Industry Best Practices in Cost Estimating

SM&A

MCR, LLC

U.S. COST

Project Time & Cost, Inc.

- SM&A (Moderator)
  - Michael R. Nosbisch, Vice President
- MCR, LLC
  - Neal D. Hulkower, Vice President
- U.S. Cost
  - Wade L. Martin, Sr. Vice President
- Project Time & Cost, Inc.
  - Kenneth A. Roberts, Executive Vice President

The Panel

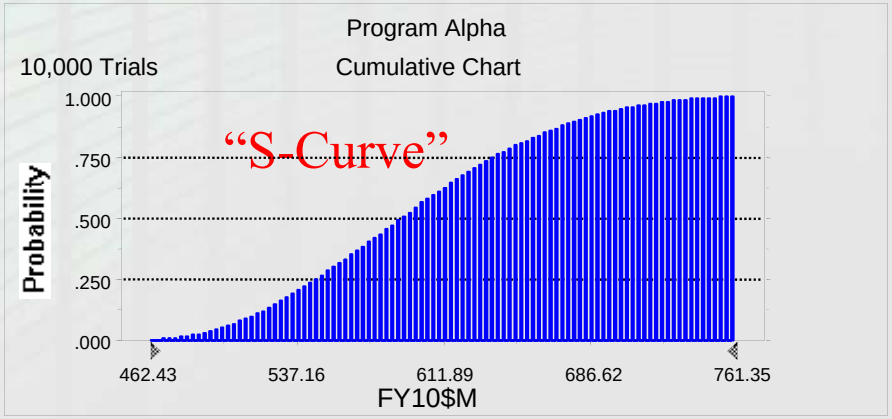
Modern Cost Estimating: A Work in Progress

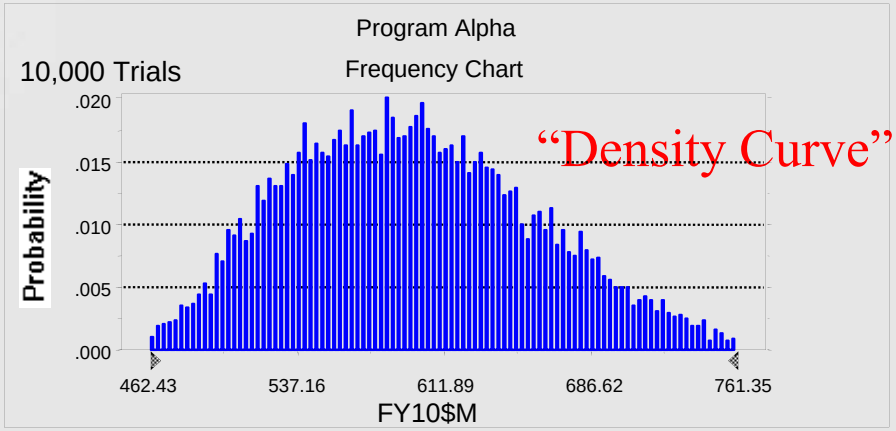
Neal D. Hulkower, Ph.D.
Vice President, Technical Planning and Quality Support
MCR, LLC

Percentile	Value FY10$M
10%	516.81
20%	538.98
30%	557.85
40%	575.48
50%	592.72
60%	609.70
70%	629.19
80%	650.97
90%	683.01

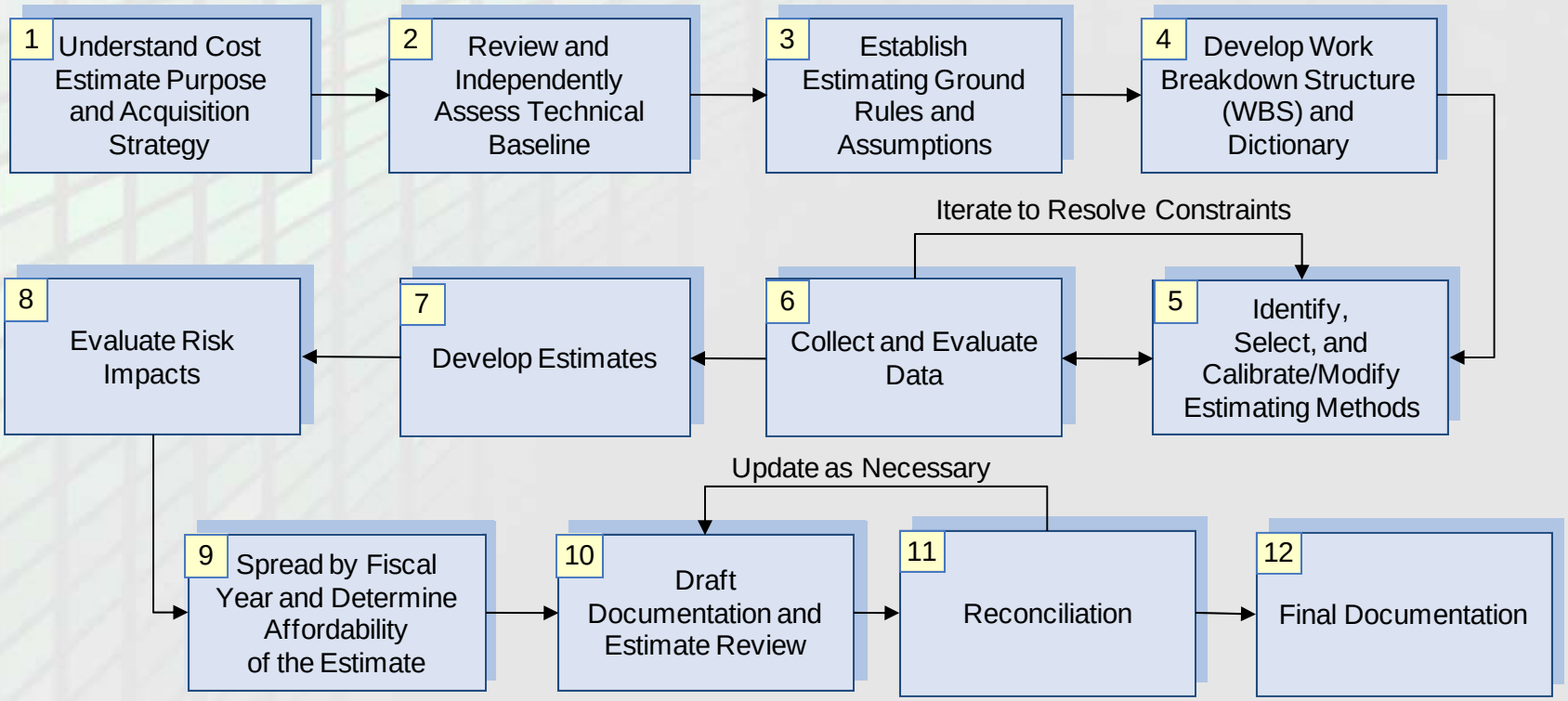
Statistics	Value
Trials	10,000
Mean*	596.40
Median*	592.72
Mode	---
Standard Deviation*	63.18
Range Minimum*	450.19
Range Maximum*	796.68

* In FY$10M





What a Cost Estimate Looks Like



How You Get There

Why Cost Estimating is Hard

- A cost estimate is not “real” - you cannot observe an estimated cost in the real world
- The cost estimator/analyst must build an estimate from the engineers’ model of a yet unrealized program
- In other words, every cost estimate is a (model, estimate, incomplete characterization, copy) of a (model, estimate, incomplete characterization, copy) which is reminiscent of....

"'Four' is cloned from 'Two', and has the mentality of an overly-curious child. Unfortunately since he is a clone-of-a-clone, his IQ is considerably lower than that of his predecessors, since the personality defects are more pronounced when a clone is cloned (The analogy from the movie refers to how a copy of a copy may not be as 'sharp' as the original)." http://en.wikipedia.org/wiki/Multiplicity_(film)

- Fits empirical data
- Is shaved by Occam's Razor
- Is predictive across the broadest set of inputs
- Satisfies an appropriate theory and/or philosophical consideration

A Good Cost Model

Out	In	Comments
"Point Estimate"	Estimate with associated confidence level	"Point Estimate" is an undefined term. A proper cost estimate must reflect its probabilistic nature.
Arithmetic Summing of Estimates	Statistical Summing of Estimates	Only means of distributions can be arithmetically summed and nothing else!
Ordinary Least Squares (OLS) and Log-OLS	Minimum Percent Error - Zero Percent Bias (MPE-ZPB)	The world is rarely linear and the assumptions for OLS are even more rarely satisfied. Multiplicative error makes more sense for cost estimates.
Learning Curves	Quantity as an Independent Variable (QAIV)	Learning slope is a significant cost driver but its selection rarely has a solid justification. Let the data dictate adjustment.
Black Box Cost Models	Transparent Cost Models	Need information about the programs comprising the data base and form of the equations to bolster confidence in model outputs.
Cost as an Independent Variable (CAIV)	Reduction of Total Ownership Cost (RTOC)	Cost is a dependent random variable, not independent. RTOC reflects a more comprehensive goal.

What's Hot and What's Not

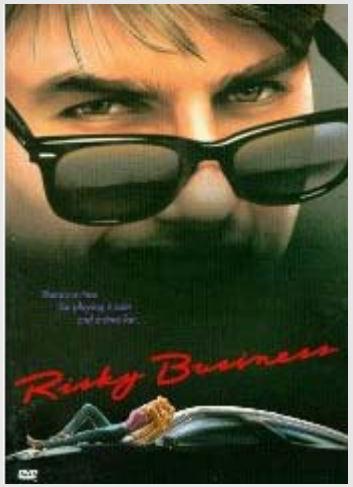
- Impact of Technology Readiness Levels
- Joint Cost-Schedule Confidence Levels
- Advanced Estimating Relationship Development
- Bringing cost methods to earned value analysis
- Application of voting theory to trade studies

Pushing the State of the Art

Estimating Risk

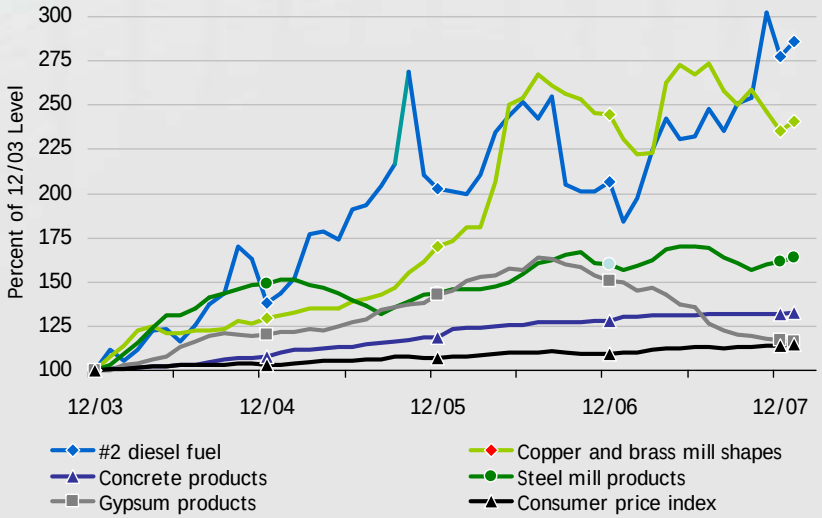
Wade L. Martin, CCC, CVS, LEED AP
Senior Vice President
Construction Cost Management Group
U.S. COST

- Can be Simple or Complex
- Differs from Other Project Risks
  - Focuses solely on the Impact on Costs
  - Not on Project Success/Failure, Loss of Life, other Project Risks
  - Can be Done at Multiple Levels
- Is important NOW:
  - Economic Uncertainty
  - Growth in Emerging Markets; Worldwide Marketplace
  - Lack of Response to Traditional Control Mechanisms
  - Rapid Technological Change
- Was not as Important 20, 15, nor 10 Years Ago
  - U.S. was the Elephant in the Market
  - Predictable Growth, Trends

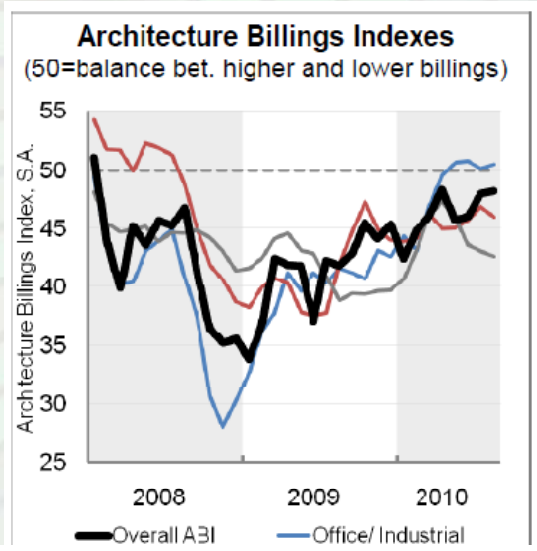


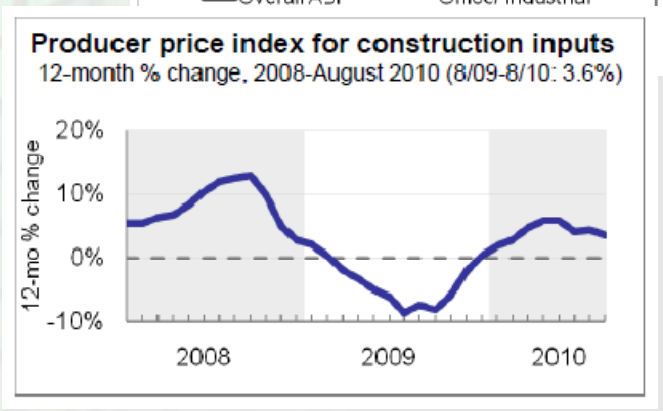
Cost Risk Assessment

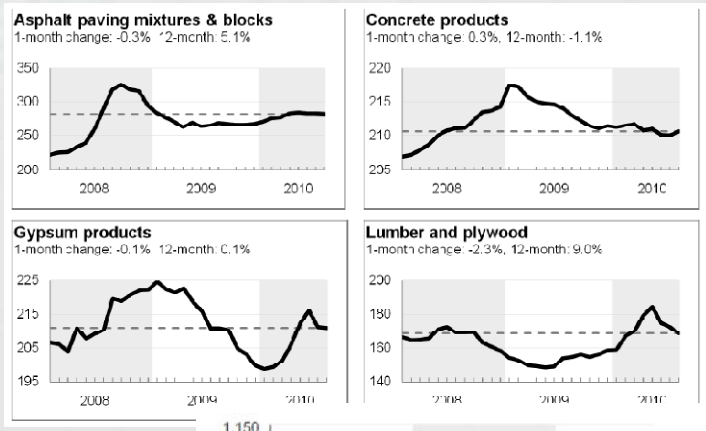
- Permitting/Permits
- **Material Availability/Cost**
- **Scope Definition**
- Labor Rates/Availability
- Equipment Availability
- Weather/Climate
- Delays/Funding Environment
- **Schedule/Work Restrictions**
- Acquisition Strategy
- Bidding Climate
- **Competing Projects**
- Fuel Costs
- Design Maturity
- **PM Team**
  - **Experience**
  - **Qualifications/Certifications**
  - **Empowerment**

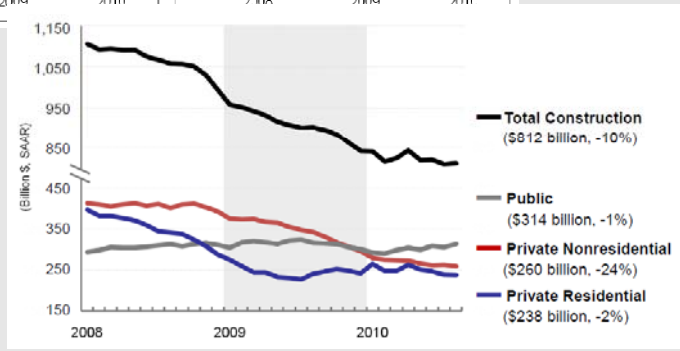


Typical Cost Risks









Just the Data

- Historical Trends (3-1/2 – 4% Construction Cost Escalation/Year)
  - Regression Analyses
  - The United States **Department** of **Labor** Home Page,
  - Bureau of **Labor** Statistics Home Page
  - Department of Commerce Home Page
  - Bureau of Economic Analysis
- **Previous Project Experience**
  - Historical Data
  - Same/Similar Technologies
- Market Research
  - Local, Regional, National, International
  - Sub (Vertical) Markets
  - Board of Governors of the **Federal Reserve** System (Beige Book Reports)
- **Black Swan Events**
  - **Summer 2004**
  - **Fall 2008**

Predictors and Outliers

- Project Timeframe and Timing
  - Longer Timeframe: Less Accuracy
  - Further in the Future: Less Accuracy
- Client Determined Certainty Level
  - Risk Adverse; Risk Accepting
  - Consequences
  - Unknowns and Unknowable's

Table ES-1. Recommended Plan Contingency Summary

Confidence Level	Base Cost + Contingency	Contingency ($)	Contingency (%)
P0	$98,568,000	($20,640,000)	-17%
P10	$122,543,000	$3,335,000	3%
P20	$127,376,000	$8,168,000	7%
P30	$131,256,000	$12,048,000	10%
P40	$134,781,000	$15,673,000	13%
P50	$138,269,000	$19,061,000	16%
P60	$141,893,000	$22,685,000	19%
P70	$145,823,000	$26,615,000	22%
P80	**$150,579,000**	**$31,371,000**	**26%**
P90	$157,496,000	$38,288,000	32%
P100	$210,999,000	$91,791,000	77%

Future Predictions

Independent Cost Estimates and Independent Cost Reviews

Kenneth A. Roberts, PMP CCC
Executive Vice President
Project Time & Cost , Inc.

- **Purpose**: Assure Management that project budgets are adequate prior to approvals to proceed/fund
- Required/essential at different project stages – with different uses:
  - Validation: Scope, Schedule & Cost
  - Negotiation Tool
  - New Perspective: Thought Catalyst

ICEs & ICRs

- Independent Cost Estimate (ICE)
  - Same Basis as Project Cost Estimate (PCE)
  - Reconcilable with PCE to Facilitate Validation
- Independent Cost Review (ICR)
  - Review/Analyze the PCE
  - Assess Quality and Accuracy of PCE
    - Examine Approach/Methodology, Assumptions, etc.

ICE vs. ICR

- Project Cost Estimate
  - Prepared by or Under Authority of Project Team
  - Should Apply Most Appropriate Methods and Level of Effort to Assure Accuracy
- Independent Cost Estimate
  - Prepared by Independent (objective) Party
  - Typically Shorter Duration/Level of Effort
  - Level of Detail & Methodologies May Differ
  - Not Limited to a Point Estimate

ICE vs. Project Cost Estimate

- Objective and impartial
- No equity or outcome interests
- Should possess sufficient institutional knowledge with minimal learning curve
- Analytical with broad estimating abilities: ability to hone in on critical elements and identify and apply appropriate methodology and level of effort

ICE and ICR Team

Prior to Critical Decision	Projects (Total Project Cost)	ICE/ICR by OECM
CD-0, Approve Mission Need	MSP (TPC ≥ 750M)	ICR
CD-1, Approve Alternative Selection and Cost Range	Projects w/TPC ≥100M	ICE or ICR as appropriate
CD-2, Approve Performance Baseline	Projects w/TPC ≥100M	ICE supporting EIR
CD-3, Approve Start of Construction/Execution	Projects w/TPC ≥100M	ICE as warranted

DOE O 413.3B

- Understand Objectives (Use of ICE/ICR)
- Time & Resource Constraints
- Prioritize – Pareto Analysis (20/80)
- Form & Format to Facilitate Reconciliation
- Estimating Methodologies
- Procurement Strategy Implications
- Scope, Schedule & Cost Risks

ICE & ICR Considerations