



The Legacy of Parametric Estimating (CV01)

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Abstract/Outline

- Early History
- Economics of Cathedral Building
- Maturing of Parametrics Culture
 - Evolution of Professional Societies
 - Parametric Achievements by Decade
- Parametric Cost Estimating Initiative (PCEI)
- Now What?





Hank Apgar, & Dave Mizer presenting Parametrician Award to Keith Burbridge

A Touch of History

Keith Burbridge (1984)

- Leonardo da Vinci (1452-1519)
 - Developed sales-price CER for Italian cargo ships based on size and capacity.
 - Genoa operated assembly line ship yards for planking, decking, fittings, masts & rigging.
- Isambard Brunel (1806-1859)
 - Developed wider railroad track & new rolling stock
 - Developed CERs considering track foot print, car weights, traction power per fuel use.
 - Proved advantage of GWR using cost-benefit analysis.
- Cyrus Field (1819-1892)
 - Adapted Brunel's railroad CERs for laying submarine telecommunications cable.
 - Leased Brunel's paddle-wheel steamship Great Eastern after two government ship failures.
 - Completed job under schedule with no failures at predicted CER estimate.
- Thomas Bayes(1702-1761)
 - Founder of Bayesian School of Statistics at Royal Academy
 - Develop treatise for developing mathematical solution for predicting 'crafting cost' based on known physical and functional variables.

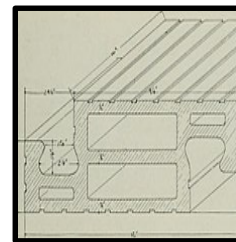


Great Western Railway (GWR)

Economics of Cathedral Building

Cost Drivers (Middle Ages: 1100-1250)

- Labor – mostly unskilled
- Material - especially location
- Design - every cathedral a “new design”
- Management – professional builders



*Standard Medieval
Cost Metric*

The standard medieval cost metric

- 7,448 units in Chartres Cathedral
- \$81K = 1 Livre [French currency] in 2018 dollars

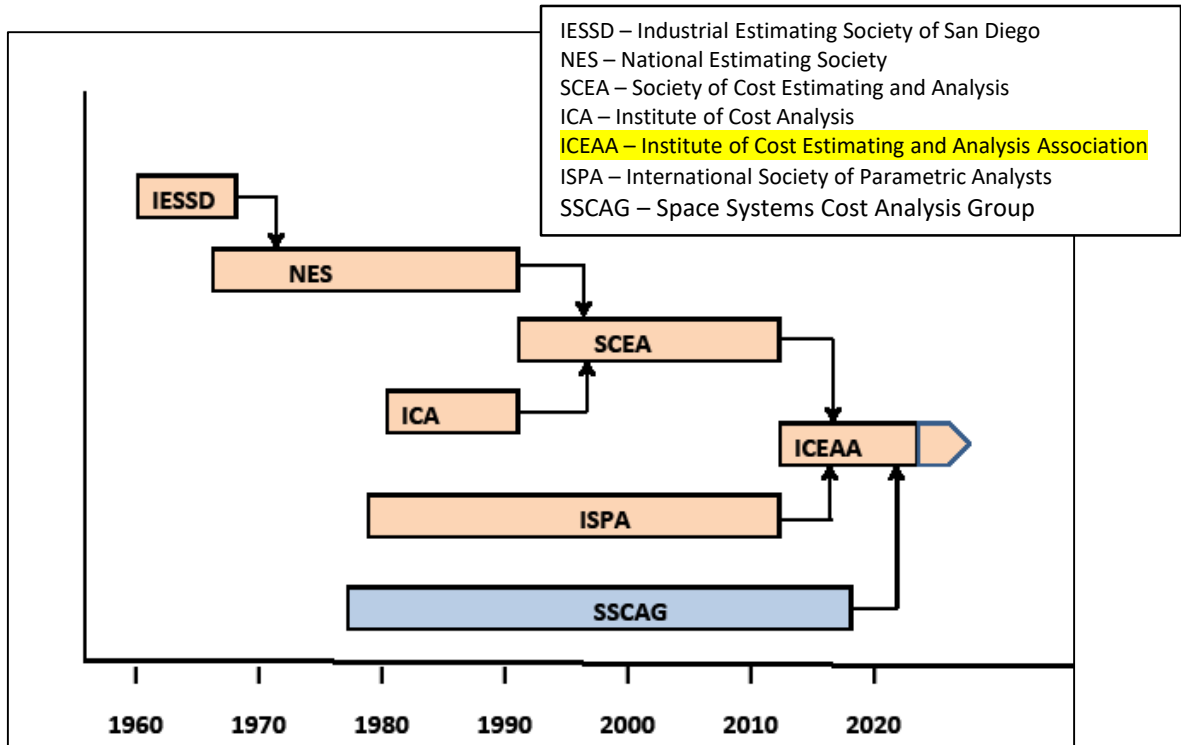


Chartres Cathedral

Estimate and cross-check

- Chartres Cathedral (initiated 1145); mismatched spires: **\$607M**
- Washington Cathedral (initiated 1907): **\$665M**

Evolution of Professional Cost Estimating Societies by Year



Evolution of Parametric Achievements

| Decade | Emphasis | Innovations | Artifacts |
|---|--|---|--|
| 1930s-1960s Statistical Estimating | Statistical cost estimating. | RAND Cost Analysis Dept.; industrial engineers. | Learning curve equations, aircraft production CERs, deductive models. |
| 1970s: Emphasis on Parametrics | Cross-checks on engineering estimates; introduction of commercial models; support decision makers. | Mainframe models; 300 baud timeshare terminals; TI-59 calculators. | Inductive models; PRICE model; DTC; CAIV. |
| 1980s: Golden Age | Parametrics for government proposals; large databases; software CERs; ISPA chapters; uncertainty. | 2400 baud PCs; MS degrees in Cost Analysis; model comparison studies. | SEER models; COCOMO model; expert system models; special purpose models. |
| 1990s: Applications | PCEI Reinvention Laboratory; independent cost estimate; business case analysis. | Everybody needs a tool; Europe joins initiatives; cost forecasting. | Parametric Cost Estimating Handbook; government cost analysis agencies. |
| 2000s: Quality | Affordability; credibility; Monte Carlo risk; software sizing (cost drivers). | DoD guidance; | Estimating handbooks; data books; CARDS; quality metrics |
| 2010s: Information | Cloud computing; focus on data rather than models. | Mathematicians; scientists; risk analysis. | Wait and see. |

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Statistical Estimating: 1930s – 1960s

- During WWII, AAF developed 'dollars per pound' statistics.
- Post WWII, USAF adopted operations research scenarios to analyze economics for producing jet aircraft, missiles, rockets.
- RAND Corp studies WBS, recurring vs non-recurring cost elements, life cycle cost drivers, and cost considerations in systems analysis.

ISPA Frascati Conference 2004

Emphasis on Parametrics: 1970s

- Early parametricians were engineers and program managers; parametric estimates used for design and feasibility studies, statistics-based estimate cross-checks; ***not for proposal estimates.***
- Frank Freiman develops first commercial (general purpose) parametric cost estimating model - PRICE H (1973); initially licensed to USAF and NASA.
- 300 parametricians from 8 nations meet in Wash DC (1979) to consider feasibility for creating professional society devoted to tools, applications, and acceptance for parametric estimating – *International Society of Parametric Estimators (ISPA)*

ISPA Pres. Bryant Barnes honors Frank Freiman as Honorary ISPA Director for his early support; later became namesake for ICEAA Lifetime Achievement Award (1979).



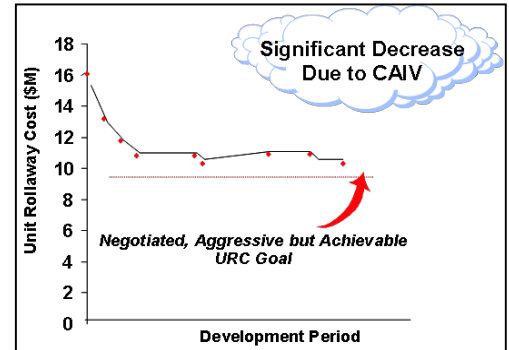
Our Golden Age - The 1980s

- Parametrics Journal (1981)
- UK Design for Through Life Costs (DTLC)
- New models (SEER, COCOMO, SoftCost, SPQR, Sage, SLiM, ECOM)
- ISPA chapters in Germany, France, and UK
- Introduction of Monte Carlo techniques to assess cost risk
- International Conferences and Workshops



Applications: the 1990s

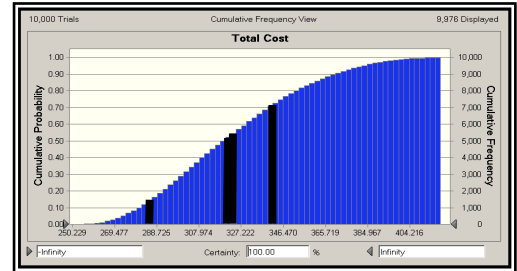
- DCAA did not accept parametrics as basis for DoD proposals unless can meet Federal Acquisition Regulations (FAR) accounting standards (1991):
 1. Logical relationships,
 2. Verifiable data,
 3. Significant statistical relationships,
 4. Reasonably accurate predictions, and
 5. Proper systems monitoring.
- DoD launched “Cost as An Independent Variable (CAIV)” in 1995 to replace Design-to-Cost (DTC) (1981)
 - Considers risk, life cycle, realistic but aggressive goals, user involvement
 - Affordability studies on flagship programs
- OSD releases Parametric Estimating Policy (1999) !!!
 - Endorses parametric methods for DoD proposal estimates
 - Achieves major ISPA goal! Parametrics now accepted everywhere.



Quality Estimates: 2000s

Journal initiates multi-year series of invited articles on “Quality Estimates”

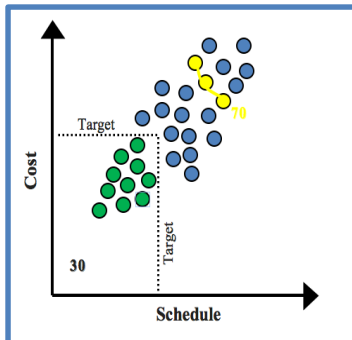
- Rich Hartley (Chief, AFCAIG):
 - Lack of transparency
 - Untraceable auditable data
 - Unrealistic risk analysis
 - Failure to integrate schedule
- Joe Hamaker (Dir, NASA Cost Div):
 - Independent estimates by non-advocates
 - Top-level sanity checks
 - Management culture that appreciates/demands quality estimates
- Richard Janda (VP, Lockheed):
 - Objective and relevant data
 - Logical process
- Stephen Bagby (Dir, Army CEAC):
 - Does budget reflect probable cost?
- Herve Joumier (Head, ESA Cost Div):
 - Ensure estimate reflects the world around you.



Demonstrating realistic risk analysis

Information Age: 2010s

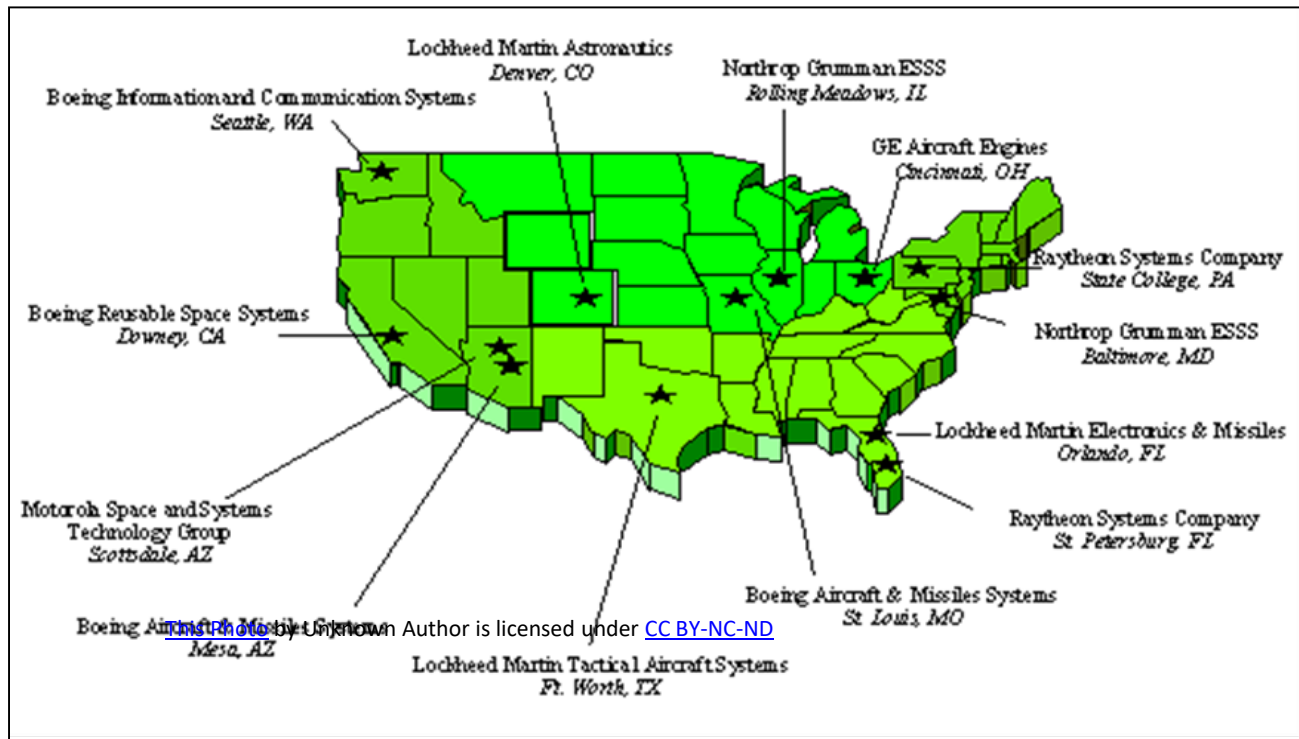
- Professional societies lauded for providing forum for knowledge and information sharing.
- Cloud likely repository for larger cost databases.
- Future models likely to be data-centric rather than CER-centric.
- NASA Cost Analysis Data Requirement (CADRe) shows trend.



- Emphasis on cost credibility.

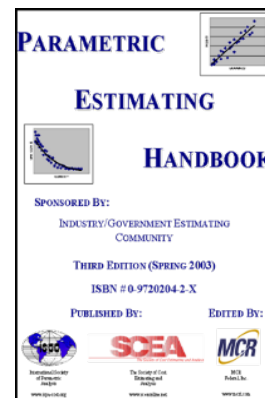
Risk assessment broadened to include schedule as well as cost risk

The Parametric Cost Estimating Initiative (PCEI) (1994)



PCEI Objectives

- Identify opportunities for using parametric techniques.
- Test parametric techniques on previous DoD/NASA proposals.
- Recommend parametric-friendly word changes for the Federal Acquisition Regulations (FAR).
- Publish PCEI Newsletter to share best practices and lessons learned plus case studies.
- Recommend parametric-friendly RFP “Instructions to Offerers”.
- Publish a Parametric Estimating Handbook.



Now What?

- Less need now for traditional approach to develop custom parametric model; options include tailored general-purpose parametric models.
- Less reliance on multiple specialized estimating groups within the same organization, i.e., supporting trade studies, bid decisions, cross-checks, cost targeting, and proposal estimates.
- Less distinction between estimating methods (parametric, detailed, analogy, Delphi, etc.). Skilled estimator incorporate all.
- Risk and uncertainty are common elements of the parametric estimate.
- Parametric databases have become the corporate memory.