TECHNOLOGY TRANSITION:

GUIDANCE VERSUS PRACTICE

THESIS

Walter Ellis Espy, Captain, USAF

AFIT/GRD/ENV/06M-04

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GRD/ENV/06M-04

TECHNOLOGY TRANSITION: GUIDANCE VERSUS PRACTICE

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Research and Development Management

Walter Ellis Espy, BS

Captain, USAF

March 2006

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

AFIT/GRD/ENV/06M-04

TECHNOLOGY TRANSITION: GUIDANCE VERSUS PRACTICE

Walter Ellis Espy, BS
Captain, USAF

Approved:

//Signed//	20 March 2006
Sonia E. Leach, (Chairman)	date

//Signed//	15 March 2006
Alan R. Heminger, (Member)	date

//Signed//	15 March 2006
Barbara L. Masquelier, (Member)	date

AFIT/GRD/ENV/06M-04

Abstract

The transition of technologies ensures that our warfighters have the necessary capabilities to fight the ever increasing and changing global threats. Through the investigative research of this study, technology transition best practices were taken from Department of Defense (DOD) publications, Air Force Instructions (AFIs), and industry. The purpose of this study was to gain an understating on what extent the Air Force Research Laboratories were implementing known technology transition best practices. In examining the use of technology transition best practices, the research provides insight into how technologies are transitioned from AFRL to the acquisition community. This study relies on the perspectives and knowledge of program managers within AFRL. Data analysis along with an extensive literature review led to recommendations such as: an implementation of a technology transition team, co-locating AFRL program managers in program offices; and program management training for managers in the S&T community. It was revealed that only some aspects of technology transition best practices were being implemented. It was also discovered that technology transition involves multiple organizations for technologies to be transitioned. Based on the data collected, it was found that the program manager needs multiple resources and the right knowledge to facilitate technology transition.

Acknowledgements

I would like to express my sincere gratitude to my committee, Major Leach, Dr. Heminger, and Barbara Masquelier for their guidance and support throughout this endeavor. Major Leach, I would like to say that I have learned many things about myself throughout this process. I know at times it was frustrating, but we pulled it off. I appreciate all of your efforts very much.

I would also like to thank all of my interview participants. Many of the interviews took longer than an hour and I would like to thank all of you for your patience. I would also like to thank my mother. She put many hours into proof reading my document. Thanks for catching all those "goofy" statements Mom.

Ellis Espy

Table of Contents

List of Figures

List of Tables

TECHNOLOGY TRANSITION: GUIDANCE VERSUS PRACTICE

I. INTRODUCTION

1.1 BACKGROUND

Many definitions of technology transition are available in the literature (Spivey et al, 1997, Dobbins, 2004, National Research Council, 2004, A Guide for S&T Program Managers, 2001, and The Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). A definition from the Guide for S&T Program Managers, published by the Deputy Under Secretary of Defense (DUSD) (Science and Technology Department) in 2001, offers the following: "technology transition is the process of inserting critical technology into military systems to provide an effective weapon and support system - in the quantity and quality needed by the warfighter to carry out assigned missions - at the best value as measured by the warfighter." Technology transition is just one aspect of the overarching process in getting technologies to the warfighter. Other processes include Small Business Innovation Research (SBIR), Defense Advanced Research Projects Agency (DARPA), and typical acquisition development. The transition of technologies from the Air Force Research Laboratory (AFRL) to the acquisition community will be the focus of this research.

For purposes of clarification throughout this document, the term "warfighter" or "user" reference those which acquire technologies to be inserted into defense systems. When a technology reaches a certain maturity point to be classified as a 6.3 program (Table 1), it is capable of being transitioned to the acquisition community. The maturity levels for technologies will be discussed in depth in later chapters. Technologies being developed in AFRL are differentiated by numerical designations. This study will

concentrate only on 6.3 projects. Typically technologies that are in the 6.1 and 6.2 categories are not mature enough to transition. Before a project is given a 6.3 designation, the project must be able to demonstrate a certain capability and have a defined customer. Research projects that have a 6.3 designation normally examine existing systems (legacy systems) that the new technology can be inserted into. Table 1 illustrates the different classifications for projects within AFRL.

Table 1 Technology Designations

Community	Numerical designation	Category
Science and Technology	6.1	Basic research
	6.2	Applied research
	6.3	Advanced technology development
Acquisition	6.4	Demonstration and validation
	6.5	Engineering and manufacturing development
	6.6	Management support
	6.7	Operational systems development

Technology transition is critical because it assists in the delivery of advanced technological warfighting systems to the end user. AFRL is an organization that plays a keys role in the development of advanced technologies. AFRL transitioning advanced technologies ensures the warfighter has superior technology to support their missions, and delivers them revolutionary "war-winning" capabilities (Deputy Under Secretary of Defense, 2001).

AFRL demonstrates through the development of advanced technologies, that they hold a position of distinct significance in the development, demonstration, and transition of technologies. As evidenced by the following statement, experimenting with advanced innovative technologies such as remote sensing, long-range precision, homeland defense, and information operations, illustrates the importance of AFRL in view of the fact that

they are intimately involved with developing technologies that give the warfighter critical

capabilities.

> "We must prepare for more such deployments by developing assets such
> as advanced remote sensing, long-range precision strike capabilities, and
> transformed maneuver and expeditionary forces. This broad portfolio of
> military capabilities must also include the ability to defend the homeland,
> conduct information operations, ensure access to distant theaters, and
> protect critical U.S. infrastructure and assets in outer space. Innovation
> within the armed forces will
> rest on experimentation with new approaches to warfare, strengthening
> joint operations, exploiting U.S. intelligence advantages and taking full
> advantage of science and technology."
>
> –The National Security Strategy of the United States, September 2002

Technology transition is a process which takes technologies from the Science and

Technology (S&T) community to a program office. This transition of technology can be

the reason for a new start program, or can be inserted into a legacy system, which are

systems currently managed by a program office. Technology transition only works if

AFRL and the acquisition communities have intimate knowledge on the technology

(Technology Transition for Affordability; A Guide for S&T Program Managers, 2001).

The acquisition communities include both the program offices and Major Commands

(MAJCOMs). The key stakeholders in the technology transition process are the research

laboratories, MAJCOMs, program offices, and the prime contractor. S&T program

managers (PMs) need to collaborate with these organizations to facilitate technology

transition. These communities may all have different goals, time lines, and funding

levels, but they still must find a way to collaborate during different phases of technology

transition (National Research Council, 2003). The collaboration is critical to achieve

success (National Research Council, 2003).

The importance of technology transition stems from senior leaders placing emphasis on military organizations to convey technologies to the warfighter faster. If these three key stakeholders (AFRL, Program Office, and MAJCOM) do not work together the technology often goes nowhere (A Guide for S&T Program Managers, 2001). In 2001, the Secretary of Defense stated the transition of technologies from the S&T community to the acquisition workforce needed to be improved by these communities working more closely together.

Technology transition should not be confused with technology transfer. Technology transfer is a partnership which facilitates the sharing of advanced technologies between the government and commercial industry (Dobbins, 2004). Technology transfer will not be addressed in this research.

1.2 THE PROBLEM

Efforts to bridge the gap between the research laboratories and the warfighter, referred to by many as the valley of death, remains an issue for AFRL and acquisition communities. The valley of death refers to technologies that are not successfully transitioned. The failure to transition can be caused by a lack of necessary buy in from organizations needed to transition AFRL projects. Other issues such as the lack of funding necessary to transition technologies can cause them to get stuck in the valley of death. Some organizations attribute technologies getting stuck in the valley of death to the different perceptions that exist between AFRL and acquisition communities, while others see it as not enough cooperation among the different communities, i.e. end user,

4

MAJCOMs, defense contractor, and program offices (Defense Systems Acquisition Management Course, 2004 and The Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003).

The technology transition process is comprised of a distinct series of actions that each requires a different method to successfully transition technology. Figure 1 illustrates the key issues associated with the technology transition process. Perceptions, funding, and different cultures pose many problems and may cause for a technology to get stuck in the valley of death. There are also different actions that must take place to transition technologies within the departments: Basic Research, Applied Research, and Advanced Technology Development. The critical set of actions, which will be the focus of this study, will concentrate on technologies in the Advanced Technology Development stage. This is also the stage of development where the project goes from a 6.3 designation to a 6.4. These actions include: stakeholder collaboration, Applied Technology Demonstration (ATD) review process, financial or budget events, and resource management.
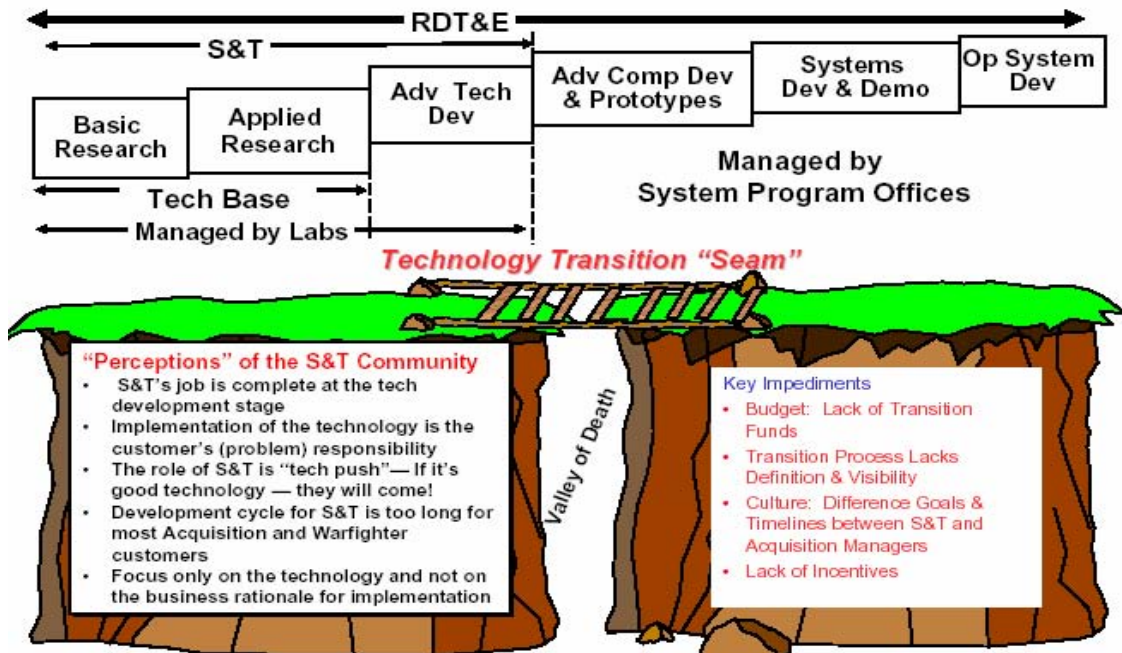
Figure 1 Valley of Death

As Figure 1 illustrates, funding is a major impediment in bridging the

valley of death. Because of events such as September 11 and the current war in Iraq, the

Department of Defense (DOD) budget is constrained (Deputy Under Secretary of

Defense, 2001). The constancy of funding for technology available for the demonstration

stage all the way through to the full maturity level is seldom available (National Research

Council, 2004). Funding needs to be available to transition technologies from the

Science & Technology community to the acquisition workforce.

To keep pace with commercially developed advanced technologies, DOD

products need to be rapidly transitioned to the operational community (Deputy Under

Secretary of Defense, 2001). AFRL must keep pace with the commercial sector to ensure

cutting edge technologies are transitioned to the warfighter faster than typical acquisition

development times. If AFRL does not keep pace with the commercial sector then they

are not delivering advanced technologies. This is critical because the average acquisition

development time ranges from 6.5 to 11 years, which by that time the technology is often

outdated (McNutt, 1998). A delay of technology transition may result in warfighters

possessing outdated systems causing an inability to respond or defend against increasing

threats of the enemy.

By the time it takes a technology to be developed and fielded to a military unit,

i.e. end state, the technology is no longer state of the art (McNutt, 1998). Quite often

these technologies being delivered to the warfighter are obsolete (McNutt, 1998). The

rapid transition of critical technologies to the warfighter is also an effort to reduce long

development times (SECDEF, 2001). If the warfighter cannot leverage up-to-date

technologies, then obsolete technologies may hinder operational effectiveness. AFRL

transitioning advanced technologies is just one effort in ensuring obsolete technologies

are not delivered to the warfighter.

1.3 THE PURPOSE

The purpose of this study is to discover to what extent AFRL is implementing

known technology transition best practices. This research will look at the current

guidance on technology transition and determine if it is presently being used by program

managers within AFRL.   This study will consider the technology transition process or

processes expressly exercised within AFRL. In most companies today, no one is in

charge of the processes, and hardly anyone is even aware of them (Hammer, 2003). An

understanding of this process from the S&T program manager's perspective should give

insight into the implementation of technology transition guidance, transition roadblocks,

collaboration methods, and views on technology transition guidance.

The best practices being evaluated come from *Technology Transition for Affordability; A Guide for S&T Program Managers*, DOD 5000.1, DOD 5000.2-R, and DOD sponsored publications on technology transition. The phenomenon of technology transition from AFRL to the Air Force warfighter, as it compares to best practice guidance, will be the focus of this research. This research will try to determine how effective the technology transition guidance is. This will be accomplished through examination of the individuals, processes, organizations, and events within AFRL.

There has not been much research to date on the topic of technology transition within AFRL. Although there is considerable literature on various aspects of technology transition, there is a paucity of published research on this topic (Spivey et al, 1997). This study will focus on the transition of technology for new start programs as well as upgrades to legacy systems. Nine best practices for technology transition commonly used by the DOD and industry will be addressed. These best practices will be used to evaluate the extent AFRL is implementing known technology transition best practices from industry and DOD standards, in order to accelerate the transition of laboratory technologies to the warfighter.

II. LITERATURE REVIEW

2.1 GUIDELINES FOR TECHNOLOGY TRANSITION

The best practices that serve as the focus for this study come from the following documents: Technology Transition for Affordability: A Guide for S&T Program Managers; DOD 5000.1; DOD 5000.2; Managers Guide to Technology Transition in an Evolutionary Acquisition Environment; and Accelerating Technology Transition; Bridging the Valley of Death for Materials and Processes in Defense Systems. Combined, these documents lay out effective steps an S&T manager can take to facilitate technology transition.

The *Technology Transition for Affordability; A Guide for S&T Program Managers* is written to serve as a guide to transition superior technologies while considering cost, budget, and funding strategies. The rapid transition for affordability is essential to stay ahead of military adversaries who might have the capabilities of purchasing advanced technologies such as weapons of mass destruction. The focus of this document is the affordability aspect of technology transition. The document also outlines key elements, guidelines, and DOD initiatives that are currently underway to help assist technology transition.

Affordability is referred to as the delivery of a quality product to the warfighter at best value (Technology Transition for Affordability; A Guide for S&T Program Managers, 2001). To attain the stamp of best value, a technology must increase performance, and lower the cost of development, production, acquisition, and life-cycle operations (Technology Transition for Affordability; A Guide for S&T Program Managers, 2001). Technology transition relies on budgets and transition funding. If

there were unlimited budgets, then there would not be a budget or funding issue. The

purpose for this document is to get S&T program managers to consider project costs,

specifically transition funding. However, this is not possible unless the S&T PM teams

with the acquisition customer early on in the project. It is essential that the acquisition

community plans for the transition early on and sets aside transition dollars. It is also

ideal that the S&T and acquisition communities establish a partnership during Milestone

A, which is the pre-systems acquisition phase (DOD 5000.1).

The DOD 5000 series, which include 5000.1, 5000.2, and 5000.2-R, attempt to

provide guidelines for the insertion of S&T products. The documents are very broad

when discussing technology transition. The 5000 series documents place emphasis on

affordability, as well as mechanisms that ensure mature technologies are transitioned.

Technology Readiness Levels (TRL), as well as demonstrating technologies in a relevant

environment, is the main mechanism used to determine technology maturity. Technology

developed in the S&T community should be demonstrated in a relevant environment or in

an operational environment to be considered mature enough to transition (Section 3.7.2.2

DOD 5000.2-R).

The DOD 5000 series documents also discuss the importance of rapidly

transitioning S&T products to acquisition programs. Figure 2 illustrates key points from

the 5000 series documentation. As stated earlier, it is ideal for the S&T and acquisition

communities to focus on Milestone A, however, S&T products can enter at Milestones A,

B, or C depending on the program state and transition windows (DOD 5000.2-R).
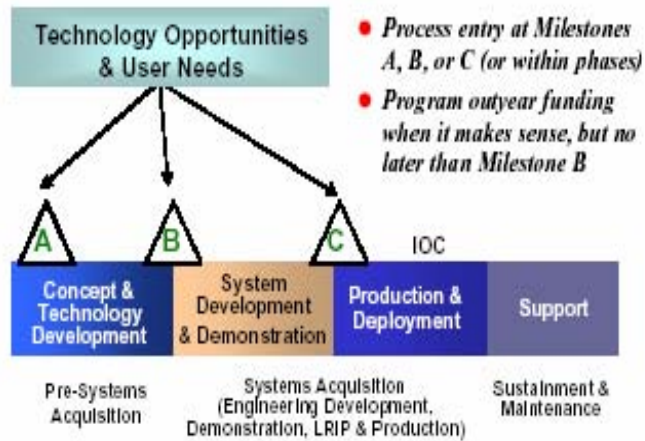
Figure 2 DOD 5000 Series Snapshot

The Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment is another important document from which technology transition best practices were derived. This document is not intended to define a specific technology transition process. It is simply to be used by S&T program managers as a reference guide. The document also suggests that the program manager refer to their immediate sources of authority when using technology transition processes (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). This guide is intended to illustrate how different communities can collaborate to promote technology transition. The document also addresses processes, programs, and challenges associated with technology transition.

According to the Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment document, there are three main communities identified that should be involved in facilitating technology transition. These three players are the

requirements generation, S&T, and acquisition communities. The requirement

community is responsible for developing requirement documents that define full

functionality of a system that meets warfighters needs at the beginning of a program. In

other words, they determine exactly what the user needs are. Another approach is

defining capabilities based on the maturity of the technology. This is a new approach for

the requirements community, which needs close interaction between the program offices

and S&T community. The requirements generation community is also responsible for the

analysis of mission capabilities. This analysis gives other communities, such as the S&T

community, more involvement in the requirements generation process. This is key

because it identifies opportunities to exploit advanced technologies that could meet

warfighter needs (Manager's Guide to Technology Transition in an Evolutionary

Acquisition Environment, 2003).

The acquisition community also plays a major role in the implementation of

technology transition. Evolutionary acquisition provides the warfighter capabilities

through a spiral approach (i.e. increments). This is the preferred method to facilitate the

rapid transition of mature technologies (Manager's Guide to Technology Transition in an

Evolutionary Acquisition Environment, 2003). The S&T PM must attempt to get the

necessary buy in from the program offices to ensure key stakeholders, such as the

acquisition community, are aware of what is going on.

The third major player in technology transition is the financial management

community. Fiscal limits are placed on budgets every year though the Defense Planning

Guidance (DPG), which are promulgated by the Secretary of Defense. This forces

program offices to develop the Program Objectives Memorandum (POM) within a

specific fiscal year. Program offices must budget for a set amount of money, which is tailored to the development of a specific program. It is important to understand this process and how the budget process affects technology transition. This process forces organizations such as the S&T community to delegate different funds (colors of money) to the development of technologies (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). The colors of money represent dollars that are specifically set aside for 6.1, 6.2, and 6.3 programs. This does not allow the managers the ability to shift funds around as they see fit. Program managers of 6.3 projects can only use money for 6.3 efforts. This means mature technologies have a limited amount of funds to get it to the transition point. The transition point is when an acquisition community or program office is willing to take ownership of the technology.

Other key players in technology transition that are discussed in The Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment guide are the Research and Development (R&D) and S&T communities. The S&T community should focus on transitioning advanced technologies to affordable products and during the process partner with the acquisition community to fully address the warfighters needs (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). This process is typically accomplished through Applied Technology Demonstrations (ATD) and Applied Concept Technology Demonstrations (ACTD). The R&D community evaluates technologies and is responsible for getting them to the field by working with the acquisition communities (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). This

community also focuses on interoperability and interface issues of systems, so the warfighter receives a user friendly product that meets their needs.

The last document that gave tremendous insight to technology transition was the publication *Accelerating Technology Transition; Bridging the Valley of Death for Materials and Processes in Defense Systems*. In 2003, the DOD requested that the National Research Council (NRC) sponsor a workshop that focused on a variety of aspects that influence technology transition. The three main focus areas were: cultures that fostered an environment to transition technology; methodologies and approaches to technology transition; and tools that enable technology transition (National Research Council, 2004).

One key aspect to creating the right culture is to foster communication through the development of prototypes. This is done by putting the prototypes in the hands of the customer as early as possible (National Research Council, 2004). The customer can get a better understanding of the capability of the technology by allowing them to interact with the technology. This essentially fosters communication among all the stakeholders, allowing them to have a common understanding of the technology potential.

Breaking down cultural barriers was another essential step to creating the right culture. There are hierarchical organizations that have cultural traits which hinder technology transition. An example would be a program office that might be in need of a specific technology in which they automatically pursue a solution through a defense contractor, bypassing possible solutions that might exist in the S&T community.

The second significant aspect to technology transition that the NRC found was the methodologies and approaches used to transition a product. One methodology is to

include a viral process which incorporates knowledge into the development process (National Research Council, 2004). A viral process is established when S&T PMs become knowledgeable about available tools that can help accelerate technology transition. These tools might include software capabilities that allow for advanced modeling and prototyping. The PM must know what resources are available to facilitate the transition of a technology.

Another methodology, or approach, found by the NRC was to foster technology transition through the creation of a successful team. For a PM to successfully transition technology, they must have the right technologies, right team skills, and the right financial support (National Research Council, 2004). For the teams to be successful the customer must be involved at the beginning. Also, if these teams do not have support from the highest level, then they will be unsuccessful (National Research Council, 2004). The formation of these teams should foster an environment focused on maturing technologies (National Research Council, 2004). A transition team focused on the maturity and reliability of the technology, which can be accomplished through multiple experimentations and demonstrations in challenging environments, can meet the demands of acquisition, testing, and evaluation organizations (Institute for Defense Analysis, 2003). This approach is also in accordance with the DOD 5000.2-R.

Another area of concern in this study was the use of enabling tools and databases. The tools discussed were the Accelerated Insertion of Materials (AIM) and Materials Engineering of Affordable New Systems (MEANS). Research performed by the NRC was focused on the rapid transition of materials, which is why the AIM and MEANS tools were discussed. Although these tools focus on material transition, it does not mean

15

the concept can not be applied to the overall notion of technology transition. Databases that can be shared and accessed by all the key stakeholders allows for better communication and understanding of that specific technology. Collaborative tools can enable an environment which fosters an innovative culture that can focus on the rapid transition of advanced technologies.

2.2 BEST PRACTICES

Communication

Communication and ownership of technologies between the S&T community and user is vital for technology transition to be successful (Spivey et al, 1997, and Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). Throughout the DOD 5000, and other DOD sponsored documents, the importance of communication between the laboratories and the acquisition personnel is stressed repeatedly (The Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003, National Research Council, 2004 and Technology Transition for Affordability; A Guide for S&T Program Managers, 2001). While communication is just one of many key aspects in transitioning technology from one organization to another, technology can be stymied in its transition if communication between the S&T community and acquisition personnel is intermittent (Spivey et al, 1997). If some players lack effective communication it can lead to the philosophy that the technology was "not invented here" and question why it should be championed (Spivey et al, 1997).

Communication is an integral part of technology transition. Some authors find communication to be the most important condition for success (Hoetker, 1997;

16

Lundquist, 1999; Russo and Herrenkohl, 1990). Communication was established as the first best practice. Developing a strategy and planning for technology transition involves many departments internal to AFRL and external which include MAJCOMs, program offices, and defense contractors. There can not be success if the collaboration lacks effective communication (Spivey et al, 1997, Dobbins, 2004, National Research Council, 2004, A Guide for S&T Program Managers, 2001, and The Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). To make a smooth transition, the S&T and acquisition communities must communicate early and often (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003, National Research Council, 2004, Technology Transition for Affordability: A Guide for S&T Program Managers, 2001). The Managers Guide to Technology Transition in an Evolutionary Acquisition Environment also suggests ways to keep in close contact with the customer, as well as ways to make pertinent information about the technology readily available. Using resources such as web sites, published articles, conventions, briefings, and shared databases, in conjunction with working directly with the program offices, enables the S&T community to effectively communicate with the customer. Well thought out strategies and communication allows all the participants to have an understanding of the project schedule, as well as the maturity of the technology. Technologies can only transition if the key stakeholders communicate, roles and responsibilities are defined, and funding is consistent (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). Proper and effective communication should facilitate technology transition and get buy in

from senior leaders and necessary stakeholders such as the MAJCOMs, Program Offices, and end user (National Research Council, 2004).

It is important to get buy in from upper management. Top-level managers should motivate personnel at every level to clearly identify objectives and identify weapon system program office needs in order to plan an effective S&T program that focuses on technology transition (A Guide for S&T Program Managers, 2001). The transition of a technology may be thwarted if there is no senior management support. Also, without support from upper-management, PMs must navigate through organizational barriers at the low and high levels within their organization as well as with outside organizations such as MAJCOMs and program offices. An additional and essential factor is a champion with sufficient authority to remove barriers, garner support, and ensure a new technology's successful implementation and use (National Research Council, 2004). If the S&T PM does not have buy in, then they do not have senior leaders willing to champion the technology. In most cases, the champion is typically a MAJCOM representative or program office willing to agree to take over program management responsibilities, as well as set aside transition money for the technology to be transitioned. If the PMs of 6.3 projects can work closely with the MAJCOMs and program offices, a natural team environment can develop. This outcome might eventually foster a culture focused on rapidly transitioning innovative technologies, which was a best practice suggested by the National Research Council.

Identifying the Customer

When a PM attempts to get buy in for their technology, they should have a customer identified. Identifying your customer and knowing what organizations frame

your customer is the second best practice for technology transition. The customer

performs a vital role in transitioning technologies. Typically, people involved in a

process look inward toward their department and upward to their boss, but no one looks

outward directly toward the customer (Hammer et al, 2003). There are different views on

who the customer is. Some view the customer as the MAJCOM, the end user, while

others view the customer as the contractor or the program office. The eventual customer

will always be the warfighter. The PM must understand the role of a customer as well as

the importance of recognizing the customer early on.

Participation

In dealing with the customer, one realizes that a key factor to successful

technology transition lies in the ability to team with the customer. Participation is the

third best practice that will be addressed. The S&T manager must work in partnership

with the customer on schedules, performance, costs, and other key areas that play a role

in technology transition (A Guide for S&T Program Managers, 2001). An organization

such as AFRL needs to partner with the acquisition community as well as the MAJCOMs

to ensure advanced technologies transition to the warfighter. Partnering becomes a major

factor because one organization cannot be responsible for transitioning technologies.

Partnership should go above and beyond everyday functional roles, which promotes an

environment where the stakeholders are flexible and willing to take risks without regard

to organizational barriers (National Research Council, 2004). Teamwork and

collaboration should take precedence over individual accomplishments and recognition

(National Research Council, 2004). To accomplish participation and collaboration, the

PM must have the right skills, abilities, and resources. The PM must have the necessary

information technology (IT) tools available and be knowledgeable in the necessary

disciplines to be able to communicate and collaborate with the customer.

Information Technology (IT)

Using IT tools as an enabler to transition technology is the fourth best practice

that facilitates technology transition. One example of IT tools that can enable the S&T

PM is being implemented by the Director Defense Research and Engineering (DDR&E)

who is planning to develop an information resource that gives all internal defense

technology providers, such as AFRL, access to most of the current DOD projects

(Manager's Guide to Technology Transition in an Evolutionary Acquisition

Environment, 2003). PMs within the S&T community will be able to access a large

number of current programs which could give them insight into weapon systems their

technology might be able to interface with. This also allows the PM the opportunity to

make contact with possible customers, facilitating communication. IT tools, such as

shareable databases, allow the PMs to disseminate pertinent information about their

project. It is important that the key stakeholders have access to the databases so there is

mutual understanding on the technology capabilities. The Virtual Technology Exposition

(VTE) is another IT resource that S&T PMs have access to. The VTE is a website that

contains subject areas on defense technology and joint warfighting capabilities (A Guide

for S&T Program Managers, 2001). The VTE website can be found at

https://vte.dtic.mil/.

Hammer (2003) sums up the importance of IT well when he says, "It is the

disruptive power of technology, its ability to break the rules how we conduct our work,

which makes it critical to companies looking for the competitive advantage." IT tools

can give the S&T PM the advantage of collaborating and communicating with their customer so technology can be rapidly transitioned. These tools can help cultivate an environment where knowledge is shared, which leads to the fifth best practice, knowledge management.

Knowledge Management

Knowledge management is important for PMs to have the ability to relate and understand the technical side and management side of program management. The National Research Council discussed the importance for teams to have the right technologies, skills, and financial support in order to implement technology transition. S&T PMs need to be intimately familiar with engineering and science to understand the technology capability and potential, as well as management practices. The essence of knowledge management is the ability to share and access information to gain knowledge. Being able to share information allows PMs to communicate easier, think outside the box, retrieve data more quickly, and avoid prior mistakes (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). To stay up to date with the latest technologies, the S&T PM must attend technical conferences, symposia, and academic meetings (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). They must also keep the acquisition community involved because the program offices are constantly being bombarded with information on possible new technologies from defense contractors. The Air Force Knowledge Now (AFKN) website is a good example of a collaborative tool which enables different communities to share information. However, they also need to understand the financial aspects such as budget, POM cycles, and affordability metrics.

These processes are typical acquisition functions, which can be looked at as important metrics that S&T PMs should be leveraging to facilitate technology transition.

Affordability Metrics

Affordability metrics and methodologies is the sixth best practice identified from the literature. The S&T manager should establish quantitative metrics in order to track the progress, exit criteria, and maturity of a technology (A Guide for S&T Program Managers, 2001). It is ideal if all the stakeholders agree to the metrics the S&T PM will use. Affordability metrics concentrate on operating and support costs, life-cycle costs, and lead-time reductions (A Guide for S&T Program Managers, 2001).

An affordability metric that can de directly applied to technology transition is the Integrated Process and Product Development (IPPD) method. The IPPD process includes the creation of Integrated Product Teams (IPTs), which are multidisciplinary teams that focus on meeting the customer's needs during the development phase as well as ensuring the technology gets transitioned. It is important for the S&T PM to establish IPTs and an IPT charter (AFI-61-101). The charter shall identify roles and responsibilities for all the team members. This should include the customer as well. Ensuring the right members are included in these IPTs is critical for success of the technology. The IPPD process also suggests that affordability metrics be used when determining system performance. The development of a transition plan is another important aspect of the IPPD process. Finally, when using the IPPD method the S&T PM must set up a senior leader review process.

These metrics and methodologies, such as experience with developing business models and Return on Investment (ROI) strategies, can be somewhat complex for PMs

that have limited experience in acquisition processes and business processes. This is why

it is essential that the teams involved with transitioning technology have all the necessary

knowledge, skills, and resources to utilize these tools.

Ensuring Technology Maturity

While PMs should understand acquisition processes, they still need to focus on

the technical capabilities and performance of their 6.3 program. To do this they must

constantly evaluate and gauge the maturity of the technology. Ensuring technology

maturity is the seventh best practice for facilitating technology transition. The National

Research Council and Government Accounting Office (GAO) both found that the

marketing of technology maturity can make or break the transition of the technology.

Quite often early concepts are marketed as being currently available, forcing the

customer not to purchase the existing product, but wait for the new technology to be

implemented (National Research Council, 2004). When this happens, an immature

concept is rushed to the demonstration phase where quite often it fails to demonstrate the

marketed capabilities (GAO, 2002). When these concepts are rushed to the

demonstration phase they are often left in the valley of death. Technologies should be

demonstrated at high levels of maturity before new technologies are integrated (A Guide

for S&T Program Managers, 2001).

One way to ensure the maturity of technology is through the use of Technology

Readiness Levels (TRLs). TRLs serve as a gauge for PMs when they need to make a

determination on the maturity of their technology. A technology that has been designated

as a TRL 4 is a lot less mature than a technology at TRL 6. All the stakeholders need to

understand the difference in TRLs because it allows them to understand the risk involved

with the technology. A technology at TRL 4 will have much more risk associated with it

than a product at TRL 6 or 7. The AFI 61-101 also places an emphasis on the use of

TRLs, which should be agreed on by all the stakeholders involved. The DOD 5000 series

documents suggest that technology must be tested in an operational environment to be

considered a mature technology. Figure 3 illustrates the different classification of TRLs.

TRL classifications also need to be included in the Technology Transition Plan (TTP).
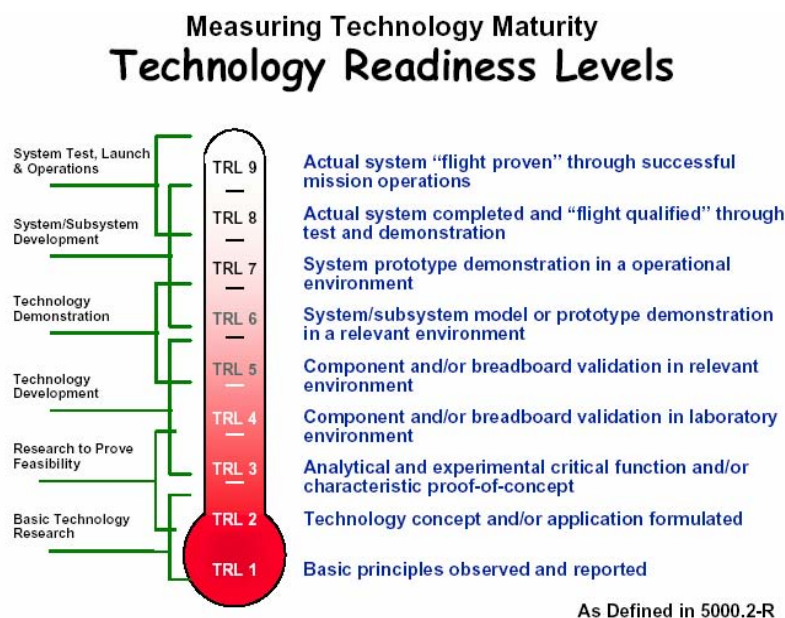
(Defense Systems Acquisition Management Course, 2004)

Figure 3 TRL Maturity Levels

The importance of having a transition plan is that it allows the S&T PM to get all

the key stakeholders to agree on transition issues such as risk associated with the

technology (AFI 61-101).   The transition plan is only effective if the key stakeholders

communicate and collaborate on project issues. A transition strategy should allow the

S&T and acquisition communities to appropriately plan for the transition of a technology.

The best evidence of a transition commitment is the inclusion of funds in either the S&T

budget or acquisition budget to bridge the gap from S&T phase to the acquisition phase

(A Guide for S&T Program Managers, 2001). Planning early on, especially with both

communities weighing the funding aspects, should help bridge the valley of death.

Technology Transition Team

   The development of a successful team provides a crucial foundation for

successful technology transition (Dobbins, 2004). The implementation of a transition

team is the eighth best practice. In an article from Defense AT&L (2004), Dobbins

explains the importance of having a transition integrated product team (TIPT). The

transition team works to maintain a smooth transition of the technology as well as

oversight responsibility for the transition. The TIPT has the capability of bringing the

MAJCOMs, program offices, laboratories, and end user together, ultimately facilitating

the transition planning and other key processes associated with technology transition.

Having the capabilities of an overarching integrated product team (OIPT) can also help

provide for a seamless transition (Dobbins, 2004). The OIPT is responsible for

completing the remainder of the transitioning activities such as cost, schedule, and

performance. The concept of people having the right technologies, the right team skills,

and the right financial support is not new; additionally, all successful transitions need to

have the customers as part of the team from the beginning in order to ensure the

military's high performance requirements are being met (National Research Council,

2004). The S&T PM must have the necessary personnel that are needed to transition the

technology. The program manager must be able to fully understand the technical and

financial aspects of their program. Program management responsibilities are quite often

new concepts that the S&T PM must understand. These responsibilities can be seen as

additional duties they are not used to dealing with, which leads to the last best practice of using incentives.

Incentives

Incentives play an important role in industry when it comes to transitioning a product to the marketplace. Quite often firms will offer cash bonuses or promotions if PMs can market and transition their product to commercial vendors. However, incentives like these do not exist within AFRL (Defense Systems Acquisition Management Course, 2004). Other than personal satisfaction, PMs do not have any incentives to transition their products.

Unfortunately, there are disincentives at the senior leader level that hinders the insertion of new technologies. At times, program offices will have the opportunity to adopt a new technology that reduces total life-cycle costs, but in the end may turn down the technology for the reason that it will lead to budget cuts for their organization (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). This can be a disincentive for S&T PMs who are trying to transition their technology.

2.3 ROADBLOCKS TO TECHNOLOGY TRANSITION

Technology transition, as with many other processes, comes with barriers and roadblocks which hinder the process. In 2003, the Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics) published data that described challenges to technology transition. Interoperability is listed as a major concern when transitioning technologies from the laboratory. The necessity for interoperability is why communication stands out as one of the most important aspects in technology transition.

If the laboratories, program offices, users, and contractors do not communicate early and often, the possibility that the technology will not be able to transition to the acquisition community becomes a reality. One of the DOD 5000 series objectives is that the PM must focus on interoperability and supportability. If the technologies coming out of the laboratories do not have some type of open system architecture, which allows for systems already in the battlefield to interface with the new technology, then the technology might again fall prey to the valley of death (The Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003). Ensuring for interoperability is vital for a smooth transition.

The test environment was considered to be another transition roadblock by the OUSD (AT&L). To further assist in a smooth transition, the test and evaluation (T&E) process must be examined. Sometimes technologies are marketed as being mature and stable in a relevant environment. When an immature technology is tested in a relevant or operational environment, it quite often fails the test phase. Therefore, the technology is left to linger in the valley of death. The T&E community provides an independent assessment of the technology which limits the chances of transitioning immature technologies to the field. They ensure the technology works as it is intended to and can stand up in an operational environment. Most S&T technologies that are at a TRL 4 - 6 are validated in a lab or simulated operational environment (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003).

Consequently, funding might possibly be the single most important roadblock to technology transition (National Research Council, 2004, A Guide for S&T Program Managers, 2001, and The Manager's Guide to Technology Transition in an Evolutionary

Acquisition Environment, 2003). If the S&T community, MAJCOMs, or program offices

have not set aside money for transition, then the technology will be very difficult to

transition from the laboratory to the program office. Proper allocation of funds requires

early communication and buy in among the stakeholders. Communication will allow

organizations an inroad of understanding to future funding requirements. If S&T PMs

align their projects with specific future warfighting needs, quite often they will obtain the

highest priority for funding (Manager's Guide to Technology Transition in an

Evolutionary Acquisition Environment, 2003). PMs must budget for three to eight years

down the road.

Among the challenges to technology transition, cultural differences must be

included. The laboratory, acquisition, and operational communities do not always have

the same goals and quite often have a difference of opinion in operational tactics, which

is why communication and participation are so important to ensure mutual understanding

(National Research Council, 2004). The senior leaders from these communities need to

effectively manage the different cultures to ensure the technology is transitioned from the

development stage to implementation (National Research Council, 2004). Different

organizations have different perceptions on how business gets done. They have different

goals and timelines, with different chains of command. All of these cultural differences

are in some way possible barriers to technology transition. The National Research

Council proposes that the introduction and acceptance of new technologies often depend

more on social, cultural, and historical factors than on technological merit.

The laboratories tend to have the perception that the role of the S&T community

is technology pull; meaning if it is a good technology they (the customer) will come

(Defense Systems Acquisition Management Course, 2004). Technology pull means the user is asking for specific capabilities, in which they seek out an organization such as AFRL to provide that capability. On the other hand, technology push can be defined as materials that are marketed to systems engineers and designers, typically in materials and processes organizations, with the goal of lining up funding commitments (National Research Council, 2004). If both organizations can work together, then the focus shifts from technology push/pull to a work environment that fosters collaboration between the S&T community and the acquisition community. Other cultural perceptions include ideas such as: the job is complete at the technology development stage; implementation of the technology is the customers responsibility; the S&T community only pushes technology; the development cycle for S&T products is too long for the acquisition and user community; and the laboratories focus only on the technology side of the project and leave the business part to other organizations (Defense Systems Acquisition Management Course, 2004). These cultural barriers usually exist because of poor communication, absent transition strategies, and lack of incentives (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, 2003).

2.4 PROGRAMS THAT FACILITATE TECHNOLOGY TRANSITION

It is important to note that there are many programs in existence that facilitate technology transition. In this study, I will discuss programs pertinent to my thesis, with emphasis on AFRL and the acquisition community. Programs that do facilitate the transition of technologies but will not be focused on are: Dual Use Science and Technology (DUS&T); Manufacturing Technology (ManTech); and the Small Business Innovative Research (SBIR) program. These programs will not be covered because they

29

are typically jointly funded by different organizations such industry and the Office of the Secretary of Defense (OSD). Programs that are jointly funded have different processes and regulations than programs such as Advanced Technology Demonstrations (ATDs).

Programs that will be addressed that facilitate technology transition are: Advanced Technology Demonstration (ATD); Advanced Concept Technology Demonstration (ACTD); and the Technology Transition Initiative (TTI). These programs will contribute to this study. Technologies available for transition usually come from either the ATD process or an ACTD program (Dobbins, 2004). These programs will be discussed in detail for the reason that they are significant in the way AFRL can transition technologies to the warfighter.

The first program that will be discussed is the ATD program. ATDs are a process for managing S&T programs that brings the team together early, and demonstrates a military capability in a joint warfighting experiment, battle lab experiment, demonstration, field test, or simulation (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment 2003). The main focus of an ATD is to transition a mature technology to the warfighter that helps improve a legacy system, or provides a new capability that the warfighter can use to improve operational capabilities.

Typically, ATDs procure an agreement between the research laboratories and the customer through transition plans and exit strategies. However, ATDs are usually prioritized by the MAJCOMs, which signify that the MAJCOMs have the final say in what becomes an ATD. If a 6.3 project does not become an ATD then it is classified as a Critical Experiment (CE). CEs should still follow the same transition path as ATDs. The principal difference between an ATD and a CE is the ATD has more funding allotted for

demonstrations, while CEs have very little funding allocated for demonstrations. These demonstrations can be very important for two reasons: (1.) it provides another avenue to test the product; (2.) it provides an opportunity for the PM to show their technology to senior leaders. This is another substantial reason as to why the S&T PM must involve other organizations, such as the MAJCOMs, early in the 6.3 program. The ATC will divide the ATDs in different categories, which are found in Table 2.

Table 2 ATD Categories

Category 1	MAJCOM or Agency supports and has programmed required funding for transition within the FYDP
Category 2A	MAJCOM or Agency supports and is committed to identify transition funding in the next Program Objective Memorandum (POM) cycle or Amended POM
Category 2B	MAJCOM or Agency supports but is not currently able to program for transition funding

(AFI 61-101)

Once there is agreement between the labs and the MAJCOMs, it does not mean that the technology will transition. Before the MAJCOM takes responsibility for the technology, roadblocks such as funding, contracting strategy, and interoperability can still prevent successful completion of the process.

ATDs require transition plans just like many other projects that plan on transitioning from the laboratory to another entity. ATDs are not funded by an outside source and require all programs going through to have their own transition plans, exit criteria, and schedules. Agencies, such as AFRL, have their own processes for nominating specific projects to become an ATD. Some criteria that a technology must meet in order to become an ATD are: the new concept addresses S&T objectives;

enhances military capability or provides a new capability; has a cost-effective approach; and is funded with completion time being less than five years (The Manager's Guide to Technology Transition in an Evolutionary Acquisition). For a project to be nominated to an ATD it must seek approval through the Applied Technology Council (ATC).

The ATC must approve each transition plan for the ATD candidate. The ATC is made up of senior-level management from the MAJCOMS, Product Centers, and representatives from AFRL. The members that specifically form the ATC are: the Chair (HQ AFMC Vice Commander for AFMC ATC, HQ AFSPC Vice Commander for AFSPC ATC, and AFMC Lead Enterprise Commander), Primary Members (MAJCOM Vice Commanders, Agency Commanders, AFRL Commander, and Air Force Acquisition Product and Logistic Center Commanders), Secretariat (usually designated by the Lead Enterprise Commander), and Invited Participants (usually AETC and other senior level stakeholders or advisory representatives) (AFI 61-101).

The purpose of the ATC is to ensure technologies are transitioned to the acquisition community in a timely manner. The ATC was also established so the acquisition communities (MAJCOMs and program offices) have a better understanding of what is going on in the S&T community. The main goal of the ATC is to facilitate the transition of ATD programs to the Air Force Material Command (AFMC), Air Force Space Command (SPACECOM), and other MAJCOMs (AFI 61-101).

ACTDs are another possible avenue used to transition lab projects to the warfighter. The ACTD program was initiated by the DOD in 1994 as a way to get new technologies that meet critical military needs into the hands of users faster and at less cost than the traditional acquisition process (GAO, 2002). ACTDs are usually a new

technology or concept that users are not very familiar with. It is also important to note the difference between ATD and ACTD. ACTDs are programs, usually employing multiple technologies that are reviewed by OSD and the joint requirements oversight council (JROC), and partly funded with OSD ACTD funds (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment 2003). An ATD is a process not a program; however, the biggest difference is that ACTDs are partly funded by another organization and ATDs are not. Another major difference is that ATDs are reviewed by the ATC and ACTDs are reviewed at the OSD level. ATDs are reviewed and approved by the services (MAJCOMs) and funded with service S&T funds (Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment 2003).

A key goal of ACTDs is to move into the appropriate phase of formal acquisition without loss of momentum, assuming the user makes a positive determination of military utility (http://www.acq.osd.mil/actd/intro.htm). ACTDs are managed by the user or sponsor. For example, once AFRL transitions a technology to a gaining unit or warfighter, the user would assume oversight responsibilities for that technology including funding and PM responsibilities. Another primary aspect of ACTDs is that the program exploits mature technologies. Just as ATDs should be mature technologies ACTDs must be able to demonstrate capabilities at TRL levels: 6 - System/subsystem model or prototype demonstration in a relevant environment, 7 - System prototype demonstration in an operational environment, 8 - Actual system completed and operationally qualified through test and demonstration (ground or space), 9 - Actual system operationally prove

through successful mission operations) before technologies can transition to an ACTD (Dobbins, 2004).

A fairly new program is the Technology Transition Initiative (TTI) program. Just like ATDs and ACTDs, the TTI program is focused on facilitating the rapid transition of new technologies from S&T programs into acquisition programs (Technology Transition Initiative Proposal Template, Fiscal Year 2006). The recurring objective for programs such as ATD, ACTD, and TTI is that these programs were put in place to get advanced technologies over the valley of death and into the hands of the warfighter. The TTI was developed by the office Under Secretary of Defense (Acquisition, Technology, & Logistics) (USD/AT&L) so promising technological innovations could transition to the operational communities (Technology Transition Initiative Proposal Template, Fiscal Year 2006).

Projects that are selected for TTI funds are reviewed at the OSD level. One key benefit of the TTI is that the projects selected for this program receive 50% of its funding with OSD money. This influx of dollars alleviates some of the pressure on the PMs and MAJCOMs when funding issues arise. The main difference between the TTI program and ATD programs are the different types of funding. ATDs typically do not receive any funding from other organizations until the technology transitions or is about to transition. Funding has been established to be a critical factor if technologies are to stay out of the valley of death. Projects that are selected through TTI will help spark the interest in funding among all the key stakeholders.

Throughout this chapter I have discussed roadblocks to technology transition, programs that facilitate technology transition, technology transition best practices, and

guidelines that organizations need to consider when dealing with the process of technology transition. As stated in Chapter One, there has not been an intense focus on AFRL and technology transition. By leveraging government sponsored documents, Air Force Directives, and industry practices I have analyzed and extracted nine commonly used best practices for technology transition. These best practices will orchestrate the collection of data necessary for this case study through structured interviews. Use of the nine best practices formulates the dynamics of this study to examine the extent to which AFRL currently employs known technology transition practices.

II. METHODOLOGY

3.1 OVERVIEW

This chapter will discuss the methodology chosen to conduct this research, as well as techniques used for data collection. As Spivey (1997) discussed, there has been little evidence published on technology transition within DOD laboratories. For this reason alone an exploratory approach with a case study design was determined to be the most suitable approach. The primary objective of this case study is to capture the circumstances and conditions of an everyday, or commonplace, situation while assuming the lessons learned from these cases will be informative as to the experiences of the average person or institution (Yin, 2003). The purpose with this approach (Yin, 2003 and Creswell, 1994) is to gain insight into how the program manager views and practices technology transition guidance. The four sections in this chapter will discuss: research methodology, qualitative design approach, the data analysis model, and ensuring research validity.

3.2 QUALITATIVE RESEARCH METHOD

The components used to structure this research design were: study questions; unit of analysis; and criteria for interpreting data (Yin, 2003). The research question for this study was:

To what extent is AFRL implementing known technology transition best practices from industry and DOD guidance to accelerate the transition of laboratory technologies to the warfighter?

Yin (2003) and Creswell (1994) agree that the essence of a case study design is to investigate a phenomenon in real life context, especially when boundaries are not clearly defined. Technology transition involves many different organizations and possibly

multiple processes, which makes the boundaries unclear. After conducting the literature review it was apparent that guidance on technology transition is not an exact science. The investigative questions are:

1. What guidance exists for technology transition within the DOD?

2. What is/are the process or processes that exist(s) to transition technologies to the warfighter?

3. Do the managers in the S&T community believe the current guidance is adequate to effectively transition technologies to the warfighter?

4. Is there best practices not being currently implemented in AFRL that could enhance the transition of laboratory technologies?

The research question and investigative questions attempt to gauge how technologies are transitioned, if best practices are being used, what are the problems, and if there are problems, how these issues could be addressed. These viewpoints will be based on those opinions of the program managers interviewed. Since the study was centered on one topic, technology transition, it led to the rationale of a single case study approach. With a focus on technology transition within the Air Force, AFRL was chosen to be the unit of analysis. This posed difficulty since technology transition has no bounds and can involve many different organizations (Yin, 2003).

In order to gather data, a focused interview was used (Merton et al, 1990). A focused interview best serves the purpose of the study because the nature of the research revolves around nine technology transition best practices. The interview focused on these best practices and followed up with some general overarching questions. The interviews also focused on a phenomenon of "human affairs" (Yin, 2003), since the

nature of technology transition can involve many communities with different cultures and perceptions.

A Subject Matter Expert (SME) within AFRL was asked to provide a list of PMs who had experience in transitioning laboratory projects to the warfighter. The SME provided a list of program managers within AFRL that had experience working with 6.3 projects. Once the interview questions were developed they were reviewed by SMEs and colleagues within the organization. Redundant questions were removed and valid questions were added per SME request. Interviews were broken down to statements after they were transcribed. Statements were analyzed for common themes. The interviews were designed to specifically measure AFRL technology transition practices as well as thoughts and viewpoints on the process. With this approach, open-ended questions were chosen to make up the interview sample (Creswell, 1994, Yin, 2003).

After interview candidates were identified, they were contacted via email and phone calls. Most interviews were scheduled in advance. All interviews were conducted face to face at the offices of the participating interviewees. Notes were taken during each interview and recorded when the participant gave permission. It was also explained that all interviews would remain confidential and the participants would be unidentifiable.

The interview questions focused on the subjects' views about: a) technology transition processes; b) current technology transition guidance and the effectiveness it has on transitioning technologies to the warfighter; c) processes currently being used to transition technologies to the warfighter; d) their role in implementing technology transition. The AFRL Internal Review Board granted permission to conduct these interviews. Interview questions are provided in Table 3 below.

Table 3 Interview Questions

BEST PRACTICES	QUESTION
Information Technology (IT)	Is your project currently identified/described in a sharable database in which your customer has access to?
	Do you have the proper tools for transitioning your project?
	Do you have problems with software interoperability? For example, can you easily send your customer a large file, do you have the software tools to open and modify their schedules, etc.?
	Do you know what your customers IT tool set includes?
	Are you aware of the Virtual Technology Exposition (VTE) website which is a database that shares information about ongoing R&D products and acquisition programs?
Communication	How do you communicate with your customer? i.e. email/phone/meetings
	How often?
	What kind of relationship do you have with your customer?
	What are your communication barriers?
	Does your customer fully understand what you are delivering?
	Do you do anything jointly with your customer (write concept papers, attend conferences, joint briefings, etc.)
Identify the Customer	Do you know who your customer is?
	Is your effort a technology push or technology pull effort?
	Was the customer identified early on your project?
Participation	Does you customer actively participate on a regular basis?
	Do necessary acquisition personnel participate when needed?
	How would you describe your relationship with the acquisition community?
	Could it be better?
	What type of interaction do you have with industry?
	Do you have any documents that outline your customer's roles and responsibilities and how they should be participating on the effort?
	If you have an outstanding relationship with your customer what would you attribute to that strong relationship?
Knowledge Management	Would you say that the majority of the PMs in AFRL are familiar with acquisition processes? i.e. Schedule, POM, PMRs, requirements generation, financial management, defense acquisition etc
	Do you know early on or even at all if your project can be transitioned/inserted into a legacy system?
	Do you base your technology availability dates on weapon system transition windows?
	Do you understand how your technology fits in providing new warfighter capabilities?
	Can you very clearly define the As-Is environment and then describe the environment with your technologies implemented?

Incentives	
	What incentives do scientists or PMs on a product development team have to reach out to the customer?
	What incentives do you have to transition your project?
	Do you have any suggestions on possible incentives?
Affordability Metrics	
	Do you use metrics for your project schedule and performance criteria?
	How do you determine your exit criteria?
	Do you have the right personnel to measure these aspects of the project?
	Did you define or coordinate your key performance parameters with your customer?
	Did you perform an Return on Investment (ROI) or create a business case at the start of your technical efforts?
Technology Transition (TT) Team	
	Do you think a technology transition team would help market AFRL projects?
	Do you think PMs in the labs have the right skills to do PM work?
	Do the product development teams have the right expertise/personnel to facilitate TT?
	Are there other career fields that could be of benefit to help projects transition?
	Would you be in favor of having someone else work the transition issues on your program?
Technology Maturity	
	How do you ensure technology maturity for your project?
	Are the Technology Readiness Level (TRLs) an appropriate gauge to measure technology maturity?
	Do you track and assess technology maturation by key milestones or just prepare a chart for Program Baseline Reviews?
	Do the TRLs help you in communicating with your customer and in meeting their expectations?
General Questions	
	In your opinion what do you think the single most important roadblock in transitioning AFRL projects?
	Do you think AFRL representation in the program offices could help transition AFRL projects?
	What do you think the process is that sells your project; i.e. transitions it or markets it?
	Who is your face to push your project to be transitioned (i.e. the PM, Applied Technology Council (ATC), Acquisition community)?
	Do you think the ATC does a good job to ensure technologies are transitioned?
	Do you think the Applied Technology Council process works to prevent delays in transition?
	How do you go about getting a champion for your project?
	What organization is the most difficult to get buy in from?

3.3 DATA ANALYSIS TECHNIQUE

The qualitative data collected through this case study used Creswell's (2003) analysis spiral as a template. The data collected was reviewed on multiple occasions using the following guidelines:

1. Organization: Data was collected via digital recorder when the researcher obtained permission. The data was then transcribed, broken up into smaller phrases, and then stored in a database.

2. Perusal: Overarching concepts were reviewed multiple times. Ideas and concepts were then broken down to an understanding of the underlying meaning.

3. Classification: Themes and topics were extracted to make up a list of common categories.

4: Synthesis: All data was summarized. Propositions and hypotheses emerged which identified categorical relationships.

Data analysis techniques included pattern matching, explanation building, and theme development (Trochim, 1989, Creswell, 1994, and Yin, 2003). After using the spiral approach above, patterns and themes emerged after synthesizing the data. This approach, compared to predicted patterns, strengthened the internal validity (Trochim, 1989). Explanation building was used to refine a set of ideas and link them to plausible or rival explanations (Yin, 2003). Another purpose for explanation building is to generate concepts for future study. Safeguards used to reduce problems associated with explanation building constantly referenced the reason for the inquiry and third party inspection of raw data during the data collection process. After data analysis was conducted the next step was to ensure the validity of the research.

3.4 ENSURING VALIDITY AND RELIABILITY

To validate the research employed, the researcher must clearly state the bias they bring to the study (Creswell, 1994). The researcher in this case did have past experience

working with AFRL. To control for bias, participants were randomly selected. The only criteria the participants had to meet were they needed be a 6.3 program manager.

Peer input was the second method used to validate the research. Having colleagues and instructors review the data in draft form ensured construct validity (Yin, 2003). Subject Matter Experts within AFRL also had the opportunity to review the interview questions and research questions. This ensured explanation for this research was clear and concise for other readers. Internal feedback was addressed through the use of this method.

Throughout this analysis, recurrent themes and patterns emerged. Pattern matching was used to interpret the data due to the lack of quantitative data. Pattern theory uses analogies to tie relationships and ideas together (Neuman, 1991).   These themes and patterns along with statements from the interviewees were given to co-workers for review. These individuals were asked to categorize the statements under the themes. The purpose for this was to see if they drew the same conclusions as the researcher. The external audit by those not associated with this study validates the synthesis of the data.

All data collection and analysis procedures were documented to ensure reliability. The goal was to minimize as many errors as possible (Yin, 2003). Case study skills suggested by Yin (2003) were employed throughout data collection, and analysis ensured: reliability was at the beginning gain a firm understanding of the issues being studied, the researcher checked all perceptions "at the door" before each interview for a variety of reasons: to be more responsive to the data; allowed the questions to be flexible and adaptive; which increased opportunities for new insight that they had not been privy

to; which ensured good questions were asked by having them reviewed by SMEs. These

data collection methods and analysis procedures allowed the researcher to gain a great

deal of understanding and insight into the phenomena technology transition.

IV. DATA ANALYSIS

4.1 INTRODUCTION

The focus of this effort is to evaluate the extent AFRL is implementing known technology transition best practices from industry and DOD standards in order to accelerate the transition of laboratory technologies to the warfighter. Through review of the literature nine best practices became the baseline for the interview questions. Then interviews were conducted with S&T program managers that had experience managing 6.3 programs. This chapter will discuss data captured through interviews and subsequent analysis. Patterns and themes were discovered using qualitative analysis techniques. The following sections will discuss the analysis of the data while pointing out themes that occurred for each technology transition best practice.

4.2 DATA ANALYSIS

Best Practice One: Information Technology

(Q1-1) *Is your project currently identified or described in a sharable database in which your customer has access to?*

It is understood that there are many IT tools out there. Even though this question focused on shareable databases, the purpose for this question was to get the participant thinking about how they use IT tools to collaborate with their customers. Four out of the twenty-three interviewed did not share data through the use of a sharable database. Three individuals suggested that the tools exist, but do not use them because no one wants the responsibility to maintain the database. However, nineteen out the twenty-three subjects saw value in leveraging a sharable database to conduct project business with their customer. The individuals that did say they leveraged sharable databases stated they

accomplished this through web-based tools or a database that was managed by their contractor.

(Q1-2) *Do you/customer have the proper tools for communicating project issues?*

Twenty out of twenty-three subjects thought they had the proper IT tools to effectively communicate and share data with their customer. Three out of the twenty-three interviewed stated they did not have the proper tools needed to effectively communicate with their customer. One subject felt an instant messaging capability was needed.

(Q1-3) *Do you have problems with software interoperability? For example, can you easily send your customer a large file, do you have the software tools to open and modify their schedules, etc.?*

Three out of twenty-three did not feel they had any issues with interoperability. Twenty individuals said they did have these issues on a regular basis. Issues ranged from access to classified data and secure applications, organizational barriers (i.e. access to software applications that are stovepiped), and contracting issues. It is important to note that reasons such as access to classified data and secure applications came from one directorate.

(Q1-4) *Do you know what your customers IT tool set includes?*

All twenty-three participants understand what IT tools the customer uses. Two participants noted that that the tools exist but are not leveraged enough as they should. The participants stated that all the customers typically did not have a specific set of tools, but did have access to tools needed to collaborate with the stakeholders.

(Q1-5) *Are you aware of the Virtual Technology Exposition (VTE) website which is a database that shares information about ongoing R&D products and acquisition programs?*

The purpose for this question was to get the participant to think about the usefulness of tools like the VTE. One out of twenty-three interviewed did know about the website. Five individuals did not have an answer. Seventeen out of twenty-three interviewed had never heard of this website. Even though the majority of participants had never heard of the VTE, they all could see some utility in a tool like this.

Two themes did emerge from this section. One was the importance participants placed on the use of IT tools. Table 4 illustrates the results. Of those individuals interviewed, 90% had a positive response about IT tools and used them to reach out to their customer and share data. Questions Q1-1, Q1-2, and Q1-4 were combined to gain a more accurate point of view on IT from the perspectives of the PMs. Theme one emerged using 69 responses. The program managers interviewed stated they leveraged tools such as web-based tools and shared databases. They all used these IT tools to conduct business on a regular basis. Even though 95% of those interviewed were not aware of the VTE tool that was illustrated in the *Technology Transition for Affordability: A Guide for S&T Program Managers*, they were aware of web-based tools that provided similar functionality.

Another theme that emerged was the overwhelming response of issues dealing with IT tools and interfaces. Theme two was considered from 23 responses. Of the twenty-three individuals interviewed, 87% had issues with their IT infrastructure. However, even though 87% had issues with their IT tools, they still saw value in the use of IT tools when working technology transition issues.

Table 4 Usefulness of IT Tools

Themes	# of responses	% of participants	# of participants
	(out of 69)		
1. Use of IT tools			
Positive Statement	64	93%	23
Negative Statement	5	7%	23
	(out of 23)		
2. Experienced IT problems	20	87%	23
Had no IT problems	3	13%	23

Best Practice Two: Communication

(Q2-1) *How do you communicate with your customer?*

The majority of the participants used email when communicating with their customer. Eleven of the twenty-three participants typically communicated with their customer through email. Seven responded as using email, phone, and meetings. Two respondents answered telephone, while another two answered face to face. One subject responded with the answer telecoms.

(Q2-2) *How often do you communicate with your customer?*

It seemed all the participants communicated often with their customer. Thirteen subjects said they communicate on a weekly basis with their customer. Two responded as communicating on a monthly basis with their customer, while another two said on a quarterly basis. Six respondents communicated on a daily basis with their customer.

(Q2-3) *What kind of relationship do you have with your customer?*

Fifteen respondents believed they had a good relationship with their customer. Eight of the interviewees said they just had an OK relationship with their customer. The subjects that described their relationship with the customer as OK generally agreed it was because of personality differences or the busy schedules of the customer.

(Q2-4) *What are your communication barriers?*

Four respondents said they had no communication barriers they were aware of. Five agreed that turnover, especially at the MAJCOM and Program Office level, really hindered the communication process. Five out of the twenty-three interviewed thought personality issues were the reasons for communication breakdowns. Another set of five respondents attributed the breakdown in communication to a lack of understanding from the different organizations involved (MAJCOMs, Program Offices, and Laboratories). It is important to note that the lack of understanding, whether it is the conveyance of organizational goals or technical knowledge by the customer, was apparent throughout multiple questions. One answered that distance between them and the customer posed a problem in communication. Another responded that the access to classified tools such as Secure Telephone Equipment (STE) and Secure Terminal Unit (STU), limited their ability to communicate with the customer. One individual stated the inability to have senior leaders talking to leadership in other organizations was a barrier to communication. The last individual interviewed stated firewalls as a limiting factor in communicating with their customer.

(Q2-5) *Does your customer fully understand what you are delivering?*

The majority of the participants attributed their customers understanding to good communication and involvement. Eighteen out of the twenty-three respondents believed their customer fully understood the technology capability they were delivering. The other five subjects did not believe their customers understood the technology they were receiving. Four out of the five respondents that stated no believed the customer only understood the novelty of the technology, but not the real "in and outs."

48

(Q2-6) *Do you do anything jointly with your customer? (write concept papers, attend conferences, joint briefings, etc.)*

The purpose for this question was to gain insight on the collaboration between the PM and the customer. Fifteen out of the twenty-three respondents performed in joint efforts such as concept papers, joint briefings, and attending conferences with their customers. Eight individuals did not work joint efforts with their customer. Again the eight individuals that did not conduct joint efforts such as these attributed it to the busy schedules of the customers.

A couple of themes did emerge from this section of questions. Questions 2-1, 2-2, 2-3, 2-4, and 2-6 combined to get an overall understanding of how effective the communication was between the PM and the customer. These questions combined totaled 115 responses. The responses for themes one and two can be found in Table 5. Out of these five questions dealing with communication 87% had a positive response. Program managers typically performed joint efforts with their customer. Most of the PMs could say they were confident they had communicated enough to the customer so they could understand what technological capabilities they were receiving.

The second theme that emerged was communication issues. Theme two emerged from 23 responses. All twenty-three PMs stated they had good relationships with their customer, however, nineteen of them stated they had communication barriers. Reasons for communication barriers for these individuals included personality issues, turnover, lack of understanding, and the lack of availability of senior leaders. Reasons are located in 2(a), 2(b), and 2(c).

Table 5 Communication between the PM and Customer

Themes	# of responses	% of participants	# of participants
	(out of 115)		
1. Communication Effectiveness			23
Positive	102	87%	23
Negative	13	13%	23
	(out of 23)		
2. Communication Issues	19	83%	23
(a) MAJCOM/Program Office Turnover	5	22%	23
(b) Understanding among stakeholders	5	22%	23
(c) Personality	5	22%	23

Best Practice Three: Identifying the Customer Early

(Q3-1) *Do you know who your customer is?*

All twenty-three respondents knew who their customer was and was able to identify them. The majority of respondents viewed their customer as the MAJCOM, Program Office, DEPOT, and Requirements community. They all agreed they had multiple customers as well.

(Q3-2) *Is your effort a technology push or technology pull effort?*

Nineteen individuals agreed that their effort was technology push while two viewed the effort as technology pull. Three out of twenty-three stated their technology was identified through technology pull. Two out of these three individuals were from the same directorate. One respondent said it was a combination of both. The purpose for this question was to understand the networking ability of the PM. After conducting the literature review it became apparent that the S&T PM needs good networking abilities to transition technology.

(Q3-3) *Was the customer identified early on your project?*

Throughout the literature review, the program managers' ability to identify the customer early on seemed critical in the technology transition process. All twenty-three

respondents agreed that the customer was identified early on in the project. They attributed this to the constant communication and shared understanding with the customer.

Two common themes from this section emerged. One theme was that PMs identified their customers early on in the project and typically pursued them. Results for these themes can be found in Table 6. The underlining meaning for this theme was that the S&T PM felt if they did not market their technology then it would likely not be transitioned. Ninety-five percent of these individuals stated PMs of 6.3 projects must be able to network themselves to other organizations, and if they do not have the ability to do that then they should not be a 6.3 program manager. In other words, S&T PMs of 6.3 projects should be a people person.

The second theme that developed from this section was that PMs were reaching out to their customer. The majority of the PMs believed their effort was technology push. This meant the PMs were collaborating and networking with their customers.

Table 6 The PMs Ability to Network

Themes	# of responses	% of participants	# of participants
1. Customer identified	23	100%	23
Customer identified early	23	100%	23
2. Technology push	19	83%	23
(a) Technology pull	3	13%	23
(b) Both	1	4%	23

Best Practice Four: Participation

(Q4-1) *Does you customer actively participate on a regular basis? (meetings, test events, and Program Management Reviews (PMRs))*

Five out of twenty-three said the customer did not participate enough. Eighteen respondents believed the customer adequately participated on a regular basis. Even

though the majority of those interviewed stated the customer participated on a regular

basis, the general consensus was that it was hard to get all the stakeholders to participate

on a regular basis due to busy schedules.

(Q4-2) *Do necessary acquisition personnel participate when needed or on a regular basis?*

In the literature review it was obvious the acquisition community was a key

stakeholder in transitioning technologies. It was important to gain an understanding of

the relationship between the PM and one of the key stakeholders. Eleven out of twenty-

three respondents thought the acquisition community did not participate when needed or

on regular basis. Eleven individuals thought the acquisition community did participate

when needed. One subject stated that the acquisition community participated 50% of the

time.

(Q4-3) *How would you describe your relationship with the acquisition community?*

The majority of the respondents felt they had a decent relationship with the

acquisition community. Six out of twenty-three subjects believed their relationship with

the acquisition community was not good. The other seventeen respondents felt they had

a good relationship with the acquisition community.

(Q4-4) *Could the relationship be better?*

Twenty-two respondents thought the relationship could be better with the

acquisition community. Three of the participants thought it could be better but did not

elaborate. Five respondents believed the relationship could be better if the program

offices had a better understanding of the technology capabilities they were attempting to

transition. Six individuals believed more communication was needed between the

laboratories and the program offices. Two of the respondents felt that senior leaders from

both communities needed to be more involved. Another two respondents believed that

organizational barriers and stereotypes needed to be broken. One respondent did not

answer the question. Two respondents thought there needed to be more trust from both

communities. One respondent suggested PMs need more experience in the program

office to gain a better understanding on the acquisition community. One individual

thought it could be enhanced if the S&T PM had a better understanding of the program

office requirements.

(Q4-5) *What type of interaction do you have with industry?*

Again, this question was to gain an understanding of the networking ability the

PM has. Twenty-one respondents stated they actively interact with industry on regular

basis. Two respondents said they do not, but agree it is important.

(Q4-6) *Do you have any documents that outline key stakeholders roles and
responsibilities and how they should be participating on the effort?*

The purpose of this question was to gain insight into the collaboration methods

the program manager used. Four respondents said they had no documents that outlined

responsibilities. Eight respondents stated they had some type of an informal agreement.

Eleven of those interviewed said they had a formal structure that described roles and

responsibilities.

(Q4-7) *If you have an outstanding relationship with your customer what would
you attribute to that strong relationship?*

Ten out of the twenty-three subjects interviewed though that communication was

the number one reason for the good relationship. Thirteen of the twenty-three attributed

understanding among the key stakeholders as the number one reason for a good

relationship.

Different themes emerged from this section of questions as well. Table 7

illustrates the results for theme one. Of the PMs interviewed, 48% felt the acquisition

community did not participate enough. The absent participation was attributed to the

busy schedule of the program offices, turnover, and a lack of interest in the technology.

The PMs interviewed stated the lack of interest was due to the program offices only

caring about what the technology could do for them short term instead of long term.

Table 7 Program Office Participation

Themes	# of responses	% of participants	# of participants
1. Acquisition personnel participated when needed	11	48%	23
Acquisition personnel did not participate when needed	11	48%	23
50% of the time	1	4%	23

Another theme that emerged was the lack of formal agreements the PMs had with

their stakeholders. Table 8 illustrates the results for theme two. Out of the twenty-three

individuals interviewed 52% either had no agreements with their customers, or had no

formal documentation that outlined roles and responsibilities. It is also important to note

that 48% of those individuals who stated the acquisition community did not participate

enough were part of the 52% of those who had no formal arrangements with their

stakeholders.

Table 8 Roles and Responsibilities

Themes	# of responses	% of participants	# of participants
2. Formal arrangements with stakeholders	11	48%	23
No formal arrangements	8	35%	23
No arrangements at all	4	17%	23

Best Practice Five: Knowledge Management

(Q5-1) *Would you say that the majority of the PMs in AFRL are familiar with acquisition processes? (i.e. Schedule, POM, PMRs, requirements generation, financial management, and defense acquisition)*

Twelve out of the twenty-three individuals interviewed believed program managers within AFRL were familiar enough with acquisition processes to do their job. The other 11 individuals interviewed did not think they understood the acquisition processes enough to do their job. The general consensus was the PMs thought they needed more training and program office experience. Even those PMs that stated they were familiar enough with the acquisition processes thought they needed refresher courses with program management and acquisition processes. After asking this question the researcher realized that S&T PMs did not need to be Level One or Level Two certified in program management. There is a certification process, but program management certification is not requirement for S&T program managers.

(Q5-2) *Do you know early on or even at all if your project can be transitioned or inserted into a legacy system?*

This question was developed as a lead in to the following question. The purpose was to get the PM thinking about how they view transition windows for defense systems that are managed by the acquisition community. Ten out of the twenty-three respondents typically could not tell if their technology could be transitioned. Thirteen of the individuals believed they could judge whether their project could be transitioned.

(Q5-3) *Do you base your technology availability dates on weapon system transition windows?*

The majority of those interviewed did not forecast dates their technology might be able to transition. Fourteen individuals did not base their project schedule on weapon

55

system transition windows. Eight individuals did base their schedules on weapon system

transition windows. One stated they did this 50% of the time.

(Q5-4) *Do you understand how your technology fits in providing new warfighter capabilities?*

All twenty-three subjects interviewed understood how their technology provided

the warfighter new capabilities. The PMs were very comfortable and confident about the

technical capabilities their technology brought to the warfighter.

(Q5-5) *Can you very clearly define the "as-is" environment and then describe the environment with your technologies implemented?*

All twenty-three agreed they understood the environment now with the legacy

system and how it would change after the implementation of their technology. Again, the

participants were confident about how their technology would make a difference for the

warfighter.

Two themes emerged here as well. Table 9 illustrates the results. Out of the

twenty-three individuals interviewed 48% did not believe AFRL program managers were

familiar enough with the acquisition processes. It is critical that the S&T PM be familiar

with the acquisition processes because the acquisition community plays a major role in

the transition of technologies. More than half of those individuals that thought PMs were

not familiar enough with acquisition processes attributed it to the lack of training or

program office experience. This theme could also be linked to the other theme that

emerged: the PMs understanding of the weapon system transition windows.

Out of the twenty-three PMs interviewed 61% did not look at future weapon

system transition windows too see if their technology could be inserted into a legacy

system. The majority of the individuals stated they did not have the necessary data to

make those forecasts. The PMs felt they needed schedules and roadmaps provided by the

program offices to forecast efficiently.

Table 9 Acquisition Processes

Themes	# of responses	% of participants	# of participants
1. PMs are familiar with acquisition processes	12	52%	23
PMs are not familiar with acquisition processes	11	48%	23
2. Do not base technology availability on transition windows	14	61%	23
Base technology availability on transition windows	8	35%	23
50/50	1	4%	23

Best Practice Six: Incentives

(Q6-1) *What incentives do scientists or PMs on product development teams have to reach out to the customer?*

The purpose of this question encouraged the participant to think about: 1) Do they

need incentives. 2) What incentives they had with which to network. Four PMs agreed

there are no incentives to reach out to the customer. Nineteen out of twenty-three felt

that the only reason to reach out to your customer was because of personal motivation.

The majority of the PMs believed they had to be internally driven to manage 6.3 projects.

(Q6-2) *What incentives do you have to transition your project?*

Four out of twenty-three said the only reason to transition was for personal

satisfaction. Another group of four individuals thought monetary compensation was an

incentive they had currently. Three out of twenty-five agreed that receiving a good rating

was an incentive. One subject thought recognition was an incentive. Another individual

thought just seeing the technology transition was an incentive. One subject could only

see a disincentive, because once a PM transitions a technology they must start all over

with a new program. Nine individuals stated there were no incentives to transition a

technology.

(Q6-3) *Do you have any suggestions on possible incentives?*

Eight out of the twenty-three individuals believed allowing the S&T PM to get experience in a program office was a start in the right direction. Seven individuals did not have any suggestions. Four out of twenty-three agreed that a better monetary reimbursement and promotion plan needed to be in place. Two individuals felt that a specific transition process put in action would be an incentive. One individual offered an incentive that would promote individuals, but allow them to stay in their expertise instead of being promoted to management. One of the subjects thought patriotism was their only incentive. They felt important and self-worth if their technology was adopted by a warfighting system.

One theme that emerged in this section was that PMs did not believe they had any incentives given to them by the organization to transition a technology. Table 10 illustrates the results. After twenty-three PMs were interviewed 65% stated there were no organizational incentives to transition their technology. Five of those individuals stated the only incentive was personal satisfaction. One individual stated there was only a disincentive to transition projects because once a technology is transitioned that individual had to find a new job.

Table 10 Incentives

Themes	# of responses	% of participants	# of participants
No organizational incentives	14	61%	23
Monetary	3	13%	23
Rating or OPR	3	13%	23
Recognition	2	9%	23
Only disincentives	1	4%	23

Best Practice Seven: Affordability Metrics

(Q7-1) *Do you use affordability metrics for your project schedule and performance criteria?*

Fourteen out of twenty-three participants stated they did not use affordability metrics. Nine individuals did say they use some type of affordability metrics. However, five of those individuals that used affordability metrics came from the same directorate. It seemed these practices were utilized more in some directorates than others. Some stated that it was a requirement for them, however the majority did not.

(Q7-2) *How do you determine your exit criteria?*

Eleven out of twenty-three interviewed stated they determined the exit criteria by meeting a certain percentage of Key Performance Parameters (KPPs). Three individuals determined their exit criteria by demonstrating their technology in a relevant environment. After demonstrating in a relevant environment the results had to be in a certain percentage range with a pass/fail rating. It is important to note the individuals that did use KPPs also demonstrated their technologies in a relevant environment. Four out of twenty-three said the used the TRL gauge to determine the exit criteria. The individuals that used the TRL as the determining factor said their technology could not meet the exit criteria if it did not reach a TRL 6. Meeting TRL 6 is also in accordance with AFI 61-101. Three out of twenty-three did not determine exit criteria. Two individuals stated it was a "best guess" in determining the exit criteria.

(Q7-3) *Did you perform a Return on Investment (ROI) or create a business case at the start of your technical efforts?*

Twenty out of twenty-three personnel interviewed said they did not perform any type of ROI or business case. Three individuals did say they used ROIs and business cases. However, one of the individuals that did perform ROIs and business cases stated

they were ineffective because too many assumptions go into the data and they did not

have the appropriate personnel to perform these.

> (Q7-4) *Do you have the right personnel to measure and perform these aspects of the project? (i.e. Affordability Metrics, ROI, IPPD, and Business Cases)*

Twelve out of the twenty-three participants said they did not have the right

personnel to perform this part of the job. Eleven individuals said they had the necessary

personnel to do this job. Four out of the eleven subjects that did say yes came from the

same directorate. Throughout the interview process it was apparent that some PMs had

sufficient support and resources available and some did not.

Two themes did emerge out of this section. Results for both themes can be found

in Table 11. One theme that emerged in this section was the nonuse of affordability

metrics. Out of twenty-three individuals interviewed 61% stated they did not use these

metrics. Throughout the literature review the use of affordability metrics was stressed

multiple times (A Guide for S&T Program Managers, 2001, DOD 500 2-R, 2002, and

The Manager's Guide to Technology Transition in an Evolutionary Acquisition

Environment, 2003). It is also important to note that when interviewees were asked about

the use of specific affordability tools (ROIs and Business Case), 87% stated they did not

use these tools.

Another common theme that arose was that 52% of those interviewed believed

they did not have adequate personnel to perform affordability metrics. These same

individuals were also part of the 87% that did not use ROIs and Business Cases as well as

part of the 61% that stated they did not use affordability metrics at all. The resources

seemed to be available in some organizations and absent in others. It is also important to

note that if the S&T PM is going to implement affordability metrics such as an ROI or business case, they will need certain data from the program offices and support from finance departments to do this correctly.

Table 11 Affordability Metrics

Themes	# of responses	% of participants	# of participants
1. Did not use affordability metrics	14	61%	23
Did use affordability metrics	9	39%	23
Did not perform ROIs or Business Cases	20	87%	23
2. Do not have the necessary personnel to perform affordability metrics	12	52%	23
Have the necessary personnel available	11	48%	23

Best Practice Eight: Technology Transition Team

(Q8-1) *Do you think a technology transition team would help market/transition AFRL projects?*

These next five questions were an attempt to see if program managers in the laboratories felt they needed additional help with transitioning technologies. Three out of twenty-three subjects interviewed said they did not think this team could be effective. However, twenty individuals interviewed did think this was a good concept and that it could be effective. Throughout these questions from this section it was clear the program managers felt they needed help in transitioning technologies.

(Q8-2) *Do you think PMs in the labs have the right skills to do PM work?*

Fourteen of those interviewed believed that the PMs within AFRL do not have the necessary skills to do the program management side of the job. Half of those fourteen attributed it to the lack of training and guidance. Nine out of twenty-three participants did believe the PMs within the labs have the necessary skills to do program management duties.

(Q8-3) *Do the product development teams have the right expertise/personnel to facilitate technology transition?*

Nine out of twenty-three said they did not have the right personnel needed to effectively transition technology. Seven people stated the resources are available, they just are not immediate. Another seven thought they did have the necessary personnel needed to facilitate technology transition.

(Q8-4) *Are their other career fields that could be of benefit to help projects transition?*

Four out of twenty-three did not think any other career fields could come in and be of benefit. However, two of those four individuals thought the S&T program manager needed more training in acquisition. Nineteen of the participants did believe other career fields could come in and be of benefit and had a variety of suggestions. Nine out of the twenty-three individuals thought a person with a marketing background could be of benefit. Seven participants thought a Subject Matter Expert (SME) would help out a great deal. A SME is a person with experience in an operational setting and is capable of providing an end user perspective. Two individuals thought a person with a couple of years of program office experience would be a good addition. One subject saw a need for a person with the ability to conduct ROIs and business cases.

(Q8-5) *Would you be in favor of having someone else work the transition issues on your program?*

Fourteen of the twenty-three interviewed favored someone else working transition issues for their project. Nine out of the twenty-three individuals did not think this would be a good approach. All nine of those individuals did not think another organization or

personnel set could be effective because they would not be familiar enough with the project.

Multiple themes emerged from this section. Results for themes one and two can be found in Table 12. Of the twenty-three individuals interviewed, 87% thought the implementation of a technology transition team would be effective. The technology transition team was an idea taken from the National research Council (2004). One of the three best practices the NRC suggested was the creation of an environment that fostered technology transition. Having the right people, skills, and abilities is one step to attaining that environment. After the first 10 interviews it was obvious that program managers needed help from other personnel with specific skill sets to transition technology. This idea also applies to the next theme which deals with the program managers' team having the necessary personnel to facilitate technology transition.

Out of twenty-three individuals interviewed, 70% had negative responses associated with PMs having the right personnel needed to facilitate technology transition. Nine individuals did not believe they had the necessary personnel, but did not elaborate on the question. Seven of those interviewed thought the resources might be there, but not immediately. Having the right people in the right place at the right time is not a new concept. The importance of this question was to gain insight into PMs having the necessary support when working transitional issues.

Table 12 Transition Team

Themes	# of responses	% of participants	# of participants
1. Believe a transition team would be of benefit	20	87%	23
Did not think a transition team would help	3	13%	23
2. PMs do not have the right personnel	9	39%	23
Personnel is available but not immediate	7	30%	23
PMs do have the right personnel	7	30%	23

Another theme was the suggestion that other career fields could be of benefit to the PM. Results for themes three and four can be found in Table 13. After twenty-three interviews, 83% of the respondents thought other career fields, if added to the IPT or development team, could be a real benefit when working transition issues. Of the nineteen individuals that responded positively, 39% believed an individual with a marketing degree would help. In an earlier question, 83% believed their effort was technology push. The importance here is even though 83% pushed their technology to the customer, almost half of those individuals stated they needed more help in the technology push effort.

The last theme from this section was that more than half (61%) felt program managers did not have the necessary skills to perform the program management part of the job. Half of these individuals attributed this to the lack of training and guidance. Throughout these questions in this section it was apparent that the majority of the PMs interviewed saw value in adding other necessary skill sets to the team as well as necessary training in acquisition processes.

Table 13 Other Skill Sets to Aid the PM

Themes	# of responses	% of participants	# of participants
3. Could other career fields benefit the PM			
Yes	19	83%	23
No other career fields could be of benefit	4	17%	23
Suggestions for career fields needed			
Marketing person	9	39%	23
Subject Matter Expert (SME)	7	30%	23
4. PMs do not have the necessary skills to do PM work	14	61%	23
Lack of Training/Guidance	7	30%	23
PMs do have the necessary skills to do PM work	9	39%	23

Best Practice Nine: Ensuring Technology Maturity

(Q9-1) *How do you ensure technology maturity for your project?*

Nine out of twenty-three individuals ensured technology maturity through

demonstrations. If the technology could not demonstrate certain capabilities or interface

with the necessary components, then the PM did consider their technology mature

enough. Eight individuals measured their maturity by using the TRL as a gauge. One

individual did nothing to ensure maturity. One individual stated that the type of funding

determined the technologies maturity level. Two out of twenty-three participants stated

that it was their personal assessment that ensured technology maturity. One subject said

it was through sufficient testing that ensured technology maturity. One manager stated

he/she could not do enough analysis to gauge the maturity of the technology.

(Q9-2) *Is the Technology Readiness Level (TRL) an appropriate gauge to measure technology maturity?*

The majority of the participants did think the TRL was a good tool and also used

the tool to measure technology maturity. Sixteen out of twenty-three participants

believed the TRL was an appropriate tool to measure technology maturity. Seven

individuals did not think the TRL was a good tool to measure maturity. These seven

individuals thought the TRL tool was inconsistent and the maturity levels could easily be

inflated to better market the technology.

> (Q9-3) *Do you track and assess technology maturation by key milestones or just prepare a chart for Program Baseline Reviews (PBRs)?*

Six out of twenty-three did not use key milestones or PBRs. However, seventeen

did use key milestones and PBRs to track the maturation of their technology. It was

apparent that the PMs that did use PBRs and key milestones communicated with their

customer on a regular basis.

> (Q9-4) *Do the TRLs help you in communicating with your customer and in meeting their expectations?*

Ten out of the twenty-three participants did believe TRLs helped in

communicating to their customer what they were delivering and how mature the

technology was. Twelve individuals did not think the TRLs helped the customer

understand what they were getting. One individual stated it was a 50/50 chance the

customer understood the TRLs. The individuals that did not think TRLs helped in

communicating with their customer also maintained that the customer did not care about

the maturity levels. The interviews concluded the PM believed the customer was more

concerned with when they were getting the technology than anything else.

One common theme that emerged from this section of questions was that 91% of

those interviewed valued ensuring the maturity of the technology. Results are located in

Table 14. As it was established in Chapter Two, the maturity of the technology is very

important. If immature technologies reach the demonstration phase, they will likely fail.

If this failure occurs the technology will fall prey to the valley of death. It is important to

note that 91% of the participants did use the TRLs as a guide, but were not necessarily

primary method chosen. Out of the twenty-one individuals that did place an emphasis on

maturity, 43% determined the maturity of their technology through demonstrations

satisfying certain capabilities. Of those individuals who ensured technology maturity,

38% used the TRL definitions as the main gauge for maturity.

Table 14 Ensuring Technology Maturity

Themes	# of responses	% of participants	# of participants
Individuals who placed an emphasis on maturity	21	91%	23
PMs ensured maturity through			
Maturity through demonstrations	9	39%	23
Maturity based on TRL definitions	8	35%	23

General Overarching Questions

(Q10-1) *In your opinion what do you think the single most important roadblock in transitioning AFRL projects?*

Eight out of the twenty-three interviewed thought the availability of funding was

the biggest roadblock. It is important to note that all individuals interviewed thought

funding was a serious issue, but offered other reasons for transition roadblocks. Seven

individuals thought the single most important roadblock was the lack of understanding

amongst the key stakeholders. Understanding issues to the program managers meant the

lack of effective communication, involvement of the necessary people, and personality

issues. One individual stated the roadblock to transition was the lack of a defined

transition process. Another subject stated the process to get transition documents signed

off on was too long. One participant stated the roadblock was the inability for the PM to

understand how their technology fit into transition windows for the program office. Two

individuals thought the transition roadblock was the inability to do multiple informal

tests. One subject believed the transition roadblock was getting buy in from senior

leaders.

(Q10-2) *Do you think having AFRL representation in the program offices could help transition AFRL projects?*

Eleven out of the twenty-three individuals thought AFRL representation in the program offices would help a great deal. The majority that gave positive affirmation thought this would give the program offices a better understanding of AFRL technologies, while bringing the two communities closer together. Twelve of the individuals did not believe AFRL representation in the program offices would help.

(Q10-3) *Do you think there is adequate guidance given to you in order to facilitate technology transition?*

Two individuals did not have an answer for this question. However, thirteen of those interviewed did not think there was adequate guidance for the S&T program manager. Eight out of the twenty-three participants did believe there was adequate guidance to facilitate technology transition.

(Q10-4) *What do you think the process is that sells your project; i.e. transitions it or markets it?*

Six out of twenty-three individuals stated it was the constant networking with key stakeholders that marketed their technology. Three individuals saw senior leaders from different organizations as the avenue that transitioned their technology. Four out of the twenty-three participants thought it was the PM marketing the technology to the Action Officers (AOs) within the MAJCOMs. Another four participants thought the PM must sell the idea to the prime contractor first, or the other key stakeholders (MAJCOMS and Program Offices) would not buy in to the technology. One subject stated the process was demonstrating a technology with a focus on interoperability with other systems. One individual stated that it was the PMs knowledge on how to transition technology.

Another individual said it was the early involvement with the program office that transitioned the technology. One subject thought it was getting buy in from the lower level worker so the subordinates could advocate for that technology to upper management. One PM stated it was waiting for the MAJCOMs to come to them (technology pull). The last individual stated it was constant communication, establishing a relationship, and building trust with the customer transitioned the technology.

(Q10-5) *Do you think the ATC does a good job to ensure technologies are transitioned?*

Nine of those interviewed believed the ATC did a good job in facilitating technology transition. Five out of the twenty-three participants did not have an answer for this question due to inexperience with the ATC. Nine of the participants did not think the ATC ensured technologies were transitioned. Those nine individuals felt that the ATC allowed their technology to get exposure to senior leaders and other organizations, but did not ensure the technology could get transitioned.

(Q10-6) *Do you think the Applied Technology Council process works to prevent delays in transition?*

Eleven of those interviewed did not think the ATC prevented delays in transition. Eight out of the twenty-three subjects interviewed did not have an answer for this question. Four individuals believed the ATC does prevent delays in transition.

(Q10-7) *How do you go about getting a champion for your project?*

Eight out of the twenty-three participants thought getting buy in from the MAJCOMs first got them a champion for their technology. Two individuals believed soliciting program offices to advocate for their technology would typically champion the project. Six out of the twenty-three individuals thought getting the right people involved

from the necessary organizations (MAJCOMs, Program Offices, and Contractor etc.), including decision makers, got a champion for their technology. Two of those interviewed stated they typically marketed their project to subordinates of decision makers so the lower level worker could advocate for the technology. Another two participants thought they had a champion when leadership from different organizations discussed the technology. Two out of the twenty-three participants said they procured people willing to champion their project because of their technology merit. One individual stated it was the ability to obtain the necessary data to conduct a reliable ROI that inspired personnel from program offices and MAJCOMs to champion the technology.

(Q10-8) *Which organization is the most difficult to get buy in from?*

Fifteen out of the twenty-three program managers interviewed thought the program office posed the most difficulty in getting buy in. One individual stated the prime contractor was the hardest from whom to get a buy in, while four participants agreed that the MAJCOM was most difficult. Three out of the twenty-three individuals stated AFRL Headquarters was the most difficult to get buy in from.

This chapter has synthesized the data collected into themes by interpreting views of program managers within AFRL. After analyzing the result the data revealed that the S&T program managers did have good relationships with their customers, but the PMs still need adequate training, guidance, and a dynamic team in order to transition technology efficiently. After the data was analyzed and broken into themes, the researcher observed that that some best practices were being used and some were not.

Synthesis of themes that emerged during the data analysis portion should provide a solid

foundation to draw conclusions and recommendations for transitioning technology.

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The purpose of this research was to determine what extent AFRL was implementing known technology transition best practices. Technology transition best practices were taken from Industry and DOD sponsored publications. Program managers of 6.3 projects were interviewed to gain insight into technology transition guidance being practiced. This research was also an attempt to gain an understanding into how effective these best practices were for the program managers using them. This chapter will provide conclusions and recommendations based on the insight given from program managers within AFRL. Also, this chapter will provide recommendations for future research.

5.2 CONCLUSIONS

Throughout the literature review the researcher was able to answer investigative question one, which is:

What guidance exists for technology transition within the DOD?

There were multiple documents that listed key elements and guidelines for transitioning technologies. While guidance on technology transition does exist, many of the documents are not directive; they are just suggestive in nature. Many best practices such as IT, transition team, communication, and participation overlapped within the documents. Some documents were tailored to specific technologies such as materials, while another focused on affordability. All of the documents that were collected from the DOD and Industry contributed to guidance on technology transition. Each document played an important role in the development of the best practices.

After conducting the interviews, the researcher determined a deficiency in the implementation of guidance and training for S&T program managers. The conclusions drawn here answer investigative question three:

Do the managers in the S&T community believe the current guidance is adequate to effectively transition technologies to the warfighter?

The majority of those interviewed (62%) did not believe there was adequate guidance on how to transition technologies. After talking with all the program managers, the researcher discerned PMs learned more about technology transition just by doing. Talking with many of the program managers, I realized there was no requirement for the PM to be Level One or Level Two certified in program management. As it was stated in Chapter Four, there is a certification process for program management, but it is not a current requirement for PMs in the S&T community. Training and certification is left up to the individual to decide whether they want to take courses dealing with program management. Table 15 illustrates the importance for effective guidance and training. Individuals that did have program office experience claimed without that experience they would be lost as a PM in AFRL. To clarify, I am not saying that AFRL program managers need to be just like the program managers in the acquisition community, but they do need to be familiar with how program offices operate because the acquisition community is a critical stakeholder in transitioning technology. S&T PMs need to understand how to look for transition windows for weapon systems. The majority of the program managers interviewed did not forecast for transition windows. Program offices which take a spiral approach to development presents a good opportunity for PMs in the laboratories to see how their technology can fit in that window of spiral development.

The lack of involvement from other organizations could be due to the perceived lack of guidance. Correct guidance can assist S&T program managers in how to involve other organizations. This is critical because there are many other organizations involved in the technology transition process.

Table 15 Transition Guidance/Training

Themes	# of responses	% of participants	# of participants
There is not adequate guidance on technology transition	13	62%	21
Acquisition personnel did not participate when needed	11	48%	23
Nothing formal that defines roles/responsibilities of the stakeholders	12	52%	23
PMs are not familiar with acquisition processes	11	48%	23
Need more PM training/program office experience	6	26%	23
Do not base technology availability on transition windows	14	61%	23
Did not use affordability metrics	14	61%	23
PMs do not have the necessary skills to do PM work	14	61%	23
Lack of Training/Guidance	7	30%	23

The second conclusion that could be drawn from this research was the need for necessary skill sets. After talking to the PMs, the researcher ascertained they needed more personnel available to help them than what was immediately available to them. Table 16 illustrates the probable needs of the S&T PM. Program managers were very quick to offer suggestions of other career fields that could be of benefit to them. Many of them also believed if they had the necessary personnel with specific skill sets they would be able to efficiently perform affordability metrics. They did not just need help with affordability metrics, but help with marketing their technology as well. In the process of my analysis it became obvious that if PMs were not somewhat extraverted, then they had a hard time marketing their technology. This in turn, would pose difficulty for them getting buy in from other organizations. Many PMs affirmed having some type of AFRL representation in the program offices would help facilitate more of an understanding between both communities. Some of the PMs had experience in their last job working

74

with an AFRL representative that was co-located in a program office. PMs that had this

experience stated it helped out a great deal. This suggestion was also consistent with one

of the general questions which asked, "What organization poses the most difficulty in

getting buy in from." Out of the twenty three PMs interviewed, 65% felt the program

office was the most difficult.

Table 16 S&T Program Managers Needs

Themes	# of responses	% of participants	# of participants
Do not have the necessary personnel to perform affordability metrics	12	52%	23
Believe a transition team would be of benefit	20	87%	23
PMs do not have the right personnel	9	39%	23
Personnel is available but not immediate	7	30%	23
Could other career fields benefit the PM			
Yes other career fields could be of benefit	19	83%	23
Marketing person	9	39%	23
Subject Matter Expert (SME)	7	30%	23
AFRL representation in program offices	11	48%	23

The third conclusion that could be drawn from this research was the lack of a

defined process. This conclusion answers investigative question two:

What is/are the process or processes that exist(s) to transition technologies to the warfighter?

As it was stated earlier, 62% believed there was not adequate guidance on technology

transition. When asked, there were ten different responses (43%) to what PMs thought

the process was that transitioned their technology. Table 17 illustrates a need for a

defined process. Throughout the interviews, the PMs implied that the only way they

knew what to do was by doing, or making phone calls to people who had experience and

the knowledge to help them. Many of them even stated there was no document they

could pick up and learn what the technology transition process is. However, it did seem

that different directorates had different types of customers, which might call for different

processes. There could be a reason for not having a defined process on technology

transition. After talking with the PMs in AFRL, the researcher concludes that all of the

actions in Table 17 need to happen for technologies to be transitioned from the S&T

community to the acquisition workforce.

Table 17 No Defined Process

Themes	# of responses	% of participants	# of participants
There is not adequate guidance on technology transition	13	62%	21
Networking with key stakeholders	6	26%	23
Senior leaders talking to one another	3	13%	23
Get buy in from MAJCOM Action Officers (AO)	4	17%	23
Get buy in from prime contractor first	4	17%	23
Demonstrate interoperability with other systems	1	4%	23
PM just knowing how to transition the technology	1	4%	23
Getting program office involved early	1	4%	23
Get subordinates on customers side to advocate for you	1	4%	23
Technology pull	1	4%	23
Communicate First-Establish a Relationship-Build Trust	1	4%	23

The fourth conclusion that can be drawn from this research is that the incentives

for transitioning technologies are not totally efficient. When PMs were first asked about

incentives for transitioning technologies, they were hard pressed to come up with an

answer. When the interviewees thought about it, 65% of them (Table 9) did not know of

any organizational incentives. After talking with the PMs, the researcher discovered

there are monetary incentives for managers who transition technologies, however, the

PMs who acknowledged there was a monetary incentive revealed that the dollar amount

was very small. Through the interviews, it was pointed out by the participants that PMs

do get some type of recognition for transitioning technologies as well. The problem with

the existing incentive program is that it is not currently recognized by many program

managers within AFRL.

The fifth conclusion that was drawn from this research maintains that there are

technology transition best practices not currently being implemented that could be of

benefit to the S&T PM. This conclusion addresses investigative question four:

*Is there technology transition practices not being currently implemented in AFRL
that could enhance the transition of laboratory technologies?*

After talking with the S&T PMs it was discovered half of the participants (52%) did not

have formal agreements with key stakeholders, which outlined roles and responsibilities.

Throughout the literature review, it was apparent that having some type of formal

agreements with the key stakeholders would facilitate collaboration among the

participants (Dobbins, 2004, National Research Council, 2004, A Guide for S&T

Program Managers, 2001, AFI 61-101, and The Manager's Guide to Technology

Transition in an Evolutionary Acquisition Environment, 2003). The majority of the

program managers thought it was critical for all the key stakeholders to have a common

understanding. Some type of formal arrangements that all the key stakeholders agree on

would help facilitate that. It was established earlier that the incentives currently in place

are not that effective. Out of the twenty three individuals interviewed, 65% did not know

of any organizational incentives to transition technology. Another best practice that was

not employed in full was the implementation of a technology transition team. Many of

the program managers thought resources were limited or not immediate. Out of the

twenty-three program managers, 52% said they did not have the necessary personnel to

perform affordability metrics, while 87% stated they did not even perform Return on

Investments (ROIs) or business cases. They simply did not have the adequate personnel

to do ROIs or business cases. Most of the individuals interviewed welcomed the idea of

having other personnel with specific skill sets to help them with transition issues.

5.3 RECOMMENDATIONS

Based on the insight given from the program managers that were interviewed, the researcher offers a few recommendations. The first recommendation is that AFRL should consider ways to foster an environment to facilitate technology transition through the implementation of a technology transition team. This team should include members with specific skill sets. The idea of the transition team is not to take over the transition issues for the PM, but to help them in the transition process. The transition team should include members that have program office experience. The general consensuses from the interviews were PMs had difficulty collaborating with program offices as well as getting buy in from them. An individual with program office experience could help the PM deal with these issues. Another individual that should be included is one with a financial background. The data disclosed that program managers could not perform certain affordability metrics that could be of benefit to them. A financial person could ensure ROIs or business cases are completed for the 6.3 projects. Another team member with a marketing background would offer additional skill set. From the data gathered, it was obvious the PM must undertake extensive networking with multiple organizations when trying to transition their technologies. A marketing person would be of considerable value to the PM and their efforts to reach out to the MAJCOMs, program offices, and defense contractors. The last skill set that might be of great benefit to the team would be a Subject Matter Expert (SME). Individuals interviewed repeatedly suggested the importance of a SME. A SME could greatly assist the PM when dealing with the end user, contractor, MAJCOMs, and requirements communities, while a SME with operational experience could be valuable to 6.3 program managers. These teams should

be stood up in each directorate to help PMs of 6.3 projects. It is understood that current organizational structures and hierarchy might not be able to accommodate a team such as this. This is just a suggestion from the researcher's point of view.

Another recommendation is for the directorates to consider implementing more co-locating programs. A co-locate program is where an S&T PM resides in a program office representing a certain AFRL directorate. Some of the PMs interviewed had experience in working with individuals who were co-located. Interviews pointed out that co-located individuals facilitated collaboration between the laboratory and acquisition community. The majority of the PMs interviewed (96%) thought their relationship with the acquisition community could be better. All program managers believed having a general understanding amongst the key stakeholders was essential to transition technology. Out of the twenty-three individuals interviewed, 48% thought having some type of AFRL representative in the program offices would help the PM work transition issues with the acquisition community. More directorates that take advantage of the co-locate program might help bridge the valley of death.

A third recommendation is for AFRL to consider developing a data storage warehouse that includes technology transition lessons learned, techniques, collaboration tools, best practices, success stories, and acquisition processes and terminologies. Through the development of the data warehouse AFRL should consider publishing a technology transition handbook. The handbook should serve as a quick reference guide on technology transition. There should be a brief overview on programs that facilitate technology transition. Programs should include SBIR, MANTECH, TTI, ACTD, DARPA, and other relevant technology transition programs. This would allow the 6.3

program manager to gain insight into other avenues to transition technology. The handbook should also outline specific steps the PM can take to network with key stakeholders such as the acquisition community, end user, defense contractor, MAJCOMs, industry, requirements community, and financial communities. Available training for the PM should also be listed with detailed descriptions of the training and how the training can help them in transitioning technologies. An all encompassing document should be able to assist the program manager in technology transition.

Another recommendation is for AFRL to readdress their incentive program for transitioning technologies. Many of the program managers (65%) were not aware of any organizational incentives to transition technology. The majority of the program managers were personally driven to transition their technology. It is possible that monetary rewards or ratings are unimportant to S&T program managers. AFRL should consider incentives for internally driven employees. One example of an incentive could be that PMs are able to transition with their technology. This could provide a valuable resource of continuity to a technology's life-cycle.

The last recommendation pertains to training. Sixty-one percent concurred that program managers did not have the necessary knowledge to do the PM work. Currently there is no official requirement for S&T PMs to be Level One or Level Two certified in program management. The recommendation is that S&T PMs be at least Level One certified as program managers. It is understood that the certification process is not attainable overnight. The program manager must take the required PM courses as well as hold a position of program manager for a certain amount of time. This certification can only help the S&T program manager when they are working with the program offices and

acquisition issues. In addition to acquisition training there also needs to be refresher courses once a year. Acquisition process and terminology are constantly changing. These refresher courses should minimize problems with the ongoing changes in the acquisition community and terminology. Procuring S&T program managers experience in the program offices could be another form of training. The co-locate program is just one way to accomplish this.

5.4 LIMITATIONS

There were limitations that arose throughout this case study. The first limitation was the inability for the researcher to obtain interview subjects from each AFRL directorate. Some organizations were located in different parts of the country which posed difficulty for the researcher to collectively gain insight into all the AFRL directorates. The second limitation was the availability of interview subjects. Multiple interviews were postponed or cancelled, and because of lack of participation from scheduled interviewees, only twenty-three PMs out of a planned thirty PMs were successfully interviewed.

5.5 RECOMMENDATIONS FOR FUTURE RESEARCH

Future research should attempt to gather additional data that will provide further insight from other audiences such as the program offices, MAJCOMs, contractors, Office of the Secretary of Defense (OSD), and end user communities. Detailed and extensive research will allow for a more in-depth look into technology transition.

Based on the data and analysis from this research, the researcher offers recommendations for future study. The acquisition community was established to be a key stakeholder in transitioning laboratory developed technologies. Research in the

future should attempt to gain insight on working relationships and processes from the acquisition community's perspective. There were obvious difficulties from the S&T PMs perspective in dealing with the program offices. For future research, interview subjects should include acquisition personnel that have had experience in working with laboratory transitioned technologies. Acquisition personnel feedback combined with this research should give more insight into how to bridge the gap over the valley of death. Other areas for future research include: interview subjects that represent all directorates in AFRL; explore the views of the defense contractor; research the implementation of other technology transition programs (MANTECH, SBIR, DUS&T etc) and their affect on AFRL; and an exploration into the policy making on technology transition. The qualitative data from this study, paired with future quantitative data, proposes an in depth look into the phenomenon of technology transition.

5.6 SUMMARY

The purpose of this study was to determine what extent AFRL was implementing known technology transition practices. It was found that the practitioners did exploit technology transition practices, but did not exploit all of the best practices focused on in this research. It was observed that S&T PMs need ample help from specific skill sets to efficiently transition technology. As it was stated in earlier chapters, to date there had not been much research on transitioning AFRL technologies. This study proposes action for future research in technology transition. Information acquired through the literature review and interviews accelerates the process toward gaining a better understanding of technology transition.

Bibliography

1. Air Force Policy Directive 61-3, (2001). from http://afpubs.hq.af.mil

2. Air Force Policy Directive 61-101, (2003). from http://afpubs.hq.af.mil

3. *ACTD Guidelines: Formulation, Selection and Initiation*. Retrieved on August, 26, 2005. from http://www.acq.osd.mil/actd/text/print_formulat.htm

4. Creswell, J. (1994). *Research Design: Qualitative & Quantitative Approaches*. Thousand Oaks, CA: SAGE Publications.

5. Creswell, J. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

6. Deputy Under Secretary of Defense S&T. (2001). *Technology Transition for Affordability: A Guide for S&T Program Managers*. Unpublished Manuscript.

7. Defense Systems Acquisition Management Course, (2004). *Transitioning S&T Programs*. Briefing.

8. Defense Procurement and Acquisition Policy Office Under Secretary of Defense AT&L. (2003). *Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment*. Unpublished Manuscript.

9. Dobbins, J .H. (2004). Planning for Technology Transition. *Defense AT&L*, 33, 14(4).

10. DOD 5000 Series Documents. Retrieved August 22, 2005. from http://akss.dau.mil/dag/DoD5000.asp?view=document

11. Government Accounting Office. (2002). *Factors Affecting Outcomes of Advanced Concept Technology Demonstrations*. Unpublished Manuscript.

12. Hammer, M., & Champy, J. (2003). *Reengineering the Corporation: A Manifesto for Business Revolution* (1st ed.). New York: HarperCollins Publishers Inc.

13. Hoetker, G., (1997) International Technology Transfer and the World Wide Web. Database 20, 3: 20.

14. Institute for Defense Analysis. (2003). *Transformation and Transition: DARPA's Role in Fostering an Emerging Revolution in Military Affairs* (IDA Paper P-3698). Alexandria, VA: Author.

15. Lundquist, G., (1999). *Technology and the Agents of Change: Change Agent Skills are as important to Our Success as are Professional Skills. Parker*, CO: Market Engineering International Press.

16. Laboratory Acquisition Management, (2004). LAB 101 Lessons. Briefing.

17. McNutt, R., (1998) *Reducing DoD Product Development Time: The role of the Schedule Development Process*. MIT, 39-41.

18. Merton, R.K., Fiske, M., & Kendall, P.L. (1990). *The focused interview: A manual of problems and procedures* (2nd ed.). London: Collier MacMillan.

19. National Research Council (2004). *Accelerating Technology Transition: Bridging the Valley of Death for Materials and Processes in Defense Systems*. The National Academies Press.

20. Neuman, W.L. (1991). *Social research methods: Qualitative and Quantitative Approaches*. Boston: Allyn & Bacon.

21. Perkins, J. M., (1993). Social Perspectives on Technology Transfer. *IEEE Transactions on Professional Communication*, 36(4).

22. Rex, J., (2003). *Strategic Technology Transition: A New Kind of Partnership*. Software Engineering Institute (Carnegie Mellon), 6(4).

23. Russo, J. & Herrenkohl R. C., (1990). Factors Affecting the Transfer of technology from Industry/University Cooperatives to Sponsoring Companies. *Journal of Technology Transfer*, 15(3), 21.

24. Soeder, W.E., Nasher A. S., and Padmanabhan V., (1990). A Guide to the Best Technology-Transfer Practices. *Journal of Technology Transfer*, 15(1:2), 5.

25. Spivey, W.A., Munson, J. M., Nelson, M. A., Dietrich, G. B. (1997). Coordinating the Technology Transfer and Transition of Information Technology: A Phenomenological Perspective. *IEEE Transactions on Engineering Management*, 44(4).

26. Technology Transition Initiative Proposal Template. (n.d.) Retrieved July 15, 2005. from http://www.dtic.mil

27. Trochim, W. (1989). Outcome pattern matching and program theory. *Evaluation and Program Planning, 12*(4).

28. Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). Newbury Park: SAGE Publications.

1. REPORT DATE *(DD-MM-YYYY)* 23-03-2006	2. REPORT TYPE Master's Thesis	3. DATES COVERED *(From – To)* March 2005 - March 2006

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Technology Transition: Guidance Versus Practice	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER If funded, enter ENR #
Espy, Walter Ellis, Captain, USAF	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)	8. PERFORMING ORGANIZATION REPORT NUMBER
Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/ENV) 2950 Hobson Way, Building 640 WPAFB OH 45433-8865	AFIT/GRD/ENV/06M-04

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The transition of technologies ensures that our warfighters have the necessary capabilities to fight the ever increasing and changing global threats. Through the investigative research of this study, technology transition best practices were taken from Department of Defense (DOD) publications, Air Force Instructions (AFIs), and industry. The purpose of this study was to gain an understating on what extent the Air Force Research Laboratories were implementing known technology transition best practices. In examining the use of technology transition best practices, the research provides insight into how technologies are transitioned from AFRL to the acquisition community. This study relies on the perspectives and knowledge of program managers within AFRL. Data analysis along with an extensive literature review led to recommendations such as: an implementation of a technology transition team, co-locating AFRL program managers in program offices; and program management training for managers in the S&T community. It was revealed that only some aspects of technology transition best practices were being implemented. It was also discovered that technology transition involves multiple organizations for technologies to be transitioned. Based on the data collected, it was found that the program manager needs multiple resources and the right knowledge to facilitate technology transition.

15. SUBJECT TERMS

Technology Transition, Best Practices, S&T Community, and AFRL

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Sonia E. Leach, Major, USAF
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U	UU	94	19b. TELEPHONE NUMBER *(Include area code)* (937)255-3636, x7390