



Accuracy, Precision and Uncertainty in Cost Estimates

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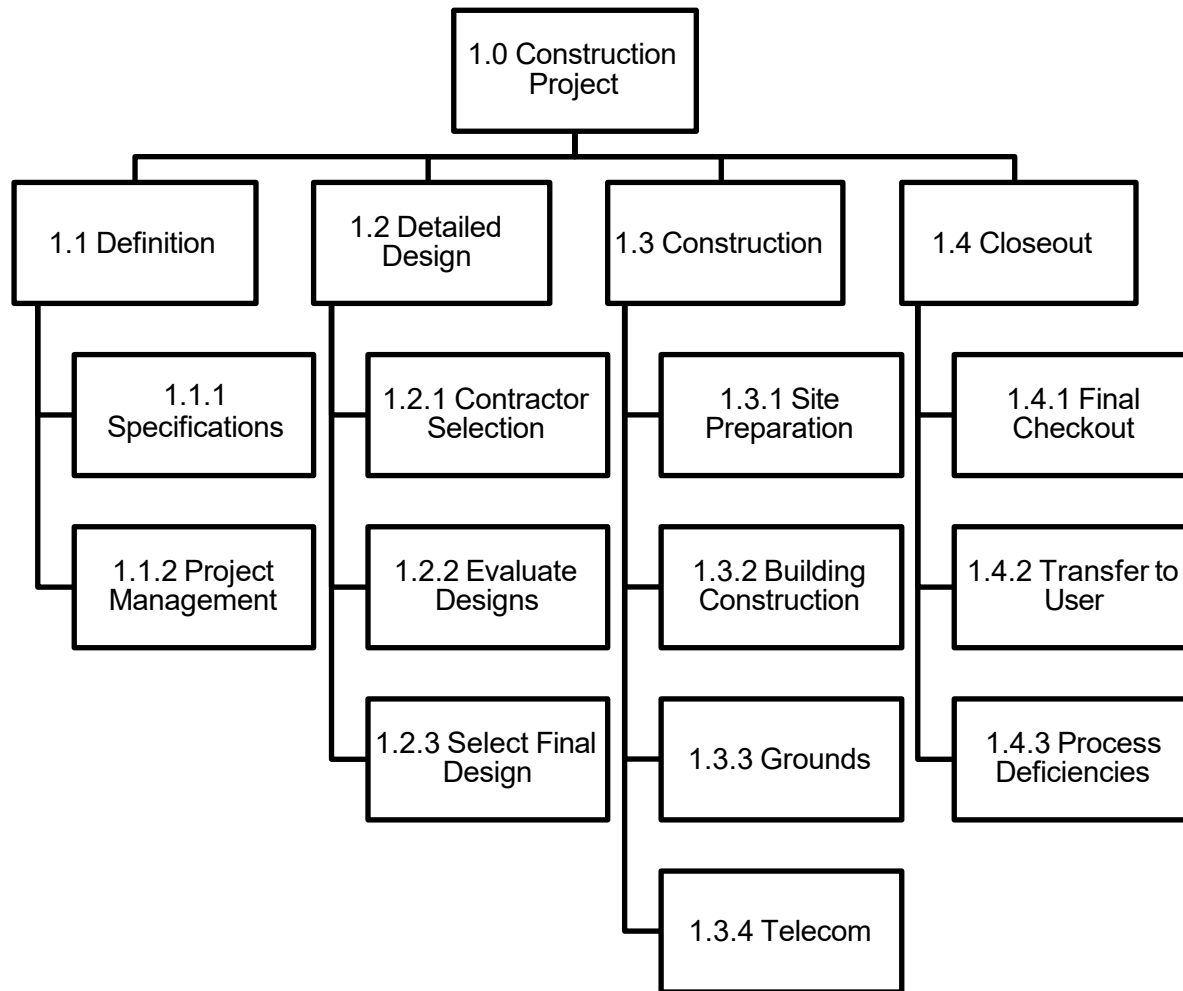
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Example Construction Work Breakdown Structure



Costs typically estimated at lowest levels and rolled up to higher levels

Generic Development of a Cost Proposal



2.3.1	\$1,423
2.3.2	\$10,386
2.3.3	\$905
•	•
•	•
•	•
2.3.n	\$27,025
Sum	\$47,925

1

Subsystem 2.3 cost derived using BOEs, engineering buildup, cost models, etc.

Our BOEs provide "pretty good" estimates at the subsystem level



2.1	\$105,286
2.2	\$848,036
2.3	\$47,925
•	•
•	•
•	•
2.n	\$2,936,284
Sum	\$16,035,366

2

WBS element 2.0 cost derived as the sum of all subsystem cost estimates

This system has LOTS of subsystems!



1.0	\$27,825,734
2.0	\$16,035,366
3.0	\$145,185,776
•	•
•	•
•	•
n.0	\$78,285,037
Total	\$545,359,722

3

Total cost derived as the sum of all WBS element costs

How much confidence do we really have in this total cost?





Precision versus Accuracy

- A precise proposal is one that can be expressed down to the nearest dollar
 - *Conveys that the actual cost is known with high granularity and near certainty*
- An accurate proposal is one that predicts the true actual cost with minimal error
 - *May be lower granularity, but gets it “about right”*

Q: Would you rather have an “accurate” proposal, or a “precise” proposal?

Q: What inaccuracies or imprecisions might be encountered when building a cost proposal?



Precision versus Accuracy

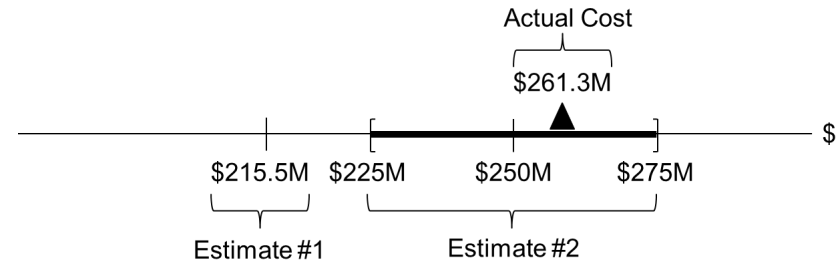
- Consider two cost proposals:

- \$215,483,756.53?
- \$250M \pm \$25M?

Q: Which proposal is more accurate?

- Now suppose the final actual cost, after five years of development was \$261,329,517.00

Q: Which proposal was actually most accurate?



- When estimating the cost of a major project, it is impossible to accurately factor in every event, mishap, test failure, labor rate, airfare, inflation rate, etc.
 - So, reporting something like #1 conveys a degree of precision that is impossible to achieve, and is likely to be too low anyway
 - It is better to develop a robust ballpark estimate starting up from the BOEs then add some reasonable risk adjustment and report the cost as a rounded number

Q: What are some implications or challenges associated with submitting proposals that are presented too precisely?



Example: Let's Look at Some BOEs

- A basis of estimate (BoE) is a collection of documents that form the fundamental underpinning of a broader cost estimate
 - May be engineering buildups, regression models, analogies, or expert opinion
 - Every significant cost element should be backed up by a BoE that serves as its basis
- Consider, for example, a travel BoE*
 - The recipient has used a buildup for four classes of travel
 - From these BoEs, the recipient will request travel funding to cover a five-year period

Conference Exhibit Travel: \$20,000/ year \$100,000 total	
\$2,000 per trip (3-5 day trip)	
Airfare	\$ 660
Lodging @ 316.76 per night	950
Per Diem	214
Ground Transportation	138
	\$ 1,962
Advisory Board Travel : \$12,000 year 1	
\$1,200 per trip (2 day trip)	
Airfare	\$ 600
Lodging @ 157 per night	314
Per Diem	153
Ground Transportation	138
	\$ 1,205
Conference Presentation: \$7,200/ year \$36,000 total	
\$1,800 per trip (2 day trip)	
Airfare	\$ 562
Lodging @ 278 per night	834
Per Diem	214
Ground Transportation	142
	\$ 1,752

International Travel: \$8,000/ year \$40,000 total	
\$4,000 per trip (5 day trip)	
Airfare	\$ 2,069
Lodging @ 332 per night	1,328
Per Diem	500
Ground Transportation	159
	\$ 4,056

Q: How accurate are these BOEs?

Q: What are some potential inaccuracies?

- Conference Exhibit Travel
 - $\$1,962 \times 2 \text{ people} \times 5 \text{ trips} \times 5 \text{ years} = \$98,100$
 - Rounded up to \$100,000
- Advisory Board Travel
 - $\$1,205 \times 10 \text{ people} \times 1 \text{ trip} \times 1 \text{ year} = \$12,050$
 - Rounded down to \$12,000
- Conference Presentation Travel
 - $\$1,752 \times 1 \text{ person} \times 4 \text{ trips} \times 5 \text{ years} = \$35,040$
 - Rounded up to \$36,000
- International Travel
 - $\$4,056 \times 1 \text{ person} \times 2 \text{ trips} \times 5 \text{ years} = \$40,560$
 - Rounded down to \$40,000
- Total Travel Cost Estimate = \$188,000

*Used by permission of National Science Foundation
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What is “Uncertainty?”

- **Uncertainty** is the general indefiniteness about the outcome of a situation – includes both favorable and unfavorable events
- Example:
 - *Simple cost estimate: Effort cost = labor hours x labor rate*

Q: What are some possible sources of uncertainty in this estimate?

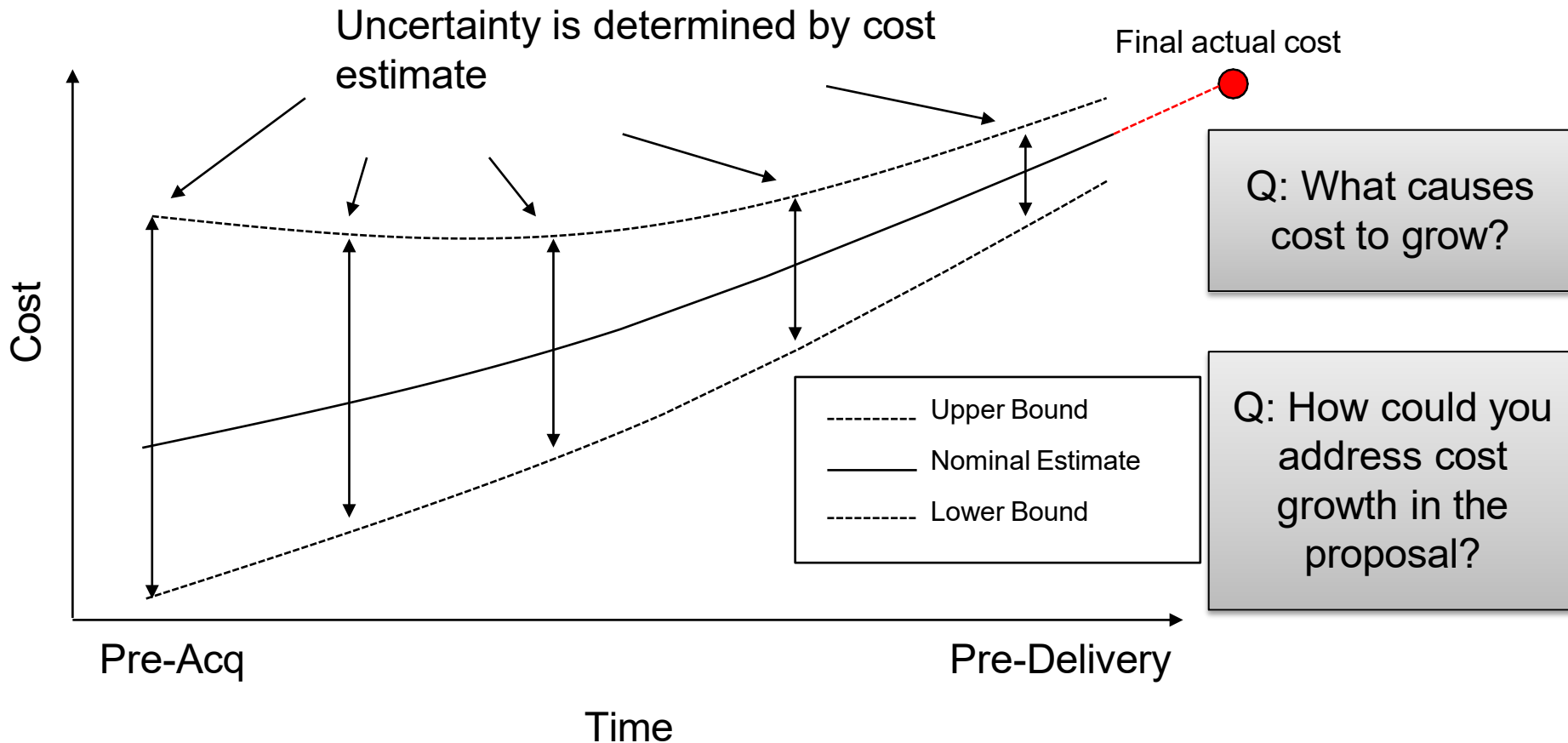
Q: What could you do to mitigate uncertainty when developing proposals?

Q: What are some other aspects of proposal development that cause uncertainty in cost proposals?



Cost Estimating Uncertainty Combined With Cost Growth

- Most complex projects end up costing more than anticipated
- As the life cycle progresses, we expect the uncertainty bounds to narrow, but we also expect cost to creep up





What About Uncertainty in Proposals?

- Contractor proposals often are typically very precise (down to the nearest dollar) but still may lack accuracy
 - *Competition pressure: Price to win*
 - *Address the “currently defined requirements” which are likely to change over time*
 - *May miss some important scope*
- It is better to be “about right” than “precisely wrong”
 - *Build the cost proposal based on the currently defined requirements, but don’t assume a perfect world – include some potential for cost growth*
- Propose to a number that is consistent with the scale and technical complexity of the project and the degree of uncertainty
 - *Example: \$250M rather than a point estimate to the nearest dollar*
 - *The point is to propose to a number that is realistic and unlikely to be exceeded*

Q: What do you assume the government is really looking for in budget proposals?

Wrap-Up

- Strive for accuracy over precision when developing cost proposals
 - *Typical proposals are frequently too low for the project to succeed without ultimately de-scoping or obtaining additional funding*
 - *Cost growth should be assumed to occur over the development lifecycle*
 - *Decide early on a reasonable level of precision, then plan the estimate accordingly to be as accurate as possible*
 - *It is better to be “about right” than “precisely wrong”*

Q: What questions do you have?