutions, process manufacturers can implement best practices for optimizing their engineering, manufacturing, and supply chain operations. As a result, AspenTech customers are better able to increase capacity, improve margins, reduce costs, and become more energy efficient. To see how the world's leading process manufacturers rely on AspenTech to achieve their operational excellence goals, visit www.aspentech.com.

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