

# estimate

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## *Dr. Strangelove Or: How I Learned To Stop Worrying and Love Parametrics*

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The title of this talk is an adaptation of the name of the 1964 Stanley Kubrick film "Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb"

# Executive Summary

The use of detailed engineering build up as an approach for estimating cost should have died out years ago

- The parametric approach should be the favored approach to estimating cost
- So if you think things aren't so simple or if you disagree, prepare your weapons now



# Cost Estimating Approaches (from 40,000 feet)

- Your lexicon may differ but I think of ...
  - **“Detailed engineering build up estimating”**
    - A buildup of labor hours translated to cost
    - Uses a detailed BOM
    - Adds in the cost of material, purchased parts, subcontracts etc.
  - **“Parametric estimating”**
    - Statistical cost estimating relationships which translate performance specifications, functions, characteristics, etc. into cost
- Other approaches are differentiated (reference NASA Cost Estimating Handbook” below)
  - I think of analogy estimating as a member of the parametric family

Table 1-3. Cost Estimating Methodology Selection Chart

|                      | Pre-Phase A | Phase A | Phase B | Phase C/D | Phase E |
|----------------------|-------------|---------|---------|-----------|---------|
| Parametric           | ●           | ●       | ◐       | ◐         | ○       |
| Analogy              | ●           | ◐       | ◐       | ◐         | ○       |
| Engineering Build Up | ◐           | ◐       | ●       | ●         | ●       |

Legend: ● Primary    ◐ Applicable    ○ Not Applicable

# Maybe All Cost Estimating is Parametric?

- About 30 years ago, a wise cost estimator\* once suggested to me that “all cost estimating is parametric”
  - By which he meant that even an estimate of hours from the shop foreman is based on history and is being generated with some kind of CER even if it all being done in the foreman’s head

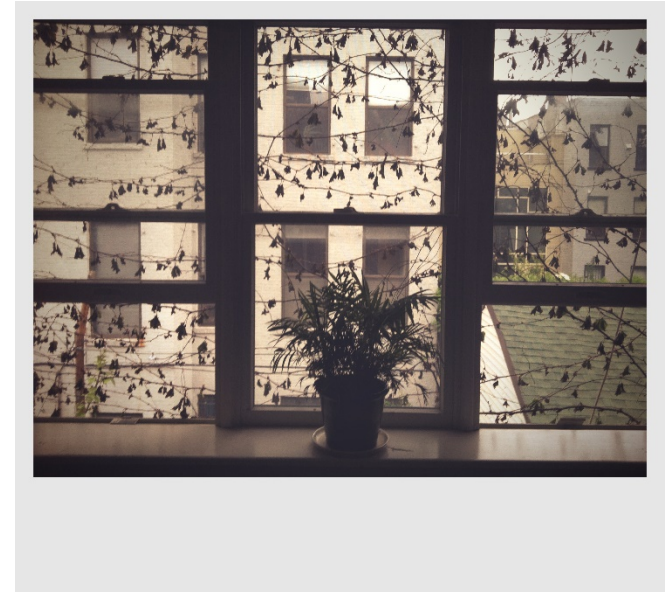


\* Rod Stewart, cost analyst and prolific author of cost analysis books through the 1970s and 80s



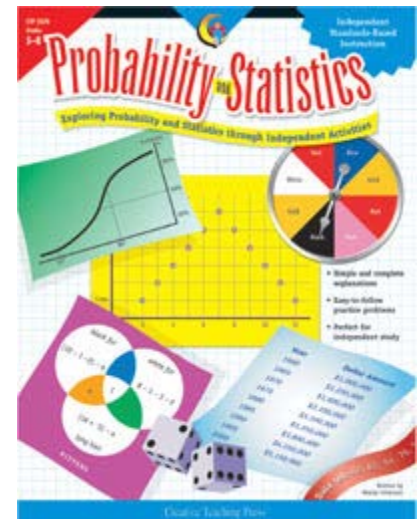
# My Introduction to Parametrics (2 of 3)

- Over the first few years in the Engineering Cost Group I exclusively used parametrics
  - Typically on Pre-Phase A, Phase A and Phase B studies
  - 90% of which died on the vine
- Every few years we would shepherd one of these studies into a “new start”
- Sometimes I was matrixed into the new Project Office to continue the early Phase C/D cost work
  - Continued trade studies
  - Integrating contractors estimates
  - Building/maintaining the overall project life cycle cost estimate



# My Introduction to Parametrics (3 of 3)

- In these endeavors I learned another curious thing about NASA cost analysis....
  - Only detailed engineering build up estimates were accepted
  - Parametric cost estimating was “black magic”
  - This belief was deeply held and permeated all of NASA
  - And still does to this day
- Despite the fact that
  - NASA is heavy with scientists and engineers
  - They all took a number of courses in probability and statistics
  - They accept the use of probability distributions in weather forecasting, physics, manufacturing, quality control, medicine
- But they often hate the use of statistics in cost estimating!



# So A Few Questions...

1. What is the most accurate/precise way to estimate cost?
2. What is the most efficient way to estimate cost?
3. What is the most effective way to perform trade studies involving cost?
4. What method is most economical and JIT?
5. What is the clearest cost estimating approach (as in explainable, understandable, repeatable)
6. What method applies across the project life cycle?
7. What method is most immune to “I forgot”, optimism bias and able to work with incomplete data?
8. What method is more immune to nefarious gaming?
9. What method is most amenable to establishing cost confidence (as in “the opposite of cost risk” or “cost uncertainty”)
10. What method is more amenable to computers and the internet collaboration?

# And The Answer Is.... (1 of 3)

- In this case one answer serves all questions...
- Parametric cost analysis, in my view, should vastly be the preferred method



## And The Answer Is.... (2 of 3)

- So Hamaker, let me get this straight....
- You seem to be saying...
  - Parametric cost analysis is better than the detailed engineering buildup method...
    - For this we pity you but we won't throw our shoes
  - But we also get the vibe that you hold the preposterous idea that parametrics should crowd out detailed engineering build up estimating
    - Now you have gone too far!



# And The Answer Is.... (3 of 3)

- Don't worry....
  - I will spare you the boredom of listening to me defend my position that parametrics "wins" on all 10 questions on the earlier chart
- Instead I will simply address some of the salient characteristics of the parametric approach which should do the trick...
  - Unless you are in NASA management in which case nothing can convince you



# More Details, Less Accuracy

- Reflecting on historical data in our databases....
  - What has more accuracy, fewer errors?
    1. The total cost of historical project X?
    2. The cost of historical project X at the next lower level of the WBS
    3. The cost of historical project X at even lower elements
- To qualify for a NASA management position, your answer should be 3
- However, I will tell you that about the only thing we know for sure is the total cost of Project X
- To the extent we go lower than this, the data is less and less accurate
  - As we go further into the details we are subject to the Village Watchman syndrome where the Village Watchman “wrote down what he damn well pleased”
- If you accept this is true for historical projects in our databases, it has to be questioned why we want to dive for the details?
- Detail estimates only provide the illusion of accuracy!

# Soothsaying

- To me, detailed engineering build up is based on little than soothsayers telling you your fortune
  - The method is inefficient, clumsy and slow
  - It is famously vulnerable to enumeration problems and gaming
  - To put a probabilistic range on the output (evidently to me) requires a few thousand iterations of the detailed engineering build up estimate



# A Problem With High Level Estimating

- Another wise cost estimator\* once told me....
  - “You should estimate cost at the level at which the technical and business decisions are being made...”
- A chink in my armor here today?
  - Lower level detail may be required
- Fine
  - Let that be parametric too
- Why would you believe that mere detail requires a return to the consultation of soothsayers?



\* Darryl Webb at Aerospace

# Is Parametric Cost Estimating Perfect?

- Some common problems/issues
  - Parametrics generally deals with (requires) more data than detailed engineering estimating build up estimating
    - Sometimes that data is not readily available
  - Even when flush with data, the data is almost always contaminated with differences
    - Requiring a lot of (controversial?) normalization
  - Different regression methods yield different CERs
    - Just like hurricane track models
  - CERs exhibit noise from the statistical scatter of the data
    - So all parametric estimates have to come with statements about ranges, confidence levels and other hedges
    - But at least you have the data and tools to characterize the noise (using the regression statistics)

# Major Causes of (NASA) Cost Overruns

- Optimism bias
  - Most often in TRLs, heritage assumptions
  - Team expertise, etc. (the Lake Wobegon Effect)
    - I want to mention that we should actually favor optimism in our project teams
      - We just shouldn't let them estimate the cost!
- The failure to enumerate requirements
  - Remember, in detailed engineering estimates you must enumerate every single requirement
  - With parametrics, you need only get the big stuff correct (mass, power, data rate, .....)
- While mismanagement after ATP may be a huge contributor to cost overruns, this is blind to how the cost was estimated

# Concluding Remarks

- Parametric cost analysis is used in many applications including
  - Aerospace
  - Ship building
  - Weapons
  - Chemical processing
  - Electronics
  - Software
  - Construction--go to this site for fun:  
<http://www.aacei.org/resources/BuildingModel.shtml>
- Parametric estimating methodology is a recognized tool for technology driven organizations
- The use of parametric methods improves the capability of such organizations to operate more effectively
- Parametric nimbleness provides a competitive advantage
- The organizations that use parametric methods will reap the associated benefits