

# PRICE, ERP, PCE, NRE: the Alphabet of Cost Estimating

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## BIOGRAPHY

Greg Pollari is a project leader in the Project Cost Estimating group at Rockwell Collins. As an engineer and manager, he has 15 years of experience in low cost communications and navigation product design for commercial and military markets. Most recently, Mr. Pollari has been using PRICE models to support product teams in achieving low cost designs. Mr. Pollari holds a BS degree in Physics and an MS degree in Electrical and Computer Engineering.

## ABSTRACT

Rockwell Collins has been using the PRICE estimating tools for more than 10 years. The primary application has been for recurring cost estimates with some ad hoc application for non-recurring estimates. The company is transitioning to a common Enterprise Resource Planning (ERP) system and a common product development process. One of the new development process's key steps is estimating project costs. A new group has been created to formalize the use of parametric cost modeling company-wide. This Project Cost Estimating (PCE) group is charged with making sure that the PRICE tools are integrated with ERP and that a common estimating process is in place for all product developments.

In addition to the technical challenges of integrating the parametric estimating tools and methodology with the ERP system, many internal customer issues and concerns must be addressed. All this must be done while showing a cost benefit. This paper discusses how Rockwell Collins is using parametric cost estimating tools as part of the common development process tied to the ERP system and how the data is used in the decision-making process.

## HISTORY

Rockwell Collins is a leading supplier of commercial avionics and military electronics systems, as well as

service and support solutions. Rockwell Collins provides products for cockpit communications and navigation, flight control and global positioning systems for commercial, business and regional aircraft; military airborne and ground-based communications and navigation equipment; and passenger in-flight entertainment and cabin management systems.

The company has been using PRICE Systems parametric modeling tools since the mid-1980s. With proper training, good historical data, discipline, and follow-through, excellent results have been observed with both recurring and non-recurring estimates. Unfortunately, the models have only been used on an ad hoc basis.

## THE NEED FOR PCE

Some product development areas are notorious for underestimating non-recurring effort and schedule. Causes include the lack of relevant historical data, under-sizing or completely overlooking project scope, being too aggressive with risk, and mandated schedules. Project leaders need proven tools and methodologies to make informed business decisions based on what is known about the project while taking into account unknowns. At the same time, organizations must avoid dysfunctional behavior, such as, "We don't like the number – give us a new one," or "gaming the system" to achieve the desired result.

The transition of the tools from a mainframe to personal computer has made accessibility easier, but with one caution: untrained usage can lead to unpredictable results.

The Project Cost Estimating (PCE) group was created to bring consistent estimating methodologies to the entire organization and to reap the benefits of efficiency from using parametric estimating tools. Probabilistic estimating is being used to change the organization's

behavior away from the single number estimate towards range estimates with associated probabilities and risks.

## **THE OPPORTUNITY**

Changing a company's culture is not easy. Estimating techniques vary from group to group, and the existing "bottoms up" style of estimating is often considered adequate. Resistance to change can be strong. Realizing the benefits of using calibrated parametric models requires buy-in from the teams doing the estimates.

At the same time that the PCE group was being formed, the company was beginning a transition to a single Enterprise Resource Planning (ERP) system. This created the opportunity to institutionalize an estimating discipline through a common development process. By integrating cost estimating training with the ERP deployment training, the PCE group is riding along with organizational change that is already underway. The new ERP system provides a vehicle for driving the change to probabilistic estimating by providing a place for best case, most likely case, and worst case recurring and non-recurring estimates. This creates the pull for users to understand how to use probabilistic estimating methods. In one fell swoop, the PCE group can train almost everyone who is responsible for generating or reviewing estimates. PCE is riding the wave of change.

## **THE APPROACH**

The first task that the newly formed PCE group undertook was to conduct a survey of its customers – the engineering product development teams. Based on that feedback, the Project Cost Estimating service was developed. The PCE service addresses seven main areas:

1. Product team ownership
2. Parametric estimating models
3. Probabilistic estimating methods
4. Non-advocate estimate support
5. Small PCE group
6. Measurable success
7. Integration with ERP system

### **Product Team Ownership**

The product teams (led by Engineering and Program Management) want to own the estimates. They made it

very clear in the survey that they do not want to be forced to commit to estimates developed by an outside group. There's a good rationale for this. First of all, an independent estimating organization can't have adequate domain knowledge for all product areas in the company. Conversely, it's much easier to have a small group, such as PCE, with estimating and parametric model expertise train and support domain estimating experts in the product teams. PCE can then provide consistency and cross-fertilization of estimating methods and techniques and model support leaving the product teams free to focus on applying their domain knowledge. The result is ownership and commitment to the estimates. The second benefit to this approach is that it accommodates definitions that vary from product area to product area. For example, the project management task may include slightly different scope for different teams. When a product team can continue to operate with familiar definitions, ownership increases. Their historical data will be easier to use as well. Thirdly, since the teams know how to use the estimating models, they can structure their projects so that data gathered on the current project is easy to use as historical data for the next time they use the model. This will instill the discipline to maintaining historical data themselves because they see the direct benefit.

Finally, with full ownership comes the freedom to use whatever estimating approach the team wants. Even though PCE advocates parametric models, the product teams can choose whatever approach works for them, although the cost savings from parametric models should be obvious.

### **Parametric Estimating Models**

The PCE group's main focus is on use of parametric estimating models. This may not always be the sole means selected for estimating, but it should be the first choice. Parametric models like PRICE H, M, and S provide:

- Valid Cost Estimating Relationships (CERs) (avoids having to develop new ones)
- A framework for consistent historical data (the models provide a boundary for the historical data that gets collected)
- A way to leverages industry average data and Rockwell historical data
- A tool for providing estimates quickly (saves money)

- Repeatable and consistent estimates
- Probabilistic estimates (allows variation and unknowns in assumptions and inputs to be taken into account)

Once organizational calibration data is available, product development teams can quickly provide reasonable, auditable bids or perform trade studies. The use of validated CERs also changes the discussion away from, “How did you calculate your estimate?” to “How can we manage the assumptions that form the basis for the estimate?” The parametric models’ probabilistic estimates also focus discussion on the unknowns that exist at the beginning of a project. By associating probabilities with the estimates, the project team avoids the pitfall of expecting to meet a single budget number - which is next to impossible.

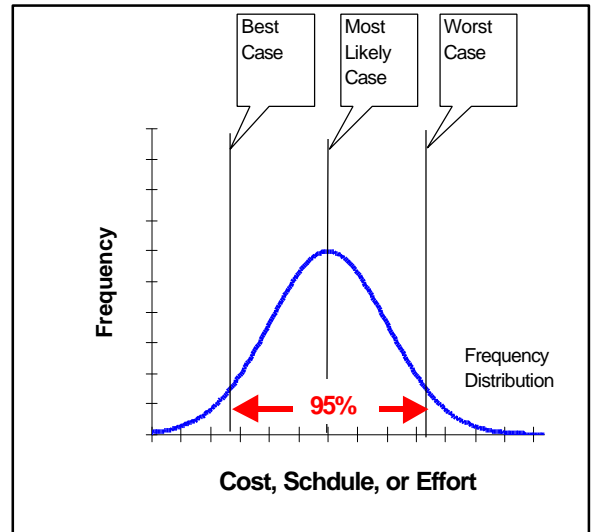
**Probabilistic Estimating Methods**

The most important concept that the PCE group advocates is probabilistic estimating. A probabilistic estimate is defined as a range of estimates and probabilities based on ranges of project characteristics. These range estimates are based on variation due to unknowns in project characteristics (such as size or difficulty) which covers 95% of the possibilities. For example, an engineer might estimate that the number of new and modified source lines of software code to be 1500. In the best case, it could be as low as 1000 and in the worst case, it could be as high as 2500. The range from 1000 to 2500 should cover 95% of the likely range in the number of modified lines of code.

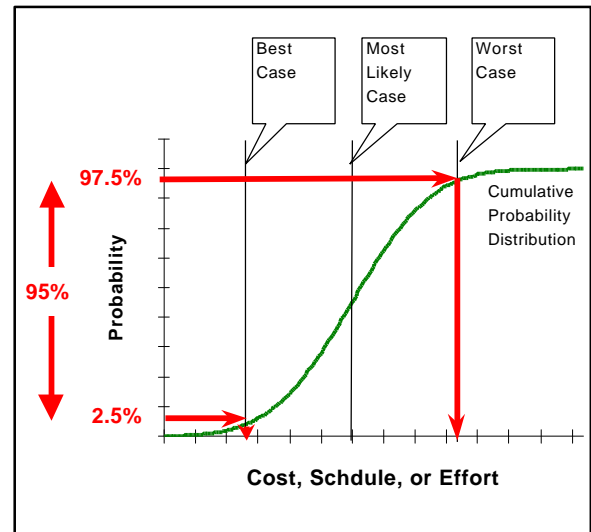
After ranges are identified for the important parameters, the resulting range in the estimate (usually derived from a Monte Carlo-type simulation) should also reflect 95% of the likely outcomes. Figure 1 shows the frequency distribution for a range estimate. Best, most likely, and worst case values are used to bound the description of the range estimate. “Best case” is defined as a 2.5% probability that the program cost will not exceed this amount (high risk); “most likely” is defined as a 50% probability program cost will not exceed this amount (risk equals opportunity); and “worst case” is defined as a 97.5% probability that program costs will not exceed this amount. It should be noted that the best and worst case estimates each have a 2.5% likelihood of occurring. The range between 2.5% and 97.5% covers the 95% of likely outcomes.

The cumulative probability for the same data is shown in Figure 2.

PCE sees the use of probabilistic estimates as essential to the business decision making process. Business decisions can be based on information about the risks and opportunities associated with any point value estimate whereas single point estimate tends to obscure the whole picture. The result is enhanced communication between business decision makers and project performers (the estimators).



**Figure 1 - Frequency Distribution**



**Figure 2 – Cumulative Probability**

## **Non-Advocate Estimate Support**

Programs often ask themselves, “Are our bids competitive? Are they too aggressive? Should we try to enter a new market?” Even though program managers may feel very confident in their ability to perform to a bid, they also want to know how it compares to what it should cost to perform the effort.

The product teams use the industry average data (model’s estimate without organizational calibration, i.e. default globals) to generate a “should cost” estimate. This is an attempt to assess what the competition could do, on average. It’s used as one data point to evaluate whether a bid is better, worse, or the same as industry. But that’s not enough. Answers are needed for questions like, “If we’re better, why? If we’re higher than industry average, can we be more aggressive? Do we need to invest? Can we afford to invest?” The industry average cost can shed some light on these questions.

Equally important is the product team’s use of the parametric model to provide the industry average data. This maintains their ownership of the estimate (versus an independent group providing the estimate). PCE’s role is to ensure that the estimating methodology and the use of the parametric model are objectively applied.

## **Small PCE Group**

Instead of a large, independent cost estimating group, the PCE team is a small group focused on internal customers. Since the estimating expertise resides with the product teams, the primary tasks of the PCE group are:

- Support parametric model users
- Provide consistent estimating methodologies across the company
- Track industry trends and changes in parametric estimating (so product teams don’t have to)
- Minimize overhead cost impact
- Review non-advocate estimating methodology and model usage

This small group approach will enable PCE members to focus on model usage, common methodologies and industry best practices and let the domain experts develop estimates with the PCE group’s support. The PCE group will provide assistance with the models regardless of the users level of expertise. Ideally, every product area has

their own estimating expert fully trained on how to use the estimating models.

Since the product teams create their own estimates, they provide their own funding. The PCE group’s effort is funded by the project. The result is negligible impact to overhead costs.

PCE’s independence allows it to objectively review a product team’s non-advocate estimates, which lends credibility to this approach using estimates based on industry average data.

## **Measurable Success**

The PCE team will measure its success with the following two metrics:

- Reduce bid and estimating costs while maintaining or improving quality
- Show that actual project performance tracks estimates using earned value cost performance index and schedule performance index

Baseline performance data must be established before threshold values for these measures can be determined. PCE is in the process of establishing this baseline.

## **Integration with ERP System**

The estimate data must be visible at all levels of the organization. Our ERP system provides the means to capture and report the estimates. The assumptions and data behind the estimates are also captured in the project repository so that the estimate can be recreated at any time in the future. This will provide the estimate history to measure PCE’s success.

## **SUCSESSES AND LESSONS LEARNED**

So far, the PCE group has had excellent results in the application of the parametric models. In looking at historical data, the models are very good at creating estimates that track actual program performance. With this historical data as a basis, projects can use the models in a forward mode and feel confident about their estimates.

One lesson learned from a previous attempt to create a cost estimating group is not to try to create a common historical database for the entire company. This doesn’t mean that historical data would not be available throughout the company, but rather that, due to unique

definitions in some product development areas, the historical data would be maintained locally by the product teams. The earlier attempt to create the company-wide database did not succeed.

## **SUMMARY**

With pressure to “Do less and accomplish more” in order to streamline our business practices, the Project Cost Estimating (PCE) group at Rockwell Collins has developed an approach to estimating that minimizes overhead cost and puts the estimating ownership in the hands of the product teams. The PCE group advocates and supports the use of parametric estimating models as efficient tools for providing a consistent estimating approach. These models also provide probabilistic estimates that are seen as key to making good business decisions.

The culture at Rockwell Collins is changing for the better with a new ERP system, and PCE is riding on the opportunity to enhance our estimating capabilities.

## **ACKNOWLEDGMENTS**

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