A stylized illustration of a person from the chest up, wearing a dark grey suit jacket, a white dress shirt, and a blue necktie. The person's hands are clasped together in front of their chest. The background is a solid light blue color.

Tailoring Your Competitive Edge – Calibrate Aspen Capital Cost Estimator™ to Fit Your Business

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As an estimator, there are several objectives to meet while juggling many balls under time constraints. Accurate estimates must be created where the level of risk is clearly defined, agility and speed must be present in order to support your company in bidding quickly and comprehensively, and finally you must encapsulate your company's unique value-add with a proprietary costing basis, project management strategies and contracting strategies. When you adopt Aspen Capital Cost Estimator™ (ACCE) to achieve efficiency, agility, speed and accuracy, you need to successfully capture your company's unique proprietary costing basis and project cost history to ensure accuracy and a competitive advantage.

This paper provides the roadmap for you to calibrate Aspen Capital Cost Estimator in a way which incorporates it into the fabric of your estimating organization, incorporates your "family jewels" of estimating and cost control history, and gives you a more accurate, efficient and powerful estimating workflow. Winning companies have found that the speed and accuracy of a bid can be used as a strategic weapon when soliciting business. The ability to develop creative product control measures by all stakeholders is required in order to achieve successful project outcomes and maximize return on investment. Owners and their contractors must be agile to take advantage of market changes and achieve industry-leading positions.

Why Adopt ACCE?

The importance of accurate and precise capital equipment estimates and subsequent bids can't be overstated. In today's marketplace of low operating margins and owner-operators demanding fix priced bids, engineering, procurement and construction (EPC) firms need a sharp pencil to make a profit. To accomplish that, economics software from AspenTech provides a unique mechanism to achieve that goal with less than 5% of the engineering design completed. There are not enough estimators and time available to achieve the required accuracy levels any other way.

Burns & McDonnell **saved clients 75% in equipment costs and 25% in capital costs**. Burns & McDonnell are able to evaluate more design alternatives effectively and transparently communicate with clients, and propose brownfield solutions that **reduce anticipated CAPEX by 15-30%** on debottlenecking projects.

The Differences Between Estimators and their Estimates

Companies need to deliver bids that are as accurate as possible with the information at hand. Ideally, with as close to zero variance as possible from the as-built capital project. A “Murphy’s Law” axiom for estimating is:

“The same work under the same conditions will be estimated differently by ten different estimators or by one estimator ten times.”

This well recognized tendency is doubled-down when those individual estimators each employ their individually customized spreadsheets. The only way to combat the undesirable variability is to codify a standard workflow through the use of a standard, transparent system; namely Aspen Capital Cost Estimator.

With this truism, estimating needs to be completed differently than the time consuming and often inaccurate use of manually entered spreadsheets that the majority of estimators use as tools. To drive estimates to zero variance, or close to it, a standardized workflow with an “engineer in a box” volumetric approach is needed to compete in today’s market. Aspen Capital Cost Estimator, based upon volumetric models, can bring this to you.

What is the concrete consequence of delivering accurate estimates? A typical process plant refurbishment can cost in the \$25m-\$30m USD range. A 2% improvement in bid accuracy equates to over \$500k USD, which is serious money. Magnify that to even just a 1% improvement in performance of a mega-project which could equal over \$1b USD in capital investment!

Drawbacks of Spreadsheets

While companies seek to engage in more bids, they encounter a number of issues that hinder their success. While businesses may have high perceived confidence using a large number of factor-based calculations built into proprietary Microsoft® Excel spreadsheets, this approach has a number of drawbacks and business risks. The sheer magnitude of time spent assembling counts of equipment and bulks and then entering them into a spreadsheet cannot be compressed. Data consistency is almost impossible to manage because of the large number of line items that are not organized in a consistent way. Change control issues as bid changes occur, and the resulting modifications, cascade from spreadsheet to spreadsheet. The inability of factor-based spreadsheets that handle estimates outside the linear zone of the factor can be the difference between a win and a loss. All of these issues add up to produce bids that are both slow to completion and inaccurate.

Calibration Sets You Free

Calibration needs to be embedded into your estimating process workflow. Aspen Capital Cost Estimator can produce Class IV estimates with modest input. However, the true worth of the tool is that it can be calibrated with local labor and equipment costs to tune the model to produce fast and accurate Class II estimates. Calibrating ACCE provides a fully integrated solution that brings improved accuracy and precision to your estimating and bidding.

Starting from the application of broad factors that align equipment, bulk commodity and labor costs and then moving to a more detailed code of account adjustments will increase accuracy as compared to the reference bid. The systematic calibration pathway will be discussed further below.

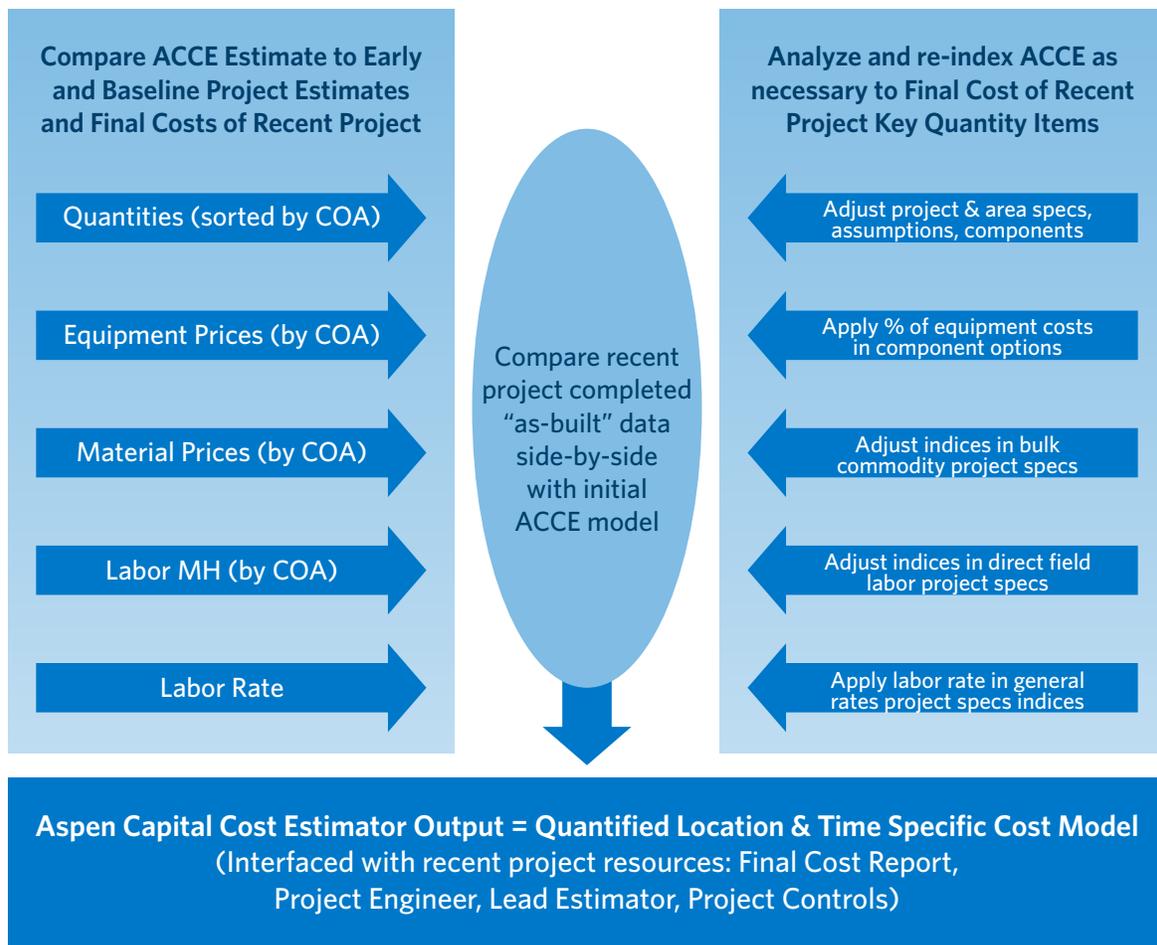


Figure 1: Calibration Steps

What is Meant by Calibration?

The default “out-of-the-box” Aspen Capital Cost Estimator, unlike conventional spreadsheet estimating software, has sophisticated cost and economic models built in. These are updated once per year by AspenTech, based on market and privately sourced material and fabrication cost data. The key point to understand is that this data is presented within the software system as “average costs”, namely costs that will apply equally well across the wide spectrum of engineering, consulting, chemical, refining and upstream oil companies who employ ACCE. Because they represent the average across all customers, they do not represent the specifics of any one customer.

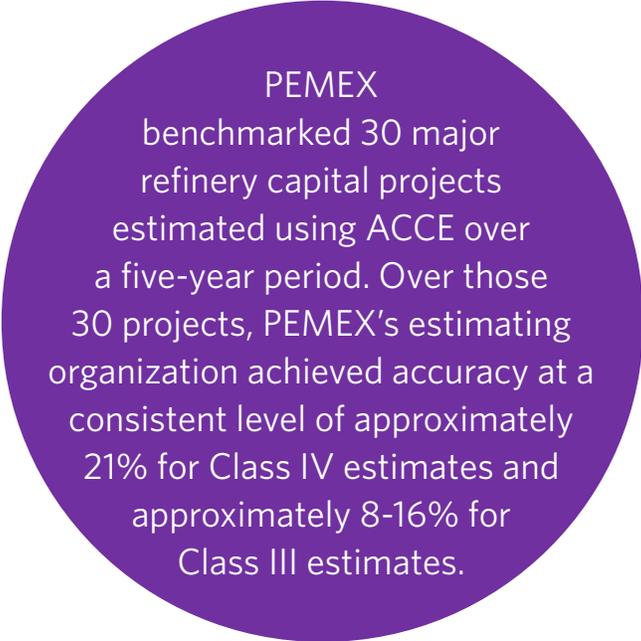
Calibration is the process of taking this average and making it specific to YOUR company, your procurement norms, your contracting strategies, and the project specifics.

The process of calibration is tuning ACCE with increasingly more company and project-specific information that replaces embedded functionality with specific equipment costs, labor rates, accurate quantities, and specific grades of piping or instrumentation. The goal of calibration is threefold:

1. Improve accuracy by guiding the system to generate:
 - a. Appropriate designs
 - b. Accurate quantities
 - c. Accurate direct field man-hours
 - d. Accurate overall labor costs
2. Reduce risk and determine the appropriate contingency for a given set of specifications
3. Customize the system and develop approaches in recognizing and dealing with “exceptions”

There are two key strategies to focus on when developing your organization’s plan to calibrate ACCE:

- **Can’t see the forest for the trees.** All equipment and labor costs are not created equal. An early mistake in calibrating ACCE is to treat all costs, either direct or indirect, as equal. Focusing on a low number, low value code of account line items consumes time and does not improve accuracy. Focusing on broad “percent adjusted” line items, like labor, saves times but doesn’t improve accuracy.
- **Scope is the basis for all decisions.** Ensuring that your scope is well captured in your code of account ensures you have the basis for a strong and accurate framework of bids.



PEMEX
benchmarked 30 major
refinery capital projects
estimated using ACCE over
a five-year period. Over those
30 projects, PEMEX’s estimating
organization achieved accuracy at a
consistent level of approximately
21% for Class IV estimates and
approximately 8-16% for
Class III estimates.

The Pathway to Calibrate ACCE

Calibration is a methodical and intuitive pathway to increase accuracy. By systematically replacing embedded volumetric data with specific referenced data tunes ACCE to local conditions and business needs. Let's review the pathway to this success:



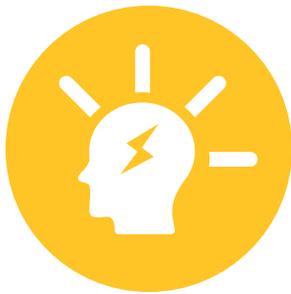
Choose it - Select your reference project for calibration

Owner-operators and EPCs have a wide variety of capital projects at any given time. To initiate calibration, one project must be used as the basis for calibration. You might choose one that has a familiar scope, known code of accounts or familiar design. Although preferable to choose a project that is completed with all the costs and line items reconciled (returned costs), you may choose a project to calibrate against using recent estimates based upon historical data, price book, recent estimates based upon 3rd party data (Richardson's, Means, etc.) or other internal standards.

The estimator's challenge is that there are no "typical" projects to choose from when looking to select a baseline project. Many projects can have a majority of equipment and components that are alike, but the devil is in the details with the items that are unique because of size, functionality or site location.

When choosing a typical reference project, make sure that it:

- Represents typical projects executed by your organization
- Contains typical component mixes
- Builds in an uncongested, on-grade area
- Has a familiar plant type and design
- Uses familiar contractor's/construction workforces



Design it – Preparation for calibration

Starting with basic equipment cost drivers, begin with your Design Basis by laying out the overarching principles that will guide the definition of your project. In doing so, there are some critical components that will have a larger effect on the design than others including vessel or equipment size, pad configuration and installation using heavy or unusual equipment.

Piping is affected by different cost drivers including fabrication method, technical components and small bore piping allowance. Civil and steel cost scope will yield more accurate estimates when detail is given to wind, seismic and soil loadings, as they can have a significant impact on equipment design and installation. Specifically, the type of concrete and pad dictated from your Design Basis influences costs.

Equipment	Piping	Civil and Steel	Instrumentation	Electrical
Design Basis	Fabrication method	Location (seismic)	Define in Design Basis	Defined in Design Basis
Size	Technical component	Wind	Affects broad range of piping and cabling	Driven by consumption
Pad	Small bore piping allowance	Soil		
Installation		Concrete type		

Table 1: Important components for calibration

Before discussing instrumentation or electrical, let's take a step back to understand how ACCE works. Aspen Capital Cost Estimator is built on volumetric models. For example, if you were to develop a cost estimate for a refinery fractionating column, you would need the following information: column diameter, tan/tan length, design pressure, design temperature, material construction, and a number of tray information as input. Volumetric modeling conceptually builds the column from sheet steel stock, calculating all related costs including rolling and bending steel, welding, fitting with piping, painting, insulating, etc. It even calculates site requirements such as a pad that is needed. ACCE, by its inherent nature, builds on volumetric models and makes them scalable.

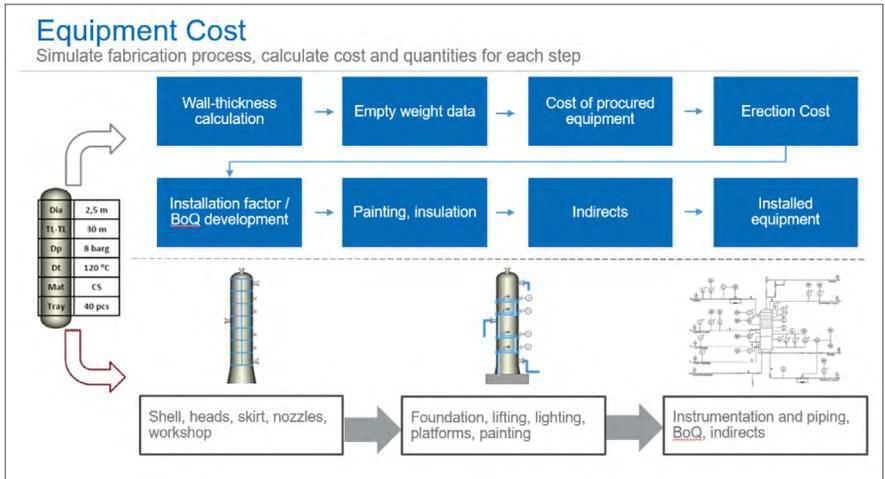


Figure 2:
Depiction of volumetric model

Based on this simple information, an initial Class IV estimate can be developed by leveraging the extensive database of costs and equipment configurations embedded in Aspen Capital Cost Estimator. Running ACCE “out-of-the-box” and comparing it to existing comparison estimates will allow you to compare methodologies and uncover basic embedded practices in the estimating process that bring increased accuracy and variability.

The instrumentation calibration includes more than just basic instrumentation. It drives the P&ID so when the instrument changes, the wiring, connections and piping that make up the instrumentation system package changes. Electrical has some of the most detailed models in ACCE based upon the consumption dictated by the equipment and the design basis specified. It is highly recommended to accurately define these systems so realistic design scope for electrical components and installation can be achieved.



List it – Develop your code of accounts

Developing a detailed code of accounts is an important step in creating reusable templates in ACCE that make ACCE a powerful tool for your business. One must consider a reusable template as “the scope plus costs”. You could think of it as COA + Labor + Materials. What makes it reusable is you can use a template as a starting point by the addition/subtraction of scope items and the refinement of labor and materials costs. ACCE develops a code of accounts for direct costs, but developing a contractor strategy will help you capture indirects and mark-ups that will need to be recorded in addition to the code of accounts.

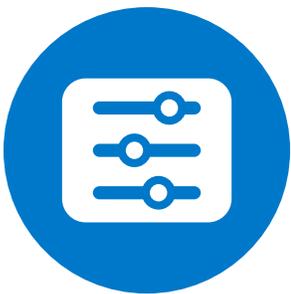
Developing a contracting strategy is important as the code of accounts does not go as deep into line item detail as direct equipment and material costs. Using an organized approach to the indirect costs of contractors will ensure you do not miss the cost of a line item when adding it to ACCE.



Compare it - Develop your first cost estimate

It's now time to compare the prepared estimate with your reference estimate. The goal is to develop an understanding of the gaps or differences that have been discovered between the historical estimate and the ACCE estimate. Here are some tips to consider:

- Compare the ACCE estimate, for each component, to the reference project and look for differences in the estimates.
- When differences arise, check that the Design Basis is the same. Is the size, functionality and structure the same?
- Look at types, ratings, materials and quantities for bulk materials.
- Make the required changes and run a second estimate to ensure the changes had the desired effect in narrowing the estimate to the reference project's cost.



Tune it - Calibrating ACCE in detail

You can take a closer look into the detailed line items of the code of accounts and tune ACCE to increase accuracy. Before looking into the details, go back to the basics and remember the two guide rules:

1. Ensure scope is correct.
2. Remember, not all costs are equal.

If there is a wide gap between the ACCE estimate and your historical reference estimate, step back and ensure your scope is correct prior to looking at individual areas or digging into details. Missing equipment, sizing or design will have a huge effect on overall accuracy.

Since not all costs are equal, first start with your material cost evaluation at a high level. Do the material costs compare to the overall reference estimate? Take a closer look into major categories including equipment and piping within materials. For an example within equipment, evaluate possible differences in storage vessels, process vessels, pumps, and heat exchangers. When you find a difference, do not mine down into individual line items, instead use a correction factor to help match this sub-category to your reference estimate of the same sub-category. A line item adjustment is certainly possible, but does not achieve significant adjustments at this early stage.

When examining construction costs, understanding the basic assumptions ACCE leverages is useful. ACCE bases its man-hours estimate on all work required to get the item from the laydown area or warehouse to an erected, set, leveled, bolted down and tested item. Further understanding of the factors that affect man-hours include:

- Scope of work
- Site-specific difficulty of performing the work
- Site-specific conditions such as special work or safety rules, congested areas, etc.
- Inherent productivity of the workforce

ConocoPhillips, a downstream organization (now Phillips66), benchmarked their estimating results over a five-year period during which they switched from using a factor-based estimating approach to using ACCE.



Check it - Expanding the calibration

The calibration is “robust” if it can run other similar type projects and come close to the benchmark results. If it can, then calibration has been effectively adjusted to the system to “model” your unique way of doing business. Expect some fine-tuning. For example, a job with more or less stainless steel than average may not be satisfactorily estimated, especially when compared to actuals since the price of stainless steel has historically fluctuated dramatically depending upon the market availability of nickel and chrome. Check with the pipe/vessel supplier for suggestions on such adjustments. You can save any of these projects to run against future version updates.

While the project estimate does need to be escalated to reflect the effect of inflation between the time base of the system and that of your project, your material and man-hour indices should not change year-to-year unless you choose to change:

- Type of projects you build
- Locations where you build or local conditions change
- Mix of items in your projects (e.g. much larger diameter pipe)
- Spec methods (e.g. “gold plate” everything)
- Mix of vendors
- Typical discounts
- Purchasing horizon or expedite requirements

Equally important, the calibrated system should be checked against the more “exceptional” jobs. This allows areas of difference to be evaluated and develops approaches to both recognize and compensate for them.



Finalize it - The last guidance

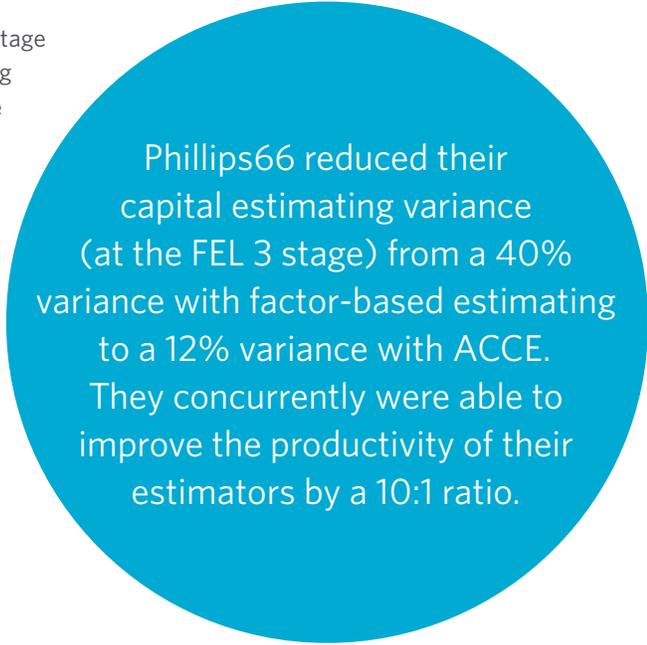
The calibration of Aspen Capital Cost Estimator is a straight forward process that will take you from a system that acts as an “engineer in a box” performing major equipment and installation calculations to one that is in tune with your specific estimating and business model. You can further fine-tune your estimates, bringing even more accuracy with these few steps:

- Get quotes on a few major cost items (quoted items are NOT indexed!).
- Ignore the large quantity of low unit cost items.
- Analyze the remaining mix of items, looking for areas of major difference; then on a major account basis, evaluate and adjust for the impact on the estimate.

The Pathway to Successful Bidding and Estimating

Owner-operators and EPCs competing with you have leveraged ACCE over a sustained period of time, and developed it to become a strategic differentiating weapon. Building estimates around factor-based calculations embedded into proprietary Microsoft Excel spreadsheets yield slow and cumbersome estimates. It's time to rethink your workflow process and build your bidding and estimating process around a workflow that provides you with better estimates in shorter time with more confidence.

What does tailoring your competitive advantage mean? It means tuning ACCE with increasing specific costing information that will change the volumetric models embedded with cost data to be specific to your business. It provides you with an estimate that is scalable and reusable through templates, shortening your estimating process and driving estimates to higher accuracy in shorter time.



Phillips66 reduced their capital estimating variance (at the FEL 3 stage) from a 40% variance with factor-based estimating to a 12% variance with ACCE. They concurrently were able to improve the productivity of their estimators by a 10:1 ratio.

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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