Activity Based Costing Efforts

Related to Advances in Total Ownership Cost Management for Aircraft Carriers

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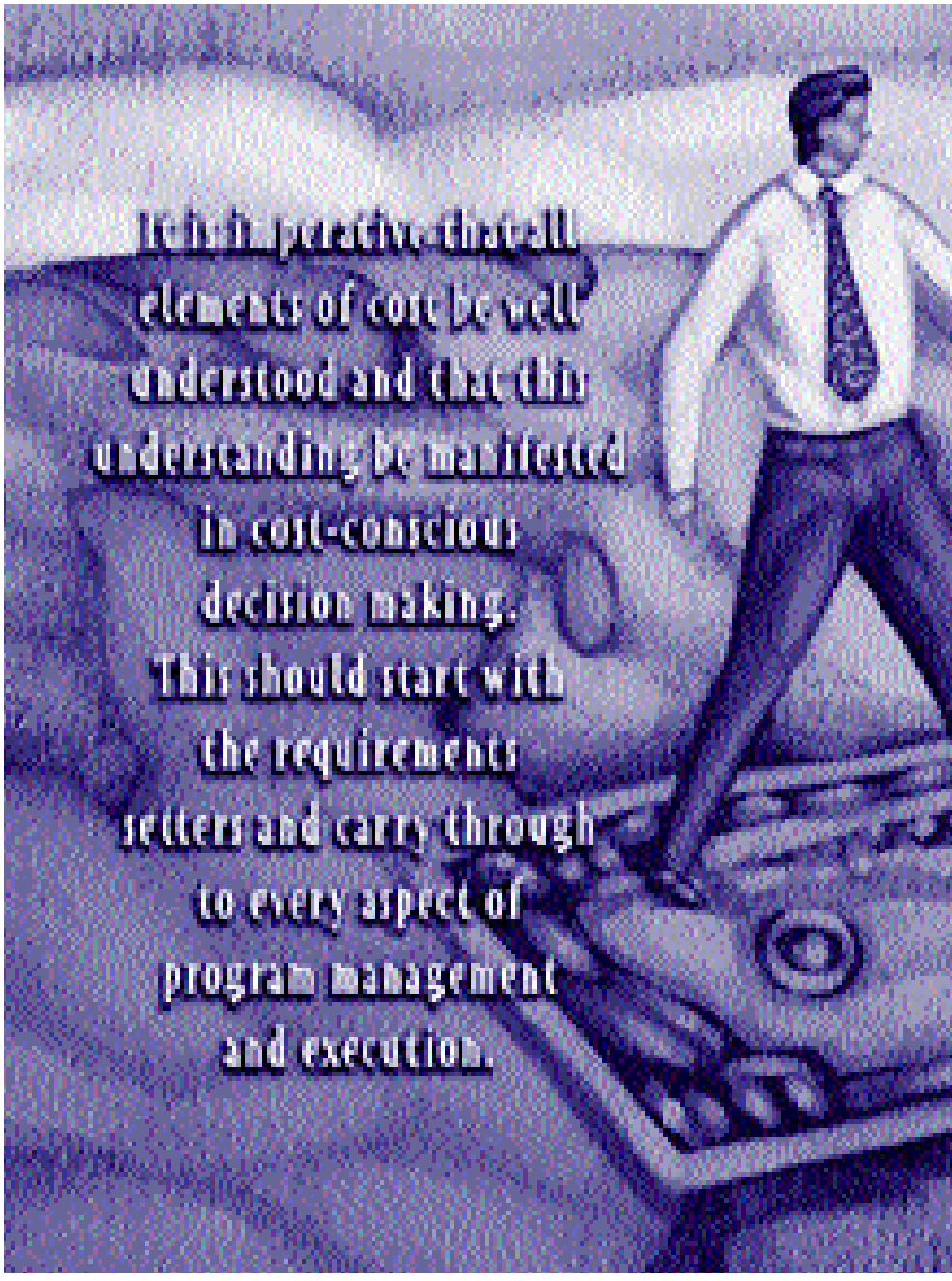
This article condenses and updates "Advances in Aircraft Carrier Life Cycle Cost Analysis for Acquisition and Ownership Decision Making," by Stephen J. Moretto and Irvin M. Chewning, published in the May 2000 *American Society of Naval Engineers Journal*.

The U.S. Navy recently conducted an Analysis of Alternatives (AOA) to set the stage for determining the characteristics and acquisition strategy for its next generation aircraft carrier. The platform design selected is expected to be in service throughout the 21st century. The issue of affordability is paramount as aging systems become more expensive to operate and maintain.

Meaningful Information for Cost-Conscious Decision Making

This article focuses on the need for the program management office and its supporting cost analysis staff to understand the Total Ownership Cost (TOC) of the existing and proposed future aircraft carriers and to then translate this data into meaningful information for cost-conscious decision making. The challenge is to relate the cost in terms the key decision makers and the engineering team can use to satisfy their respective roles. Thus, it is necessary to translate the results of the given ship design alternative TOC into the paradigms of the respective stakeholders:



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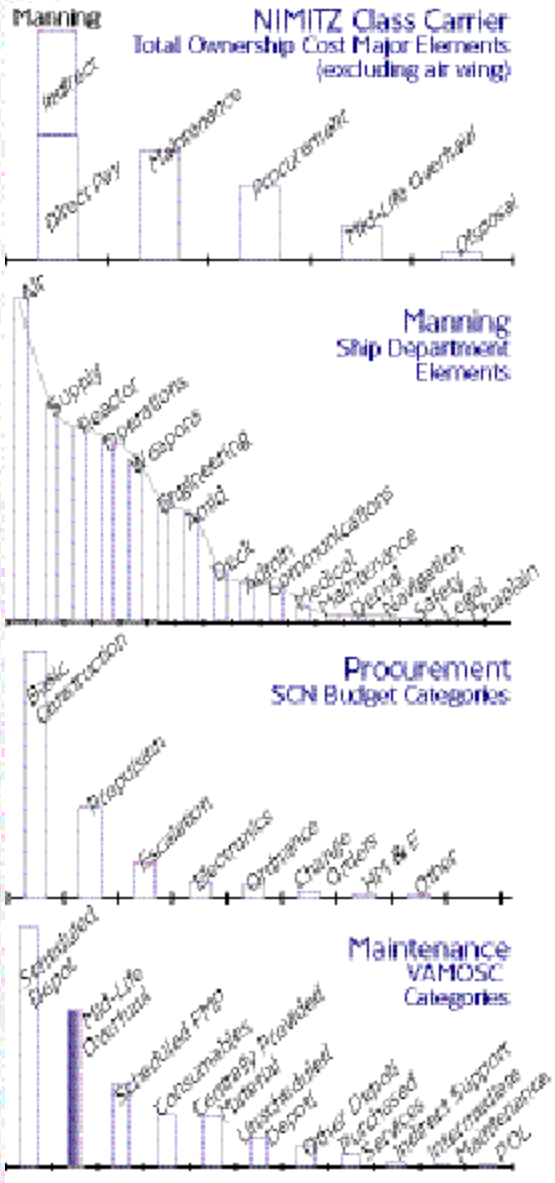
- Fleet User (operators of aircraft carriers)
- Ship Designers (translators of the fleet operator requirements)
- Program Sponsors (providers of the funding resources)
- Program Management Office, Shipbuilder and Supporting Industry (executors of the acquisition and construction of the ship)
- Navy and OSD decision makers (overseers of program execution).

This article also describes how the aircraft carrier TOC breakdown structure was converted from traditional cost accounting format to a system or activity-based structure that supported the program manager's decisions through Milestone I. The structure has been used in the AOA as a tool to identify cost drivers in order to perform Cost As an Independent Variable (CAIV) analysis and develop its evolutionary approach to aircraft carrier design.

ESWBS—Central Backbone of the Cost Work Breakdown

The Navy's Expanded Ship Work Breakdown Structure (ESWBS) has emerged as the central backbone of the cost work breakdown for AOA work. The ESWBS structure is a natural choice as it is the framework within which the design and engineering community works. It provides the best framework from which to relate to program requirements, as it describes the ship-by-ship sub-system. The approach, for the first time, provides a breakdown of all life cycle cost elements by ESWBS. From this structure, it is possible to present costs in other formats for CAIV analysis, Cost Driver analysis, TOC management, design feature analysis, requirements analy-

FIGURE 1. **Traditional Aircraft Carrier Total Ownership Cost Major Element Breakdown**



sis, and Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) Milestone Reviews.

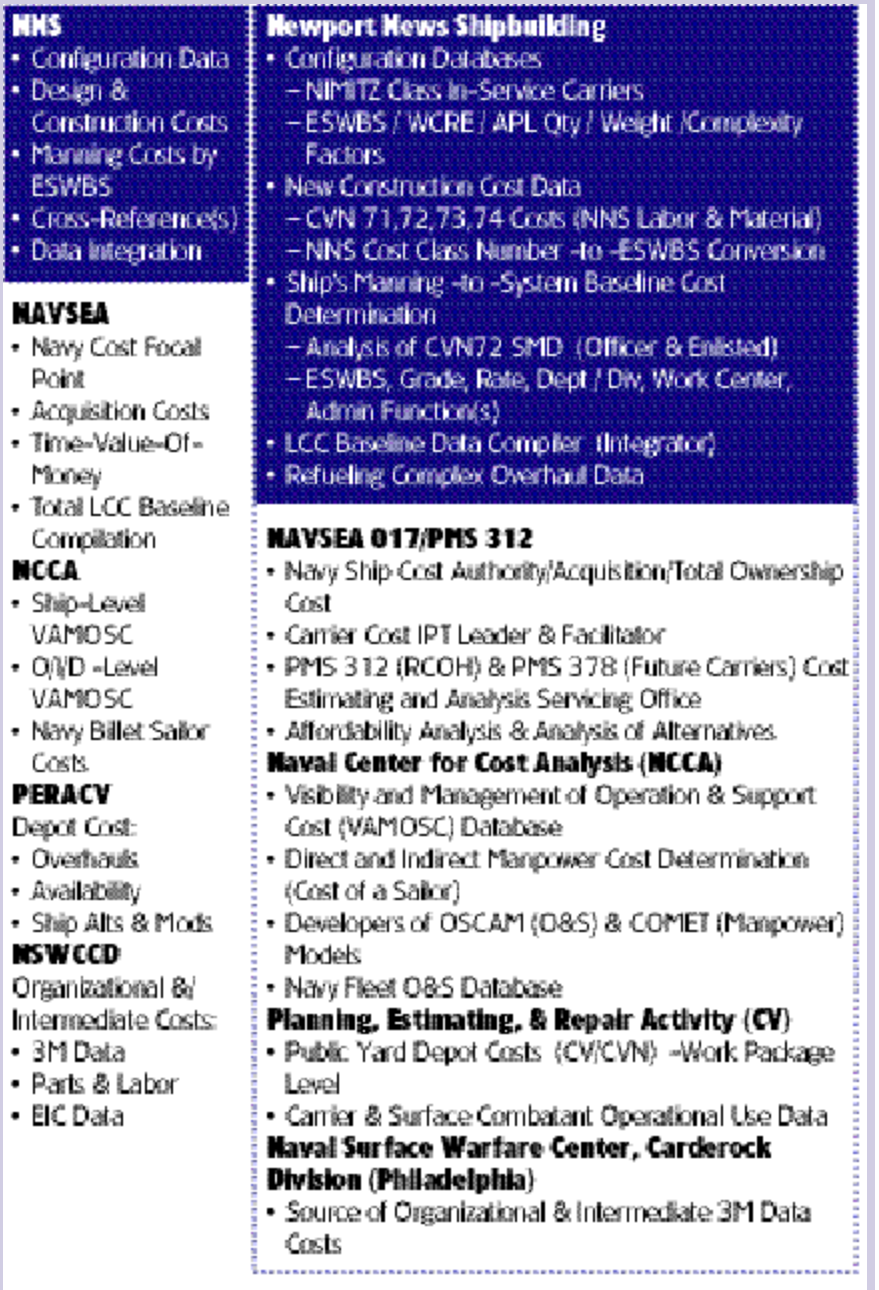
Inadequacy of Cost Accounting Format

Historically, the life cycle cost of weapon systems has been presented in a standard cost accounting format to satisfy program milestone requirements. Essentially the format was one-dimensional and provided cost data in a summary fashion with little insight into variables that drive cost, especially at the ship sub-system or design feature level. Additionally, OSD requires that programs must establish TOC reduction goals, associated metrics, and processes to evaluate progress toward cost reductions. In order to do this, the program must determine what cost reductions are achievable and how they should be allocated. The problem is that this cannot be achieved using off the shelf accounting system data.

Due to decreasing budgets within the Department of Defense, new reporting requirements have been put in place to increase program focus on cost reduction. Programs must develop TOC estimates for their systems and submit a TOC management plan.

In constant fiscal 2000 dollars, the TOC of a *Nimitz* Class carrier is estimated to be approximately $28 billion. Figure 1 on p. 37 shows the hierarchical breakdown of the TOC by major cost elements. The breakout shows manpower, procurement, and maintenance costs. Further breakdown of these elements shows traditional cost accounting formats and gives engineers little information to make design and programmatic decisions.

FIGURE 2. **Government/Industry Integrated Product Cost Team**



Developing a TOC Baseline

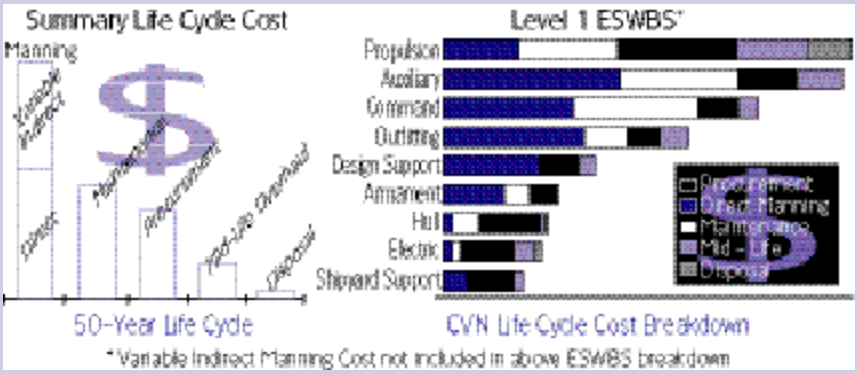
In order to understand the life cycle cost and the impact of design on affordability, a baseline TOC for the *Nimitz* class needed to be developed. The first step was to develop a TOC baseline that both the aircraft carrier program office engineers and upper management could use in making cost-based decisions. The initial problem to be overcome was that the Navy's database did not completely capture the data and did not present the data in a ship system format. Therefore, it was of limited use by those who were designing, managing, and overseeing the program.

To overcome this problem, a government-only team was formed to evaluate and compile databases into a total ownership cost estimate. The team determined that the ESWBS structure offered the greatest promise for a meaningful total TOC structure. After re-engineering the TOC structure for utility in the design, engineering, and decision-making process, the team recognized that it would need industry involvement in order to reach lower levels of detail it desired. Also, industry involvement was necessary to achieve buy-in, and institutionalize the TOC process within the aircraft carrier community. Therefore, a Navy/Industry Integrated Product Team (Figure 2) was formed and produced a baseline far surpassing the detail and content of those previously developed.

FIGURE 3. **TOC Balanced Scorecard**

Most Important TOC Management Process Attribute(s)	"General" Tactic(s) To Be Used To Achieve TOC Process Attribute(s) Success	TOC Process Attribute(s) Metric(s)/Measurement (How To Measure Success)	"Physical" Action(s) To Be Taken To Achieve TOC Process Attribute(s) Success
Affordability TOC Process must be able to accomplish our objectives within the defined budgets	• Get Leadership's Programmatic Buy-In and Funding • Simplify TOC Process • Identify TOC Baseline Costs/Reduction Objective(s) • TOC Accounting System	• Present vs. Future Projected Delta Dollar Estimations • Manpower/Billet Numbers Reductions • ROI Measurement • CAIV Cost Objective & Threshold Measurement/ Tracking	• Draw-Up Commitment Agreements • Establish Contractual Incentives • Standardize Cost Accounting Processes • Establish Ship-Specific TOC Baselines • Establish TOC Reduction Goals • Allocate Cost Reduction Goals to Teams • Use Competition to Reduce TOC • Eliminate Unnecessary Requirements
Accountability/ Responsibility Combines both accountability/responsibility and covers the TOC Process roles & interactions (including duties and commitments) that must be embraced by all Stakeholders	• Establish TOC Organization • Assign TOC/CAIV Requirements to Individuals • TOC Education For All Carrier Player(s) • Publicize/Update TOC Goals, Objectives, & Results • Publicize TOC Successes	• Organizational Chart Availability • Personnel/Responsibility Matrix • Necessary TOC Management Reporting Process In-Place & Being Used	• Assign, Regulate, & Hold People Accountable for TOC Action Items • TOC/CAIV Integrated into Performance Agreements • Define & Provide Team Product Requirements/Cost Goals • Definition of TOC Team Decision Authority Levels/Limitations • Stated TOC Reporting/Deliverable Requirement(s)
Implementability TOC Process must be simple enough to accomplish within the time, budget, and regulatory constraints of each program	• Establish/Empower the TOC Implementation Team to Make It Happen • Automated databases • Use the 80/20 rule	• TOC Management Plan Developed By 12/18/98 • TOC Management Plan Approved For Implementation in 1999 • Updates to Plan at Milestones and as Required	• Identify/Involve Stakeholders • Address Concerns & Get Buy-In • Develop "Who Does What" TOC Program Accountability Matrix • TOC Implementation Schedule • Keep TOC Process Simple • Establish TOC/Design Guidelines • Allocate Carrier Team Member TOC Reduction Objective(s)
Measurability TOC Process must establish indicators that are quantifiable/reproducible, & track progress toward these goals	• Standard Carrier TOC Baseline • Standard TOC Equations • Standard Rules of Measurement (i.e. ROI Methodology)	• TOC Equations/Methods Are Reproducible (Dollars Add-Up The Same Every Time) • TOC IPT Quarterly or Yearly Accountability Score Card	• Monitor TOC Goal(s) Achievement • Program Approved TOC Equations • Acceptable Acquisition/O&S Costs Reduction Identification • Approved TOC Measurement Guideline(s) & Metric(s) Document
Flexibility TOC Process must have the ability to be adapted and incorporate change(s)	• Implement TOC Process Reviews • Utilize an Open TOC System Architecture • Keep TOC Process Simple / Simple Processes=Flexiblity Are Easier To Adapt to Modifications • Assign TOC Process Ownership	• Time Required to Incorporate TOC Process Change(s) • Time Required to Close Open TOC Process Action Item(s) • TOC Process Review Frequency • Users Survey (Are Users Happy With Methodology?)	• Implement TOC Process Change Control (Where We've Been, Where We're Going, & Why) • Action Item Tracking/Status Monitoring List • Scheduled TOC Process Reviews
Believability TOC Process must be credible/acceptable Buy-in from all the PEO Stakeholders	• TOC Buy-In: Conduct PEO Carrier Management Briefing(s) • TOC Open System Architecture That Allows For Verification and is Repeatable • Implementation Road map • TOC Procedure formalization	• TOC Process User Survey (Is It Working or Not) • Repeatable Result Check(s) • Carrier TOC Pilot Project Results (Check To Ensure That It Works On a Small Scale-First)	• Presentation to Senior Management • CVN LCC Baseline's Letter of Validation by Component Cost Organization • TOC Process Develop Flowchart • Establish a TOC Pilot Program • TOC Web site-Latest Data, All the Time
Utility TOC Process: accessible, user-friendly and useful in making TOC decisions.	• TOC Communication/Training • Provide TOC, CAIV & ROI Tools and Software to Users • TOC Process Must Satisfy Whole Ship Integration Issue(s)	• TOC Process/Tools User Survey (Are They Working or Not)	• TOC Program Funding Identified/Provided • Published/Approved TOC Management Plan • Web site Real-time TOC Database • Web site Based TOC Tools • Provide TOC Training (Everyone)

FIGURE 4. **TOC Process Attributes & Implementation Tactics, Metrics, and Action Plans**



Application

This work has significantly advanced the abilities of the Navy to address the cost details of aircraft carriers and provide the key information essential to manage the program, make cost-conscious decisions, and determine resource and technology investment strategies. The new approach enables a better understanding of the economic consequences of acquisition decisions and operational choices from a total life cycle cost perspective.

For the first time, we have established a methodology and database framework that identifies aircraft carrier cost drivers comprehensively, and establishes a life cycle framework for design trade-off analysis using CAIV. This tool will permit a clear focus on aircraft carrier ownership and cost-reduction initiatives, and provide a mechanism for continued process improvement toward a more affordable fleet.

This new database and methodology have been and are being used for the transition technology implementation, requirements setting, and AOA for future carrier planning. They constitute the key instrument in identifying and achieving cost reduction goals in aircraft carrier ownership. Figure 3 (preceding page) shows the balanced scorecard and methodology that formed the foundation for establishing the current PEO carrier TOC management process. This process can be an effective starting point for other programs and Services in establishing an effective TOC management program.

Lessons Learned

The new comprehensive data structure facilitates a far more insightful view of the cost drivers underlying an aircraft carrier's TOC. Figure 4 shows how the traditional limited TOC breakdown can be decomposed into its subordinating elements and ranked from highest to lowest cost, by cost element. This allows one to identify (using the Pareto technique) the hierarchy of cost drivers within the ESWBS framework. The data are useful to ship designers and others, showing where the cost drivers are and, in turn, where to focus design efforts for maximum economic effect.

Similarly, the effects of systems or requirements changes can be readily assessed and compared to the baseline cost data to illustrate the cost effects. The data have been useful to both Navy and Department of Defense management, helping to justify the Navy's Research and Development (R&D) investment strategy.

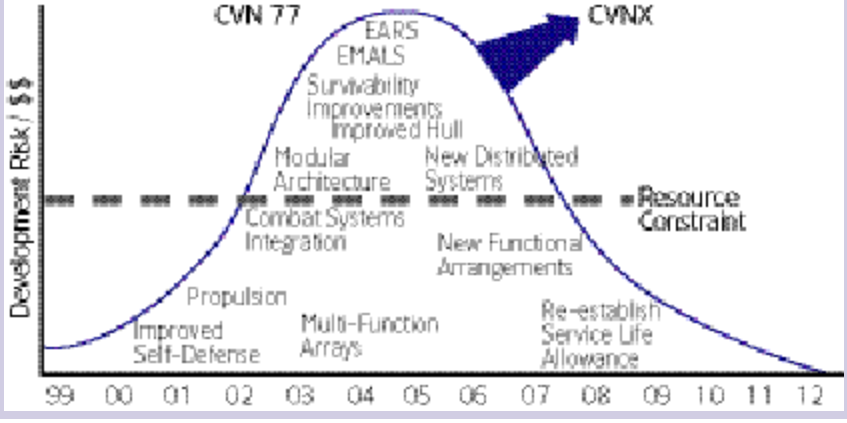
It makes sense to invest in the top cost drivers where the most significant cost reductions can be achieved. The aircraft carrier program, in fact, is pursuing this strategy. On CVNX1, the propulsion system is being replaced with a new design, which greatly reduces TOC, and enables follow-on technologies to be introduced as a result of increased electrical power capacity.

The aircraft launching system, which falls in the second highest cost driver ESWBS, *Auxiliary Systems,* is also being introduced on CVNX1. And, on CVN 77 a new warfare system is being introduced that falls into the third highest cost category, *Command and Control Systems*.

The system-level TOC analysis has served perhaps its most important function in providing the information used in arriving at the current aircraft carrier evolutionary strategy.

Initially the approach to the new class of carriers was a clean-sheet design (Figure 5), or a one-step approach to a new design where all changes from the baseline *Nimitz* class would be made in the initial ship of the CVNX class. Although the TOC clearly showed the greatest potential for TOC reduction across a class of aircraft carriers, the near-term affordability constraint carried the most

FIGURE 5. **Clean Sheet One-Step Approach is Unaffordable**



weight in the decision process. Clearly, there would be an overbearing up-front cost to be borne in the near-term Future Years Defense Plan (FYDP). The near-term timeframe was in this case the measure of greatest importance regarding the affordability issue.

As an alternative to the clean-sheet approach, an evolutionary strategy of gradual change to the *Nimitz* Class leading to the CVNX Class was proposed (Figure 6). The TOC estimates for this strategy also demonstrate significant TOC reductions that have been proven through investment metrics such as Net Present Value (NPV), and Return on Investment (ROI) analysis. This strategy permits the program to stay within the affordability constraints of the near-term FYDP while achieving large reductions in operating costs in the long-term. Figures 5 and 6 show how the CVNX program spread system development efforts over a three-step evolutionary approach.

Understanding the Top System-Level TOC Drivers

Cost data should be translated to a WBS that captures the costs by major subsystems for each TOC element. Cost requirements should also include a requirement for the baseline and alternatives to be presented in terms of sub-systems rather than in arbitrary cost accounting formats. This will enable engineers and managers to understand the top system-level TOC drivers in a complex weapon system. This understanding will result in better allocation of scarce program resources to the high-impact drivers, and reduce allocation to areas that may have vocal support but are not drivers of cost.

Having the TOC data broken out by system will facilitate developing the program office's evolutionary acquisition approach through generating Pareto breakouts of system cost drivers. Using the CAIV process in choosing the best alternatives and supporting technologies, top system-level drivers would be identified and tackled first in an evolutionary strategy to have the most impact in making cost/performance trade-offs.

Reliable return cost data are needed to prepare TOC estimates. Contractor Cost Data Reporting requirements should require that contractors provide return costs of R&D and Development Contracts. Within the Navy, current techniques use bid data and top-level data as starting points to generate program non-recurring and procurement costs.

Better data would result in better program estimates at program inception, reducing program risk and cost. The system return cost WBS should break out subsystems at sufficient detail to support the designers', cost engineers', and managers' respective roles throughout the acquisition process. Reliable return cost would also enable better management and negotiation of future contracts.

Renewed Interest in TOC Resulting in Improved Cost Analysis

Aircraft Carrier cost analysis has progressed dramatically over the past several years. This is the result of the renewed emphasis now placed on ownership cost reduction along with the realities of tight fiscal constraints. It is imperative that all elements of cost be well understood and that this understanding be manifested in cost-conscious decision making. This should start with the requirements setters and carry through to every aspect of program management and execution.

Moreover, advances in the relationship between the shipbuilder, the aircraft carrier program office, the engineering community, and the Naval Sea Systems Command cost analysis group working as a team have set the stage for continued improvement in our collective understanding and awareness of ship costs and program objectives. This affords maximum opportunity to leverage the collective knowledge and interests of the stakeholders toward a common objective.

A carefully thought out life cycle cost structure with supporting data is an invaluable tool in identifying cost drivers and providing essential information for investment alternatives. Timely, comprehensive, and meaningful life cycle cost information can enlighten the management of ship design, acquisition, construction, and ownership of naval warships.

Editor's Note: Moretto welcomes questions of comments on this article.Contact him at morettosj@navsea.navy.mil.

FIGURE 6. **CVNX Evolutionary Concept**