Advanced Management Program

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DEFINING BUSINESS CASE CRITERIA FOR TECHNOLOGY CHANGES ON THE TRIDENT MISSILE SYSTEM

Team Number:
5

Executive Summary

The TRIDENT II D5 Missile System expected service life has been extended. Originally designed as a 20 year system, its life has been extended to 40 years to match the service life of its ship delivery platform, the OHIO class Ballistic Missile Submarine. To ensure system reliability is maintained throughout the missile's life, the Program Manager has asked for a review of the systems and components and their ability to meet the new service life guidelines.

This review has identified some potential aging issues with the electronics in the guidance and flight control subsystems. These issues are considered serious enough to warrant the replacement of the electronic subsystems. Two alternatives are to be considered:

1. Inserting current technology electronics in new Guidance and Flight Control Subsystems and retrofitting fleet assets
2. Reconstituting production lines to produce the required quantity of Guidance and Flight Control subsystems to insert into new missiles and retrofit into fleet assets

This paper identifies several criteria that are viewed as critical to the decision between the alternatives. These criteria are discussed within three main categories:

Logistics: Lead Time, Spares, Configuration Control, Maintenance, and Testing

Technical: Technical maturity, Reliability, and Performance

Cost: Initial and Life Cycle costs

A methodology to evaluate the decision criteria is introduced for use in the business case. This results in a qualitative measure of Return On Investment (ROI_Q). This measure is derived from the known costs and confidence factors determined by the stakeholders for the technical and logistics issues. Provided the correct criteria are evaluated reasonably to determine the confidence factors then the actual ROI should be proportional to the ROI_Q. Estimated costs for each alternative are plotted and show that costs over the life of the program are expected to be less for Alternative 1 (new technology) even with the increased initial investment. This crossover point occurs during the sixth production year.

The implementation of this plan requires stakeholder buy in to the approach and their assessment of the confidence levels described above. This methodology can then be used to formally develop the business case analysis to present to the program manager for decision.

Recommend a business case analysis be conducted to aid in the choice between these alternatives. Recommend this methodology should be reviewed for potential application to similar decision points in other programs. Recommend including a weighting factor be considered for applicability to other situations.

INTRODUCTION

The TRIDENT II D5 missile is an essential element of our nation's Strategic Deterrence Triad. The decision has recently been made to extend the service life of the missile for another 20 years. This has prompted the Program Manager to examine what impact the extended life requirements would have on the missile and its components. Some technical concerns have been raised about the reliability of the guidance and flight control electronics sub systems over the new anticipated life cycle. This report investigates two Program Alternatives:

1. Inserting current technology electronics in new Guidance and Flight Control Subsystems and retrofitting fleet assets
2. Reconstituting production lines to produce the required quantity of Guidance and Flight Control subsystems to insert into new missiles and retrofit into fleet assets

ENVIRONMENT

DOD 5000.1 and other Acquisition Instructions, including NAVSEA 4000.8, provide guidance to the Program Manager to evaluate Program Alternatives based on all the pertinent factors. They also recommend the development of a Business Case Analysis to objectively provide the framework for a decision.

The TRIDENT II D5 missile program was originally envisioned as a 20-year life cycle program to develop a total of 425 missiles. The design for the missile electronics systems (guidance and flight control) was based on 1980's components. The program office bought the necessary components and anticipated spares during the early 1990s to meet the anticipated requirements for the life of the program. Those components are no longer made. Some spares are currently available in the supply system but they will be exhausted in the next few years. The primary contractor, Lockheed-Martin, is recommending that the new technology be adopted in lieu of the current system electronics.

Approximately 4 missiles are expended annually in Live Fire Tests. To extend the service life for the additional time frame the Program Office has determined that 392 subsystems will be needed. Some will be placed in new construction missiles, others will be retrofitted to missiles currently in the fleet, and the balance will be used as spares.

PROPOSAL

To properly evaluate the options facing the Program Office, objective criteria had to be established. The criteria fell into three main categories:

Logistics: Lead Time, Spares, Configuration Control, Maintenance, and Testing

Technical: Technical maturity, Reliability, and Performance

Cost: Initial and Life Cycle costs.

Anticipated issues related to each category are discussed below. These issues need to be validated by the program's stakeholders. The stakeholders would be asked to evaluate the technical and logistics issues and determine a confidence level for each area. Confidence levels will be expressed as percentages. The confidence levels would then be combined with the estimated costs to determine a qualitative Return on Investment (ROI).

LOGISTICS

Logistics can be defined as the degree of difficulty to design, produce, deliver, maintain and test one or the other strategy. It is a subset of the overall decision process. The likelihood of success or failure of a given direction needs to be determined, taking into consideration the overall risk of a given strategy and the impact of one strategy versus another.

Stakeholders will be asked to provide input to a logistics confidence level based on the following sub-factors:

1. Lead Time - Time required to design, produce and deliver the new missile or reproduce the existing missiles or reproduce the existing missiles with the required modifications is considered the most important issue because it relates directly to the overall military readiness and is weighted accordingly.
2. Availability of Spares – Are sufficient spares in stock? What is the availability of spares or the costs associated with setting up a production run if the additional manufacture of spare parts is required? It is also an important measure of logistics readiness and can impact lead-time. Availability of spares for the new missile is assumed to be 95%, which takes lead-time and production issues into account.
3. Engineering Change Proposal – An important factor in determining the difficulty in retrofitting the existing missiles and/or designing the changes or technical advances in the

new missiles. Both alternatives will require approx 19 years to fully integrate the change into all fleet assets. During this period there will be additional cost and administrative burden on the program office to manage and track the changes to individual missiles.

4. Maintenance – Identifying and evaluating issues and difficulties of maintaining the existing missiles; compared to maintaining the existing missiles and the new missiles. This impacts the training, technical documentation, repair kit inventories, etc.
5. Testing – Evaluating the issues associated with testing the existing missiles, compared to testing the two missile types. This could impact the test procedures, test equipment, and first article testing if a new design where incorporated.

Logistics and Technical elements are not easily converted to quantifiable measure for evaluation. Therefore, the stakeholders will be asked to provide a qualitative assessment as a percentage. This should reflect the stakeholder's confidence level that the proposed alternative will meet the program's requirements in each of the factors listed. This confidence level will be expressed as L_C (Logistics) or as T_C (Technical).

TECHNICAL

Technical tradeoffs for development of new or continued use of existing Trident II electronics includes an assessment of the performance, reliability, and maturity of components available.

1. Performance - A key technical parameter that must be maintained is performance. Specifically, range and accuracy must not be negatively impacted by any change to the guidance and flight control electronics. In addition, any change to electronic systems must be compatible with the current Trident II missile system.

2. Reliability - Reliability of the system must also be maintained or enhanced. It is imperative that the electronics work in all missile operational environments. This includes underwater, atmospheric, and space environments. The original Trident II electronics system was designed to last 25 years. The reliability beyond this point falls below acceptable levels. Thus, replacement of all missile electronic systems is necessary in order to match the life of the Trident II submarine hulls (2043).
3. Maturity - The current Trident II electronics system is of late 1980's technology. A majority of the components are no longer in production, which results in large start up costs to remanufacture components. Tradeoff analysis must be conducted to determine whether the existing system should be used or a newer technology should be used. Most importantly, any component, old or new, must have the form, fit, and function of the current Trident II missile system. If a new design is incorporated it must be of a mature technology with proven performance.

COST

All costs used in this paper are calculated using FY04 dollars. During early phases of evaluation it is difficult to quantify all applicable costs. Estimates have been based on the best available data from the program office. Each alternative has its own specific cost challenges, which is discussed below:

Alternative 1: This alternative would require the replacement of all subsystems with a new design that incorporates current technology. The development of the new design will require a significant initial investment. This has been estimated to be $335.2M. This initial investment is expected to be offset by a lower component cost. This lower component cost is driven by commercial demand for similar items. The program office plans to replace the electronics in 24 missiles annually. This annual cost is estimated to be $47.8M. At that rate it will take 19 years to complete the change in the entire inventory. The cost per missile is calculated by:

$$C_M = (C_I + C_A * A) / N = (\$335.2M + \$47.8M * 19) / 392 = \$2.85M$$

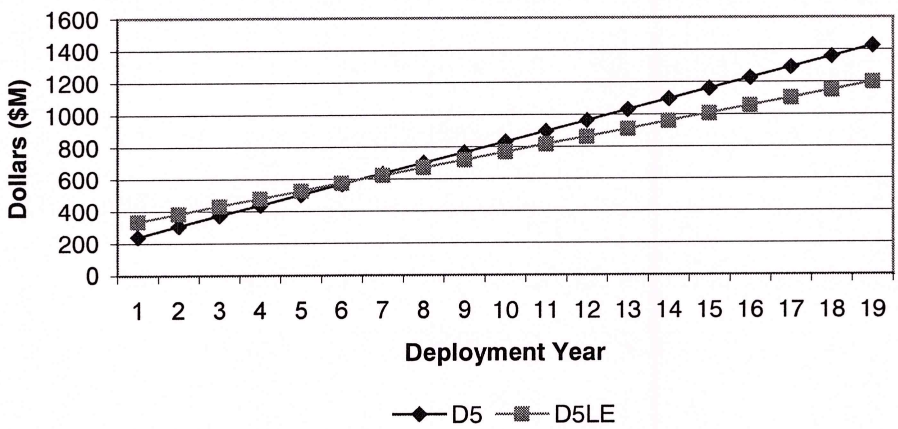
where C_M is the cost per missile, C_I is the initial investment, C_A is the annual investment, A is the number of years of the investment, and N is the number of missiles.

Alternative 2: This alternative requires the replacement of all subsystems with the proven design. The aging characteristics of the components raise reliability concerns past the 25-year life. This drives the need for total replacement of all components. However, these components are no longer manufactured. Reconstituting the production lines will require an initial investment of $238.9M. Since there is not a commercial demand for these outdated components, the total costs will be borne by the Navy resulting in higher component costs. The annual cost of replacement based on the same throughput as above is $67.76M. The cost per missile for this alternative is:

$$C_M = (C_I + C_A * A) / N = (\$238.9M + \$67.76M * 19) / 392 = \$3.35M$$

As Figure 1 shows, with total costs for both options fully amortized over a 19-year deployment period, the cost indices cross during year 6. In other words the new D5LE will require a bigger investment initially but will result in significant savings over the life of the program.

Figure 1: Cost Comparison of Alternatives



COST-BENEFIT

Comparison of the Return On Investment (ROI) for each alternative to be considered is desirable. ROI is defined below:

ROI = Benefits / Costs

However, accurate assessment of the true costs and expected benefits are difficult to develop. In this case the logistics and technical areas are not easily identifiable in terms of a cost, efficiencies, or other readily quantifiable measure. A qualitative assessment of these areas will be conducted. A qualitative evaluation of the return on investment could be characterized by:

$$ROI_Q = \frac{1}{C_M} * \left(\frac{L_c + T_c}{2}\right)$$

where the actual Return on Investment (ROI) is related to ROI_Q by the following:

$$ROI = k * ROI_Q$$

where k is a proportionality constant that accounts for the true quantitative measures.

Each stakeholder will be asked to evaluate each alternative in terms of a confidence level (Logistics Confidence (L_c) and the Technical Confidence (T_c)). In other words how much confidence do they have that the approach outlined will meet the needs of the program. This confidence level will be expressed as a percentage (100% = 1.00). For illustrative purposes, this paper shall estimate the confidence levels as shown in Table 1.

Confidence Levels	D5 (Old Electronics)	D5LE (New Electronics)
L_c	.85	.90
T_c	.90	.95

TABLE 1: Logistics and Technical Confidence Levels

Using the C_M calculated above, the ROI_Q for each alternative is shown as:

$$\text{Alternative 1: } ROI_Q = \frac{1}{C_M} * \frac{(L_c + T_c)}{2} = \frac{1}{2.85} * \frac{(.90 + .95)}{2} = 0.32$$

$$\text{Alternative 2: } ROI_Q = \frac{1}{C_M} * \frac{(L_c + T_c)}{2} = \frac{1}{3.35} * \frac{(.85 + .90)}{2} = 0.26$$

While not a direct measure of actual ROI, the comparison of the ROI_Q for each alternative does provide a reasonable assessment of expected returns. For the example above Alternative 1 would provide a greater return on the investment in the new design.

IMPLEMENTATION STRATEGIES

Implementation of this approach involves reviewing the analysis with the stakeholders. Stakeholders should be asked to validate the criteria selected and modify where deemed appropriate. The validated criteria will then be evaluated by the stakeholders and actual confidence levels calculated. Cost figures should be reviewed to ensure they are accurate with current estimates. ROI can then be calculated and a business case analysis presented to the program manager for decision.

RECOMMENDATIONS

Prepare a business case outlining the issues covered in the business case preparation guidance following the implementation plan above.

Review approach for effectiveness in evaluating similar decision points in other programs.

Evaluate incorporation of a weighting system for the confidence levels. This would change the ROI_Q calculation to

$$ROI_Q = \frac{1}{W_C C_M} * \left(\frac{W_L L_c + W_T T_c}{2}\right)$$

Where W is the relative weights assigned to each factor

APPENDIX A

References:

NAVSEA INSTRUCTION 4000.8, SEA 04L/078, 21 JUL 04

Department of Defense Directive 5000.1, 12 MAY 03

Department of Defense FY 2005 Budget
http://www.dod.mil/comptroller/defbudget/fy2005/fy2005_weabook.pdf