CER Issues And Solutions

12 December 2018

International Cost Estimating and Analysis (ICEAA) Workshop

Leidos Campus Point, La Jolla, California

Kurt Brunner, CCEA-P
Parametric Cost Estimator / CI PTW

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- Views expressed are strictly and solely those of the author!

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Objective

- Become aware of probable problems with the use of Cost Estimating Relationships (CERs) and potential remedies

$$y = \beta_0 + \beta_1 x$$

y = estimated cost
β_0 = y-intercept (vertical calibration)
β_1 = coefficient of x (constant change in cost per constant in x)
x = independent variable (cost driver)

Background

- The use of CERs is a widely accepted method of creating estimates
- There are some issues regarding CER development and their application in the estimate which need to be addressed
  - They should not be accepted blindly
  - Some concerns are interrelated and not mutually exclusive
- Being cognizant of some common shortcomings and being familiar with CER creation and usage may mitigate these shortcomings – there are ways to make the appropriate adjustments

Issues And Solutions

- Issue: Normalization (To constant year dollars)
  - The actual impacts of inflation or escalation that has occurred is not really known
  - Future escalation is also a matter of conjecture
  - Arbitrary factors without solid substantiation are often applied in CER development
  - “Blanket” overarching factors are frequently used
  - Future inflation in estimates is not always uniform with the de-escalation used in determining T1

- Solution(s):
  - Consider that inflation is an unknown and treat it as an uncertainty in creating CERs and in cost modeling
  - Use escalation and de-escalation factors derived from programs that are as similar as possible (BLS [Bureau of Labor Statistics], CPI [Consumer Price Index], etc.) and break out by labor types and material constituents
  - Apply future escalation consistently with the method used in developing the CER

Issues And Solutions (Continued)

- Issue: Improvement (or learning) Curve Applications
  - Improvement Curves are utilized in CER development and application
  - Slopes and curve type (Unit, Cumulative) are assumed and/or are averages
  - Are often arbitrary and not necessarily based on data in their derivation
  - The slope and curve type may not be consistently applied with the methodology used in creating T1s and the CER expression
- Solution(s):
  - Consider that the Improvement Curve is an unknown and treat it as an uncertainty in creating CERs and in cost modeling
  - Use slopes and curve types derived from actual program history or from programs that are as similar as possible
  - Project Improvement at the lowest level possible or practical
  - Apply future improvement consistent with the slope and curve type employed in developing the CER

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Issues And Solutions (Continued)

- Issue: History Used
  - May be incomplete
  - Not all programs are included - Programs that are cancelled, that have aberrations, or are incomplete aren't used
    - A complete picture of the past and present is not presented
  - "Outliers" are excluded
    - 'Unusual' events have a likelihood of reoccurring
  - Estimates To Complete (ETCs) often don't include the "tail-up" impact
    - Problems are left until the end of the project to resolve
- Solution(s):
  - Include all possible history and incomplete program projections in creating CERs and in cost modeling
  - Don't dismiss outliers
  - Project the upswing in costs as the project nears completion
  - The uncertainty reflected in the CER expression should accommodate a complete chronicle of past occurrences
    - In this way "Known" and "Unknown" Unknowns are included

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Issues And Solutions (Continued)

- Issue: Lack of Trend Projections
  - CERs tend to address only what has happened in the past and not what will occur in the future
  - Old experience is used as a baseline without adjusting for the future (Moore's Law or the opposite)
  - The present and beyond is frequently not projected
  - Changes in effort (cost or labor) through time as technology evolves and economics change is not considered
  - We extend what has previously happened and not what may occur
- Solution(s)
  - Employ time trend lines of effort changes and project it to the program being estimated Period of Performance (PoP)
  - Technology changes impacting time, materiel, and cost trends with associated CER growth or reduction can also be determined by:
    - Exploring product line experience through time
    - Developing trend profiles which will project or modify CER(s) for the time in the future when the activity will occur
    - Determine changes to methods and resultant cost impact
    - Apply the possible outcome as an unknown

Issues And Solutions (Continued)

- Issue: Technical Parameter Accuracy
  - Objective items such as historical weights, software lines of code, Bills of Material, reuse factors, power, and the like used in CER development may not be accurate
    - Often derived from estimates or proposals rather than actual data
  - Subjective factors (team make-up, TRL levels, etc.) are open to interpretation and optimism
  - Schedule realism
  - Task description inconsistencies
- Solution(s)
  - Use real measurements
  - Solicit impartial and unbiased opinions from a variety of sources
  - Define tasks carefully
  - Employ uncertainty

Issues And Solutions (Continued)

- Issue: Accounting of Quantities
  - Quantities don't always reflect total experience or may be optimistic
    - All past lots and those currently in production
    - Partial completions
    - Concurrent Production
    - Commonality with other products
    - Spares
    - Interim production between now and the planned item
- Solution(s):
  - Be thorough and attentive in accounting for the items above in establishing CERs when normalizing for quantity
  - Include any such planned activities when placing the program being estimated on an improvement curve
  - Incorporate uncertainty when quantities are unknown
  - Account for partial quantities, commonality, and spares through the use of equivalent units (i.e., If 10 spares each weighing 1/10 of a complete unit have been manufactured, consider them to be equivalent to a unit of production) in CERs and estimates

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Issues And Solutions (Continued)

- Issue: Other Considerations
  - Many CERS are lognormal with definite end points which may be outside the parameters of the estimated task
  - Descriptors often are inconsistent - Not all items of a certain nomenclature are the same with regards to technology and cost
  - Out of scope changes are not defined or incorporated in the CER
  - Is it more appropriate to work at the system level or a lower level?
  - Etc.
- Solutions:
  - Whenever possible incorporate CERs with ranges encompassing the quantity of the project being estimated
  - Each element needs to be approached and defined meticulously
  - Estimate at the most appropriate Work Breakdown Structure (WBS) level
  - Accommodate any known scope changes
  - Incorporate uncertainties both in developing and applying CERs

Summary and Conclusions

- These are a few common pitfalls with CERs
- Developing suitable CERs and applying them properly is tough
- There are always constraints in creating CERs and estimating in terms of time and information ("Better can be the enemy of good enough")
- Best practices:
  - Make allowances for the issues mentioned
  - Utilize due diligence to the maximum extent practical
  - Understand the CER and its derivation
    - May be difficult to impossible with "Black Box" models and pre-packaged CERs
  - Incorporate uncertainty in the CER and Modeling whenever there are unknowns
  - Calibrate and Validate estimates CERs to ensure credibility
  - Understand and analyze the program being estimated
  - Don't take anything at face value – examine critically
- Use of CERs is still the best and usually most the accurate technique available

Questions and Comments

Kurt Brunner

Parametric Cost Estimator

Senior Principal Competitive Intelligence Positioning to Win Analyst

Leidos

3934 Desert Heights Drive

Twentynine Palms, CA

kurt.r.brunner@leidos.com

(310) 524-3151

This briefing was presented in a substantially different format at the ICEAA Workshop at Bristol in the United Kingdom, October 2016

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