CRITICAL THINKING.
SOLUTIONS DELIVERED.

Simplifying the Cost Estimate

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Jeremy Goucher

Agenda

– Background

– Challenges of Detailed CES

– Data, CES, CV, and Mean

– Starting High

– Wrap Up

Background

- Plans of Actions and Milestones (POAMs) are six months or longer for ACAT I cost estimates
- Much of this time is spent researching and analyzing data down to five or more levels in the work breakdown structure (WBS) or Cost Element Structure (CES)
- At the lowest levels of the WBS, it can be difficult to find comparable data
- Cost often has to be normalized across programs to ensure the analysis is accurate
- Complexity factors may be applied on a subjective basis.

Challenges of Detailed CES

Complicated Cost Estimates Are…

- Time Consuming
- Prone to Mistakes
- Difficult to Make Quality Assurances (QAs)
- Difficult to Brief
- Comprised of Lengthy Assumptions

- BAD!!!

Exponentially Expanding CES

- MIL-STD-881D CES for Aircraft Systems (Appendix A) includes 16 elements at Level II
- Level III of the same includes an additional 60 elements
  - That's 60 additional calculations for one movement down the CES
  - More if intermediate calculations are needed
- Two ways of developing a cost estimate for these elements
  - Perform data analysis as a function of a technical perameter
  - Perform data analysis as a ratio to a major element, such as total PMP
  - Either way it's a large workload

Cost Estimating Goals

- Precision, as measured by the coefficient of variation (cv) of the estimate
- Accuracy, as measured by the mean of the estimate compared to actuals

- Precision is only as good as it is defensible
  - Analyst, “Our CV is only 5%!! What a great estimate!”
  - Cost Lead, “We haven’t reached Milestone A yet. Are you sure you’ve correctly assessed your variance?”
- Accuracy is very difficult to assess due to
  - Mid-stream programmatic changes
  - Time between estimate completion and knowledge of actuals

Data, CES, CV, and Mean

The Role of Data

- CV and Mean of an estimate are a reflection of the data used and the data not used
- General system level data for similar products can provide an enormous amount of lifecycle cost information
- Detailed subsystem, component, and parts level data, when properly analyzed, can provide insights into specific phases of the lifecycle and the cost drivers of a system
- Poorly analyzed data will likely result in a misleading estimate in terms of both CV and Mean

Data and the CES

- Data discovery must be consistent with the level of indenture of the Cost Element Structure (CES)
- An estimate developed at Level III of the CES may require only general system data
  - Easy to analyze, fewer pieces of data, fewer opportunities for mistakes, fewer “temptations”
- An estimate developed at Level VI of the CES will require very detailed data…
  - More pieces of data, but often fewer observations
  - More calculations, more opportunities for mistakes

Availability of Data?

- A high level estimate may have a single total cost for materials and integration, assembly, test and checkout (IATCO)
  - Nearly all ACAT designated DoD systems have some high level cost data
- A low level detailed estimate will require individual calculations for materials, as well as each piece of the IATCO equation
  - Many ACAT designated DoD systems do not have reporting requirements at low levels of the WBS
- More pieces of data to analyze, but likely fewer observations for each equation

Impact to CV and Mean

- Suppose all identified systems for an estimate have the same level of detailed data
  - Analysis of general data would likely result in the same CV and Mean as analysis of the detailed data build up
- Suppose of the identified systems, only 60% of the observations contain detailed data
  - Further suppose each system with lower level data includes a different mix of available data
    - Further suppose again of those with the right data availability, certain subcomponents are deemed different and dropped from the analysis

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Data Cleaning & Outliers

- Observations are typically dropped due to:
  - Out of family components (gas versus electric power)
  - Shocks which are not likely or possible to repeat (extreme weather incident)
- Assessment of outliers is a case-by-case practice
- Often overlooked is the case where one event is not likely to repeat, but an alternative event is a new risk
  - Weather event didn’t happen again, but an unexpected political event temporarily halted production
  - One off risks are by there very nature unpredictable

What about Engineering Inputs

- Engineers are often pressured to make assessments of physical characteristics before enough information is known to make accurate assessments
  – Ex: SLOC, Weight, Volume
- These metrics become the foundation of the estimate, but result in misleading and unjustified confidence

So what to do now???

Starting High

Why detailed estimates are desirable

- Defensible argument – more knowledge of a system demonstrated via a detailed CES results in a better estimate

False

- Control argument – an estimator can isolate and control the data feeding the estimate

Misleading

- Accuracy argument – a detailed estimate must be more accurate because it excludes irrelevant data that might exist at higher levels

Subjective

Truths About Detailed Estimates

- Better is defined by objectivity, not level of detail
- Control is defined by lack of external influence, not the ability to unilaterally or multi-laterally manipulate data
- Accuracy is measured by the mean as compared to actuals, which won’t be determined for years

The Right Level of Detail

- Estimates earlier in the lifecycle should have less detail
  - Less technical detail is known, more subjective information
  - More opportunity for shocks and risks translate to more inclusion in the data set
- Assess the CV
  - When analyzing the lower level data, does the CV of the underlying data change?
  - Is relevant information being excluded at the lower level?
- Considering assessing how many shocks in addition to types of shocks
  - A significant number of observations experienced unique shocks indicating a shock to the program is likely even if unidentifiable

Start High

- Identify the universe
  - Ships, aircraft, satellites, etc
  - Include all technically relevant systems
  - Assess system level cost and descriptive statistics
- Drop down one level
  - Did any observations go away due to lack of data?
  - Are any systems identified as out of family?
  - What is the impact to descriptive statistics?
  - How many potential outliers and/or shocks are identified?
- If the answers are in the negative, then why continue into the darkness?
- If the answers are in the positive, proceed cautiously to lower levels

Does the phase of the lifecycle matter?

- Early phase estimates are filled with subjective data; keep estimates at high level in order to incorporate as much historic information as possible
- Late phase estimates (post Milestone C) may have detailed data and may be a candidate for an extrapolation from actuals, but...
  - Is the additional effort necessary?
  - Are any subsystems changing?
  - Is there a major process change coming?

To some extent, yes, but not always

When to be detailed

- Engineering Build Up
- AoA
- Cost Savings Excursions

Wrap Up

Where to go from here

- Research is needed to focus on the cost of technology increases associated with performance parameters
- Research is needed to understand macro trends by family of systems over years
- Change management may be needed to implement a “Start High, Add Detail” process

Summary

- Complicated estimates at low levels of the WBS are
  - Time consuming
  - Prone to errors
  - Difficult to produce
- Detailed estimates do not necessarily increase estimate quality
- Descriptive statistics are the guiding key
- External influence should be minimized
- Start high and work down to lower levels with caution

Additional Work

- Research the number of GAO overrun articles
- Research stability of mean and variance