THE IMPACT OF TECHNOLOGY REFRESHMENT ON THE DEFENSE ACQUISITION LIFE CYCLE

YEN-CHOU CHOU

May 2013

PUBLISHED BY
THE DEFENSE ACQUISITION UNIVERSITY
PROJECT ADVISER: MATT KENNEDY
ENGINEERING AND TECHNOLOGY DEPARTMENT,
CAPITAL AND NORTHEAST REGION, DAU
THE SENIOR SERVICE COLLEGE FELLOWSHIP PROGRAM
ABERDEEN PROVING GROUND, MD

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Abstract

In this paper, we will define what technology refreshment (or tech refresh) is in the Department of Defense (DoD) acquisition context. We will show the awareness of the acquisition community on this subject and assess the sentiment of the community toward the acquisition process with respect to tech refresh, and, in particular, the adequacy of the acquisition process in dealing with rapid advancement in Information Technology (IT) and Commercial Off The Shelf (COTS) tools.

Acknowledgments

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Chapter 1—Introduction

In almost all acquisition programs, especially for the major weapon systems or Major Automated Information Systems (MAIS), the development cycles may take 10 years or longer (Harp, 2009). The average time to deliver an initial DoD program capability is 91 months, according to a Defense Science Board analysis of 32 major information system acquisitions (Takai, 2012). It is difficult to keep pace with user needs and technology evolution; therefore, it is important to have a mechanism to eliminate obsolescence at the time of delivery. After deployment, these systems may be in service for much longer time (Donley, 2011). During these times, there will be rapid advancement in the underlying technologies, such as in computing processors, IT, or electronic devices, as witnessed in the past few decades. Furthermore, obsolescence of underlying technologies or components becomes a more pressing issue for the program managers (PMs). There is a need to understand what would be an appropriate time to insert the new technology into the acquisition life cycle, and what the supporting mechanisms are and any programmatic concerns that need to be addressed for successful management of technology refreshment (or tech refresh).

The research has three major goals:

1. Evaluate awareness of the acquisition community on tech refresh.
2. Assess the sentiment of the community toward the acquisition process with respect to tech refresh.
3. Determine the adequacy of the acquisition process in dealing with rapid advancement in IT and COTS tools.

We will show what the acquisition community knows about tech refresh and their experiences in dealing with tech refresh. We will analyze if the acquisition community feels that the acquisition process can or cannot support tech refresh effort adequately. Since IT and software

play important roles in our weapon and business systems, we will show how the community feels about the process with respect to its dealing with rapid advancement in IT.

As part of literature review, we will show the definition of tech refresh from the DoD regulations and policies, the purposes for tech refresh, the requirements for tech refresh as mandated by regulations, policies or resources perspectives, or recommendations, guidance from similar sources. We show the guidelines or supports for anyone involved in tech refresh, the challenges PMs or acquisition personnel face and how they can deal with these challenges with respects to managing tech refresh.

Background

When performing literature review, it was found that terms such as technology refreshment, technology transfer, technology transition, and technology insertion tend to be used interchangeably and therefore it would be important to define them and make a clear distinction (when applicable) for the purpose of this research. Before we dig into the details, a subtle but important feature that makes tech refresh different from others is that tech refresh is to be done "periodically" and "incrementally." This continuity of effort does not appear in the definitions of other terms. It suffices to say that since the advancement of technology is rapid and continuous, it should not be one time effort for the other cases either. Maturity of the technology involved requires a considerable planning and management effort, especially for tech transition.

Tech Refresh (TR)

The definition of tech refresh from DoD Instruction (DoDI) 5000.02:

> *Definition of Technology refreshment (or tech refresh)*
> *Technology Refresh (TR) is defined as the periodic replacement of both custom-built and Commercial-Off-The-Shelf (COTS) system components, within a larger DoD weapon system, to assure continued supportability throughout its lifecycle.*

Another definition of tech refresh found from *Integrated Product Support (IPS) Element Guidebook*:

> *Continuous technology refreshment is the intentional, incremental insertion of newer technology into existing systems to improve reliability, and maintainability, or reduce cost typically in conjunction with normal maintenance.*

This definition shows that tech refresh is done incrementally, continuously and usually in conjunction with normal maintenance. Being intentional requires deliberate planning for resources, schedule and reliability, maintainability considerations by the program management office. It should be noted that in this definition tech refresh is typically done in conjunction with normal maintenance.

Technology Insertion (TI)

Technology Insertion is defined as "a change that incorporates a new product or functional capability, which is the result of industry growth or DoD advanced development (Haines, 2001). An alternative definition for TI is "*the utilization of a new or improved technology in an existing product*" (Kerr, 2008). Stocker further elaborated that "TI refers to the "refreshment" and "enhancement" of system performance and functionality in existing or deployed defense systems by the utilization of a new or improved technology" (Stocker, 2010). From this definition and discussion below from discovery of related DoD source, in this paper, we make no distinction between TR and TI.

DoD 7000.14-R does not differentiate between technology refreshment with insertion and modifications stating that "continuous technology refreshment is the intentional, incremental insertion of newer technology to improve reliability, improve maintainability, reduce cost, and/or add minor performance enhancement, typically in conjunction with depot or field level maintenance" (DoD 7000.14-R). Sue C. Payton, the Deputy Under Secretary of Defense

(Advanced Systems and Concepts) had published on a paper on nine technology insertion programs that can speed acquisition (Payton, 2006). There was no formal definition of technology insertion there, but she advocated that "the Department of Defense must innovate faster than ever before because our adversaries have equal opportunities. To meet this challenge, several technology insertion processes have been consolidated at the Office of the Secretary of Defense, and they can do a lot to speed acquisition." She also indicated that in the recent years, the threats were rapidly evolving and thus created for the needs to rapidly evolving technologies that exceeded our capability to insert those technologies supported by our processes. She cautioned that when introducing technology, our focus should be on mature technologies instead of less proven ones that often delay schedules and drive up costs. She quoted the words of Acting Deputy Secretary of Defense and Secretary of the Navy Gordon England, "The greater institutional risk for DoD is overreliance on traditional platforms and delaying the advent of new technologies and systems". The nine technology insertion programs mentioned in her paper included:

1. Using R&D [Research and Development] That Already Has Been Done under the Independent Research and Development Program
2. Using World-class Developments taking advantage of the Foreign Comparative Testing Program
3. Moving Key Technologies out of Labs Faster with the Technology Transition Initiative
4. Achieving Milestone B Faster under the Advanced Concept Technology Demonstration Program
5. Accelerating Joint Capabilities with the Joint Capabilities Technology Demonstration Program
6. Speeding DoD Technology to Private Sector Manufacturers with the Technology Transfer Program
7. Faster, Better, and Cheaper Manufacturing by the ManTech Program
8. Speeding Production of Critical Technologies with Defense Production Act Title III Program

9. An On-Ramp for Industry Innovation using the Defense Acquisition Challenge Program

It is clear that her idea of TI is a big umbrella under which the DoD acquisition processes can benefit from all sources and that evolving technologies can be provided faster than dictated by the current process. Tech transition, technology transfer, foreign or Science and Technology (S&T) sources, private sectors, are all included as tech insertion efforts.

Technology Transition (TT)

In the *Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment,* Ms. Payton and Frank Anderson, Jr., president of DAU, stated that an important initiative is to get the latest technology into the hands of the warfighters in the quickest, most cost-effective manner possible [DAU, 2005]. TT is defined as "the use of technology in military systems to create effective weapons and support system—in the quantity and quality needed by warfighters to carry out assigned mission at the "best values" as measured by the warfighters." TT can occur during the development of systems or after the deployment of the systems. The guide does not provide any differentiation between TT and TR. It provides the following advice to the Acquisition, R&D, and Sustainment Communities: "no matter whether your system uses defense-unique technology or commercially technology, your program must be designed to keep pace with the rapid cycle of the commercially available technology, changes and obsolescence will be continual. The way to deal with these changes and obsolescence is to design for them, plan for, budget for, and have a technology refreshment programs in place so improvements in both capability and affordability can be incorporated throughout the useful life of the system." There also are considerations for putting incentives in the contract for continuously inserting and refreshing value-added technology. Regular upgrades using tech refresh are encouraged instead of major end-of-life modification or a follow-on system also is advised. Tech refresh can help the

sustainment community to improve weapon system reliability, maintainability, and supportability and maintain long-term competitive pressures (to the vendors).

Here we summarize the definitions of technology insertion, technology refreshment, technology transfer, and technology transition in the table below:

Table 1. Definitions of Technology Insertion, Refreshment, Transfer, and Transition

Technology Insertion	*A change that incorporates a new product or function capability, which is the result of industry growth or DoD advanced development.* Alternatively, it is defined as *the process of incorporating and exploiting new or improved technology into existing platforms, systems, and equipment.*
Technology Refreshment	*The periodic replacement of commercial off-the-shelf (COTS) components within larger systems to assure continued supportability of the system through an indefinite service life.* Alternatively, it can be defined as *a strategy to provide cost-effective support and upgrade strategies, to keep a program ahead of the obsolescence curve. This strategy should result in regular upgrades instead of major end-of-life modifications or follow-on systems.*
Technology Transfer	*Technology transfer is the process of sharing knowledge gained in federal laboratories with the private sector, generally to encourage new commercial markets and applications.*
Technology Transition	*The process of applying critical technology in military systems to provide an effective weapons and support system—in the quantity and quality needed by the warfighter to carry out assigned missions and at the "best value" as measured by the warfighter.*

When discussing and trying to understand tech refresh, the author found out that there were several concepts that may be useful to form the basis for dealing with tech refresh. They are discussed as follows:

Agile Process

Agility in system acquisition has been a hot topic among the research and acquisition communities. The agile process used in the Network Integration Evaluation (NIE) has been the guiding principle for the semiannual integration and evaluation effort. In providing the rationale for agility in the system development, the author argued that "the need to rapidly field system has never been more important" due to the fast-paced nature of technology (Kennedy & Ward, 2012).

Well-defined requirements alone are not sufficient for the success of any acquisition program, but the ability to respond to change during development, deployment, and after deployment is equally important. Otherwise, the system may become obsolete even before it is fielded, the author cautioned. As quoted in the paper, the March 2009 *Report of the Defense Science Board (DSB) Task Force on Department of Defense Policies and Procedures for the Acquisition of Information Technology* concluded that "the conventional DoD acquisition process is too long and too cumbersome to fit the needs of the many IT systems that require continuous changes and upgrades" (DSB, 2009). In a research paper for the Army War College on Moral Imperative for Change when he studied the Army's failed programs, LTC William Robare indicated it is paramount to focus on the speed at which we develop and deliver the capabilities that the warfighter require on the battlefield (Robare, 2011).

Technology Readiness Levels (TRLs)

Payne mentioned that when inserting technology the focus should be on mature technology to reduce the risk of a negative cost and schedule impact if unproven technologies are used (Payne, 2006). A well-known concept of TRL measures the maturity of technology. The acquisition policies require a minimum of TRL 7 ("system prototype demonstrated in an operational environment") for a critical technology to be incorporated into a production program (an important best practice recommended by the Government Accountability Office (GAO) to control technical risk, and strongly supported by DoD). On the other hand, expectations for the S&T community have traditionally been to advance new technologies only to the TRL 5 level of maturity ("component and/or breadboard validation in a relevant environment" [e.g., high-fidelity laboratory]). The gap or chasm between the DoD S&T (TRL 5) and acquisition (TRL 7) communities, commonly referred to as the "valley of death," illustrates the challenge for tech

transition and needs to be bridged through cooperative efforts and investments by both communities.

In Department of Defense Report to Congress on Technology Transition (DoD, 2007), four broad areas for improvement were recommended (paraphrased here):

1. S&T community "pushes technology" by having early and frequent collaboration between the developer, acquirer and user for "*technology push.*" Technical issues, resource requirements/sources, avoiding unintended consequences, and ultimately gaining the most yield for the S&T investment can be identified in this effort.
2. PM "pulls" technology by conducting early and frequent communication with the developer about user requirements and companion acquisition plans requirements, resources, and acquisition strategies for timely technology transition ("*acquisition pull*").
3. Include innovators from the private sector and eliminate technical, cultural, and business barriers to integrating new suppliers and new technologies into defense system architectures. The pace at which new technologies are discovered, innovated, developed, and deployed in the private sector is staggering, and at odds with the linear, deliberate nature of some military acquisitions.
4. Use a federated approach to coordinate agile acquisition efforts, look for unrealized synergies among transition programs, and ensure adequate resourcing.

The report provided a synopsis of the challenges reported by the military departments and defense agencies for technology transition, including Organizational and Culture Barriers, Acquisition Regulations, and Technology Transition's Role in the Planning, Programming, Budgeting, and Execution (PPBE) System. For each challenge area, considerations were suggested. For example, to address organizational barrier, it was suggested that "mechanisms are needed that continually train and motivate the S&T and acquisition communities to work together to reach a common outcome." The communities need a clear understanding of requirements, needs, S&T, acquisition, supportability, statutory/regulatory guidance, and resourcing methods.

For acquisition regulation challenge, it is recommended that "an amendment for a 'bridge' between the end of the basic research portion of a contract award under a Broad Agency Announcement (BAA) and the award of a contract under a new acquisition for advanced research or production could fill the void created by the existing contracting regulations." For PPBE issues, there may be needed "a business process to provide gap funding to sustain technology effort until the next budget cycle in which obligation and disbursement rates would not be cause for reprogramming." These challenges and considerations should be equally applicable to tech refresh effort.

Problem Statement

Rapid advancement of technology coupled with long development and service life of the weapons systems pose challenges to the acquisition community in the tech refresh planning effort.

Purpose of This Study

The purposes of this study are to assess the awareness of the acquisition community on tech refresh, assess the sentiment of the community for the acquisition process with respect to the support of tech refresh, and assess if the current acquisition process adequately addresses tech refresh effort, especially for IT and COTS.

Significance of This Research

The rapid advancement of technologies in the past few decades causes the underlying technologies used in the weapon systems or information systems to become obsolete and unable to address the ever-evolving threats. Given the long development time and service life of weapon systems and MAIS, it is important for the acquisition community to gain a better understanding of the issues and planning of tech refresh to avoid obsolescence and meet the new threats.

Overview of the Research Methodology

The research was guided by conducting a literature review that evaluated federal laws, DoD and Army regulations or guidelines, Defense Acquisition University (DAU) resources, Webster University libraries, and various acquisition and research publications related to tech refresh. Then a survey consisting of questions designed to draw answers to the research questions was sent out to the acquisition and S&T communities at Aberdeen Proving Ground, MD. The survey results then were analyzed and summarized to see if the research questions were addressed. The research was augmented by two case studies on tech refresh to compare and contrast the survey results with operational programs.

Research Questions

In this research, the author attempts to address the following:

1. Evaluate awareness of the acquisition community on tech refresh.
2. Assess the sentiment of the community toward the acquisition process with respect to tech refresh.
3. Determine the adequacy of the acquisition process in dealing with rapid advancement in Information Technologies (IT) and Commercial Off The Shelf (COTS) tools.

Limitations of the Study

The audience of the survey is mostly from the Aberdeen Proving Ground, MD, and thus does not provide the experience and insight from the overall Army or DoD acquisition community.

Validity of the Research

From the return of the survey, roughly half of the respondents replied no previous experience with the subject of the research. This provides some challenges in analyzing the results because some of the questions may be affected by the experience in tech refresh. On the other hand, it provides us a good opportunity to compare and contrast to see if the experience affects the opinions and understanding of this subject. In the analysis section, if there is discrepancy in the

result, we will show the results from the general audience and compared against with those with experience. We may show the percentage from the whole population on some question and show the corresponding percentage from those with experience when it is convenient to do so. For example, for survey Question 14, we will show 34 percent (51 percent) answered “Yes” and 55 percent (49 percent) answered “No” to show that 34 percent from the general audience and 51 percent from the experienced population answered “Yes.”

Reliability of the Responses

Judging from the insight and balance of views provided in the written comments, the available data are deemed reliable and valid enough to use in support of this research.

Chapter 2—Literature Review

Research Project Requirements

While presenting the literature review, we will start with general description on DoD policy or regulations, guidance that Program Management Offices (PMOs) need to be aware of or plan for, also from sources like DAU training material or courses on this subject, then we will cover the rationale and enablers for technology refreshment, followed by acquisition process considerations for PMOs including programmatic and budgeting concerns, and finally a summary.

General Discussion

In this section, the findings from the literature review on Defense acquisition policies, regulations, and *Defense Acquisition Guidebook* (*DAG*) are presented to show what PMs need to plan and prepare for, what the budgeting requirements are, which personnel should be in charge of the effort, and what guidance and help is available.

DoD Instruction 5000.2

DoD Instruction (DoDI) 5000.02 requires PMs to use technology refreshment as a means to "optimize operational readiness" in an affordable manner. (DoDI 5000.02)

Army Acquisition Policy, Army Regulation (AR) 70–1

Section 8.15 states that continuous technology refreshment is the *intentional, incremental* insertion of newer technology into existing systems to improve reliability, and maintainability, or reduce cost—typically in conjunction with normal maintenance. It further specifies the conditions under which color of money (that is, Operations and Maintenance Army (OMA), Research, Development, Test, and Evaluation (RDT&E), or procurement) can be used for technology refreshment in accordance with 10 U.S.C. 2245a, annual DoD appropriation acts, and DoD 7000.14–R.

DoD and Army Guidance

There are many sources from DoD or the Army providing guidance. For example, in the *Integrated Product Support Element Guidebook*, the following advice was given:

> *A technology refresh program will need to have an enterprise perspective and include the functional areas of supply chain management, obsolescence and Diminishing Manufacturing Sources and Material Shortages, capability enhancement, life cycle sustainment planning, and metrics to guide and drive resources and efforts.*

In the *DAG*, a section on Standardization suggests that "these standards also facilitate rapid insertion of new technologies and integration of parts from alternate sources and suppliers, which improves supportability and permits rapid technology refresh of military systems that are often in service for decades." Also the section on Support Concepts advises using "Iterative Technology Refresh" as one of the key Support Concept sub-elements (*DAG*, 2011).

In product support section 5.1.1.1 of the *DAG*, the following advices were given to PMs when planning for product support concept. It needs to support both the hardware and software (including COTS software). Also a plan for tech refresh and maintaining the software after production is needed. It should include how changes will be budgeted and executed along with the necessary technical data required to sustain the software throughout the system life. The plan should address how obsolescence, technology refreshment, and maintaining the software including the effort for sustaining and administering the software, customer support, and help desk should be budgeted and managed.

Senior Leader Thoughts on Tech Refresh

When Malcolm O'Neill, the former Assistant Secretary of the Army for Acquisition, Logistics and Technology, addressed National Defense Industrial Association (NDIA) Executive Seminar, April 20, 2010, on Army Acquisition Challenges and Opportunities, he showed there are

many opportunities for improvement (O'Neil, 2010). One particular opportunity was product obsolescence due to the acquisition process. There should be a tactical focus on urgent needs and contingency operations execution. O'Neill indicated that technology evolves faster than the traditional acquisition process. There is a need to prepare for evolving threat environment, and plan for increment insertions of technology updates. A balanced "horizontal" view of technology across the enterprise is necessary to avoid stovepipes, and must commit to a program through stable funding. There was another opportunity on cycle time which was caused by inflexibility in budget planning process and an evolving operational environment, and every step in the acquisition process inevitably lengthens the cycle time. Although O'Neill's talk did not directly address tech refresh, there were several points he raised that can be resolved by tech refresh.

Defense Acquisition University

An online course CLL 019 "Technology Refreshment Planning" introduces students to an overview and introduction to technology refreshment as it applies across the weapon system life cycle. It shows topics such as what technology refreshment is and an awareness of the importance of technology refreshment to the weapon system program. The students are advised on making strategic decisions during the systems engineering process that will determine the ease and affordability when new technology is inserted into existing systems. Other considerations also were addressed such as the system development approach, Modular Open Systems Approach (MOSA), use of COTS technology, Performance Based Logistics (PBL) approach, and how to identify and manage Diminishing Manufacturing Sources and Material Shortages (DMSMS). More information on MOSA can be found in the *Program Manager's Guide to A Modular Open Systems Approach to Acquisition*.

Rationales for Technology Refresh

Grasso stated that "Federal information technology programs operate in an environment of rapid technology evolution in which some system components become obsolete while the program is still in development" (Grasso, 2009). He further indicated that due to the fast pace of technology advancement, the program teams need to have agility in the decision process and must keep their skill base current. This point merits good attention because most attention in the literature has been on managing technology advancement and little on the skills of the people who manage the change. The *DAG* stresses that, due to the extensive life of our systems and rapid technology change, it is important to have technology refreshment and obsolescence management. That includes successful parts management to address DMSMS. Such planning should be performed in the proposal, design, and sustainment phases of a product. PMs are advised to take a proactive approach in managing obsolescence problems before they impact the life cycle costs (LCCs) and system availability adversely. An Air Force vision on Technology Horizons for 2010-2030 said the fast pace of technological advancement was compounded by the fact that the weapon systems will remain in service long after they are fielded (Donley, 2011). Integrating new technology-derived updates is found to be difficult and costly. The report further stated that the global technology refresh rate is now far faster than just a decade or two ago. Adversary capabilities obtained with less exquisite systems may have increasing access to faster technology refresh cycles. To maintain a sufficient technological advantage, it is necessary for the Air Force to remain nimble and adapt to the faster technology refresh rates. It was highlighted that "new approaches that can enable far faster technology refresh rates in Air Force systems and subsystems are key to achieving the far greater flexibility that will be needed to respond to the range of future threats." The conclusions drawn are equally applicable to other military Services.

An NDIA paper on Affordability stated that a majority of defense systems are kept in use far beyond the intended lifespan. The DoD also is buying fewer systems and keeping them longer. The paper suggests that periodic investments, such as major modifications, SLEPs, or major upgrades (to change or enhance mission or performance) are needed to extend the service lives of existing systems. It also suggests that for systems driven by shorter life cycles such as COTS subsystem or Information Technology systems, emphasis on technology management, including technology refreshment or insertion would be beneficial (NDIA, 2010).

It can be summarized that the purposes for tech refresh include:

a. Supply of parts or components addressing obsolescence and DMSMSs,
b. Capability enhancement,
c. Life cycle sustainment,
d. Improve reliability, and maintainability, or reduce cost,
e. Service life extension programs (SLEPs.

Acquisition Process and Programmatic Considerations

Architectural Considerations

In *DAG*, Figure 5.3.1.F1 lists key system architecture attributes that can provide a solid sustainment foundation. Architectural considerations like open system orientation, modularity, and scalability are critical to implementing an incremental acquisition strategy. These architectural attributes that expand system flexibility can make easier the implementation of tech refresh effort to manage obsolescence and end-of-life issues.

There also was a discussion on open architecture in the Naval Open Architecture (NOA) in the acquisition strategies (Guertin & Clements, 2010). The authors defined open architecture as "an architecture that employs open standards for key interfaces within a system." Since the standards are based on consensus and publicly published, any competent supplier can provide confirming implementation, thus allowing the owners the opportunity for competitive bids for each

module to provide the best solution. Modular designs with loose coupling and high cohesion allow for independent acquisition of system components, enhanced transparency of system design, and analysis to determine which components will provide the best return on investments based on factors such as changes due to technology upgrade or part obsolescence and costs associated with the changes. The authors considered two dimensions of change: the pace of change in the underlying technology and potential demand for capability change by warfighters. The two change dimensions require a technology refresh strategy and a capability evolution strategy. These two strategies actually are two sides of the same coin and need to be incorporated into a coherent program plan.

Planning Considerations

Under Computer Resource in Product Support Policy Assessment Criteria, there are assessments concerning technology refresh in the *Logistics Assessment Guidebook* (DoD, 2011a). They are shown verbatim below.

12.1.20 There are plans for processor upgrades such that technology refresh can be accomplished with minimal software modifications.
12.1.23 A process to proactively project vendor discontinuance of software support, software revisions, upgrades, etc., has been developed and documented to ensure both program software and software support tools can be sustained and software refresh can adequately be planned
12.2.2 A proactive process is in place for support of software to include system and third-party software to effectively: 1) forecast software sustainment issues and identify time periods for software availability and support; 2) capture the cost trade-off criteria for full or partial software updates; 3) identify upgrade schedules to reduce transition costs associated with updates; 4) identify accurate budget estimates; and 5) provide a process that can be used to help manage and optimize the efficiency and effectiveness of software tech refreshment.

Performance Based Logistics Strategy

PBL strategy focuses weapon system support on identified warfighter required performance outcomes, rather than on discrete transactional logistics functions. Although PBL is not directly related to tech refresh, vendors under PBL agree that technology refresh may be used as a means to achieve PBL. It was reported that PBL can be used as a tool for proactive DMSMS (Shimazu). Shimazu indicated that features in PBL will encourage proactive DMSMS management and have shown replacement part availability guarantees rate of 85 percent to 90 percent and have ensured projected obsolete parts have substitutes or alternatives. Also fixed-price PBL contracts will limit cost risk to the government and encourage low-cost parts substitutions instead of costly redesigns. The briefing showed success stories such as Navy F-14 Night Target System PBL with $33 million savings over 8 years; E-2 Mission Computer with $14 million savings over 15 years; and ARC-210 Radio with $5.4 million savings over 5 years.

The *DAG*, section 5.4.3.5.2, states the PM should use PBL contracts that provide significant latitude to manage technology refreshment. The contractors should be incentivized to maintain currency with state-of-the-art technology and use readily available items to avoid the high cost of DMSMSs over the system's life. It is critical to balance carefully investments in logistics and technology to leverage technological advances through the insertion of mature technology. The PM should ensure that the PBL strategy addresses warfighter requirements during peacetime, contingency operations, and war.

Contracting Considerations

From a sustainment perspective, contracts should be structured to balance three major objectives throughout the life cycle of the system: 1) delivering sustained materiel readiness; 2) minimizing the requirement for logistics support through technology insertion and refreshment;

and, 3) continually improving the cost-effectiveness of logistics products and services. It is critical to carefully balance investments in logistics and technology to leverage technological advances through the insertion of mature technology.

In the *DAG*, section 5.1.5.2, a methodology for implementing sustainment contracts stressed that contracts should be structured to balance three objectives:

1) Delivering a sustained materiel readiness
2) Minimizing the requirement for logistics support through technology insertion and refreshment
3) Continually improving cost-effectiveness of logistics products and services

It also stressed that leveraging technological advances through the insertion of mature technology is critical.

Budgeting Considerations

In AR 70-1, *Army Acquisition Policy*, the funding categories to be used for tech refresh are specified in 8-15.b, c, and d (AR 70-1, 2011). The related rules are shown below verbatim as follows:

a. The OMA funds may pay for continuous technology refreshment only if it is classified properly as an expense under expense or investment threshold criteria in accordance with 10 U.S.C. 2245a, annual DoD appropriation acts, and the DoD Financial Management Regulation.

b. Continuous technology refreshment cannot be OMA funded when—

1) It is properly classified as an investment under expense or investment threshold criteria in accordance with 10 U.S.C. 2245a, annual DoD appropriation acts, and DoD 7000.14–R;

2) The spares or components used in refreshment are centrally managed;

3) The end item to be refreshed has not been produced and fielded;

4) The changes are part of a Service Life Extension Program; or,

5) The changes are made to increase the performance envelope or mission capability.

c. *If any criteria in paragraph c, above, apply, then RDT&E funds or procurement funds, as appropriate, will be used in accordance with normal funding criteria.*

Several budget justifications for including funding for tech refresh from many programs can be found in the Defense Technical Information Center (DTIC) database. Samplings of these budget justifications with different Budget Activities (BAs) and activities related to tech refresh effort are shown below:

a. BA 3: Advanced Technology Development (ATD) to "conduct a technology refresh to make <product> more valuable to the community and more efficient to operate"
b. BA 7: RDT&E for "A technical refresh will provide the <system> with a replacement for the obsolete <system>"
c. BA 5: System Development and Demonstration (SDD) for "future Technical Refresh insertions for obsolescence and processing Improvements"
d. BA 6: *RDT&E Management Support to* "address technology refresh, obsolescence and sustainment issues … and refresh software to run on new hardware"
e. BA 5: for "a COTS refresh development effort will be necessary …"
f. BA 7: *Operational Systems Development* "to refresh end-of-life <system>"
g. BA 7: *Operational Systems Development* for "Technology Refresh will modernize legacy <system> processing and thereby extend its effective service life"

Shown here are some samplings to illustrate the purposes for which the budgets for tech refresh were requested. The budget justification can be for managing obsolescence, extend end-of-life of service, enhance performance, or adaptation (ex. run on new processor).

System Engineering Process and Life Cycle Support

In the *DAG*, when advising PM in establishing logistics support concepts (e.g., organic, two-level, three-level, contractor, etc.), key support concepts should be considered to provide cost-effective, total life-cycle logistics support. "Iterative technology refreshment" is one such key concept (Section 4.4.19.2). Furthermore, in section 5.1.1.1 Product Support, it is stated that tech refresh should be planned for maintaining software after production, maintaining the software due

to changes for obsolescence and technology refreshment should be budgeted and executed along with the necessary technical data required to sustain the software throughout the system life. Aspects such as customer support, systems administration help desk support, etc., need to be considered while sustaining the software.

The extensive life of the weapon systems and rapid technology changes are cited as the reasons technology refreshment and obsolescence management are needed in *DAG* [section 5.4.3.4.2]. Addressing diminishing manufacturing and material shortages are necessary in the proposal, design, and sustaining phases of a product. The PM also is advised to adopt a proactive approach to handle obsolescence problems before it has an adverse impact on LCC and system availability. Three approaches are suggested for consideration:

1) Design features that facilitate changes and insertion of new technology (Sandborn & Singh, 2005).
2) Establish a change management process for life cycle support.
3) Use PBL contracts. See PBL strategy section for the benefits and impacts on tech refresh.

Post-Production Support Planning (PPSP) includes management and support activities necessary to ensure attainment of readiness and sustainability objectives with economical logistics support after cessation of the production phase for a system. AR 700–127, July 17, 2008, specifies that the completion and update of PPSP will be done in different phases of the life cycle. For example, the initial Post Production Support (PPS) plan should be included as an annex to the Life Cycle Sustainment Plan (LCSP) by Milestone C. It further states that “continuous Technology Refreshment will be addressed as part of the PPS strategy to provide a means to acquire technologically improved replacement parts and to reduce ownership costs.”

Challenge for Program Managers

Kathy Peake, a DAU professor, addressed the specific challenges for the PM of Information Technology (IT) (Peake, 2010). She indicated that although DoDI 5000.02 provided a more defined approach for weapon system acquisition than that of IT systems. The 5000.02 process was fairly rigid and did not allow for the flexibility needed for managing IT system acquisitions. Although she indicated tailoring was possible, there were still three issues related to IT—namely, the rate of technological improvements, the processes for both acquiring and fielding new IT components, and funding for IT programs. Obsolescence was an issue for IT as new technologies emerged, seemingly overnight. IT users also demanded the latest technology for increased functionality, or to patch a vulnerability, cyber threat or incompatibility created by other emerging capabilities. Although obsolescence was also an issue for weapon systems, having to replace certain components in IT systems due to repetitive obsolescence was difficult. The rapid change and undefined processes challenged the PM to avoid significant delays, cost overruns, and performance problems. She advised that contracts for IT need to be well written to accommodate the rapid changes in IT. Contracting modification processes needed to be flexible and streamlined to avoid impeding tech refresh. Another area for concern is the systems engineering process. A mechanism was needed to support multiple baselines as well as support the upgrades. User training was another aspect of the tech refresh effort that needed to be managed. She pointed out the PPBE process did not function well with the rapid pace of technology advancements. How did the PM budget for the unknown requirements? In all, she stressed that the PM needed to think ahead and have a well-thought-out tech refresh process. Peake concluded that dedication by senior government officials who recognize the issues caused by the current processes and can affect the needed change in those processes. In the author's opinion, some of the issues raised in this paper

are similar to those faced with the weapon systems PM because some of the technologies used in weapon system also may experience rapid advancement.

Acquisition Phases

Various advices and considerations for tech refresh abound in all phases of the acquisition phases. For example, there are assessment criteria for Milestones B, C and at Full Rate Production (FRP) that evaluate if there are tech refresh plans for processor upgrades or software refresh, if there is a process to help manage and optimize the efficiency and effectiveness of software tech refresh in the *Logistics Assessment Guidebook* (DoD, 2011a). Some of the criteria are shown below verbatim to illustrate some of the considerations.

12.0 Computer Resources	**Milestones**		
ASSESSMENT CRITERIA	B	C	FRP
12.1.20 There are plans for processor upgrades such that technology refresh can be accomplished with minimal software modifications.	F	U	U
12.1.23 A process to proactively project vendor discontinuance of software support, software revisions, upgrades, etc., has been developed and documented to ensure both program software and software support tools can be sustained and software refresh can adequately be planned.	F	U	U

F (Finalized) checks if the activity has been completed and finalized. U (Update) denotes that the activity is updated as required by statue, regulation, or to reflect new data.

There is another assessment on COTS that evaluates if there is planning for technology refresh and insertion as a part of the systems engineering process and includes market research over the life of the system to identify potential replacements in anticipation of end-of-life issues.

During the Operations and Support (O&S) Phase, the Product Support Manager (PSM) is advised to be actively engaged in planning for tech insertion, system upgrades, or engineering change proposals. Using an evolutionary approach to deliver the capabilities in increments, the PSM needs to recognize up front the need for future capability enhancements and opportunities to improve reliability, maintainability and availability (DoD, 2011b, section 5.6.5.4). In the same

section, while performing upgrades for SLEP, the PSM was advised to pay due diligence on the following areas: technology maturity, COTS, design integration, configuration management and status accounting, and supportability.

Coordination

The PSM has the responsibility for ensuring the maintainability and suitability of the fielded system, while reducing the LCC (DoD, 2011b). However, in order to identify and leverage improvement opportunities, the PSM must work in conjunction with the PM and systems engineer. While involved in a modification to the weapon system, the PSM should consider obsolescence, PBL to support the modification, and ensure funding and resources are allocated.

Commercial Off The Shelf

In the *Product Support Manager Guidebook*, there is a section (5.6.5.4) on Technology Refresh and Insertion that addresses the particular issues related to tech refresh in the Operations and Support Phase (DoD, 2011b). In addition to advising the PSM to be engaged actively in planning for technology insertion and system upgrades, the PSM is cautioned not to overlook areas that have a direct impact on supportability such as technology maturity, COTS, design integration, configuration management and status accounting, and supportability. Before adopting COTS, the PSM should be involved in an Analysis of Alternatives. Moreover, while COTS may provide benefits such as reducing schedule, greater technology maturity and stability, and reduced cost initially, supportability in the long run must outweigh such initial benefits. It is warned that there is generally an overestimation of configuration management, maintenance planning, design integration complexity, rigidity applicable to intended operational environment, intellectual property access, design interface challenges (System of System compatibility) and obsolescence. This issue will further described later in the case studies.

In a Department of Homeland Security (DHS) Acquisition Directive 102-01, there was a caution that Commercial Off The Shelf/Government Off The Shelf (COTS/GOTS) procurements require the same due diligence and careful planning. It indicates that if the COTS/GOTS products are modified more than 5 percent, they no longer are considered COTS/GOTS. This directive requires the development and approval of a technology refresh plan that addresses suppliers in an Integrated Logistics Support Plan (ILSP), in addition to a tailored set of Systems Engineering Life Cycle (SELC) phases and documents (DHS, 2010). The low threshold (5 percent) for modification to COTS should be noted.

Enablers of Tech Refresh

A research paper showed a methodology for forecasting technology insertion concurrent with obsolescence driven design refresh planning (Sandborn & Singh, 2005). The authors stated that many systems and products that have longer life cycles than the constituent parts (the special interest of the authors were in COTS electronic parts). They claimed that this mismatch in life cycles between systems and constituent parts has caused high sustainment costs in order to keep an existing system operational, and continue to manufacture and field versions of the system that satisfy the original and evolving requirements.

In a short position paper, Shiwanand Pathak showed several key drivers for tech refresh as: (1) aging and obsolete technology, (2) out-of-support technology, (3) skill-set shortage, (4) compliance, (5) cost reduction, (6) standardization, (7) innovation, and (8) vendor stability (Pathak, 2011). The key points of his papers are:

(A) Many companies worldwide do not have a proactive approach to technology assessment; as long as the existing technology is meeting its stated purpose it is good to go. These legacy technologies get heavily customized to meet the user demands and make it harder to migrate to a newer technology.

(B) As long as the outdated technology is used, the organizations are stuck with out-of-support technology components.

(C) That will slowly lead a skill-set shortage as the number diminishes of people who know the legacy technology and getting skilled resources becomes a problem.

(D) Regulatory compliance is mandatory for all organizations. When a technology component becomes obsolescent, or the existing vendors stop supporting it, this component becomes vulnerable to compliance requirements.

(E) Pathak believes technology refresh helps in reducing the operational spending and enhances the organization capability and helps to lower the IT cost. Legacy technology becomes expensive to maintain over time.

(F) Due to merger or acquisition, companies often bring together diverse technology components. There is a need to decide how to integrate them in a standardized way. Technology refresh can be used as a way to achieve their standardization goals.

(G) Organizations look for the innovations to improve their competitive positions. "Technology refresh" can be used as a strategy to migrate to newer technologies.

(H) Vendor stability is one of the key factors which drive "technology refresh" considerations. If the vendor stability becomes an issue, it will affect its competitiveness.

Although the author did not offer any theoretical grounding for his claims, the points coincide with the *Integrated Product Support Element Guidebook* in continuous modernization and improvement section that use of performance standards, COTS/Non Developmental Item (NDI) preferences, commercial specification and standards, and open system architecture will be helpful in modernization. New technologies can be introduced rapidly into weapon systems to meet new requirements with continuous modernization, which anticipates obsolescence, anticipates emerging requirements, and ensures new technologies are available to satisfy the new requirements (DAU, 2011, section 3.5.2). It is noted that China has marshaled the political will and resources to ensure the progress of science and technology as the cornerstone of China's economy (Song, Zuga, & Pecht, 2013). One of the primary objectives is the development of a strong dual-use industrial

base. The authors observed indicators of an emerging government sponsored dual-use industrial base. Given the budgetary constraints in the defense acquisition programs, it seems that the development of dual-use industrial base in the United States would be a good idea to facilitate tech refresh. However, it is less likely a sponsoring organization will emerge will emerge in the United States.

Summary of the Literature Review

The acquisition community has numerous policies and regulations which mandate the use of tech refresh. However, little research exists on whether these policies and regulations help or hinder the tech refresh effort. In addition, there are various papers, guidebooks, and training modules available to assist the community in the tech refresh process but the extent to which they are known to the acquisition community is yet to be determined. We summarize the purposes of Tech Refresh as follows:

I. Managing Parts or technology obsolescence
II. Handling DMSMS
III. Improving System Performance
IV. Introducing New Technologies
V. Reducing O&S Costs
VI. Service Life Extension
VII. Dealing with new threats or user needs

Chapter 3—Research Methodology

The purpose of this study is to evaluate the awareness of the acquisition community on tech refresh, assess the sentiment of community toward the current acquisition process with respect to its helpfulness or hindrance to tech refresh, and determine the adequacy of the acquisition process in dealing with rapid advancement in IT and COTS.

Research Process

The research started with literature review from several sources of information mostly from the Army, DoD such as DoD and Army guidance and regulations, the DAU, *Army Research Journal*, DTIC, *Defense AT&L magazine*, DAU sources (such as Ask A Professor, short courses), and the *DAG*. Based on the literature review, it becomes clear there are many sources on what must be done (regulations, guidance) but not many references can be found on how the acquisition process supports or hinders tech refresh. Nor are there many references that show the results of the tech refresh. Therefore, a set of survey questions was designed to gather information to answer the research questions shown in the previous section.

In addition, the author had a chance to conduct an interview with a program that has gone through many tech refresh efforts.

Data Collection

The data were collected through an online survey that consists of 31 questions, divided into three categories: (1) The first category of questions gathers information on the respondents' previous experience with tech refresh; (2) The second category asks the respondents for their opinions on when and how tech refresh should be planned and started, and what timeframe or acquisition phase the respondents believe the optimal time for planning or introducing tech refresh; and (3) The third and last category is on the respondents' opinions about how well the acquisition

process supports or facilitates tech refresh. There are many questions that concentrate on IT and COTS. There are several questions to gather demographical information.

How Will the Data be Collected?

The data will be collected by a research survey sent out to the acquisition community. In addition, input from S&T community was also sought. Two case studies on separate tech refresh efforts were included. One of the case studies used face-to-face interviews with the development team. The other case was from the author's personal experience in a previous program that went through COTS tool migration.

Chapter 4—Findings

The objective of this research is to find out the challenges faced by the PMO and Acquisition Community when dealing with tech refresh and specifically how the current acquisition process supports it. Before we present the analysis from the survey data, we show two cases related to tech refresh.

Case Studies

Case 1: AN/TSC-93E

The AN/TSC-93 Tactical Satellite Communications (SATCOM) terminal was designed in the middle to late 1970s to support long-haul data traffic requirements from theater to theater. At conception, the system was manually operated and setup. As the performance of ground hardware improved, less expensive space certified hardware was possible. The system underwent Radio Frequency (RF) upgrades that were a huge success programmatically and technically. With the advent of computers more prevalent, the idea to automate via instrumentation technology refresh effort was put forward. The tech refresh effort was performed by SATCOM Developmental Systems Branch under guidance of Rick Dunnegan. Control Monitor and Alarm (CMA) software automation was first introduced in the "D" version. The software was designed and developed 100 percent by government employees at the Joint SATCOM Engineering Center (JSEC). To move forward with the CMA, both hardware and software upgrades were considered. The second automation upgrade "E" version, as a Service Life Extension Program (SLEP), required several elements of the AN/TSC-93 to be upgraded (Dunnegan, 2013).

AN/TSC-93E SLEP Upgrade included:

- Enhanced data rate capability meets/exceeded 50 Mbps [Megabits per second] requirements.

- Utilized DISA [Defense Information Systems Agency]-certified MD-1366 Enhanced Bandwidth Efficient Modem [EBEM].
- Downsize converters reduces number of converters required using block conversion.
- Provide CV-MCU converters for fiber optic user circuits.
- Added Ka capability option.
- Wired for Time Division Multiple Access (TDMA) option.
- Used “Up-Armor” configuration.

There were several limitations on the “D” version hardware, such as outsourced compute assembly; limited serial ports, RAM, and processing power; and inability to follow Windows 7 migration. An interim expansion solution including Ka Band capability was devised to utilize serial to USB conversion with COTS components and eliminate the need for major hardware reconstruct. The upgrade in computer hardware included a 1.2GHz (gigahertz) processor, 4GB (gigabytes) RAM, and the number of serial ports was doubled and expansion capabilities were increased utilizing the current 485 bus. Windows 7 was fully tested on this computer, and operations were demonstrated in Windows 8.

There were many changes in CMA hardware. Several existing hardware components were replaced with newer technology. For example:

- High Voltage Power Supply retained all of the Control Graphical User Interface (GUI) and 95 percent of the original code was replaced. Two minor additions to GUI include refreshing every 20 seconds, and power or communication failure indications.
- Down Converter was retooled with some control GUI changes, no code change, and power or communication failure indications.
- ETSSP (Enhanced Tactical Satellite Signal Processor), which was originally designed as a stand-alone application, was transferred from CMA 2.0 series and incorporated into CMA. Communication format was used for ACU. There was much coding effort to provide 80 percent visible data with single line parsing for ETSSP and made it the most autonomous equipment.

- New Up and Down Converters were added to provide down- and up-link communications.
- SLM-5650A Modem was added with design, function, and much of the code reused from another mission. New coding still is needed.
- CV-MCU2 comes with the unit a two-line front panel display. But GUI provides easy programming and is preferred by the soldiers.
- L3 Ka Block Up Converter provides complicated communication capability and is required for Ka Interface box.
- Wavestream Block Up Converter for which a stand-alone Control GUI was developed in 2 weeks and integrated into CMA in 2 additional weeks. It requires Ka interface box.

With the changes in hardware and associated code, the new CMA possesses:

- Ability to query, operate, and maintain all new hardware suites for control and monitoring as well as the old devices connected polling all automatically keeping the operator aware of their current condition as did the previous version.
- Capability to provide the same Help file access and navigation to the soldier on the new hardware without requiring training.
- All around standard interface familiar to current soldiers in the field to continue to operate and maintain as before. This affects 70 percent of the LCCs. More important, it reduces learning curves for technicians and provides speedier recovery to mission restoral on failures.

A user manual was ported from the “D” version Technical Manual (TM) into Adobe FrameMaker authoring software. Help Files were also incorporated into CMA. The Help Files provide instructions for initial equipment set up, software installation/de-installation and updates, diagrams showing computer control bus and signal flows, quick reference tables that show cable numbers, connection labels, addresses, and firmware version installed on the devices. Instructor guide and TMs from the original equipment manufacturers also were included in the Help Files. The Help file was organized topically, was indexed, and had clickable links to move about quickly.

The way Help Files were organized, the developer claimed, makes it easier to keep in pace with the underlying software and provides the users information needed without much retraining.

The development manager summarizes AN/TSC-93 Tactical SATCOM System Technical Refresh as follows:

- The AN/TSC-93 LRIP models were in test in 1977. At that time, they were cutting edge of technology interfacing on one intermediate frequency, one satellite, serial data.
- Today, through a series of tech refresh, the AN/TSC-93 framework remains as it was in 1977, but the capabilities of AN/TSC-93E evolved with technology and as a system. The AN/TSC-93E is beyond its time.
- Today the AN/TSC-93E is capable of acting as a relay between two satellites using two different bands. There are no other tactical systems with that capability.
- The AN/TSC-93E is capable of :
  - Interfacing with three (3) different intermediate frequencies
  - Handling serial and IP data
  - Dual satellite interface (simultaneous)
  - 100 percent compatibility with MIL-SATCOM constellation
  - Time Division Multiple Access (TDMA)
  - Frequency Division Multiple Access (FDMA)
  - Independent out-of-band order wire

This effort was funded by the Department of the Army to mitigate requirements risk. The element involved in this technical refresh included Research, Development and Engineering Command (RDECOM) for actual refresh engineering and software development and Communications-Electronics Command (CECOM) for life-cycle management, implementation, and field support. The technical execution by the government eliminates contracting risks. The developer claimed that the AN/TSC-93E is a true technology refresh success story by having maintenance tracked and revealing when it is cheaper to upgrade components rather than to

maintain. Also, many of the newer systems can be put together cheaply that at times seem to be engineered to wear out where technical refresh strategy provides more direct control of quality in the taxpayers' hands. It is noted that the system eventually will reach its end of life.

From the cost-saving data provided by the developer, there was a saving of $16,2631 per unit, with the total saving of $16,443,911 ($16.4 million) for 101 units. It should be noted that the code development and integration efforts were not accounted for. Still, the saving from this tech refresh effort is quite impressive, considering the total replacement costs of the existing units.

Table 2. Cost Savings Due to Tech Refresh

D MOD	**Old** Cost FY09	E MOD	**New** Cost FY09 Per Terminal	Difference	Savings Difference Per 101 TACSAT'S
MD-1340/TSC (2 Each) C Mod	$77,346	5650A (2 Each)	$21420	$ 56106	$5,666,706
UP CONVERTER C MOD	$31,753	BLOCK UP CONVERTER	$10,566	$21,187	$2,139,887
DN CONVERTER (2 Each) C MOD	$63,506	BLOCK DN CONVERTER	$10,233	$53,273	$5,380,573
RFMOW D Mod	$40,000	L BAND RFMOW	$22,880	$17,120	$1,729,120
FAMU B Mod	$24,537	SAFETY INTERLOCK	$9,412	$15,125	$1,527,625
Per Single TSC-93	$237,142		**74,511**	$162,811	
				Savings	**$16,443,911**

Case 2: Migration of a Knowledge Management Tool

A Web-based project and product collaborative environment that consisted of Knowledge Management (KM) Tool was developed and maintained by a major Army acquisition program where the author worked. The collaborative environment provided the government personnel, prime and subcontractors for accessing, sharing, collaborating, integrating, and controlling program information defining the products developed in the program, via secured sign-on process. It allowed authorized participants secure, immediate, and controlled access to a single source of

authoritative data, including product, technical, and program management information. It facilitated collaboration via focused tasks to be identified and managed through threaded discussions and workflow-based processes. Two major components that went thru a major upgrade of the underlying COTS will be the subject of this paper. One component, referred to as PD[1], provided a lattice of interrelated authoritative program data structures like product structure, specifications, requirements, Work Breakdown Structure (WBS), architecture, logistics, software, and program management. Another component, hereafter referred to as PJ, facilitated collaboration via "projects" which were self-administered short-term teaming and sharing collaboration space for anyone interested in joining. It provided role-based controlled access, discussion forums, data sharing, resource management and project execution and reporting.

The two components PD and PJ were based on a vendor provided solution for Product Lifecycle Management (PLM). The COTS provided capabilities for configuring and managing product structures, product deliverables that included diagrams, documents, software, and so on. The COTS provided by the vendor was used for PJ without any modification, while there had been many program and vendor initiated customizations on PD to suit particular needs. Over the course of the program, there had been more than 60 customizations. There had been several major releases from the vendor, but the program was about two major releases behind (that is, the program used Version VA[2], two versions behind the recently out VB version). The vendor may soon drop the support of VA. It was under such circumstances that the contractor started to plan the migration of COTS to VB. It was decided that the migration would be done in two phases: the first for PJ and the second for PD.

[1] The intent of this case study to show the lessons learned from conducting migration of COTS as a tech refresh effort. No attempt has been made to assess the performance of the contractor nor of the tool vendors. So the identity of the tool and vendor is withheld.

[2] Again, to protect the identity of the vendor, VA and VB represent the version the KM tool used and the newest release from the vendor, respectively. Notes that VA is two major releases behind VB.

Migration of PJ to VB

To prepare for the migration, standing weekly meetings were set up and a PJ migration plan was produced to guide the effort. The user community was informed of the effort well ahead and advised to save files under the project in temporary locations and avoid creating new projects in order to facilitate the migration. Then those common tasks were performed, such as cleaning existing projects and other data, setting up a migration environment, saving database. At the migration time, the production system was shut down, access to PJ blocked, the database was exported from production system, and the vendor-provided migration tool was executed. When the migration tool finished conversion, the database was imported into the new environment. After some administrative steps and system test activities successfully performed, the migration of PJ to version VB was done over a weekend with no major issue. After PJ was put back into production, several user training sessions were offered to cover the new whistle and bell of the new version and enhanced features. The only thing the users may have to do was to upgrade JAVA to newer version, if they did not already have it.

Migration of PD to Version VB

The migration of PD from version VA to VB was managed in similar way as that of PJ with one exception. PD was not used as is. There had been more than 60 customizations done to PD. There were various reasons why customization was needed. What exactly those customizations were is not really pertinent to the discussion here. However, to give some flavor to the readers, for example, there was change made to PD for requirements management and tracking system interface, a requirement management tool. There were changes to PD for Earned Value Management (EVM), Workflow, WBS, Contract Management, Environment, Safety and Occupational Health (ESOH) compliance and tracking, Interface to Software Item Database, After

Action Report (AAR) and so on. The vendor had provided automated tool to help clients migrate from older version to VB. The customizations had to be manually migrated before the tool could be used. In VB, there had been major architectural changes to PD including the way the product information was organized (changed from cabinet to library and container), the default contextual organization and association, the object initialization rules (that assigned associations and behaviors to object type upon creation), rules affecting life cycle based access control, and so on. In a nutshell, the customization codes had to be modified manually and adapted to the new architecture.

A test environment was set up to allow migration from VA to VB and allowed the team to migrate the customizations to VB. The vendor had a manager on site to assist the migration. First the development team took on many training courses on VB provided by the vendor. The master schedule and plan were developed to define and manage the migration milestones, track risks, manage critical paths, and provide horizontal integration. A team of system architects were working on the overall migration strategy and methodologies for application conversion. In addition, the team identified and enforced standards for common functions and helped resolving technical issues. Guidelines and roadmaps were developed to guide the developers in the migration effort. Common software practices were defined.

To handle the complexity and sheer number of customizations, the contractor decided to adopt the agile scrum process for the software migration effort instead of using its traditional waterfall development process. Each of the customizations was grouped by the functionalities and areas it touched and managed by a team of a leader and several developers. The team members met in the daily scrum to report progress, goals for next and any obstacles. Scrum of scrums meetings attended by the architects and team leads focused on major technical and cross- team issues. There

was a sprint each week which assessed the work progress and determined the tasks for the next sprint. The customization migration effort took a team of 24 developers 7 months to complete. The vendor had also provided resident manager and developers to support the migration. The whole migration took almost one year with no new development in this period.

Summary of the Case

It is obvious that the migration of PD from VA to VB took a lot of resources and was labor intensive. As the same time, there had been no new development. In contrast, the migration of PJ took about one month to complete. It should be noted that the comparison of PJ with PD is like comparing apples with oranges because by nature PD is much more complicated to PJ in terms of functionalities and the underlying infrastructure. However, the migration of PD was complicated by having to manually convert the customizations made in VA to VB.

As mentioned earlier, the major architectural changes in VB made the migration much more complicated. The upgrade manager tool provided by the vendor could only handle the base conversion. As noted in one of the fact sheets about VB, the vendor said it had experienced continuous success building a complete portfolio of turnkey PLM solutions. These solutions were all based on the same shared foundation architecture, and were designed to address specific business needs by providing predefined, configurable business rules and processes. Because of this shared architecture, customers now had an opportunity to migrate their existing “custom” environment forward, and leverage the Out-Of-The-Box (OOTB) capabilities available in the tool suite. The vendor has been working closely with customers to develop a set of customer-validated methodologies and tools to simplify the migration to newer version. The vendor had created a number of simple, clear pathways that enable customers to bring their existing PD information to the new version and fully leveraged its many additional capabilities. Unfortunately, this was not

the case for the program to be able to take advantage of this migration capability. Moreover, from the fact sheet, the vendor's intent was obvious to encourage the customers use OOTB capabilities. The government PM's intent also was to minimize customizations in order to decrease migration complexities for the future versions of the tools.

This case shows that a strategic planning for tech refresh is critical to the success of any PM in managing the developing and maintaining software project. The program is still using a version two major releases behind the current version in the COTS. This partially makes the migration harder because of the major architectural changes. Another lesson learned in this case is that when using COTS, any customization should be avoided. Otherwise, as evident in this case, a lot of costs will be incurred in migrating to the new version. The migration path and resources should be part of the strategic plan. When adopting any COTS, the PM should understand the refresh cycle and schedule impact and resources needed for managing the refresh effort.

Population and Sample Size

The acquisition and S&T communities are the target audience for collecting input on the survey questions. There are 293 responses, where 4 respondents skipped the survey. 46 percent and 43 percent of the respondents are either in GS 12-13 or GS 14-15, respectively. About 50 percent have working experience under 10 years, 36 percent with more than 21 years of working as civilian employees, 3 percent in the 11- to 15-year experience band and 7 percent within 16 to 20 years. Somehow the age distribution does not correlate to the experience band. Coincidentally, the experience spread exemplifies the Bathtub effect. Most of the respondents are system engineers with System Planning, Research, Development and Engineering—System Engineering (SPRDE–SE) or SPRDE S&T. The readers can browse the demographical information of the respondents in Appendix A for details.

Collected Data

Section 1. Previous Experience with Tech Refresh

Questions in this section attempt to find out whether the respondents have previous experience with tech refresh and if so, when the effort occurred.

Question 1: Prior Experience with Tech Refresh

When asked whether they had previous experience with tech refresh in the program on which respondents worked, 48 percent responded "yes" and 52 percent "no." This dichotomy in experience provides us an opportunity to analyze the data to see if the experience affects the respondents' attitude, understanding, or opinion in any way.

Question 2: In which phase of the acquisition life cycle did tech refresh take place?

When asked in which phase of the acquisition process the tech refresh effort happened, most happened during either Technology Development (TD) or O&S phases. It should be noted that the respondents were asked to enter the number of programs for which they had experienced tech refresh.

Question 3: How long had the programs been ongoing when tech refresh took place?

More than 60 percent of tech refresh efforts occurred during the first 1 to 5 years, according to the responses. A little more than 30 percent occurred in the 6- to 10-year period. The efforts then tailed off as the programs aged. It is worth mentioning that a rather large (7 percent) percentage of tech refresh occurred even when the program was less than 1 year old.

Section 2. Opinions on Tech Refresh

This section contains the questions on the opinions on tech refresh, such as the optimal time frame to plan for tech refresh, timeframe to start it, good sources for new technologies, reasons there should be tech refresh and the importance of tech refresh.

Question 4: What is the optimal phase in the acquisition life cycle to plan for tech refresh?

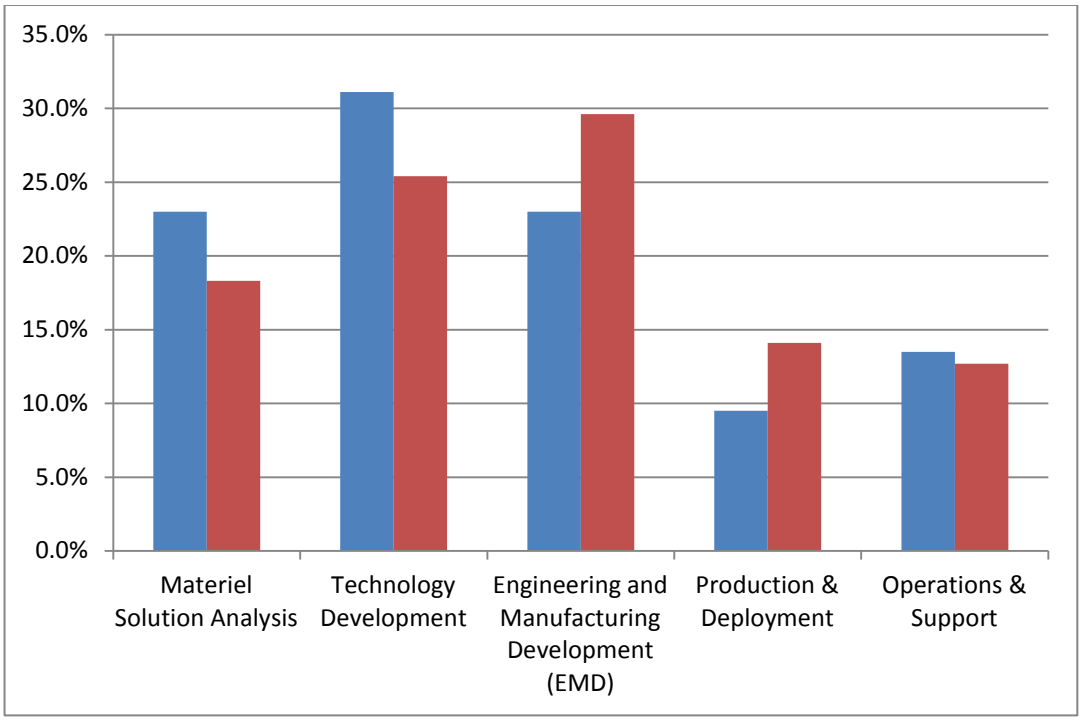

Figure 1. Optimal Phase to Plan for Tech Refresh

Shown in figure above, the blue bars represent the responses from the respondents with no TR experience and the red bars represent the responses from people with TR experience. The top three phases that the respondents answered as the optimal phase to plan for tech refresh are the first three phases of the acquisition life cycle, namely Materiel Solution Analysis (MSA), TD, and Engineering and Manufacturing Development (EMD).

Question 5: What is the optimal phase in the acquisition life cycle to start tech refresh?

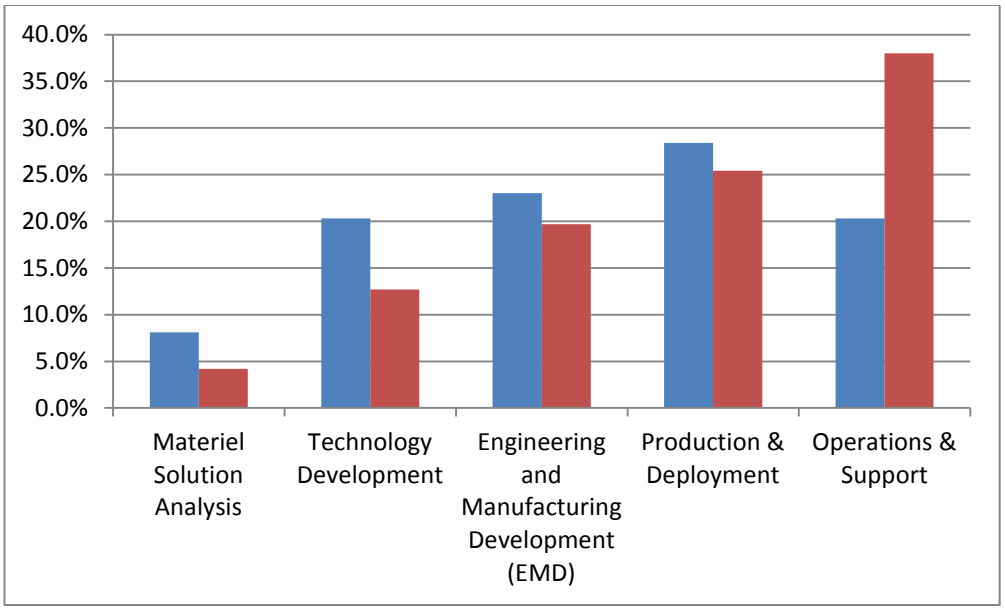

Figure 2. Optimal Phase to Start Tech Refresh

This question asks which phase would be the best time to start tech refresh. The answers shift to the later phases of the life cycle, namely EMD, Production and Deployment (P&D), and O&S. Notably, O&S phase is the top choice for those respondents with TR experience (red bar).

Question 6: What timeframe is optimal for a program to consider tech refresh?

Sixty-four percent of respondents with no TR experience answered that the optimal timeframe for a program to consider tech refresh is between 1 to 5 years. Twenty-seven percent answered the 6- to 10- year timeframe. The majority of answers fall into these two timeframes. The same two timeframes were selected by the people with TR experience, 76 percent and 27 percent, respectively.

Question 7: What are the reasons tech refresh should be considered?

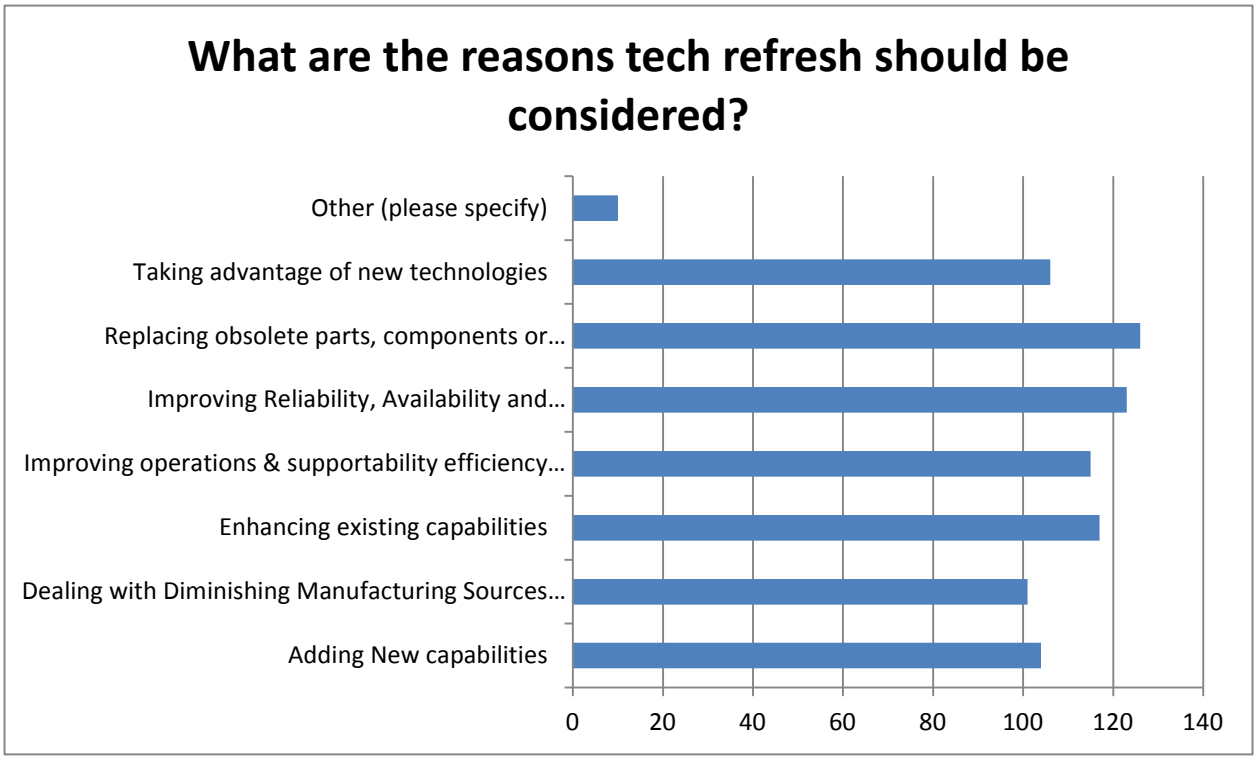

Figure 3. Reasons for Tech Refresh

The answers are almost equally spread for all reasons listed (the respondents were asked to select all that apply). They are almost 10 percent higher among those people with TR experience when selecting Improving O&S efficiency (reducing O&S costs) and replacing obsolete parts, components, or technologies. There are a few respondents that give reasons other than those shown in the question. One answered that Tech Refresh on systems is a part of the life of a system planned every 3 years in sustainment. Other answers included "Replacing aging or broken hardware," "Achieving requirements that were not initially met," "Maintaining COTS Support for Information Assurance/Authority to Operate," "Reduce development time for new customized software," "Reducing repair costs and cost of spares," and "A second source." One answer "All plus new threats" shows an important reason was missing from the question, namely, the new

threat. A perspective to “refresh a program” was brought up by one respondent. It is shown verbatim to allow no misinterpretation by the author.

> *Should be considered for all types of "mini upgrades," and not major releases, which should be new PORs. Otherwise, we get locked into a stale PM office fighting to maintain an organization. New PORs should not be established regularly and often, which take over the old one and apply a major revision.*

Question 8: What are the good sources for tech refresh?

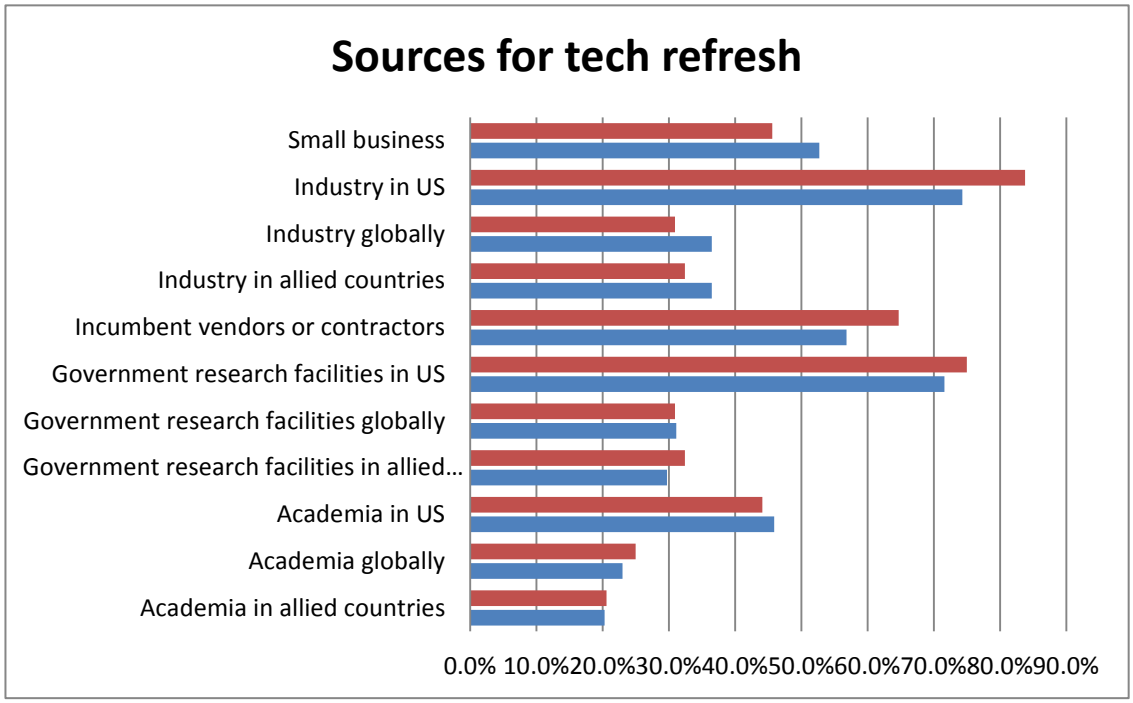

Figure 4. Sources for Tech Refresh

The red bars represented those answers from people with TR experience. More than 70 percent of respondents answered that sources in the United States should be considered including government research laboratories (71 percent (U: unfamiliar with TR) or 75 percent (F: familiar with TR) or the industry in the United States (74 percent (U) or 84 percent (F)). Incumbent vendors or contractors came next with about 60 percent. U.S. academia and small businesses also are considered good sources. Industry in allied countries or globally, and government research

facilities in allied countries or globally, seem to be in the same ball park of 30 percent to 34 percent. It should be pointed out that only 20 to 23 percent of respondents think academia in allied countries or globally are good sources. From the text answers, security or sensitivity of program should be considered. One respondent thinks any source that can enhance our warfighting capability is good. Input from the user community is considered to be a good source by one respondent. One respondent considers all listed are good source but advises considering the timeframe when the technology will be available.

Question 9: How important is tech refresh planning in an acquisition program?

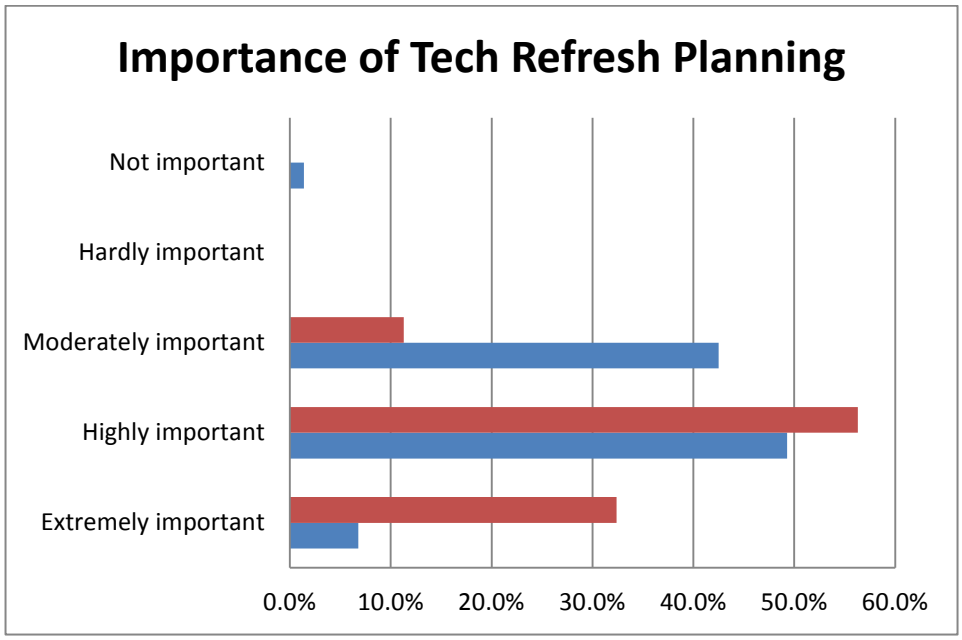

Figure 5. Importance of Tech Refresh Planning

Most of the respondents think it is important to have tech refresh planning. Those with TR experience feel more strongly about the importance.

Question 10: What should be considered when planning for tech refresh?

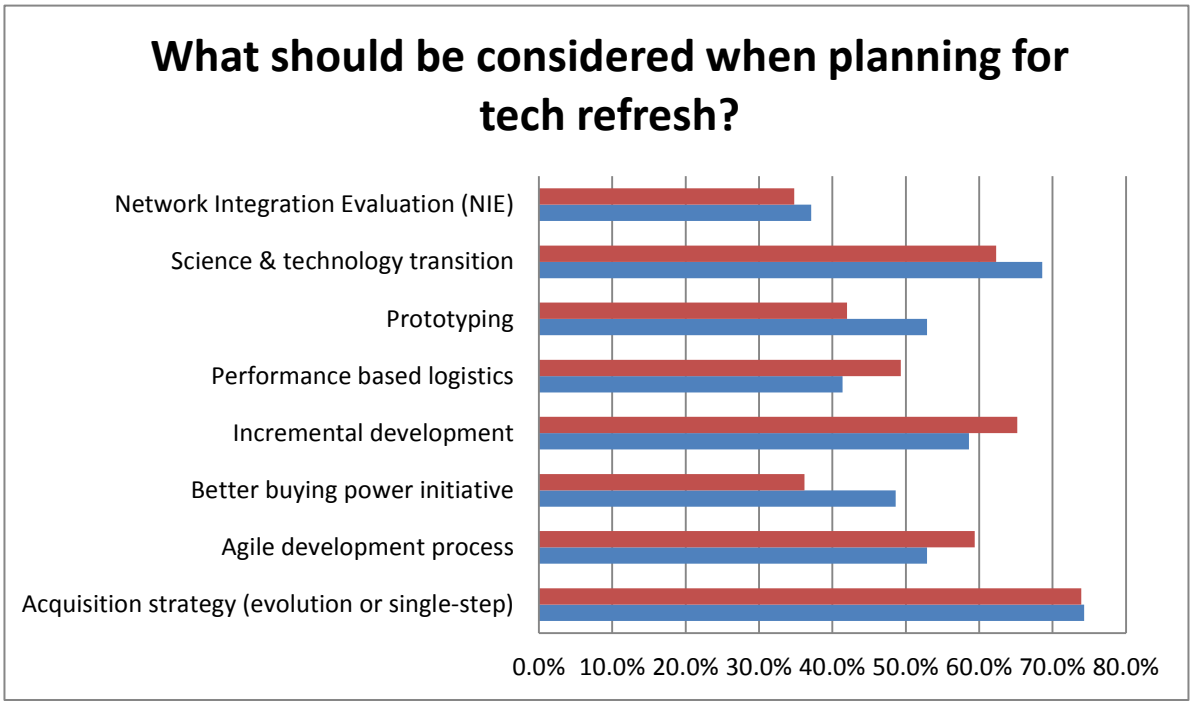

Figure 6. What Should be Considered When Planning for Tech Refresh?

The question asks what should be considered when planning for tech refresh. Acquisition strategies such as evolution or single step get the highest percentage (more than 70 percent for both groups). The experienced group selects the incremental development as the second top choice (65 percent). Those respondents with no TR experience, however, selected S&T (69 percent) as the second top choice. There are many insightful comments from the text answers. One stressed that security is "an absolute must consideration." The expected life of the system was suggested. Also put forward: The Acquisition Category (ACAT) level of the program, the COTS life cycles and supplier obsolescence (assuming survival of the supplier), DMS, and upgrade or integration path. One respondent suggested there should be an interweaving of tech refresh or refreshing in increment (that is, one after another). Configuration management and setting up configuration baseline when choosing an incremental fielding strategy should be considered. One respondent

suggested it is important to make sure the system would not become obsolete before it is fielded. There were suggestions that all aspects of the defense acquisition strategy should be considered and none of the steps skipped. System vulnerability system should be considered, too. One responded that "*just because tech refresh offers newer, better, faster does not mean it is needed, systems performance requirements should drive the needs for tech refresh.*"

Question 11: Which area(s) would benefit most from tech refresh?

Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems are ranked the top area that would benefit the most from tech refresh, followed by Weapon System, then Business Systems.

Question 12: Should tech refresh activities be budgeted for in the original PMO funding proposal?

Ninety percent (F) and 87 percent (U) of respondents thought that PMO budget proposal should include the activities for tech refresh.

Question 13: Who should be involved in tech refresh planning?

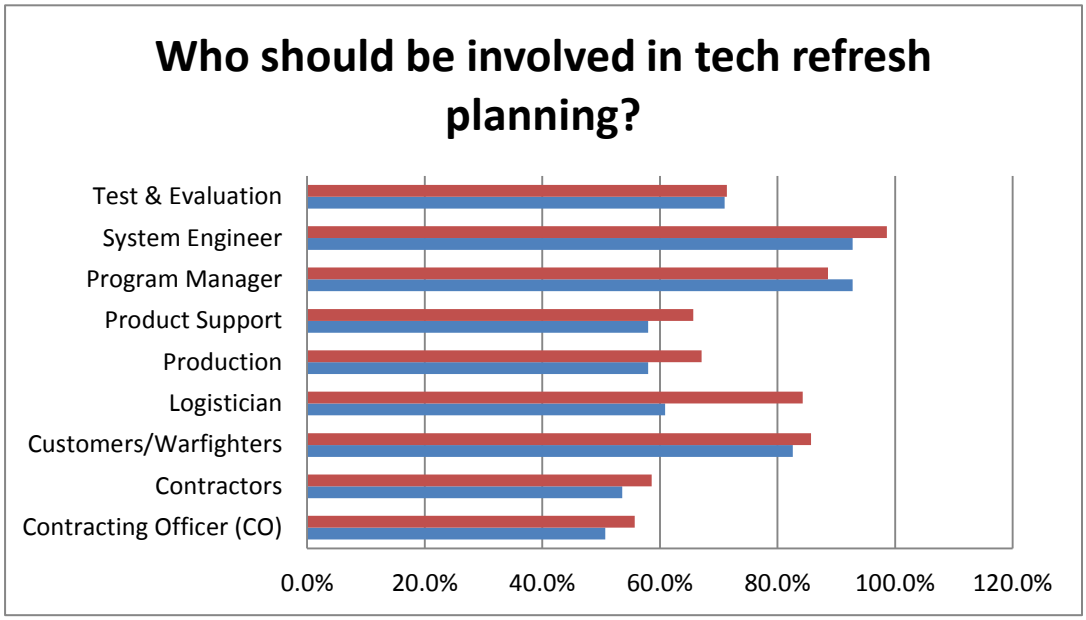

Figure 7. Who Should be Involved in Tech Refresh Planning?

From the responses, it seems that all personnel involved in PMO should be involved in tech refresh planning. PMs, Systems Engineers, and Customers/Warfighters are the three top selections. Logisticians get almost 24 percent more than the counterpart. This is consistent with the literature review result in that much guidance is found in the sustainment area. Army laboratory, Congress, U.S. Army Training and Doctrine Command (TRADOC), National Security Agency (NSA), Requirements Developers, Procurement and Business Managers were suggested, too. One respondent indicated that if anyone is excluded, the project management process has failed. However, there was an entirely different opinion that "The more people involved, the more worthless this will be." One respondent even suggested that R&D community should compete for ideas.

Question 14: Is there currently a strategic planning effort for tech refresh in your program?

Thirty-four percent (U) or 51 percent (F) answered "Yes," and 55 percent (U) or 49 percent (F) answered "No" to this question.

Question 15: Should there be a strategic planning effort for tech refresh in a program?

Ninety-two percent (U) or 97 percent (F) answered "Yes," and 7 percent (U) or 3 percent (F) answered "No" to this question. From the answers to Questions 14 and 15, we can see that there is a discrepancy in what it is and what it should be.

Question 16: How soon the migration to new version of COTS should occur?

The top choice by the two groups is "Stay within two or more releases" (40 percent, 48 percent, respectively for no experience vs. with TR experience), followed by "Stay within one release" (34 percent (U), vs. 30 percent (F)), then "As soon as new release comes out" (around 13

percent to 14 percent). Still, there is high percentage of people express the opinion that it should wait until vendor no longer supports the old release. Three percent and 1.4 percent think there should be no refresh, for no experience group and with TR experience group, respectively.

Section 3. Acquisition Process

In this section, questions related to how the acquisition process supports or facilitate tech refresh are presented.

Question 17: Does the current acquisition process facilitate tech refresh?

When asked if the current acquisition process facilitates tech refresh, 77 percent (56 percent from the group with TR experience) of the respondents answered "No." Despite the simplicity of this question, there were many written comments. Some of the comments are summarized below. There are common themes that the process is too rigid and inflexible. The budgeting and Program Objective Memorandum (POM) process take too long and thus does not support tech refresh. The process is too driven by older requirements established without the foresight to see improvements. Lack of system-wide knowledge (or expertise) makes it hard to come up with a plan. The process is said to take too long and too cumbersome. One respondent said frequent changes in leadership make it difficult to plan for the long term. One respondent thought each improvement gets treated like a new program, delaying implementation and increasing costs. Company proprietary information may impede the effort for tech refresh.

On budgeting aspect, some commented that since budget is allocated too far in advance, it is hard to predict when good tech refresh investment can be made. The budgeting process is regarded as often too slow to keep up with changing technology. It is commented that the process is not adaptable to suit the individual programs and defense needs. One respondent believed that the need for tech refresh is recognized, but its budget and execution is another matter.

There were concerns about risk taking (or risk-adverse) approaches and that some programs "shy away from 'something new'" and there was "great resistance to retouch capabilities that have already been fielded." The risk-averse attitude also affects tech refresh cooperation with S&T community.

Funding is a concern of respondents. One commented that funding is so scarce that it is difficult to budget enough for O&S, much less for refresh. Another commented, "This issue always seems to be money." There was criticism that the process fails to address the planning, roles, and responsibilities for tech refresh, especially in the Sustainment (O&M) phase.

There are, however, quite a few good points made about the process (shown below verbatim):

1. Tech Refresh is an integral part of the system I work on.
2. Usually planned in a PM program.
3. Various research programs are funded to develop new technology.
4. Had no problems with DoDI 5000.02 when planning and executing tech refresh programs on Army construction and materials handling equipment.
5. DoDI provides for great feedback from the field and streamlines the process for improving technologies. Furthermore, the tech refresh seems to fit perfectly in the O&S phase of programs.
6. Processes are identified to allow for component update.
7. (Because) our equipment appears to be refreshed when necessary.

Question 18: Does the current acquisition process address the rapid advancement in IT?

Since 75 percent (U) or 70 percent (F) of respondents thought the current acquisition process does not address the rapid advancement in IT, it would not be surprising that many commented on the process as unable to keep pace with rapid technological advancement. One respondent indicated here are no tech refresh "advocates" in many PM shops. One commented that

5000.02 requires “slow, deliberate acquisition.” The restrictions posed by the Weapon Systems Acquisition Reform Act (WSARA) make it difficult to start new increments or a tech refresh phase. The NIE agile process that Systems Under Evaluations (SUEs) go through prior to becoming part of a Program of Record (POR) was suggested as a help. One positive comment on the process is that tech refresh is being done and the acquisition process is used. However, one person reported that the firmware he or she supports is reaching the point of “non-sustainable” (supply- and cost-wise) and so a tech refresh should be done. One person is working on hardware from last decade and code is more than 20 years old.

Many comments on the program management aspects include: 5000 series is a good guide and is written at very high level to allow adaptation, but the PM needs to do what is right within the current acquisition process without blindly following the process. One comment is that PMs always want more funds to feed their contractors.

Comments specific to IT most centered on the rapid speed of change in IT and the acquisition process does not handle that properly. IT is commented to have short support life cycles and the process does not recognize that. In addition, Army IT is subject to Chief Information Officer G-6 approval in addition to the normal acquisition process). The Information Assurance requirement is posing challenges. It was suggested an entirely different approach is needed when the commercial world drives the market. The process is too slow to respond to new technical development. Several respondents commented that IT Box methodology has promise, but is still evolving (Willis, 2012). Furthermore, on the speed of change, one commented that “*the current acquisition process takes at least 3 years (other said 7 years) from identification of a requirement to procurement. That is a full 2 generations of technology in the IT world.*”

Some commented on funding that it needs to become more agile, as in the NIE process, with greater funding flexibility. The POM process for programming funds for POR was seen as too slow to accurately support tech refresh.

Overly frequent change in leadership was cited as the reason long-term planning is difficult. Moreover, it was commented that some leaders unable to understand what the Army actually needs vs. what is available commercially.

Others suggested that putting "specific language (for) WRT Technology Refresh" could help. One respondent replied that sometimes, driven by contractor protests, we adopted conservative contracting and legal policies and followed a low-risk approach that resulted in not pushing the technological envelope.

Question 19: Does the current acquisition process adequately address the funding?

There were 27 percent (U) or 29 percent (F) of respondents who thought the current acquisition process adequately addresses the funding for tech refresh, while 73 percent (U) or 71 percent (F) thought it does not. Beside the claims that budgeting process is too slow, rigid, and inflexible, one comment said decisions are made by people who do not understand the technology or the benefits. One respondent thought tech refresh would cause spikes in budget. On the funding aspects, comments included the observation that not enough funding was allocated; funding for tech refresh is usually cut; and that the process favors funding for hardware, not IT or software. One respondent replied that the PPBEs and POM should be updated to reflect the tech refresh. One doubted there is not enough funding to provide both materials and tech support. A comment was to have resource available to account for rapid adaptation of breakthroughs—disruptive technologies. One suggestion was to have the majority of an IT program on "tech refresh" to allow the constant evolution of an IT capability. A similar comment called for budgeting and planning allow tech

refresh at regular intervals. One person commented that budgeting is too influenced by politics. One wondered if it should mandate tech refresh planning lines in the POM? One respondent commented that funding has always dictated decision making whether to refresh or not. One pointed out that IT refresh is rarely even addressed in Statement of Work (SOW). There are comments on the cost or cost estimate. One is that tech refresh costs are very high. It seems that the expense associated with IT is often far greater than estimated. Estimating processes for IT need to catch up with reality. Finally, there was a comment that there is no confirmed process to field a SUE after successful NIE.

Question 20: Do the senior leaders believe that the current acquisition process adequately addresses the IT programs?

Questions 17 to 19 ask the respondents how they feel the adequacy of the acquisition process related to tech refresh. It turns out that quite a large percentage of respondents do not think it does. Question 20 tried to find how the respondents feel if the senior leaders share the same "pain." Forty-five percent answered "Yes," 55 percent answered "No" from the group with no TR experience. Fifty percent responded "Yes" and 50 percent "No" from the group with TR experience.

Question 21: How important is the support and dedication from senior leaders to ensuring a program's success in technology refreshment?

A majority of the respondents think it is extremely or highly important the support and dedication from senior leaders in ensuring a program's success in tech refresh (88 percent (U) vs. 90 percent (F)). It may not be a far stretch to say that the support from senior leadership is equally important to the overall success of a program.

Question 22: Should COTS be modified?

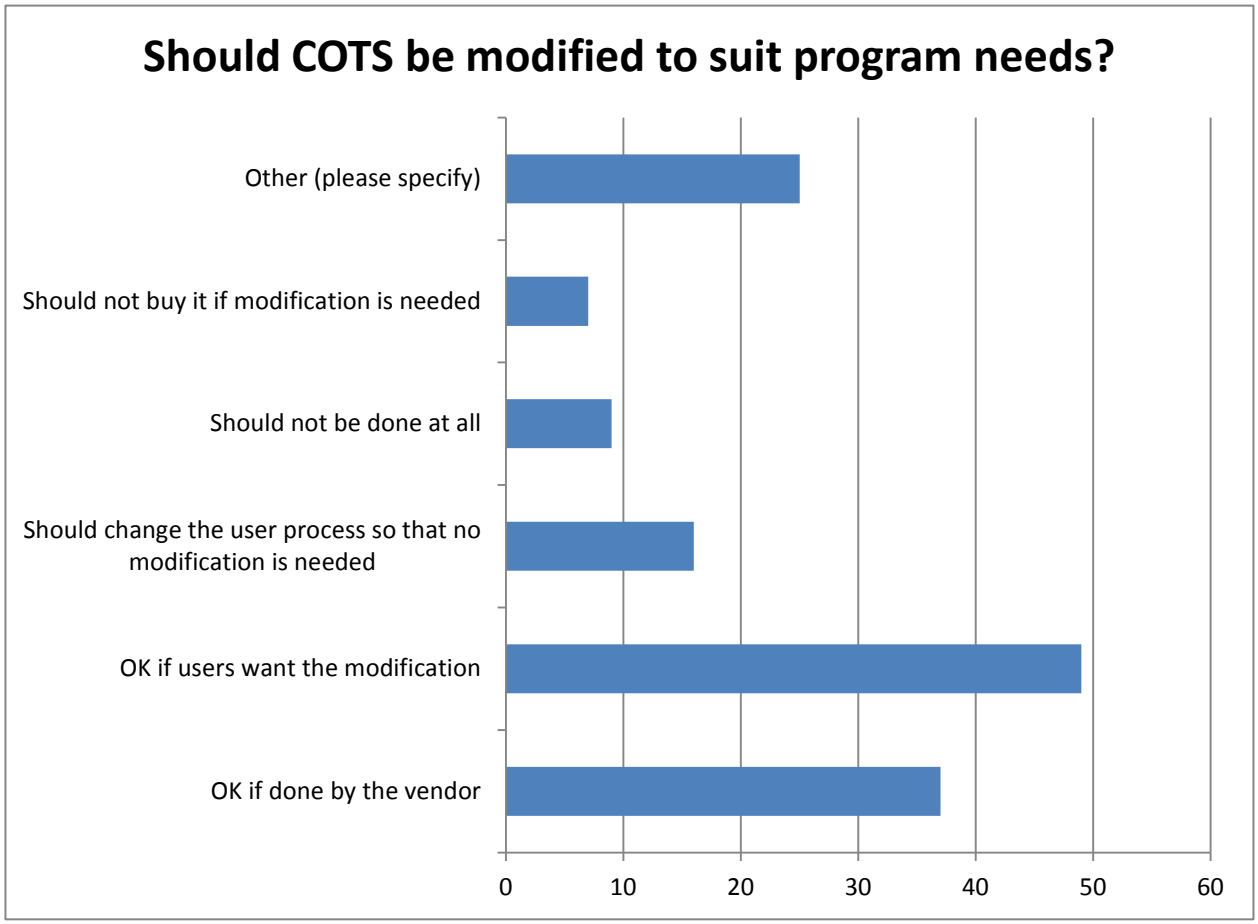

Figure 8. Should COTS be Modified to Suit Program Needs?

There is a quite high percentage of respondents who think modification to COTS is justified if the users request the change (39 percent (U) vs. 44 percent (F)) or the modification is done by the vendor (31 percent (U) vs. 31 percent (F). Relatively fewer people think that the user process should be changed rather than modifying COTS (10 percent (U) vs. 17 percent (F)). Fewer people said no modification should be made or should not purchase COTS if a modification is to be made. Some of the comments gave reasons COTS can be modified.

There are comments that are against modification of COTS. Others offer caution on how to decide whether COTS should be modified. The for-school of thought suggested that changes may

be necessary for interface or interoperability. One respondent indicated that, if properly implemented, the changes can save "tremendous development cost and should be used when technically and financially viable." There is a comment that stresses "ALL COTS IT should be reviewed and modified to remove unnecessary processing, applications and implanted vulnerabilities." Those who were against modifying COTS indicated that, once COTS is modified, it no longer is COTS. One comment concerned about the long-term impact, that once COTS is modified, the next release will need to be modified and "would have to be made again and again." Cautions were raised that configuration management is the key and it may drive up sustainment costs. One warned that, if COTS is modified too much, the economic benefits from using the COTS may be diminished. One expressed concern that the vendor may dictate too much. Use of Open Source COTS was suggested to provide competition. One the other hand, the incumbent vendor should be consulted first when considering modification to COTS because it has the expertise.

Question 23: How was a decision to stop older release made?

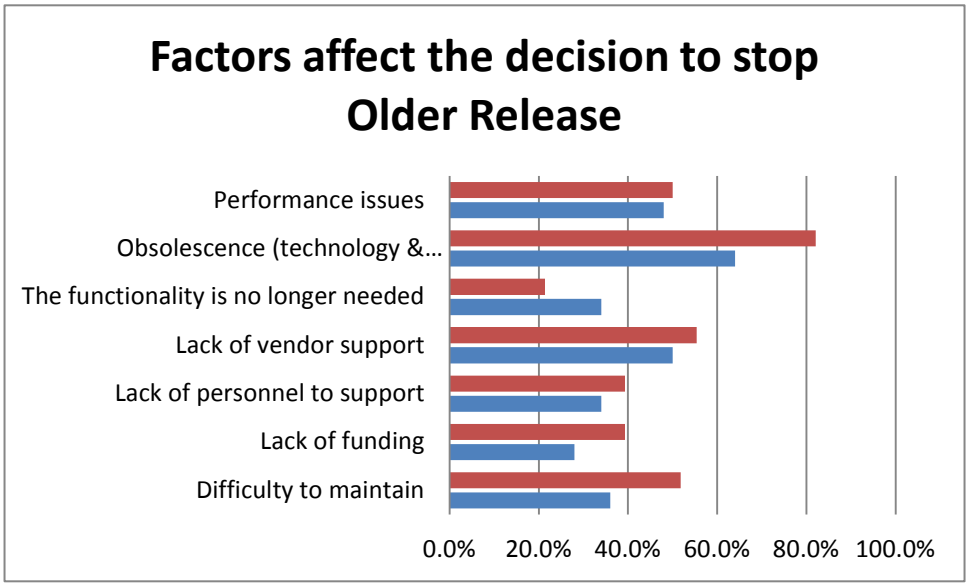

Figure 9. How Was a Decision to Stop Older Release Made?

The intent of this question is to find out what factors affect the decision for a program to stop supporting older version. Obsolescence either in the component or technology was selected as the top reason, followed by lack of vendor support, performance issues, and difficulty in maintaining the older versions (or multiple versions at the same time). Lack of personnel to support, lack of funding and functionality is no longer needed had also been the reasons for some respondents. It is almost the same for the experienced, except that there are significantly higher percentage for obsolescence and difficult to main reasons.

The other reasons given by the respondents provided more insight on how a decision was made. Some commented that a newer release should replace the older—why should there be dual baselines of the same? One respondent noted that multiple versions may be confusing to the operators and may cause incompatibilities issues among the many versions. Multiple versions also add sustainment costs. From an Information Assurance perspective, it is not supportable. Sometimes, it is mandated to move to the newer version (such as Vista to Windows 7). One respondent replied that sometimes the PM gets stuck with what they know and it becomes cultural issue/barrier to evolution. External pressure is mentioned but it is not clear how that affects the decision.

Summary of Analysis

The survey shows almost half of the respondents had previous experience in performing tech refresh. In general, the experience with TR does not affect much about the sentiment toward the acquisition process, or support of IT and COTS.

Most tech refresh efforts happened during either TD or O&S phases. It is found that more than 60 percent of tech refresh efforts occurred during the first 1 to 5 years, according to the responses. A little more than 3 percent occurred in the 6- to 10-year period.

Nineteen percent responded that it is extremely important to plan tech refresh. Fifty-three percent thought that it is highly important. When asked about the optimal phase to *plan* for tech refresh, the top three choices happened to be the first three phases of the acquisition life cycle, namely MSA, TD, and EMD. When asked about be the best time to *start* tech refresh, the answers shift to the later phases of the life cycle, namely EMD, P&D, and O&S.

The sentiment toward the acquisition process tends to be on the negative side as shown in answers to Question 17 (does the process facilitate tech refresh), Question 18 (addressing rapid development in IT), and Question 19 (funding for tech refresh).

The survey by and large supports the finding from the literature review. There are some discrepancies that deserve attention. The first discrepancy is the attitude on modifying COTS. Sixty percent of respondents think modification to COTS is all right if it is requested by the user or done by the vendor. This runs against what the general research advocates and against the author's experience dealing with migrating the COTS based KM Tool.

The second discrepancy can be classified as a reality check. It is revealed by questions on if there is planning and if there should be planning for tech refresh (Questions 14 and 15, respectively). From those respondents with no experience, 34 percent answered "Yes" and 66 percent answered "No" to the first question, while 93 percent answered "Yes" and 7 percent "No" to the second question. The answers to the first question from the experience population are 51 percent vs. 49 percent, while the answers to the second question are 97 percent vs. 3 percent. This shows discrepancy between what is and what should be the case.

Question 12 asks if tech refresh should be budgeted for in the original PMO funding proposal. Eighty-nine percent of respondents thought that PMO budget proposal should include the activities for tech refresh. This again shows discrepancy in what it is and what people think it

should be. Question 19 asked how important tech refresh planning in an acquisition program is. Nineteen percent of people responded that it is extremely important to plan tech refresh. Fifty-three percent thought it is highly important. Twenty-seven percent thought that it is moderately important. That is, 72 percent think positively about tech refresh planning. But only 34 percent of the programs have a strategic planning for tech refresh.

Additional Comments

The respondents have entered many text comments. The comments are shown in Appendix B.

Chapter 5—Conclusions and Recommendations

Observing the long development time in almost all acquisition programs and the long service time after deployment, while advances in technology seem to be accelerating, the research tries to find out how the DoD acquisition process deals with the challenge of rapidly changing technology by examining how well the acquisition community understands and plans for the tech refresh planning.

From reviewing the literature from available sources from DoD, Army, and DAU, the author finds there are many regulations and guidance on tech refresh. There are considerations suggested in the areas such as contracting, budgeting, system engineering, planning, coordination, life-cycle issues, and so on. Although there is good coverage on tech refresh, there is not much reported on actual performance of it. The two case studies conducted by the author augmented the coverage.

The survey by and large supports the finding from the literature review. The experience with tech refresh does not affect much the way the respondents answer the questions. There are some discrepancies that deserve attention. The first discrepancy is the attitude on modifying COTS. Sixty percent of respondents think that modification to COTS is all right if it is requested by the user or done by the vendor. This runs against what the general research advocates. It is contrary to the author's experience in dealing with migrating the COTS based KM Tool.

The second discrepancy can be classified as the reality check. That is, what the very high percentage of respondents feel positively about the necessity of tech refresh planning vs. the reality that much lower percentage of the projects currently have any tech refresh effort. Are the high percentage of respondents believe tech refresh effort should be budgeted in the PMO's proposal and a similarly higher percentage of respondents think it is important to have tech refresh planning.

That contrasts with the fact that a low percentage of responses indicate there is a tech refresh effort. One respondent suggested that there should be tech refresh “advocates” in the PM shops.

Despite all of the laws, policies, guidance, and training, half of the respondents were unfamiliar with tech refresh. Therefore, it is hoped that more awareness of tech refresh and the preparation, planning, and the challenges associated with it can help any program office manage many issues with rapid advancement of technology and long development time. It is recommended that each PMO designate an advocate for tech refresh, who also will be responsible for planning and monitoring the tech refresh project as a regular part of his or her job. Tech refresh planning should start as early in the life cycle and get budget for the effort.

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Glossary of Acronyms and Terms

AAR.....After Action Report

ACAT.....Acquisition Category

APG .....Aberdeen Proving Ground

AR.....Army Regulation

AS&C.....Advanced System and Concepts

ATD .....Advanced Technology Development

AT&L.....Acquisition, Technology and Logistics

BA.....Budget Activity

BAA .....Broad Agency Announcement

BAA .....Budget Activity Account

C4ISR.....Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance

CECOM .....Communications-Electronics Command

CIO.....Chief Information Officer?

CMA .....Control Monitor and Alarm

CO.....Contracting Officer

COTS .....Commercial-Off-The-Shelf

CV-MCU .....Converter Multi-Channel Unit

DAG.....Defense Acquisition Guidebook

DAU.....Defense Acquisition University

DCMA .....Defense Contract Management Agency

DISA .....Defense Information Systems Agency

DMSMS .....Diminishing Manufacturing Sources and Material Shortage

DoD.....Department of Defense

DoDAF.....DoD Architecture Framework

DoDI .....Department of Defense Instruction

DHS .....Department of Homeland Security

DSB.....Defense Science Board

DTIC .....Defense Technical Information Center

EBEM .....Enhanced Bandwidth Efficient Modem

EMD.....Engineering and Manufacturing Development

ESOH.....Environment, Safety and Occupational Health

ETSSP.....Enhanced Tactical Satellite Signal Processor

EVM.....Earned Value Management

FDMA.....Frequency Division Multiple Access

FRP .....Full Rate Production

GAO .....General Accounting Office (now known as the Government Accountability Office)

GB.....Gigabytes

GHz.....Gigahertz

GOTS .....Government Off The Shelf

GUI .....Graphical Interface User

H_0 .....Null Hypothesis

H_1 .....Alternate Hypothesis

ILS .....Integrated Logistics Support

ILSP .....Integrated Logistics Support Plan

IPPD .....Integrated Product and Process Development

IPS .....Integrated Product Support

IPT .....Integrated Product Team

IT .....Information Technology

JSEC.....Joint SATCOM Engineering Center

KM.....Knowledge Management

LCC.....Life Cycle Cost

LCSP .....Life Cycle Sustainment Plan

LRIP.....Low Rate Initial Production

MAIS .....Major Automated Information Systems

Mbps .....Megabits per second

MOSA .....Modular Open Systems Approach

MSA.....Materiel Solution Analysis

NDI .....Non Developmental Item

NDIA.....National Defense Industrial Association

NIE .....Network Integration Evaluation

NOA .....Naval Open Architecture

NSA .....National Security Agency

O&S .....Operations and Support

OMA .....Operations and Maintenance Army

OOTB.....Out Of The Box

P&D .....Production and Deployment

PBL .....Performance-Based Logistics

PLM .....Product Lifecycle Management

PM .....Program Manager or Program Management

PMO .....Program Management Office

POM.....Program Objective Memorandum

POR.....Program of Record

PPBE .....Planning, Programming, Budgeting, and Execution

PPS.....Post Production Support

PPSP.....Post Production Support Planning

PSM .....Product Support Manager

R&D.....Research and Development

RAM .....Random Access Memory

RDECOM .....Research, Development and Engineering Command

RDT&E.....Research Development Test and Evaluation

RF.....Radio Frequency

S&T .....Science and Technology

SATCOM.....Satellite Communications

SDD .....System Development and Demonstration

SE.....Systems Engineering

SELC .....Systems Engineering Life Cycle

SLEP .....Service Life Extension Program

SOW.....Statement of Work

SPRDE.....System Planning, Research, Development and Engineering

SSCF .....Senior Service College Fellowship

SUE.....Systems Under Evaluation

TD .....Technology Development

TI .....Technology Insertion

TM.....Technical Manual

TMDA.....Time Division Multiple Access

TR .....Technology Refresh

TRADOC.....Training and Doctrine Command

TRL .....Technology Readiness Level

TT .....Technology Transition

USD (AT&L).....Under Secretary of Defense for Acquisition, Technology and Logistics

WBS.....Work Breakdown Structure

WSARA.....Weapon Systems Acquisition Reform Act

Appendix A—Demographics of the Respondents

Table 3—Sample Size

Name	Completed	Skipped	Total
Respondents	289	4	293

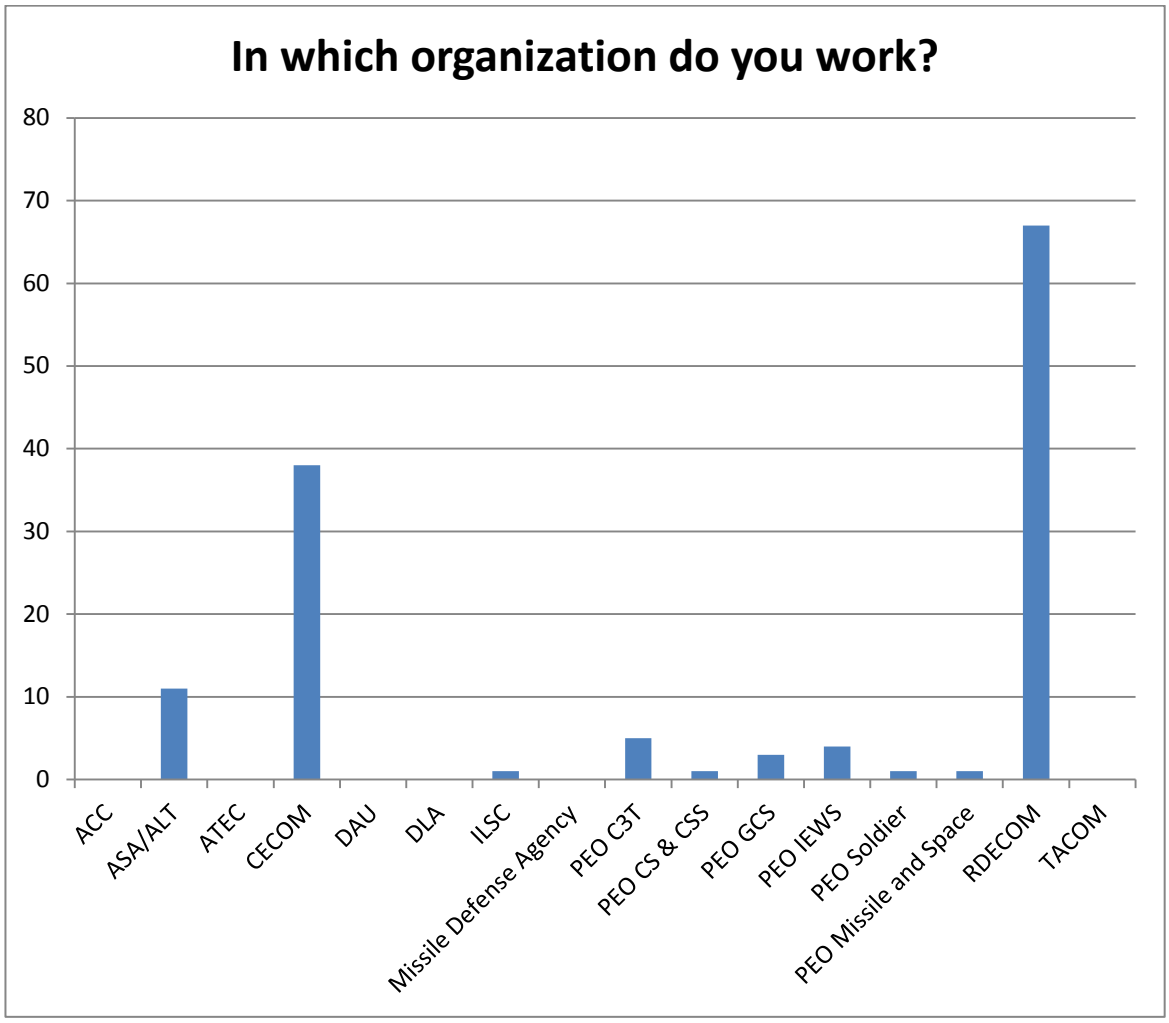

Figure A.1—Organizations of the Respondents

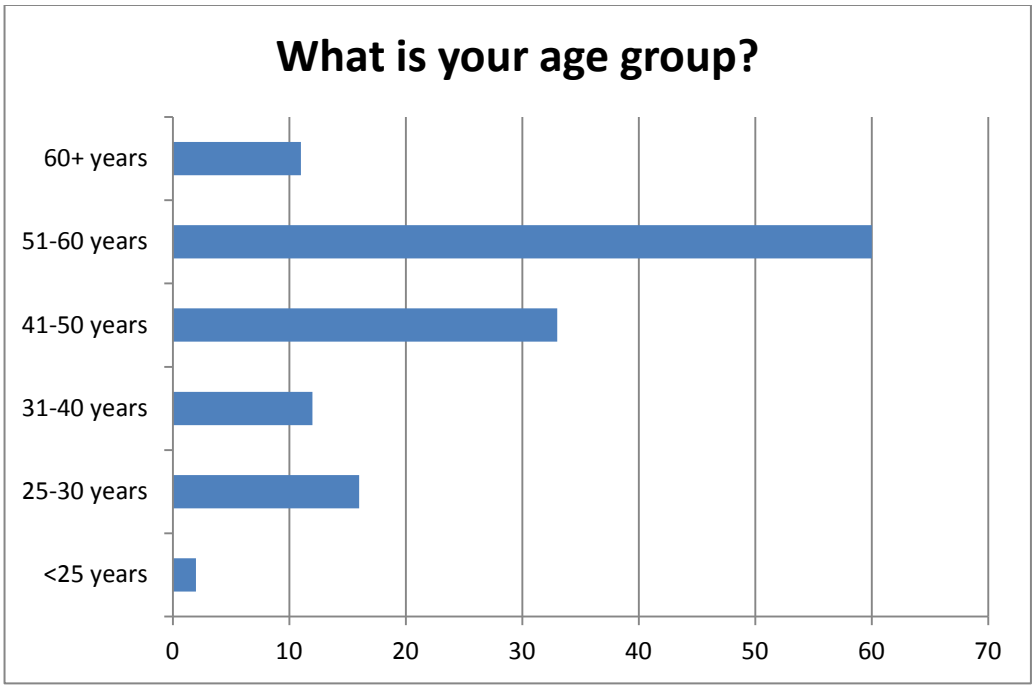

Figure A.2—Age Group of Respondents

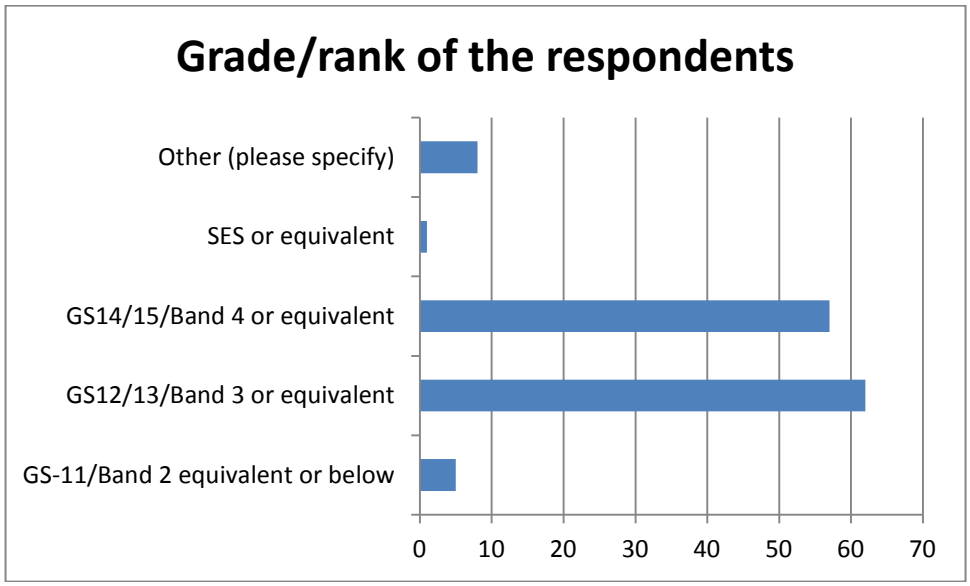

Figure A.3—Grade/Rank of the Respondents

Some of the respondents are contractors. (One is an E6 Soldier.)

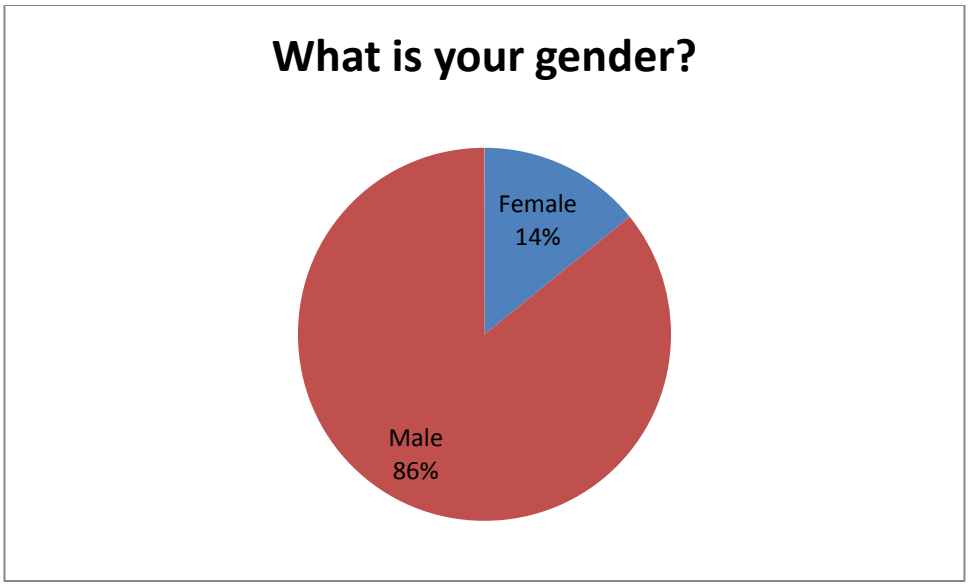

Figure A.4—Gender Distribution of Respondents

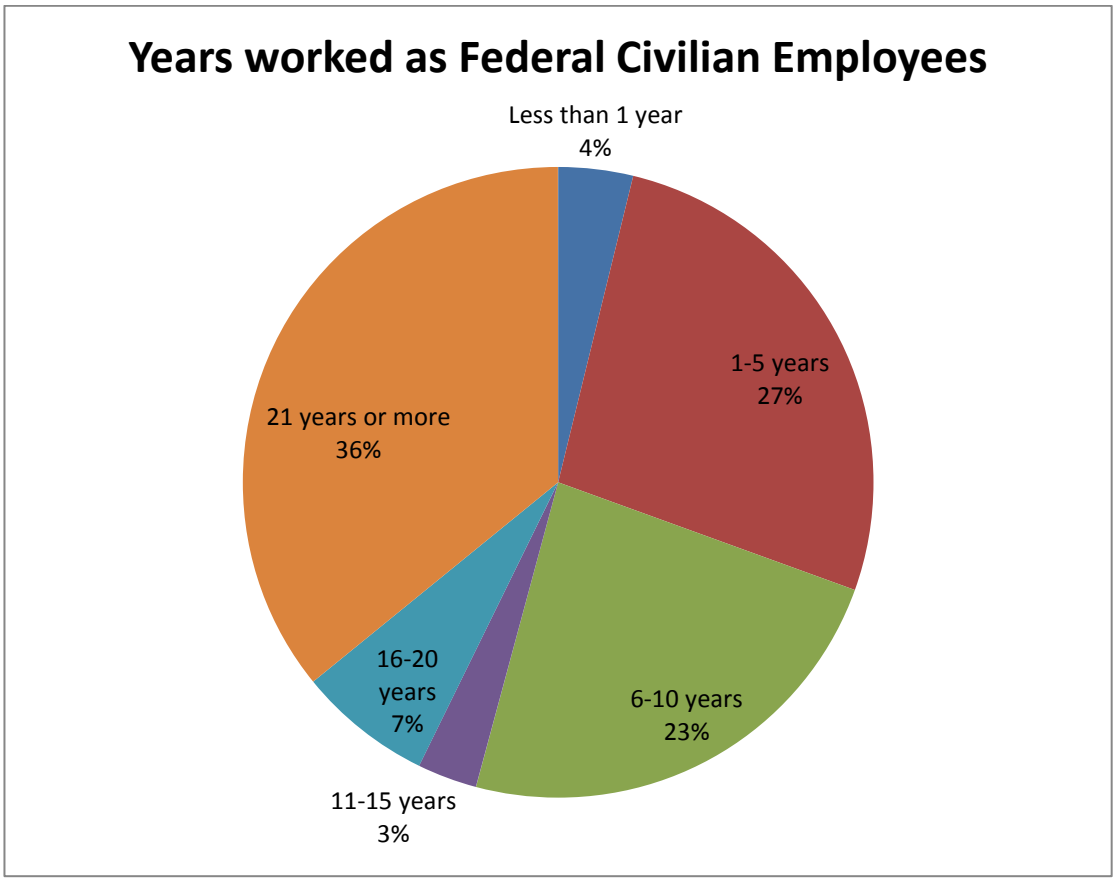

Figure A.5—Years Worked as Federal Civilian Employees

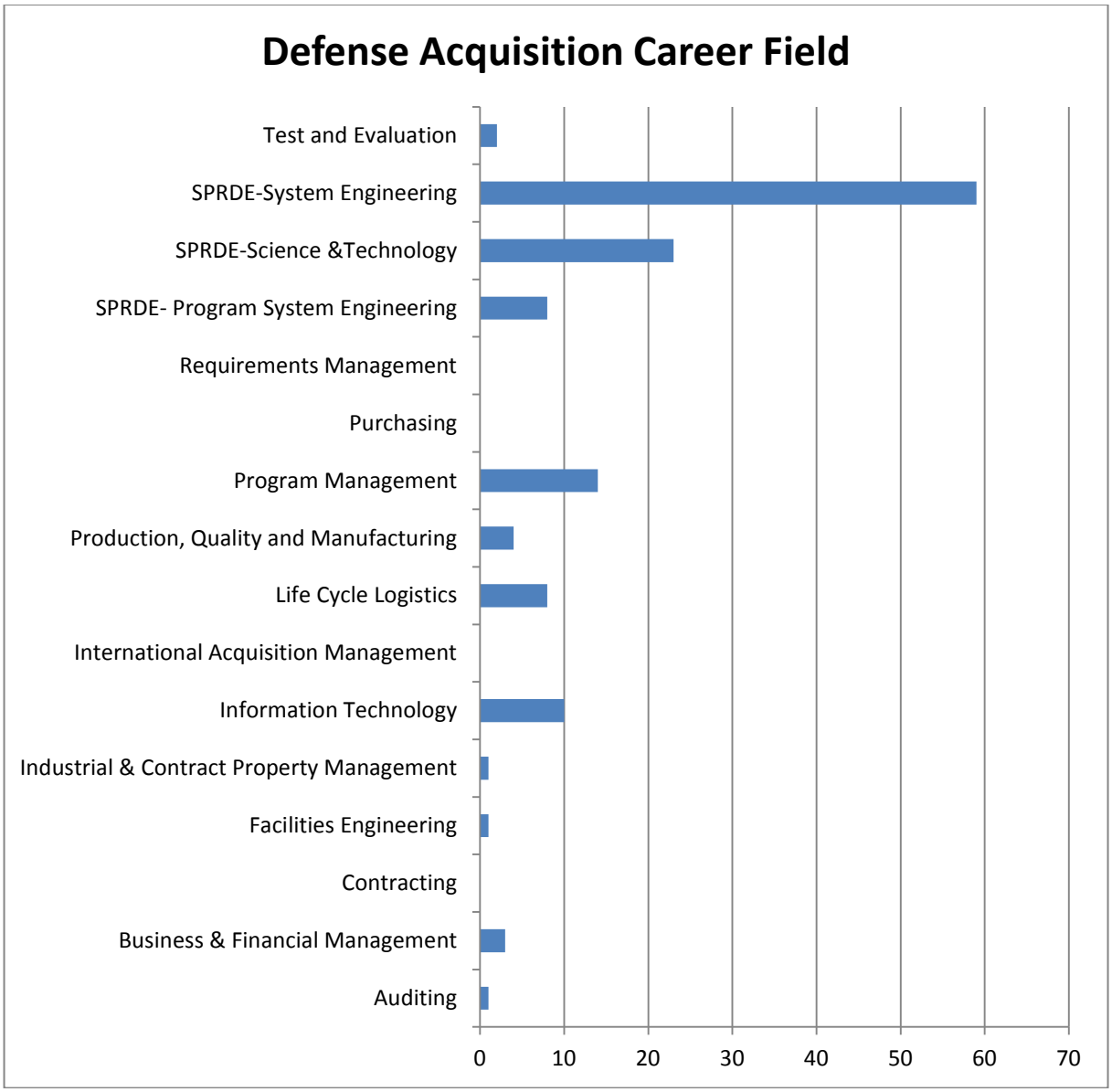

Figure A.6—Career Fields of the Respondents

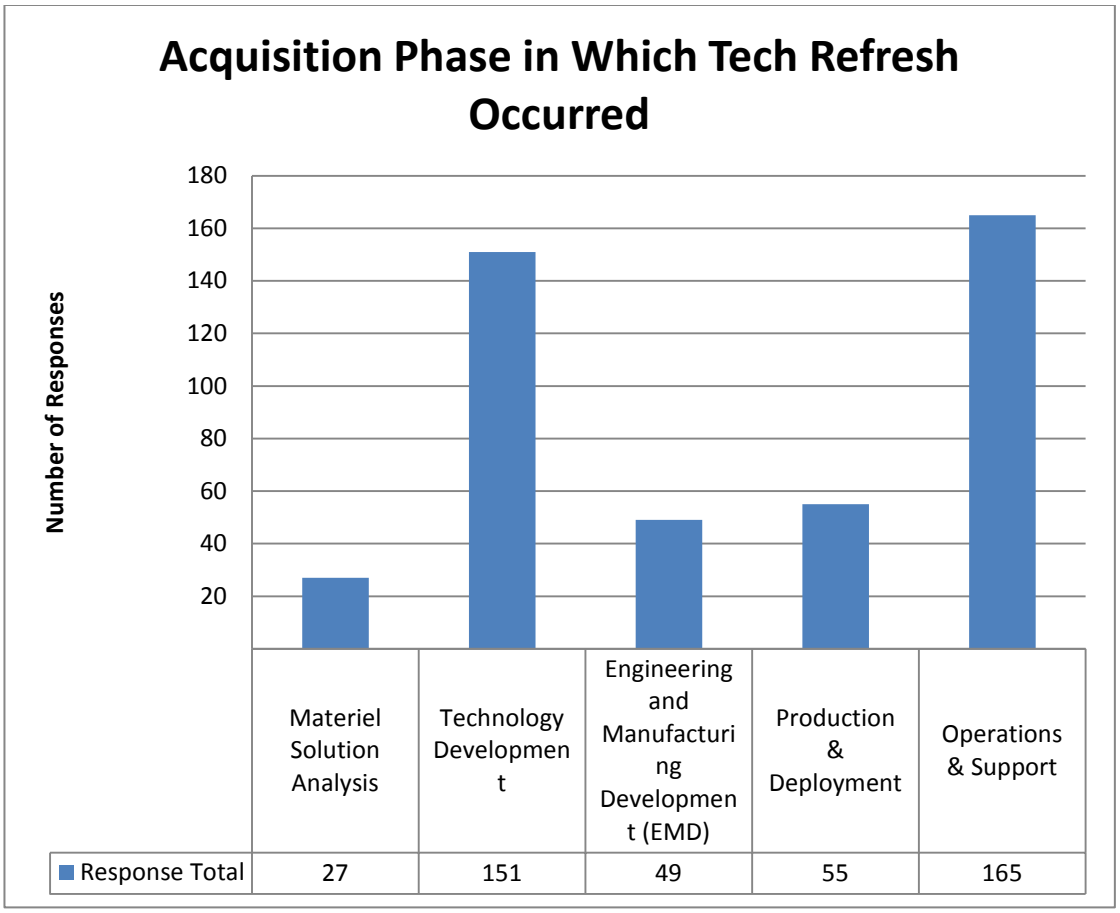

Figure A.6—Acquisition Phase in Which Tech Refresh Occurred

Appendix B—Written Comments on Some Questions

The written comments gathered from the survey questions were shown here almost verbatim (with minor typographical correction).

Written Comment to Question 17 "Does the current acquisition process facilitate tech refresh?"

Tech refresh is identified as needed and should be planned for. Budget and execution is another matter

I think the 5000 does. However, the POM process often does not.

Funding is so scarce that it is difficult to budget enough for O&S, much less for refresh.

PdM only looks toward what is specifically a requirement, requirements community usually writes requirements to what is known, procurement tends to 'buy' what they have priced, and shy away from 'something new'... .

It provides the planning and stages in the Technology Refreshment project but does not explicitly ask the question where or when. Reliability & Maintainability studies and cost benefit analysis at certain points in the DoD 5000.2 process may prompt action for Tech refresh.

The budgeting process is too slow to support the ability to keep up with changing technology in many cases.

Great resistance to retouch capabilities that have already been fielded.

Because our equipment appears to be refreshed when necessary

Not enough flexibility. Each improvement gets treated like a new program, causing delays in implementation and increasing costs.

DoDI 5000.02 is a very comprehensive and general approach to the acquisition of a weapon system. In practice, the process is not well adapted to individual programs and defense needs. Successful program management and systems engineering requires adaptation of the process to the specific needs. DoDI 5000.02 (and the common interpretation thereof) does not allow sufficient flexibility to adapt. This forces focus on the one-time acquisition of a capability, and diminishes the importance of tech refresh.

Takes too long.

The whole process takes too long

Too structured, inflexible and schedule driven

PORs usually do not want to take on the risk associated with tech refresh through the S&T community.

Current acquisition program is too slow and does not plan for tech refresh. Leadership changes too frequently and makes difficult to plan long term.

Budget is allocated so far in advance it is impossible to predict where good tech refresh investments can be made, and there is little flexibility once the information is available.
The PM can always do what is best for his system and can justify it so long as the funding exists.
The problem is the “Politics of the Rice Bowls”

The planning cycle is outside the 5 years.

This process assumes once we get to support phase, especially for Software, it remains until it gets to end of life (no assumed replacement of functionality). Example: If you are used to Word Processing and that version end of life is reached, will you remove it from the desktop without considering what will be used instead?

Too rigid to go all the way back through the required testing processes and documents. My only experience was with a QRC and we were very short-staffed; perhaps in a major PoR there would be more hands to help.

Not sufficiently familiar with DoDI 5000.02.

Science and Technology Research and Technology Demonstration.

Too driven by older requirements that didn’t have the foresight to see improvements.

Tech Refresh is an integral part of the system I work on.

The phased acquisition milestone timeline doesn’t account for a continuous feedback loop to the milestone B/pre milestone B phase.

Usually planned in a PM program.

I am unfamiliar with this process, but I am sure it could use improvement.

Fails to address the planning, roles and responsibilities for tech refresh, especially in the Sustainment (O&M) phase

1. Lack of funding. 2. Lack of systemwide knowledge to come up with a plan.

Various research programs are funded to develop new technology.

The acquisition process is much too cumbersome.

I don't know about the standard. This issue always seems to be money.

The Acquisition Process is just that—a process, blind to both common sense and reality of spiral development of emerging technologies.

Had no problems with DoDI 5000.02 when planning and executing tech refresh programs on Army construction and materials handling equipment.

If not planned early on in acquisition, it is difficult to rebudget the cost and schedule of a program. Often, tech refresh is only considered once the program is in the O&M phase. Some reasons are tech refresh are obsolescence and Information Assurance requirements. This is often not best handled in the O&M phase unless prior planning has already addressed the cost and schedule to refresh.

Issues with company proprietary work versus tech refresh from government, academia, or other vendors

DoDI provides for great feedback from the field and streamlines the process for improving technologies. Furthermore, the tech refresh seems to fit perfectly in the O&S phase of programs. As new capabilities are needed, new hardware has to come with it. I do feel more explicit language would help.

Minimize the number of releases required to update to the most current.
Because the systems/end users wants and is always looking for better performance, lower cost.

The POM process for programming funds for Programs of Record is too slow to accurately support the needs of a tech refresh. The other issue is that technology/components that fall into "Moore's Law" move to quickly to be used in the acquisition process.

Process does not facilitate agility in updating technology, such as configuration management.

Processes are identified to allow for component update.

PMs disband as they should once the transition to sustainment is completed.
Incremental development.

There are adequate procedures for incorporating tech refresh

Current acquisition process predicated upon procurement of a system at a fixed price w/o budgeting for replacements but limited to only working out the bugs in the existing system.

DoDI 5000.02 does not facilitate acquisition of anything. Successful acquisitions are conducted "outside" the system or at a minimum, in a highly modified process.

Difficulty in accounting for the cost of future tech refresh when calculating up front total program cost.

Written comments on Question 18: Does the current acquisition process address the rapid advancement in IT?

Program planning and execution is highly dependent on the individuals involved. The 5000.02 is hardly ever a reason that things get done or don't get done. If a PM is managing out of the book, there are so many ways to get distracted by all the chaff they will be challenged to be successful. The 5000 series is a good guide but if followed verbatim it is too heavy for ANY program to support.

It doesn't provide enough coordination with contracting limitations.

Acquisition lead times are too long and DoDI 5000 policies are too restrictive.

Specifically called out, but acquisition process is so slow that you cannot keep up with new IT.

My desk PC and support S/W is usually three or four steps behind commercial market (at least). ... SOCOM has SIPR Wi-fi, yet we can't get NIPR wifi networks at our place of work (secure defense facilities??)

I do not work with IT that changes quickly; mostly with embedded firmware. At the point of "No longer sustainable" (Supply and cost wise)—a tech refresh should be done. Although CDD and CPD document is regularly updated. I have not seen in my career an CDD or CPD document.

As stated, the process needs to become more agile, as is used in the NIE process, with greater funding flexibility.

From the C4ISR perspective, the software advancements outpace the hardware capabilities.

Because it addresses that there is rapid advancement in IT, but due to unforeseen circumstances funding is not always available to accommodate.
IT has its own issues, requiring CIO G-6 approval (outside the normal acquisition process) which is very time consuming and adds cost.

See above. DoDI 5000.02 is even worse for IT (or any other rapidly changing market). There needs to be an entirely different approach when the commercial world drives the market (compare and contrast the weapon system market driven by defense, with the mobile phone market driven by consumers).

Takes too long.

Advances in IT often are dealt with the same as with physical items and are not suited for the rapid changes associated with IT.

Too structured, inflexible and schedule driven.

Not that I aware of.

It can take 7 years from concept to deployment. In the cell phone industry, that's 14 to 21 versions of hardware in that timeframe.

Current acquisition program is too slow and does not plan for tech refresh. Leadership changes too frequently and makes difficult to plan long term. Some leaders not able to understand what Army actually needs vs. what is available commercially.

The current acquisition process takes at least 3 years from identification of a requirement to procurement. That is a full 2 generations of technology in the IT world.

It is up to management to do what is right within the current acquisition process. Management can always do what is best for the Army/DoD and can justify it so long as the funding exists. As stated before, the problem is the "Politics of the Rice Bowls" and PMs always want more funds to feed their contractors. Specific language WRT "Technology Refresh" could help.

Too hard to use current vendor.

We currently program to hardware from last decade. Code is more than 20 years old.

DoDI 5000.02 requires slow, deliberate acquisition.

Not sufficiently familiar with DoDI 5000.02.

Information System ICD "IT Box"

Law is complex and technology changes too fast. Keeping up requires ability to quickly navigate through numerous acq processes, which few have been able to do at a pace needed to match tech changes/industry

Same as above. PMs are too rigid too.

I see Tech Refresh being done on the system I work on. Acquisition process is used.

Requirements do not change rapidly enough to keep up with the advancements in the IT area. This is apparent by the invention of the "IT Box" concept and the IS ICD.

Too slow. Tech insertion points missed.

I am unfamiliar with this process, but I am sure it could use improvement.

Fails to properly address the rapid obsolescence/short support life-cycles of COTS items, especially as it affects Information Assurance efforts.

The acq process takes 1-3 years to develop a system. IT products have a 3-6 month life cycle before another new product is introduced.

Behind in implementing IT technology than the public/private sectors.

The acquisition process takes too long to keep up with rapidly advancing IT.

NO experience.

DoDI 5000 is typically inflexible, and even when some flexibility is accounted for, it is usually limited by the contractual language and conservative legal policies, driven by contractor protests, which result in an excess of caution when it comes to contract matters. That excess caution results in low risk, but low risk results in not pushing the technological envelope.

No recent experience, but believe DoDI 5000.02 is written at a high enough level to facilitate execution flexibility in IT decision making.

Regular updates/upgrades to computers occur so that computers are within one new release of software.

No—it takes a long time to use the current acquisition process to address rapid advancement in IT.

Acquisition cycles too long. Prompted by over-ambitious expectations of government

I feel the DoDI 5000.2 should be modernized to keep pace with the speed at which computer equipment is updated so the Soldier can take better advantage of new IT solutions.

Warfighter systems are constantly being affected in a negative fashion with outmoded OS support due to the system being a stand-alone system with no connectivity to an IA certified backbone.

Similar answer as above. The POM process for programming funds for Programs of Record is too slow to accurately support the needs of a tech refresh. The other issue is that this technology and their components usual fall into “Moore’s Law” move to quickly to be used in the acquisition process.

No tech refresh “advocates” in many PM shops.

IT has additional IA concerns that derail most tech refresh efforts. There should be better coordination with IA to allow for intelligent incorporation of new elements.

The assumption is made at the user level that a new IT capability is a new requirement. Nothing could be further from the truth.

Too slow to respond to new technical development.

IT changes faster that DoDi processes consider. It box methodology has promise, but is still evolving.

We still buy technology w/o funding to support take advantage of rapid advancement in IT.

Acquisition process does not support the speed of Technology Development.

Restrictions of WSARA in starting new increments or a tech refresh phase.

Within Agile process subset for SUEs prior to becoming part of a POR

Written comments on Question 19: Does the current acquisition process adequately address the funding?

It allows to PM to plan as necessary but doesn't specifically require it as much as I understand.

Should the 5000.02 mandate tech refresh planning lines in the POM?

Budget is a separate process and influenced too much by politics.

This response is specific to the MHS. Hope the rest of DoD does it in a better way.

No funding vehicle adequately supports refresh.

N/A, unsure.

The PPBEs should be updated for the program and the POM should be updated to reflect the tech refresh—From ACQ201 and PPBE class.

Too slow to support the tempo required to maintain currency.

Although system HW was refreshed once, there is currently no plan for another refresh.

Because more than not there is not enough funding to provide both materials & tech support.

The budgeting process is not agile enough to keep up with rapidly changing IT technologies.

The majority of the cost of an IT program should be focused on "tech refresh" and the constant evolution of an IT capability.

Funding doesn't exist and gets cut.

The expense associated with IT is often far greater than estimated. Estimating processes for IT need to catch up with reality.

Resources not planned to account for rapid adaptation of breakthroughs—disruptive technologies.

Not that I aware of.

It has not been a focal point of consideration so far.

Not sure on this question.

Not flexible enough, and decisions are made by people who do not understand the technology or the benefits.

There needs to be specific language to address “technology Refresh” so that PMs are provided with an incentive to address it.

Tech refresh implies a different type of money be used.

I don’t know?

Not sufficiently familiar with DoDI 5000.02.

No prior experience.

Tech refresh costs are very high. Acq. process can’t control or really impact that.

Typically, ASA-ALT wants to see flat budget numbers in the POM. Tech refresh would cause spikes.

Too slow. Too little funding. Too late.

I am unfamiliar with this process, but I am sure it could use improvement.

Instruction language is vague and ambiguous /

Funding has always dictated decisionmaking whether to refresh or not.

More funding should be provided to develop new technology.

The acquisition process does not encourage funding technology refreshment for IT program. It is still slanted toward hardware.

Again, no experience. We would do tech refresh via the PO&M.

I believe funding is a much bigger issue than DoDI 5000.02 can fix.

Again, often the program has not been budgeted and planned to undergo a tech refresh at regular intervals. This makes it difficult to fund tech refresh later on in the program's lifecycle.

Have not seen adequate planning for funding to cover rapid advancement in IT development and appropriate tech refresh into systems.

Not enough emphasis is placed on updating IT equipment as new technologies become available. There should be a "bar" set that directs a percent of money to be used to refresh IT systems.

Program execution speaks volume—IT refresh is rarely even addressed in SOWs.

The POM "cycle" is too slow.

Not a funding priority.

Just look at where the cuts take place first—PPSS.

POM cycles are not agile.

We do a better job of allocating funding needed to purchase computer workstations for government employees every 3 years due to the rapid advancement in IT so that we stay current on the hardware and we also buy and get the software updates on a regular basis. If we could transfer this procurement process to the DoD acquisition process, it would be a win-win!

It can support tech development.

No confirmed process to field a SUE after successful NIE.

Usually not sufficiently funded.

Budget guidance is too rigid.

Written Comments on Question 22: Should COTS be modified to suit program needs?

Best solution but sometimes a change must be done.

Case-by-case determination required, no one answer.

Vendors dictate too much when using COTS. Limit work to themselves. Cost more in the long run.

OK,if its cost effective and there are long-term benefits.

Based upon project requirements. If we need X,Y and Z and this product doesn't have that, why are we going to use it in the first place?

It really depends on the program requirements. This type of development should be minimized.

There is no single answer to this one; it depends on the program and application of the COTS product. In general, if there is a need for a change (which should be driven by the voice of the user), then modification should be considered. Who performs a modification again depends on the need, but the vendor should first be approached concerning the proposal, considering they have the expertise (whereas the government would need to build an organic capability).

I think there needs to be a cost benefit analysis to determine if the level of modification is worth it.

OK, if modification is needed to address requirements of the program, including derived system engineering requirements.

This is clearly program and technology specific.

Should use Open Source COTS so multiple vendors can compete.

What kind of question is this?? This doesn't even make sense.

Modification should only be applicable to meeting requirements

ALL COTS IT should be reviewed and modified to remove unnecessary processing, applications, and implanted vulnerabilities.

OK, if defined under contract and a spec.

Too complicated an answer for multiple choice.

Have to be careful not to engineer it too far away from the vendor offering on the economy.

If possible, COTS programs should not be modified because the modifications probably won't be in the next software release so modifications would have to be made again and again.

Modified COTS products, when properly implemented, can save tremendous development cost and should be used when technically and financially viable.

OK if tested extensively to meet requirements.

If the third party contractor is modifying the COTS, I would disagree. However, if the program is able to work directly with the vendor to modify its own COTS components, then I would prefer that.

Needs testing by a service lab. Configuration Management is key, and may drive up sustainment costs.

Consider on case-by-case basis

As soon as you mod COTS to meet program needs it is not COTS.

Depends on interface/interoperability changes required.

End of Question 22 comments

Additional Comments:

The respondents were asked to provide additional comments that they feel like to contribute.

Not sure I get the gist or intent of this survey. If a tech refresh is required before a program is in sustainment lifecycle, I'd think that was the exception. Why develop a new program that already needs a tech refresh. Once in sustainment, it is a part of life, especially refreshes driven by Information Assurance Requirements (products become End-Of-Life most common).

The relationship between requirements, PdM's, technology development labs (RDECOM) and labs within Army technology development (ARL vs. ARDEC vs. ERDC vs. CERDEC) is broken. Army labs are in each other's lanes, competing for the same resources, in the name of "technology refresh." A quote from a colleague, "The Army acquisition process is broken. I personally developed close to 100 material solutions for the South African conflicts in less than 10 years. Now, within the DoD process (he is now a defense contractor), we're doing good if during a war we can get just a handful of items out to help the soldier. ... Bureaucracy. . . . And nonagile system prevent technology insertion, and the field is left holding 1000s of pieces of old gear, instead of having what they need (technologically best capability, when they need it) ... .

Didn't answer most questions as I don't have the background to answer fairly or intelligently.

Allow more decision making at the PM or PEO level.

I was not aware of Tech refresh before this survey. Maybe if there was a (Not Sure, N/A, Unknown) option in each question for participants in my situation, you would get 100 percent of the questions answered.

May want to relook the wording of some questions for clarification and intents.

I am having trouble understanding the value of this survey. Most of the questions are too vague, and too dependent on opinion. Many questions asked for a single general answer to a question that really ought to be informed by the needs of the particular program. The question about whether senior management values tech refresh I'm not even sure how to answer—is this asking for my perception of their value, or am I supposed to skip it because I am not senior management? I thought most of the Yes/No questions could have used a "Maybe" response.

Good Survey but did not considered sufficiently the politics and management side, which is often part of the problem

Many of these questions are poorly written. Addition of the "I don't know" field would have helped prevent noise in the data.

I am a contractor.

With DoD funding pressures, I doubt new initiatives will be launched unless major savings can be clearly shown.

Tech Refresh should be built in from the start of the program, and planned for as part of the industrial base to maintain proficiency and meet 50-50 requirements.

Timeliness of tech refresh is key. Units see it as an intrusion to their already hectic training schedule. We need to progress to a wireless refresh or a CD that the S6 use to do the refresh as the unit's schedule permits.

Many of the answers depend upon the circumstances of the refresh. What capabilities are being added, what deficiencies are being corrected, how much does the refresh cost, how much time will it take to implement? Always plan for upgrades upfront and early.

Though federal employee less than 5 years, have 14 years working for prime contractors, 3 years SETA for a PM, and 6 years for TRADOC and 7 years as a field user of tactical IT systems.

This survey is too long and detailed.

One gentleman left his contact info so the author can ask for more input. His willingness is greatly appreciated.

Author Biography

Yen-Chou Chou attended Senior Service College Fellowship (SSCF) program from DAU, Aberdeen Proving Ground, MD, from July 23, 2012. Before joining SSCF, he served for Synchronized Fielding in System of System Integration (SOSI) Directorate, ASA/ALT, U.S. Army. He worked in the Army's Future Combat Systems program where he worked as the Chief Software Engineer for three logistics software applications: Platform-Soldier Mission Readiness System (PS-MRS), Logistics Decision Support System (LDSS), and Logistics Data Management System (LDMS) for the Logistics Products Directorate. He has extensive experience in acquisition program management, software engineering, logistics, Platform Health Management (PHM), software development project management in government and in industry. He is Level III certified in SPRDE-SE, SPRDE-PSM, and IT. He is Level II certified in PMT.

Prior to his Army employment, he worked at AT&T Bell Laboratories, Lucent Technologies (and Avaya), as software architect and development leads and developer for various software development environment, telecommunications, and optical network products, and Web-based applications. He also was an assistant professor at the department of computer science, teaching undergraduate and graduate level courses in software engineering, computer architecture, compiler theory, and artificial intelligence. He obtained both his Bachelor of Science in Mathematics and his Master of Science in Computer Science from National Tsing Hua University, Hsin Chu, Taiwan, and his Ph.D. in Computer Science from Northwestern University, Evanston, Ill. He is a member of the IEEE. Outside his professional life, he enjoys reading books, photography, bicycling, golfing and traveling. He lives in Edison, NJ, and works at Aberdeen Proving Ground, MD.