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Control of Total Ownership Costs of DoD Acquisition Development Programs Through Integrated Systems Engineering Processes and Metrics

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Preface & Acknowledgements

During his internship with the Graduate School of Business & Public Policy in June 2010, U.S. Air Force Academy Cadet Chase Lane surveyed the activities of the Naval Postgraduate School's Acquisition Research Program in its first seven years. The sheer volume of research products—almost 600 published papers (e.g., technical reports, journal articles, theses)—indicates the extent to which the depth and breadth of acquisition research has increased during these years. Over 300 authors contributed to these works, which means that the pool of those who have had significant intellectual engagement with acquisition issues has increased substantially. The broad range of research topics includes acquisition reform, defense industry, fielding, contracting, interoperability, organizational behavior, risk management, cost estimating, and many others. Approaches range from conceptual and exploratory studies to develop propositions about various aspects of acquisition, to applied and statistical analyses to test specific hypotheses. Methodologies include case studies, modeling, surveys, and experiments. On the whole, such findings make us both grateful for the ARP's progress to date, and hopeful that this progress in research will lead to substantive improvements in the DoD's acquisition outcomes.

As pragmatists, we of course recognize that such change can only occur to the extent that the potential knowledge wrapped up in these products is put to use and tested to determine its value. We take seriously the pernicious effects of the so-called "theory–practice" gap, which would separate the acquisition scholar from the acquisition practitioner, and relegate the scholar's work to mere academic "shelfware." Some design features of our program that we believe help avoid these effects include the following: connecting researchers with practitioners on specific projects; requiring researchers to brief sponsors on project findings as a condition of funding award; "pushing" potentially high-impact research reports (e.g., via overnight shipping) to selected practitioners and policy-makers; and most notably, sponsoring this symposium, which we craft intentionally as an opportunity for fruitful, lasting connections between scholars and practitioners.

A former Defense Acquisition Executive, responding to a comment that academic research was not generally useful in acquisition practice, opined, "That's not their [the academics'] problem—it's ours [the practitioners']. They can only perform research; it's up to us to use it." While we certainly agree with this sentiment, we also recognize that any research, however theoretical, must point to some termination in action; academics have a responsibility to make their work intelligible to practitioners. Thus we continue to seek projects that both comport with solid standards of scholarship, and address relevant acquisition issues. These years of experience have shown us the difficulty in attempting to balance these two objectives, but we are convinced that the attempt is absolutely essential if any real improvement is to be realized.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the Acquisition Research Program:

- Office of the Under Secretary of Defense (Acquisition, Technology & Logistics)
- Program Executive Officer SHIPS
- Commander, Naval Sea Systems Command
- Army Contracting Command, U.S. Army Materiel Command
- Program Manager, Airborne, Maritime and Fixed Station Joint Tactical Radio System

- Program Executive Officer Integrated Warfare Systems
- Office of the Assistant Secretary of the Air Force (Acquisition)
- Office of the Assistant Secretary of the Army (Acquisition, Logistics, & Technology)
- Deputy Assistant Secretary of the Navy (Acquisition & Logistics Management)
- Director, Strategic Systems Programs Office
- Deputy Director, Acquisition Career Management, US Army
- Defense Business Systems Acquisition Executive, Business Transformation Agency
- Office of Procurement and Assistance Management Headquarters, Department of Energy

We also thank the Naval Postgraduate School Foundation and acknowledge its generous contributions in support of this Symposium.

James B. Greene, Jr.
Rear Admiral, U.S. Navy (Ret.)

Keith F. Snider, PhD
Associate Professor

Panel 16 – Contributions of Systems Engineering to Effective Acquisition

Thursday, May 12, 2011	
9:30 a.m. – 11:00 a.m.	**Chair: Rear Admiral John Clarke Orzalli,** USN, Vice Commander, Naval Sea Systems Command ***Control of Total Ownership Costs of DoD Acquisition Development Programs Through Integrated Systems Engineering Processes and Metrics*** Paul Montgomery and Ron Carlson, NPS ***Applying an Influencer Approach to Ingrain Systems Engineering into Pre-Milestone B Defense Programs*** Bob Keane, Ship Design USA, Inc. ***Factors Influencing the Effectiveness of Systems Engineering Training and Education in the Department of Defense*** William Fast, NPS

Rear Admiral Orzalli—Vice Commander, Naval Sea Systems Command (NAVSEA). Rear Admiral Orzalli is the son of a retired Navy captain. He graduated with distinction from the U.S. Naval Academy in 1978.

At sea, he served aboard USS *Snook* (SSN 592) as an engineering division and weapons officer; and as USS *Helena's* (SSN 725) engineering officer. Ashore, Orzalli has served at the U.S. Naval Academy, as well as tours at naval shipyards in Mare Island, Puget Sound, and Portsmouth.

Orzalli was the 45th shipyard commander at Puget Sound Naval Shipyard from 2002–2005. During his command tour, he assumed additional duties in establishing the Northwest Regional Maintenance Center. Following selection to flag rank, Orzalli was the deputy director, Fleet Readiness Division, OPNAV (N43B); commanding officer, Mid-Atlantic Regional Maintenance Center, then established commander, Regional Maintenance Centers.

Most recently, Orazalli was the director, Fleet Maintenance on the staff of commander, U.S. Fleet Forces Command. His service decorations include the Legion of Merit (with four stars), the Meritorious Service Medal (with two stars), Navy Commendation Medal (with star), Navy and Marine Corps Achievement Medal (with three stars) and various other unit and operational awards.

Orzalli holds a Bachelor of Science in Marine Engineering from the U.S. Naval Academy, Naval Engineer, a Master of Materials Science and Engineering from Massachusetts Institute of Technology, and a Master of Science in Systems Management from Golden Gate University.

Control of Total Ownership Costs of DoD Acquisition Development Programs Through Integrated Systems Engineering Processes and Metrics

Paul Montgomery—After retiring in 1990 from a 20-year career in the Navy, Dr. Montgomery served as a Senior Systems Engineer with Raytheon and Northrop Grumman corporations and developed communications, surveillance, and sensor systems for commercial, military (USN, USA, USAF), and intelligence communities (NSA, NRO). He earned his doctorate in Systems Engineering from George Washington University (D.Sc. 07) performing research related to cognitive/adaptive sensors, MSEE (1987) from Naval Postgraduate School, and BSEE (1978) from Auburn University. The International Council on System Engineering (INCOSE) certifies him as an Expert Systems Engineering Professional (ESEP). Dr. Montgomery is an SE Department–embedded faculty member providing onsite research and instruction support to NAVAIR (Patuxent River, MD), NAVSEA (Dahlgren, VA, Carderock, MD), and NPS SE students in the Nation Capital Region. [prmontgo@nps.edu]

Ron Carlson—Mr. Carlson served 26 years in Naval Aviation as a pilot, seven years of which were at NAVAIR, where he led NAVAIR Systems Engineers through several years of systems engineering revitalization to the NPS SE Department. He is currently in the Systems Engineering doctoral program at Stevens Institute of Technology. He earned master's degrees in Strategic Studies and National Policy from the Naval War College and Business Administration-Aviation from Embry Riddle Aeronautical University and his Bachelor of Science in Nuclear Engineering from the University of Michigan. Mr. Carlson is an SE Department–embedded faculty member providing onsite research and instruction support to NAVAIR (Patuxent River, MD), NAVSEA (Dahlgren, VA, Carderock, MD), and NPS SE students in the Nation Capital Region. [rrcarlso@nps.edu]

Abstract

Many DoD weapon systems acquisition programs are exceeding their original estimates for total ownership costs. There are probably many contributing factors to this cost growth, but is Systems Engineering (SE) one of them? How can systems engineering processes, methods, and practices be improved to better control total ownership cost growth in DoD acquisition programs? This paper discusses research in developing an understanding of how SE can be optimized for developing high confidence estimates and better control of acquisition program total ownership costs (TOC). Although this research is in the very early stages, we discuss the technical approach to investigating systems engineering methods and practices related to TOC as executed at one of the Navy's major system acquisition commends (Naval Air Systems Command-NAVAIR). We discuss very preliminary findings and set the stage for further research results.

Background

Total Ownership Cost (TOC) Definitions

Many DoD weapon systems acquisition programs are exceeding their original estimates for total ownership costs. There are probably many contributing factors to this cost growth, but is Systems Engineering (SE) one of them? How can systems engineering processes, methods, and practices be improved to better control total ownership cost growth in DoD acquisition programs? This paper discusses research in developing an understanding of how SE can be optimized for developing high confidence estimates and better control of acquisition program total ownership costs (TOC). Although this research is in the very early stages, we discuss the technical approach to investigating systems engineering methods and practices related to TOC as executed at one of the Navy's major system acquisition commends (Naval Air Systems Command; NAVAIR). We discuss very preliminary findings and set the stage for further research results.

Before proceeding further, it would be useful to establish definitions for TOC. In general, TOC is made up of four categories of cost that are incurred during the system acquisition lifecycle. These are not completely independent but overlap and are associated with four major phases of the system lifecycle. TOC is comprised of the following:

- Research and development cost that extend from the concept phase to the technology development phase and through to development and demonstration,
- Costs associated with system production,
- Operations and support cost during sustainment phase, and
- Disposal and retirement costs.

Another broad definition of TOC is that "TOC is comprised of costs to research, develop, acquire, own, operate, and dispose of weapon and support systems, other equipment and real property, the costs to recruit, train, retain, separate and otherwise support military and civilian personnel, and all other costs of business operations of the DoD" (Gansler, 1998).

A more specific example of how TOC elements can be decomposed can be found in Figure 1. This figure is derived from NAVAIR discussions and their perspective of aviation weapons systems acquisitions. TOC, therefore, includes many components of cost that go well beyond simply the initial acquisition of the system.

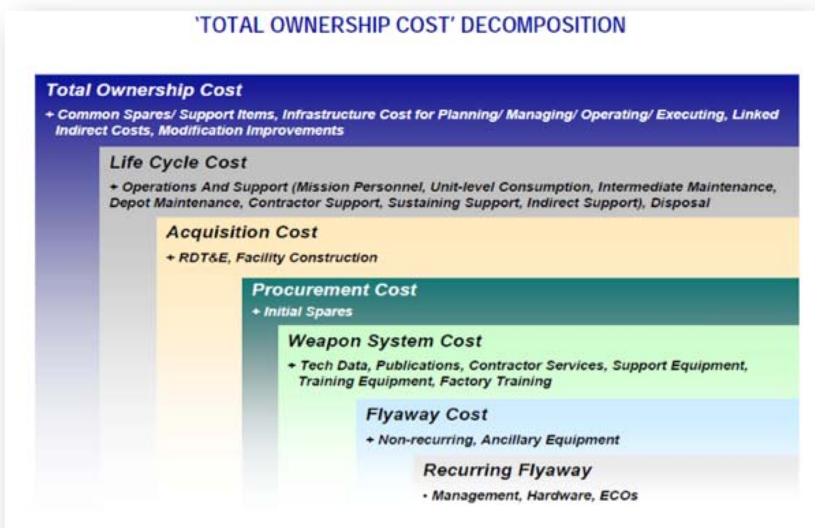

Figure 1. Total Ownership Cost Components at NAVAIR

DoD Acquisition Total Ownership Cost Concerns

DoD systems are often acquired with operational performance in mind during the engineering phase. For warfare systems, this is entirely appropriate as the systems are usually employing leading technology, operate in challenging environments, and their failure can result in potentially cataclysmic national impact. The acquisition of warfare systems has, however, manifested a higher total ownership cost over the lifetime of the system then was either predicted or anticipated when the program was originally made a program of record. Considerations for how a system would operate beyond the acquisition cycle has often fallen to the logisticians, maintainers, supply chain analysts, and communities involved with operations and maintenance. The total cost of operating the systems, however, during these phases can easily exceed 50% of the total cost of the system from birth until retirement.

While design for performance remains the key objective for systems acquisition, designing for affordability is emerging as a key companion objective which may require new system engineering practices, trade-off analyses, optimization and value assessment, and other modifications to the system engineering methodologies currently employed in a performance-first focus. Additionally, system engineering, logistics, and program organizational realignments also may be necessary to influence the entire enterprise to ensure that design for affordability is increased in stature as compared to design for performance. New methods of engineering emphasis on governance and analysis appear to be needed as major military acquisitions continue to exceed total ownership cost objectives and estimates.

Senior leaders in the DoD and the Navy have started to apply new emphasis to the reduction of total ownership cost (R TOC) of systems. This emphasis and reduction in total ownership costs has resulted in pilot programs that examine logistics, maintainability, and supply chain management issues that are intended to discover ways to improve readiness and reduce logistics footprint (Wynne, 2003). This has spawned research dedicated solely to reduction of TOC but often from a management (vice engineering) perspective (Boudreau, 2003). Recently, the Chief of Naval Operations stated that total ownership costs will become a priority at beginning of program start: “I tell my leaders if we’re going to talk about a program or policy we’re going to start with the discussion of total ownership costs before we get on to anything else. That’s absolutely key” (Roughead, 2010).

Additionally, to increase the visibility and measurability of affordability of a program, the Under Secretary of Defense has recently recommended that affordability be mandated as a requirement in any program (Carter, 2010).

It is well understood that the determining factors of total ownership cost are established early in the development of the system. The design decisions, architectures, logistics strategies, and operational concepts all are established early and, in effect, “set in concrete” the destiny of the overall lifecycle cost of the system. As shown in Figure 2, some chronic TOC problems are starting to show up where early estimates of total ownership cost have proven to be inaccurate, which brings unpleasant surprises later in the lifecycle of systems that have been deployed. This error in estimation or the inability to control ownership cost is causing significant perturbations to the operational and sustainment (O&S) budgets within the DoD.

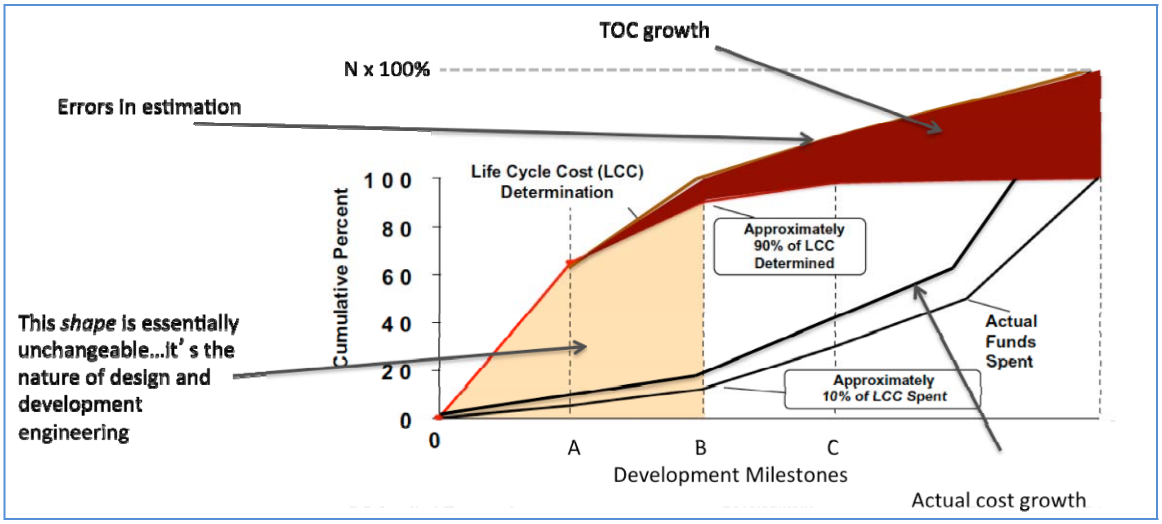

Figure 2. Dimensions of Total Ownership Cost Growth in the Acquisition Cycle

Note. This figure was derived from Eggenberger (2010).

As shown in Figure 3, these O&S costs can represent 70–80% of the total program cost. The question remains, if the trajectory of total ownership costs is set early in the design phase of a program acquisition, what can be done during those early phases to improve the accuracy of the estimates and ultimately the control of the cost later in the lifecycle?

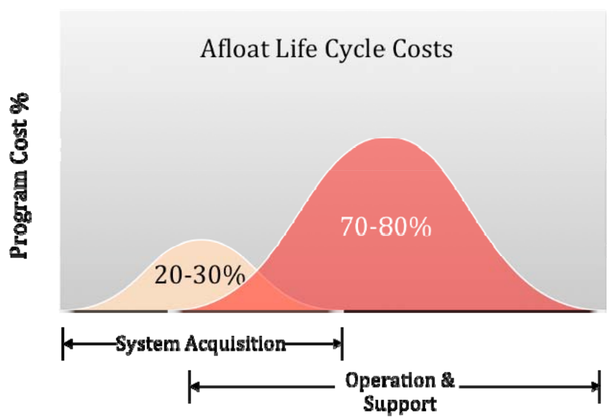

Figure 3. Distribution of Key TOC Components

(Eggenberger, 2010)

NAVAIR TOC Research

Problem Definition

The Naval Air Systems Command (NAVAIR) is a highly experienced and technical system acquisition organization that acquires U.S. Navy's aircraft and supporting systems. They have robust engineering and logistic processes that shepherd the acquisition of new systems into the Naval aviation enterprise. NAVAIR realizes, as with the other systems commands, that the estimation and control of TOC remains a challenge, especially in this era of high-tempo combat operations. An investigation is underway to examine whether or not specific processes can be improved to increase TOC estimation accuracy and control.

The System Engineering Development and Implementation Center (SEDIC) at NAVAIR has been investigating how the earliest system engineering activities influence TOC estimation accuracy and control and whether or not the system engineering activities can be improved upon. The authors have participated with the SEDIC to assist in the development of improved system engineering solutions and also to examine the opportunity to develop new SE metrics and tools to the larger system engineering community. Specific problems and research questions that we've established are listed as follows:

- **Problem:** Systems engineering (SE) is optimized for designing for best system performance but may not be aligned, prioritized, or defined well to designing for affordability and TOC objectives.
    - **Research Question 1:** How does SE contribute to TOC estimation, reduction, and control objectives and activities?
    - **Research Question 2:** Can SE activities be improved, better defined, or integrated into other TOC reduction activities to improve TOC estimation and control?
    - **Research Question 3:** Can TOC metrics be developed and integrated into SE and program activities and toolsets to quantitatively develop TOC KPPs, KSAs, MOEs, etc., and quantitatively assess program performance against those metrics?

This research positions itself between the system engineering activities that are typically associated with designing for performance and the system engineering activities and logistics activities which are often considered to be designing for affordability (see Figure 4). The research is attempting to find best practices that are successful in developing accurate TOC strategies as well as assisting in identifying improvements and linkages among these methodologies.

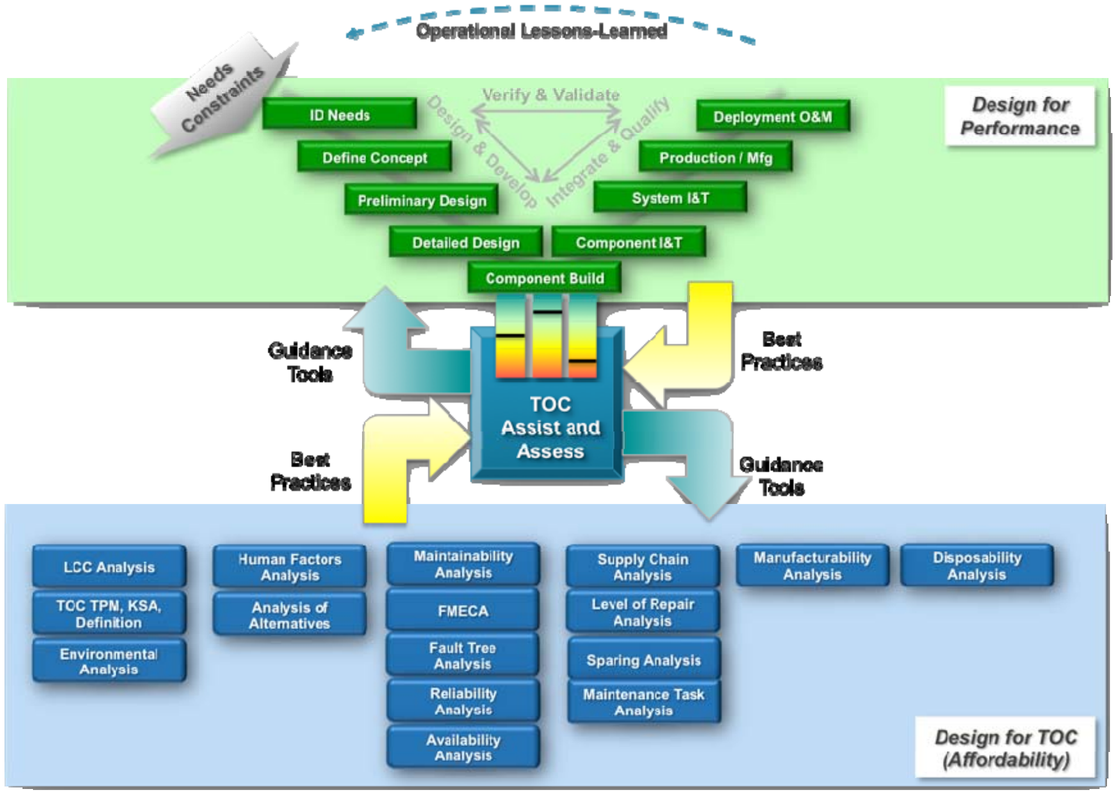

Figure 4. This Research Focuses at the Intersection of Design for Performance and Design for Affordability Methods and Practices

Previous and Related Methodologies

The estimation, measurement, and control of acquisition costs is not a new topic, nor is there a lack of techniques that are intended to control such costs. This research is highly focused on the early system engineering activities and how they can directly impact TOC estimation and control. We acknowledge proven bodies of knowledge and methodologies and will not reinvestigate or replicate but, rather, will attempt to integrate the most applicable facets of those methodologies into any SE methodology we may be able to discover. In particular, methodologies associated with (1) value methodology, (2) O&S cost engineering, (3) design to cost, and (4) cost as an independent variable form a substantial foundation upon which to build. Each of these disciplines, however, brings their own perspective to cost estimation and control and may be enriched by enhancing with system engineering activities that are also focused and similar areas. Following discussions highlight how these different existing disciplines are focused.

Value Methodology

Value methodology (VM; also Value Engineering, VE), is a structured approach used to analyze manufacturing products and processes, design and construction projects, and business and administrative processes. VM helps achieve balance between required functions, performance, quality, safety, and scope with system cost. The proper balance results in the maximum value for the project where value is often the ratio of cost-to-functionality (SAVE, 2011).

Value methodology is often implemented through a process consisting of a series of activities, including:

- Mission and requirements definition,
- Functional analysis,
- Alternative synthesis, and
- Evaluation, trade-off, and selection.

This methodology is mature and SE has inherited and incorporated many of the VM tenants in Functional Analysis and Allocation, Requirements Engineering, and System Analysis processes. Applicability to this research is the proposition of "value" and how that assessment relates to the "value" metrics of TOC.

Cost Engineering

The Operating and Support (O&S) Cost element structure is often divided into six major categories: (1) personnel, (2) operations, (3) maintenance, (4) sustainment support, (5) system improvements, and (6) indirect support (OSD, 2011). At NAVAIR, the cost process includes the following activities:

- Break-Even Analysis,
- Present Value Analysis,
- Regression Analysis,
- Forecasting,
- Sensitivity Analysis,
- Should Cost Analysis,
- Cost Modeling,
- Financial Analysis,
- Cost Data Analysis,
- Proposal Analysis,
- Overhead Analysis,
- Rate Analysis,
- Engineering Cost Analysis, and
- Learning Curve Application. (NAVAIR, 2011)

The varied analysis and modeling activities mentioned previously are highly dependent on accurate, high-fidelity engineering inputs in order to produce high-confidence cost estimates. The focus of this research is not to explore different cost engineering methodologies, but rather to discover better ways of performing systems engineering to produce more meaningful, relevant, accurate, high-confidence information that serve as inputs to the models and estimate analyses of cost engineering; all with a focus on TOC.

Design-to-Cost (DTC) and Cost-as-an-Independent-Variable (CAIV)

The Design-to-Cost (DTC) methodology focuses upon projected average unit production costs (with O&S as a second-order factor). We feel the DTC process and metrics may often work against control of TOC. With the emphasis on production costs, the program management team may obscure the long-term TOC issues during development in order to satisfy DTC objectives.

Cost-as-an-Independent-Variable (CAIV) is another methodology (like DTC) that uses cost as an end goal. In CAIV, cost is treated as an independent variable among the three variables traditionally associated with a defense acquisition program: cost, schedule, and performance. Cost is “fixed” and other variables traded off against the fixed constraint of cost. Most often, the “cost” associated with CAIV are, indeed, total program and life cycle costs (i.e., TOC). The control or reduction of estimated future life-cycle costs are considered as important as trade-offs to meet the schedule and performance thresholds (Land, 1997).

We anticipate that CAIV methodologies are very closely related to the end goals of this research. Our thesis is that CAIV methods are only as good as the inputs received to perform meaningful cost trade-offs. The goal is to improve those inputs and processes related to SE to improve upon CAIV, where used. Additionally, we are searching to find opportunities to decompose CAIV into other components such as RMA (reliability, maintainability, and availability) as an independent Variable (MAIV), or TOC as an independent variable (TAIV), etc.

NAVAIR Technical Approach

The technical approach for this research is shown in Figure 5. The desired outcomes are to publish best practices to the system engineering (primarily), competency engineering (e.g., aero engineering, mechanical engineering, etc.), logistics, and program management communities at NAVAIR. We also seek to improve existing review processes (i.e., SE Technical Reviews, SETR). Finally, we want to identify and be able to assess metrics that emerge from system engineering that can provide program and engineering managers an assessment of the confidence of their program’s TOC posture.

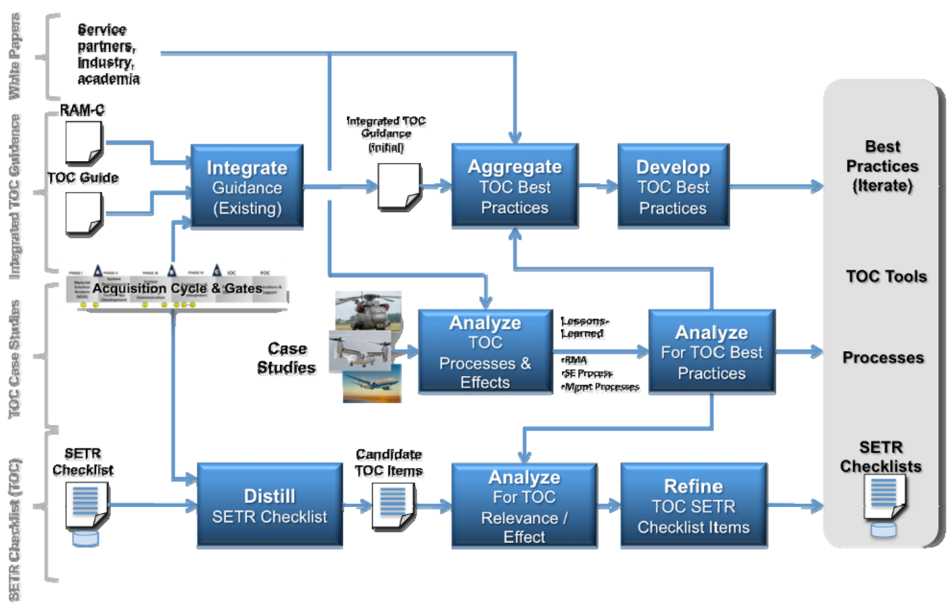

Figure 5. Technical Approach to TOC Research at NAVAIR

As stated in the previous section, we are leveraging well-established methods within the DoD and in industry that are supported by recent academic research (e.g., CAIV, cost engineering, etc.). Using that as a baseline, we are integrating emerging standards related to TOC or reliability, availability, and maintainability into a first-order guidance that is aligned to the acquisition cycle milestones and gate reviews. Currently, NAVAR uses a checklist tool that aids the program and engineering managers to navigate the technical review process (SETR), and we are evaluating how design considerations related to TOC are included in those lists in a relevant and clear manner, as well as considered early and continually throughout the acquisition process. Finally, we are examining various acquisition program case studies to understand where they encountered problems in TOC estimation or control to understand best practices or common themes that could reveal necessary remediation in the system engineering methods.

Current Findings

Case study analysis, interviews, documentation integration, and process improvement activities are in early phases and have yet to generate major discoveries. This paper, however, lays out the technical approach and strategy with some early findings that will set the stage for continuing dialogue and discussion as this research proceeds.

Throughout many interviews with engineers experienced with system development at NAVAIR, certain themes are emerging. The impacts to TOC growth, in many cases, could be categorized as caused by operational, process, and/or design issues (see Figure 6). Unanticipated operational tempo or harsh real-world environments caused TOC growth from the exigencies of combat operations that were not anticipated, and these operations were conducted in particularly harsh environments (e.g., heat, sand, etc.). Some of the aircraft systems were of unusually high complexity and introduced new technologies unlike previous aircraft. This dissimilarity made early TOC estimates difficult with high degrees of uncertainty. Finally, processes and analyses associated with reliability, maintainability, and availability (RMA) and integrated logistics support (ILS) analyses were challenged at early design phases; that also resulted in high variance in final TOC. These three dimensions appear to have strong mutual coupling of their dependencies and each have impacts on TOC. The intent is to discover these independencies and correlated effects through case study analysis.

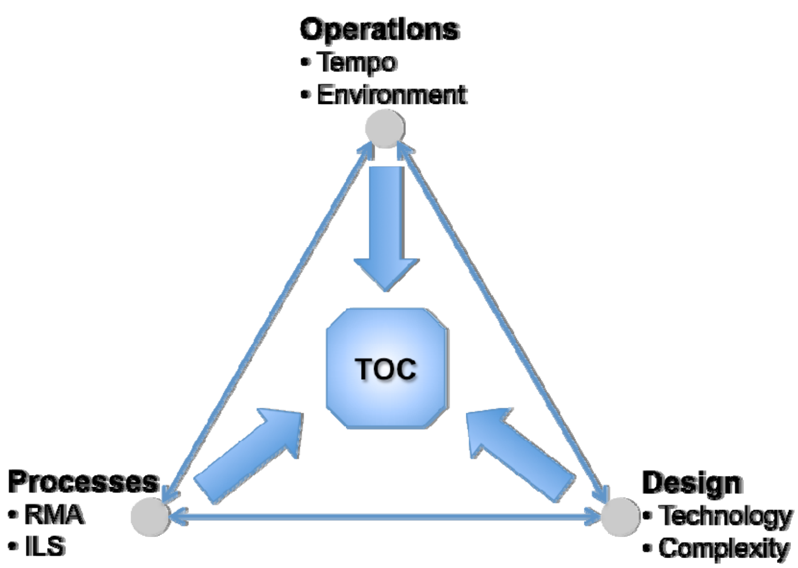

Figure 6. Key Contributors to TOC Derived From Case Studies

Documentation and Guidance

As we examine the emerging guidelines for TOC and reliability, maintainability and availability, we found through interviews and user interaction that the documentation had not been placed into common usage. It became apparent that many documents brought different perspectives that were difficult for the engineering teams to reconcile. In other cases, the documentation did not translate well into the design phase or acquisition process of the program. Additionally there was little quantitative help in either of the documents.

We were able to parse and aggregate the emerging standards and documentation where appropriate to align the relevant portions of each to the proper technical reviews, major milestones, and associated gate reviews. Currently, we have integrated that information into a tool that is web-based and are now exposing the engineering community to the tool to get feedback as to its effectiveness.

Figure 7 depicts an example of how portions of documentation are being aggregated to align with the major milestones, and Figure 8 indicates a similar alignment of the documentation to the gate reviews. The web-based tool allows the user to investigate which TOC issues need to be addressed prior to the reviews or the milestones as they progress in the development cycle.

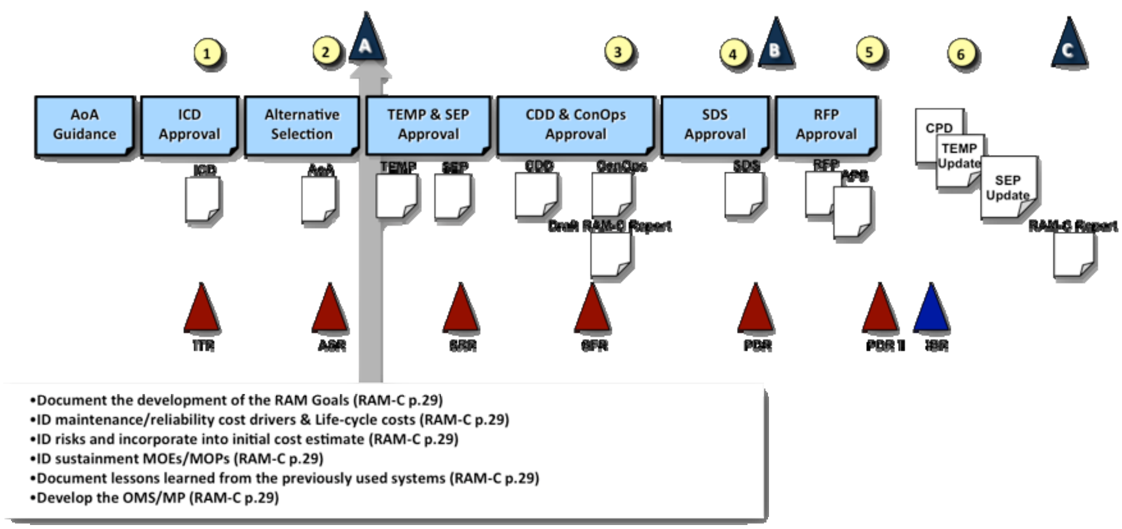

Figure 7. Integrating Standards and Aligning to Major Acquisition Milestones

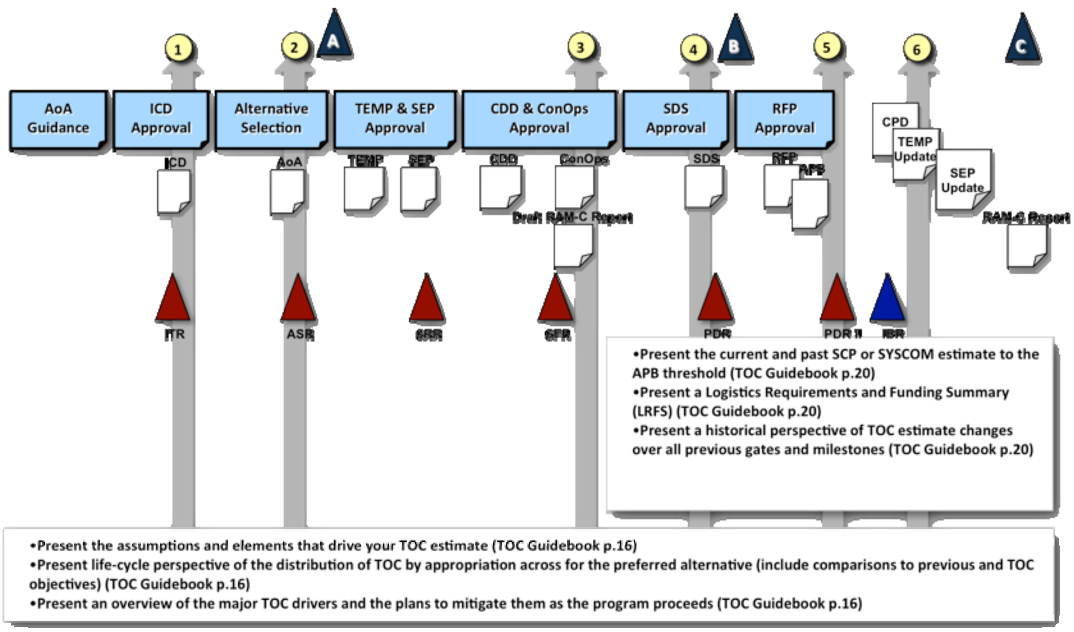

Figure 8. Integrating Standards and Aligning to Gate Reviews

Technical Review Checklist

We are carefully reviewing the large body of SE technical review items that are currently used in the NAVAIR SETR checklists for applicability to TOC. We are exploring specific checklist items that pertain to TOC, how the language of the checklist item can be strengthened relative to TOC objectives, timing of the items, and whether they expose or stimulate necessary engineering activity to help increase TOC estimation accuracy at the correct phase of an acquisition. Figure 9 indicates an early assessment of how many TOC related checklist items are addressed at each design review as prescribed by current checklist policy. Although this data is very preliminary, it does support how design decisions related to TOC are most appropriately applied early in the program. The results of this activity will be to produce a set of refined and more directed checklist items (relative to TOC) they can be reintegrated into the existing web-based checklist tool.

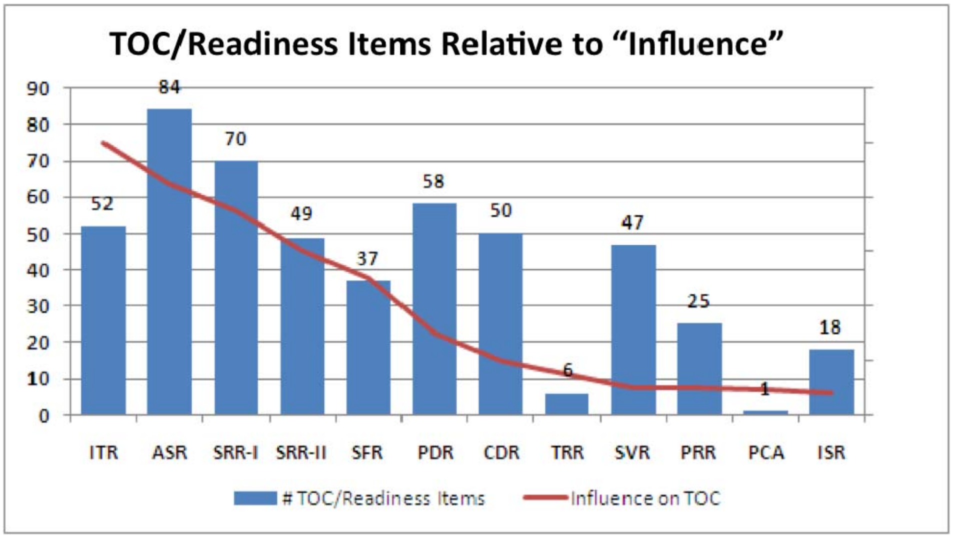

Figure 9. TOC-Related SETR Checklist Items Appear Appropriately Front-Loaded During Acquisition

Reliability Analysis

Initial case study interviews indicate there is a strong correlation between the early reliability and maintainability analysis performed on the program and the quality of assessing the TOC of the program. It's generally accepted at the working level that reliability analyses that are performed during the early design phases have a high degree of uncertainty because of the many undefined features of the system that is being designed. As the design proceeds, reliability analyses become more accurate as they reflect more and more actual components that will comprise the system. Unfortunately, early program TOC estimates must be based on these early reliability analyses which, when published, can overly bias the later TOC estimates that use the refined RMA data, thus creating high variance in total program TOC control. We will continue to investigate process improvements, additional metrics, and the strength of correlation between TOC growth and early reliability estimations.

Cost Modeling

Early coordination with cost estimation organizations confirms that while those organizations have high confidence in the cost models, the models themselves and the resulting outputs are, of course, dependent on the quality of input. Currently we are investigating inputs to the cost model related to the technical baseline of the system, spare parts, depot level repair strategy, and related supply chain issues, as these are indicating a strong impact on model performance.

SE Process Alignment

Together with aggregation of emerging standards into a guidance document, we are also investigating how to align SE processes to the TOC objective and also maintain alignment with technical reviews and gate reviews. As shown in Figure 10, we are starting to model and posit alignment of SE activities that will be explored further and validated within the NAVAIR community.

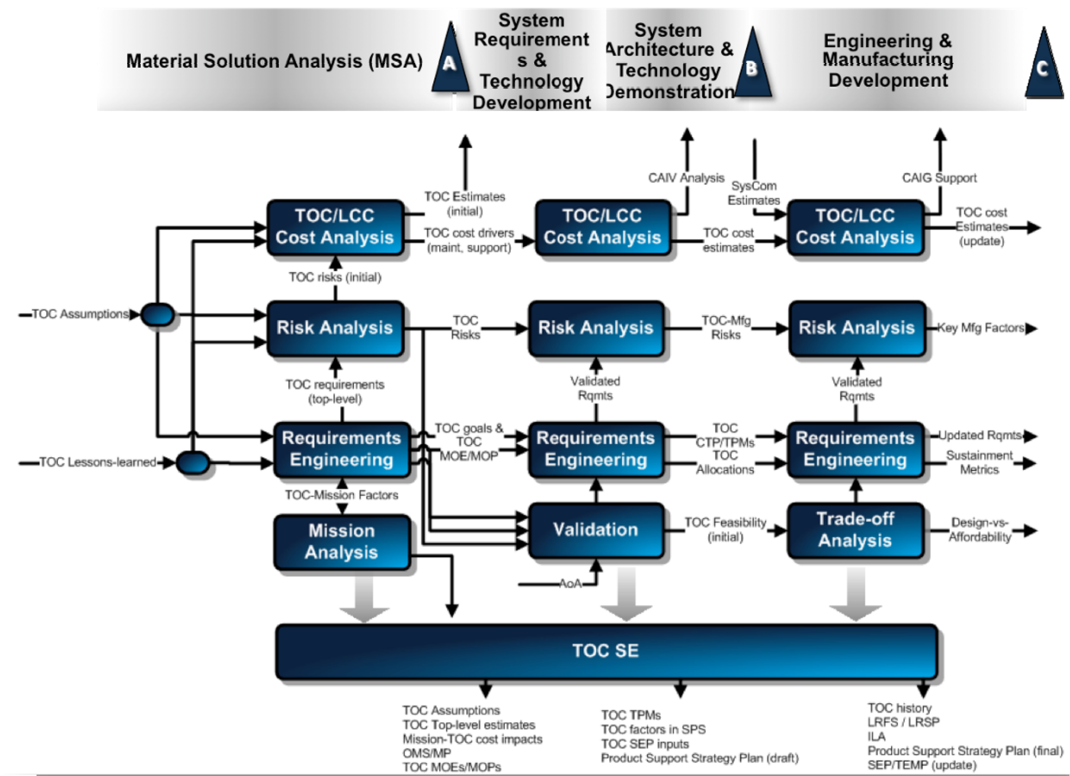

Figure 10. Initial SE TOC-Related Process Alignment to Acquisition Cycle

Summary and Future Research

This research investigates how SE processes and methods can be improved to increase the fidelity of TOC estimation and, ultimately, TOC control at NAVAIR. Early findings are beginning to point to the conclusion that there are opportunities for improvement both in SE processes but also the tools and documentation and guidance which is distributed throughout the organization.

We are investigating existing documentation and integrating that documentation into guidelines that are meaningful to TOC. We are trying to enrich existing tools (with TOC relevance) that guide engineering and acquisition teams through the technical development and review process. We are investigating historical and ongoing aircraft acquisition programs to discover best practices and to reveal opportunities for processes to improve TOC. Finally, we are in the early phases of uncovering SE metrics that may aid in the development of tools for the program management and engineering management teams to assess the TOC posture of their program. Further research will continue along the activities outlined in this paper and will be shared in subsequent papers and forms.

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Disclaimer

The opinions in this paper are the authors' and do not necessarily reflect the opinion of NAVAIR or the SEDIC team members.