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Pre-Milestone-A Cost Analysis: Progress, Challenges, and Change

The natural law of inertia: matter will remain at rest or continue in uniform motion in the same straight line unless acted upon by some external force.

- W. Clement Stone

Abstract

With roughly eighteen months logged in parallel research and application efforts aimed at enabling Pre-Milestone-A analysis, the time investment has produced dividends of progress and lessons learned for a team of Army researchers. More than ever, it is clear that early acquisition investment decisions must be cost-informed, and the demand for this early cost information is growing.

Although concrete tools are being developed to enable the analysis to support early investment decisions, it will not be achievable without an analysis culture with the policy, procedure, and willingness to develop and/or accept cost estimates that are less precise than those developed at Milestone B or Milestone C. Making early analysis a reality will require large-scale, department-wide culture change within and around the analysis community.

Introduction

Pre-Milestone-A Cost Analysis: It's a relatively unfamiliar concept in defense analysis, but one very well-known to a team of Army analysts at the Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE). With roughly eighteen months logged in parallel research and application efforts, the time investment has produced dividends of progress and lessons learned. More than ever, it is clear that early acquisition investment decisions must be cost-informed, and the demand for this early cost information is growing.

But how can cost estimates be developed so early with so little system definition? There are three major elements that enable Pre-Milestone-A cost estimating. The first is an analysis framework that can make use of qualitative capability data (along with any physical, technical, and performance data available at that time) to produce a cost estimate. The second is a cumulative high-level cost data source that links systems to their capability sets. The third is an analysis culture with the policy, procedure, and willingness to develop and/or accept cost estimates that are less precise than those developed at Milestone B or Milestone C.

The first element, the capability-based analysis framework, has been developed and is being continuously refined and applied under the ODASA-CE internal research efforts[1]. The second element, the high-level capability mapping coupled to cost data, has been developed, populated, and is growing as more data becomes available[2]. The third element, however, is one that involves more than mere research and data collection. It requires large-scale, department-wide culture change within and around the analysis

community. It is clear that, without this third element, an ample supply of elements one and two alone will not enable capability-based, early cost estimating.

Observations and Lessons Learned

Precision Considerations at Milestone A

The Concept Decision Experiment, underway within the Department of Defense since 2006, has placed very visible emphasis on leadership's commitment to making early investment decisions[3]. One of the main objectives of the experiment is to enable early concept decisions that evaluate a trade-space of material and non-material alternatives to fill capability gaps. The evaluation and selection of an alternative are to be cost- and risk-informed and coupled with some measure of how well the alternative fills the capability gap. The analysis vehicle that prepares this cost, risk, and effectiveness information for the Tri-Chair Review is the Evaluation of Alternatives (EoA). A desired outcome of this early investment decision-making is more stable defense acquisition programs.

Intuitively, the primary focus of the on-going research is how to enable early cost analysis (and its context). One of the terms used to describe the cost analysis required for early analyses like an EoA is "rough order of magnitude" or ROM[3]. However, the term *ROM* is problematic, in that it has a well-understood mathematical definition that does not apply to the common DoD use of the term. A more accurate way to characterize cost analysis at Concept Decision or Milestone A is to observe that the estimate range (indicating the range of probable costs) would be wider due to reduced system definition and greater uncertainty. To date, there has been no comprehensive

effort to characterize the form and expectation of EoA and Pre-Milestone-A analysis, and therefore, there is great diversity in interpretation across the department.

One analyst might believe a Pre-Milestone-A estimate is a range estimate based on one or more variables that gives reasonable level of confidence (75 percent, for instance). Another might believe it to be very similar to a Milestone B cost estimate (filling the many data gaps with assumptions) with the ability to perform single variable "what-if" cases. It is becoming clear that an unambiguous definition is needed of what a Pre-Milestone-A/EoA estimate is and what level of analysis is considered acceptable. At Milestone A or Concept Decision, if the system concept is at the level of maturity expected at that time (likely not well-defined), it would seem that the analysis should be something appreciably less detailed than at Milestone B. In fact, the level of system definition required to build a detailed cost estimate may not exist, or may require extensive "creative" assumption-making that may not be appropriate. Moreover, if the intent is to provide a way to distinguish between alternatives to inform prudent investment decisions, then a less precise estimate, coupled with risk ranges and measures, may be exactly what is required.

This is a key issue within the analysis community. At present, Milestone-B and -C decisions require the development of a Cost Analysis Requirements Document (CARD) that includes a lengthy system description with, ideally, all of the system detail required to build a cost estimate. In the opinion of some, this has created an expectation of a certain level of detail that is required to conduct cost analysis. In a few cases, it has also created an expectation of detail from customers of cost analysis. This expectation is certainly warranted in the case where great precision is needed. However, if a lesser

degree of precision is sufficient for Pre-Milestone-A decision-making, it can be conducted without stringent system descriptions.

Since early investment decisions must be cost-informed, this issue is not only critical within the analysis community, it is also critical to the success of early acquisition decision-making in general. A clear, detailed Pre-Milestone-A analysis guidance set, along with culture change within the analysis community and department at large, will be required.

Figure 1a and 1b illustrate this spectrum of cost estimate precision and cost analysis inputs required to obtain precision.

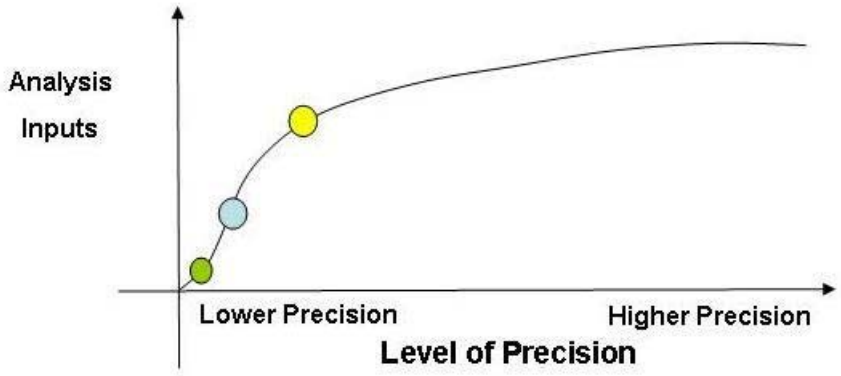

Figure 1a: Level of Analysis Precision In Relation to Analysis Inputs

Consider *Figure 1a*. It is intuitively clear that cost estimates can theoretically vary in precision from the lowest level of precision to an exactly precise value with no risk. To add precision to a completely imprecise estimate, we must provide analysis inputs----

things like system definition, or analysis resources (staff, money, and/or time). To progress further to a more precise and more detailed estimate with a narrower risk range, we add more of these analysis inputs. In short, we pay for precision. In the case of Pre-Milestone-A cost estimates, it is assumed that system definition is low. Greater system definition may only be achievable through extensive assumption-making. Therefore, analysis resources (such as time and money) are the most promising candidates for adding precision, but this will very likely introduce time delay or exorbitant costs. This addition of delay and cost negates a key intention of early decision-making: acquisition stability and streamlining through schedule compression and efficiency.

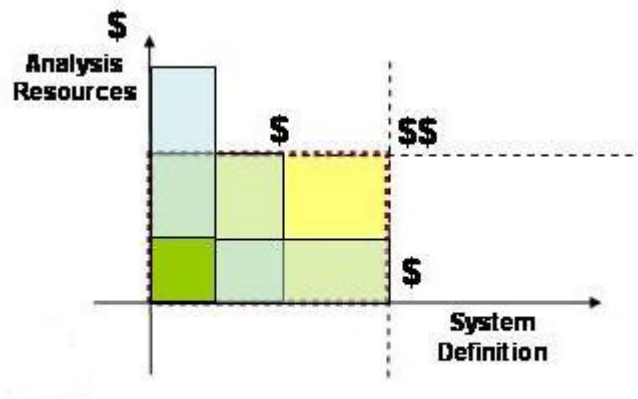

Figure 1b: Analysis Inputs to Cost Estimates

The colors in *Figure 1b* correspond to those in *Figure 1a*. It simply illustrates the idea that adding system definition or adding analysis resources (time, staff, etc.) is costly. In

the darker green area, we find an early capabilities-based estimate; relatively little system definition and few analysis resources are required. Moving out from there will require time, staff, or system definition and will generate a more precise and detailed cost estimate.

Probabilistically speaking, any one point estimate has a zero percent chance of being correct. As any cost analyst will confirm, risk analysis is an important element of any cost analysis result. It is also important to note that a Pre-Milestone-A point estimate is not very informative on its own----it must include a risk analysis or a cost range to capture the uncertainty associated with the estimate. As we add precision by adding system definition and/or analysis resources, our certainty around the associated point estimate will narrow. Intuition indicates that the range around the point cost estimate will narrow as we move from Milestone A to Milestone B to Milestone C (see *Figure 2* below).

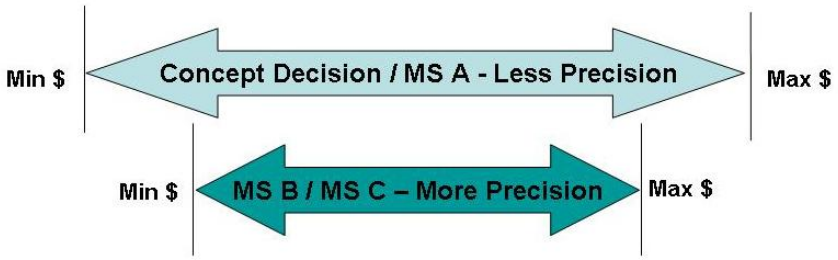

Figure 2: Impact of System Maturity on Estimate Precision

Enabling Department-Wide Capabilities-Based Cost Analysis

One of the first tasks undertaken by the team was to devote significant research and data collection time to searching for a standardized, broad set of capabilities. This capability set had to be unambiguous in language, extremely precise in description, and valid for use as a classifier or variable. Although the immediate intuition led us to the Joint Capability Areas (JCA) or Joint Integrated Activity Sets (JIAS), our efforts to conform these architectures to our particular requirements yielded little.

The Functional Capabilities Board (FCB) within the Department of Defense is a capabilities-based management system within the Joint Capabilities Integration Development System (JCIDS), which provides a means of distinguishing among different purposes of strategic capabilities. The FCBs are responsible for ensuring that new capabilities are developed with a joint warfighting context; organizing, analyzing and prioritizing capabilities proposals; supervising development and updating of functional concepts; and ensuring that integrated architectures are reflective of their functional area. The JCAs are closely linked to the FCBs, and are currently under a re-baselining process. The JCAs are intended to provide a "common language to discuss and describe capabilities across many related Department activities and processes.[4]" Though the JCA structure is invaluable in understanding how capabilities-based management and communication happens and is comprehended within the department, the JCA structure does not provide a direct translation to variables for parametric modeling. However, it is quite clear that the JCA must be directly related to any architecture built to enable capability-based modeling.

In light of this, the research team set forth to develop a capability modeling framework based on a need for specific, distinguishable, and analysis-ready variables. It uses plainly-worded, high-level capabilities like “Move”, “Shoot”, “Communicate”, “Sense Environment”, and “Sustain” (for example), and then drills down into them. It enables the analyst to ask questions such as, “Does my Pre-Milestone-A solution *Move*?” and be able to identify an unambiguous “yes” or “no” answer. The initial framework has developed, refined, and augmented into what we believe is a suitable structure for capabilities-based parametric data analysis. This architecture is directly linked to the JCA so that Department capability gaps can directly translate to capability-based analysis. However, this is certainly a living document that changes as we learn more about the department’s currently-acquired and future capabilities.

Through the development of internal capabilities-based cost pilots, we have demonstrated that the developed capability structures and definitions are rigorous enough to be used in parametric cost estimating, but if capability-based cost analysis is to be useful and effective throughout the department, a universal understanding of the requirements for capability-based analysis must be in place, and a consensus must be reached on how to define and apply capability variables.

Conclusions

The department-wide efforts over the past two years to enable early investment decision-making have demonstrated the level of difficulty inherent in achieving such an objective. It is clear that a commitment to the fiscal responsibility and long-term acquisition stability that Pre-Milestone-A decision-making can provide will require far-reaching culture change and a willingness to look beyond the typical issue set. Pre-

Milestone-A analysis is the foundation upon which investment decision-making is built, and it is important to note some of the most challenging obstacles to building this foundation. The required level of analysis and cost estimate detail must be clearly specified, so that ambiguity is kept to a minimum. Additionally, the body of analysts within the department must reach a common understanding of how to define and frame capability information in order to enable capability-based analysis that is universally understood. Change is not easy and inertia is difficult to counter, but, for early investment decisions to be successful, the forces of friction that prevent effective Pre-Milestone-A analysis must be overcome.

1 Roper, Martha. “Capabilities-Based Costing: Approaches to Pre-Milestone A Cost Estimating.” *Armed Forces Comptroller*. Vol. 52. No. 2. Spring 2007. pp. 24-28.

2 Roper, Martha. “Pre-Milestone-A Cost Estimating”. Joint *ISPA/SCEA International Conference and Workshop*. 14 June 2007.

3 “The Concept Decision Review and Time-Defined Acquisition: A Working Description of Concepts, and supporting Evaluation of Alternatives”. 19 June 2006. 7pp.

4 Secretary of Defense Memorandum dated May 6, 2005.