2004-12

Return on investment in the public sector

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http://hdl.handle.net/10945/1317

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

RETURN ON INVESTMENT IN THE PUBLIC SECTOR

by

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December 2004

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December 2004	**3. REPORT TYPE AND DATES COVERED** Master's Thesis

4. TITLE AND SUBTITLE: Return on Investment in the Public Sector	**5. FUNDING NUMBERS**
6. AUTHOR(S) Joshua Bigham and Thomas Goudreau	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited	**12b. DISTRIBUTION CODE**

13. ABSTRACT (maximum 200 words)

In an environment of scarce resources and rising federal deficits the people not only expect, but demand greater accountability for the spending of public funds. This demand has created a trend in the public sector, not only in the United States, but worldwide as well, towards the importation of private sector business practices to improve accountability-oriented analysis. One example is increased emphasis on return on investment (ROI) analysis in public sector organizations.

Development and application of ROI analysis is challenging in the public sector since most government organizations do not generate profit necessary for calculation of ROI in the manner in which it is done in the private sector. This thesis develops the methodology necessary for use of ROI analysis in the public sector. ROI methodology is applied for test evaluation with the Space and Naval Warfare Systems Command (SPAWAR) in San Diego. The test demonstrates that ROI can be applied successfully to assess the relative efficiency of value-added work and to improve the process of choosing between investment alternatives. Properly designed ROI analysis reveals how and for what goods and services money is spent and provides a means for comparing the value derived from investment and work performed.

14. SUBJECT TERMS ROI, return on investment, public sector finance	**15. NUMBER OF PAGES** 81
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89) Prescribed by ANSI Std. 239-18

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RETURN ON INVESTMENT IN THE PUBLIC SECTOR

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Submitted in partial fulfillment of the
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MASTER OF BUSINESS ADMINISTRATION

from the

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In an environment of scarce resources and rising federal deficits the people not only expect, but demand greater accountability for the spending of public funds. This demand has created a trend in the public sector, not only in the United States, but worldwide as well, towards the importation of private sector business practices to improve accountability-oriented analysis. One example is increased emphasis on return on investment (ROI) analysis in public sector organizations.

Development and application of ROI analysis is challenging in the public sector since most government organizations do not generate profit necessary for calculation of ROI in the manner in which it is done in the private sector. This thesis develops the methodology necessary for use of ROI analysis in the public sector. ROI methodology is applied for test evaluation with the Space and Naval Warfare Systems Command (SPAWAR) in San Diego. The test demonstrates that ROI can be applied successfully to assess the relative efficiency of value-added work and to improve the process of choosing between investment alternatives. Properly designed ROI analysis reveals how and for what goods and services money is spent and provides a means for comparing the value derived from investment and work performed.

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TABLE OF CONTENTS

I. INTRODUCTION 1
  A. PURPOSE 1
  B. BACKGROUND 1
  C. RESEARCH OBJECTIVES 3
  D. RESEARCH METHODOLOGY 3

II. TRADITIONAL VS. NOTIONAL ROI 5
  A. TRADITIONAL ROI 5
    1. How to Determine Traditional ROI 5
    2. Practical Applications of Traditional ROI 5
    3. Traditional ROI Example 6
    4. Difficulties Utilizing Traditional ROI in the Public Sector 7
  B. NOTIONAL ROI 8
    1. Exploring ROI in the Public Sector 8
    2. Non-Monetized Notional ROI 9
    3. Monetized Notional ROI 11

III. PREVIOUS EFFORTS AT DEVELOPING ROI IN THE PUBLIC SECTOR .. 13
  A. AUSTRALIA 13
    1. Scope and Reasoning behind the Effort 13
    2. Lessons Learned 14
  B. NEW ZEALAND 14
    1. Scope and Reasoning behind the Effort 14
    2. Lessons Learned 17
  C. UNITED STATES POSTAL SERVICE 18
    1. Scope and Reasoning behind the Effort 18
    2. Lessons Learned 19
  D. NAVY DENTAL CORPS 20
    1. Scope and Reasoning behind the Effort 20
    2. Lessons Learned 21

IV. NOTIONAL ROI FORMULA DEVELOPMENT FOR SPAWAR PEO C4I AND SPACE NEW SHIP CONSTRUCTION 25
  A. T-AKE PROJECT 25
    1. Ship Class Background Data and Building Plan 25
    2. Turnkey Approach 26
  B. NROI FORMULA SEQUENCE OF DEVELOPMENT 27
    1. 1st Iteration 29
    2. 2nd Iteration 31
    3. 3rd Iteration 32
    4. WBS Categories and Associated VAFs 33
    5. 4th and Final Iteration 37

V. FINAL NOTIONAL ROI FORMULA 41
A. T-AKE 1 NROI 41
B. NROI COMPARABILITY FOR ONE SHIP CLASS 45
C. LPD-19 NROI...48
D. NROI COMPARABILITY FOR MULTIPLE SHIP CLASSES 52
E. COMPARISON OF RCS NROI: T-AKE 1 AND LPD-19.......................54
F. CHALLENGES...57
1. Formula Limitations...57
2. Applicability Limitations..59

VI. SUMMARY AND CONCLUSION 61
A. SUMMARY 61
B. CONCLUSIONS 61

LIST OF REFERENCES 63

INITIAL DISTRIBUTION LIST 65

LIST OF FIGURES

Figure 1. T-AKE 1: USNS Lewis and Clark (Global Security, 2004)............................25
Figure 2. LPD-17 Class (Global Security, 2004)..48

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LIST OF TABLES

Table 1. Selected Financial Data for PepsiCo: 2001 (millions of dollars) 6
Table 2. Weighting Method Comparison..10
Table 3. Determining ROI with the Participant Impact Estimation (Oldham, et al., 2002: 140, 145) 16
Table 4. Determining ROI with the Forecasting Method (Oldham, et al., 2002: 144-45) 17
Table 5. Raw Data: Pearl Harbor Branch Dental Clinic FY2000 (York, 2004)............23
Table 6. ROI for Navy Branch Dental Clinics..24
Table 7. T-AKE 1 WBS Category Cost Data 41
Table 8. T-AKE 1 Non-value Added Actual Costs and Projected Totals......................42
Table 9. T-AKE 1 Cost Schedule and NROI Determination..44
Table 10. LPD-19 WBS Category Cost Data 48
Table 11. LPD-19 Non-value Added Actual Costs and Projected Totals........................49
Table 12. LPD-19 Cost Schedule and NROI Determination..51
Table 13. Individual WBS Totals as a Percentage of Total Projected WBS Costs 55
Table 14. Comparison of Total Projected Non-value Added Costs................................56

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ACKNOWLEDGMENTS

The authors would like to gratefully acknowledge those individuals who provided their support and assistance throughout the development of this thesis, especially to Professor Larry Jones, whose guidance and inspiration made this study possible. We also thank Thomas Hughes, John Mutty, and Donald Summers who kept us on time and on track. Warm thanks are also in order for Dr. Patricia Phillips, who provided timely assistance and supplied research materials that were quite helpful. Many thanks are also extended to Joe Mayer, Ken Ayers, Jim Burgess, Mike Cullison, Kevin Gerald, Bill Marshall, Steven Sonntag, Tom Sommers and, most notably, Travis Tillman, a prime mover in the critical areas of both data collection and NROI formula development.

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I. INTRODUCTION

A. PURPOSE

This thesis identifies and assesses several previous efforts to use return on investment (ROI) criteria as benchmarks in the public sector. Lessons learned from this review have been applied in the development of a notional ROI (NROI) formula identified for applicability with the Program Executive Office (PEO) Command, Control, Communication, Computers, and Intelligence (C4I) Shipbuilding Coordinator (SC) at Space and Naval Warfare Systems Command (SPAWAR). Specifically, the data used in the NROI formula apply to the design, procurement, testing, installation, integration, personnel training, and certification of the radio control suite (RCS) equipment and associated gear for the first ship of T-AKE new construction. The same formula was applied for comparison purposes with a similar effort on the LPD-19, third ship of the LPD-17 class. This thesis provides a detailed analysis of the strengths and weaknesses of applying ROI in the public sector, with specific emphasis on original work performed cooperatively with PEO C4I SC.

B. BACKGROUND

The Navy and Department of Defense (DoD) are attempting to define and apply improved methods for evaluating ROI in various ways, under pressure from Congress, the President's Office of Management and Budget and the scarcity of resources available for defense (McCaffery and Jones, 2004: 1-20). ROI is one of the key methods used to quantify the level of success achieved or achievable in a business endeavor. The concept of ROI is used throughout private industry not only to determine past results, but also to evaluate the current situation and as a decision making tool for the future. The advantages of ROI are clear in that it provides the flexibility to anticipate output changes in advance. This benefit results in the ability to not only preview the future in a real world sense, but also to modify the inputs to the numerator and denominator of the equation to model potential courses of action for the enterprise.

Although a useful concept, ROI does not easily transition for use in the public sector. Unlike private enterprise, the public sector has no "profit" or "total sales" to use in the equation. The increasing need for some method to quantify ROI in the public arena has led to multiple attempts from a diverse group of public enterprises with varying results. The Australian government placed increased emphasis on what they termed the "value added" approach in an effort to determine the output they were receiving as a result of budgetary expenditures. The Royal New Zealand Navy desired a determination of ROI for the implementation of a retention bonus plan used to control the attrition problem that was being experienced with marine engineers. Both of these results were somewhat mixed with valuable lessons learned. The United States Postal Service (USPS) met with a greater level of success in their effort, due largely to the fact that they are run much more like a private enterprise. Although not seeking to be "profitable," the USPS does generate revenue which can be used in the numerator of the formula which when divided by the USPS asset base in the denominator results in a fairly conventional ROI. Finally, the US Navy Dental community effort was much more ambitious in that it attempted to convert non cash outputs into cash equivalents in order to closely adhere to the traditional ROI formula. The resulting Navy Dental ROI was dogged by the questionable accuracy of some inputs, but the overall approach remained fundamentally sound.

The previous efforts focused on in this study have helped define the need for a new method to determine ROI in public sector enterprises. The intent of this thesis is to review the previous efforts and to develop a new approach for attaining this important goal as well as to provide a workable response to the Chief of Naval Operation's (CNO) call for an innovative method of linking investments with measurable outputs. In November of 2003, in an Echelon II visit feedback memo, the CNO Admiral Vern Clark outlined the need to develop a workable ROI formula:

> This is an area where we are struggling the most. We need to know that we are making the right type and level of investment. We have made some progress in understanding what we are investing in and have even made progress in understanding the output of our processes. However, we are struggling to link the two (investment to output). We need to model how increases or decreases in investments (people, dollars, and technology) will change the output.

It is with the CNO's request in mind that the PEO C4I SC T-AKE ROI project was initiated. The design, installation and integration of the T-AKE class command and control suite equipment -- specifically the Radio Control Suite (RCS) -- including ancillary equipment costs is used as the test platform to apply what we term the NROI method specifically applicable for use in the public sector. Our definition of NROI is based on the asset turnover ratio and return on asset approach as they are referred to in private sector accounting and finance.

C. RESEARCH OBJECTIVES

The immediate objective of this effort is to develop a workable NROI formula for use within the SPAWAR organization, specifically PEO C4I SC. In a more broad sense, however, the underlying objective is to validate an approach to developing NROI formulae for use in the public sector across a wide variety of organizations. The sequence of development of the NROI formula is reported in this thesis to provide the reader with a road map to follow, including valuable examples and lessons learned.

D. RESEARCH METHODOLOGY

The methodological approach used in this thesis evolved as the research project and process unfolded over a period of approximately ten months. The initial phase included extensive (literally worldwide) research of past efforts at determining ROI in the public sector. After deriving a number of lessons learned from these past efforts, focus shifted to a determination of the criteria that had to be followed for successful NROI development. This step was followed by a series of assessments of the NROI formula under development for the T-AKE project, including the necessary reduction of scope to a focus on solely the RCS. The ensuing stages of formula development and evolution incorporated elements from the research on what others had attempted (in the private and public sectors) and what was necessary for design and use with the specific units of analysis (Navy ships) under study. Finally, the NROI formula was used to compare return on investment in the RCS for the first T-AKE class ship in production at different points in time, and the RCS for both T-AKE 1 and LPD-19. More detailed articulation of the development of the NROI methodology follows.

II. TRADITIONAL VS. NOTIONAL ROI

A. TRADITIONAL ROI

1. How to Determine Traditional ROI

ROI has traditionally been measured in the private sector to quantify an organization's past, present, and potential future performance. There are several methods by which an organization can determine its ROI. Most compare the net financial output of a company, or profit, to the financial input. One of the most common methods is to compute a percentage return on a company's assets. An organization can determine how efficiently it has used its assets by comparing a period's operating income to the total amount the company has invested in the assets that produced that income. ROI is traditionally calculated as follows (Garrison and Noreen, 2003: 542):

$$Return\ on\ Investment = \frac{Net\ Operating\ Income}{Average\ Operating\ Assets}$$

Net operating income is the difference between revenue and expenses, usually before taxes and interest. An average asset base is normally used since the amount of assets in use may have changed during the period of measurement. Regardless of the exact method of measurement, a higher return indicates a more proficient use of organizational assets and ultimately a higher return for its shareholders.

2. Practical Applications of Traditional ROI

ROI calculations also may be used to determine the potential reward of a single investment decision or to assist in choosing between multiple investment options. For a single investment decision, forecasted streams of revenue are estimated and compared to the expected capital investment and operating costs. These are compared over the life of the proposed project and used to determine an internal rate of return (IRR), actually a forecasted ROI. The IRR is then compared to a firm's cost of capital for a single investment decision. It can also be compared to the IRR forecasted from other investment decisions in the case of multiple options to assist in choosing between them. With reasonable forecasting accuracy, this becomes an effective tool used in the private sector for deciding between capital venture decisions.

3. Traditional ROI Example

There are two frequently used methods to determine a corporation's ROI. Consider an investor deciding whether or not to make an investment in PepsiCo in 2002. One method for estimating PepsiCo's future performance is to look at its previous year's use of assets. This is commonly referred to as an organization's return on assets, or ROA. This was the method discussed in the previous section. Selected data for PepsiCo taken from 2001 (Brealey, Marcus, and Myers, 2004: 450-51) are presented in Table 1.

Table 1. Selected Financial Data for PepsiCo: 2001 (millions of dollars)

Earnings Before Interest and Taxes	$4,181
Net Income (after interest and taxes)	2,662
Total Assets	21,695
Total Shareholder Equity	8,648

To determine PepsiCo's ROA for 2001, their earnings before interest and taxes are taken from the income statement and must be divided by their total assets from the balance sheet. The result is then multiplied by one hundred to produce a percentage ROA. Thus, for PepsiCo in 2001;

$$\text{ROA (\%)} = \frac{\$\,4.2\text{B}}{\$21.7\text{B}} \text{X}\,100 = 19.3\%$$

This indicates that every dollar invested in assets at PepsiCo yielded 19.3 cents of return in 2001.

Another more relevant method to the investor would be to determine PepsiCo's return on equity, or ROE for 2001. This explicitly gives the return on investor equity in PepsiCo. ROE is determined by dividing the net income (income after interest and taxes) by the corporation's total shareholder equity. The result is then multiplied by one hundred to produce a percentage ROE. Thus for PepsiCo in 2001;

$$\text{ROE (\%)} = \frac{\$2.7\text{B}}{\$8.6\text{B}}\ \text{X}\,100 = 31.4\%$$

This indicates that every dollar invested in PepsiCo by investors yielded 31.4 cents of return to the shareholders in 2001.

It is important to keep in mind that taken on its own the ROI is of limited value. In this example it would be wise to compare the ROA and ROE for PepsiCo to prior years or with other companies in the same business during the same year. This comparability is very helpful in determining if the ROI is superior, average, or mediocre. Careful evaluation of the inputs to the ROI formula can uncover what may be the root of the success or problem.

4. Difficulties Utilizing Traditional ROI in the Public Sector

Public sector ROI calculations are considerably more problematic to utilize than in private industry. The traditional method of determining investment returns in the private sector is not directly compatible with many public sector organizations. Consider how a public sector organization would determine its financial output. Many public sector organizations do not produce revenues or generate profits as outputs. Therefore, their outputs are difficult to quantify in dollars. Instead, they provide a service or capability to the public. Oftentimes this service or capability is unique to the public sector and is not produced by the private sector. This increases the difficulty when trying to value these unique services or capabilities. For example, how much value is added to the respective service when another tank or fighter jet is produced? We certainly know what they cost. However, it is difficult to quantify their value added to the Army or Air Force. Placing dollar values on these items is complex since similar items are not valued in the private sector. The value added to the services from these items cannot be easily, if at all, measured in dollars. This makes the use of traditional ROI criteria impossible.

Some public sector organizations could be measured by the equivalent value of the service or capability provided in the private sector. For example, a comparison could be made between the USPS and the United Parcel Service. Perhaps a cost comparison for compatible services between private and public sector organizations could be used to measure performance. However, many public sector companies do not have comparable organizations in the private sector. For example, consider the DoD. The DoD provides defensive and offensive capability for the United States. This capability cannot be measured against the private sector due to the uniqueness of the services it provides. Therefore, to facilitate a ROI metric for many public sector organizations, a different approach needs to be used.

B. NOTIONAL ROI

1. Exploring ROI in the Public Sector

ROI measurements are under exploration in the public sector for three primary reasons. First, as with any private sector corporation, there are significantly more investment opportunities than public funds available. There is intense competitive pressure between organizations to continually prove their need for additional or even continued program funding. Deciding between these alternatives is oftentimes subjective in nature since objective data is not available. Realistically, some public organizations will be funded regardless of their ROI. However, ROI measurements could provide one metric to objectively decide between investment alternatives in public programs. They could also be used by organizations to show their value added to the public, and consequently provide support for their continued funding.

Second, increased public spending and rising budget deficits have considerably raised the public's concern for the way the public sector spends its money. There has been a notable increase in the required accountability of the public sector to the taxpayers. Evidence of this is the Government Performance and Results Act of 1993. The general purpose of this legislation is to establish metrics within the United States government to hold organizations accountable (Phillips and Phillips, 2002: 4). ROI measurements are one way this accountability requirement to taxpayers can be satisfied.

Finally, there has been a long and continuing trend within the public sector to import successful business practices from the private sector. This is no surprise since many of the public sector's leaders had previous careers in the private sector. In fact, three of the public sector's most senior leaders, the current United States President, Vice President, and the Secretary of Defense, are all previous chief executive officers from the business community. In addition, the private sector is generally viewed by the American public and many academics as more efficient than the public sector. Unless a private organization produces a unique product or service, efficiency is essential for competitive survival. These same pressures are not present in the public sector to the same degree and facilitate the increased efficiency in the private sector. Consequently, the public sector oftentimes looks to mimic the more efficient practices in the private sector. ROI measurement is just one of many business practices within the private sector that is under experimentation in the public sector.

2. Non-Monetized Notional ROI

The inability to directly apply ROI techniques to many organizations in the public sector indicates that a different approach is required. One such approach includes the use of cost effectiveness analysis to provide a useful framework with which to assign weights to the numerator variables. In *Cost Benefit Analysis: Concepts and Practice*, the authors address this issue:

> If the analyst is unable…to monetize the major benefit, then cost-effectiveness analysis may be appropriate. Because not all of the impacts can be monetized, it is not possible to estimate net benefits. The analyst can, however, construct a ratio involving the quantitative, but non-monetized, benefit and total dollar costs (Boardman, et al., 1996: 36).

This was the initial approach used for analyzing the PEO C4I SC T-AKE project. The resulting formula would produce a non-monetary output considered to be the NROI. As changes to the numerator variables or the denominator are considered, a new NROI can be generated to determine the potential impact of the changes.

In order for the NROI formula to be of credible value, weights must be assigned to each of the numerator variables. Weights are indicative of how the decision makers prefer to balance the impact of the attributes. This step is extremely important since the weight distribution has a tremendous impact on the output. Determination of weights can be an objective result of models and data analysis, a subjective result of discussion by the decision makers, or a combination of both. There are four common methods for determining weights: equal weighting, rank reciprocal, pair-wise comparison, and direct assessment (McNab, 2004). Table 2 presents a comparison of the various methods using the six categories from the initial NROI formula for the T-AKE project as an example.

Table 2. Weighting Method Comparison

Weighting Methods

Effectiveness		Equal Weighting	Rank Reciprocal	Pair-wise Comparison	Direct Assessment
C_P	Capability	.167	1/1→60/147	9→9/65	.10
C_T	Cost	.167	1/2→30/147	11→11/65	.25
S_K	Schedule	.167	1/3→20/147	17→17/65	.05
Q_T	Quality	.167	1/4→15/147	4→4/65	.30
E_2	Effectiveness & Efficiency	.167	1/5→12/147	13→13/65	.15
I_P	Intellectual Properties	.167	1/6→10/147	11→11/65	.15

The equal weighting method simply assigns equivalent weights to all of the variables. The rank reciprocal method has four steps. First, each variable is ranked in order of relative importance (1 – 6 in our example). Next the reciprocal of the ranks is taken (1/1, 1/2, 1/3, etc…). The resulting fractions are then added together using a common denominator to create a new base (60/60 + 30/60 + 20/60 + 15/60 + 12/60 + 10/60 = 147/60). Finally, the original reciprocals for each variable are divided by the new base (147/60) with the resulting distribution being used for weighting (see Table 2). The equal weighting and rank reciprocal methods generally do not provide a high enough level of subjective scrutiny to be of value in a detailed project. With the pair-wise comparison method, the decision makers are provided a specific number of points to be distributed as they see fit between the variables (65 points for the example in Table 2). After discussion, each variable is assigned a numerical value. The sum of the values is then used as the denominator for the variable weighting, with the numerator being the assigned numerical value. Like the previous two methods; pair-wise also fails to provide enough ability to fine-tune the weighting distribution for a detailed project. The direct assessment method uses deductive reasoning to determine and assign weights to each variable. Although this method is purely subjective, it is less random and can easily be modified as necessary. The subjective nature of direct assessment can be alleviated to some extent by using a number of technical experts to develop the weighting values to be used in the formula.

Once weightings have been assigned, the non-monetized value of the numerator variables can be determined. After adding the variables together, the resulting numerator value is divided by the asset base to provide an NROI output. The validity of this NROI on its own is minimal. Trend analysis is required, using subsequent alterations to the numerator variables for the first ship in the class as it is completed and compared with independent data from the second ship in the class as it progresses. Essentially, the first NROI developed sets a baseline that is used to compare with subsequent outputs for the same ship. The trend data from the first ship can then be analyzed to determine if priorities can be adjusted for the second ship in order to improve the output. Additionally, comparisons can be made between ship classes provided the category modifiers are the same and the scope of the project is similar; as is the case with the RCS.

3. Monetized Notional ROI

While it is important to provide weights to the categories used in the numerator of the equation, it is even more important if at all possible to use monetary values for the NROI formula. In *The Bottomline on ROI*, while discussing the determination of ROI in the public sector, Patricia Phillips states that "converting data to monetary benefits is critical…the process is challenging, particularly with soft data, but can be methodically accomplished" (2002: 73). For the formula to be most applicable for the purpose of comparing the past, present, and future NROI of a number of projects, it was determined that the effort must be expended to convert the data to monetary values. This would also serve to provide an NROI as near to traditional as possible for a public sector organization.

As formula development progressed it became clear that the final formula would be a combination of both monetized and non-monetized approaches. The cost data would be actual monetary values broken down into a number of categories. Each category would then be modified by a non-monetized value added factor (VAF) determined by a number of system experts using the direct assessment approach. The resulting formula would incorporate the essential cost elements while also attempting to capture the intangible benefits provided by the public sector entity in the absence of profit.

III. PREVIOUS EFFORTS AT DEVELOPING ROI IN THE PUBLIC SECTOR

A. AUSTRALIA

1. Scope and Reasoning behind the Effort

In an attempt to justify government acquisitions, Australia's government continues to focus on improving its own ability to develop and implement ROI criteria. In a society vigorously competing for scarce public resources, receiving the best value for money spent has become central to government policy. The Australian Commonwealth demands this accountability. In response, Australia's government has taken strides to emphasize the development of ROI criteria to make acquisition decisions throughout its governmental departments. However, we were unable to find a specific example where ROI criteria were successfully developed and implemented by a governmental organization. Dr. Allen Hawke, Australia's previous Secretary of Defense, acknowledges the public's frustration with their lack of success to date. According to Dr Hawke's address in February of 2000, "there is a widespread dissatisfaction with Defence's Performance (regarding Australia's Defense Organization use of funds)…In essence we have a credibility problem."

Australia's Department of Finance and Administration (ADOFA) is responsible for providing direction to Australia's ministries in making procurement decisions. Instead of simply choosing the lowest cost alternative, ADOFA emphasizes the "achievement of value for money" (2003). Among other things, this method weighs the ability of the alternatives to meet the stated objectives, the reliability and reputation of the contractor, and the whole of life costs instead of just the initial procurement cost. Instead of providing structured guidance to determine ROI, ADOFA provides a substantial list of things to consider and leaves it to the particular agency to identify and weigh those things that apply. Due to the unique benefits of each procurement decision, this general approach may be appropriate. However, recent comments from Australia's Defense Procurement Review indicate a lack of success thus far within the acquisition community. The review concludes with the following comment;

> Our review of the acquisition process has led us to conclude that there is no single cause of the failures that have become apparent in the development of capability and the acquisition and support of defence equipment (Australia Dept. of Defence, 2003: 47).

2. Lessons Learned

The Australian government does acknowledge the need to consider ROI when making procurement decisions. However, by merely emphasizing value for money in broad terms, they are not actually implementing quantitative ROI criteria within their government. They do highlight the need to consider many important factors other than costs for procurement decisions such as quality and contractor performance. Yet, they do not provide a universal method for considering the weighting of these factors so that decisions can be consistently made the same way across the different ministries. Perhaps this inconsistency is one of the reasons for their continued lack of success within the Department of Defence acquisition community.

B. NEW ZEALAND

1. Scope and Reasoning behind the Effort

The following ROI case concerning the Royal New Zealand Navy (RNZN) is summarized from a case study authored by Beryl Ann Oldham, Paul Toulson, Brenda Sayers, and Graham Hart (2002). The RNZN had encountered considerable difficulty retaining their marine engineers (ME) in the mid 1990s due to high attrition rates. The ME community is responsible for many of the complex systems aboard the RNZN's fleet ships including operation and maintenance of diesel engines, gas turbines, electrical generators, and air conditioning and refrigeration plants (Royal New Zealand Navy, 2004). The attrition problem was so significant that the ability of the RNZN to maintain an acceptable operations tempo was threatened. Several suggestions were made in an effort to reduce the ME attrition rate. These measures included improved ME career management initiatives, better management of leave and maintenance periods, improved pay, compensation time for working weekends, and the more controversial Marine Engineer Retention Bonus Scheme (MERBS). It was believed that implementation of an immediate retention bonus was imperative to control the attrition problem in the short run since the other proposed initiatives would be slower to take effect (Oldham, et al., 2002: 132).

The MERBS was an expensive human resource endeavor for the RNZN. MERBS costs included both administrative program set up costs and the retention payments to personnel themselves. These overall costs were estimated at almost five million Australian dollars (144). However, the MERBS was considered a successful initiative since it did reduce attrition rate for the MEs to an acceptable level. Unfortunately, it was difficult to determine just how successful the MERBS was, especially considering that other retention initiatives were occurring simultaneously. Consequently, an ROI study was conducted to determine the isolated effect of the MERBS on ME retention in the RNZN.

The monetary benefits of any retention program are the avoided expenses for replacement and training of new personnel and the separation costs incurred for personnel leaving the military. There are also some less tangible benefits including higher experience levels, improved morale and increased flexibility. However, in order to remain objective, the focus of the study was placed on the monetary benefits achieved by the MERBS. There were two approaches taken to isolate the monetary benefits of the MERBS on retention.

The first approach was more subjective in nature and involved the use of a questionnaire taken by both the participants in the MERBS and their managers. The questions were tailored to evaluate the effectiveness of the MERBS and its isolated impact on the ME participants to stay in the RNZN. It was ultimately determined, based on these questionnaires, that forty one percent of the participants' decisions to stay in the RNZN were influenced by the MERBS. These forty one percent were then asked to rate the accuracy of their answer regarding the influence of the bonus payments on their decision to stay. The reply indicated they were ninety-three percent confident in the accuracy of their answer regarding the MERBS influence on their decision to stay (138). The actual monetary benefit was determined by multiplying the participants' impact estimation of the retention payments by the estimated savings of retention for each of the

170 personnel participating in the MERBS. The estimated savings per participant and the detailed calculation of the ROI from this approach is shown in Table 3.

Table 3. Determining ROI with the Participant Impact Estimation (Oldham, et al., 2002: 140, 145)

Number of participants in the MERBS at the end of three year period = 170
Estimated separation cost per ME leaving the service = \$4,260
Average replacement cost per ME leaving the service = \$105,133
Percentage of decision to stay influenced by retention payments = 41%
Confidence in decision to stay influenced by retention payments percentage = 93%
Participants estimation of retention payment's impact = 0.41 x 0.93 = 0.38
Monetary Benefits = (\$4,260 + \$105,133) x 170 x 0.38 = \$7,066,789
ROI from participant impact estimation = Net Benefits/Program Costs x 100 = (\$7,066,789 - \$4,926,504)/(\$4,926,504) x 100 = 43 %

The second approach involved a more objective approach using retention trend data. Predicted turnover of ME personnel without the retention payments was estimated based on historical trends in both ME and non-ME personnel prior to the MERBS period. Based on previous trends of non-ME and ME personnel before the MERBS initiative, ME turnover averaged 5.5 percent higher than non-ME personnel (Oldham, et al., 2002: 141). These data were used to determine an expected ME turnover without the retention payments. This was compared to the actual turnover during the MERBS period to determine an actual number of ME participants that were retained as a result of the bonus payments. Based on this comparison, it was concluded that seventy-three additional personnel were retained during the MERBS period than was predicted based on trend data without the MERBS initiative. The detailed determination of the ROI based on this second approach is shown in Table 4.

Table 4. **Determining ROI with the Forecasting Method (Oldham, et al., 2002: 144-45)**

Number of personnel retained attributed to MERBS initiative = 73
Estimated separation cost per ME leaving the service = $4,260
Average replacement cost per ME leaving the service = $105,133
Monetary Benefits = ($105,133 + $4,260) x 73 personnel = $7,985,689
ROI from Forecasting Method = Net Benefits/Program Costs x 100 = ($7,985,689 - $4,926,504)/ ($4,926,504) x 100 = 62 %

2. Lessons Learned

It is interesting to note the similarities and differences between the two approaches. Both approaches determine program costs the same way. Even though the methods of determining monetary benefits are very different, the results are surprisingly similar. The participant impact estimation yields a monetary benefit of approximately seven million dollars while the forecasting method yields a monetary benefit of approximately eight million dollars. However, these numbers do yield significantly different ROI for the MERBS initiative.

The question then becomes which approach is more valid? Both approaches are logical and defendable. The forecasting approach is more objective since it is based entirely on data and trend analysis. However, the shortcoming is that it does not entirely isolate the effect of the MERBS initiative from the other retention initiatives occurring simultaneously. It is plausible that most of the seventy-three additional personnel retained were a result of the MERBS, but it is certainly possible that other proposed initiatives played a factor. The participant impact estimation approach is clearly more subjective since it is based on responses from a questionnaire. Conversely, it does better address the isolated effect of the MERBS initiative through the inclusion of specific questions in the questionnaire. Unfortunately, ROI methodologies based on non-traditional methods cannot always be purely objective. This is what makes it so challenging in the public sector. The objective is to develop a credible methodology, which is what was accomplished here. Therefore, both methodologies are valid as long as their shortcomings are kept in mind. This is true of any mathematical formula.

A lesson learned discussed in the case relates to data collection. Ideally, the decision to perform an ROI determination is made prior to program implementation. This way data required can be determined and recorded while the program is taking place. For this case, the decision to determine the ROI for the MERBS was not made until after the program was implemented and well under way. Therefore, many data collection opportunities were missed. The recommendation of the study is to consider ROI evaluations and associated data collection needs during the development phase of program initiatives if possible (Oldham, et al., 2002: 146).

Another lesson learned from the case was the extent taken to keep the ROI methodology simple. They could have attempted to determine monetary values for more complex but less tangible benefits. For example, they could have attempted to determine the monetary benefit of the increased operations tempo or increased experience levels available because of the higher retention rate. However, it is easy to imagine that this would involve potentially long and complex mathematical formulae and additional subjectivity. By avoiding these attempts, the ROI methodology is easier to understand and more credible.

C. UNITED STATES POSTAL SERVICE

1. Scope and Reasoning behind the Effort

The USPS used an Economic Value Added (EVA) program to determine their ROI from 1996-2002. EVA was calculated by determining the net operating income and subtracting a fee proportional to the cost of the assets used to produce that income (USPS, 1997). This difference represented a positive net cash flow that added financial value to the post office. A higher EVA indicated a more efficient use of assets. Consequently, senior post office executives were rewarded for performance at the USPS based on this figure. This provided financial incentive for post office employees to seek out new and better ways to improve efficiency within the organization. This program was credited with contributing to the $3.5 billion in net income earned by the USPS from 1996-2000 (USPS, 2002). However, amid strong controversy relating to the calculation of EVA program incentive bonuses, the effort was abandoned in 2002.

The USPS 2003 Annual Report cites the continued use of ROI criteria for capital venture decision-making. Unlike many public sector organizations, the USPS is one of the few public sector companies that generate revenue. This facilitates using the traditional method of calculating ROI. The USPS continues to invest in automation equipment to reduce personnel work hours in mail processing and delivery (USPS, 2003: 25). The cost savings realized from automation is then compared to the cost of acquiring the required equipment for making procurement decisions. The USPS also uses a Cash Flow/Capital Expenditure (CAPEX) ratio as a benchmark for assisting in making capital purchase decisions (USPS, 2003: 24). The additional yearly cash flow to operations is compared to the yearly cash outlays to support the project. This helps to determine the attractiveness of the proposed project and the required need to borrow funds to support it.

2. Lessons Learned

The basis for determining economic value added at the USPS had significant flaws. The idea of subtracting additional costs from increased benefits to determine value added from a given investment is sound. However, the application of the EVA Variable Pay Program was inconsistent when overall USPS performance is considered. For example, the USPS lost $199 million in fiscal year 2000 but still paid out over $280 million in performance bonuses (Lexington Institute, 2001). It is counterintuitive for an organization to lose money in a given fiscal year and still pay out such a significant sum of money in performance bonuses. In fact, the reason the USPS lost money that year was due to the bonus payouts. Inconsistent ROI measurements such as EVA are not credible if they indicate positive results when other metrics such as negative net income indicate to the contrary.

The USPS uses simple and intuitive methods for determining ROI for evaluating investment decisions. The use of cost savings as a basis for determining ROI is a commonly used method for public sector organizations. This is because many procurement decisions made by public sector organizations involve investments that will ultimately improve efficiency. If these efficiencies are able to be quantified, they can be used as a basis for comparison to the required capital expenditure to determine an ROI. The CAPEX ratio used by the USPS to evaluate capital purchase decisions is also an intuitive way to determine an ROI. Comparing cash flows to required capital expenditures is very similar to a net present value calculation commonly used in the private sector to evaluate investment alternatives. It is important to emphasize that the USPS does generate annual revenues which lends itself to the use of traditional ROI metrics. This is uncommon among most other public sector organizations.

D. NAVY DENTAL CORPS

1. Scope and Reasoning behind the Effort

In response to the CNO's call for better decision making tools, the Navy Dental Corps (NDC) has developed a simple metric to determine ROI at the branch clinic level. Captain York, the navy representative at the Tri-Service Center for Oral Health Studies (TSCOHS), spearheaded the effort to determine a practical method for defining NDC's return for investment dollars. While not using the traditional method of ROI that compares earnings to assets, this effort provides an easily understood metric to quantify performance at the branch clinic level.

NDC's ROI formula compares a branch clinic's quarterly output, defined as Dental Weighted Values (DWVs), to its required investment in funding dollars and military labor. The formula is as follows (Mitton, 2004):

$$ROI\,(\%) = \frac{(Qtrly\,DWVs\;x\;100) - ((Branch\,APF + Annual\,Branch\,Milab)\;x\;0.25)}{(Branch\,APF + Annual\,Branch\,Milab)\;x\;0.25}\;x\;100$$

DWV ($) – Dental Weighted Values

Branch APF ($) – Branch Clinic Annual Planned Funding

Annual Branch Milab ($) – Branch Clinic Military Labor

Branch APF is the operation and maintenance funding allocated to the clinic. Both Branch APF and Annual Branch Milab are converted to quarterly values to determine quarterly ROI. DWVs and Annual Branch Milab are determined through separate data collecting programs described next.

DWVs are determined by input from the branch clinic into a program known as DENCAS. The clinic enters the different procedures performed on a given day using American Dental Association (ADA) procedural codes, known as Common Dental Terminology (CDT) codes. CDT codes are converted into DWVs that are essentially equal to one hundred dollars worth of dental services. This result is multiplied by one hundred to convert the DWVs directly into dollars for use in the ROI formula.

Annual branch clinic labor is determined by the collection of data into the Medical Expense and Performance Reporting System (MEPRS). Branch clinic employees specifically document their hours worked performing a variety of individual tasks on MEPRS sheets. Different tasks such as various medical duties, training, and even leave/liberty times are documented. These data are correlated at the comptroller level to determine military labor hours and is converted into a dollar figure based on the rank and rate of the military employees working at the clinic.

2. Lessons Learned

The Navy Dental ROI formula discussed above is no longer used for three reasons. First, there is significant skepticism regarding the quality of the data being tracked for use in the calculation of ROI. Specifically mentioned was the inaccurate data collected by MEPRS. Many dental employees failed to log their hours on a daily basis; instead, they would record their hours on a weekly or monthly basis. This brings the accuracy of the type and number of hours into question due to the delay time in recording. Many times employees would wait until the end of the month and simply log eight hours of work arbitrarily for each day. Commander Mitton, from the Navy Bureau of Medicine and Surgery in Washington DC, referred to this popular method as “logging straight eights” (2004).

It is also difficult to use this formula for comparison. Different branch dental clinics may be responsible for different operating costs. For example, some of the clinics are responsible for paying their rent and utilities while other clinics are provided with these resources free of charge directly by the base command. This directly affects the amount of Branch APF the clinic would receive and, consequently, affected the results of the ROI formula.

Finally, the Navy Dental ROI formula does not include many of the cost elements required to staff and operate a branch dental facility. For example, large expenses such as the cost of training Navy dentists and dental technicians are not included. Other large costs such as accession bonuses for dentists and depreciation expenses for major equipment are also not included. Therefore, ROI for the Navy branch dental clinics needed to be more adequately defined.

As a consequence, Captain York developed a more robust formula to be used in calculating ROI for Navy Dental clinics. Although similar to the previously discussed formula, it also includes many of the lacking cost elements. See Table 5 on the following page for a sample calculation using Pearl Harbor for FY 2000. ROI is calculated as shown below (York, 2004):

$$ROI\ (\%) = \frac{Production\,Value - Cost\ of\ Production}{Total\ Cost\ of\ Production}\ x\ 100$$

Production Value is determined similar to the DWVs calculated in the original formula. The Cost of Production, however, includes significantly more cost elements. For example, note the system costs listed in Table 5. These are the allocated training costs to the Pearl Harbor dental clinic from the dental training pipeline. These were not included in the original formula but are real costs burdened by the NDC and should be included. These system costs are divided between all the clinics proportionately based on the number of dental technicians and dental officers employed at the clinic.

Table 5. Raw Data: Pearl Harbor Branch Dental Clinic FY2000 (York, 2004)

FY 00 COSTS (EXCLUDING DENTAL COST AND PRODUCTION ABOARD SHIPS)

Command/Branch:	**PEARL HARBOR**	
Number of command/BDC Dental Officers	**28**	**(to determine system costs)**
Number of military dental techs. (incl. ships)	**2807**	

	NDCs	**NHs**	**SYSTEM**	**TOTAL**
Military Pay (Claimancy 18)	$ 5,708,382		$ 86,309	$ 5,794,691
NDRI Military Pay			$ 18,694	$ 18,694
Dental Bonus (above composite)			$ 368,186	$ 368,186
Dental Accession Bonus			$ 9,146	$ 9,146
Civilian (GS)	$ 449,140			$ 449,140
Contracts	$ 548,086			$ 548,086
Reserve (composite including travel)	$ 529			$ 529
Dental Scholarships			$ 207,520	$ 207,520
Outservice Training (DO)			$ 8,663	$ 8,663
Officer Indoctrination School			$ 22,041	$ 22,041
DT "A" School (w/o student pay)			$ 68,517	$ 68,517
DT "A" School Student Pay			$ 66,237	$ 66,237
DT "A and C" School Staff Pay			$ 20,562	
DT "C" School			$ 57,157	$ 57,157
RDH Training Program			$ 3,080	$ 3,080
Officer Recruiting			$ 5,828	$ 5,828
Enlisted Recruiting			$ 104,807	$ 104,807
Recruit Training			$ 103,770	$ 103,770
MED-06/OODC			$ 1,359	$ 1,359
NDRI Operating Funds			$ 40,757	$ 40,757
Material (equip & supplies)	$ 464,619			$ 464,619
Equipment Depreciation				$ -
Other Procurements Navy (OPN)				$ -
Reimbursable	$ 48,457			$ 48,457
Free Receipts				$ -
All Other	$ 385,049			$ 385,049
Total Cost of Production	$ 7,604,262	$ -	$ 1,192,635	**$ 8,796,897**
Production Value *	$ 9,973,433	$ -		**$ 9,973,433**
Production Value minus Cost of Production				**$ 1,176,536**
			ROI	**13.4%**

* Based on the 1995 ADA Survey of Dental Fees (75th percentile), adjusted to 1997 dollars using the Consumer Price Index for Dental Services.
Production data source: Navy Executive Information System (EIS), Dental Weighted Values.

There is still significant variation between the branch dental clinics using the improved ROI formula. Table 6 compares the ROI calculated by the above formula for all the navy branch clinics. Note that the ROI varies from approximately negative ten percent to over one hundred percent. These variations are not due solely to differences in performance levels. For example, NNDC is responsible for the costs of the Naval Dental Postgraduate School. Due to this fact, the NNDC ROI includes the impact of manpower costs and low productivity of the student-body significantly reducing their ROI.

Therefore, even though this formula is more robust, one must consider more than just the final ROI output to fairly compare commands.

Table 6. ROI for Navy Branch Dental Clinics

COMMAND	COST	PRODUCTION VALUE	PROD - COST	ROI
GREAT LAKES	$28,476,040	$60,746,220	$32,270,180	113.3%
OKINAWA	$18,156,185	$30,022,556	$11,866,371	65.4%
MID ATLANTIC	$29,003,564	$46,150,165	$17,146,601	59.1%
PARRIS ISLAND	$10,810,353	$15,747,470	$4,937,117	45.7%
CAMP PENDLETON	$19,227,602	$26,027,670	$6,800,068	35.4%
SOUTHWEST	$34,282,076	$45,365,397	$11,083,321	32.3%
SOUTHEAST	$19,366,135	$24,946,372	$5,580,237	28.8%
GULF COAST	$14,541,505	$18,741,273	$4,199,768	28.9%
CAMP LEJEUNE	$17,474,322	$22,031,239	$4,556,917	26.1%
EUROPE	$12,454,115	$15,642,759	$3,188,644	25.6%
PEARL HARBOR	$8,796,897	$9,973,433	$1,176,536	13.4%
FAR EAST	$13,896,531	$15,376,018	$1,479,487	10.6%
NORTHEAST	$11,073,148	$12,213,250	$1,140,102	10.3%
NORTHWEST	$9,987,892	$9,711,583	-$276,309	-2.8%
NNDC	$32,151,242	$29,096,131	-$3,055,111	-9.5%
ALL NDCs	$279,697,607	$381,791,536	$102,093,929	36.5%

IV. NOTIONAL ROI FORMULA DEVELOPMENT FOR SPAWAR PEO C4I AND SPACE NEW SHIP CONSTRUCTION

A. T-AKE PROJECT

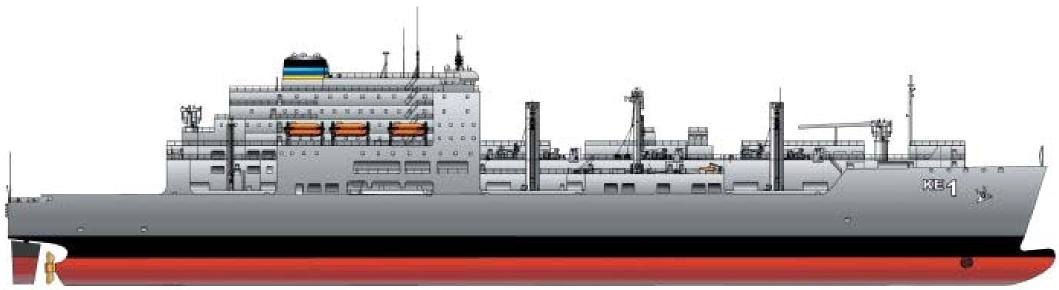

Figure 1. T-AKE 1: USNS Lewis and Clark (Global Security, 2004)

1. Ship Class Background Data and Building Plan

The T-AKE class of ships will provide Naval forces at sea with replenishment capability involving ammunition, food, repair parts, consumables, and to a lesser extent marine and aviation fuel. The initial plan is for twelve ships to be constructed in three distinct sets of four ships each known as flights (Program Executive Office, 2003: iv). The role of PEO C4I SC with regard to the T-AKE is to "design, procure, integrate, test, deliver, install, train, and logistically support the T-AKE C4I suite of equipment" (iv).

SPAWAR Systems Center Charleston (SSCC) was tasked with configuring the RCS portion of the overall installation. The RCS consists of all shipboard equipment used for voice and data communications. In addition to T-AKE, SSCC is also responsible for the RCS configuration on the LPD-17, LHD-8, and CVN-68 classes of ships. By retaining sole responsibility for the RCS across a number of platforms, SSCC translates lessons learned from one class of ships directly onto other classes, limiting the duplication of errors prevalent in stove-piped efforts. The assemblage of concentrated experience and talent at SSCC provides an environment whereby problems can be worked through quickly and efficiently and most importantly where developed better business practices can significantly improve the deliverables.

Initial engineering efforts to plan the design for the T-AKE RCS began in the fourth quarter of 2001. This effort continued into early 2004 with necessary modifications made along the way. Concurrently, design of the Test Integration Facility (TIF) and procurement of equipment began in the fourth quarter of 2002 and continued on into the third quarter of 2004. Transfer of the tested RCS will be conducted in the first quarter of 2005. USNS Lewis and Clark, as T-AKE 1 will be called when completed, is being built at the NASSCO shipyard in San Diego, CA. She is expected to be commissioned in mid 2005.

2. Turnkey Approach

With the conventional shipbuilding approach, all equipment destined for installation on the ship had to be identified well in advance, typically 5-9 years with regard to RCS equipment (Program Executive Office, 2003: 2). This extensive lead time led to many problems such as cost overruns due to technology refresh requirements, engineering rework caused by the need to make modifications to support new equipment, and in some cases no cost impact but rather an efficiency impact as outdated or even obsolete equipment were left on board. A more novel method called the Turnkey Approach is now being utilized by SPAWAR.

With the Turnkey Approach, design deadlines are developed with regard to space and power requirements but responsibility for installation rests with PEO C4I SC and not with the shipbuilder. In this way the shipbuilder can continue on with ship construction, providing the spaces and cable routes as prescribed by PEO C4I SC but leaving the installation and integration of the actual equipment up to PEO C4I SC. This allows for a dramatic reduction in lead time for the procurement of the equipment from 5-9 years down to 2 years (2).

The key element to successful implementation of the Turnkey Approach is the TIF located at SSCC. The TIF is essentially a mock up of the eventual RCS for a particular ship. The actual equipment that will be used on the ship is installed and integrated in advance at the TIF vice the conventional method onboard ship. This allows for the technicians to work out the problems coincident with any such endeavor. Once the TIF RCS is up and running at top efficiency the components are packed and shipped to the shipboard site for actual installation. In stark contrast to conventional methods, the installation of the RCS systems is not normally done until approximately 140 days prior to the builder's ship trials. (Program Executive Office, 2003: 3)

B. NROI FORMULA SEQUENCE OF DEVELOPMENT

The sequence of development for the SPAWAR/PEO C4I SC NROI application spanned over ten months of time and involved several face-to-face and video teleconference (VTC) meetings with Command personnel. Since SPAWAR is a public sector organization, they do not report a net income which would traditionally be used in the private sector to determine a corporation's ROI. Therefore, our task was to develop an NROI formula that would credibly measure the PEO C4I SC ROI for the T-AKE project. This evolutionary process produced four iterations before deciding on the final NROI formula in an effort to fairly represent the added value contributed by SPAWAR/PEO C4I SC to the T-AKE project.

The NROI formula development process had to be approached considering a number of criteria in an effort to make it both acceptable and useful. Nine non-mutually exclusive criteria applied in development of the NROI method included: simplicity and intuitiveness, feasibility of implementation, credibility, theoretical adequacy and utility, flexibility, validity, ability to be replicated, comprehensiveness, and consideration of all program costs. These must all be taken into account, as per advice provided in Patricia Phillips *The Bottomline on ROI*, and are summarized below as related to development of the NROI for PEO C4I SC (2002: 60-62).

Simplicity and Intuitiveness: NROI formulae should be straightforward and easily understood. Complex NROI formulae made up of long mathematical equations serve little purpose and can be unnecessarily confusing to those they are intended to assist. NROI formulae should be quickly comprehended, thus providing managers a useful tool to understand the information provided for their use.

Feasibility of Implementation: Implementation of a new performance measurement for the organization can be time consuming and costly. For example, the requirement of a new data collection method to measure performance might require significant managerial resources and dollars to employ. Therefore, consideration must be given to the feasibility of the elements that make up the NROI formula in order to minimize this burden. In cases where it is possible, utilization of existing data collection methods (provided they are relevant) is recommended.

Credibility: The developed NROI formula must be considered credible by those whose efforts it is intended to measure and by the managers reviewing the results. A performance measurement not considered credible by those tasked to implement it is useless. It will either not be implemented as it was intended or will simply be disregarded. Whenever possible, it is imperative to use objective measures to represent the outputs that are used to measure performance. In cases where this is not possible, steps must be taken to minimize the formula's subjectivity. Finally, a conservative approach must be considered when choosing between formula alternatives in order to preserve the credibility of the process.

Theoretical Adequacy and Utility: The NROI formula developed must be consistent with other measurements of ROI. According to Patricia Phillips; "The ROI methodology must be theoretically sound and based on generally accepted practices" (2002: 61). The numerator must represent the organization's net benefits and the denominator must represent the total costs associated with achievement of those net benefits. This enables utility similar to private sector uses of ROI.

Flexibility: The developed NROI formula must be flexible enough to be used in several applications. This includes the assessment of the ROI during various phases of the T-AKE project as well as the program's overall ROI.

Validity: Validity of the developed NROI formula must be verified through actual application to the organization. It should produce output consistent with expectations. For example, an increase in non-value added costs should reduce the organization's NROI.

Replicable: The formula should allow replication of results by independent sources provided the same data are available. Once developed and approved, the formula should be able to be applied objectively, even though it may contain some subjective elements.

Comprehensiveness: All relevant components of an organization that add value to the final products and services should be represented in the formula if possible. Some outputs may be difficult to quantify, and must be noted as intangibles. However, maximum inclusion of benefits is necessary for fair valuation of the organization's outputs.

Consideration of All Program Costs: Fair assessment of the organization's ROI also involves accurately accounting for all the program costs that are incurred in producing the output. These include the direct costs of the project as well as a fair share of the corporate costs or overhead incurred by the organization.

The most basic ROI formula is shown below (Phillips, 2002: 19):

$$ROI\ (\%) = \frac{Net\ Program\ Benefits}{Program\ Costs}\ x\ 100$$

This was chosen as the baseline template to be used in the development of the NROI formula for PEO C4I SC. Net program benefits are benefits minus the costs of achieving those benefits. Program costs will include both direct costs of the program as well as a fair share of the corporate costs. An ROI determined directly from this formula yields a percentage ROI similar to the ROI formulas used in the private sector.

1. 1st Iteration

Dr. Lawrence R. Jones, RADM George F. A. Wagner/SPAWAR/PEO C4I and Space Professor of Public Management in the Graduate School of Business and Public Policy (finance curriculum) at the Naval Postgraduate School (NPS) in Monterey spearheaded a new approach to solving the public sector ROI dilemma. Beginning in late 2003 Dr. Jones worked closely with (RADM ret.) William Marshall, an independent contractor from American Systems Corporation (ASC) serving as a consultant to PEO

C4I SC in San Diego. Their goal was to think through the application of ROI to the Navy and PEO C4I SC in response to the call for such action by the CNO. A value-added approach to determine an NROI was developed by Jones with assistance from Marshall, Tom Sommers and other PEO C4I SC staff. After several months of serious dialogue on the task at hand, the decision was made by Joe Mayer, head of PEO C4I SC, to move forward with a specific project. The platform to be modeled was the C4I suite of a new class of supply ship (T-AKE). The role of PEO C4I SC is the installation, integration and testing of the suite as well as the personnel training required for the operators. Ironically, the first ship and class name is Lewis and Clark, named for the two explorers who led a visionary project of exploration. (United States Dept. of Defense, 2003)

The original NROI formula was developed with the help of a number of SPAWAR/PEO C4I SC representatives, led by Jones, Sommers and Marshall, at their semi-annual meeting in December 2003 (Jones et al.):

$$NROI\,(\%) = \frac{(Cp + Ct + Sk + Qt + E2 + Ip)}{Asset\ Base}\, x100$$

The numerator inputs will be weighted according to the relative importance to one another and would ultimately be multiplied by the cost of labor hours devoted to that category. As described previously, the weighting is very important and was to be determined using primarily subjective analysis by the key players. It is important now to take a closer look at each of the numerator inputs individually with the realization that the formula inputs were still in the development stage. Each of the sub categories would also be weighted within each variable using one of the four aforementioned methods.

Capability (Cp) addresses the integration and testing of the hardware and software, the scalability of the suite, and the ease with which the technology can be updated. Cost (Ct) accounts for the time versus the resources used, benefits from consolidated buys, and lessons learned. Schedule (Sk) assesses the TIF integration process, flexibility, and management performance. Quality (Qt) focuses on metrics, testing, and interoperability standards. Effectiveness and Efficiency (E2) determines the effect of economies of scale, lessons learned, and standard practices. Lastly, Intellectual

Properties (Ip) represent the expertise, experience, and training of the personnel involved in the process (Jones et al., 2003).

2. 2^{nd} Iteration

A second iteration of this formula was developed at the May 2004 SPAWAR PEO C4I and Space semi-annual meeting. It is shown below including the minor modifications that were made to ease the data collection for the formula:

$$NROI\,(\%) = \frac{(Cp + Sk + Qt + Ip)}{Asset\ Base} x100$$

The Cost and Effectiveness and Efficiency value added categories were dropped from the formula. This was done as a result of a consensus opinion that these two categories were largely indistinguishable from elements already present in the remaining four categories. The major obstacle still before the effort at this point was developing a data collection method that would allow for easy translation of labor hours into the remaining four categories.

Unfortunately, even with the modifications to the baseline formula, the 2^{nd} iteration was later determined to be technically unfeasible for two primary reasons. First, the value added categories as developed remained too vague. It was concluded that it would be too difficult to objectively separate the labor hours from the T-AKE project into the individual categories. Also, some of the labor hours might fit into more than one of the categories. For example, an hour of labor spent installing equipment may contribute to both Capability (Cp) and Quality (Qt). How would these "double value" hours be separated to best represent their contribution? Secondly, data collection was not already in place to support this formula. Gathering data would have required the creation of new data collection methods thought to be too cumbersome and costly. It was also determined that it would not be feasible to develop credible values for average labor rates for use in the numerator since they vary considerably throughout the organization. Consequently, without quality data available to support the 1st or 2^{nd} iterations, a change of approach was in order.

3. 3rd Iteration

The 3rd iteration of the baseline formula was developed at a conference held in San Diego at ASC on July 23, 2004. This formula represented a much refined approach to the problem relying on a much smaller core group of key players as opposed to the more open ended discussions at the semi-annual meetings. In the process of lengthy discussion about data availability, validity and applicability with Travis Tillman, the Platform Manager for the T-AKE project, the third version of the NROI formula was developed by Jones, Bigham and Goudreau as shown below:

$$NROI(\%) = \left(\frac{PM x 1.1 + ENG x 1.4 + SM x 1.15 + PR x 1.4 + INST x 1.3 + SS x 1.2 + MM x 1.1 + Avoidance Costs - Rework Costs}{Radio Control Suite Program Costs} - 1\right) x 100$$

WBS CATEGORIES

PM – Program Management
ENG – Engineering
SM – Supportability Management
PR – Production (Integration)
INST – Installation
SS – Shipyard Support
MM – Material Management

The numerator of the formula was changed considerably as compared with the first two iterations. There are four significant differences, the use of SSCC's existing cost tracking method of Work Breakdown Structure (WBS) categories, the utilization of VAFs, the addition of avoidance costs, and the capturing of rework costs.

First, rework costs incurred due to PEO C4I SC actions would be separated out of the value added categories. Rework does not add value to the project and, consequently, should not enhance the NROI. Second, based on a recommendation that arose during a phone conference with Dr. Patricia Phillips, the president and CEO of the ROI Institute, a cost avoidance category was added to the numerator (2004). The purpose of this adjustment is to capture any costs avoided as a consequence of the role PEO C4I SC plays in coordinating the expenditure of DOD resources. For example, if PEO C4I SC makes a bulk buy of radio room equipment to support multiple DOD contracts and saves a particular sum of money, this would be considered a cost avoided. If a piece of this equipment is then used in the T-AKE ship project, some of this avoided cost should be credited to the project as an avoidance cost and improve the project's NROI.

Lastly, the WBS categories parallel data already kept by the T-AKE's platform manager with only minor modifications. It was determined that the same process of applying weighting factors could also be used to determine VAFs to modify the seven existing WBS categories in order to represent the value added by PEO C4I SC to the RCS for the T-AKE project. For example, engineering's VAF of 1.4 indicates that every dollar spent on engineering gives the final product a total value of $1.40. A detailed description of the WBS categories and VAFs follows.

4. WBS Categories and Associated VAFs

The WBS categories used in the numerator of the NROI formula reflect the seven categories commonly used across all SSCC RCS Programs. The numerical values for the VAFs for each of the WBS categories were initially proposed by Travis Tillman at the July ASC conference. However, in an effort to strengthen the accuracy, validity and credibility of the weighting methodology, other experts within SSCC were asked for their valuation of the different WBS cost categories via email correspondence at the beginning of August. The following five members, with their associated titles, then participated with the authors in a video teleconference (VTC) meeting on Aug 6, 2004 during which final agreement on the VAFs was established:

Mr. Travis Tillman – T-AKE 1 Class Platform Manager

Mr. Ken Ayers – LPD-17 Radio Communications System Program Manager,

Mr. Jim Burgess – CVN-68 Radio Communications System Program Manager

Mr. Mike Cullison – LHD-8 Radio Communications System Program Manager

Mr. Kevin Gerald – CVN-68 Radio Communications System Project Engineer

The VAFs for each of the WBS elements were developed by consensus among this group of SSCC civil servants who collectively have over 60 years of experience designing, engineering, installing, integrating, testing, and supporting radio communications systems for Ship's Construction, Navy (SCN) platforms. Experience of these members includes a number of different delivery approaches across several platforms spanning the last 20 years.

The following discussion of the different WBS categories and their associated VAFs is derived primarily from explanations provided by Travis Tillman in person, via VTC and through email (2004). Our explanation serves as a summary of comments made principally during the VTC where the VAF values were decided upon by the participating group members.

Program Management (PM): A weighting factor of 1.2 was applied to program management based on the agreed amount of value added to dollars spent within this category. RCS managers have the required education and experience to make decisions within their programs that are based on best engineering practice and past experience. The RCS managers also have the benefit of discussing and sharing issues with each other at SSCC. Currently, the four SSCC RCS managers have, on average, 15 years of direct SCN integration and installation experience. SSCC managers are also using a number of project management tools. For example, the LPD-17 Class program is using the Capability Maturity Model® Integration (CMMI®) project. CMMI® is a collaborative effort to provide models for achieving product and process improvement. The primary focus of the project is to build tools to support improvement of processes used in the development and sustenance of systems and products. The output of the CMMI® project is a suite of products, which provides an integrated approach across the enterprise for improving processes, while reducing the redundancy, complexity, and cost resulting from the use of separate and multiple capability maturity models (CMM®s).

Engineering (ENG): A weighting factor of 1.4 was applied to engineering based on the agreed amount of value added to dollars spent within this category. The weighting factor of 1.4 was applied to engineering based on the RCS managers' past experience developing engineering products for a number of SSCC delivered radio control systems for platforms currently in construction as well as those recently delivered to the fleet (Current: CVN 70/77, LHD 8, LPD 17 – 21, T-AKE 1 – 4; Recent: CVN 69/76). The core team of engineers has collectively worked on over 15 RCS programs during the past 20 years. SSCC uses a core team of engineers, leverages engineering products from one hull to the next, uses best engineering practices, to include baseline management, and uses an extensive number of Standard Operating Procedures (SOP) to improve efficiency.

SSCC has also developed engineering products that are tailored to the specific platform's requirements. For example, once a specific drawing is developed for a given communication system, such as High Frequency (HF), it becomes the starting point for follow-on platforms. Drawings can be sized or scaled to meet follow-on platform requirements. The ability to leverage drawings from one platform to the next is one way SSCC achieves a significant cost savings in engineering. SOPs are also used as a tool for SSCC to minimize cost. SOPs are constantly refined to improve the quality of engineering products developed. One of the most beneficial practices employed by SSCC is Baseline Management. Baseline Management allows multiple agencies, as well as multiple contractors, to stay on the same page. Although engineering products and associated development are leveraged across multiple hulls at SSCC, the final products are still tailored to the specific platform and allow for the resultant Information Capabilities Document, cable run sheets, and "As Built" drawings to be a comprehensive set of documentation to be used by both ship's force and future installers. Because these final tailored packages are designed and reviewed before and during the Production phase of acquisition, the latest available technology insertion can be employed to provide the fleet with the most recent equipment the ship's C4I baseline will allow.

Material Management (MM): A weighting factor of 1.1 was applied to material management based on the agreed amount of value added to dollars spent within this category. Although most of the efforts associated with material management will occur regardless of the acquisition strategy or approach, the SSCC SCN Material Management team has many years of experience in this category and has developed and consistently refined efficient standard operating procedures. The labor for the team and lessons learned are shared across multiple platforms constantly improving work practices.

Supportability Management (SM): A weighting factor of 1.15 was applied to supportability management based on the agreed amount of value added to dollars spent within this category. The SSCC has a core team of experts that have been supporting the SCN process locally for the past eight years. Most of the efforts associated with supportability management are common across all platforms and will occur regardless of acquisition strategy or approach. However, the crew familiarization and limited maintenance training are developed for the specific platform. The development of the supporting documents and classroom packages are leveraged from previous performed training. This efficient process provides a cost savings over developing these training programs from the ground up each time. SSCC has established a Supportability Integrated Product Team (SIPT) that crosses all past, current, and future platforms. The SIPT's sharing of lessons learned across multiple platforms is also incorporated into the weighting factor.

Production/Integration (PR): A weighting factor of 1.4 was applied to production/integration based on the agreed amount of value added to dollars spent within this category. There is significant "value added" in the integration and testing that SSCC performs in each TIF. The production efforts SSCC performs serve several functions. They allow for integration and testing of radio room components to occur prior to installation on the ship. SSCC production efforts include providing the cables, connectors, back shells and other systems not sponsored by the hardware providers, but that are required to make individual RF/switching systems into an integrated RCS system. The test and integration process is used to allow individual systems to be pre-assembled and tested in a lab environment vice onboard ship, where there is potential for damage to occur due to the industrial work ongoing during new ship construction.

The TIF provides the first opportunity to test systems for interoperability with other new and legacy systems. The TIF environment also allows for a full "mock up" of the shipboard spaces that is used to arrange equipment in an effective and efficient environment as well as ensure Human Machine Interfaces (HMI) are located in the optimal location for monitoring the equipment. This is essential to ensure that actual onboard operators of the equipment can adequately monitor operations within the proposed configuration of the radio room. Additionally, the TIF "mock up" ensures the required access space for maintainers and operators is maintained.

Installation (INST): A weighting factor of 1.3 was applied to installation based on the agreed amount of value added to dollars spent within this category. This was derived from SSCC's vast experience and lessons learned from previous SCN RCS installations. Many of the efforts associated with the installation process are common across different acquisition strategies and approaches (ie. government vs. shipbuilder installation). However, the experience of SSCC personnel and associated contractors greatly decrease the installation and test time needed during the construction window. Also, the installing team is typically much more familiar with the systems to be installed and tested. The integration and testing that occurs at each SSCC TIF that was previously discussed, greatly reduces the install time as well as the troubleshooting required within the industrial environment at the shipyard. Using the full Turnkey Approach for installation allows for radio control room installation later in the ship production schedule. This allows PEO C4I SC to deliver an RCS that is closer to "state of the art" when compared to other approaches, at platform delivery.

Shipyard Support (SS): A weighting factor of 1.2 was applied to shipyard support based on the agreed amount of value added to dollars spent within this category. SSCC places civil service and/or contractor personnel on-site at the shipyards that are skillfully versed in the various Turnkey processes. They are in place to interface daily with the shipbuilder directly. The on-site personnel improve communication between PEO C4I SC and the shipbuilder, which allows for quicker identification and resolution of issues and concerns. Major issues can lead to stop work orders, which can be extremely expensive. The use of shipyard support personnel helps significantly in avoiding such work stoppages.

5. 4th and Final Iteration

The fourth and final iteration of what had now become the Jones, Bigham, and Goudreau NROI formula to be used for project analysis was determined during a VTC with Travis Tillman on October 1, 2004. The final version is shown below:

$$\text{NROI}\,\% = \frac{(\text{WBS} - \text{Rework}) \text{ x VAF} + \text{Avoidance Costs}}{\text{Radio Control Suite Program Costs}} \text{X}\,100$$

Shown next is the final iteration with the WBS categories broken out. Note that in the interest of space, the WBS categories are presented in their net benefit format with rework already removed:

$$\text{NROI } (\%) = \frac{\text{PM x } 0.1 + \text{ENG x } 0.4 + \text{SM x } 0.15 + \text{PR x } 0.4 + \text{INST x } 0.3 + \text{SS x } 0.2 + \text{MM x } 0.1 + \text{Avoidance Costs}}{\text{Radio Control Suite Program Costs}} \, x\, 100$$

There are two notable differences from the third iteration. First the VAFs are shown in their net benefit form. Consequently, one is no longer subtracted from the fractional portion of the formula. This allows the numerator of the NROI formula to represent the net benefit to the project similar to the use of net income in a traditional private sector ROI formulation. Secondly, rework costs are no longer subtracted separately in the numerator. Instead, rework costs are subtracted directly within their respective categories. This gives absolutely no benefit to rework costs determined to be required as a result of PEO C4I SC. In the third iteration, rework costs were deducted separately and may have inadvertently improved the formula result. Although they were also subtracted out in the numerator, this was only after being multiplied by their respective VAF. Thus, $10 of rework engineering would have been multiplied by 1.4 first and then $10 subtracted from that product. This would have given a credit of $4 to the project when in fact the rework costs should provide no enhancement to the PEO C4I SC NROI.

The fourth iteration of the formula to measure PEO C4I SC NROI for the T-AKE project best meets the nine criteria previously discussed. First, the model developed for the NROI is simple and theoretically sound. It is free of any complex mathematical equations and mimics a commonly used private sector return on asset approach. More importantly, it is intuitive such that with brief introduction one can understand how it might represent a ROI for dollars invested in the T-AKE project.

The fourth iteration is also easy to implement. The data required to consider all program costs are already kept by platform managers at PEO C4I SC. There is some manipulation required to determine rework dollars spent, avoidance costs, overhead costs, and to pull travel costs from each of their respective categories. This is done since dollars spent on travel costs add no value to the T-AKE RCS, whether the travel is necessary or not. However, the additional time required by the platform manager to produce the data required is still relatively minimal.

The final NROI formula meets the credibility standards outlined earlier and results are also able to be replicated. The cost data used in the seven WBS categories are objective numbers taken directly from the platform manager's cost reports. This maximum use of objective data ensures NROI output can be replicated. The VAFs do add subjectivity to the formula, but efforts were taken to minimize this impact. Platform managers from four different ship classes worked together, reaching consensus on the actual values used for the VAFs in each of the seven categories. In this way subjectivity was minimized. Furthermore, this also enhances credibility since personnel that will be tasked with the formula's implementation were included in its development.

This formula provides the utility to measure NROI for past, present, and future project evaluation as well as cross-class comparisons of similar scope. The fourth iteration enables RCS NROI calculation across four ship classes since the same VAFs remain applicable. This improves formula flexibility.

The fourth iteration is also comprehensive in nature and considers all of the various program costs. The WBS breaks down all dollars spent on the RCS into individual categories. All of these are considered when determining value added to the RCS. All relevant program costs have also been considered, to include non-value added costs such as the service center fee, travel, material, and rework.

Finally, careful consideration has been given to each of the elements included in both the numerator and denominator in the fourth iteration. Specifically, their individual and combined effects on the overall NROI output have been verified to be in accordance with expectations. For example, additional non-value added costs to a program included in the formula have been verified to actually reduce the NROI. This meets the validity requirement discussed earlier and will be demonstrated in the following pages.

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V. FINAL NOTIONAL ROI FORMULA

A. T-AKE 1 NROI

The final NROI formula was developed to be applied practically and represents the most appropriate ROI developed for and adapted to the design, equipment procurement, testing, installation, personnel training, and certification of the radio room equipment and associated gear for the first ship of T-AKE new construction. The calculation of the T-AKE 1 RCS NROI as of August 27, 2004 and the projected overall NROI are provided and analyzed below.

Actual costs collected through August 27, 2004 and projected totals are shown in Table 7 below for each of the seven WBS categories. Note that nothing has been spent as of August 27th, on either Installation or Shipyard Support since none has been required up to this point in the program.

Table 7. T-AKE 1 WBS Category Cost Data

WBS Category and VAF	Actual Costs through August 27, 2004	Projected Totals
Program Management (0.2)	$549,432	$765,932
Engineering (0.4)	$1,411,618	$1,451,618
Support Management (0.15)	$157,897	$242,897
Production (0.4)	$469,349	$869,349
Installation (0.3)	$0	$650,000
Shipyard Support (0.2)	$0	$75,000
Material Management (0.1)	$101,899	$191,899

Table 8 shows actual costs through August 27, 2004 and projected totals for the T-AKE RCS project for non-value added costs associated with the program. The service center fee represents the share of corporate costs or overhead charged to all SPAWAR projects. Travel costs are normally charged to the individual WBS categories. However, they are separated from their respective WBS categories since they are a non-value added cost to the T-AKE 1 ship. The role of PEO C4I SC in material procurement is like that of a middle man, buying existing equipment from suppliers and delivering them to the buyer. Therefore, the cost of the material itself is considered a non-value added cost. PEO C4I SC adds value to materials only after installation, testing and integration in the radio room.

Table 8. T-AKE 1 Non-value Added Actual Costs and Projected Totals

Non-Value Added Cost	Actual Costs through August 27, 2004	Projected Totals
Travel	\$121,119	\$181,119
Service Center Fee	\$39,204	\$64,204
Material	\$1,487,840	\$1,912,840
Engineering Rework (must be subtracted from ENG category prior to VAF modification)	\$5,600	\$5,600

Due to lack of specific data collection, PEO C4I SC generated rework was estimated to be approximately \$5,600 in the engineering category. Also, no avoidance costs were tracked for the T-AKE 1 RCS project. They are assumed to be zero in an effort to be conservative. As discussed earlier, rework is simply removed from the WBS category prior to modification by the VAF; it is included in the program costs. All the data have now been presented to allow calculation of an NROI for the T-AKE 1 RCS project as of August 27, 2004 and an NROI based on projected totals. These calculations are shown below. The actual NROI as of August 27, 2004 is calculated as follows:

$$\text{NROI}\,\% = \frac{(\text{WBS - Rework})\text{ x VAF} + \text{Avoidance Costs}}{\text{T - AKE 1 RCS Program Costs}}\text{ X 100}$$

$$= \frac{\text{PM x } 0.2 + (\text{ENG} - \text{Rework})\text{ x } 0.4 + \text{SM x } 0.15 + \text{PR x } 0.4 + \text{INST x } 0.3 + \text{SS x } 0.2 + \text{MM x } 0.1 + \text{Avoidance Costs}}{\text{T - AKE 1 RCS Program Costs}}\text{ X 100}$$

$$= \frac{\$893{,}907 + 0}{\$4{,}338{,}358}\text{ X } 100 = 20.6\,\%$$

The projected NROI at completion of the T-AKE 1 RCS program is calculated as follows:

$$= \frac{\$1{,}344{,}957 + 0}{\$6{,}404{,}958}\text{ X } 100 = 21.0\,\%$$

More detailed calculations are provided in Table 9 on the next page. Notice that the actual and projected NROI remains relatively stable. Of course this assumes that no more PEO C4I SC generated rework will be incurred and avoidance costs will continue to be zero. The slight differences in NROI are due to a shifting in proportions between the WBS categories as the project matures.

Table 9. T-AKE 1 Cost Schedule and NROI Determination

	PROGRAM MANAGEMENT	ENGINEERING	SUPPORT MANAGEMENT	PRODUCTION	INSTALLATION	SHIPYARD SUPPORT	MATERIAL MANAGEMENT	TRAVEL	C/S FEE	MATERIAL	Totals
Actuals through 8/27/04	$549,432	$1,411,618	$157,897	$469,349	$0	$0	$101,899	$121,119	$39,204	$1,487,840	**$4,338,358**
Projections	$216,600	$40,000	$85,000	$400,000	$650,000	$75,000	$90,000	$60,000	$25,000	$425,000	**$2,066,600**
Totals	$765,932	$1,451,618	$242,897	$869,349	$650,000	$75,000	$191,899	$181,119	$64,204	$1,912,840	**$6,404,958**
ACTUALS											
Factors	0.2	0.4	0.15	0.4	0.3	0.2	0.1				
	PM	ENG	SM	PRO	INSTALL	SS	MM		**Totals**		
Modified WBS categories	$109,886	$562,407	$23,685	$187,740	$0	$0	$10,190	=	$893,907		
		*						BASE	$4,338,358		
								ROI	**20.60%**		
PROJECTED TOTALS											
Factors	0.2	0.4	0.15	0.4	0.3	0.2	0.1				
	PM	ENG	SM	PR	INST	SS	MM		**Totals**		
Modified WBS categories	$153,186	$578,407	$36,435	$347,740	$195,000	$15,000	$19,190	=	$1,344,957		
		*						BASE	$6,404,958		
								ROI	**21.00%**		
	* Reduced by estimated Rework totalling $5600										

B. NROI COMPARABILITY FOR ONE SHIP CLASS

The developed NROI formula possesses the flexibility to enable calculation of the NROI at various times for any given T-AKE ship RCS project. An NROI could be estimated prior to project initiation based on projected WBS and associated non-value added costs. It can be calculated at any time during the project cycle with actual costs up to a given date. NROI is also able to be calculated at project completion. If senior level buy in for the proposed formula was obtained, this could be used as one of the benchmarks to indicate the amount of output PEO C4I SC is providing for the program dollars invested. A priority of the CNO discussed earlier, this would begin to answer the request of linking actual outputs to dollar investments.

Comparisons made of the T-AKE RCS project NROI at different times during the acquisition cycle must be carefully considered. The underlying assumptions and circumstances must be evaluated cautiously since several factors can attribute to NROI increasing or decreasing at discrete points in the project cycle. These factors include changes in the amount of PEO C4I SC generated rework, a shift in the proportional amounts of value added costs in the WBS categories, adjustments made in avoidance costs, or changes in the amount of non-value added costs attributed to the project.

PEO C4I SC generated rework costs are subtracted from the numerator of the NROI formula since they provide no net benefit. They are included as a program cost of the project in the denominator. Therefore, as the amount of PEO C4I SC generated rework increases over the project cycle, a negative impact on the NROI calculated will occur. This is one possible explanation for a decreasing NROI over the life of a project.

Shifts in the proportional amounts of the value added costs in the WBS categories over the life of the project will also affect the NROI. This may be due to no fault of the program itself. For example, one of the highest value added categories is engineering. Table 7 from the previous section illustrates how as of August 27, 2004 most of the engineering dollars were spent while some lower value added categories such as shipyard support and installation remained unspent. This shift in WBS category costs is a natural result of the T-AKE project progression. Significant engineering dollars are spent up front to design and develop the RCS while installation takes place much later in the cycle after most engineering dollars have been spent. This shifting of WBS category costs could be responsible for changing the NROI between two discrete points in the project cycle since each WBS category is converted to value added using numerically different factors. A non-proportional shift in WBS costs to lower value added categories will lower the NROI. Conversely, a non-proportional shift in WBS costs to higher value added categories will have the effect of increasing the project NROI.

Costs avoided by PEO C4I SC during the life of the T-AKE project will have a positive effect on NROI. Avoidance costs are added in their entirety to the numerator and are not included in the denominator. This is also a possible explanation for increasing NROI over the life of the project. Unfortunately, no avoided costs were captured by the current method of data collection used for this project.

Varying amounts of non-value added costs over the course of the T-AKE project will have a direct effect on the project's NROI. Non-value added costs include expenses such as travel, overhead, and purchased material. These costs are part of the NROI formula's denominator but are not included in the numerator since they provide no "PEO C4I SC added value" to the radio room. Therefore, changing amounts of non-value added costs will impact the NROI between any two points in the project cycle.

NROI between different ships of the T-AKE class can also be evaluated. For example, the NROI of the T-AKE 1 RCS can be compared to the NROI of the successive T-AKE ship radio rooms as the actual or projected cost data become available. This could potentially indicate the ROI for employing PEO C4I SC for multiple ships within the T-AKE ship class or indicate problems with a specific T-AKE hull. As with the comparisons made at different points in one T-AKE RCS project cycle, comparisons made between successive T-AKE radio rooms must also be evaluated carefully. The potential causes for changing NROI analyzed and described previously for a single T-AKE project all apply to comparisons made between different T-AKE hulls. However, additional considerations must be made when making comparisons between hulls. The natural learning curve between successive identical platforms and the significant potential for increased avoidance costs should also be assessed.

A learning curve naturally occurs when repetitive tasks are performed by an organization such as PEO C4I SC. This will occur for many reasons including increased familiarization with the tasks required and improved project coordination. The DoD not only considers this, but expects it as well, when awarding contracts for multiple item procurements such as successive ship hulls (Rendon, 2004). Improved efficiencies will be realized and some costs from the first RCS will be avoided on subsequent platforms. For example, much of the engineering design and development costs will be avoided on later T-AKE hulls since they will be "cookie cutter" examples of the first. Also, it is likely that SPAWAR generated rework on a previous T-AKE hull will be avoided on later T-AKE hulls due to lessons learned. This improved efficiency and avoided costs can affect the NROI either positively or negatively. Increased avoidance costs for successive hulls would increase the NROI from one hull to the next. Conversely, significantly reducing engineering costs in later hulls may have a negative effect on NROI since this is one of the two highest value added WBS categories.

It is essential to understand that any ROI formulation, in and of itself, has very little meaning. It requires a comparison to some relatively similar baseline or benchmark to gain significance. It is also important that when making these comparisons, the context of the two numbers being compared is well understood. This is no different than when considering traditional ROI. Consider an investor who gained five percent on his or her portfolio over the previous year. For this to be considered a respectable ROI would depend on several factors. If this was a low risk investment, five percent may be adequate. If this were an aggressive investment, it is likely that five percent would be considered sub par. However, if the economy was in a recession, five percent return may be superior regardless of the investment profile. The point is that an NROI requires a comparison data set to give it meaning. Thus, careful consideration must be given to the context of two NROI being compared to fully understand their significance, just as with comparing traditional ROI in the private sector.

C. LPD-19 NROI

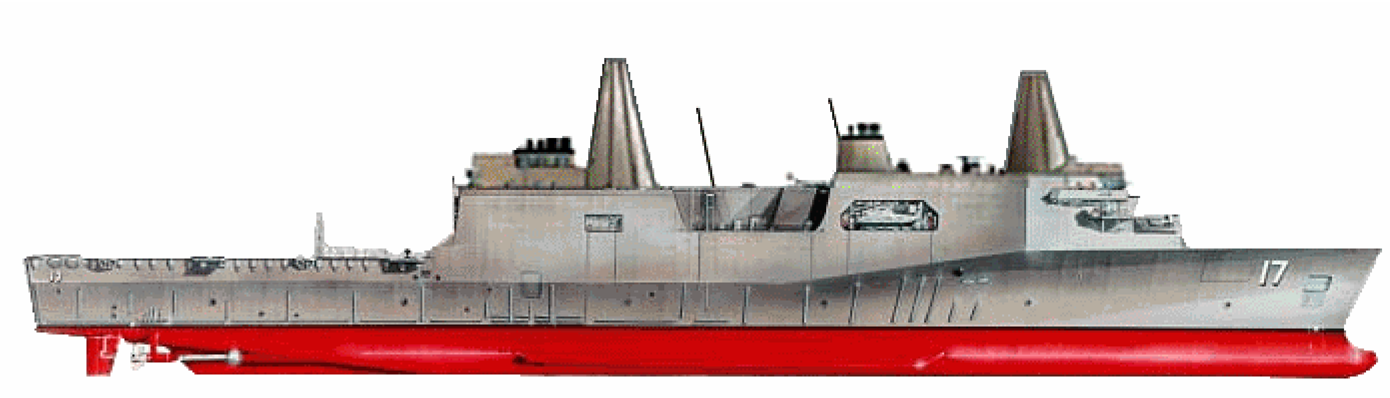

Figure 2. LPD-17 Class (Global Security, 2004)

LPD-19 is the third vessel of the new LPD-17 ship class. Data were collected in the same WBS category format to allow calculation of an NROI in a similar manner that the T-AKE NROI was ascertained. Recall that the same VAFs used for the T-AKE RCS are also valid for the LPD-17 class. The details of the NROI calculations for LPD-19 are based on actual cost data through September 4, 2004 and on projected totals. WBS category costs are shown in Table 10.

Table 10. LPD-19 WBS Category Cost Data

WBS Category and VAF	Actual Costs through September 4, 2004	Projected Totals
Program Management (0.2)	$1,352,275	$1,985,275
Engineering (0.4)	$195,000	$612,000
Support Management (0.15)	$1,096,160	$1,328,260
Production (0.4)	$3,128,951	$6,252,951
Installation (0.3)	$1,293,766	$3,086,509
Shipyard Support (0.2)	$0	$0
Material Management (0.1)	$1,186,544	$2,373,088

The value added costs represent those spent for the RCS of the LPD-19 to allow better comparability to the T-AKE results. Non-value added costs as of September 4, 2004 and projected totals are shown in Table 11. Note that to date no SPAWAR generated rework has been incurred for LPD-19. This is most likely due to the fact that she is the third ship of her class and many lessons have already been learned whereas the previous data were for the inaugural ship of the T-AKE class. In an effort to remain conservative, avoidance costs for LPD-19 are also assumed to be zero since they were not tracked.

Table 11. LPD-19 Non-value Added Actual Costs and Projected Totals

Non-Value Added Cost	**Actual Costs through September 4, 2004**	**Projected Totals**
Travel	$71,103	$229,353
Service Center Fee	$85,433	$117,083
Material	$2,059,481	$2,271,481
Engineering Rework	$0	$0

The actual NROI for the LPD-19 as of September 4, 2004 is calculated as follows:

$$\text{NROI}\,\% = \frac{(\text{WBS} - \text{Rework})\text{ x VAF} + \text{Avoidance Costs}}{\text{LPD - 19 RCS Program Costs}} \text{ X } 100$$

$$= \frac{\text{PM x } 0.2 + \text{ENG x } 0.4 + \text{SM x } 0.15 + \text{PR x } 0.4 + \text{INST x } 0.3 + \text{SS x } 0.2 + \text{MM x } 0.1 + \text{Avoid Costs}}{\text{LPD - 19 RCS Program Costs}} \text{ X } 100$$

$$= \frac{\$2{,}271{,}244 + 0}{\$10{,}468{,}713} \text{ X } 100 = 21.7\ \%$$

The projected NROI at completion of the LPD-19 RCS program is calculated similarly as follows:

$$= \frac{\$4{,}503{,}296 + 0}{\$18{,}256{,}000} \text{ X } 100 = 24.67\ \%$$

The NROI of LPD-19 does increase over the life of the project. This is primarily due to the significant number of dollars still left to be spent on the high value-added categories of production and installation. More detailed calculations are provided in Table 12 on the next page

Table 12. LPD-19 Cost Schedule and NROI Determination

	PROGRAM MANAGEMENT	ENGINEERING	SUPPORT MANAGEMENT	PRODUCTION	INSTALLATION	SHIPYARD SUPPORT	MATERIAL MANAGEMENT	TRAVEL	C/S FEE	MATERIAL	Totals
Actuals through 9/04/04	$1,352,275	$195,000	$1,096,160	$3,128,951	$1,293,766	$0	$1,186,544	$71,103	$85,433	$2,059,481	**$10,468,713**
Projections	$633,000	$417,000	$232,100	$3,124,000	$1,792,743	$0	$1,186,544	$158,250	$31,650	$212,000	**$7,787,287**
Totals	$1,985,275	$612,000	$1,328,260	$6,252,951	$3,086,509	$0	$2,373,088	$229,353	$117,083	$2,271,481	**$18,256,000**
ACTUALS											
Factors	0.2	0.4	0.15	0.4	0.3	0.2	0.1				
	PM	**ENG**	**SM**	**PRO**	**INSTALL**	**SS**	**MM**		**Totals**		
Modified WBS categories	$270,455	$78,000	$164,424	$1,251,580	$388,130	$0	$118,654	=	$2,271,244		
								BASE	$10,468,713		
								ROI	**21.70%**		
PROJECTED TOTALS											
Factors	0.2	0.4	0.15	0.4	0.3	0.2	0.1				
	PM	ENG	SM	PR	INST	SS	MM		**Totals**		
Modified WBS categories	$397,055	$242,560	$199,239	$2,501,180	$925,953	$0	$237,309	=	$4,503,296		
								BASE	$18,256,000		
								ROI	**24.67%**		

D. NROI COMPARABILITY FOR MULTIPLE SHIP CLASSES

NROI comparisons between PEO C4I SC installed radio control rooms can also be made between ship classes. Some of the same factors that must be considered when making comparisons between radio rooms of the same hull must also be considered here. Differences in avoidance costs realized, the proportions of costs within the WBS cost categories, and the amount of PEO C4I SC generated rework and other non-value added costs will all promote differences in the two NROI. However, there is the potential for these factors to have a much greater effect when comparing NROI of radio rooms between different ship classes. Differences in the learning curve, the relative amounts of value added costs and non-value added costs, and the VAFs themselves must all be considered when making comparisons between different ship classes.

The learning curve will vary significantly between hulls from different ship classes for several reasons. First, technical complexity between the radio control rooms of different ship classes can vary widely. The RCS installed in a T-AKE class vessel would not be considered very complex when compared to the RCS of an aircraft carrier. Increased complexity can either increase or decrease the learning curve. Also, the number of hulls being built within a given ship class will affect the amount of benefit realized from a learning curve. If only a few hulls are to be constructed as compared to a ship class with a large number of hulls designated, there will be less benefit from the learning curve achieved for the smaller ship class. The different learning curves may affect the amount of cost avoidance realized from hull to hull and, thus affect the NROI.

The relative amounts of value added costs between the WBS categories will also produce differences in NROI compared between ship classes. A warship on the cutting edge of technology would require larger amounts of dollars to be spent in the engineering, production (integration), and installation categories than an auxiliary ship with average radio control room technology. These shifts affect the net benefit, or numerator, determined in the NROI formula. Consequently, shifts in WBS costs between ship classes will affect the resulting NROI.

The amount of non-value added costs may vary considerably between hulls of different ship classes. The amount of material required for purchase to support the radio room, the amount of travel required, and the service center fee charged will all affect the NROI. Most notably is the amount of material that needs to be acquired. The CVN-68 class will require appreciably more material to be purchased than an auxiliary ship like the T-AKE class. This large difference in non-value added costs due to material differences will dampen the NROI for the carrier since the value of the denominator will increase with no increase in the numerator. The amount of travel required may also vary considerably depending on the location of the shipyard chosen to build a ship class. Also, depending on the allocation method for overhead, the amount of the service center fee may differ considerably between ship classes. The different relative amounts of non-value costs may have a large impact on the NROI when comparing hulls from different ship classes.

Finally, the VAFs used to determine an NROI for a given ship class can also differ. For the context of this thesis, the VAFs chosen were developed by SSCC resident experts from the T-AKE, CVN-68, LPD-17, and LHD-8 classes of ships. These VAFs represent their best judgment as to the value PEO C4I SC adds to dollars spent within the respective WBS categories. However, the VAFs would likely not be the same for a Virginia class submarine. It is relatively easy to surmise that such differences would change the bounds of the equation entirely.

NROI comparisons made between hulls of different ship classes must be made cautiously. The learning curve, relative amounts of value added costs and non-value added costs, and the NROI VAFs can all differ appreciably. This may skew the results to indicate one project is operating better than the other when in fact some of the differences may be attributable to the uniqueness of the project itself. Let us consider again comparisons of traditional ROI measurements. The return in the bond market is not expected to equal returns in the stock market. They are two different investment vehicles. However, the expected return on bonds can be approximated if the return on the stock market is known once an adjustment is made to take into account the different investment options. This adjustment, commonly called a risk premium, is based on market history. A similar type of adjustment, once determined, could be used to compare NROI of entirely different ship classes.

E. COMPARISON OF RCS NROI: T-AKE 1 AND LPD-19

The LPD-19 and T-AKE 1 RCS NROI both surpass twenty percent. This indicates over a twenty percent ROI based on the NROI formula developed. On the surface, both projects appear to add significant value to their respective radio rooms. However, it is important to consider the frame of reference used when making this judgment. A twenty percent return in the stock market by most benchmarks is excellent. Conversely, to more accurately evaluate the value added to a radio room, a new benchmark must be created based on similar data collected over time.

The LPD-19 RCS project has both a slightly higher NROI to date and at project completion based on projected totals. Taken at face value, this would indicate that the LPD-19 project funds are better spent since dollar for dollar they add more value than the funds spent on the T-AKE 1 venture. However, as indicated previously, NROI results cannot be compared without taking into consideration other factors. One must consider the complex underlying circumstances for derivation of the numbers to make a fair comparison. Best use of the NROI is between ships of the same class vice between classes. However, additional refinement of the methodology may make such comparison between platforms more valid. We remind readers that ROI in itself is but one piece among many types of financial information available to platform, program and financial management decision makers when comparing actual and potential investment options.

The proportions of dollars spent within the WBS categories for the two ships vary considerably. Table 13 on the following page shows a breakdown of each individual WBS category cost as percentage of total WBS dollars projected to be spent. Most of these differences are inherent to the project. The largest difference is in the engineering WBS category. A much larger proportion of WBS dollars are spent on engineering for the T-AKE 1 RCS than on LPD-19. This is intuitive since significantly more engineering dollars are required for the first ship of any class. This is the case with the T-AKE-1 RCS. LPD-19 is the third ship of the LPD-19 class, and consequently, requires less expenditure in the engineering WBS category.

Table 13. Individual WBS Totals as a Percentage of Total Projected WBS Costs

WBS Category	T-AKE 1 RCS (%)	LPD-19 RCS (%)
Program Management	18	13
Engineering	34	4
Support Management	6	8
Production	20	40
Installation	15	20
Shipyard Support	2	0
Material Management	5	15

The LPD-19 RCS requires considerably more dollars to be spent in the production WBS category. This includes both absolute dollars and as a percentage of total WBS category costs. This also is to be expected since the LPD-19 RCS project is approximately three times the size of the T-AKE 1 RCS project based on total program dollars. The LPD-19 RCS is more complex in nature than the RCS of the T-AKE 1 vessel. Production is a high value added WBS category and this difference is the leading contributor to LPD-19's higher NROI. Thus, while LPD-19 does have a slightly higher NROI, this is due largely to the inherent differences between the programs.

LPD-19 spends no dollars in the shipyard support category. This is not a large contributor to the NROI differences. However, it is important to re-emphasize that when comparing ships from different classes some of the VAFs chosen may be different or not apply at all, as in this case. This must be carefully considered when making these evaluations.

The comparison of non-value added costs is shown in Table 14. Note that in all cases except for rework, LPD-19 has a larger burden of non-value added costs. This is expected for both the material required and the service center fee considering the larger scope of the project. Travel is a separate function of the chosen location to build the ship. LPD-19 should also be expected to have less rework costs given that it is the third ship of the LPD-17 class.

Table 14. Comparison of Total Projected Non-value Added Costs

Non-value Added Cost	T-AKE 1 RCS ($)	LPD-19 RCS ($)
Material	1,912,840	2,271,481
Service Center Fee	64,204	117,083
Travel	181,119	229,353
Estimated Rework	5,600	0

One aspect not indicated in the numbers is that an integral system required for each RCS is procured in an entirely different manner. The HF system for the T-AKE 1, due to its uniqueness, was procured by the RCS manager using program dollars allocated to the T-AKE 1 RCS program. However, the HF system for the LPD-19 was procured using dollars from a separate pot of money other than from the LPD-19 RCS program. The different methods of procurement and associated accounting for program dollars do affect the projects NROI as the formula stands. Since material is treated as a non-value added cost, increases in dollars spent on material will lower a project's NROI. Therefore, the effect is to lower the T-AKE's NROI and, subsequently, increase the LPD-19's NROI. Given that the HF system can cost in upwards of millions of dollars, the effect on these NROI is not trivial. For better comparison, this adjustment should be made.

Finally, while avoidance costs were not tracked due to the timing of this endeavor, they could have potentially had a major impact on the NROI of the two projects. For example, since LPD-19 is not the inaugural vessel, it is plausible to presume that many costs were avoided on the third ship versus those that were incurred on the first. Also, since it is likely that large equipment purchases for multiple class ships result in a cost savings, these would also increase the avoidance costs credited to a particular program. These avoidance costs would positively impact the project NROI.

Considering the number of inherent differences between the programs and the small numerical differences between the NROI calculated, it cannot be concluded that the differences reflected in the NROI calculation are due to one program operating more efficiently than the other. Unfortunately, at this point evenhanded comparisons made of NROI between ship classes can be difficult, depending on the degree of scope differences between the programs. While the LPD-19 and T-AKE 1 RCSs both use the same VAFs, many disparities still exist between the programs that must be considered to level the playing field between the projects. This comparison might further be complicated if the use of different VAFs were required. Continued data collection and NROI calculations need to be made in order to better establish an expected or normal benchmark to facilitate comparison and more accurately understand how differences in various programs can be expected to affect the NROI. Armed with this knowledge, comparisons between ship classes can be more easily made.

F. CHALLENGES

1. Formula Limitations

There are several challenges ahead for PEO C4I SC to successfully implement the developed NROI process and formula application within the organization. First, the subjective nature of the VAFs will require senior level management buy-in to strengthen the formula's credibility. Phillips and Phillips point out three audiences which must buy in to the ROI process for it to be useful. They include the practitioners who are responsible for implementing the formula and held accountable by the results, senior level management who hold the practitioners accountable for these results, and researchers (Phillips and Phillips, 2002: 12). The VAFs and the entire NROI formula were developed in cooperation with several experts at the practitioner level. However, in order for the NROI formula to satisfactorily represent program–performance, senior managers responsible for evaluating this performance must buy in to the formula and, more importantly, the selected values of the VAFs. For example, senior management must agree that an engineering dollar spent on the T-AKE platform RCS produces approximately one dollar and forty cents worth of value. The NROI formula will not be used by the practitioners if it will not hold weight with their managers. This is true of any new process initiatives in the work place.

Segregation of responsibilities with regard to data collection and evaluation must also be achieved to strengthen the credibility of the results. In our case study due to personnel availability, Travis Tillman provided assistance in both formula development and data collection. However, as Platform Manager he is also responsible for the results of the T-AKE Class RCS. There is a clear motive to skew the results if the person responsible for the results also collects and interprets the data. Segregation of these duties is necessary going forward if the NROI metric is to be utilized within PEO C4I SC for actual management decision making.

Increased resources will be required from PEO C4I SC to modify the NROI development process and collect data for the evaluation of other projects. No two projects within the PEO C4I SC organization are exactly alike and some modification of the work done for this project will be required. This will demand managerial effort to develop an approved NROI measurement and some amount of resources to collect the required data for other projects.

Ideally, the NROI process should be implemented at the inception stage of a project instead of during or after the project is in progress. The T-AKE RCS program was already well underway before this research began. Consequently, some data collection opportunities were missed and some data either had to be estimated or discarded altogether in an effort to remain conservative. This limits the accuracy of the formula. For example, rework costs were not collected up to the point the formula was created and had to be estimated. Avoidance costs were also not being tracked and were assumed to be zero since including an artificial number would have increased the NROI.

The final limitation is that the makeup of the formula itself limits the possible range of results more than a traditional ROI formula would. Traditional ROI used in the private sector is not as bound by the formula itself. ROI values in the private sector normally range from negative one hundred percent (a total loss which could also be surpassed in rare cases) to an unbound positive value. Negative and positive ROI are routinely observed in the stock market. Any organization with a negative net income will have a negative ROI. Organizations with a positive net income will have a positive ROI. However, the NROI formula developed for PEO C4I SC prevents a negative number for a result. The lowest value achievable would result from minimum WBS costs, significant rework costs, and no avoidance costs. Theoretically, this could be zero, although practically it would have to be some number above zero since some amount of work performed will not be classified as rework.

The values chosen for the VAFs also place an upper bound on the value attainable for a NROI. They place an explicit upper bound if there are no avoidance costs. Consider the VAFs developed for the T-AKE RCS project. The largest values of 0.4 are from the WBS categories of engineering and production. The highest NROI theoretically achievable without avoidance costs would result from all costs placed into these two categories and no non-value added costs like rework, overhead, or travel. This would place an upper theoretical limit of the NROI of forty percent. Consequently, the VAFs chosen for a particular project will set bounds for the potential results derived from the NROI formula. This limitation must be considered when evaluating the results.

2. Applicability Limitations

The NROI formula developed for the T-AKE RCS has clear applicability limitations to other DoD and public sector programs. This application of the NROI formula is, by itself, relevant only to the platforms for which the VAFs were developed. These include radio rooms from the T-AKE, LPD-17, CVN-68, and LHD-8 ship classes. These factors define how the key players involved in their development numerically define how dollars spent within the different WBS categories result in added value to their respective RCS projects. These are not applicable to other programs. The VAFs would most likely change if they were developed for another public sector organization since their personnel may view the process of adding value much differently.

The use of WBS categories is also not universal across the DoD. WBS categories are primarily used within the acquisition community to allow program managers and contractors to breakdown large acquisition projects into smaller more manageable tasks.

Therefore the use of these WBS categories as a data collection basis for an NROI application is limited to this community.

The NROI development methodology of defining how an organization adds value via its products or services and creating a representative metric is not unique to PEO C4I SC. The methodology employed in this thesis can be applied to any public sector organization that is willing to go through the necessary steps to define how they create value in the products or services they provide. Several public sector organizations have already successfully implemented ROI metrics as one benchmark to demonstrate their performance. However, due to the distinct public sector outputs, this endeavor is often times challenging. Private sector organizations typically have the common goal of producing profit. Conversely, public sector organizations have a myriad of different goals most of which do not include the generation of profit.

VI. SUMMARY AND CONCLUSION

A. SUMMARY

This thesis has probed the efforts of diverse institutions in the quest for a workable method of determining ROI in the public sector. Past efforts provided valuable lessons learned which were identified and discussed. The United States Postal Service was notably successful, but perhaps only because they function much more like a private company than is the norm for public sector entities. In Australia, the bold effort to develop a “value added” approach within the entire government budget process made some progress, but fell short primarily due to a focus on analysis lacking a quantifiable formula for determining the output. The Royal New Zealand Navy enjoyed relative success but was hampered in some ways by an inability to screen out other influences besides the bonus scheme for retention of MEs. The United States Navy Dental community effort was largely successful in the development of an ROI methodology, but fell short in their ability to use the output since they lacked trust in the method developed for determining some of the inputs.

The ultimate point of this thesis was to develop an NROI formula specifically tailored for the SPAWAR PEO C4I SC RCS. The sequential process of NROI formula development for the T-AKE RCS was reproduced as a way of highlighting the significant challenges inherent in this effort as well as to serve as a roadmap for others to follow. It can only be hoped that use of this roadmap may help others to avoid some of the distractions and obstacles that the lessons learned exposed. The utility of the final formula was gratifying in that it was readily usable not only for the T-AKE class but also as a comparison tool for the RCS projects from LPD-17, CVN-68, and LHD-8 ship classes. Of course adjustments must be created to directly compare ships with vastly different asset bases in play, but the formulaic approach is sound.

B. CONCLUSIONS

The initial goal of this effort was to develop a formula that would ultimately provide DoD with a means of incorporating NROI criteria in the decision making process from the highest levels of government. From there the scale was refined to creation of an NROI formula specifically tailored for SPAWAR PEO C4I SC leadership to utilize concerning new ship construction. An additional reduction in scope was soon forthcoming with the new focus zeroed in on the T-AKE 1 RCS. The narrowing of scope from first intentions to ultimate conclusion was necessitated by the sheer complexity and inherent resistance to this effort. The relative failure to successfully evaluate ROI in the public sector despite past efforts is well known and has served to create an indifference to trying among many civil servants and military personnel. The result of this effort should at least serve to embolden those who would continue to press on in this endeavor.

Perhaps the most important lesson learned throughout this process was that the scope of such an effort must remain focused to be successful. Once NROI formulae are established at the project level and successfully demonstrated, an expansion of utilization could be envisioned which may ultimately lead to the availability of ROI data for senior DoD decision making. The goal now is to continue moving in the right direction to answer the CNO's call to action for developing a method of determining ROI to assist the Navy decision making process. The CNO reaffirmed this vision in a visit to the Naval Postgraduate School on March 17, 2004. In the words of Douglas A. Brook, Dean of the Graduate School of Business and Public Policy at NPS:

> The CNO is clearly focused on the business management aspects of running the Navy. He is challenging the Navy to focus on effectiveness and costs rather than what he perceives to have been a "readiness at any cost" approach (Brook, 2004).

Dean Brook also pointed out that one of the specific tasks noted by the CNO for the faculty and students of NPS included finding "a way to calculate ROI." It is our sincere desire and belief that we have assisted in attaining this goal through the development, test application and evaluation of the NROI methodology presented in this thesis.

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