Dynamic Cost-Contingency Management
A Method for Reducing Project Cost While Increasing Probability of Success

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Cost-overrun problem: Déjà-vu

“*Their judgment was based more on wishful thinking than on sound calculations of probabilities.*”

*Thucydides, 431 B.C.E.*

- Thucydides’ observation is very insightful and still appropriate today

- Projects that come-in under cost do not necessarily deserve kudos
  - They may have carried excessively safe budgets!
Cost overrun causes “Top 10” list

Common threads among “top 10” lists

- **Institutional and organizational culture**
  - Procurement process, management pressure, poor project definition...

- **Real Vs. idealized human behavior**
  - Psychology is relevant to economics, decision-making, management,...
  - The “100% rational” person is a theoretical model that differs from reality

- **Inadequate analysis - Today’s typical Probabilistic Cost Analysis**
  - Ad-hoc data elicitation, improper distributions, omitted and/or limited dependencies, omitted high-risk events & decision points
  - Shift from deterministic to probabilistic approach is NOT silver bullet
    - Monte Carlo simulation is only a mathematical tool: GIGO

- **Poor management practices**
  - Lack of appreciation of probabilistic concepts and psychological influences in budget allocation and control of management reserve
Current project reality leads to cost overruns

Win project

- Management pressure for low estimates
  - Optimism about technology
    - Conflict
    - Some leads want safe estimates
  - Today's typical PCA
    - Achieve technical performance
  - Conflict

Low project cost estimates

- Conflict

Project cost overruns

- Inadequate project management
  - Management wants to meet schedule
  - Conflict

Legend

- Practices
- Human behavior
- Organization/Politics

Addressed in other presentations
Psychology can teach us much about cost overruns

- **Overconfidence**
  - R&D folks are intrinsically optimistic about new technologies
    - "For heaven's sake, spread those fractiles! Be honest with yourselves! Admit what you don’t know!" [Alpert and Raiffa, 1982]

- **Negative human behavior - MAIMS Principle**
    - Task underruns are rarely available to protect against tasks overruns. Task overruns are passed on to the total project.

- **Mistakes of reason**
  - "Too many details tend to cloud the big picture."
    - Total project cost is not simply the sum of cost elements. Project risks are likely to affect multiple elements.
    - "Implicitly trusting the most readily available information or anchoring too much on convenient facts." [Russo and Schoemaker, 1990]

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**Realistic cost analysis requires a systems perspective**
Integrate psychological influences, valid mathematical models, and sound management techniques
MAIMS significantly impacts project cost

Properties of MAIMS - Modified probability distributions
- Minimum value: allocated budget, $x^*$
- Spike (Dirac delta function) at $x^*$
- Identical to original cost element for values > $x^*$

MAIMS impact increases with increased budget allocation
Budget allocation impacts project cost and probability of success

Mythical Project
- “100% Rational” team
- Each cost manager spends only as necessary to satisfy requirements
- Actual cost may be less than budgeted costs

Real Project
- Human & organizational influences
- MAIMS principle: No cost manager spends less than his/her budget
- Actual cost increases with higher allocated budget
It’s NOT your textbook contingency anymore!

- Cost contingency depends on desired probability of success and cost management strategy
  \[ MCC(PoS, PBC_1, \ldots, PBC_n) = TEC(PoS, PBC_1, \ldots, PBC_n) - PBC \]
  - MCC: Management Cost Contingency
  - TEC: Total Estimated Cost
  - PoS: Probability of Success
  - PBC_i: Baseline Budget for Cost element C_i
  - PBC: sum over all cost elements

- Major differences with both deterministic practice and today’s typical PCA
  - MCC is not a fixed percentage of PBC
  - MCC incorporates depends on the management strategy
  - MCC is an interactive and iterative process
    - Analysts, engineers, managers
Contingency, cost, & success are NOT directly related

- High cost NEED NOT provide (1) high PoS or CL and/or (2) high contingency
- Low contingency DOES NOT necessarily equate to low cost
- High contingency DOES NOT necessarily equate to high cost and/or padding

Realistic budget allocation, adequate contingency, and dynamic allocation are critical to optimal cost and probability of success.
Fable of a project cost overrun

- Agency X issues a RFP
  - Requests cost at 50% CL
- Contractor A prepares bid
  - Possesses limited sophistication; not cognizant of MAIMS principle
  - Performs today’s typical PCA
    - P50: 7,348 K$
    - Min: 5,633 K$
- Cont. A submits bid of 7,348 K$
  - Confident of success. Thinks cost estimate has a 30% margin.
- Contractor A is winner
- Project starts & budgets allocated
  - Cost element baseline at mean: 7,665 K$

- Much time is spent reallocating and prorating budgets
  - Budget cost elements at 50% CL
    - Baseline cost: 7,002 K$
    - Management reserve: ~ 5%

The outcome

Everybody works very hard. But the project runs out of budget and is cancelled

- Epilogue
  - Another project has succumbed to the MAIMS principle
  - Today’s typical PCA models a mythical project
  - Contracting agencies & contractors use proposed approach
High technical risks require individual risk mitigation plans

- Technical risks often associated with high-consequence events
  - Detailed engineering analysis more suitable than statistical analysis
  - Identify possible Risk Response Actions (RRA)
    - Accept risk as is, Immediately implement RRA, Obtain addition information
  - Develop risk-specific RRAs including critical decision points
    - Scenarios and Decision Trees (DT)
  - Assess risk reduction profile
    - Technical performance parameters, Cost and Schedule earned-value system

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**Basic RRA DT**

**Specific RRA DT**

Decisions made – 6/06
- Pursue both

Decisions to be made / Drop-dead dates
- Select technology & design: 6/07
- Select manufacturing option: 7/07
The efficient management of technical risks requires a portfolio approach

- Proposed approach based on Markowitz’s efficient portfolio selection principle

- The PMO manages high technical risks as a whole rather than focus on the individual risks per se
  - Systematic development and implementation of Efficient RRA Set
    - Lowest total project cost for a given probability of success
  - System-level oversight
  - Dynamic allocation of contingencies for RRAs

- Contingencies held and managed at the project-wide level
  - Protection against MAIMS principle

Example of an Efficient Contingency Frontier
Risk monitoring & reserve analysis avert surprises

- Risk exposure metric
  - Baseline risk (unmitigated)
  - Residual risk over time (mitigated)
  - Cost of mitigation over time
  - Clearly reveals progress and value of RM effort

- Risk metrics track RM effectiveness and value throughout LC
  - Risk exposure metric - one of many useful quantitative risk metrics
  - Technical Performance Measurements (TPM) for KPPs

- Risk monitoring and metrics should be produced continually
  - Integrated with other PM activities and databases

- Reserve analysis compares contingency reserves to residual risk
  - Assures adequate contingency reserves for remaining risks
Implementation is the challenge!

- Efficient project cost management requires a rigorous framework supported by probabilistic risk analysis and decision-making under uncertainty.

- Some R&D is required
  - Integrated analysis of performance, cost, and schedule
  - Tool for dynamic budget allocation.

- The greatest challenge is the implementation of systems thinking at the personnel, organizational, and institutional levels.

Dynamic cost-contingency management is well worth the additional effort.
The benefits are likely to be significant.