NAVAL POSTGRADUATE SCHOOL
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THESIS

IDENTIFICATION OF COMMERCIAL ITEMS RISK FACTORS

by

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March 2003

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13. ABSTRACT ***(maximum 200 words)***

Since the end of the Cold War, reduced budgets have limited technology growth in the defense industry making the use of Commercial Off-The-Shelf (COTS) software the accepted way to build systems. Twenty years ago, almost all DOD software-intensive systems were built by awarding large multimillion-dollar contracts to defense contractors to build systems from scratch. Consequently, with dwindling budgets, the military has recognized that they can no longer build an infrastructure independent of commercial industry.

The use of commercial items does not reduce or eliminate the risks associated with the traditional development of software systems. Numerous programs have stumbled for the lack of careful consideration and identification of the unique risk factors imposed by commercial items. Even though the types of programs are diverse, there are common risk factors that can be identified from the past experiences of these programs.

This thesis focuses on the critical risk factors and lessons learned associated with integrating commercial items into DOD software programs. It summarize lessons learn from programs that have made extensive use of commercial items, provides a risk checklist/questionnaire to assist PMs and developers in understanding the risks associated with their developments of a system using commercial items, and suggests mitigation strategies, which can be used as guidelines for the risk factors, to consider when adopting commercial components. Providing the starting point for a systematic structure approach to the risk management of commercial items.

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IDENTIFICATION OF COMMERCIAL ITEMS RISK FACTORS

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I. INTRODUCTION

A. AREA OF RESEARCH`

Building of systems from commercial items depends on successful evaluation and selection of the commercial software. A number of risks associated with commercial items have been identified in the literature. This thesis will research the risk factors associated with the use of commercial items in Department of Defense Management Information Systems (MIS); command and control systems; and weapons systems. This will provide valuable insight into reducing the risks associated with COTS-Based Systems (CBS) development.

B. RESEARCH QUESTIONS

Principal Research Question: What are the unique challenges and risk factors that need to be managed when selecting COTS products for Department of Defense Systems (DOD)?

Secondary Research Questions:

- What are the definitions of commercial items and risk management?
- How are the familiar notions of risk and risk management affected by the presence of commercial software?
- Is there a specific approach/process that addresses risk identification for commercial (COTS) based programs?
- What makes the integration of commercial (COTS) products into a system different from traditional integration of items designed and produced for DOD?

C. DISCUSSION

Throughout the Department of Defense (DOD), operations and support costs are rising, with fewer dollars available for research, test and evaluation and procurement of new systems; thus, increasing the pressure to achieve more with less. To achieve this goal, DOD is expanding the use of commercial items to leverage the perceived massive technology investments of the private sector while allowing DOD to reap the benefits of

reduced cycle times, faster insertion of new technologies and lower life cycle costs, increasing system stability, higher number of alternative solutions and increasing level of system interoperability. These advantages also bring related disadvantages, including integration difficulties, performance constraints, and incompatibility among products for different vendors.

The use of commercial items does not reduce or eliminate the risks associated with the traditional development of software systems. Despite the risks, if COTS acquisition is addressed correctly it can provide significant benefits for buying commercial software; unfortunately the DOD policy on the risk management of commercial items is lacking. In the new less-restricted DOD directive 5000.1, the program manager is expected to tailor risk management practices to the needs of the program. Tailoring DOD risk management policy to support commercial items leaves the program manager with too much guesswork. A program manager using commercial items cannot reasonably benefit from DOD risk management guidance, procedures, and tools because he or she is focused on new development program risks and risk management practices. Missing are any explicit considerations of unique commercial items risk and risk management. Underestimating the risks associated with commercial software has often resulted in longer schedule delay, higher development cost, and higher maintenance cost.

Because of the numerous risks inherent in the use of commercial items, there needs to be a flexible and proactive commercial item based risk management approach to avoid common mistakes in commercial items utilizations. Government system integrators need to be aware of the differences between military and commercial acquisition and the potential challenges and risks that need to be managed. The objective of this thesis is to focus on the critical risk factors associated with integrating commercial items into DOD software programs. It will summarize lessons learn from programs that have made extensive use of commercial items and offer suggestions for reducing the risk of developing systems with commercial items.

D. SCOPE OF THESIS

The scope of the thesis will include the following:

- In-Depth review of available literature, DOD Regulations, Audits and Reports as they relate to the use of commercial items.
- Interview Program Managers (PMs) who utilize commercial products within their programs to reflect their experience and lessons learned from using COTS within their programs.
- Provide a questionnaire to serve as a checklist to identify and understand the risk factors associated with COTS for the PMs to complete.
- Summarize and analyze the questionnaires and various lessons learned found in technical documents about risk associated commercial items.
- Derive conclusion and provide suggestions for reducing the identified risk factors of commercial items.

E. METHODOLOGY

The methodology used in this research consists of the following steps:

- Conduct a literature search of books, journal articles, magazine articles, World Wide Web, and other library information resources regarding the definitions and history of commercial items and risk management.
- Analyze and evaluate lessons learned and audit reports to identify risk factors and challenges (reliability, maintainability, and availability) associated with COTS.
- Develop a questionnaire based on these factors and challenges. Send this questionnaire electronically and conduct interviews with Product Managers in the Department of Defense whose programs do or have tried to utilize commercial items
- Summarize and analyze results of the questionnaire.
- Propose mitigation suggestions for reducing these factors.

F. ORGANIZATION

This thesis is organized into the following sections:

- Chapter II: *Commercial Items Defined.* The introduction of COTS products into system acquisition has resulted in new terms associated with this process. Chapter II provides the terms and definitions associated with commercial items.

- Chapter III: Risk *and Challenges of Commercial (COTS) items.* Chapter III provides a summary of different sources, DOD technical reports, audits, and handbooks, used for identifying the unique challenges and risks within a system when using commercial items.
- Chapter IV: *COTS Risk Questionnaire/Checklist.* Chapter IV provides the framework for evaluating and reducing the risk of software systems developed with commercial items. The key to successful development of any system is having a sound approach and asking the right questions. A critical set of questions were developed and sent to project managers to assist them with understanding the risks associated with the developed of systems using commercial items within DOD.
- Chapter V: *Questionnaire Implementation.* Chapter V sending the questionnaire electronically to elicit responses and provide results on current DOD projects using commercial products.
- Chapter VI: Mitigation Strategies and Suggestions. Chapter VI describes some mitigation strategies and offers some techniques/suggestions, which can be used as guidelines for the risk factors, to consider when adopting COTS components.
- Chapter VII: *Conclusion.* Chapter VII provides thesis conclusion and recommendations.

G. BENEFIT OF THE STUDY

The practice of risk management does not benefit from "cookbook" solutions [STEV97]. Numerous programs have stumbled for the lack of careful consideration and identification of the unique risks factors imposed by commercial items. Even though the types of programs are diverse, there are common risk factors that can be identified from the past experiences of these programs. DOD PMs, developers, and contractors can benefit from these past experiences since they provide a starting point for a systematic structure approach to risk management of commercial items and assist them in overcoming these barriers within their programs. They will be able to identify, as early as possible, the common risk factors and lessons learned from similar programs and determine how to use these experiences to adjust strategies and manage the risks, thus enhancing their programs while meeting OSD goals for incorporating COTS into their programs.

II. COMMERCIAL ITEMS DEFINED

A. INTRODUCTION

For the government, making greater use of commercial-off-the-shelf (COTS) products is becoming increasingly popular. Increased use of commercial products holds the hope of getting, at a reasonable cost, something that already performs the functions needed by government systems. Everyone from industry executives to Congress is suggesting that leveraging commercial capabilities will save time and money while improving the performance of software-intensive systems. To encourage this approach, then-Secretary of Defense William Perry directed in June 1994 that DOD acquisitions should make maximum use of performance specifications and commercial standards, thus increasing the opportunities to make use of commercial products. The purpose of this section is to explain the different ways that the term COTS has been used, and the role commercial products can play in a commercial (COTS)-based system. The following definition of COTS is provided for the sole purpose of understanding the intent and scope of this paper. It is not meant to be 'the' definition.

B. DEFINING "COTS"

The term COTS is a familiar and well-used term within industry and DOD. The term COTS is generally used to describe commercial products. It commonly refers to things that one can buy, ready-made, from some manufacturer's "store shelf" (through a catalogue or from a price list). This usage, however, is imprecise and not universally accepted. The government, which needs a precise definition for procurement, has defined the term commercial item. On 26 June 2000, the Office of the Secretary of Defense (OSD) defined a commercial item in their report, "Commercial Item Acquisition: Considerations and Lessons Learn" [DODA00]. This official definition of the term commercial item is given in the Federal Acquisition Regulations (FARs), appendix A; a summary along with an illustrative example, figure 1, are provided here.

A *commercial item* is

(1) Any item, other then real property, that is of a type customarily used for nongovernmental purposes and has been sold, leased, or licensed, or offered for sale, lease or license to the general public;

(2) Any item evolved from an item in (1) through advances in technology and is not yet available commercially but will be available in time to satisfy the requirement;

(3) Any item that would satisfy (1) or (2) but for modifications customarily available in the commercial marketplace or minor modifications made to meet DOD requirements;

(4) Any combination of items meeting (1), (2), (3) above or (5), below, that are customarily combined and sold in combination to the general public;

(5) Services for installation, maintenance, repair, training, etc. if such services are procured for support of an item in (1), (2), (3) or (4) above, as offered to the public or provided by the same work force as supports the general public, or other services sold competitively in the commercial marketplace;

(6) Services offered and sold completively in the commercial market-place at catalog prices;

(7) Any item, combination of items or service referred to in (1) – (6), above, that have been transferred between or among separate divisions, subsidiaries, or affiliates of a contractor;

(8) A nondevelopmental item (NDI) developed exclusively at private expense and sold competitively to multiple state and local governments.

The key point is that commercial product(s) are developed by a commercial entity for commercial purposes and for the general public. In order to gain the advantages of commercial products, commercial software products should be defined as those that are offered to the public and are actually used by the public in the same version as those in military applications.

C. DEFINING NDI

A closely related term often heard in government circles is "nondevelopmental item" (NDI).

A *nondevelopmental item* is:

(1) Any previously developed item used exclusively for government purposes by a federal, state, or local agency or government or by a foreign government that has a mutual defense agreement with the U.S.;

(2) Any item described in (1) above that requires only minor modification or modifications normally available in the commercial marketplace to meet requirements;

(3) Any item being produced that does not meet (1) or (2) above only because it is not yet in use.

The key point here is that NDI refer to something already developed by someone else. It might have been developed by a commercial interest, but typically it will have been developed for some other government, department, or agency. Hence, what is commonly called "government off-the-shelf" (GOTS) is a form of NDI item. A large-scale example of a NDI would be a fighter aircraft developed by some other nation. A more meaningful example in the current context would be radar developed for one aircraft that is available for use in another aircraft.

D. COMMERCIAL ITEMS CLARRIFIED

On January 5, 2001, Dr. Gansler, then Under Secretary of Defense for Acquisition, Technology and Logistics, issued a policy memorandum to clarify and to help overcome some of the barriers being experienced within the Department of Defense in utilizing commercial items. An Integrated Process Team (IPT) had been formed at his direction and was headed by both the Deputy Under Secretary of Defense for Acquisition Reform (DUSD (AR)) and the Director of Defense Procurement. The IPT was chartered to review DOD commercial item determinations and evaluate whether additional guidance, tools, or training were necessary. Dr. Gansler's memorandum says that the IPT found "inconsistent commercial item determination and weak market research among the

obstacles that exist to broadening the use of commercial items within the DoD." [DODA01]

Dr. Gansler's memorandum also provided clarifying definitions of FAR Part 12 for greater consistency within DoD. Four of the most important of these are as follows:

Commercial Off-the-Shelf (COTS): A product does not have to be commercial-off-the-shelf (COTS) to meet the "commercial item" definition. COTS items are a subset of commercial items. The commercial item definition is much broader than products that are presently available off-the-shelf. It includes items that have only been "offered" for sale, lease, or license to the general public, as well as those that have evolved from a commercial item and are offered for sale, even if not yet available in the commercial marketplace. However, evolved items must be available in the commercial marketplace in time to satisfy solicitation delivery requirements. In addition, all other elements of the commercial item definition at FAR 2.101 must also be met.

Modified Commercial Items: When items available in the commercial market cannot meet the Department's need, DoD must determine whether market items can be or have been modified so that FAR Part 12 can be used. Two types of modifications are available: (1) modifications of a type available in the commercial marketplace; and, (2) minor modifications of a type not customarily available in the commercial marketplace made to Federal Government requirements. For modifications of a type available in the commercial marketplace, the size or extent of modifications is unimportant. For minor modifications, the item must retain a predominance of nongovernmental functions or physical characteristics.

"Of a Type": The phrase "of a type" is not intended to allow the use of FAR Part 12 to acquire sole-source, military unique items that are not closely related to items already in the marketplace. Instead, "of a type" broadens the commercial item definition so that qualifying items do not have to be identical to those in the commercial

marketplace. The best value offer in a competitive Part 12 solicitation can be an item that has previously satisfied the Government's need but has not been sold, leased, licensed, nor offered for sale, lease or license to the general public (a nondevelopmental item as defined in 10 USC 403 (13). In this scenario, the phrase "of a type" allows the best value offer to qualify for a Part 12 contract as long as it is sufficiently like similar items that meet the government's requirement and are sold, leased, licensed, or offered for sale, lease or license to the general public. In such instances, "of a type" broadens the statutory commercial item definition to allow Part 12 acquisition of a government-unique item that can compete with commercial items that meet the government's requirement. This avoids the undesirable result of shutting out otherwise price-competitive preexisting suppliers of government-unique items from Part 12 solicitations. [DODA01]

Government Off-The-Shelf (GOTS) is also a commonly used term for nondevelopmental items (NDI) that are government-unique items in use by federal, state or other governmental agency or by a foreign government with which the United States has a mutual defense cooperation agreement. This area will also be excluded and this term will not be utilized in this thesis.

Since COTS has been defined as a subset of "commercial items" and Dr. Gansler's memorandum specifically addresses the broader scope of commercial items, this researcher will use the term "commercial item(s)" throughout this thesis.

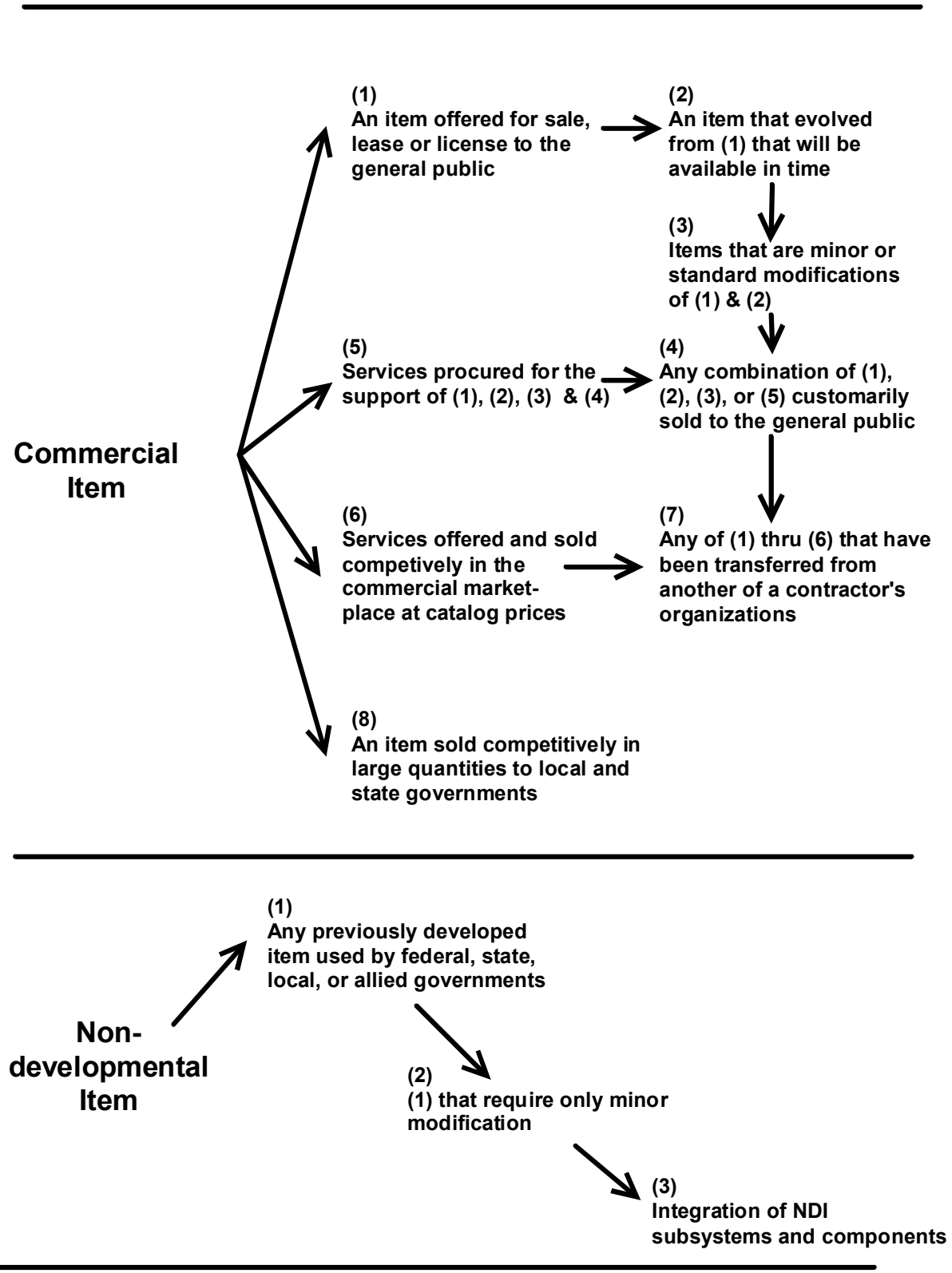

Figure 1. FAR Definition Summarized "From [DODA96]"

E COMPARING COMMERCIAL (COTS) ITEMS AND NDI

NDI and commercial items are similar in that they both already exist, which is what makes them attractive. They are different in that commercial products usually appear in some sort of catalogue or price list, whereas it may be more difficult to discover the existence of NDI. Commercial items used to be considered a subset of NDI, but now this position is reversed, since a restricted form of NDI qualifies as a commercial item (see item (8) under *commercial item*). In addition, support services such as installation and training are now also defined as commercial items.

Because the specific emphasis within DoD is to increase the utilization of commercial items, and nondevelopmental items (NDI) are placed second in the priority of implementation, this thesis will only address commercial item usage. NDI literature will be reviewed inasmuch as problems experienced utilizing NDI, will for the most part, apply to commercial item usage as well. Also, there is a great deal of indiscriminate and imprecise terminology usage. Thus, when the term "NDI" is used, the literature may actually be referring to a commercial item. Thus, the same types of precautionary and risk-mitigation suggestion recommended in this thesis for commercial items may be used when acquiring nondevelopmental items.

F. WHAT ARE COMMERCIAL (COTS)-BASED SYSTEMS (CBS)?

A commercial (COTS)-based system is a system that has been built primarily by acquiring and assembling a set of components that are commercial products into a working system. These components may perform generic functions that are independent of the system's application domain or services that other components of the system depend on.

Incorporating commercial software products to form a commercial-based system involves designing their interfaces with other system components, and the work of integrating them. The integrator responsible for building the system does so by buying the components and assembling them into a complete system. This involves minimal code development as most of the components are not developed from source but are purchased off-the-shelf. The code development required is that necessary to: tailor the

commercial software; build the components that are not being supplied through commercial sources; and glue the commercial components together. The number of interfaces a commercial product has with other system components, and the number of components it interfaces with determines the extent of integration.

One type of system is the commercial solution, a system in which a single commercial product or product suite, provided by one vendor, that may be tailored that provides the primary solution to the problem. The amount of tailoring and data conversion is often significant. These systems may be found in application areas with general concurrence on application practices, examples being personnel management and financial management applications.

A commercial intensive system, commercial-aggregate system, one in which a number of commercial components have been acquired from different sources and are assembled into a complete system. Combining the functionality of the different components provides the system services; there is no dominant single commercial component. Often the use of the particular set of components is unprecedented and requires substantial resources to select and integrate a cohesive set of components. These systems may be found where the needs of the system cannot be satisfied by a single product or product suite or when the system's operational procedures are unique. For example, a command and control system could be constructed from a client/server GUI system, a GIS system, a set of databases, and data analysis tools.

G. RISK MANAGEMENT

Risk Management, one of the most critical and most difficult aspects for project management, is a proactive approach for minimizing the uncertainty and potential loss associated with a project. It follows a two-stage, repeatable and iterative process of assessment (i.e., the identification, estimation and evaluation of the risks confronting a program) and management (i.e., the planning for, monitoring of, and controlling of the means to eliminate or reduce the likelihood or consequences of the risks discovered). It is performed continually over the life of a program, from initiation to retirement.

The unpredictable quality of commercial software creates a unique set of risks for software systems using commercial components. The CBS acquisition process, then, should include risk management, which identifies high-risk items that can jeopardize system quality and attempts to resolve them as early as possible to ensure rapid and successful delivery of the system. Early identification and understanding the risks associated with commercial items is the first step to ensuring that the acquiring activities can achieve the benefits of using commercial products.

This thesis will focus on this first step of risk management, the assessment, identifying the unique problems, risk factors associated with integrating commercial items that have an important influence on whether a program will succeed or fail. It will provide the understanding of these unique risks to the program managers so they can successfully execute their programs and manage the risks associated with commercial items. It will also provide some suggestions for mitigating these factors. A wise manager will recognize risks that are specific to the integration of multiple products into a CBS and will take action to mitigate and control those risks.

H. SUMMARY

This chapter has explored the definition of commercial items and commercial based systems. It uses the broader term of commercial items from the FAR when referring to COTS. A CBS was defined as a system that has been built primarily by acquiring and assembling either a single component or a set of components that are commercial products and integrating them into a working system. In order for systems to be successful and achieve the benefits of using commercial items, they need to minimize the uncertainties and manage the unique risks associated with commercial items. With any risk, awareness of lessons learned by other organization that have implemented systems using commercial items will help build or strengthen strategies to address any unexpected challenges that may arise.

The next chapter presents a review of literature and lessons learned from programs implementing and integrating commercial items in government programs. These sources identify a consistent pattern of unique risks associated with commercial

items. Project managers' can capitalize on these many "lesson learned" to identify and understand the risks associated with commercial items.

III. IDENTIFICATION OF CHALLENGES AND RISKS WITH COTS

A. INTRODUCTION

Commercial (COTS)-based acquisition strategy can be viewed as a risk management approach with the goal of reducing or eliminating the potentially severe risks and resultant adverse effects typical of custom-developed systems. However, while the use of commercial products can help to deal with these "custom acquisition" risks, using commercial products also introduces other forms of risk, stemming directly from the unique characteristics of commercial products. This increased use of commercial products by government organizations is creating a new acquisition operations and support environment which requires that a standard approach be established for identifying and managing (i.e., mitigating) the unique risks of commercial products. This chapter presents many of the unique risk factors associated with developing systems using commercial software. These factors are based on an extensive analysis and review of common government/industry lessons-learned as found in numerous technical documents, journals and other literature review. Summaries of some of the major documents used for the foundation of this thesis are provided in this chapter with the full list of the sources provided in the list of references.

Examining the similarities and differences of organizations that have applied commercial (COTS) products, the successes and failures of those organizations, will allow us to identify a number of unique factors and significant capabilities that an organization must have to succeed with developing a system using commercial items.

B. BACKGROUND INFORMATION

1. United States Air Force Scientific Advisory Board: Ensuring Successful Implementation Of Commercial Items In Air Force Systems, April 2000

The Air Force was frustrated over the lack of success of those programs attempting commercial products implementation and were concerned that the customers were expecting miracles. Just being told to "maximize use of commercial (COTS) items"

without guidance, training, infrastructure, processes, tools, metrics, incentives, and leadership won't make it so. A panel was formed to look into a broad range of commercial hardware and software products involving varying degrees of integration and complexity; however, the commercial hardware considered was limited to computers and electronics. The primary purpose of this report was to capture the issues, pitfalls, myths, lessons learned, best practices and critical success factors associated with commercial (COTS) items.

The panel made an assessment of 34 programs and organizations, table 1, covering three broad domains – management information systems (MIS); command, control, communications and intelligence (C3I); and weapon systems listing the well-recognized benefits and several not so well recognized risks to consider when utilizing commercial items. The panel observed about 25 common pitfalls that programs are experiencing with most struggling with the technology, processes and complexity issues of commercial items with a few failing miserably. Most of these pitfalls could have been avoided or mitigated if appropriate risk management processes or procedures were in place that people understood and followed. While the concept of a commercial (COTS)-based system is easily understood, the implementation is not. The successful implementation of commercial products impacts virtually every aspect of the acquisition process including acquisition strategy, source selection, program management, system development, integration, and sustainment.

Of the 34 programs interviewed, five were considered exemplary and, generally, those with the most experience were realizing the biggest gains. The study panel identified the common characteristics between these five programs and strongly recommended that these critical success factors form the basis of an implementation policy within the Air Force (and DOD). To serve as a framework to drive acquisition strategy, source selection, program management and, indirectly, the aerospace industry. In addition, since everyone is on a steep learning curve, they recommended that a periodic or annual review be conducted to incorporate additional lessons learned into the policy until the situation stabilizes.

Program/Organization	Service	Organization
Advanced Amphibious Assault Vehicle	USMC	General Dynamics Amphibious Systems
AF Operational Test and Evaluation Center	USAF	AFOTEC/CNR
AFPEO/LI for Logistics Info SPO, Gunter, AFB	USAF	AFPEO/LI
AFRL COTS Initiatives USAF	USAF	AFRL COTS Initiatives USAF AFRL/MLM & /IFTA
AWACS Computer Modernization	USAF	ESC/AWC
B-2 Data Storage	USAF	ASC/YSA
B-2 EFX 99	USAF	Northrop Grumman
Boldstroke, commonality initiative Open Systems Architecture & Software Component Technology		The Boeing Company
Bradley Fighting Vehicle	USA	United Defense LP
CALCE Electronic Products and Systems Consortium		University of Maryland
DCAC/MRM – Define & Control Airplane Configuration / Manufacturing Resource Mgt		The Boeing Company
COTS Supplier Approaches		DY 4 Systems
Earth Sensor		TRW Space & Technology Division
F-117 & F-119 Engine Electronics	USAF	ASC/LPC & /LPR
F-15E COTS-based Products & F-16 Upgrade	USAF	ASC & ASC/YPV
F-22 Program	USAF	ASC
Global Broadcast System	USAF	Raytheon Systems
GPS, Ground Control Segment	USAF	SMC/CZG
GPS Receiver	USAF	TRW Space & Technology Division
Ground Station		TRW Space & Technology Division
Reuse of COTS Software		GTE Information Systems Division
JASPO, Signal Intelligence Infrastructure	USAF	ASC/RAJ
Joint Direct Attack Munitions	USAF	Program Director
Large ADP Systems & Software Development Process		TRW Federal Enterprise Solutions
Manufacturing Resource Planning	USAF	MRP II Program Office
COTS Implementation in the Mobility SPO	USAF	ASC Commercial Aircraft Program

Program/Organization	Service	Organization
New Attack Submarine and Acoustic Rapid COTS Insertion Programs	USN	Lockheed Martin Undersea Systems
Enabling E-Commerce & Distributed Computing		Interoperability Clearinghouse
Office of the Department of Defense Chief Information Officer	OSD	ASD/C3I CIO
PVS/EVS – Enterprise Visibility Service		Boeing Information Systems
Deputy Assistant Secretary for Management Policy & Program Integration	USAF	SAF/AQX
T-38C Avionics Upgrade Program	USAF	ASC/EN
T-6A Joint Primary Aircraft Training System	USN USAF	ASC/EN
TacTech (Parts Management)		Transition Analysis of Component Technology, Inc.

Table 1. 34 Programs or Organizations Reviewed "From [USAF00]"

2. United States Air Force Space Command: Commercial Space Opportunity Study (CSOS), February 2000

Caught between intensifying warfighter needs in space and tight constraints on its budget, the Air Force has been encouraged to explore options in the commercial market for enhancing space capabilities while reducing costs. Beginning in 1996, the Air Force initiated a series of these studies to determine the potential of commercial space to support Air Force space missions and requirements. The prior studies were general in nature, but identified promising opportunities in commercial space and advised Air Force leaders to move forward. In late 1997, the Chief of Staff, USAF, tasked the Chief Scientist of the Air Force to conduct a study called the "Doable Space" Quick Look Study. This study found that the military potential of commercial space was not well defined or understood, and recommended that the Air Force conduct "an aggressive study on exploiting the space commercial revolution." The CSOS was chartered to build on and go beyond these previous studies and systematically exposed and assessed the technical, operational, policy and programmatic implications of potential commercial paths.

The CSOS set out to identify new opportunities to satisfy military requirements while reducing Air Force costs, expanding capabilities and/or achieving higher operational efficiencies focused on military activities that the commercial market was capable of implementing in both near and long term opportunities. The objective was to develop actions to address the issue of how the government and commercial space community can best work together to capitalize on commercial space opportunities and move the Air Force toward an integrated architecture that best serves the Air Force's needs and budget. The core of the CSOS approach was to develop business cases through intensive discussions with industry, and to show whether "commercialization" would support or impair national security and readiness.

The study's approach was to look for areas where interests of the military space community and the commercial space community coincide. Proprietary discussions were held with interested commercial firms in areas of: customer satisfaction, market share, product development, industry growth potential, and cost control. By comparing the two sets of needs, the study identified common areas of interest to both communities. These common activities were launch, command and control (C2), remote sensing, communications, and navigation. The purpose of the discussions were threefold:

1) To ensure that industry fully understood current Air Force space activities;

2) To determine whether commercial providers could and would provide equivalent or superior services at costs lower than government costs; and

3) To find out whether commercialization could be executed within the Air Force and not violate national policy requirements.

Detailed business cases were solicited from those firms judged to have the capability to provide the space activity or function in question. The business cases described how the providers would meet Air Force requirements and why they thought they could profitably provide the services or products. All business cases were reviewed through several iterations until the study leadership felt it had a complete understanding of each provider's concept and an understanding of the capability of the relevant industrial base as a whole.

3. Department of Defense Inspector General, Lessons Learned from Acquisitions of Modified Commercial Items and Nondevelopmental Items, Report No. 97-219. 23 September 1997

The objective of this report was to determine lessons learned from the acquisition management of Defense systems developed and procured using modified commercial items and nondevelopmental acquisition strategies. They used available information from ongoing and past management efforts within DOD to identify many lessons learned from acquiring commercial items. They also reviewed audit reports addressing acquisitions of modified commercial and nondevelopmental items to determine whether the acquisition community is making progress in developing acquisition strategies that avoid some of the acquisition difficulties identified in earlier audit reports. The report summaries and categorizes the lesson learned from the buying organizations into critical program management elements and evaluates the effectiveness of their management controls.

Specifically, they reviewed 37 programs, table 2, 10 Army, 23 Navy, and 4 Air Force acquisition programs in which the military department was acquiring modified commercial and nondevelopmental items as entire systems, subsystems, or major components. They identified 91 lessons learned in developing acquisition strategies for program definitions; program structures; program designs; contracting; program assessment; and decisions, reviews, and periodic reporting. In addition, they visited 22 of the 37 buying organizations to discuss specific lesson learned. For the most part, the organizations identified program uncertainties involved with acquisitions that affect product performance, quality, and logistical support. The report then identifies key acquisition strategies that would be disseminate to provide buying organizations with useful information on how to acquire modified commercial and nondevelopmental items from commercial suppliers.

Department of the Army	Modified Commercial	Nondevelopmental
Biological Integrated Detection System		X
Cargo Utility Commercial Vehicle		X
Cargo Utility Global Positioning System Receiver		X

Department of the Army	Modified Commercial	Nondevelopmental
Communications-Electronics Command Commercial Communications Technology Lab	X	
Deployable Universal Combat Earthmover		X
Lightweight Multiband Satellite Terminal		X
Lightweight Video Reconnaissance System		X
National Automotive Center	X	X
Near Term Digital Radio		X
Precision Lightweight Global Positioning System Receiver	X	
DEPARTMENT OF THE NAVY	**Modified Commercial**	**Nondevelopmental**
Advanced Deployable System		X
ARC-210 Very High Frequency/Ultra High Frequency Radio	X	
Battle Group Passive Horizon Extension Surface Terminal	X	
Combat Systems Engineering	X	X
Common Support Equipment		X
Control Display Navigation Unit		X
Fixed Distributed System	X	
Ground Proximity Warning System	X	X
High Frequency Radio Group		X
Hull, Mechanical and Electrical Equipment Data Resources System	X	X
Joint Maritime Command Information System-Afloat	X	
Joint Power Projection/Real Time Support		X
Medium Tactical Vehicle Remanufacturing		X
Miniature Digital Assigned Multiple Access	X	
New Attack Submarine	X	
P100 Portable Firefighting Group		X
Riverine Assault Craft		X
Strategic Systems Program	X	X
Submarine Message Buffer	X	

Department of the Navy	Modified Commercial	Nondevelopmental
Surface Ship Torpedo Defense		
a. Launched Expendable Acoustic Device		X
b. Multi-Sensor Torpedo Recognition and Alertment Processor	X	
Surveillance Towed Array Sensor System	X	
Surveillance Towed Array Sensor System- Low Frequency Active		X
Department of the Air Force	**Modified Commercial**	**Nondevelopmental**
C-130J Aircraft	X	
Commercial Aircraft Program	X	
Military Products From Commercial Lines	X	
T-1A Aircraft		X

Table 2. 37 Modified Commercial and Nondevelopmental Programs Reviewed From "[DODI97]"

4. FAA, COTS Risk Mitigation Guide: Practical Methods For Effective COTS Acquisition and Life Cycle Support, June 2002

Since the introduction of the Federal Aviation Administration's (FAA) Acquisition Management System (AMS) in 1996, the agency has fielded numerous commercial (COTS)-based systems into the National Airspace System (NAS). However, due the lack of any available internal or external guidance on how to manage the unique risks associated with commercial item acquisitions, the FAA as well as many other Government agencies has had a variety of experiences, many of them adding to system cost, schedule and performance risks. This guide was established to capitalize on these many "lessons-learned" from government and industry and imbed them in a practical manner within the context of an acquisition management process to more effectively acquire and provide life cycle support for commercial (COTS)-based systems. The guide provides the necessary underlying structured for a standardize approach to identify commercial (COTS) risks, analyzes the likelihood and consequences of the risks and

determine appropriate mitigation strategies to minimize their impact. It uses a set of worksheets and schedules to

- Collect the information
- Assess the risk level
- Select the most suitable solution
- Develop and deploy the solutions
- Develop the technical rational to justify funding requirements

Using the programmatic risk management element of it systems engineering progress (Figure 3.1), the FAA collected information on commonly experienced government and industry "lessons-learned" in the areas of reliability, maintainability, availability, supportability trends, and market research activities. They used the Internet, in-house experience, plus commercial and DOD publications and then converted them into risk factors. The risk factors were subsequently analyzed to determine practical risk mitigation strategies that could be included as part of early program acquisition, planning and which could be continuously applied throughout a system's lifecycle. The information contained in this COTS risk mitigation guide would be incorporated as part of the overall risk management program for both existing and new start commercial (COTS)-based system acquisitions. Because technology and commercial products evolve rapidly, this process must be updated on a frequent (proactive) basis to avoid disruption (reactive) of system operations helping to avoid the disruptions caused by commercial items.

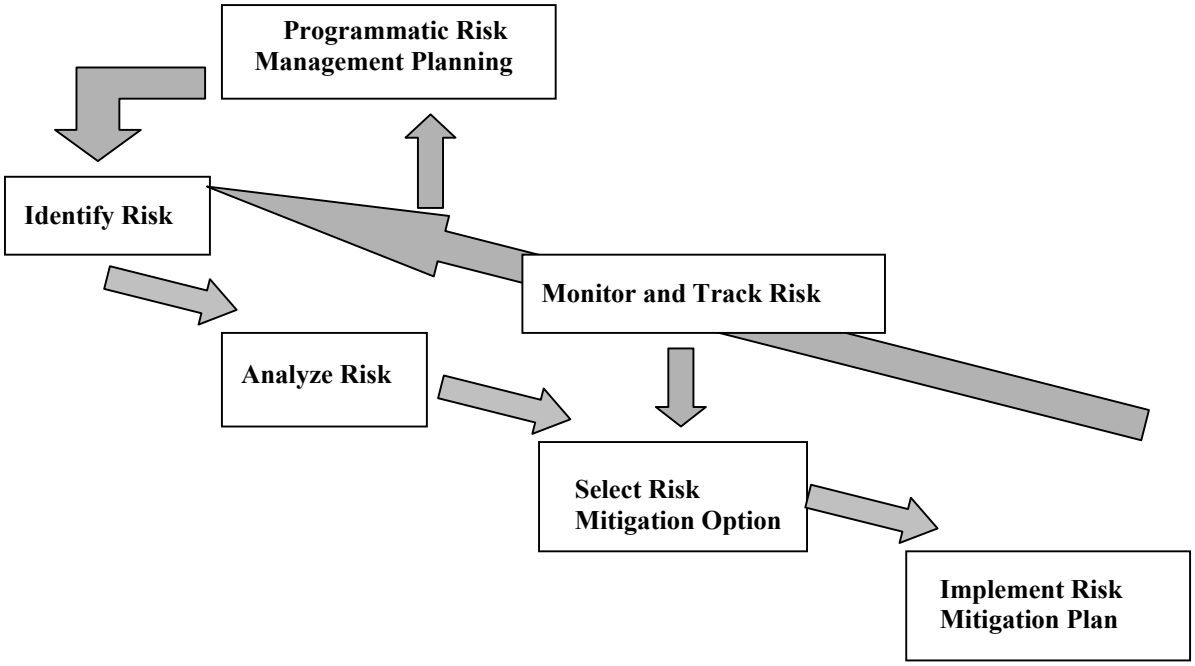

Figure 2. FAA Programmatic Risk Management Process "From [FAAC02]"

5. Department of Defense, Office of the Under Secretary of Defense for Acquisition and Technology, SD-2: Buying Commercial & Nondevelopmental Items: A Handbook, April 1996

The Department of Defense must learn to use commercial and nondevelopmental items (NDI) effectively. Our ability to field affordable, state-of-the-art systems when they are needed, and to buy the millions of items needed to support our troops and fielded systems, depends on efficient use of available resources. The use of commercial items is no longer a question of "yes or no" but a question of to what degree. This handbook was developed as a guide for acquisition managers and personnel in other functional areas who are involved in buying commercial and nondevelopmental items (NDI). It is intended to help these individuals buy these items without inhibiting their use of creative and innovative strategies.

It offers guidance on commercial and NDI acquisitions. It addresses the entire spectrum of acquisitions from systems, subsystems, assemblies, parts, and items of supply. This guide does not present a "cookbook" approach to commercial and NDI acquisitions; however, it does offer best practices and "lessons learned" along with additional "things to consider", when buying commercial items. It presents case studies to demonstrate the effectiveness of using commercial products and practices in:

- Defining Requirements
- Acquisition Process
- Logistics Support
- Test and Evaluation
- Product Assurance

With relatively short lead times for fielding commercial and nondevelopmental items, acquisition decision must not be made until tradeoff factors are identified, analyzed, and compared with other alternatives. In determining if use of a commercial or nondevelopmental item is feasible, personnel must tailor the guidance provided to the circumstances of their particular acquisitions and devote more program resources to addressing life-cycle support as more of the quantifiable program risk areas become known.

6. Naval Sea Systems Command, Commercial Off-The-Shelf and Non-Developmental Items Handbook, March 2000

This document was created in response to the challenge of DOD to use more commercial products in its military systems and the feedback from the Naval Sea Systems Command (NAVSEA) Commercial-Off-the-Shelf (COTS) Workshop held in Norfolk, VA in August 1998, where the Fleet and the NAVSEA user community expressed the need for NAVSEA guidance in the utilization of commercial items. Given the fiscal constraints under which NAVSEA operates, it has significantly increased Commercial Off The Shelf/Non-Developmental Item (COTS/NDI) in system acquisitions. Employing COTS/NDI is a prudent means of lowering the costs of acquiring equipment and systems that satisfy the Navy's needs. However, effective management of commercial hardware and software in Navy systems presents difficult and different challenges than traditional item acquisition and life cycle support.

The document provides overall guidance and outlines approaches for developing successful acquisition, integration, and maintenance support strategies whenever commercial products are employed in military applications under the cognizance of the Naval Sea Systems Command. It is written from a global perspective and is intended to will help managers and implementers decide “what” factors to consider when employing, integrating and supporting COTS/NDI into systems; providing the framework to develop,

manage and execute a comprehensive, cost effective, COTS/NDI program based on DOD policy. By consolidating points from previously prepared plans, reports and studies, they leverage industry experience, lessons learned in other military applications, and current "best practices" to allow individuals to tailor these "what" factors to their specific program.

It focuses on the acquisition and life cycle support of COTS/NDI for hardware and software for all NAVSEA programs (excluding Nuclear Propulsion Programs under the cognizance of SEA 08). It provides guidance for those disciplines involved in all phases of the COTS/NDI acquisition and life cycle support process:

- Program Management
- Technology Management
- Systems Engineering
- Test and Evaluation
- Configuration Management
- Logistics Support
- Product Assurance

While it is understood that every acquisition projects is unique and will vary greatly in complexity and requirements, the guiding tenets contained within this handbook should be reviewed, addressed and tailored accordingly to ensure successful application of COTS/NDI products to mission and program needs. The considerations contained in this guidance are not a "cookbook" for the application of COTS/NDI in NAVSEA Systems but intended to provoke questions that can then be answered by obtaining additional information on the COTS/NDI product.

7. Department of Defense, Data & Analysis Center for Software, Commercial-Off-The-Shelf (COTS): A Survey, December 2000

The goal of this report was to survey the state of the practice in commercial (COTS)-based development and provide evidences of both successful use and failures of commercial (COTS) items in projects using them. Each commercial software component used is less code that needs to be designed and implemented by the developers. However, the developer is faced with the problem of ensuring that the commercial

product does perform the functionality that it claims to perform, that it does not intentionally perform functionality to be harmful to the system, that it will not adversely affect the system and that it can robustly respond to failures and anomalous inputs to prevent errors from propagating through the entire system.

This report discusses the definition of commercial items and commercial (COTS)-based system, listing the pros, cons and issues in commercial (COTS)-based development. The use of commercial products in software development can require a considerable integration effort. Early estimation of this effort will help developers to choose the right commercial products and to decide whether to develop their own software instead of using a commercial item.

The central part of this report is dedicated to survey methods and techniques that can be useful in commercial (COTS)-based development. There are little or no techniques that allow a user to assess the dependability of a commercial item (in the sense of availability of the functionality promised by the documentation, reliability of the functionality, availability and quality of documentation); therefore, successful implementation of commercial items depends on several factors. They try to summarize and analyze these factors by discussing how these factors influence the success of a project using commercial items. They then propose a process to support commercial (COTS)-based development with emerging standards and techniques for component integration discussed. By aggregating the factors they argue that using a dependable commercial item in a non-critical project based on a single commercial item is probably a reasonable choice. On the other hand, integrating several commercial products, just released, in a highly critical project means probably asking for trouble. In between lies a twilight zone where the decision on using commercial items has to be carefully evaluated case by case.

8. A Management Guide to Software Maintenance in COTS-Based Systems, November 1998

The use of commercial products can significantly change the process by which systems are maintained in their operational phase. We are just beginning to experience and understand these changes, and to recognize that life-cycle planning for commercial

(COTS)-based systems must take into account, in early planning, the issues that must be confronted in order to facilitate the maintenance phase. The objective of this guidebook was twofold:

1) To provide planning guidance that results in low risk and cost-effective strategies for maintaining Commercial Off-the-Shelf (COTS) software products in commercial (COTS)-based systems, and

2) To provide guidance on the preparation of a commercial (COTS) Software Life-Cycle Management Plan.

The authors believe there is no single way to manage and sustain all commercial (COTS)-based systems; therefore, they developed a generic commercial (COTS) life-cycle plan and guidelines, describing the changes in the software maintenance process for systems using commercial products and how this process can be tailored for each system depending on its specific requirements and constraints. The basis for this guidance was a review of DOD and industry experiences and lessons learned in commercial (COTS) product applications, and attendance at meetings/workshops whose focus was on the implementation of commercial (COTS)-based systems. The guidebook considers the issues and risks in using commercial software over the life cycle and how to control them. Each commercial (COTS)-based system must look at and control the risks associated with the operational and technical characteristics of the system, the administrative policies and constraints placed on the program, and its financial situation. With the use of commercial products, the operation and maintenance phase starts sooner and continues for a much longer portion of a system's life cycle. This makes early life cycle planning for maintenance of commercial products even more important.

C. RISKS AND CHALLENGES

Those who have followed the commercial (COTS) path have been learning the hard way that "just buying commercial items" does not necessarily lead to all of the desired benefits; problems and difficulties in acquisition procedures, product development, and logistics support, as well as the skills and experience required of personnel supporting the project are also introduced by the use of commercial products.

The extensive review of common government/industry lessons-learned and other literature identified the need for identifying and understanding the unique risks factors (or characteristics) and challenges associated with using commercial products. Risks that are not identified have the greatest chance of becoming problems, while risks that are identified and assessed have the greatest chance of being resolved. This section proposes a set of commercial items risk factors and challenges that can be classified into three categories of commercial risks with each category being further divided into elements or attributes. These categories are based on the numerous technical documents and personal experience. These categories are:

- **Process:** The key considerations for developing and executing a successful acquisition process with the system/program requirements driving the organization to consider a commercial solution and the "fit" of those requirements with available commercial application package(s). Key areas are organizational, planning, tracking, contractual parameters, and evaluation of vendors' experience and past performance.
- **Technology:** The technical "fit" of the commercial product(s) with the existing and planned technical architecture, which supports an organization. How well the selected product will perform in the environment provided by the system. This includes the organization's inherent technical challenges, such as the number and complexity of interfaces.
- **Implementation/Logistics Support:** The process contains intermediate and final work product characteristics for the delivery of a commercial solution within an organization that includes - but is not limited to performance measures, vendors availability of support, testing and managing organizational change.

1. Process Risk Factor: Commercial Standards

Military equipment is required to operate under conditions not always required of commercial equipment. For instance: gunfire vibration, hot and cold extremes, and nuclear hardness are normal operating environments for military equipment. Commercial elements must be selected with these requirements in mind and there may not always be a commercial element that will work.

Until recently the government drove technology development for military applications with large infusions of research and development (R&D) funding for custom-developed systems. The government could afford to specify exactly what was

desired, set requirements, and therefore promoted a "buyers" market of firms interested in meeting this demand. However, commercial products are typically designed and built to a variety of commercial standards that provide high-level guidance on such product characteristics as performance, quality and inter-operability fostering a "sellers" marketplace that is no longer driven by government R&D but by a much larger (and more profitable) commercial customer-base. This means that the commercial vendors have several customers and their products are manufactured to meet more general consumer demands, instead of being configured to meet specific and often-inflexible government requirements.

This competitive environment and the rapid advances in the underlying technologies both drive and allow commercial product manufacturers to anticipate customer demands and to quickly develop and market their commercial products. Leaving the government with no control and minimal influence over how the commercial product evolves. Hence, if operational requirements are viewed as not negotiable, and the suppliers are unwilling to modify their commercial products to meet a unique military need, then the probability of finding an exact match between requirement and commercial product is diminished. [USAF00]

2. Process Risk Factor: License Agreements

Licensing is the vehicle for securing the use of products that you need; data rights and warranties are marketplace vehicles for protecting you (and the vendors) in the long-term use of those products. Understanding, mastering, and negotiating the licensing agreements with the vendor can have a tremendous impact on the success of your program. The fee structures of licenses and maintenance services may change without warning potentially resulting in a large cost impact. Different licensing and maintenance support options are available and negotiable which are sometimes unknown to customers. Enterprise licensing is rarely available and not many users within the DOD are using the same commercial software for the same purpose.

3. Process Risk Factor: Vendors Past Performance

While many individual commercial products from different manufacturers might satisfy a particular set of functional requirements, there can be marked differences from one product to the next. Differences in the components manufacturers choose to use, quality assurance practices, manufacturing processes, labor force composition, market share, product support, upward/downward compatibility, corporate longevity, etc. can all affect the quality and therefore desirability of the commercial products that are offered for sale. The "buyer beware" maxim applies when choosing among apparently similar products. A vendor with a limited product line is likely to sacrifice a product to compensate for adverse market financial flux, while a vendor that employs ad-hoc development practices may not be able to sustain long-term product evolution, with other vendors offering little or no warning for produce releases/upgrades forcing the maintainer into reactive evolution mode to deal with obsolescence issues.

4. Technology Risk Factor: Rapid and Asynchronous Changes

Rapid turnover in the commercial product can be both a risk and a missed opportunity for the program manager who is unaware of these changes. If the sole objective of a system upgrade is to capture new technology more cheaply, then the use of commercial products may suffice. But many DOD systems have a 30- to 50-year lifetime or more, while the average commercial component is upgraded every 6 to 12 months and new technology emerges about every 18 to 24 months. Changes to a commercial product is driven primarily by the vendors' perceptions of how to achieve a greater market share, how to anticipate customer demands and to quickly develop and market their commercial product to meet these demands. Thus the changes are based on what will sell well to the largest number of current and potential users, not on the unique needs of your particular programs. Vendors can add or take away functionality and may not place the same priority as you do on a change that you need or the retention of a feature on which you rely. The money that is saved by using a commercial product with proprietary interfaces can quickly be lost in maintenance as products and their interfaces change with the marketplace forcing customers to accept the upgrades of the new product in order to obtain the desired functionality. Even if the expected lifetime of a system is only five to

ten years, the fluctuations in commercial products and technology result in a state of constant change for any system employing them.

Program management generally cannot control the frequency or the content of new commercial releases. Vendors are continually producing new products as well as revising the products that are already on the market with the timing of a new commercial product release tending to be asynchronous and independent of the new releases of other commercial products and components in the system. Upgrading to the latest version can result in risks such as the following and stresses the need to fully test each upgrade before incorporating it into the system:

- The new software version is incompatible with other commercial software products in the system, necessitating updating of those products too.
- The new version has new data formats that require changes to be made to the formats and contents of existing files and databases that were created by prior versions of the commercial software.
- The new version of the software is incompatible with the version of the hardware that is in the system.
- A new version of the hardware is introduced into the system that forces changes to the existing versions of the software to make them compatible or because timing has changed under the new hardware.
- The new version of the software changes the user interface in ways that require retraining operators.
- Changes in the consumption of time or memory resources by upgrades to commercial software are not compatible with the system requirements or the hardware capacities.
- The new version forces changes in the operational capabilities of the system because it no longer supports those capabilities in the same way or at all.
- A new version may provide more capabilities that may have to be suppressed or restricted due to security concerns.

5. Technology Risk Factor: Integration

The complexity of commercial software interfaces (e.g. operating system) with other commercial software products/applications, middleware, glue code, custom/legacy interfaces and integrating these multiple commercial products within one single system can lead to many interoperability problems:

- Lack of commonality with other products. It is possible (in fact, likely) that using a closed commercial product commits the user to proprietary interfaces and solutions that are not common with any other product, component, or system.
- Performance feature clash. Commercial software vendors typically overload their systems and includes more features and functionality than are normally needed. Precautions must be taken during system development and subsequent upgrades to assure that these unused features do not clash with other software products. System's architects must provide a way of masking the unwanted functionality so that it is inaccessible to the end-users and system programmers.
- Multiple configurations. Changing generations of commercial products will occur. Depending on system complexity, the number of systems to be fielded and the length of time it takes to deploy them, the number of configurations could be significant. It is not uncommon for part numbers and software release identifiers to be the same but have different features or contents. For example, one production lot can be functionally equivalent to the next lot but contain different components and subassemblies. If a product contains firmware or if it is a software product, revisions can be made to subsequent product releases to correct deficiencies or to add unique features to enhance product marketability. A commercial product manufacturer may or may not elect to identify these configuration changes to its customers.

6. Technology Risk Factor: Reliability

Today, with the rush to bring many products to market, commercial products are notoriously error prone. One must recognize that a new product in a hot market segment will have problems, some potentially crippling to a system's reliability. This is a major concern since all military equipment must be highly reliable in the field. This sometimes requires equipment with failure rates not achievable with available commercial elements, forcing us to have an understanding about the vendor's track record in building reliable commercial products. For certain applications, occasional errors and downtime may be acceptable. For other applications, the requirements may specify a Mean Time Between Failures and Mean Time To Repair that are very demanding-resulting in higher project cost.

Evaluating commercial product reliability is somewhat different than evaluating the reliability of new development products. With commercial items the basic product is

already designed and its reliability established; however, detailed engineering and manufacturing data for commercial products is frequently not available. The Government is not involved in the design process and production testing for a commercial product. So the Government cannot continuously evaluate the reliability during design reviews, through analysis, or based on production test results.

Consequently, the reliability assessment should be an operational assessment of the military application in the expected military environments since the buyer cannot control the basic design of a commercial item. The commercial product must pass the same reliability evaluations as the host components; otherwise the commercial product will be the weakest link in the chain of components and will be the determinant of software system reliability. The essential reliability analysis/tasks that must be performed are reliability predictions, system level Failure Mode Analysis, Failure Reporting and Tracking Analysis, and reliability verification. Consider the following when evaluating and fielding commercial products:

- Reliability predictions may be difficult to obtain from the vendor.
- Lack of data may limit the depth of failure mode analysis that can be done on commercial products.
- Vendor's definition of reliability data may be different than DOD/Government standards (e.g., Ao, MTBF, MTTR).

7. Technology Risk Factor: Information Security

When the government develops its own custom systems, it can specify and develop system security characteristics very precisely. Although vendors provide products with built in security features that address the commercial components interoperability issues, these products are typically developed to commercial standards with insecure defaults that introduces potentially significant security risks for several reasons.

- The increased inter-operability among different products that meet commercial standards raises the chances that unauthorized access can be gained.
- The use of commercial standards allows a greater number of people to be familiar with the software protocols used to manage information. This knowledge can be used to access or disrupt information flow. The "open-

> ness" of a particular architecture, the degree to which it links with other external commercial (COTS)-based systems, and the nature of the security measures in place will determine the extent to which the products and systems using them are susceptible to unauthorized access. [FAAC02]

Most commercial software is developed and implemented outside this country. It is common in software product development in the United States to use teams from other countries. In a government project with particular security requirements this presents major risk factors that may be unacceptable. Because a commercial product is essentially a black box, in the sense that the implementation of the software is most often hidden, leading to the possibility that a trap door or "Trojan Horse" may be embedded in the code, there may be a backdoor feature in the code, or unexpected capabilities. As a result, specific security relating to project requirements may not be guaranteed, as the security of the commercial products implementation cannot be ascertained.

8. Implementation/Logistical Risk Factor: Product Obsolescence (discontinuation)

Commercial products life cycles are generally much shorter with new versions of a commercial software package appearing as frequently as every 18 months. As succeeding generations of commercial products are introduced into the commercial market, the manufacturer must determine at what point when it is no longer profitable or desirable to support the older generation products. The manufacturer must make a tradeoff between selling its newer product line while at the same time not alienating the older generation product consumer base. After three or four upgrades, the manufacturer may choose to no longer maintain the earlier version incorporated in the military system. Also, a commercial product may be selected for a particular niche feature. If it turns out that the commercial market is not interested in this capability, there could be a lack of support or subsequent revisions that may exclude the feature entirely.

When a commercial product is projected to be nearing end-of-life (EOL) (i.e., out of production) or end-of-service (EOS) (i.e., no longer supported by the manufacturer), the effects of these projected changes of state on the product and on systems using the product must be examined to determine what action if any is needed. It is not a foregone conclusion that all products declared to be EOL or EOS need to be replaced immediately

by newer versions of those products. Effects can range from no impact to high impact. The obsolescence support options that are available to address these impacts can range from taking no action to making a major system redesign [FAAC02]. The categories of impacts due to obsolescence are defined as follows:

- No impact – In this case the product's projected End of Life/End of Service status has no impact on the product or on any system using that product and therefore requires no action. The commercial product is considered reliable and there are sufficient spares (at acceptable prices, within the market or on-hand) to support the projected failure-driven demand over a pre-determined timeframe.
- Low impact – This situation typically requires compatibility testing for the new product and a documentation change to identify the new product as a suitable alternative replacement part upon failure of the old part. The manufacturer's next generation product is compatible i.e., interchangeable); if there are other manufacturer products that are compatible; and if there are no associated changes to interfacing products within the system.
- Medium impact – This category of impact, like the low impact category, also applies when a commercial product must eventually be replaced. The manufacturer's next generation product requires minor software changes and/or if related changes to interfacing products are required.
- High impact – This category of impact, like both the low and medium impact categories, applies when a commercial product must eventually be replaced. However, a major impact situation exists if there are no compatible replacement products or technologies available on the market. This situation typically calls for a major redesign or an integrated system change.

9. Implementation/Logistical Risk Factor: Proprietary Data

A major drawback of including commercial items in a software system is the lack of visibility into how the commercial components were developed and an incomplete understanding of the components' behavioral properties [SCHN00]. A commercial product manufacturer remains in business because it owns and controls the research and manufacturing processes needed to meet market demands and to keep product costs competitive. As consumers, we have little insight into the specifics of how a commercial product has been developed and at times even into the details of how it behaves and why. This lack of visibility can hamper efforts to integrate the product with others to create a

larger system since the vendor may not be willing to provide detailed interface design documentation. As a result, the commercial product must be viewed as a "black box" with defined interface and performance characteristics but allowing no insight into the internal composition of that product. Because we do not have access to the source code, developers cannot modify the code to change the functionality of the commercial product (perhaps this is a good thing!).

10. Implementation/Logistical Risk Factor: Underestimated Costs

Accelerating the introduction of commercial products into government and military systems has been advertised as a "faster, better, cheaper" way of meeting requirements. However, unless a risk management program includes proactive mitigation strategies looking at the total ownership of cost for commercial products, the initial cost benefits can be offset by the often more costly fixes of the risks that weren't effectively managed. Examples of the cost considerations for a commercial (COTS)-based acquisition strategy that need to be included as part of a total cost of ownership analysis include [FAAC02]:

- Inadequate-planning costs – Probably the major life cycle cost-driver associated with the use of commercial products is the lack of effective planning and budgeting. When a program fails to apply commercial risk mitigation strategies, the program then loses the advantage of proactive planning and becomes increasingly reactive to emerging commercial-driven obsolescence situations.
- Test and integration costs –Programs often underestimate the impact of testing commercial items. In addition to the actual costs of the test facilities needed to support the possibility of multiple system configurations, different commercial products with varying characteristics typically require that "glue code" be developed to allow the products to interact effectively. Each product must be tested for compliance to performance requirements, conformance to open system standards and compatibility with the system with which it will be integrated.
- Modification costs – In some cases a commercial product must be modified to meet a particular or unique requirement. There is a cost to actually modify the commercial product itself. There is also a cost to assume life cycle management responsibility for that specific product because modifying a commercial product typically voids (unless functions are incorporated as part of the commercial product line) any warranty and the vendor will no longer provide support. This forces the life cycle

support for that product to be the responsibility of the acquiring activity. Costs for documentation, maintenance, training and spares costs will increase in this situation and must be planned for in the life cycle budgeting for that modified product. In addition, regression testing at the system level may be needed to ensure that the modification does not change the expected performance of the system.

- Configuration management costs – A consequence of using rapidly changing commercial products within a given system is the strong likelihood that an acquisition of multiple copies of that system will include more than one configuration of the commercial products used in the system. This situation not only demands a rigorous application of configuration management (CM) processes to document and manage system baselines but also requires that test facilities can replicate all fielded configuration baselines.
- Continuous system engineering costs –Commercial products forces a continuous system engineering effort, which adds additional cost to a program. Because commercial (COTS)-based systems are dynamic in nature, continuous systems engineering activities are needed to perform market surveillance/research/investigation; analyze obsolescence projections; determine the available options to limit obsolescence impacts; and integrate the resulting information with new requirements and field data as part of the overall integrated program planning. You need to be able to go out and see what is going on in the marketplace and do some technology forecasting.
- Obsolescence management costs – There are costs associated with vendors or suppliers either dropping support for a commercial item or going out of business. The continuous system engineering activities needed to manage obsolescence can result in more frequent engineering changes to the system. The development, deployment and configuration management of these changes is an added cost that must be included in all commercial (COTS)-based system program planning. These costs must continuously be refined as system product obsolescence information is gathered and analyzed.

11. Implementation/Logistical Risk Factor: Testing

Commercial item's capabilities may not always be as stated and demand excessive testing. There may be "hidden behaviors" associated with the commercial item, or bugs that affect the system. System integration and system level testing becoming even more vital, particularly in commercial (COTS)-based systems with many components (commercial (COTS), NDI, custom, legacy) where interoperability issues abound; therefore, one must ensure that the system fulfills all specified requirements and

that catastrophic faults are detected early. When commercial products are modified, the system may exhibit behavior different from the baseline requiring additional testing. In the past, unique custom designs were static so that the system tested was the system to be manufactured and deployed. Because of the volatility of systems incorporating commercial products, the system that is subjected to initial operational, testing and evaluation (IOT&E) is likely to be different from the system that enters production, since upgrades will have been incorporated. This constant evolution of a system is a cause of, since the consequences of the changes introduced into the initial production design are unknown.

Testing and fault isolations are further complicated by the reality of restricted visibility into the behavior of the commercial product with any documentation that you may have, often incomplete and inconsistent, causing you to shift from a "white box" to "black box" testing process [SCHN00]. The integrator/testers must thoroughly test all inputs and outputs to "prove" to a vendor with potentially significant evidence that a particular commercial component is failing in a particular way, whether a detected failure is in a single component (and then, which one) or in the interactions among two or more components. This may take significant resources (time and very skilled technical staff) to isolate and resolve with the vendors. It is not the vendor's responsibility for the ultimate success of your system; rather it becomes the integrating organization's responsibility. You might want them to fix some bug or something, and they may or may not do it in that given release. Sit down in advance with your vendors to determine the routine for working out solutions to problems that will be encountered and find a way to cooperatively work together to find a satisfactory resolution.

D. SUMMARY

This chapter summarizes some of the major government/industry lessons-learned and other technical information to form a foundation for understanding and identifying the unique risk factors associated with developing systems using commercial software. It proposed a set of commercial item risk factors and challenges that were classified into three categories: process, technology, and implementation/support, with each category being further divided into specific elements or attributes. Only by understanding and

addressing the unique factors imposed by commercial items will program managers be able to attain their benefits and move towards market-oriented business practices that are better suited to the acquisition and life cycle support of commercial (COTS)-based systems.

IV. COTS RISK QUESTIONNAIRE/CHECKLIST

A. INTRODUCTION

Widespread use of commercial products in complex software systems poses many unique challenges and risks to both the developers and managers of systems using commercial items. It is virtually impossible to develop, modify or purchase commercial software without incurring risks. These risks can be known, unknown, or unknowable. Known risks are those that one or more project personnel are aware as concerns. The unknown risks are those that would surface (i.e., become known) if project personnel were given the right opportunity, cues, and information. The unknowable risks are those that, even in principle, none could foresee. Hence these risks, while potentially critical to project success, are beyond the purview of any risk identification method.

Identifying the unique risk factors, assessing these factors, and controlling them are the keys to proper risk management with commercial items. Identification surfaces risks before they become problems and adversely affect a project. The sooner risks are identified, the better off the software managers, system engineers, project manager or decision-managers will be able to monitor, adequately mitigate, and resolve the risks; thus, achieving the desired benefits of using commercial items by ensuring a rapid and successful delivery of the system.

B. IDENTIFICATION OF RISKS

This section presents a questionnaire (Appendix B), checklist, for adopting and integrating commercial product(s) into systems or programs. The questionnaire is intended to provide a guideline (reminders), to any of the participants on the program, whether on the acquiring side or the contracting side, and focus their attention on the possible risk factors that individuals need to understand when using commercial items. It consists of two sections and is designed to provide a systematical tool, starting point, for managers to identify, investigate, and plan for the unique risks associated with implementing commercial items. It incorporates some of the most significant lessons learned from a variety of commercial implementations [ITRB99] and helps you evaluate

the risk by determining the severity of these risks for your own organization. While it may not be complete and has some obvious weaknesses, the checklist provides an organization, which is considering the adoption and integration of commercial items, insight into the areas that must be carefully considered. It also serves an important purpose for large-scale organizations by providing a repeatable approach for commercial items risk evaluation.

1. Section I. Demographic Information.

Collecting background information about the organization and experience of the individual(s), with commercial product(s), completing the questionnaire.

2. Section II. Risk Questions

A modification was done to the Information Technology Resources Board's (ITRB) "Risk Profile"[ITRB99], in order to structure 42 questions around the three broad categories that represents critical aspects required for the successful implementation of commercial items as identified in chapter three: process, technology, and implementation/logistics support, defined below, with several questions for each category. Even though some questions may not pertain to every project, these questions can be modified accordingly to meet the needs of the software project. Each question prompts you, the respondent, to think about key factors for a successful commercial product(s) implementation and how these factors pertain to your project within your own organization.

- **Process:** The key considerations for developing and executing a successful acquisition process with the system/program requirements driving the organization to consider a commercial solution and the "fit" of those requirements with available commercial product(s). Key areas are organizational, planning, tracking, contractual parameters, and evaluation of vendor's experience and past performance.
- **Technology:** The technical "fit" of the commercial product(s) with the existing and planned technical architecture, which supports an organization. This includes the organization's inherent technical challenges, such as the number and complexity of interfaces.

- **Implementation/Logistics Support:** The process contains intermediate and final work product characteristics for the delivery of a commercial solution within an organization that includes - but is not limited to performance measures, vendors availability of support, testing and managing organizational change.

C. ASSESSING RESULTS

Completing the questions and assessing/compiling the results should help managers better understand the significance level of risk associated with implementing a commercial product(s) and assist in identifying their causes given current business needs and organizational conditions. In turn, this knowledge will help guide the managers and let them take the steps necessary to minimize specific risks associated with the implementation of a commercial product(s) and formulate a strategy for acquiring commercial product(s) for their organization.

1. Risk Severity Rating

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively with points assigned for different levels. The level of risk is somewhat subjective and should be based on the experienced judgment of your best technical people with assigned responsibility. However, user input and feedback, along with industry comments also need to be considered.

- **Low risk, point value = 1,** Actions within the scope of the planned program and normal management attention should result in maintaining an acceptable level of risk.
- **Moderate risk, point value =2,** Corrective actions and/or careful monitoring of status by management are required to reduce risk or to see that the level of risk does not increase.
- **High risk, point value = 3,** Significant corrective action and high priority management attention are required to achieve an acceptable level of risk.

2. Calculating the Risks

To arrive at the programs total risk, each individual section of the risk categories must be examined. A box is provided for adding the total number of a, b, or c responses for each section. The table below illustrates this concept. The first column is the categories of the risks associated with a program implementing commercial product(s): process, technology, and implementation/logistics support. Moving to the right across the other columns in the table you will find space for recording the number of a, b, and c responses associated with each risk category. These individual point values are then summed to provide the total risk severity rating, point score, indicated in the lower right corner of the table. This determines where the point total falls on the scale shown and identifies the programs overall risk rating of using commercial items. In turn, each individual category risk rating could be determined by calculating the responses for that individual category, based on the number of questions for that category.

If most of your responses were a's, your organization has a low risk profile for successfully implementing a commercial application package(s). While an overall low risk is a strong indicator, it is important to note that this does not mean there is "no-risk". Every commercial product(s) implementation involves some degree of risk.

If most of your responses were b's, your organization has a moderate risk for implementing a commercial product(s). Carefully examine the questions, particularly with medium risks (b) and high risks (c) responses to identify specific vulnerabilities and record them in a database or risk mitigation plan with action items or task plans to track risks to closure.

If most of your responses were c's, your organization has a high degree of risk for implementing a commercial product(s). Review the questions to help your organization identify critical areas that need to be reexamined regardless of its commercial implementation phase.

Total Calculations	a's	b's	c's
Totals from Process:	____	____	____
Totals from Technology:	____	____	____
Totals from Implementation/ Support	____	____	____
Totals			

Program Totals

Total a's ____ x (1)
+ Total b's ____ x (2)
+ Total c's ____ x (3)
Project Total = ____

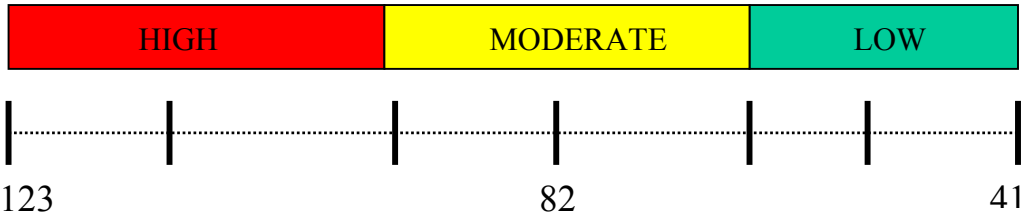

Table 3. Commercial Item Risk Profile

D. SUMMARY

This chapter described a method for facilitating the systematic and repeatable identification of risks associated with use of commercial items. It presents a questionnaire, checklist, to start the managers and engineers thinking about and planning on how to avoid, mitigate and accept the risks inherent in any software project using commercial items. Risks that are not identified have the greatest chance of becoming problems. Many organizations who attempt to implement a commercial products(s) without sufficient analysis and preparation encounter significant challenges that can be related to the business processes used to build systems, technologies used to construct the system, and logistical support issues that inevitably arise. As a minimum, the project manager, software manager, system engineer/manager, any software technical leads, and the software engineers, should fill out and discuss the risk identification method stated in this chapter. Careful consideration of these issues will help to minimize your

organization's risk severity rating and curb future expenditures. With any level of risk, awareness of lessons learned by other organizations that have implemented commercial items will help build or strengthen strategies to address any unexpected challenges that may arise.

V. COTS RISK QUESTIONNAIRE ANALYSIS

A. INTRODUCTION

The questionnaire was sent electronically to the Office of the Secretary of Defense, Command Control and Communication (C3I) Commercial Policies and Oversight Office, the Army's Communication and Electronics Command (CECOM), the Marines Systems Command along with numerous other individual project offices that utilize commercial products to elicit responses, capture experiences, and record the results of the questionnaire for active Department of Defense (DOD) projects that utilize commercial products. The intent was for the major commands or organizations to distribute the questionnaire to project offices within their organizations that use commercial products to complete, revealing the highest risks for their projects. The following are responses from active programs using commercial product(s).

B. DEFENSE LOGISTIC AGENCY (DLA): BUSINESS SYSTEMS MODERNIZATION

The Defense Logistic Agency (DLA) is the primary logistics provider for the DOD and is continually seeking ways to improve and reduce the cost of distribution. It is undergoing a major Information Technology and reengineering transformation, Business Systems Modernization (BSM), to modernize the agency's business practices by using best DLA and commercial practices and commercial software; thus, allowing them to rely on industry for support and reduce inventory levels by hundreds of millions of dollars.

The new information technology system being implemented allows DLA to exploit new emerging technologies and streamline its supply chain process by consolidating its operations to one level of national inventory, generating great economies of scale as well as total visibility of all DOD stocks. Letting them achieve the proven benefits of commercial software, provide better service at higher workloads, reduce the cost, and pass the savings of this improved process back to their military customers.

The questionnaire was completed by an individual with over 10 years of experience on building systems using commercial products; however, his experience was with minor projects, not one of this magnitude (enterprise-wide). Some of the lessons learned from acquiring and developing commercial product(s) for this project are:

- Do not modify core COTS software
- Willingness to adapt
- Completeness of requirements

Table 4 provides the risk profile for DLA's BSM project with the following factors being identified as a high risk. The complete results from the questionnaire are contained in Appendix C.

- Many functions supported by the commercial product
- Very complex interfaces between commercial product and other systems
- Many of the interfaces must remain unchanged
- Extensive training required to operate and maintain the commercial product

Total Calculations	a's	b's	c's
Totals from Process:	12	6	0
Totals from Technology:	5	3	4
Totals from Implementation/ Support	5	5	1
Totals	22	14	5

Program Totals

Total a's 22 x (1)
+ Total b's 14 x (2)
+ Total c's 5 x (3)
Project Total = 65

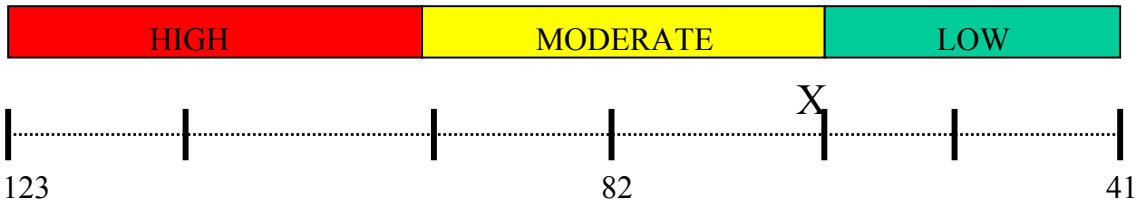

Table 4. DLA BSM Commercial Item Risk Profile

C. ARMY HUMAN RESOURCE SYSTEM (AHRS)

The Army Human Resource System Product Management Office provides and maintains the personal management information system for the active Army, the Army Human Resource System (AHRS) Super Server. It is an integrated automated field military personnel management system designed to:

- Serve America's Army during mobilization, war, and demobilization
- Serve the Active Army during peacetime
- Provide commanders a responsive personnel management system, which facilitates peacetime personnel strength accounting management and wartime operations.

The questionnaire was completed by an individual with over 30 years of experience on building at least 20 systems using commercial products. Some of the lessons learned from acquiring and developing commercial product(s) for this project are:

- Do not use software that does not have a long standing commercial user base
- Do not allow GOTS products to be forced onto your program. These are generally built with commercial products no longer in business

Table 5 provides the risk profile for the Army's Human Resource System project with the following high risks factors being identified. The complete results from the questionnaire are contained in Appendix D.

- Many functions supported by the commercial product
- Much customization of the commercial product needed to meet the needs of the organization
- Testing approach was designed for traditional testing of a system

Total Calculations	a's	b's	c's
Totals from Process:	17	1	0
Totals from Technology:	7	3	2
Totals from Implementation/ Support	6	4	1
Totals	30	7	3

Program Totals

Total a's 30 x (1)
+ Total b's 7 x (2)
+ Total c's 3 x (3)
Project Total = 53

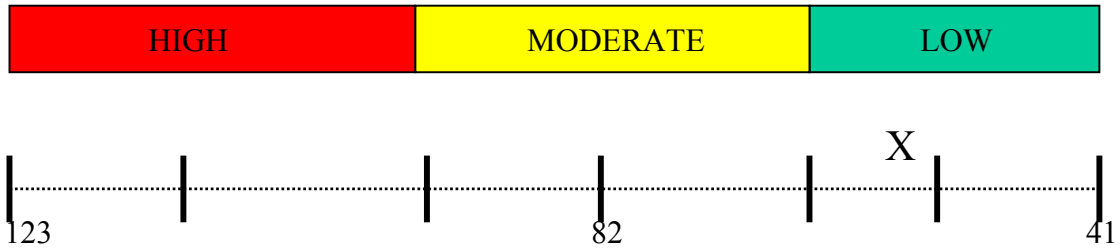

Table 5. Army's Human Resource System (AHRS) Commercial Item Risk Profile

D. ARMY (CECOM) COMMUNICATIONS SOFTWARE ENGINEERING SUPPORT DIVISION (CSES)

The Communications Software Engineering Support (CSES) Division provides life cycle software engineering services to the Program Executive Office for Command, Control, and Communications Systems (PEO C3S), as well as other Department of the Army and DOD organizations and agencies. These services include all activities necessary to ensure the reliability, maintainability, interoperability, and configuration integrity of the software components used in communications and related Mission Critical Defense Systems (MCDSs) for both systems under development and systems deployed to operational units worldwide assuring joint interoperability of tactical switching and network management software/firmware through quality assurance testing;

oversight and certification recommendation of all new software releases; supporting acquisition of interoperable tactical switching and network management systems; and serving as the single point of contact for the warfighters in all matters involving switch interoperability.

The questionnaire was completed by an individual with four years of experience making recommendations on commercial product(s) that were no longer supported or reached their end of life with two recommendations for commercial replacements being integrated. Some of the lessons learned from acquiring and developing commercial product(s) for this project are:

- Known your requirements well
- Assess and evaluate different available commercial products based on the requirements well in advance
- Close, continuous, and active partnership among the vendor, customers, developer, and most importantly the users

Table 6 provides the risk profile for the Army's Human Resource System project with the following high risks factors being identified. The complete results from the questionnaire are contained in Appendix E.

- Vendor unknown or poor performance in integrating the commercial application
- Vendor has a track record of exceeding total life cycle cost estimates
- No discussion with the vendor for future plans of the commercial product
- System is a new system
- Very complex interfaces between commercial product and other systems
- No flexibility in the design to allow future changes in functionally
- Program has not gather information from other organizations that implement commercial applications
- No performance measures to measure the effectiveness of the commercial product
- No contingency plan for commercial vendor going out of business
- Extensive training required to operate and maintain the commercial product

Total Calculations	a's	b's	c's
Totals from Process:	3	12	3
Totals from Technology:	2	7	3
Totals from Implementation/ Support	0	7	4
Totals	5	26	10

Program Totals

Total a's 5 x (1)

+ Total b's 26 x (2)

+ Total c's 10 x (3)

Project Total = 87

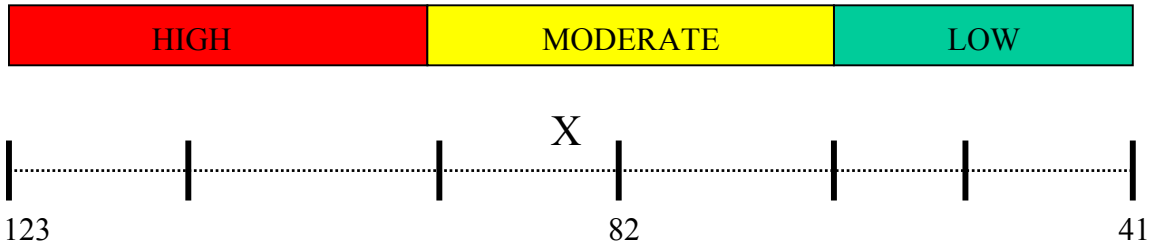

Table 6. Army's Communications Software Engineering Support Division Commercial Item Risk Profile

E. ARMY GLOBAL COMBAT SUPPORT SYSTEM (GCSS)

Global Combat Support System (GCSS)-ARMY is the largest and most complex information technology program in the Army, which will, over time, replace or interface to all of our existing CSS automated systems and provide automatic, user-transparent communications for routine transactions. It will encompass personnel, financial, medical, and other non-logistics CSS functions and be made up of a series of functional modules (or Product Lines) such as Supply, Property, Maintenance and Management with each module operating within the Defense Information Infrastructure and run at any level or organization where the Army performs that function.

Designing the modules at the same time gives the modules a common look and feel using a graphical user interface with point and click techniques with Commercial-Off-The Shelf hardware and the Windows NT operating systems used to support the new

software. These two features coupled with embedded training will simplify initial and sustainment training requirements tremendously.

The questionnaire was completed by an individual with one year of experience on building systems using commercial products with no lessons learned and since the program is under implementation with over 130,000 expected users with multiple and different training requirement; there, he could not answer questions like “how efficient is it?”

Table 7 provides the risk profile for the Army’s Global Command Support System project. Even though the project has a low profile for successful implementation with commercial products, it is important to note that this profile does not mean a "no-risk" profile. Every commercial product(s) implementation involves some degree of risk. The complete results from the questionnaire are contained in Appendix F.

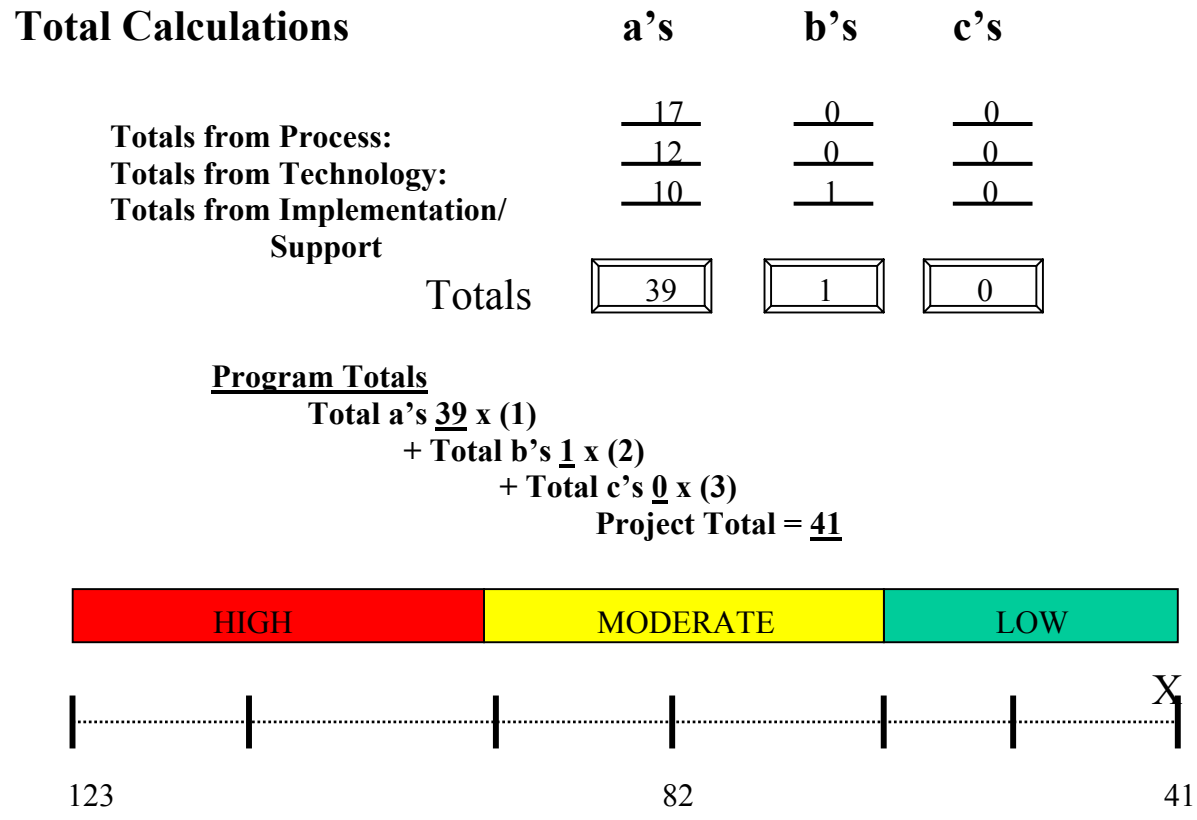

Table 7. Army’s Global Combat Support System Commercial Item Risk Profile

F. MARINE CORPS COMBAT VEHICLE TRAINING SIMULATOR

The Marines want to be able to use the simulators to cover the full breadth of training from the beginning driver all the way to the tactical driver, who is in severe off-road conditions and inclement weather and blackout conditions. Too often, driving simulations are based on flight simulations or video games, and therefore are unsatisfactory for serious training. The simulator will not only display exterior driving conditions, but also will provide a realistic environment of the interior of the vehicle. Everything the driver will have available to him in the vehicle will be available to him in the simulator.

A Semi-Automated Forces (SAF) demonstration system will be developed that will be networked with Raydon-developed LAV-25 and M1A1 Abrams Tank simulators via the High Level Architecture (HLA) protocol be and operate in two basic modes. As an exercise editor, it is used to define entities and their characteristics, build a scenario containing a selection of those entities and assign appropriate behavior to those entities. As a runtime engine and Situation Awareness Display, the SAF controls the behavior of its entities and displays the composite worldview of all entities in the simulation, including those external to the SAF. There will also be three visual databases: a desert database, a geotypical European database and a geotypical rural database to support training in both Visual and Thermal modes.

The questionnaire was completed by an individual with five years of experience building systems with commercial products; however, she has never participated in selecting commercial software for the integration into a system. Table 8 provides the risk profile for the Marine Corps' Ground Transportation Engineer Systems project with the following high risks factors being identified. The complete results from the questionnaire are contained in Appendix G.

- No data right negotiated into the contract
- Uncertain about what licensing agreements are needed
- Much customization of the commercial product needed to meet the needs of the organization
- Many functions supported by the commercial product

- Program has not gather information from other organizations that implement commercial applications
- No performance measures to measure the impact and effectiveness of the commercial product
- Extensive training required to operate and maintain the commercial product
- Very little training resources available to the customer
- Testing approach was designed for traditional testing of a system

Total Calculations	a's	b's	c's
Totals from Process:	5	11	2
Totals from Technology:	5	5	2
Totals from Implementation/ Support	2	4	5
Totals	12	20	9

Program Totals
Total a's 12 x (1)
+ Total b's 20 x (2)
+ Total c's 9 x (3)
Project Total = 79

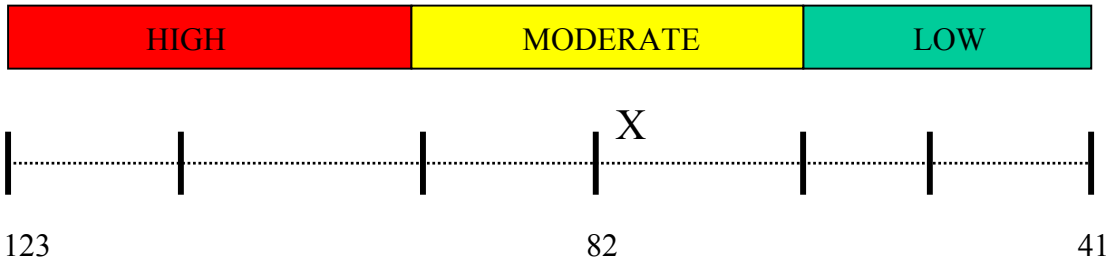

Table 8. Marine Corps Combat Vehicle Training Vehicle Simulator Commercial Item Risk Profile

G. ARMY COMMON SOFTWARE PROGRAM

The Army's Common Software Program is based upon the Global Command and Control System (GCCS) which has two main objectives: the replacement of the World-Wide Command and Control System (WWMCCS) and the implementation of the

Command, Control, Communications, Computers, and Intelligence (C4I). For the Warrior. GCCS is designed to become the single, global command, control, communications, and intelligence system to support the war fighter, whether from a foxhole or from a command center. The GCCS system is based upon the Common Operating Environment (COE) which provides the infrastructure for all command and control systems. This COE consists of an integrated architecture made up of hardware and software that provides standard, modular, system support and applications support software for a set of functional applications. The COE software is a multi-layered open system architecture consisting of modular functional applications, application support software, standard system support software which is designed to operate on a standard suite of computers and consists of 19 functional areas. It fully supports a reuse program that is domain specific, architecture centric, and systematic, implementing the Department of Defense (DOD) software reuse vision and strategy.

The questionnaire was completed by an individual with two years of experience building systems with commercial products and has participated only once in the selection of software components that were later adapted or integrated. Some of the lessons learned from acquiring and developing commercial product(s) for this project are:

- Never rely on a single vendor for critical functionality, always have alternate products lined up
- Consider the likelihood that the vendor will not be there to support it in the future

Table 9 provides the risk profile for the Army's Common Software program with the following high risks factors being identified. The complete results from the questionnaire are contained in Appendix H.

- The implementation team has no experience with the commercial product
- Many functions are supported by the commercial product
- New or immature commercial product
- Program has not gather any information from other organizations that have implemented commercial products
- Testing approach was designed for traditional testing of a system
- No contingency plan for commercial vendor going out of business

- Other contractors supporting the organization in functions affected by the commercial product have no experience (new commercial product)

Total Calculations	a's	b's	c's
Totals from Process:	9	8	1
Totals from Technology:	4	6	2
Totals from Implementation/ Support	6	1	4
	19	15	7

otals

Program Totals

Total a's 19 x (1)

+ Total b's 15 x (2)

+ Total c's 7 x (3)

Project Total = 70

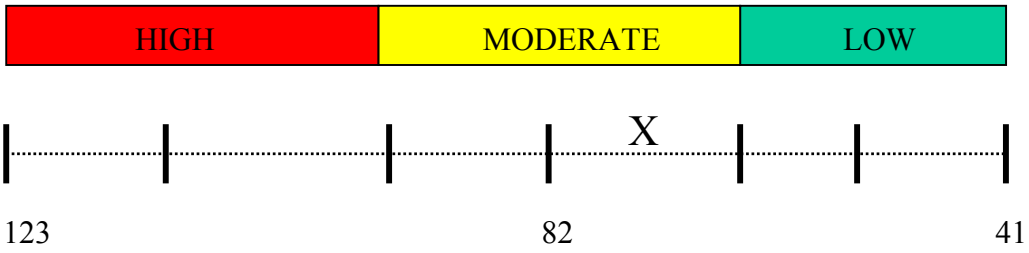

Table 9. ARMY Common Software Commercial Risk Profile

H. SUMMARY

The questionnaire was implemented on current DOD projects that utilize commercial products. It provided to be an effective and efficient tool that could be applied by the program manager or decision maker in a consistent and systematic manner to assist them with the early identification and prioritization of risks associated with commercial products. This provides the program manager or decision maker with sufficient information and expands the time they will have to mitigate and resolve the risks by letting them make wise decisions and apply proper resources, based on the prioritization, early in the process and use their creativeness to properly mitigate and resolve each risk.

Identifying and understanding the risks of commercial products is the first step to ensure that the acquiring activity can minimize downstream surprises and problems and achieve the benefits of using commercial products. Shrinking budgets and tighter schedules virtually eliminate any margins that could be retained to offset problems that might occur later in a program. The next chapter provides some strategies and offers suggestions to help organizations manage and mitigate the risks associated with commercial products.

VI. MITIGATION STRATEGIES AND SUGGESTIONS

A. INTRODUCTION

Once the risks have been identified, mitigation strategies to reduce or eliminate the risks need to be developed and managed. Even though there are many risks, there are specific ways that the risks can be reduced. This section describes some mitigation strategies and offers some techniques/suggestions to help organizations tackle the risk/challenges listed in the previous chapter.

B. SYSTEM REQUIREMENTS

1. Flexible and Negotiable

A traditional development model that specifies all system requirements prior to considering the capabilities available in the marketplace is ill suited to the development of systems incorporating commercial items. Since product development is based on commercial market needs and is under the manufacturer's control, requirements must be written with a quantifiable range of acceptable performance limits (e.g., high and low values) offering flexibility and letting the integrator make the best possible match (within constraints) between commercial product capabilities and the requirements.

The requirements should also be prioritized with criteria established to distinguish absolute requirements (must have) from the less absolute (nice to have) requirements; providing the needed flexibility when selecting among a variety of commercial product candidates. This flexibility is especially important with commercial products since they are sold and supported by manufacturers in an "as is" state which may not meet all the requirements as stated. Government and commercial programs that were successful in incorporating commercial products were able to trade-off requirements with the operational and acquisition communities in order to achieve a best value solution. For example, The AWACS program eliminated salt spray requirement to facilitate the use of commercial computers, while the NSSN submarine structure was modified to provide environmental isolation [USAF00]. Adapt the requirements to meet the commercial product is better than modifying the commercial product to the requirements to meet the requirements.. If a commercial product is modified to meet a requirement, the warranty

would be voided and a unique product may be created that requires uniquely developed (and often more costly) life cycle support.

2. Examine Requirements Gap

Ideally, the commercial product(s) functionality should closely match the intended use. However, because no commercial product(s) have been specifically designed to meet your organization's unique requirements, there will be a gap between the business processes supported by your existing systems and those supported by the commercial product(s). It is imperative that you understand this gap well before the implementation begins. If this gap is too great then more effort will be expended developing adequate interfaces than developing the product from scratch.

3. Involve Users

Because the implementation of a commercial product significantly impacts the functions of an organization, it is imperative to involve the user community in the planning process from the outset. Early end-user involvement is a common risk mitigation strategy to ensure that the requirements accurately reflect user needs. User familiarization allows for requirement prioritization and the early identification and resolution (trade-offs) to minimize user acceptance issues and avoid costly changes and delays during system development and deployment activities. It also allows the user community the time to become familiar with commercial technologies that are available for meeting their needs. Once a system is placed in-service, formal user participation is continued as the system evolves and undergoes changes and updates requiring commercial products. In addition to the technical issues, understanding the business issues will lower the risks associated with the commercial implementation. A stable operating environment coupled with the users willing to accept a new way of doing business will also minimize implementation obstacles.

Suggestions

The following suggestions can be helpful for the requirements specifications of commercial items:

To develop flexible and negotiable requirements:

- Requirements must be written with a quantifiable range of acceptable performance limits.
- Identified, prioritized, and negotiated all absolute requirements (must have) and plan to make repeated tradeoffs among the requirements and the capabilities in the marketplace.
- Document all tradeoffs made.

To bridge requirements gap:

- Determine the gap between the capabilities and services provided in the marketplace and those required by the system.
- Include the vendor in tradeoff discussions when possible.
- Provide incentives to encourage the contractor to investigate all solutions that lead to the appropriate outcome.
- Ask vendor to conduct demonstrations.
- Don't modify the commercial item. Encourage vendors to change product capabilities and performance to meet your requirements only if the change will be incorporated into the commercial product(s).

To Involve Users:

- Communicate and cooperate early with the user to ensure flexibility in the system requirements and to share knowledge of potential commercial product(s) that may be available to meet requirements.
- Provide early functional demonstrations, prototyping to provide user hands on familiarization with the capabilities of the candidate commercial product(s) and get user buy-in on contract requirements.

C. EVALUATION OF COMMERCIAL PRODUCT (S)

It is critically important to evaluate all aspects of a commercial item. In some cases, commercial item evaluations are performed as part of source selection. This is a highly constrained form of evaluation that must be conducted only in accordance with source selection criteria and the source selection plan. However, the definition of evaluation applied in this document is far broader. Evaluation is also necessary to assist in identifying commercial capabilities such as security and information assurance, inter-operability, reliability, and maintainability when choosing among alternate architectures and designs, in determining whether new releases continue to meet requirements, and in

ensuring that the commercial items function as expected when linked to other system components. These forms of commercial-item evaluation provide critical information about the tradeoffs among system context, architecture and design, and commercial capabilities. Unfortunately, evaluating commercial items in order to identify system tradeoffs is an unfamiliar process for many program managers (and their users). It is equally unfamiliar for many contractors who are more comfortable with simply meeting a specified set of requirements.

1. Market Research

Successful systems that incorporate commercial items recognize that, as customers, they must be informed and assertive to maximize the benefits of using commercial items [ALBE03] by attempting to gain leverage on the vendors through market research. Market research is a process of collecting information about existing and emerging technologies, products, manufacturers, suppliers and their trends. It consists of market surveillance and market investigation. Market surveillance is a continuous canvassing of the commercial market to identify existing and future technologies, vendors' products and market trends. It can include Internet searches, attending trade shows, reading technology publications, hiring consultants, visiting manufacturer/supplier facilities and product demonstrations. Market investigation is a more focused process of identifying and determining if specific commercial items can meet particular functional requirements. It involves not only identifying potential alternatives for investigation, but also identifying any deficiencies in the commercial item that would require modification, and then determining the extent of that modification. Extensive modification of commercial items within a program would take the product out of the category of a commercial item, thus increasing the program's risk.

Market Investigations also includes proactively planning for the continued support or replacement of soon-to-be obsolete products, identifying the product(s) end of life (EOL) and end of service (EOS) dates. One program selected commercial items with the expectation that the vendor would provide the necessary maintenance capabilities. However, the vendor's commercial support strategy did not provide the spares, training, or repair cycles necessary for military use. The program was left with a choice: redesign the system or buy the additional capability. [USAF00]

2. License and Data Rights

Licensing is the primary vehicle for securing the use of commercial items such as software; data rights are marketplace vehicles for protecting a vendor's intellectual property. Understand completely, the details associated with the product contract, including the licensing agreement. Vendors offer different licensing agreements and you need to select the agreement appropriate to your program and circumstances. For example, if everyone in the organization will need to access the product, ensure the license is for the entire enterprise. Be sure to find out: who owns the license to the source code; what rights are provided relative to source code modification; and what arrangements will exist at contract expiration. One program expressed frustration that the de facto selection of a commercial item had already been made prior to release of the solicitation because of the beneficial pricing arrangements from previously negotiated enterprise licenses. While the larger organization saved money in negotiating one set of licenses covering use by many programs, this practice limited the individual program's flexibility in choosing the most appropriate commercial item for the system. Another program neglected to negotiate for all necessary licenses as part of the initial procurement. After the commercial item was selected and system development began, the vendor's price for additional licenses increased dramatically [USAF00].

Some commercial products are so critical to the system that the program must be protected from a vendor's potential unwillingness or inability to support older releases of the product. Some programs found that an agreement to put technical data in an escrow account (rather than purchasing technical data directly) was a cost-effective compromise. However, one program never checked that the escrow account was set up and maintained by the vendor. When the vendor went out of business, the program was forced to gather what technical data it could from personnel who had previously worked for the vendor [DODA00]. On the other hand, successful programs negotiated terms of the escrow to include the essential data and contingencies, audited the escrow account regularly to make sure the data was current and complete, and budgeted for the cost of the escrow throughout the life of the system.

3. Vendor Relationship

It is incumbent on the program manager to determine how important the program is to a specific vendor as part of the commercial-product evaluation. The relationship between the program manager and the vendor is, in most instances, very different from the relationship with a contractor. While contract incentives shape the relationship with a contractor, the vendor is selling a product. Program managers should obtain commercial product(s) from vendors who view the software as one of their products. If a vendor does not consider an item to be part of its business, and/or developing software products is not the main business of the vendor, then its development, release management, and documentation practices may not be adequate.

Program managers need to develop a trusting, but contractual and mutually beneficial relationship with the vendor. Finding vendors with the best quotes and support services are time consuming and not an easy process. Assess the vendor's past experience employing commercial products. When both government and the vendor were experienced in applying commercial products, the success rate was high and cost savings were dramatic. When both were inexperienced the success rate was very low and costly, many times resulting in substantial overruns and even program failure [FAAC02].

Consider the characteristics of the vendor as part of the process. Examples of characteristics to look for include company size, their level of establishment, how long they have been selling the product, its level of support (does it continue to support customers using significantly older versions of their product as well as the customers using the latest version), and is the company willing to work with the organization rather than for it (will they maintain their autonomy and listen to the organization's requests for enhancements rather than automatically accepting that such changes must be made?).

Figure out the leverage you have and how you can influence the vendor to be responsive to unique program needs and incorporate new features into the commercial item. Some program managers have expressed frustration that vendors do not react to program needs and direction. Other program managers have tried to use the same techniques with vendors that had been successful when applied to contractors and subcontractors—usually with disappointing results [DODA00]. The degree of leverage

you can apply to your vendors varies depending on the size of your program and the presence your organization has in the industry. The larger your organization the more pressure you can exert in getting vendors to meet your projects requirements.

One approach to this is to join the vendor users' group and the appropriate professional and standards bodies. Joining the users' group is valuable as it provides the organization some insight into the use of the product in other parts of the marketplace. Future directions of the product may be discussed in these meetings, providing the organization with the opportunity to express their needs in the domain the product addresses. Joining the relevant professional and standards bodies is important so that the program can remain current with the direction being taken that affects their system. Further, by being active in the professional and standards bodies, the organization is able to influence (although not control) the future course of the business approach so that the business practices embodied by the philosophy are more likely to remain consistent with the organization's needs.

4. Testing, Evaluation, and Validating Reliability

Given the lack of technical information about commercial product(s) (i.e., “black box” – undisclosed designs) and the variety of product types that change rapidly, testing potential commercial product(s) is a necessary step in product evaluation to ensure that operational suitability; reliability, availability and maintainability requirements are met, since manufacturer claims about the capabilities tend to be optimistic. More effective up-front planning of independent test and evaluation is needed to ensure that enough data is obtained to fully evaluate the capabilities. Exercise a healthy skepticism of commercial product claims by testing candidate products using an application testbed to verify features and to support your selection decision.

Full system-level testing must be performed in a test facility that provides or emulates the external interfaces and actual operating environment in order to verify operational suitability, effectiveness and performance and should never be waived. This raises the probability that the commercial product(s) perform as they did in the development environment and that they do not introduce any unknown performance characteristics into the interfacing systems. As engineering changes are introduced into

the continuously evolving system, a dedicated testing environment must be maintained to replicate the integration steps and determine if the new product or integrated change has affected the performances of the system.

Confirm, with other users, the product's capabilities, especially performance, reliability, and scalability by ensuring that the product's capabilities support the needs of your organization. For instance, confirm that the product has previously supported the number of users and geographic locations your organization will require.

Reliability requirements must be established early in order to insure adequate testing and verification of the reliability of commercial items. Since a commercial item has already been designed and developed, and its reliability already established by the vendor, the reliability verification should be an assessment of the product within the military wartime environment in which it will be used. Testing the commercial item in your operating environment to verify that the item's reliability is meeting the user's requirements. Lower reliability greatly impacts the support costs, system availability, and thus the mission accomplishment.

Suggestions

The following suggestions can be helpful for evaluating commercial items:

- Employ outside experts to support program-office evaluation activities.
- Train the program office and the stakeholders/users on how to evaluate commercial items.
- If possible, obtain hands-on experience with the system. Consider prototyping or piloting the commercial item in your environment. Ask vendor for a demonstration.
- At a minimum, visit another organization that is operating the same software.
- Decide in advance what information you want to gain from the evaluation of a commercial item.
- Unless it is impractical, evaluate potential commercial items in a system test bed. Do not consider buying any commercial product you haven't demonstrated in house.

To understand the marketplace:

- Conduct market research independent of the contractor to capture current information and base market research decisions on fairness, competition, and ethics.
- Participate in the relevant conferences, trade shows, and user, professional, and standards groups.
- Allocate resources for marketplace activities.
- Proactively anticipate obsolescence situations due to rapid and asynchronous product changes.
- Assess the total system operation and support effectiveness, not just system performance by determining the projected manufacturer support period and inventories for a particular product.
- Select a reputable and reliable vendor that plans to be available to support the product.

To help with Licenses and Data Rights:

- Thoroughly understand commercial products licensing terms and conditions to ensure warranties are enforceable.
- Contracting officers should consider including contract options(s) for parts and technical buyouts to support future logistics requirements.
- Licenses that transfer to the government/maintainers.
- Volume discounts.
- Put technical data into escrow accounts. Regularly audited the accounts to make sure the data I complete and current and complete.

To strengthen vendor relationships:

- Verify the claims made for commercial items by vendors and contractors.
- Verify the availability of commercial items.
- Examine any acquisition strategy to see where it can be made more flexible or better suited to the unique commercial aspects of the system in question.
- Use contract incentives to encourage appropriate relationships .
- Maintain close relationships with vendors to exploit improvements and avoid surprises.

To test commercial items and validate reliability:

- Do not rely on vendor claims, verify with operational demonstrations as early as possible by evaluating the potential commercial products in a system test bed to ensure product(s) are compliance with performance requirements.
- Focus test beds on high-risk items.
- Test for unanticipated side effects in areas such as security, safety, reliability and performance from commercial-item upgrades. Ensuring all system configurations (more are possible with commercial product use) can be recreated; and determine if new manufacturer changes to a commercial product configuration cause any unforeseen impacts (i.e., "unknown-unknowns" to system performance).
- Ensure that performance pass or fail criteria are clearly specified in the contract.
- Contracting offices should require contractors to fully disclose item reliability data.
- Test Organizations should validate the reported reliability of commercial item components and test them thoroughly in new operational environments.
- Select a mature product. Implementing a commercial item with a successful track record is less risky than one that involves new, unproven capabilities.

D. TECHNOLOGY

The technology as well as your ability to deal with it may both be immature and change rapidly. Planning ahead for technology insertion should be an integral part of your program. One has to predict the change cycle for each imbedded commercial product and plan for regular refreshment of the system throughout the design, development, production and sustainment phases of the program.

1. Integration

Integrating commercial product(s) into a functional system presents new challenges and projects cannot be treated as normal low-risk commercial item acquisitions. Different vendors write different components with different needs in mind that may need to be adapted to work properly. Integration efforts may not only require

research and development, but also may need both a demonstration and a full-scale development phase before production

Although the expertise is growing, relatively few programs or contractors have extensive experience integrating commercial items into DOD systems. Knowledge of both the system context and each selected commercial item is necessary. One program assumed that heterogeneous commercial items could be integrated with relatively minimal effort. The program neglected the hard engineering work needed to develop realistic integration and test schedules, to specify acceptance criteria for the system, or to plan for long-term system evolution [DODA00]. These oversights resulted in unhappy users, finger-pointing between the vendors and the program office, and cost and schedule overruns. Several other programs found that unique technical expertise was required to integrate commercial items because the internal architectural and usage assumptions of the items were unknown.

Three integration techniques for commercial items are:

- To wrap the items in a software container.
- Use glueware to mediate item interactions.
- Using bridges or adaptors to smooth over incompatibilities in the item interfaces.

All of these are "black-box" techniques that can be applied without access to the commercial product(s) source code. Wrappers are software containers used to mediate access to the commercial items. They can be used to force compliance to programming standards, provide a standard interface to the commercial product(s), restrict the available functionality of the commercial item, or can be upgraded or swapped out with a different vendors commercial item [MAUR00]. Glueware is used as middleware to bind components together. It can be used for control flow, to invoke the item's functionality and do exception handling. This can also include code to resolve incompatibilities among commercial items [MAUR00]. By acting as an adaptor or bridge, the glueware can allow the interaction of two items [MAUR00].

2. Obsolescence and Upgrades

Many organizations or program office assume they can avoid the problems associated with upgrade by simply continuing to deploy an older release of a commercial item. While this may be true for some hardware items, it is rarely the case for software items, where new and desirable capabilities and performance are frequently added, bugs are fixed, and vendors drop maintenance for older releases. A release or two can sometimes be safely skipped, but most software commercial items (and many hardware commercial items) must eventually be upgraded. Except in very specific cases, DOD is normally ill prepared to implement the necessary changes to old versions of commercial items in order to avoid technical obsolescence and keep them functioning, even when good technical data is available. Several programs were successful by deliberately pre-planning for frequent upgrades of commercial items, technology insertion, and retirement of obsolete items [DODA00]. Of course, even the most careful planning cannot anticipate all exigencies, such as a vendor going out of business or being taken over by a larger firm with different priorities

3. New and Strong Configuration Management Techniques

The rapid evolution and proprietary nature of commercial products/systems require a robust and diligent configuration management (CM) program. Frequent changes to commercial items have caused many programs to maintain multiple configuration baselines both during development and in the field. This places unusual demands on traditional configuration-management processes that strive to maintain a single configuration baseline. Several programs that depended on multiple commercial items found that some items required specific versions of other items in order to interface effectively. Upgrading one commercial item caused a chain reaction that demanded changes to other commercial items within the system [DODA00].

Unlike custom developed systems, the government has no control over the speed and content of product configuration changes since the commercial product manufacturers control them. Vendors release items according to their own schedules, and many programs found that individual sites were not always willing to upgrade to the latest version. This requires programs to possess a configuration-management system

that lets then select from among multiple versions of commercial items in order to construct different system configurations.

Commercial products are proprietary to the manufacturer and get documented at a higher level (source control drawings, specification sheets, inputs/outputs, etc.) resulting in limited information on manufacturing processes, internal design, components, etc. Included with this higher level of documentation are different numbering conventions by the manufacturers. These differences shift CM focus from controlling configurations (as with custom development programs) to managing commercial product and system configurations (at the manufacturer-controlled product level).

Suggestions

The following suggestions can help minimize the impact of commercial technology:

To integrate product(s)

- Establishing an ongoing market research effort that includes market surveillance (technologies, trends, available manufacturers and products, etc.) and market investigation (product testing and obsolescence projections).
- Developing/delivering integrated technology evolution planning data, conducting working group meetings and providing status at program reviews.
- Base interfaces on publicly recognized industrial standards that are widely supported in the marketplace.
- No vested interest in any one particular manufacturer or commercial product set.

To manage change:

- Ensure that rigorous configuration management is exercised.
- Monitor the marketplace for technology advancements.
- Establish plans to work with vendors for problem resolution.
- Periodically check with vendors for planned software upgrades/updates to commercial products.
- Developing/delivering periodic (every four months) system product obsolescence projections, impacts and solutions.

- Establishing a test facility capable of continuously testing commercial products for compatibility, compliance and conformance.

E. AVOIDING MODIFICATION

Modification of commercial products can involve the addition or deletion of code, changes to the hardware design, or changes to any of the product support (documentation, spares, etc.). Commercial products must be used "unmodified" to retain the value of a commercial product; otherwise, voided warranties, lack of support, and upgrade difficulties will result. If this strategy is ignored the program runs the risk of incurring additional support costs and supportability issues that may be less cost effective the custom design. The savings in development costs and schedules would be offset by the modifications of the commercial products resulting in a unique version of the product that the manufacturer will not support under warranty and must be supported separately from other versions, often with increased support costs. One private corporation fell into the trap of modifying most of its commercial items in order to give them a unique corporate flavor. As a result of the practice, many of the corporate programs modifying commercial items experienced recurring technical problems and cost overruns [DODA00].

Suggestions

The following suggestions can help organizations avoid modifications to commercial product(s):

- Persuading the manufacturer to incorporate the acquiring activities unique requirements as part of the commercial product's functionality;
- Verify that the contractor proposes to use the commercial product without modification
- Requiring that notification of proposed COTS modifications be made only with trade-off considered and Government consent;

G. TOTAL OWNER COST (TOC)

Both commercial and DOD programs frequently underestimate the unique sustainment costs associated with commercial items. These costs include market

research, evaluation, test and integration for version upgrade, commercial-item replacement, technology refresh, and annual licensing fees. Programs must deal with change and expense elements throughout a product lifecycle that may not be evident in a custom product. Successful programs have generated strategies for assessing items such as product deviations caused by commercial product evolution cycles, extended military product support and licensing against the expected benefits of more affordable sparing, shorter development times and increased performance [USAF00].

Suggestions

The following suggestions can help organizations identify Total Ownership Cost (TOC):

- Identify and budget sufficient funds and staff for monitoring current and emerging commercial product(s) and technology – market research, integration lab, testing facility, license renewal and data rights, and reacting to new product releases -version upgrades in annual budgets
- Incentive the prime contractor to provide a credible estimate of support costs
- Use multi-year, unrestricted contracting could potentially reduce costs even more.

H. SUMMARY

Unfortunately, there are no silver bullets to resolve the risks/challenges associated with commercial items. Early identification of the risks associated with commercial items and the techniques and suggestions discussed in this chapter provide an effective approach that can be incorporated into an overall risk management program for systems employing commercial items. Such a risk mitigation approach allows the acquiring activity to benefit from commonly experienced government and industry lessons-learned. Personnel will become better educated, trained, and effectively employ commercial items by actively soliciting and rigorously incorporate into their plans those lessons learned from organizations similar to theirs and by exploring products before selecting them, talking to some of the product's other customers and understanding the product's customer base. Allowing them to effectively and efficiently employ commercial items within their programs.

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VII. CONCLUSION

The inclusion of commercial items in the acquisition process is recognized as an opportunity to save both time and money. But it is not the Holy Grail. Anyone who believes that selection of a commercial product and inserting it into a program will be the quick fix believes in fairy tales, and does not really understand the process. Commercial products can do all that everyone expects them to do, and may be an excellent solution in many cases, but their use should be the result of careful analysis and research. There is a tendency to assume that a commercial product can be used as-is, without any serious thought given to the difficulty and risk involved in the commercial product. It has been assumed that the use of a commercial product alleviates all risk of integration, when, in fact, just the opposite may occur: commercial products may be even more difficult to integrate.

Every aspect of acquisition planning, system engineering processes, test planning, etc. must be explicitly crafted to account for every challenge the commercial product presents. The mentality ought to be how we can do it as opposed to why we cannot. Everything about the commercial product must be known and understood by those who establish the requirements. Not every new requirement can realistically be addressed with a commercial product. The commercial products must be chosen carefully with the marketplace clearly understood in order to have a flexible range of "requirements" sufficient to allow commercial products to qualify.

The risks associated with traditional system development do not disappear simply because the system makes use of commercial products. Risks associated with commercial products are likely to change more rapidly, and new risks may arise more often than with customary system risks. In order for systems to be successful and achieve the benefits of using commercial items, they need to minimize the uncertainties and manage the unique risks associated with the commercial product(s). Identification, the first step in the process, involves transforming the uncertainties and issues about the project into distinct (tangible) risks that can be described and measured. With any risk, awareness of lessons learned by other organization that have implemented systems using

commercial products will help build or strengthen strategies to address any unexpected future challenges.

This thesis describes a framework, checklist (questionnaire) and provides some strategies and suggestions to help organizations manage and mitigate the risks associated with commercial products. The checklist serves as a starting point and enhances the project manager's or decision-maker's risk management abilities by providing a systematic and repeatable method, early in the process, for the identification of risks associated with the use of commercial products. It uses a set of known risks that are classified into three categories: process, technology, and implementation and support. Many organizations which attempt to implement a commercial product(s) without sufficient analysis and preparation encounter significant challenges that can be related to the business processes used to build the systems, technologies used to construct the systems, and logistical support and implementation issues that inevitably arise. Each category is then further divided into specific elements or attributes to generate the projects risk profile. This profile determines what level of impact (high, medium, or low) these factors have on the programs that incorporate the commercial product. Managers can then prioritize these risks and apply resources to properly mitigate and resolve the identified risks.

To test the checklist, it was implemented on active DOD programs that incorporate commercial products into their systems and proved to be an effective and efficient tool. Project managers or decision-maker's were provided with sufficient information to identify and prioritize risks early in the process. They could then use their creativity along with some of the suggestions to make wise decisions and positively impact the success of their programs. [FALV02, FLAN02, HAKE03, PORT03, TRIE02, WILL03]

While considerable work still remains to be done in developing additional identification methods, analysis, planning, tracking, and controlling risks associated with commercial products. The project manager or any decision maker, should, as a minimum, fill out and discuss the checklist, with the checklist becoming a natural part of the project activities. This will force program managers to focus their efforts on the

highest impact areas and eliminate fires before they happen, thus, minimizing their organization's risk severity rating while curbing future expenditures. Although the scope of the thesis ends at this point, it is recommended that the program or project manager's develop a risk plan for each prioritized risks. These identified risks would then be monitored and tracked continuously throughout the life cycle of each project. Only by understanding and addressing these unique factors imposed by commercial products will the program managers be able to attain their benefits. Enhancing their ability to manage the risks associated with commercial products and making them more successful in all the software development projects they lead. Moving towards market-oriented business practices that are better suited to the acquisition and life cycle support of commercial (COTS)-based systems.

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APPENDIX A FAR DEFINITION OF COMMERCIAL ITEM

(a) Any item, other than real property, that is of a type customarily used for nongovernmental purposes and that —

(1) Has been sold, leased, or licensed to the general public; or,

(2) Has been offered for sale, lease, or license to the general public;

(b) Any item that evolved from an item described in paragraph (a) of this definition through advances in technology or performance and that is not yet available in the commercial marketplace, but will be available in the commercial marketplace in time to satisfy the delivery requirements under a Government solicitation;

(c) Any item that would satisfy a criterion expressed in paragraphs (a) or (b) of this definition, but for

(1) Modifications of a type customarily available in the commercial marketplace; or

(2) Minor modifications of a type not customarily available in the commercial marketplace made to meet Federal Government requirements. Minor modifications means modifications that do not significantly alter the nongovernmental function or essential physical characteristics of an item or component, or change the purpose of a process. Factors to be considered in determining whether a modification is minor include the value and size of the modification and the comparative value and size of the final product. Dollar values and percentages may be used as guideposts, but are not conclusive evidence that a modification is minor;

(d) Any combination of items meeting the requirements of paragraphs (a), (b), (c), or (e) of this definition that are of a type customarily combined and sold in combination to the general public;

(e) Installation services, maintenance services, repair services, training services, and other services if such services are procured for support of an item referred to in paragraphs (a), (b), (c), or (d) of this definition, and if the source of such services —

(1) Offers such services to the general public and the Federal Government contemporaneously and under similar terms and conditions; and

(2) Offers to use the same work force for providing the Federal Government with such services as the source uses for providing such services to the general public;

(f) Services of a type offered and sold competitively in substantial quantities in the commercial marketplace based on established catalog or market prices for specific tasks performed under standard commercial terms and conditions. This does not include services that are sold based on hourly rates without an established catalog or market price for a specific service performed;

(g) Any item, combination of items, or service referred to in paragraphs (a) through (f), notwithstanding the fact that the item, combination of items, or service is transferred between or among separate divisions, subsidiaries, or affiliates of a contractor; or

(h) A nondevelopmental item, if the procuring agency determines the item was developed exclusively at private expense and sold in substantial quantities, on a competitive basis, to multiple State and local governments.

APPENDIX B COMMERCIAL ITEM RISK QUESTIONNAIRE

The purpose of this questionnaire, which takes about 10 minutes to complete, is to identify and investigate the unique risks associated with implementing Commercial-Off-The-Shelf (COTS) software application package(s). Answering the questions will help you better understand the overall level of risk within your program. It is recommended that someone responsible for specifying, procuring and developing software systems should complete this questionnaire. After completion, please e-mail the questionnaire to rcummins@nps.navy.mil. We believe that you will find the questionnaire both interesting and provocative and look forward to receiving your reply. We appreciate your help in our research effort, therefore if you would like a copy of our completed study please indicate this on the last page of the questionnaire.

Thank you in advance for your time and co-operation.

The questionnaire is divided into two parts:

Section I. Demographic Information. Collecting background information about the survey respondents.

Sections II. Risk questionnaire, a modification to the Information Technology Resources Board's (ITRB) "Risk Profile", that is organized around three broad categories: process, technology, and implementation/logistics support. Each category, which represents critical aspects required for the successful implementation of a commercial application package(s), is defined below:

- **Process:** The key considerations for developing and executing a successful acquisition process with the system/program requirements driving the organization to consider a commercial solution and the "fit" of those requirements with available commercial application package(s). Key areas are organizational, planning, tracking, contractual parameters, and evaluation of vendor's experience and past performance.
- **Technology:** The technical "fit" of the commercial product(s) with the existing and planned technical architecture, which supports an organization. This includes the organization's inherent technical challenges, such as the number and complexity of interfaces.

- **Implementation/Logistics Support:** The process contains intermediate and final work product characteristics for the delivery of a commercial solution within an organization that includes - but is not limited to performance measures, vendors availability of support, testing and managing organizational change.

SECTION I

Service: _____

Agency or Organization: _____
Project/System Name: _____

Telephone: _____ Fax: _____

1. Which category best describes your main job function in your organization?

   a. Management
   b. System analysis or design
   c. Application or system programming

2. Have you participated in selecting COTS software components that where later adapted or integrated into your project/system? How many times? _____
_____

3. How long is your work experience with building system from COTS components? _____ Years

4. Please state any good practices, or lessons you have learnt from past experience when acquiring and developing systems using COTS software.

_____

_____

_____

_____

SECTION II

Questions are organized around the three broad areas of implementing a COTS solution as presented above. Each question prompts you, the respondent, to think about key factors for a successful COTS application package implementation. You should

carefully consider your answer in terms of how it pertains to projects within your own organization.

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively.

Process

1. How well are the requirements for your system/program documented?

   a. Thoroughly—comprehensive, current documentation exists
   b. Moderately well—comprehensive documentation exists, but has not been updated recently
   c. Poorly—minimal documentation exists

2. Because specific requirements are associated with each COTS application package(s), how would you describe the relationship between the specifications of the COTS product(s) and the requirements of your system/program?

   a. Ideal—great fit, fully meets requirements
   b. Satisfactory—acceptable fit, meets most requirements
   c. Unsatisfactory—marginal fit, must be modified to meet requirements

3. How many COTS product(s) can accommodate your system/program requirements?

   a. Many
   b. Some
   c. Few

4. How would you describe the process by which your organization will implement new requirements after the initial implementation of the COTS product(s)?

   a. Well-defined, proven process has been established to evaluate and implement new requirements (e.g., configuration control board)
   b. Process for evaluating and implementing new requirements has been discussed, but not solidified
   c. No process exists for evaluating and implementing new requirements

5. How would you describe your system/program's ability to adapt to the new requirements supported by the COTS product(s)?

   a. Very able—there is a general understanding that the new requirements would enhance organization's operation
   b. Somewhat able—there is a general understanding that the new requirements would not enhance or deter organization's operation

c. Not able—there is a general understanding that the new requirements would deter organization's operation

6. How was the COTS product evaluated and selected?

a. Well-defined, proven process has been established to evaluate and select COTS product
b. Process for evaluating and selecting COTS products have been discussed, but not solidified
c. Ad hoc, no process exists for evaluating and implementing new requirements

7. What is the vendor's experience with implementing the COTS product(s) in organizations of a size similar to yours?

a. Extensive experience, established company with quality workforce and facilities
b. Some experience
c. No experience, company is start-up and situation is highly dynamic

8. How has the vendor performed in the integration of the COTS application package(s) elsewhere?

a. Excellent past performance
b. Good past performance
c. Poor or unknown past performance

6. What is the vendor's experience with implementing the considered COTS product(s) in organizations of a management structure similar to yours?

a. Extensive experience, established company with quality workforce and facilities
b. Some experience
c. No experience, company is start-up and situation is highly dynamic

10. How would you describe the operational control of the organization affected by the COTS product(s) implementation?

a. Centralized
b. Combination of centralized and decentralized
c. Decentralized

11. How would you describe the sufficiency of *skilled staff in the system/program affected* by the COTS application package(s) implementation?

a. Sufficiently staffed and skilled
b. Minimally staffed and skilled
c. Insufficiently staffed and skilled

12. How much experience does the COTS implementation project team have with the COTS product(s)?

a. Extensive experience
b. Some experience
c. No experience

13. How much experience does the project team have with implementation of other COTS products?

a. Experienced with many COTS products
b. Experienced with a few COTS products
c. Experienced with no other COTS products

14. What is the vendor's track record with implementing the COTS product(s) within their cost proposal?

a. Below total life cycle cost estimate
b. Met total life cycle cost estimate
c. Exceeded total life cycle cost estimate

15. How financially stable is the vendor?

a. Solid financial situation
b. Mixed financial picture, may have strong revenue but no profit margin
c. Financial problems, such as poor credit, low revenues and low profit margin

16. To what extent does your acquisition approach include an understanding of the vendor's future plans for the COTS product(s)?

a. Statement of direction for the product, including planned enhancements and release dates, has been received
b. Discussions have been conducted with vendor regarding future direction, but no plans have been received in writing
c. No discussion with vendor regarding future direction

17. Have data rights been properly negotiated with the vendors?

a. All data rights negotiated into the contract
b. Many data rights have been negotiated into the contract
c. No data rights have been negotiated into the contract

18. Have cost-effective licensing agreements been worked out with the vendors?

a. All licensing agreements negotiated into cost
b. Many licensing agreements negotiated into cost
c. Uncertain what licensing agreements are needed

Responses in Process Section:

a____x 1 = ___

b____x 2 = ___

c____x 3 = ___

Total = ___

Technology

1. Is the COTS application package(s) a totally new system for the organization?

a. System is a replacement
b. Components of the system are new
c. New system

2. To adequately address your organization's needs, what is the level of customization required for the COTS product(s) baseline?

a. No customization necessary
b. Some customization necessary
c. Much customization necessary

3. How do the COTS application package(s) "fit" with the organization's existing and planned architecture?

   a. Good fit
   b. May fit
   c. Not a fit

4. Is the COTS product(s) view as a time-tested, mature product?

   a. Very mature
   b. Somewhat mature
   c. New or immature

5. How many functions (e.g., accounting, procurement) are supported by the COTS application package(s)?

   a. Single function
   b. Few functions
   c. Many functions

6. How would you describe the complexity of the interfaces between the COTS product(s) and other systems?

   a. Simple, easy to understand
   b. Somewhat complex
   c. Very complex, difficult

7. How many systems interfaces must remain unchanged after the implementation of the COTS product(s)?

   a. Few
   b. Some
   c. Many

8. How would you describe the sufficiency of documentation supporting the system(s) with which the COTS application package(s) will interface?

   a. Extremely high quality, thorough documentation
   b. Adequate, some documentation
   c. Poor documentation or does not exist

9. To what extent has your organization tested COTS application package(s) in your environment?

a. Conducted extensive testing
b. Conducted some testing
c. Have not conducted any testing

10. Do the security features included in the COTS product(s) need modification to meet your organization's requirements?

a. Meets security requirements, no modification needed
b. Meets most security requirements, some modification needed
c. Will not handle security requirements, extensive modification needed

11. How flexible is the design of the COTS product(s) to allow for future changes in functionality?

a. Very flexible—product functions can be easily separated to be modified
b. Moderately flexible—product functions can be separated to be modified
c. Not flexible—product functions can not be separated to be modified

12. What is the reliability history of the COTS product?

a. Product is stable and has proven itself over time with its customer base
b. Product has occasional errors but none will result in data loss or other critical problem
c. Product has errors that result in data loss, work lost, system crashes, etc.

Responses in Technology Section:

a____x 1 = ___

b____x 2 = ___

c____x 3 = ___

Total = ____

Implementation/Logistics Support

1. Has your organization examined and applied the lessons learned from other organizations that implemented the COTS application package(s)?

    a. Yes—relevant lessons learned have been incorporated into the implementation plan
    b. Somewhat—past projects have been discussed by the project team
    c. No—have not gathered any information regarding other implementations

2. How will your organization measure the impact and effectiveness of the COTS product(s)?

    a. Comprehensive performance measures (including cost, time spent on each activity, etc.) have been established
    b. Performance measures have been discussed but not finalized
    c. No discussion of performance measures

3. What sort of testing approach is planned for the COTS product(s)?

    a. Designed specifically for a COTS implementation
    b. Combines traditional systems development testing with COTS-specific testing
    c. Designed for traditional systems development activities

4. How would you describe your organization's ability to support new releases of the COTS product(s)?

    a. Sufficient—staffing plan for ongoing support of the COTS application package(s) has been developed
    b. Moderate—staffing needs have been identified, but plan has not been finalized
    c. Minimal—no staff resources are available after the initial implementation

5. How has the organization prepared for the possibility that the COTS application package(s) vendor goes out of business or discontinues support for the product?

    a. Contingency plan finalized and ready to implement
    b. Possibility discussed, but have no finalized plan
    c. Possibility not discussed, no contingency plan being developed

6. How would you describe the run time performance of the COTS product(s) in your environment?

a. Very efficient
b. Moderately efficient
c. Not efficient

7. Does the run time performance of the COTS application package(s) meet the organization's performance needs?

a. Efficiently supports the number and location of users
b. Supports needs with performance degradation
c. Does not support needs

8. How do other users of the COTS product describe their satisfaction with availability of the vendor staff?

a. Very satisfied, easy to access key personnel at vendor
b. Somewhat satisfied, can access key personnel some of the time
c. Unsatisfied, access to key personnel is difficult

9. What training is needed to operate and maintain the COTS product?

a. No training
b. Some training
c. Extensive training

7. What training sources are available to the customers?

a. Extensive training resources
b. Some training resources
c. No training resources

11. How much experience does other support contractors serving your organization in functions affected by the COTS implementation have with the COTS application package(s)?

a. Extensive experience
b. Some experience
c. No experience

Responses in Implementation/Logistical Support Section:

a____x 1 = ___
b____x 2 = ___
c____x 3 = ___

Total = ____

APPENDIX C DLA BUSINESS SYSTEMS MODERNIZATION QUESTIONNAIRE RESPONSES

SECTION I

Service: ___Defense Logistics Agency_____

Agency or Organization: ___Defense Logistics Agency_____
Project/System Name: _Business Systems Modernization_____

Which category best describes your main job function in your organization?

a. Management
a. System analysis or design
b. Application or system programming

Have you participated in selecting COTS software components that where later adapted or integrated into your project/system? How many times? **First ERP – Other minor COTS projects in past – never of this magnitude (enterprise-wide).**

How long is your work experience with building system from COTS components? **10** Years

Please state any good practices, or lessons you have learnt from past experience when acquiring and developing systems using COTS software.

- Do not modify core COTS software
- Basic integration practices for COTS are the same as software development (i.e., basics of configuration management, software QA, repeatable processes, etc.
- Willingness to adapt
- Completeness of requirements

SECTION II

Questions are organized around the three broad areas of implementing a COTS solution as presented above. Each question prompts you, the respondent, to think about key factors for a successful COTS application package implementation. You should carefully consider your answer in terms of how it pertains to projects within your own organization.

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively. Please record your answers to the questionnaire directly on this form. We ask that you make the best effort possible to provide an answer to all the questions. If you are unsure of an answer, or feel a question does not apply to your project, please indicate so rather than leaving a question blank.

Process

1. How well are the requirements for your system/program documented?

   a. Thoroughly—comprehensive, current documentation exists

   b. **Moderately well—comprehensive documentation exists, but has not been updated recently**

   c. Poorly—minimal documentation exists

2. Because specific requirements are associated with each COTS application package(s), how would you describe the relationship between the specifications of the COTS product(s) and the requirements of your system/program?

   a. Ideal—great fit, fully meets requirements

   b. **Satisfactory—acceptable fit, meets most requirements**

   c. Unsatisfactory—marginal fit, must be modified to meet requirements

3. How many COTS product(s) can accommodate your system/program requirements?

   a. Many

   b. Some

   c. Few

4. How would you describe the process by which your organization will implement new requirements after the initial implementation of the COTS product(s)?

a. **Well-defined, proven process has been established to evaluate and implement new requirements (e.g., configuration control board)**

b. Process for evaluating and implementing new requirements has been discussed, but not solidified

c. No process exists for evaluating and implementing new requirements

5. How would you describe your system/program's ability to adapt to the new requirements supported by the COTS product(s)?

a. **Very able—there is a general understanding that the new requirements would enhance organization's operation**

b. Somewhat able—there is a general understanding that the new requirements would not enhance or deter organization's operation

c. Not able—there is a general understanding that the new requirements would deter organization's operation

6. How was the COTS product evaluated and selected?

a. **Well-defined, proven process has been established to evaluate and select cots product**

b. Process for evaluating and selecting COTS products have been discussed, but not solidified

c. Ad hoc, no process exists for evaluating and implementing new requirements

7. What is the vendor's experience with implementing the COTS product(s) in organizations of a size similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b. Some experience

c. No experience, company is start-up and situation is highly dynamic

8. How has the vendor performed in the integration of the COTS application package(s) elsewhere?

a. **Excellent past performance**

b. Good past performance

c. Poor or unknown past performance

9. What is the vendor's experience with implementing the considered COTS product(s) in organizations of a management structure similar to yours?

a. Extensive experience, established company with quality workforce and facilities

b. Some experience – first major DOD implementation

c. No experience, company is start-up and situation is highly dynamic

10. How would you describe the operational control of the organization affected by the COTS product(s) implementation?

a. **Centralized**

b. Combination of centralized and decentralized

c. Decentralized

11. How would you describe the sufficiency of *skilled staff in the system/program affected* by the COTS application package(s) implementation?

a. **Sufficiently staffed and skilled**

b. Minimally staffed and skilled

c. Insufficiently staffed and skilled

12. How much experience does the COTS implementation project team have with the COTS product(s)?

a. Extensive experience
b. **Some experience**
c. No experience

13. How much experience does the project team have with implementation of other COTS products?

Experienced with many COTS products
Experienced with a few COTS products
Experienced with no other COTS products

14. What is the vendor's track record with implementing the COTS product(s) within their cost proposal?

a. Below total life cycle cost estimate
b. Met total life cycle cost estimate
c. Exceeded total life cycle cost estimate

15. How financially stable is the vendor?

a. **Solid financial situation**
b. Mixed financial picture, may have strong revenue but no profit margin
c. Financial problems, such as poor credit, low revenues and low profit margin

16. To what extent does your acquisition approach include an understanding of the vendor's future plans for the COTS product(s)?

a. **Statement of direction for the product, including planned enhancements and release dates, has been received**

b. Discussions have been conducted with vendor regarding future direction, but no plans have been received in writing

c. No discussion with vendor regarding future direction

17. Have data rights been properly negotiated with the vendors?

a. **All data rights negotiated into the contract**

b. Many data rights have been negotiated into the contract

c. No data rights have been negotiated into the contract

18. Have cost-effective licensing agreements been worked out with the vendors?

a. **All licensing agreements negotiated into cost**

b. Many licensing agreements negotiated into cost

c. Uncertain what licensing agreements are needed

Responses in Process Section:

a 12 x 1 = 12
b 6 x 2 = 12
c 0 x 3 = 0

Total = 24

Technology

1. Is the COTS application package(s) a totally new system for the organization?

a. System is a replacement

b. Components of the system are new

c. **New system**

2. To adequately address your organization's needs, what is the level of customization required for the COTS product(s) baseline?

a. **No customization necessary**
b. Some customization necessary
c. Much customization necessary

3. How do the COTS application package(s) "fit" with the organization's existing and planned architecture?

a. **Good fit**
b. May fit
c. Not a fit

4. Is the COTS product(s) view as a time-tested, mature product?

a. **Very mature**
b. Somewhat mature
c. New or immature

5. How many functions (e.g., accounting, procurement) are supported by the COTS application package(s)?

a. Single function
b. Few functions
c. **Many functions**

6. How would you describe the complexity of the interfaces between the COTS product(s) and other systems?

a. Simple, easy to understand
b. Somewhat complex
c. **Very complex, difficult**

7. How many systems interfaces must remain unchanged after the implementation of the COTS product(s)?

a. Few
b. Some
c. **Many**

8. How would you describe the sufficiency of documentation supporting the system(s) with which the COTS application package(s) will interface?

a. Extremely high quality, thorough documentation
b. **Adequate, some documentation**
c. Poor documentation or does not exist

9. To what extent has your organization tested COTS application package(s) in your environment?

a. **Conducted extensive testing**
b. Conducted some testing
c. Have not conducted any testing

10. Do the security features included in the COTS product(s) need modification to meet your organization's requirements?

a. Meets security requirements, no modification needed
b. **Meets most security requirements, some modification needed**
c. Will not handle security requirements, extensive modification needed

11. How flexible is the design of the COTS product(s) to allow for future changes in functionality?

a. Very flexible—product functions can be easily separated to be modified

b. **Moderately flexible—product functions can be separated to be modified**

c. Not flexible—product functions can not be separated to be modified

12. What is the reliability history of the COTS product?

a. **Product is stable and has proven itself over time with its customer base**

b. Product has occasional errors but none will result in data loss or other critical problem

c. Product has errors that result in data loss, work lost, system crashes, etc.

Responses in Technology Section:
# a 5 x 1 = 5
# b 3 x 2 = 6
# c 4 x 3 = 12
Total = 23

Implementation/Logistics Support

1. Has your organization examined and applied the lessons learned from other organizations that implemented the COTS application package(s)?

a. Yes—relevant lessons learned have been incorporated into the implementation plan

b. **Somewhat—past projects have been discussed by the project team**

c. No—have not gathered any information regarding other implementations

2. How will your organization measure the impact and effectiveness of the COTS product(s)?

a. **Comprehensive performance measures (including cost, time spent on each activity, etc.) have been established**

b. Performance measures have been discussed but not finalized

c. No discussion of performance measures

3. What sort of testing approach is planned for the COTS product(s)?

a. **Designed specifically for a COTS implementation**

b. Combines traditional systems development testing with COTS-specific testing

c. Designed for traditional systems development activities

4. How would you describe your organization's ability to support new releases of the COTS product(s)?

a. Sufficient—staffing plan for ongoing support of the COTS application package(s) has been developed

b. **Moderate—staffing needs have been identified, but plan has not been finalized**

c. Minimal—no staff resources are available after the initial implementation

5. How has the organization prepared for the possibility that the COTS application package(s) vendor goes out of business or discontinues support for the product?

a. Contingency plan finalized and ready to implement

b. **Possibility discussed, but have no finalized plan**

c. Possibility not discussed, no contingency plan being developed

6. How would you describe the run time performance of the COTS product(s) in your environment?

a. **Very efficient**
b. Moderately efficient
c. Not efficient

7. Does the run time performance of the COTS application package(s) meet the organization's performance needs?

a. **Efficiently supports the number and location of users**
b. Supports needs with performance degradation
c. Does not support needs

8. How do other users of the COTS product describe their satisfaction with availability of the vendor staff?

a. Very satisfied, easy to access key personnel at vendor
b. **Somewhat satisfied, can access key personnel some of the time**
c. Unsatisfied, access to key personnel is difficult

9. What training is needed to operate and maintain the COTS product?

a. No training
b. Some training
c. **Extensive training**

10. What training sources are available to the customers?

a. **Extensive training resources**
b. Some training resources
c. No training resources

11. How much experience does other support contractors serving your organization in functions affected by the COTS implementation have with the COTS application package(s)?

a. Extensive experience

b. **Some experience**

c. No experience

Responses in Implementation/Logistical Support Section:

a 5 x 1 = 5
b 5 x 2 = 10
c 1 x 3 = 3

Total = 18

APPENDIX D ARMY HUMAN RESOURCE SYSTEM QUESTIONNAIRE RESPONSES

SECTION I

Service: __U.S. Army

Agency or Organization: ___PEO EIS, AHRS
Project/System Name: _Army Human Resource System

Which category best describes your main job function in your organization?

a. Management
a. System analysis or design
b. Application or system programming

Have you participated in selecting COTS software components that where later adapted or integrated into your project/system? How many times? **Yes, at least 20.**

How long is your work experience with building system from COTS components? **30** Years

Please state any good practices, or lessons you have learnt from past experience when acquiring and developing systems using COTS software.

- Do not use software that does not have a long-standing commercial user base
- Never be forced to use products with questionable long-term life-cycle support
- Do not allow GOTS products to be forced on your program, these are generally built with COTS products no longer in business.

SECTION II

Questions are organized around the three broad areas of implementing a COTS solution as presented above. Each question prompts you, the respondent, to think about key factors for a successful COTS application package implementation. You should carefully consider your answer in terms of how it pertains to projects within your own organization.

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively. Please record your answers to the questionnaire directly on this form. We ask that you make the best effort possible to provide an answer to all the questions. If you are unsure of an answer, or feel a question does not apply to your project, please indicate so rather than leaving a question blank.

Process

1. How well are the requirements for your system/program documented?

    a. **Thoroughly—comprehensive, current documentation exists**

    b. Moderately well—comprehensive documentation exists, but has not been updated recently

    c. Poorly—minimal documentation exists

2. Because specific requirements are associated with each COTS application package(s), how would you describe the relationship between the specifications of the COTS product(s) and the requirements of your system/program?

    a. **Ideal—great fit, fully meets requirements**

    b. Satisfactory—acceptable fit, meets most requirements

    c. Unsatisfactory—marginal fit, must be modified to meet requirements

3. How many COTS product(s) can accommodate your system/program requirements?

    a. **Many**

    b. Some

    c. Few

4. How would you describe the process by which your organization will implement new requirements after the initial implementation of the COTS product(s)?

a. **Well-defined, proven process has been established to evaluate and implement new requirements (e.g., configuration control board)**

b. Process for evaluating and implementing new requirements has been discussed, but not solidified

c. No process exists for evaluating and implementing new requirements

5. How would you describe your system/program's ability to adapt to the new requirements supported by the COTS product(s)?

a. **Very able—there is a general understanding that the new requirements would enhance organization's operation**

b. Somewhat able—there is a general understanding that the new requirements would not enhance or deter organization's operation

c. Not able—there is a general understanding that the new requirements would deter organization's operation

6. How was the COTS product evaluated and selected?

a. **Well-defined, proven process has been established to evaluate and select cots product**

b. Process for evaluating and selecting COTS products have been discussed, but not solidified

c. Ad hoc, no process exists for evaluating and implementing new requirements

7. What is the vendor's experience with implementing the COTS product(s) in organizations of a size similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b. Some experience

c. No experience, company is start-up and situation is highly dynamic

8. How has the vendor performed in the integration of the COTS application package(s) elsewhere?

a. **Excellent past performance**

b. Good past performance

c. Poor or unknown past performance

9. What is the vendor's experience with implementing the considered COTS product(s) in organizations of a management structure similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b**.** Some experience – first major DOD implementation

c. No experience, company is start-up and situation is highly dynamic

10. How would you describe the operational control of the organization affected by the COTS product(s) implementation?

a. **Centralized**

b. Combination of centralized and decentralized

c. Decentralized

11. How would you describe the sufficiency of *skilled staff in the system/program affected* by the COTS application package(s) implementation?

a. **Sufficiently staffed and skilled**

b. Minimally staffed and skilled

c. Insufficiently staffed and skilled

12. How much experience does the COTS implementation project team have with the COTS product(s)?

a. **Extensive experience**
b. Some experience
c. No experience

13. How much experience does the project team have with implementation of other COTS products?

a. **Experienced with many COTS products**
b. Experienced with a few COTS products
c. Experienced with no other COTS products

14. What is the vendor's track record with implementing the COTS product(s) within their cost proposal?

a. Below total life cycle cost estimate
b. Met total life cycle cost estimate
c. Exceeded total life cycle cost estimate

15. How financially stable is the vendor?

a. **Solid financial situation**
b. Mixed financial picture, may have strong revenue but no profit margin
c. Financial problems, such as poor credit, low revenues and low profit margin

16. To what extent does your acquisition approach include an understanding of the vendor's future plans for the COTS product(s)?

a. **Statement of direction for the product, including planned enhancements and release dates, has been received**

b. Discussions have been conducted with vendor regarding future direction, but no plans have been received in writing

c. No discussion with vendor regarding future direction

17. Have data rights been properly negotiated with the vendors?

a. **All data rights negotiated into the contract**

b. Many data rights have been negotiated into the contract

c. No data rights have been negotiated into the contract

18. Have cost-effective licensing agreements been worked out with the vendors?

a. **All licensing agreements negotiated into cost**

b. Many licensing agreements negotiated into cost

c. Uncertain what licensing agreements are needed

Responses in Process Section:

a 17 x 1 = 17
b 1 x 2 = 2
c 0 x 3 = 0

Total = 19

Technology

1. Is the COTS application package(s) a totally new system for the organization?

    a. System is a replacement
    b. **Components of the system are new**
    c. New system

2. To adequately address your organization's needs, what is the level of customization required for the COTS product(s) baseline?

    a. No customization necessary
    b. Some customization necessary
    c. **Much customization necessary**

3. How do the COTS application package(s) "fit" with the organization's existing and planned architecture?

    a. **Good fit**
    b. May fit
    c. Not a fit

4. Is the COTS product(s) view as a time-tested, mature product?

    a. **Very mature**
    b. Somewhat mature
    c. New or immature

5. How many functions (e.g., accounting, procurement) are supported by the COTS application package(s)?

    a. Single function
    b. Few functions
    c. **Many functions**

6. How would you describe the complexity of the interfaces between the COTS product(s) and other systems?

a. Simple, easy to understand
b. **Somewhat complex**
c. Very complex, difficult

7. How many systems interfaces must remain unchanged after the implementation of the COTS product(s)?

a. Few
b. **Some**
c. Many

8. How would you describe the sufficiency of documentation supporting the system(s) with which the COTS application package(s) will interface?

a. **Extremely high quality, thorough documentation**
b. Adequate, some documentation
c. Poor documentation or does not exist

9. To what extent has your organization tested COTS application package(s) in your environment?

a. **Conducted extensive testing**
b. Conducted some testing
c. Have not conducted any testing

10. Do the security features included in the COTS product(s) need modification to meet your organization's requirements?

a. **Meets security requirements, no modification needed**

b. Meets most security requirements, some modification needed

c. Will not handle security requirements, extensive modification needed

11. How flexible is the design of the COTS product(s) to allow for future changes in functionality?

a. **Very flexible—product functions can be easily separated to be modified**

b**.** Moderately flexible—product functions can be separated to be modified

c. Not flexible—product functions can not be separated to be modified

12. What is the reliability history of the COTS product?

a. **Product is stable and has proven itself over time with its customer base**

b. Product has occasional errors but none will result in data loss or other critical problem

c. Product has errors that result in data loss, work lost, system crashes, etc.

Responses in Technology Section:

a 7 x 1 = 7
b 3 x 2 = 6
c 2 x 3 = 6

Total = 19

Implementation/Logistics Support

1. Has your organization examined and applied the lessons learned from other organizations that implemented the COTS application package(s)?

   a. **Yes—relevant lessons learned have been incorporated into the implementation plan**

   b. Somewhat—past projects have been discussed by the project team

   c. No—have not gathered any information regarding other implementations

2. How will your organization measure the impact and effectiveness of the COTS product(s)?

   a. **Compreh**ensive performance measures (including cost, time spent on each activity, etc.) have been established

   b. **Performance measures have been discussed but not finalized**

   c. No discussion of performance measures

3. What sort of testing approach is planned for the COTS product(s)?

   a. Designed specifically for a COTS implementation

   b. Combines traditional systems development testing with COTS-specific testing

   c. **Designed for traditional systems development activities**

4. How would you describe your organization's ability to support new releases of the COTS product(s)?

   a. **Sufficient—been developed**

   b. Moderate—staffing needs have been identified, but plan has not been finalized

   c. Minimal—no staff resources are available after the initial implementation

5. How has the organization prepared for the possibility that the COTS application package(s) vendor goes out of business or discontinues support for the product?

a. Contingency plan finalized and ready to implement
b. **Possibility discussed, but have no finalized plan**
c. Possibility not discussed, no contingency plan being developed

6. How would you describe the run time performance of the COTS product(s) in your environment?

a. **Very efficient**
b. Moderately efficient
c. Not efficient

7. Does the run time performance of the COTS application package(s) meet the organization's performance needs?

a. **Efficiently supports the number and location of users**
b. Supports needs with performance degradation
c. Does not support needs

8. How do other users of the COTS product describe their satisfaction with availability of the vendor staff?

a. **Very satisfied, easy to access key personnel at vendor**
b. Somewhat satisfied, can access key personnel some of the time
c. Unsatisfied, access to key personnel is difficult

9. What training is needed to operate and maintain the COTS product?

a. No training
b. **Some training**
c. Extensive training

10. What training sources are available to the customers?

a. **Extensive training resources**
b. Some training resources
c. No training resources

11. How much experience does other support contractors serving your organization in functions affected by the COTS implementation have with the COTS application package(s)?

a. Extensive experience
b. **Some experience**
c. No experience

Responses in Implementation/Logistical Support Section:

a 6 x 1 = 6
b 4 x 2 = 8
c 1 x 3 = 3

Total = 17

APPENDIX E ARMY COMMUNICATION SOFTWARE SUPPORT DIVIDION QUESTIONNAIRE RESPONSES

SECTION I

Service: ___U.S. Army_____

Agency or Organization: ___CECOM-SEC or AMSEL-SE-WS-COM
Project/System Name: _Post Production Software Support

Which category best describes your main job function in your organization?

a. **Management and Software Support**
b. System analysis or design
c. Application or system programming

Have you participated in selecting COTS software components that where later adapted or integrated into your project/system? How many times? **We made recommendations based on the legality use and when COTS products are no longer supported or reach end of life. There were two incidents where our recommendations of COTS replacement were integrated.**

How long is your work experience with building system from COTS components? **4**Years

Please state any good practices, or lessons you have learnt from past experience when acquiring and developing systems using COTS software.

- Know your requirements well
- Assess and evaluate different available COTS products and its cost based on the requirements way in advance
- Close, continuous, and active partnership among the vendor, customers, developer, and most importantly the users

SECTION II

Questions are organized around the three broad areas of implementing a COTS solution as presented above. Each question prompts you, the respondent, to think about key factors for a successful COTS application package implementation. You should carefully consider your answer in terms of how it pertains to projects within your own organization.

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively. Please record your answers to the questionnaire directly on this form. We ask that you make the best effort possible to provide an answer to all the questions. If you are unsure of an answer, or feel a question does not apply to your project, please indicate so rather than leaving a question blank.

Process

1. How well are the requirements for your system/program documented?

   a. **Thoroughly—comprehensive, current documentation exists**

   b. Moderately well—comprehensive documentation exists, but has not been updated recently

   c. Poorly—minimal documentation exists

2. Because specific requirements are associated with each COTS application package(s), how would you describe the relationship between the specifications of the COTS product(s) and the requirements of your system/program?

   a. Ideal—great fit, fully meets requirements

   b. **Satisfactory—acceptable fit, meets most requirements**

   c. Unsatisfactory—marginal fit, must be modified to meet requirements

3. How many COTS product(s) can accommodate your system/program requirements?

   a. Many

   b. **Some**

   c. Few

4. How would you describe the process by which your organization will implement new requirements after the initial implementation of the COTS product(s)?

a. **Well-defined, proven process has been established to evaluate and implement new requirements (e.g., configuration control board)**

b. Process for evaluating and implementing new requirements has been discussed, but not solidified

c. No process exists for evaluating and implementing new requirements

5. How would you describe your system/program's ability to adapt to the new requirements supported by the COTS product(s)?

a. **Very able—there is a general understanding that the new requirements would enhance organization's operation**

b. Somewhat able—there is a general understanding that the new requirements would not enhance or deter organization's operation

c. Not able—there is a general understanding that the new requirements would deter organization's operation

6. How was the COTS product evaluated and selected?

a. Well-defined, proven process has been established to evaluate and select cots product

b. **Process for evaluating and selecting COTS products have been discussed, but not solidified**

c. Ad hoc, no process exists for evaluating and implementing new requirements

7. What is the vendor's experience with implementing the COTS product(s) in organizations of a size similar to yours?

a. Extensive experience, established company with quality workforce and facilities

b. **Some experience**

c. No experience, company is start-up and situation is highly dynamic

8. How has the vendor performed in the integration of the COTS application package(s) elsewhere?

a. Excellent past performance

b. Good past performance

c. **Poor or unknown past performance**

9. What is the vendor's experience with implementing the considered COTS product(s) in organizations of a management structure similar to yours?

a. Extensive experience, established company with quality workforce and facilities

b. Some experience

c. No experience, company is start-up and situation is highly dynamic

10. How would you describe the operational control of the organization affected by the COTS product(s) implementation?

a. Centralized

b. **Combination of centralized and decentralized**

c. Decentralized

11. How would you describe the sufficiency of *skilled staff in the system/program affected* by the COTS application package(s) implementation?

a. Sufficiently staffed and skilled

b. **Minimally staffed and skilled**

c. Insufficiently staffed and skilled

12. How much experience does the COTS implementation project team have with the COTS product(s)?

a. Extensive experience
b. **Some experience**
c. No experience

13. How much experience does the project team have with implementation of other COTS products?

a. Experienced with many COTS products
b. **Experienced with a few COTS products**
c. Experienced with no other COTS products

14. What is the vendor's track record with implementing the COTS product(s) within their cost proposal?

a. Below total life cycle cost estimate
b. Met total life cycle cost estimate
c. **Exceeded total life cycle cost estimate**

15. How financially stable is the vendor?

a. Solid financial situation
b. **Mixed financial picture, may have strong revenue but no profit margin**
c. Financial problems, such as poor credit, low revenues and low profit margin

16. To what extent does your acquisition approach include an understanding of the vendor's future plans for the COTS product(s)?

a. Statement of direction for the product, including planned enhancements and release dates, has been received

b. Discussions have been conducted with vendor regarding future direction, but no plans have been received in writing

c. **No discussion with vendor regarding future direction**

17. Have data rights been properly negotiated with the vendors?

a. All data rights negotiated into the contract

b. **Many data rights have been negotiated into the contract**

c. No data rights have been negotiated into the contract

18. Have cost-effective licensing agreements been worked out with the vendors?

a. All licensing agreements negotiated into cost

b. **Many licensing agreements negotiated into cost**

c. Uncertain what licensing agreements are needed

Responses in Process Section:

a 3 x 1 = 3
b 12 x 2 = 24
c 3 x 3 = 9

Total = 36

Technology

1. Is the COTS application package(s) a totally new system for the organization?

    a. System is a replacement
    b. Components of the system are new
    c. **New system**

2. To adequately address your organization's needs, what is the level of customization required for the COTS product(s) baseline?

    a. No customization necessary
    b. **Some customization necessary**
    c. Much customization necessary

3. How do the COTS application package(s) "fit" with the organization's existing and planned architecture?

    a. Good fit
    b. **May fit**
    c. Not a fit

4. Is the COTS product(s) view as a time-tested, mature product?

    a. Very mature
    b. **Somewhat mature**
    c. New or immature

5. How many functions (e.g., accounting, procurement) are supported by the COTS application package(s)?

    a. Single function
    b. **Few functions**
    c. Many functions

6. How would you describe the complexity of the interfaces between the COTS product(s) and other systems?

a. Simple, easy to understand
b. Somewhat complex
c. **Very complex, difficult**

7. How many systems interfaces must remain unchanged after the implementation of the COTS product(s)?

a. **Few**
b. Some
c. Many

8. How would you describe the sufficiency of documentation supporting the system(s) with which the COTS application package(s) will interface?

a. Extremely high quality, thorough documentation
b. **Adequate, some documentation**
c. Poor documentation or does not exist

9. To what extent has your organization tested COTS application package(s) in your environment?

a. **Conducted extensive testing**
b. Conducted some testing
c. Have not conducted any testing

10. Do the security features included in the COTS product(s) need modification to meet your organization's requirements?

a. Meets security requirements, no modification needed

b. **Meets most security requirements, some modification needed**

c. Will not handle security requirements, extensive modification needed

11. How flexible is the design of the COTS product(s) to allow for future changes in functionality?

a. Very flexible—product functions can be easily separated to be modified

b**.** Moderately flexible—product functions can be separated to be modified

c. **Not flexible—product functions can not be separated to be modified**

12. What is the reliability history of the COTS product?

a. Product is stable and has proven itself over time with its customer base

b. **Product has occasional errors but none will result in data loss or other critical problem**

c. Product has errors that result in data loss, work lost, system crashes, etc.

Responses in Technology Section:

a 2 x 1 = 2
b 7 x 2 = 14
c 3 x 3 = 9

Total = 25

Implementation/Logistics Support

1. Has your organization examined and applied the lessons learned from other organizations that implemented the COTS application package(s)?

    a. Yes—relevant lessons learned have been incorporated into the implementation plan

    b. Somewhat—past projects have been discussed by the project team

    c. **No—have not gathered any information regarding other implementations**

2. How will your organization measure the impact and effectiveness of the COTS product(s)?

    a. Comprehensive performance measures (including cost, time spent on each activity, etc.) have been established

    b. Performance measures have been discussed but not finalized

    c. **No discussion of performance measures**

3. What sort of testing approach is planned for the COTS product(s)?

    a. Designed specifically for a COTS implementation

    b. **Combines traditional systems development testing with COTS-specific testing**

    c. Designed for traditional systems development activities

4. How would you describe your organization's ability to support new releases of the COTS product(s)?

    a. Sufficient—staffing plan for ongoing support of the COTS application package(s) has been developed

    b. **Moderate—staffing needs have been identified, but plan has not been finalized**

    c. Minimal—no staff resources are available after the initial implementation

5. How has the organization prepared for the possibility that the COTS application package(s) vendor goes out of business or discontinues support for the product?

a. Contingency plan finalized and ready to implement
b. Possibility discussed, but have no finalized plan
c. **Possibility not discussed, no contingency plan being developed**

6. How would you describe the run time performance of the COTS product(s) in your environment?

a. Very efficient
b. **Moderately efficient**
c. Not efficient

7. Does the run time performance of the COTS application package(s) meet the organization's performance needs?

a. Efficiently supports the number and location of users
b. **Supports needs with performance degradation**
c. Does not support needs

8. How do other users of the COTS product describe their satisfaction with availability of the vendor staff?

a. Very satisfied, easy to access key personnel at vendor
b. **Somewhat satisfied, can access key personnel some of the time**
c. Unsatisfied, access to key personnel is difficult

9. What training is needed to operate and maintain the COTS product?

a. No training
b. Some training
c. **Extensive training**

10. What training sources are available to the customers?

a. Extensive training resources

b. **Some training resources**

c. No training resources

11. How much experience does other support contractors serving your organization in functions affected by the COTS implementation have with the COTS application package(s)?

a. Extensive experience

b. **Some experience**

c. No experience

Responses in Implementation/Logistical Support Section:

a 0 x 1 = 5
b 7 x 2 = 14
c 4 x 3 = 12

Total = 26

APPENDIX F ARMY GLOBAL COMBAT SUPPORT SYSTEM QUESTIONNAIRE RESPONSES

SECTION I

Service: ___U.S. Army

Agency or Organization: ___PM Logistics Information Systems
Project/System Name: _Global Combat Support System – Army Tactical

Which category best describes your main job function in your organization?

a. **Management**
b. System analysis or design
c. Application or system programming

Have you participated in selecting COTS software components that where later adapted or integrated into your project/system? How many times? **Yes, several**

How long is your work experience with building system from COTS components? **1**Years

Please state any good practices, or lessons you have learnt from past experience when acquiring and developing systems using COTS software.

SECTION II

Questions are organized around the three broad areas of implementing a COTS solution as presented above. Each question prompts you, the respondent, to think about key factors for a successful COTS application package implementation. You should carefully consider your answer in terms of how it pertains to projects within your own organization.

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively. Please record your answers to the questionnaire directly on this form. We ask that you make the best effort possible to provide an answer to all the questions. If you are unsure of an answer, or feel a question does not apply to your project, please indicate so rather than leaving a question blank.

Process

1. How well are the requirements for your system/program documented?

    a. **Thoroughly—comprehensive, current documentation exists**

    b. Moderately well—comprehensive documentation exists, but has not been updated recently

    c. Poorly—minimal documentation exists

2. Because specific requirements are associated with each COTS application package(s), how would you describe the relationship between the specifications of the COTS product(s) and the requirements of your system/program?

    a. **Ideal—great fit, fully meets requirements**

    b. Satisfactory—acceptable fit, meets most requirements

    c. Unsatisfactory—marginal fit, must be modified to meet requirements

3. How many COTS product(s) can accommodate your system/program requirements?

    a. Many

    b. Some

    c. Few

4. How would you describe the process by which your organization will implement new requirements after the initial implementation of the COTS product(s)?

    a. **Well-defined, proven process has been established to evaluate and implement new requirements (e.g., configuration control board)**

    b. Process for evaluating and implementing new requirements has been discussed, but not solidified

    c. No process exists for evaluating and implementing new requirements

5. How would you describe your system/program's ability to adapt to the new requirements supported by the COTS product(s)?

a. **Very able—there is a general understanding that the new requirements would enhance organization's operation**

b. Somewhat able—there is a general understanding that the new requirements would not enhance or deter organization's operation

c. Not able—there is a general understanding that the new requirements would deter organization's operation

6. How was the COTS product evaluated and selected?

a. **Well-defined, proven process has been established to evaluate and select cots product**

b. Process for evaluating and selecting COTS products have been discussed, but not solidified

c. Ad hoc, no process exists for evaluating and implementing new requirements

7. What is the vendor's experience with implementing the COTS product(s) in organizations of a size similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b. Some experience

c. No experience, company is start-up and situation is highly dynamic

8. How has the vendor performed in the integration of the COTS application package(s) elsewhere?

a. **Excellent past performance**

b. Good past performance

c. Poor or unknown past performance

9. What is the vendor's experience with implementing the considered COTS product(s) in organizations of a management structure similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b. Some experience – first major DOD implementation

c. No experience, company is start-up and situation is highly dynamic

10. How would you describe the operational control of the organization affected by the COTS product(s) implementation?

a. **Centralized**

b. Combination of centralized and decentralized

c. Decentralized

11. How would you describe the sufficiency of *skilled staff in the system/program affected* by the COTS application package(s) implementation?

a. **Sufficiently staffed and skilled**

b. Minimally staffed and skilled

c. Insufficiently staffed and skilled

12. How much experience does the COTS implementation project team have with the COTS product(s)?

a. **Extensive experience**

b. Some experience

c. No experience

13. How much experience does the project team have with implementation of other COTS products?

a. **Experienced with many COTS products**

b. Experienced with a few COTS products

c. Experienced with no other COTS products

14. What is the vendor's track record with implementing the COTS product(s) within their cost proposal? **(Impossible to answer)**

a. Below total life cycle cost estimate

b. Met total life cycle cost estimate

c. Exceeded total life cycle cost estimate

15. How financially stable is the vendor?

a. **Solid financial situation**

b. Mixed financial picture, may have strong revenue but no profit margin

c. Financial problems, such as poor credit, low revenues and low profit margin

16. To what extent does your acquisition approach include an understanding of the vendor's future plans for the COTS product(s)?

a. **Statement of direction for the product, including planned enhancements and release dates, has been received**

b. Discussions have been conducted with vendor regarding future direction, but no plans have been received in writing

c. No discussion with vendor regarding future direction

17. Have data rights been properly negotiated with the vendors?

a. **All data rights negotiated into the contract**

b. Many data rights have been negotiated into the contract

c. No data rights have been negotiated into the contract

18. Have cost-effective licensing agreements been worked out with the vendors?

a. **All licensing agreements negotiated into cost**
b. Many licensing agreements negotiated into cost
c. Uncertain what licensing agreements are needed

Responses in Process Section:

a 17 x 1 = 17
b 0 x 2 = 0
c 0 x 3 = 0

Total = 17

Technology

1. Is the COTS application package(s) a totally new system for the organization?

a. **System is a replacement**
b. Components of the system are new
c. New system

2. To adequately address your organization's needs, what is the level of customization required for the COTS product(s) baseline?

a. **No customization necessary**
b. Some customization necessary
c. Much customization necessary

3. How do the COTS application package(s) "fit" with the organization's existing and planned architecture?

a. **Good fit**
b. May fit
c. Not a fit

4. Is the COTS product(s) view as a time-tested, mature product?

a. **Very mature**
b. Somewhat mature
c. New or immature

5. How many functions (e.g., accounting, procurement) are supported by the COTS application package(s)?

a. **Single function**
b. Few functions
c. Many functions

6. How would you describe the complexity of the interfaces between the COTS product(s) and other systems?

a. **Simple, easy to understand**
b. Somewhat complex
c. Very complex, difficult

7. How many systems interfaces must remain unchanged after the implementation of the COTS product(s)?

a. **Few**
b. Some
c. Many

8. How would you describe the sufficiency of documentation supporting the system(s) with which the COTS application package(s) will interface?

a. **Extremely high quality, thorough documentation**
b. Adequate, some documentation
c. Poor documentation or does not exist

9. To what extent has your organization tested COTS application package(s) in your environment?

a. **Conducted extensive testing**

b. Conducted some testing

c. Have not conducted any testing

10. Do the security features included in the COTS product(s) need modification to meet your organization's requirements?

a. **Meets security requirements, no modification needed**

b. Meets most security requirements, some modification needed

c. Will not handle security requirements, extensive modification needed

11. How flexible is the design of the COTS product(s) to allow for future changes in functionality?

a. **Very flexible—product functions can be easily separated to be modified**

b**.** Moderately flexible—product functions can be separated to be modified

c. Not flexible—product functions can not be separated to be modified

12. What is the reliability history of the COTS product?

a. **Product is stable and has proven itself over time with its customer base**

b. Product has occasional errors but none will result in data loss or other critical problem

c. Product has errors that result in data loss, work lost, system crashes, etc.

Responses in Technology Section:

a 12 x 1 = 12
b 0 x 2 = 0
c 0 x 3 = 0

Total = 12

Implementation/Logistics Support

1. Has your organization examined and applied the lessons learned from other organizations that implemented the COTS application package(s)?

   a. **Yes—relevant lessons learned have been incorporated into the implementation plan**

   b. Somewhat—past projects have been discussed by the project team

   c. No—have not gathered any information regarding other implementations

2. How will your organization measure the impact and effectiveness of the COTS product(s)?

   a. **Comprehensive performance measures (including cost, time spent on each activity, etc.) have been established**

   b. Performance measures have been discussed but not finalized

   c. No discussion of performance measures

3. What sort of testing approach is planned for the COTS product(s)?

   a. **Designed specifically for a COTS implementation**

   b. Combines traditional systems development testing with COTS-specific testing

   c. Designed for traditional systems development activities

4. How would you describe your organization's ability to support new releases of the COTS product(s)?

   a. **Sufficient—staffing plan for ongoing support of the COTS application package(s) has been developed**

   b. Moderate—staffing needs have been identified, but plan has not been finalized

   c. Minimal—no staff resources are available after the initial implementation

5. How has the organization prepared for the possibility that the COTS application package(s) vendor goes out of business or discontinues support for the product?

a. **Contingency plan finalized and ready to implement**
b. Possibility discussed, but have no finalized plan
c. Possibility not discussed, no contingency plan being developed

6. How would you describe the run time performance of the COTS product(s) in your environment?

a. **Very efficient**
b. Moderately efficient
c. Not efficient

7. Does the run time performance of the COTS application package(s) meet the organization's performance needs?

a. **Efficiently supports the number and location of users**
b. Supports needs with performance degradation
c. Does not support needs

8. How do other users of the COTS product describe their satisfaction with availability of the vendor staff?

a. **Very satisfied, easy to access key personnel at vendor**
b. Somewhat satisfied, can access key personnel some of the time
c. Unsatisfied, access to key personnel is difficult

9. What training is needed to operate and maintain the COTS product?

a. **No training**
b. Some training
c. Extensive training

10. What training sources are available to the customers?

a. Extensive training resources
b. **Some training resources**
c. No training resources

11. How much experience does other support contractors serving your organization in functions affected by the COTS implementation have with the COTS application package(s)?

a. **Extensive experience**
b. Some experience
c. No experience

Responses in Implementation/Logistical Support Section:

a 10 x 1 = 10
b 1 x 2 = 2
c 0 x 3 = 0

Total = 12

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APPENDIX G MARINE CORPS COMBAT VEHICLE TRAINING SIMULATOR QUESTIONNAIRE RESPONSES

SECTION I

Service: ___United States Marine Corps

Agency or Organization: ___Marine Corps Systems Command
Project/System Name: _Global Transportation and Engineer Systems

Which category best describes your main job function in your organization?

a. **Management**
b. System analysis or design
c. Application or system programming

Have you participated in selecting COTS software components that where later adapted or integrated into your project/system? How many times? **No.**

How long is your work experience with building system from COTS components? **5**Years

Please state any good practices, or lessons you have learnt from past experience when acquiring and developing systems using COTS software.

- Combined Synopsis/Solicitation are great tools

SECTION II

Questions are organized around the three broad areas of implementing a COTS solution as presented above. Each question prompts you, the respondent, to think about key factors for a successful COTS application package implementation. You should carefully consider your answer in terms of how it pertains to projects within your own organization.

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively. Please record your answers to the questionnaire directly on this form. We ask that you make the best effort possible to provide an answer to all the questions. If you are unsure of an answer, or feel a question does not apply to your project, please indicate so rather than leaving a question blank.

Process

1. How well are the requirements for your system/program documented?

    a. Thoroughly—comprehensive, current documentation exists

    b. **Moderately well—comprehensive documentation exists, but has not been updated recently**

    c. Poorly—minimal documentation exists

2. Because specific requirements are associated with each COTS application package(s), how would you describe the relationship between the specifications of the COTS product(s) and the requirements of your system/program?

    a. Ideal—great fit, fully meets requirements

    b. **Satisfactory—acceptable fit, meets most requirements**

    c. Unsatisfactory—marginal fit, must be modified to meet requirements

3. How many COTS product(s) can accommodate your system/program requirements?

    a. Many

    b. Some

    c. Few

4. How would you describe the process by which your organization will implement new requirements after the initial implementation of the COTS product(s)?

    a. **Well-defined, proven process has been established to evaluate and implement new requirements (e.g., configuration control board)**

    b. Process for evaluating and implementing new requirements has been discussed, but not solidified

    c. No process exists for evaluating and implementing new requirements

5. How would you describe your system/program's ability to adapt to the new requirements supported by the COTS product(s)?

a. **Very able—there is a general understanding that the new requirements would enhance organization's operation**

b. Somewhat able—there is a general understanding that the new requirements would not enhance or deter organization's operation

c. Not able—there is a general understanding that the new requirements would deter organization's operation

6. How was the COTS product evaluated and selected?

a. Well-defined, proven process has been established to evaluate and select cots product

b. **Process for evaluating and selecting COTS products have been discussed, but not solidified**

c. Ad hoc, no process exists for evaluating and implementing new requirements

7. What is the vendor's experience with implementing the COTS product(s) in organizations of a size similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b. Some experience

c. No experience, company is start-up and situation is highly dynamic

8. How has the vendor performed in the integration of the COTS application package(s) elsewhere?

a. Excellent past performance

b. **Good past performance**

c. Poor or unknown past performance

9. What is the vendor's experience with implementing the considered COTS product(s) in organizations of a management structure similar to yours?

a. Extensive experience, established company with quality workforce and facilities

b. **Some experience – first major DOD implementation**

c. No experience, company is start-up and situation is highly dynamic

10. How would you describe the operational control of the organization affected by the COTS product(s) implementation?

a. Centralized

b. **Combination of centralized and decentralized**

c. Decentralized

11. How would you describe the sufficiency of *skilled staff in the system/program affected* by the COTS application package(s) implementation?

a. **Sufficiently staffed and skilled**

b. Minimally staffed and skilled

c. Insufficiently staffed and skilled

12. How much experience does the COTS implementation project team have with the COTS product(s)?

a. Extensive experience

b. **Some experience**

c. No experience

13. How much experience does the project team have with implementation of other COTS products?

a. Experienced with many COTS products

b. **Experienced with a few COTS products**

c. Experienced with no other COTS products

14. What is the vendor's track record with implementing the COTS product(s) within their cost proposal?

a. Below total life cycle cost estimate

b. **Met total life cycle cost estimate**

c. Exceeded total life cycle cost estimate

15. How financially stable is the vendor?

a. Solid financial situation

b. **Mixed financial picture, may have strong revenue but no profit margin**

c. Financial problems, such as poor credit, low revenues and low profit margin

16. To what extent does your acquisition approach include an understanding of the vendor's future plans for the COTS product(s)?

a. Statement of direction for the product, including planned enhancements and release dates, has been received

b. **Discussions have been conducted with vendor regarding future direction, but no plans have been received in writing**

c. No discussion with vendor regarding future direction

17. Have data rights been properly negotiated with the vendors?

a. All data rights negotiated into the contract

b. Many data rights have been negotiated into the contract

c. **No data rights have been negotiated into the contract**

18. Have cost-effective licensing agreements been worked out with the vendors?

a. **All licensing agreements negotiated into cost**
b. Many licensing agreements negotiated into cost
c. **Uncertain what licensing agreements are needed**

Responses in Process Section:
# a 5 x 1 = 5
# b 11 x 2 = 22
# c 2 x 3 = 6
Total = 33

Technology

1. Is the COTS application package(s) a totally new system for the organization?

a. **System is a replacement**
b. Components of the system are new
c. New system

2. To adequately address your organization's needs, what is the level of customization required for the COTS product(s) baseline?

a. No customization necessary
b. Some customization necessary
c. **Much customization necessary**

3. How do the COTS application package(s) "fit" with the organization's existing and planned architecture?

a. Good fit
b. **May fit**
c. Not a fit

4. Is the COTS product(s) view as a time-tested, mature product?

a. Very mature
b. **Somewhat mature**
c. New or immature

5. How many functions (e.g., accounting, procurement) are supported by the COTS application package(s)?

a. Single function
b. Few functions
c. **Many functions**

6. How would you describe the complexity of the interfaces between the COTS product(s) and other systems?

a. Simple, easy to understand
b. **Somewhat complex**
c. Very complex, difficult

7. How many systems interfaces must remain unchanged after the implementation of the COTS product(s)?

a. Few
b. **Some**
c. Many

8. How would you describe the sufficiency of documentation supporting the system(s) with which the COTS application package(s) will interface?

a. **Extremely high quality, thorough documentation**
b. Adequate, some documentation
c. Poor documentation or does not exist

9. To what extent has your organization tested COTS application package(s) in your environment?

a. **Conducted extensive testing**

b. Conducted some testing

c. Have not conducted any testing

10. Do the security features included in the COTS product(s) need modification to meet your organization's requirements?

a. Meets security requirements, no modification needed

b. **Meets most security requirements, some modification needed**

c. Will not handle security requirements, extensive modification needed

11. How flexible is the design of the COTS product(s) to allow for future changes in functionality?

a. **Very flexible—product functions can be easily separated to be modified**

b. Moderately flexible—product functions can be separated to be modified

c. Not flexible—product functions can not be separated to be modified

12. What is the reliability history of the COTS product?

a. **Product is stable and has proven itself over time with its customer base**

b. Product has occasional errors but none will result in data loss or other critical problem

c. Product has errors that result in data loss, work lost, system crashes, etc.

Responses in Technology Section:

a 5 x 1 = 5
b 5 x 2 = 10
c 2 x 3 = 6

Total = 21

Implementation/Logistics Support

1. Has your organization examined and applied the lessons learned from other organizations that implemented the COTS application package(s)?

    a. Yes—relevant lessons learned have been incorporated into the implementation plan

    b. Somewhat—past projects have been discussed by the project team

    c. **No—have not gathered any information regarding other implementations**

2. How will your organization measure the impact and effectiveness of the COTS product(s)?

    a. Comprehensive performance measures (including cost, time spent on each activity, etc.) have been established

    b. Performance measures have been discussed but not finalized

    c. **No discussion of performance measures**

3. What sort of testing approach is planned for the COTS product(s)?

    a. Designed specifically for a COTS implementation

    b. Combines traditional systems development testing with COTS-specific testing

    c. **Designed for traditional systems development activities**

4. How would you describe your organization's ability to support new releases of the COTS product(s)?

    a. Sufficient—staffing plan for ongoing support of the COTS application package(s) has been developed

    b. **Moderate—staffing needs have been identified, but plan has not been finalized**

    c. Minimal—no staff resources are available after the initial implementation

5. How has the organization prepared for the possibility that the COTS application package(s) vendor goes out of business or discontinues support for the product?

a. Contingency plan finalized and ready to implement
b. **Possibility discussed, but have no finalized plan**
c. Possibility not discussed, no contingency plan being developed

6. How would you describe the run time performance of the COTS product(s) in your environment?

a. **Very efficient**
b. Moderately efficient
c. Not efficient

7. Does the run time performance of the COTS application package(s) meet the organization's performance needs?

a. **Efficiently supports the number and location of users**
b. Supports needs with performance degradation
c. Does not support needs

8. How do other users of the COTS product describe their satisfaction with availability of the vendor staff?

a. Very satisfied, easy to access key personnel at vendor
b. **Somewhat satisfied, can access key personnel some of the time**
c. Unsatisfied, access to key personnel is difficult

9. What training is needed to operate and maintain the COTS product?

a. No training
b. Some training
c. **Extensive training**

10. What training sources are available to the customers?

a. Extensive training resources
b. Some training resources
c. **No training resources (very little)**

11. How much experience does other support contractors serving your organization in functions affected by the COTS implementation have with the COTS application package(s)?

a. Extensive experience
b. **Some experience**
c. No experience

Responses in Implementation/Logistical Support Section:
# a 2 x 1 = 2
# b 4 x 2 = 8
# c 5 x 3 = 15
Total = 25

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APPENDIX H ARMY COMMON SOFTWARE PROGRAM QUESTIONNAIRE RESPONSES

SECTION I

Service: ___U.S. Army

Agency or Organization: ___PM Ground Combat Command & Control (GC C2)
Project/System Name: _Common Software

Which category best describes your main job function in your organization?

a. Management
b. System analysis or design
c. **Application or system programming**

Have you participated in selecting COTS software components that where later adapted or integrated into your project/system? How many times? **Yes, one time.**

How long is your work experience with building system from COTS components? **2**Years

Please state any good practices, or lessons you have learnt from past experience when acquiring and developing systems using COTS software.

- Never rely on a single vendor for critical functionality, always have alternate products lined up
- Carefully consider the likelihood that the vendor will not be there to support it in the future

SECTION II

Questions are organized around the three broad areas of implementing a COTS solution as presented above. Each question prompts you, the respondent, to think about key factors for a successful COTS application package implementation. You should carefully consider your answer in terms of how it pertains to projects within your own organization.

Answers to each question are provided by the choice a, b or c, which correlate to the three levels of risk: low, medium and high, respectively. Please record your answers to the questionnaire directly on this form. We ask that you make the best effort possible to provide an answer to all the questions. If you are unsure of an answer, or feel a

question does not apply to your project, please indicate so rather than leaving a question blank.

Process

1. How well are the requirements for your system/program documented?

    a. Thoroughly—comprehensive, current documentation exists

    b. **Moderately well—comprehensive documentation exists, but has not been updated recently**

    c. Poorly—minimal documentation exists

2. Because specific requirements are associated with each COTS application package(s), how would you describe the relationship between the specifications of the COTS product(s) and the requirements of your system/program?

    a. Ideal—great fit, fully meets requirements

    b. **Satisfactory—acceptable fit, meets most requirements**

    c. Unsatisfactory—marginal fit, must be modified to meet requirements

3. How many COTS product(s) can accommodate your system/program requirements?

    a. Many

    b. **Some**

    c. Few

4. How would you describe the process by which your organization will implement new requirements after the initial implementation of the COTS product(s)?

    a. Well-defined, proven process has been established to evaluate and implement new requirements (e.g., configuration control board)

    b. **Process for evaluating and implementing new requirements has been discussed, but not solidified**

    c. No process exists for evaluating and implementing new requirements

5. How would you describe your system/program's ability to adapt to the new requirements supported by the COTS product(s)?

a. Very able—there is a general understanding that the new requirements would enhance organization's operation

b. **Somewhat able—there is a general understanding that the new requirements would not enhance or deter organization's operation**

c. Not able—there is a general understanding that the new requirements would deter organization's operation

6. How was the COTS product evaluated and selected?

a. Well-defined, proven process has been established to evaluate and select cots product

b. **Process for evaluating and selecting COTS products have been discussed, but not solidified**

c. Ad hoc, no process exists for evaluating and implementing new requirements

7. What is the vendor's experience with implementing the COTS product(s) in organizations of a size similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b. Some experience

c. No experience, company is start-up and situation is highly dynamic

8. How has the vendor performed in the integration of the COTS application package(s) elsewhere?

a. **Excellent past performance**

b. Good past performance

c. Poor or unknown past performance

9. What is the vendor's experience with implementing the considered COTS product(s) in organizations of a management structure similar to yours?

a. **Extensive experience, established company with quality workforce and facilities**

b. Some experience – first major DOD implementation

c. No experience, company is start-up and situation is highly dynamic

10. How would you describe the operational control of the organization affected by the COTS product(s) implementation?

a. Centralized

b. **Combination of centralized and decentralized**

c. Decentralized

11. How would you describe the sufficiency of *skilled staff in the system/program affected* by the COTS application package(s) implementation?

a. **Sufficiently staffed and skilled**

b. Minimally staffed and skilled

c. Insufficiently staffed and skilled

12. How much experience does the COTS implementation project team have with the COTS product(s)?

a. Extensive experience

b. Some experience

c. **No experience**

13. How much experience does the project team have with implementation of other COTS products?

a. **Experienced with many COTS products**

b. Experienced with a few COTS products

c. Experienced with no other COTS products

14. What is the vendor's track record with implementing the COTS product(s) within their cost proposal? **(Impossible to answer)**

a. Below total life cycle cost estimate

b. **Met total life cycle cost estimate**

c. Exceeded total life cycle cost estimate

15. How financially stable is the vendor?

a. **Solid financial situation**

b. Mixed financial picture, may have strong revenue but no profit margin

c. Financial problems, such as poor credit, low revenues and low profit margin

16. To what extent does your acquisition approach include an understanding of the vendor's future plans for the COTS product(s)?

a. **Statement of direction for the product, including planned enhancements and release dates, has been received**

b. Discussions have been conducted with vendor regarding future direction, but no plans have been received in writing

c. No discussion with vendor regarding future direction

17. Have data rights been properly negotiated with the vendors?

a. **All data rights negotiated into the contract**

b. Many data rights have been negotiated into the contract

c. No data rights have been negotiated into the contract

18. Have cost-effective licensing agreements been worked out with the vendors?

a. **All licensing agreements negotiated into cost**
b. Many licensing agreements negotiated into cost
c. Uncertain what licensing agreements are needed

Responses in Process Section:
# a 9 x 1 = 9
# b 8 x 2 = 16
# c 2 x 3 = 6
Total = 31

Technology

1. Is the COTS application package(s) a totally new system for the organization?

a. System is a replacement
b. **Components of the system are new**
c. New system

2. To adequately address your organization's needs, what is the level of customization required for the COTS product(s) baseline?

a. No customization necessary
b. **Some customization necessary**
c. Much customization necessary

3. How do the COTS application package(s) "fit" with the organization's existing and planned architecture?

a. **Good fit**
b. May fit
c. Not a fit

4. Is the COTS product(s) view as a time-tested, mature product?

a. Very mature
b. Somewhat mature
c. **New or immature**

5. How many functions (e.g., accounting, procurement) are supported by the COTS application package(s)?

a. Single function
b. Few functions
c. **Many functions**

6. How would you describe the complexity of the interfaces between the COTS product(s) and other systems?

a. Simple, easy to understand
b. **Somewhat complex**
c. Very complex, difficult

7. How many systems interfaces must remain unchanged after the implementation of the COTS product(s)?

a. **Few**
b. Some
c. Many

8. How would you describe the sufficiency of documentation supporting the system(s) with which the COTS application package(s) will interface?

a. Extremely high quality, thorough documentation
b. **Adequate, some documentation**
c. Poor documentation or does not exist

9. To what extent has your organization tested COTS application package(s) in your environment?

a. Conducted extensive testing

b. **Conducted some testing**

c. Have not conducted any testing

10. Do the security features included in the COTS product(s) need modification to meet your organization's requirements?

a. **Meets security requirements, no modification needed**

b. Meets most security requirements, some modification needed

c. Will not handle security requirements, extensive modification needed

11. How flexible is the design of the COTS product(s) to allow for future changes in functionality?

a. **Very flexible—product functions can be easily separated to be modified**

b. Moderately flexible—product functions can be separated to be modified

c. Not flexible—product functions can not be separated to be modified

12. What is the reliability history of the COTS product?

a. Product is stable and has proven itself over time with its customer base

b. **Product has occasional errors but none will result in data loss or other critical problem**

c. Product has errors that result in data loss, work lost, system crashes, etc.

Responses in Technology Section:

a 4 x 1 = 4
b 6 x 2 = 12
c 2 x 3 = 6

Total = 22

Implementation/Logistics Support

1. Has your organization examined and applied the lessons learned from other organizations that implemented the COTS application package(s)?

   a. Yes—relevant lessons learned have been incorporated into the implementation plan

   b. Somewhat—past projects have been discussed by the project team

   c. **No—have not gathered any information regarding other implementations**

2. How will your organization measure the impact and effectiveness of the COTS product(s)?

   a. Comprehensive performance measures (including cost, time spent on each activity, etc.) have been established

   b. **Performance measures have been discussed but not finalized**

   c. No discussion of performance measures

3. What sort of testing approach is planned for the COTS product(s)?

   a. Designed specifically for a COTS implementation

   b. Combines traditional systems development testing with COTS-specific testing

   c. **Designed for traditional systems development activities**

4. How would you describe your organization's ability to support new releases of the COTS product(s)?

   a. **Sufficient—staffing plan for ongoing support of the COTS application package(s) has been developed**

   b. Moderate—staffing needs have been identified, but plan has not been finalized

   c. Minimal—no staff resources are available after the initial implementation

5. How has the organization prepared for the possibility that the COTS application package(s) vendor goes out of business or discontinues support for the product?

a. Contingency plan finalized and ready to implement
b. Possibility discussed, but have no finalized plan
c. **Possibility not discussed, no contingency plan being developed**

6. How would you describe the run time performance of the COTS product(s) in your environment?

a. **Very efficient**
b. Moderately efficient
c. Not efficient

7. Does the run time performance of the COTS application package(s) meet the organization's performance needs?

a. **Efficiently supports the number and location of users**
b. Supports needs with performance degradation
c. Does not support needs

8. How do other users of the COTS product describe their satisfaction with availability of the vendor staff?

a. **Very satisfied, easy to access key personnel at vendor**
b. Somewhat satisfied, can access key personnel some of the time
c. Unsatisfied, access to key personnel is difficult

9. What training is needed to operate and maintain the COTS product?

a. **No training**
b. Some training
c. Extensive training

10. What training sources are available to the customers?

a. Extensive training resources

b. **Some training resources**

c. No training resources

11. How much experience does other support contractors serving your organization in functions affected by the COTS implementation have with the COTS application package(s)?

a. Extensive experience

b. Some experience

c. **No experience**

Responses in Implementation/Logistical Support Section:

a 6 x 1 = 6
b 1 x 2 = 2
c 4 x 3 = 12

Total = 20

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LIST OF REFERENCES

[ABTS97] Center for Software Engineering, University of Southern California F30602-94-C-1095, *COTS Software Integration Cost Study Model*. By Christopher Abts and Dr. Barry W. Boehm, 29 June 1997.

[ALBE03] Albert, Cecilia, Brownsword, Lisa, Brownsword, Morris, Ed, *COTS-Based Development: Taking the Pulse of the Project*., February 2003.

[BASI01] Basili, Victor R., Boehm, Barry*, COTS-Based Systems Top 10 List,* Software Management, pp 91-93, May 2001.

[BASI02] Basili, Victor R., Boehm, Barry, Lindvall, Mikael, Rus, Ioana, Seaman, Carolyn, *A Web Repository of Lessons Learned from COTS-Based Software Development*, Crosstalk, September 2002.

[BOEH02] Boehm, Barry, Kind, Peter, Turner, Richard, "*Risky Business: 7 Myths about Software Engineering That Impact Defense Acquisition"*, Program Manager, pp 74-79, May-June 2002.

[BROW00] Software Engineering Institute, Carnegie Mellon University CMU/SEI-2000-TR-010, *An Activity Framework for COTS-Based Systems*. By Lisa Brownsword, Patricia Obendorf and Carol A Sledge, September 2000.

[CAMP00] Campbell, Luke."*COTS: Is it Just a Check for Your Program? Or Are You a Real Part of Acquisition Reform?", Project Manager*, pp 16-20, March-April 2000.

[CARI02] Carina, Alves, Finkelstein, Anthony, *Challenges in COTS Decision-Making: A Goal-Driven Requirements Engineering Perspective,* In

Workshop on Software Engineering Decision Support, in conjunction with SEKE'02, Ischia, Italy, July 2002.

[CARN97] Carney, David J., Obendorf, Patricia A., *The Commandment of COTS: Still in Search of the Promised Land*, Software Engineering Institute, Carnegie Mellon University, Crosstalk, May 1997.

[CARR93] Software Engineering Institute, Carnegie Mellon University CMU/SEI-2000-TR-010, *Taxonomy-Based Risk Identification.* By Marvin Carr, Surech L. Konda, Ira Monarch, F. Carol Ulrich, Clay F. Walker, June 1993.

[CLAJ01] Clapp, Judith, "Common Risks and Risk Mitigation Actions for Management of a COTS-Based System", Edge Perspectives, http://www.mitre.org/pubs/edge_perspectives/march_01/risks.html, March 2001.

[CLAP98] Electronic Systems Command, F19628-99-C-0001, *A Management Guide to Software Maintenance is COTS-Based Systems,* By Judith A. Clapp and Audrey E. Taub, November 1998.

[CLAP01] Clapp, Judith, "Understanding Risks Alleviates COTS-based Systems Woes",EdgePerspectives, http://www.mitre.org/pubs/edge_perspectives/march_01/ep_clapp1.html, March 2001

[CSOS00] Depart of the Air Force, Headquarters Space and Missile Systems Center and Headquarters Air Force Space Command, *Final Report Commercial Space Opportunity Study (CSOS).* 16 February 2000.

[DDAU02] DOD. Defense Acquisition University. *Risk Management Guide for DOD Acquisition, Fifth Edition*. June 2002.

[DODA96] DOD. Office of the Deputy Under Secretary of Defense for Acquisition and Technology. *SD-2 -Buying Commercial and Nondevelopmental Items: A Handbook*. April 1996.

[DODA00] DOD. Office of the Deputy Under Secretary of Defense for Acquisition Reform. *Commercial Item Acquisition: Considerations and Lessons Learned*. 14 July 2000.

[DODA01] DOD. Office of the Deputy Under Secretary of Defense for Acquisition Reform. *Commercial Acquisition*. 5 Jan 2001.

[DODI97] DOD IG. Department of Defense Inspector General. *Lessons Learned from Acquisitions of Modified Commercial Items and Nondevelopmental Items*. Report No. 97-219. 23 September 1997.

[DODS96] DOD. *Defense Standardization Program Office, SD-2: Buying Commercial & Nondevelopment Items: A Handbook*. April 1996.

[FAAC98] Federal Aviation Administration (FAA). *COTS Initiative: Phase 2, COTS Software Integration Cost Modeling, Version 0.4, 16 September 1998*.

[FAAC02] Federal Aviation Administration (FAA). *FAA COTS Risk Mitigation Guide: Practical Methods For Effective COTS Acquisition and Life Cycle Support*. June 2002.

[FALV02] Falvey, David, Defense Logistics Agency, COTS Questionnaire Research, rcummins@nps.navy.mil from david_falvey@hq.dla.mil, 09 December 2002.

[FLAN02] Flanders, Pat, APM Logistics Information Systems, COTS Questionnaire Research, rcummins@nps.navy.mil from flanderst@lee.army.mil, 04 December 2002.

[GUIT02] Gutierrez, Paul D."*Commerical or Non-Developmental Item Acquisition Strategy: A Look at Benefits vs. Risks"*, *Project Manager*, pp 66-68, May-June 2002.

[HAKE03] Hake, Peggy L., Marine Corps System Command, COTS Questionnaire Research, rcummins@nps.navy.mil from HakePL@mcsc.usmc.mil, 07 February 2003.

[HALL01] Hall, Jeff, Naff, Ray. *The Cost of COTS,* IEEE AESS Systems Magazine, pp 20-24, August 2001.

[HENS00] Hensley, Barry J. "Development of a Software Evolution Process for Military Systems Composed of Integrated Commercial Off The Shelf (COTS) Components", *Master's Thesis*, Naval Postgraduate School, Monterey, California, March 2000.

[ITRB99] Information Technology Resource Board (ITRB), *Assessing the Risks of Commercial-Off-The Shelf Applications*. December 1999

[LIPS01] Lipson, Howard, Mead, Nancy, Moore, Andrew, *A Risk Management Approach to the Design of Survivable COTS-Based Systems,* August 2001.

[MATS99] Matsuo, Eric K. "Risk Assessment in Incremental Software Development", *Master's Thesis*, Naval Postgraduate School, Monterey, California, December 1999.

[MAUR00] Data and Analysis Center for Software (DACS), SP0700-98-D-4000, *Commercial-Off-The-Shelf (COTS): A Survey.* By Maurizio Morisio and Nancy Sunderhaft, December 2000w/ or w/o a period – check all the way..

[MEYE00] Willard D. Meyer. "Increasing the Utilization of Commercial Items is Acquisition Programs: Problems, Issues, and Best Practices", *Master's Thesis*, Naval Postgraduate School, Monterey, California, December 2001.

[MORR02] Morris, Edwin, Software Engineering Institute, Carnegie Mellon University, COTS Information, rcummins@nps.navy.mil from ejm@sei.cmu.edu, 17 July2002

[NAVY02] Navy Sea Systems Command. *Commercial Off-The-Shelf and Non-Developmental Items Handbook,* March 2000.

[PORT03] Portland, Jeffrey, PdM Common Software, COTS Questionnaire Research,rcummins@nps.navy.mil from Jeffrey.Portland@c3smail.monmouth.army.mil, 20 February 2003.

[SCHN00] Schneidewind, Norman, *The Ruthless Pursuit of COTS*, NATO Symposium: Commercial Off-The-Shelf Products in Defense Applications, Brussels, Belgium, April 2000

[SEDI01] Sedigh-Ali, Sahra, Ghafoor, Arif, Paul, Raymond A., *Software Engineering Metrics for COTS-Based Systems,* IEEE Computer, pp 44-50, May 2001.

[SHAF02] Shaffer, Gordon, *Controlling COTS Risks: A Practical and Systematic Approach*, COTS Journal, pp 15-20, February 2002.

[STEV97] Stevens, Michael R., *Addressing Risk Management in Non-Developmental Items Acquisition Programs*, Defense Acquisition University, Acquisition Review Quarterly, Winter 1997.

[TRAN97] Tran, Vu, Liu, Dar-Biau, *A Risk-Mitigating Model For Large-Scale COTS (Commercial-Off-The-Shelf)Integrated Software Systems*, In Proceedings of the 1997 Annual Reliability and Maintianability Symposium, pp 361-67, January 19997.

[TRIE02] Trieu, Linda P, CECOM SEC, COTS Questionnaire Research, rcummins@nps.navy.mil from Linh.Trieu@mail1.monmouth.army.mil, 02 December 2002.

[USAF00] United States Air Force Scientific Advisory Board, SAB-TR-99-03, *Ensuring Successful Implementation Of Commercial Items in Air Force Systems.* April 2000

[VOAS98] Voas, Jeffrey, "*COTS Software: The Economical Choice"*, IEEE Software, 15(2), 16-19, Mar 1998.

[WILE03] Williams, Ester, Computer Sciences Corportation, Research Assistance, rcummins@nps.navy.mil from willia3e@ncr.disa.mil, 11 February 2003

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