The Challenge of Estimating Space System Costs— Modeling the Relationship with Acquisition Strategy

Mr. Paul Killingsworth, GG-14
Chief, Cost Research Branch
SMC/FMCR

Motivation for the Research

- **Numerous studies have highlighted space acquisition challenges**
  - Booz-Allen, “Space Systems Development Growth Analysis,” Aug 2002.
  - OUSD/AT&L, “Acquisition of National Security Space Programs,” aka “Young Report,” May 2003.
  - Lexington Institute, “Can the Space Sector Meet Military Goals for Space?” October 2005.
  - Kadish. *Defense Acquisition Performance Assessment*, January 2006.
  - GAO, “DoD Needs to Take More Action to Address Unrealistic Initial Cost Estimates of Space Systems,” November 2006.
  - GAO, “Space Acquisitions: Actions Needed to Expand and Sustain Use of Best Practices,” April 2007.
  - GAO, “Major Space Programs Still at Risk for Cost and Schedule Increases,” March 2008.
  - RAND, “Improving the Cost Estimating of Space Systems,” August 2008.
- **The focus of cost estimating improvement efforts has mostly been internal to the function**
  - Better data collection processes—e.g. SWBS, data CDRLs, rigorous normalization
  - Better application of statistical analysis– e.g. rigorously developed, up-to-date CERs
  - Cost research to address sources of cost variation—reqm’ts creep, cost imp., sys eng
  - Better assessment and characterization of cost risk—stochastic methods
  - Better staffing and training

However, we should consider how our cost estimates are used in the context of the program management process in general and acq strategy in particular.

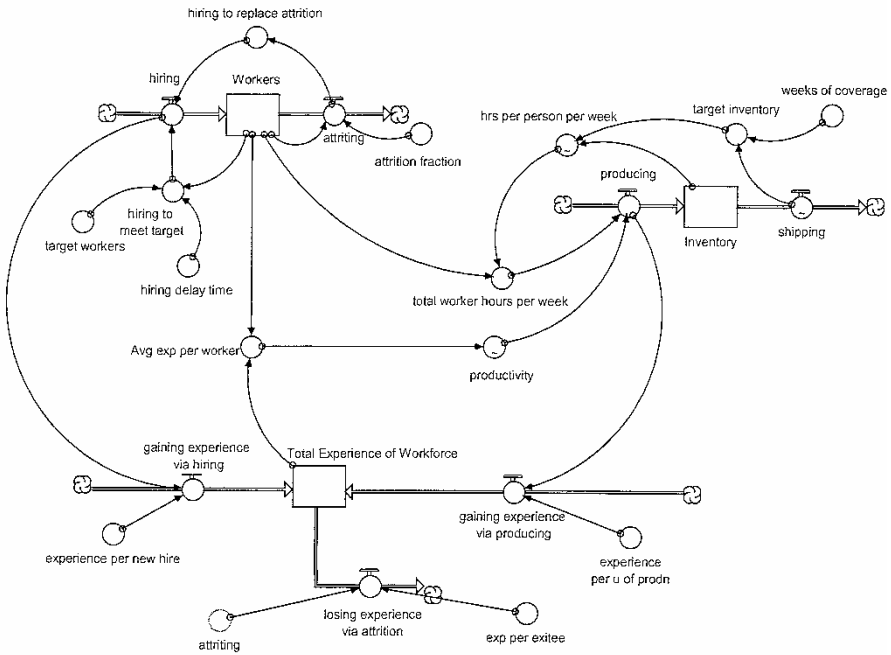
Things Cost Analysts Say Over Beers After Work

- **"We completed our cost estimate, but the program manager knows the budget bogey and intends to stay within it."**
- **"That budget was laid out two years ago on a gov concept."**
- **"The more we look for risk and uncertainty in these programs, the more we find."**
- **"If every program is budgeted at 70% confidence level, then how can the PEO's portfolio be affordable overall?"**
- **"How do we keep our fully risk-burdened baseline from becoming a new minimum for the program cost?"**
- **As hard as we work to make our estimates sufficient are they useful in the context of the PPBE system?**

As we work to improve our methods and account for program risks, we need to start thinking about how our estimates interact with the overall *system*.

It's time to start addressing the "barroom questions."

Is There a Way to Address the Context of Our Estimates?



Product Production Infrastructure Model*

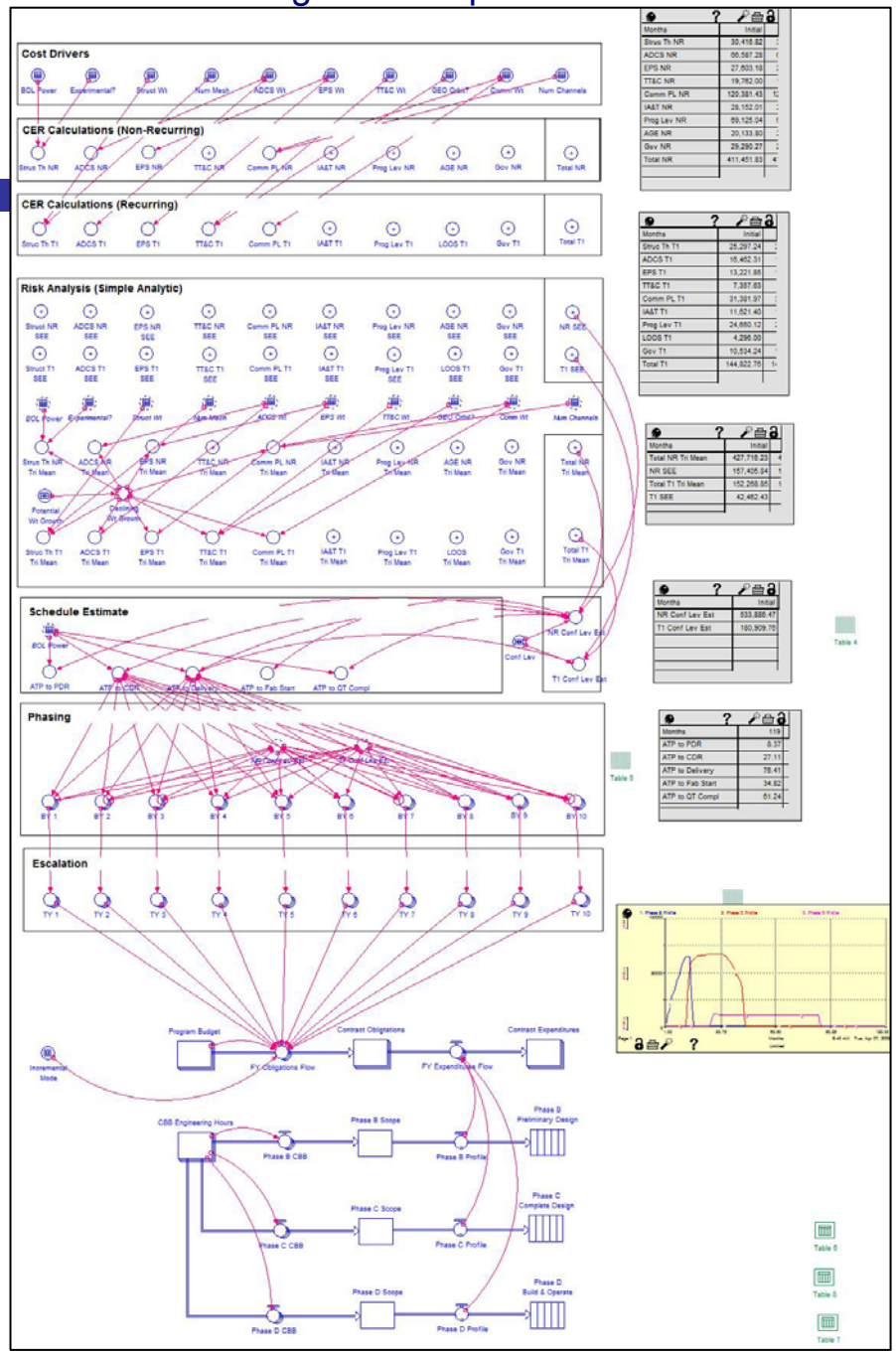
**Introduction to Systems Thinking with iThink Software,* isee Systems, 2004.

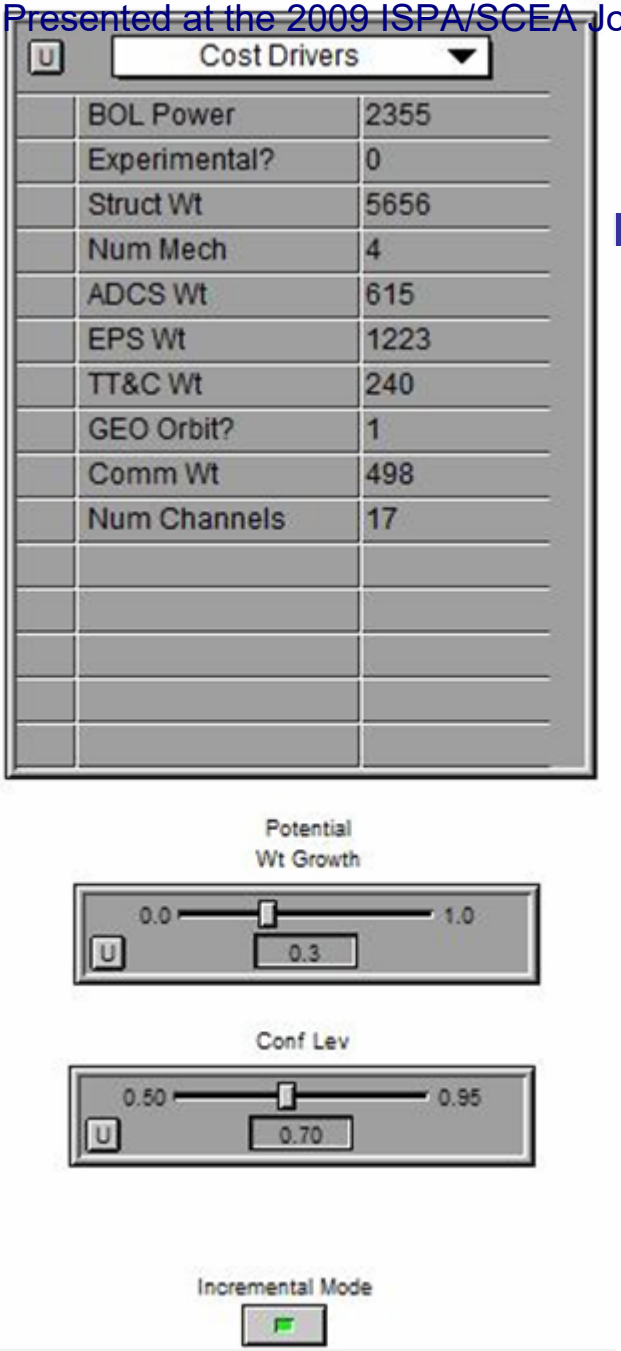
- **Recent business tool developments facilitate the mapping of organi-zational processes**
- **Even subjective decisions can be modeled**
- **Probability distributions can be applied to not only a single program cost estimate, but to a portfolio of programs**
- **Lead-times / Lag-times, impacts of cost uncertainty can be modeled and assessed**

This Research Had Three Objectives

- **Objective #1: Attempt a high-level representation of the cost estimate and acquisition strategy for a notional military comsat program**
- **Objective #2: Apply the model to evaluate the impact of at least one alternative acquisition strategy**
- **Objective #3: Introduce "Systems Thinking" as a method of evaluating the programmatic context of cost estimates**

Research applied the *iThink® software package.*

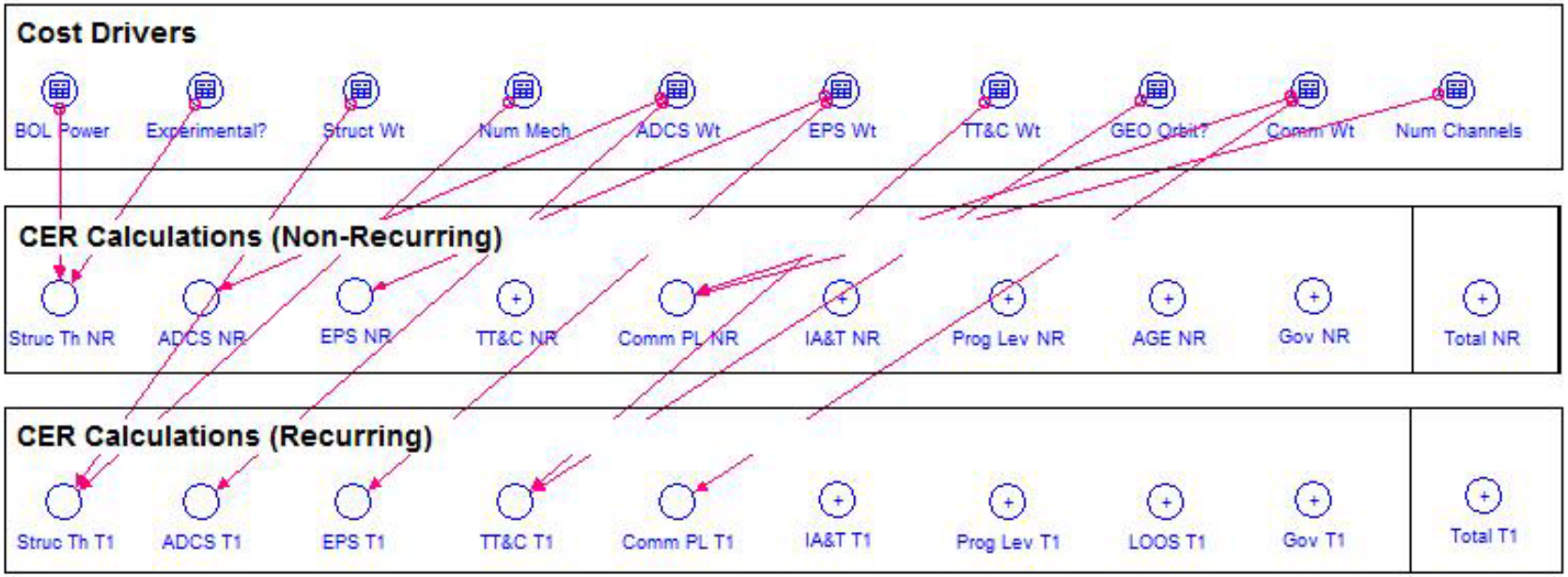




Ground Rules & Model Inputs

- **Cost estimate used USCM 8 CERs and associated statistics**
- **Start of Phase B (EMD)**
  - Estimates required for Phases B, C, D
- **NR: No heritage; Rec: T1 only**
- **Focus on conducting entire estimate with the simulation software**
  - Point estimate (NR & Rec)
  - Risk analysis
  - Schedule estimate
  - Phasing
  - Escalation to $TY
- **Upper limit of weight growth is variable**
- **Confidence level of estimate is variable**

Point Estimate Calculation

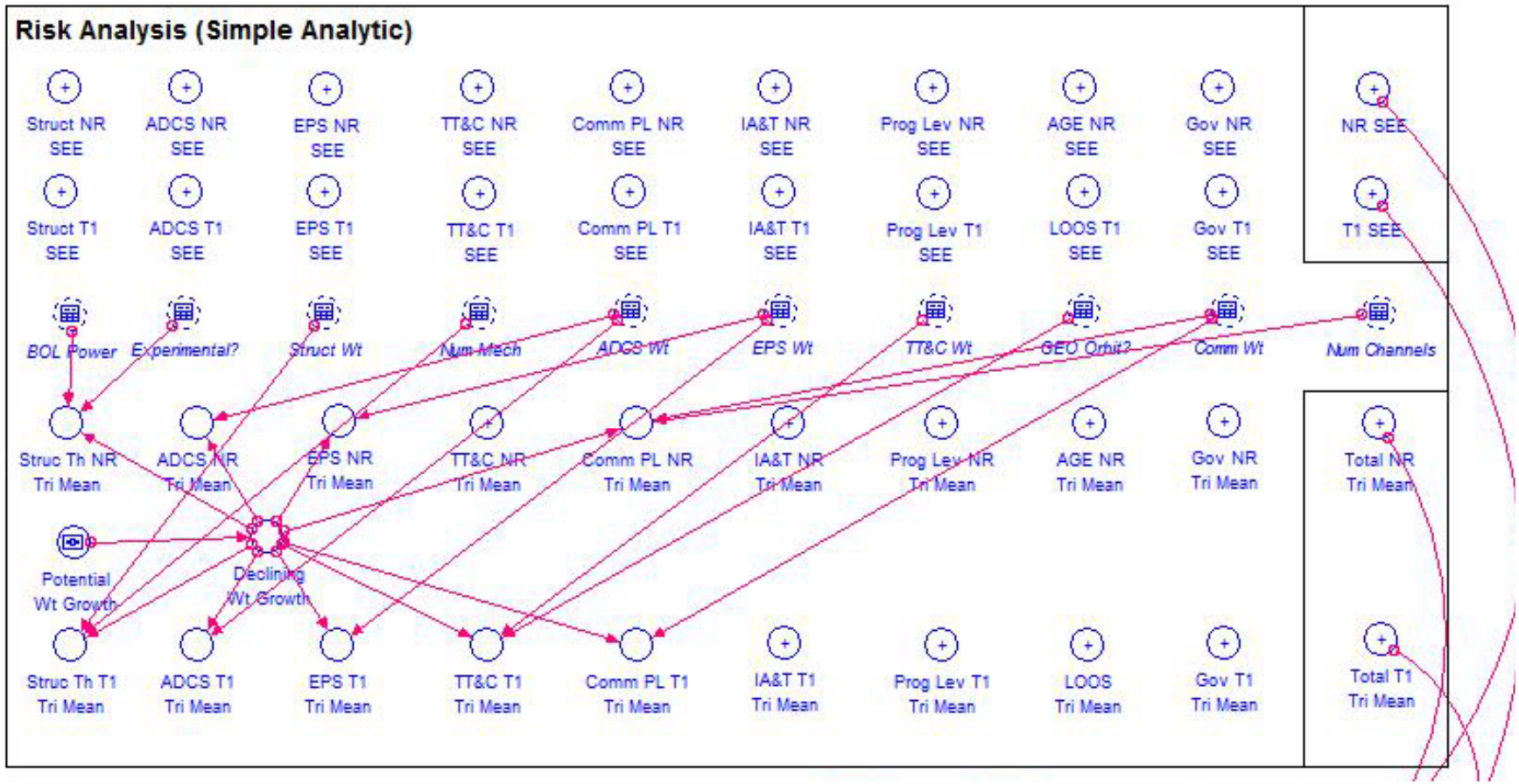


- **USCM8 CERs imbedded in variable "balloons"**
- **Links indicate cost driver inputs**

Total NR: $411.4 million (FY2000 BY$)

Total T1: $144.8million (FY2000 BY$)

Risk Analysis Was Rudimentary

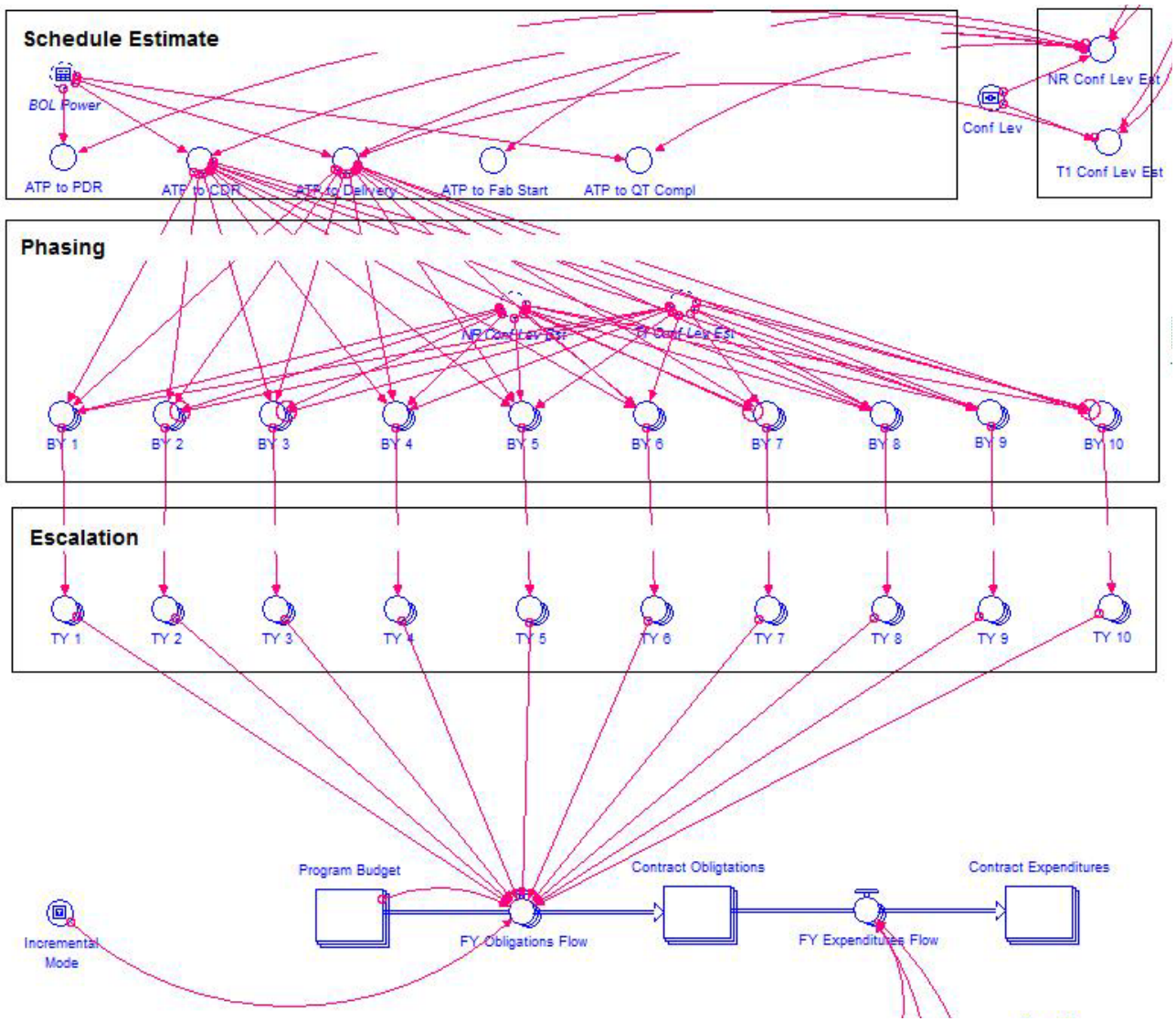


- ***FRISK*-like methods possible, true Monte Carlo would be difficult**

70% CL NR: $533.9 (FY2000 BY$)

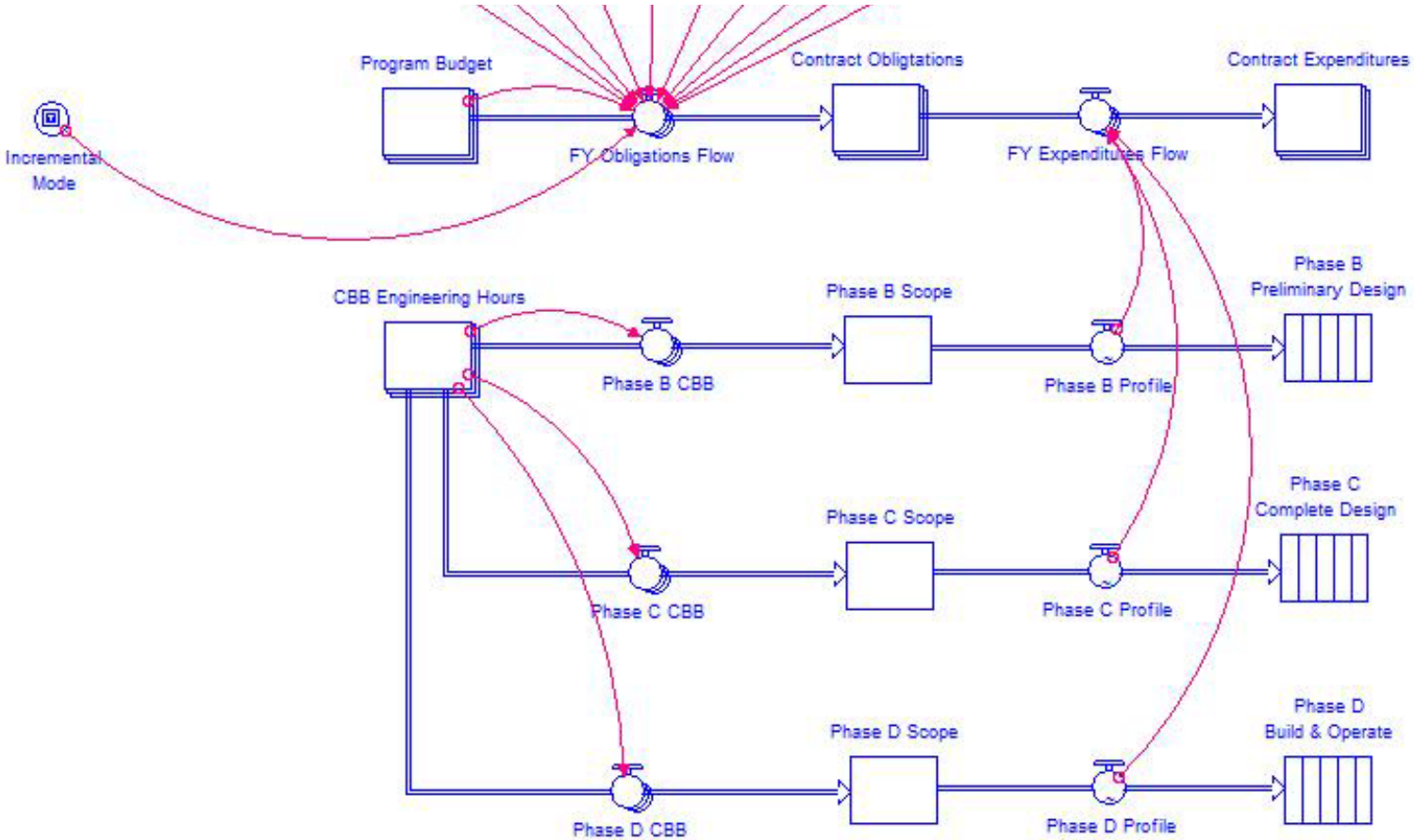
70% CL T1: $180.9 (FY2000 BY$)

Scheduling, Phasing, Escalation



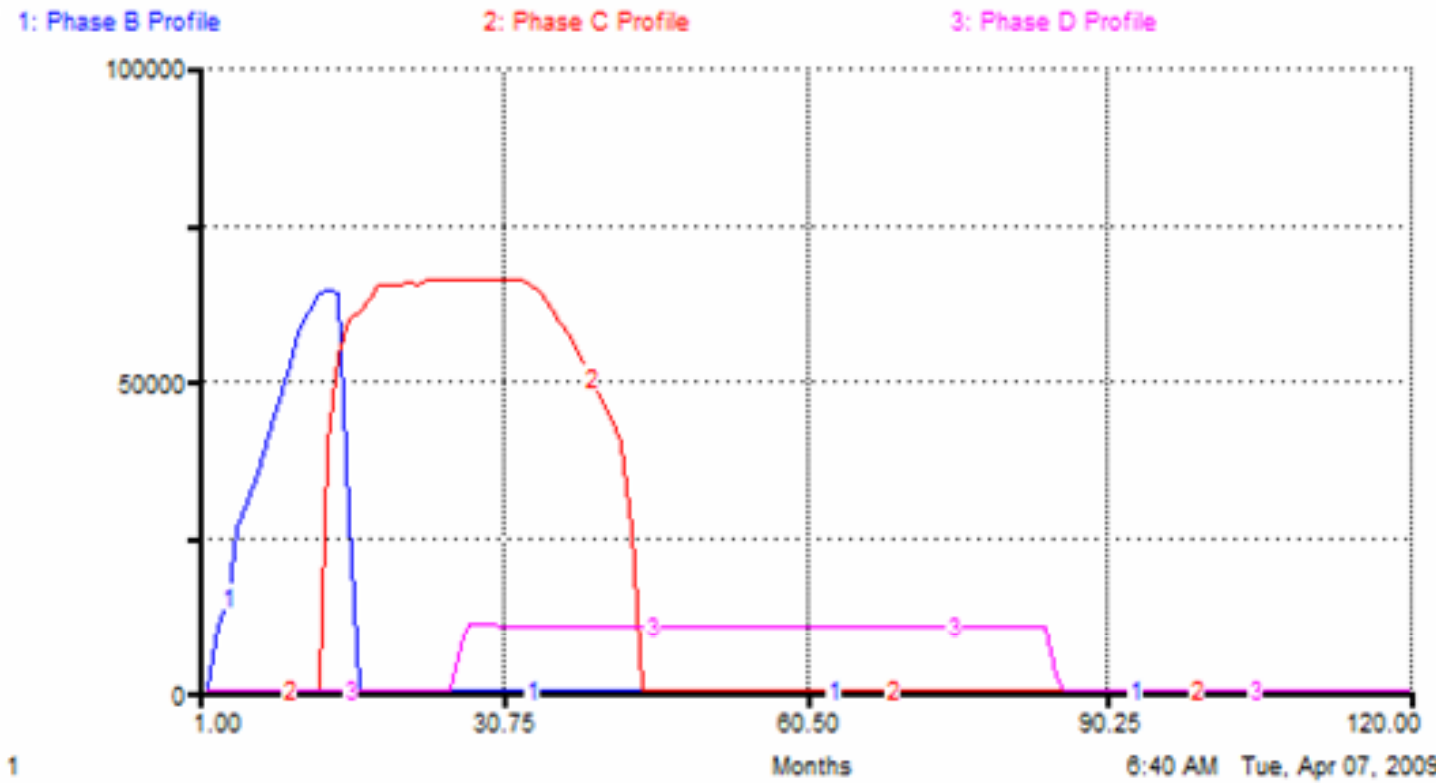
- **Schedule estimates used SMC SERs**
- **Phasing was straightforward, using Weibel curves**
- **Escalation not a problem**
- **Phased estimate was input into program budget for execution**

Program Execution Processes



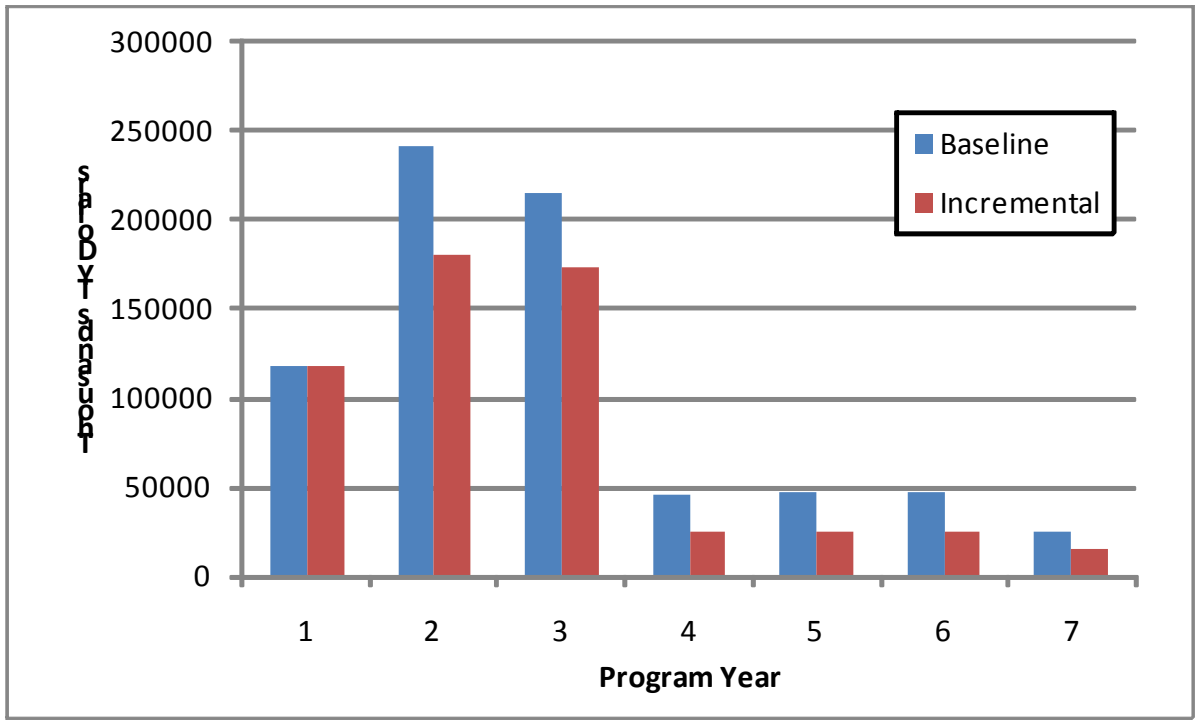
- **Budget converted to Engineering Hours using $200/hr**
- **Program "charges" budget as hours burned**
- **Representation is rudimentary, but has potential**

What the Baseline Program Looks Like



- **Phasing logic needs work**

Alternative Strategy Evaluation



- **Baseline program estimate is for Phases B, C, D conducted at entry into Phase B**
- **Alternative assumes options for Phases C, D re-estimated at start of each Phase**
  - "Incremental" switch in model activated
  - Weight grows, but uncertainty decreases at each Phase

Possible Benefits of Evaluating Cost Estimates in Context of Program Execution

- **Impact on program of various levels of cost risk can be evaluated**
  - Strategies for mitigation examined
- **Impact of alternative contracting approaches**
  - What's so bad about fixed price development contracts?
  - Can the effects be modeled?
  - Can the effects be mitigated with incentives?
- **Examine role of cost estimates and risk levels in context of PPBE system**
  - Lag time to respond to reprogramming
- **Model impacts of multiple programs and effect on mgmt reserve levels—portfolio management**

Demonstration model was rudimentary. More sophisticated models could provide insight into multiple issues.

Questions and Discussion

This briefing represents solely the views of the author,
and does not represent the position of the US Air Force or SMC.