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THE TECHNOLOGY CHALLENGE OF THE ADVANCED TACTICAL FIGHTER: A STUDY OF THE TECHNOLOGY TRANSITION PROCESS

THESIS

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THESIS

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Abstract

The purpose of this study was to examine the technology transition process at the Aeronautical Systems Division between the Wright Research and Development Center (WRDC), and the Advanced Tactical Fighter Systems Program Office (ATF SPO) at Wright Patterson AFB OH. Four groups were surveyed, they included: WRDC, ATF SPO, ASD engineering, and the defense contractors involved in the development of the ATF. Five Investigative Questions guided the research: (1) How has the operating command contributed in the development and transition of technology? (2) How well have the official and unofficial technology transition processes worked as perceived by laboratory, SPO, EN, and contractor personnel? (3) What organizations are considered important sources of information on new technology, and what is the frequency of contact with those organizations? (4) What influence is the contractor perceived to have on the success or failure of moving technology from WRDC to the ATF SPO? (5) Is the perceived risk of new technology by the SPO a significant barrier in the transition process?

This study found that the using command was perceived important in the transition process, although they have no official involvement. The formal mechanisms and processes

were not generally rated as effective, while the informal methods received an "effective' rating. There was a barrier identified in the general communications patterns between WRDC and the SPO, as well as WRDC and the product division engineering. The contractor was perceived to have a significant impact on the success or failure of transition. Respondents agreed that the willingness to accept risk was important to successful transition, and risk aversion by the SPO was not considered a barrier except by WRDC.

This study recommended a number of changes to the Senior Engineering Technology Assessment Review (SENTAR), including informing and involving contractors in the process. In addition, general recommendations were made based upon the study. Included in the recommendations were mechanisms to improve the working relationships between EN and WRDC.

THE TECHNOLOGY CHALLENGE OF THE ADVANCED TACTICAL FIGHTER: A STUDY OF THE TECHNOLOGY TRANSITION PROCESS

I. Introduction

Background

The U.S. Air Force relies on a technological edge in its weapons systems to offset the military strength of enemy nations (8:I-3). The U.S. has been able to achieve this because of a superior technology base in industry, government laboratories, and in academic institutions (11:I-1). The successful transition of new technologies from this base into military systems is of primary importance, yet is often one of the biggest barriers in providing U.S. forces with capable weapon systems (11:I-1).

The time required to develop new technology, identify and correct deficiencies in current capabilities, and field the resulting product to the operational Air Force directly affects the ability to maintain its weapons superiority. A smooth and timely transition of technology from the developing laboratory to the product divisions is essential in maintaining this technological edge in war fighting capability. Consequently, technology transition is an important issue for the research and development organizations of the U.S. Air Force.

General Issue

The 1987 Defense Science Board (DSB) study of Technology Base Management concluded that the problem of rapid technology transition to fielded systems is a primary objective of successful R&D management (10:3.3). The DSB further states:

> The Study Group believes that both the Defense Department and industry are seriously deficient in rapid technology transition into fielded systems and products. This situation is a primary contributor to the growing military competition as Soviet weapons systems performance approaches and, in some cases, exceeds that of U.S. and Allied forces. Because we can anticipate general numerical inferiority to Eastern Bloc and other potentially hostile forces, outcomes of conflict with these forces could be disastrous for the U.S. in the future unless this situation is reversed or otherwise offset by technology. The Study Group found that the greatest opportunity to improve this situation is to accelerate the transition of technology to existing or emerging systems. (10:3.3)

The literature reviewed attested to the fact that DoD has been concerned about technology transition for some time. A 1984 MITRE corporation study mentions three other studies that were performed since 1980 on the technology transition problem. All these studies agreed that there is a problem with the technology transition process within the DoD (37).

In 1985 the U. S. General Accounting Office (GAO) was given the task of reviewing the technology transition process within DoD. Although the GAO did not issue a final report, a letter was issued to the Secretary of Defense in January of 1987 highlighting their findings. The GAO letter said they felt that the technology transition process was not getting enough management attention at the Secretary of Defense level (27:1). Additionally the report stated:

> There is also a belief within the DoD science and technology community that it takes too long to transition innovative technologies into weapon development programs and ultimately into fielded systems. (27:1)

An additional testimony to the concern of technology transition within the Aeronautical Systems Division (ASD), is the recent formation of the Technology Exploitation Directorate in the Wright Research and Development Center (WRDC). The director explained that one of the primary reasons for forming the directorate was to increase effectiveness of technology transition within ASD and WRDC (25).

Ineffectiveness of technology transition results in lengthy delays or premature transition of technology to development. This phenomenon ultimately results in weapon systems that are not as technologically advanced, or development money and time wasted on immature technology. Therefore, problems associated with technology transition may directly affect the future sovereignty of the United States.

Definition of Terms

Before a thorough understanding of technology transition can be obtained it is first necessary to understand the meaning of technology, and transition.

Technologies can be in many forms, and exist at many different levels of complexity and newness. "Anything that increases one's knowledge or know how may be considered to be technology" (36:199). Technologies then can range from equipment to ideas, and can only be specified by the context in which it is being discussed.

> Accordingly, all technologies are ultimately reducible to some kind of knowledge. Technology is therefore the knowledge to make machines, invent patterns, solve problems, develop things, and conceive new ideas. Thus, a technology is any storehouse of knowledge that can lead to more knowledge. (36:199)

The terms transition, transfer, and transfusion are often used interchangeably within the DoD. Technology transition is usually associated with a vertical movement of technology from one R&D phase to the next; cumulating in the application of the technology into a new or modified Air Force weapon system. Transferring and transfusing both refer to the horizontal movement of technology from one mature system to another. Technology transfer is used to define technology relocation from the government sector to industry or to foreign countries (32:2). It should also be noted that the private sector uses the term technology transfer to encompass transition, transfusion and transfer.

This study will confine its terminology to technology transition. Technology transition is defined by Air Force Systems Command (AFSC) regulation 80-1 as:

> The transition of science and technology (S&T) efforts from one R&D category to another. The most obvious transition is from demonstrated technical capability to full scale-engineering development or directly to operational capability (combat or support). (15:1)

Specific Problem

This study examines the technology transition process between the Wright Research and Development Center (WRDC) and the Advanced Tactical Fighter Systems Program Office (SPO). Specifically, the research will identify the helpful mechanisms, as well as the barriers encountered in the WRDC/ATF technology transition process, as perceived by three selected groups. The three groups include the laboratory, SPO, and contractor personnel involved in this particular process.

The WRDC population consists of program managers and engineers involved in the transition of technology with the ATF SPO, and their Branch and Division Chiefs. Personnel from the ATF SPO include SPO management as well as engineering. The defense contractors include the managers of laboratory programs transitioning to the ATF SPO, as well as the prime contractors OPR's.

Then, after identifying the facilitators and barriers to technology transition, the study will determine where and why they exist. From this research, conclusions, recommended changes, and solutions will be suggested.

The process of technology "transition" in this study will be limited to the transition of technology from the laboratory to the system program office within ASD, specifically from WRDC to the ATF SPO.

Investigative Questions

The task of examining the technology transition process of the ATF inspired some specific questions which guided the research. These questions are presented below

1. How has the operating command contributed in the development of and transition of technology.

2. How well have the official and unofficial technology transition processes worked as perceived by laboratory, SPO, EN, and contractor personnel.

3. What organizations are considered important sources of information on new technology, and what is the frequency of contact with those organizations.

4. What influence is the contractor perceived to have on the success or failure of moving technology from WRDC to the ATF SPO.

5. Is the perceived risk of new technology by the SPO a significant barrier in the transition process.

Definitions For The R&D Categories

To adequately understand the process of technology transition within the Air Force, it is necessary to understand the basic categories of the R&D process.

The Department of Defense divides the R&D process into six major categories: research, exploratory development, advanced development, engineering development, management and support, and operational systems development (34:41). Categories one through four apply to the development of technology in the R&D process. The management and support category provides for support of the laboratories such as: construction, test ranges, etc. The last category is not really an official category, but it is shown within other budget programs of major systems as the research development test and evaluation (RDT&E) cost. The other category of interest in this study is the manufacturing technology. Because this study is focusing on the transition from advanced technology development to engineering development, only the first four categories of the R&D process and MANTECH will be discussed in length.

The Five Year Defense Program (FYDP) displays the funding for approved programs. The FYDP designates that RDT&E is designated the number 6, and the sub-categories under 6 begin with the number 1. Consequently, the R&D categories are numbered 6.1, 6.2, 6.3, and 6.4.

<u>6.1 Research</u>. The scientific study and experimentation directed toward increasing knowledge and understanding in the physical, biological-medical, and behavioral-social sciences. This work is not immediately applicable to national security, but it is directed at long term national

security needs (15). It also provides part of the technological base for exploration and advanced developments, and new or improved military capabilities (37:3).

6.2 Exploratory Development. An effort ranging from fundamental research to sophisticated bread-board experiments. The dominant characteristic of the 6.2 category is that it is aimed at solving a specific military problem. It is designed to develop and evaluate the feasibility and practicality of proposed solutions and their alternatives (15, 34:42).

6.3 Advanced Development. Projects that have moved into the development of hardware (or software) for experimental or operational testing. This is really the first stage of engineering application, contrasted to the first two stages which were aimed at improving the knowledge base and finding possible solutions. Furthermore,

> Advanced development is divided into two parts designated 6.3A and 6.3B. The first part is for the examination of alternative concepts, while the second part is concerned with the demonstration of the selected concept. (34:42)

6.4 Engineering Development. These are development programs that are engineered for military use, but are not yet approved for acquisition or operation. Upon completion of this phase the technology should be ready for production and implementation into the operational Air Force (15, 34:42).

7.8 Manufacturing Technology (MANTECH). The manufacturing technology is not part of the R&D process, but a separate and related category.

> The MANTECH program will pursue Research and Development projects in manufacturing and related sciences which are geared to solving particular manufacturing, maintenance, quality, or industrial base problems. (15:1)

It is one of four programs under the Program Element 78011F, Industrial Preparedness. The other programs are the industrial facilities, and industrial preparedness planning, and industrial productivity and responsiveness.

The normal evolution of technology is from research to exploratory development, advanced development, and then on to engineering development with MANTECH incorporated as necessary. But not all technologies pass through these stages. They may skip some stages or remain at the same level for further evaluation and testing. They may prove mature and usable enough by themselves, or be included as a subsystem to another system in the same or advanced state. Whatever the path of maturity, the progression should provide some insurance that the technology is proven and the risk of failure has been significantly reduced.

Systems Acquisition Process

Weapon System programs go through a sequence of key program decisions and milestones known as the systems acquisition process or the acquisition life cycle. The acquisition process is a logical flow progressing from an identification of a system need to operational deployment and support of the new system.

Operational Requirements. The operational requirements process is the first step in a weapon system's acquisition. This is a process within the DoD that identifies the operational deficiencies, or states a new need to counter the threat. This is done via the coordination and publication of a Statement of Need (SON) by the operating command.

The basis for an effective identification and statement of need is done through a mission analysis. This analysis examines the basic mission and task of a command in terms of current and future projections of capability as well as those of the threat.

In addition to the mission area analysis the development of new technology may affect the applications of weapons systems. In the development of weapon systems within DoD the scientific as well as the operational communities must be alert to the possible solutions and enhancement offered through new technology and their applications (28:section VI).

Concept Exploration/Definition Phase. Once the need is established a new weapon system will enter the concept exploration/definition stage. At this point a commitment is made only to identify and explore alternative solutions. This stage generally consists of paper studies, but limited experiment and test may be performed. Each alternative, even at this early stage, must address the technical feasibility as well as cost, schedule, and risk of the concepts.

Selection of the concepts that offer the best balance of cost, schedule and technical performance will be made during this stage. If the selected alternatives warrant system demonstration then approval of the SECDEF must be obtained before proceeding into the next phase. demonstration/validation.

Demonstration Validation. In the demonstration/ validation phase selected alternatives from the previous stage are further evaluated and defined. The central thrust of the effort during this phase is reduction of risk and economic uncertainty and a more detailed definition of the new system. During demonstration/validation the systems still have no defined design. During Demonstration/ validation, the following occurs:

> The definitization work is typically carried out in one of three ways: (1) primary system hardware prototyping, (2) "paper" studies, or (3) paper definition plus subsystem prototyping. (28:section VI)

It should be emphasized that any prototyping at this point only resembles the operational system to the point that performance testing and evaluation can be performed.

Once this phase is completed the results are forwarded through the appropriate channels to the SECDEF for approval to proceed into the next phase.

Full Scale Engineering Development. During this phase of the acquisition life cycle the system is designed, developed, fabricated, and tested. At the end of this phase design specifications and engineering drawings will be finalized.

Testing and evaluation (T&E) are an important part of this phase. Through rigorous T&E the contractor and the Air Force identify and solve engineering problems. Furthermore, the T&E demonstrate that program objectives have been met and that continuation to production is warranted.

Production/Deployment. During this phase the system, including training equipment, spares, facilities, etc is produced for operational use. Testing is continued, and the and the system is integrated into as close as an operational configuration as possible.

Deployment begins when the weapons are provided to the operating command. The operating command then has the responsibility to assume operation and maintenance and assume property accountability. This point is identified as initial operational capability (IOC).

The Senior EN Technology Assessment Review (SENTAR) Panel

During January of 1984 in an effort to enhance the technology transition process at the Aeronautical Systems Division the commander implemented procedures to institutionalize the process of technology transition. The reason was stated as follows:

> A formalized process for timely and efficient transition of laboratory developed or validated technology to aeronautical systems is essential to the ASD development of superior weapon systems. (18:1)

In accordance with ASDR 80-6, the SENTAR panel was established as an engineering focal point for the review and evaluation of the Wright Research and Development Center (WRDC) new start proposals and Advanced Development Programs (all 6.3 activities). Additionally, the laboratories of other product divisions who are developing technology for ASD have agreed to abide by the SENTAR process. The SENTAR charter states:

> The panel will assess the objectives of the programs, the technical approach, the potential payoff to aeronautical systems and subsystems, the proposed technology transition criteria, and the readiness of the technologies for transition to ASD development and acquisitions programs. (39:appendix 1)

The Laboratories have traditionally been responsible for structuring new programs, and there has always been a dialogue between the laboratories and the system program offices (39:2), usually on an AD-HOC basis. "The "what's new" is a formal mechanism for involving the customers technical arm (EN) in structuring technology programs" (39:2). The panel also reviews the laboratories' technology transition plans (TTPs), and gives their signature of approval in addition to those of the laboratory commander and prospective users. SENTAR then follows the progress of the technology development program by assigning technology monitors who assess technology maturity during the laboratory phase.

Organization. The SENTAR panel is composed of the Deputy for Engineering (EN), Functional Organization Technical Directors, EN Assistant for Product Assurance, the director of Engineering for ASD/XR, and a representative from the PRAM office. It is chaired by ASD/ENS Technical Director; ASD/ENO Technical Operations provides the vice chairman, and ASD/ENS provides the Secretariat (39:appendix 1).

The ATF Transition Process

General Information. The uniqueness of the ATF acquisition and its stage within the Acquisition life cycle, make the ATF an excellent candidate for a study of the technology transition process. The ATF is presently in the demonstration/validation (DEM/VAL) stage of the acquisition process, with two competing prime contractor teams. The ATF program currently has an acquisition strategy that allows for the development of four aircraft (two for each team) within the DEM/VAL stage. Furthermore, there is a reasonable amount of time allowed for completion.

DEM/VAL is the stage where new technology has the biggest impact, and where the best opportunity for transition exists (21). During DEM/VAL the contractor has the opportunity to evaluate trade-offs associated with different types of technology in achieving system specifications. The four year DEM/VAL stage allows the contractor to demonstrate a large number of technologies, and define the optimal mix of technologies in order to meet the Air Force's cost, performance, reliability, and maintainability requirements. This is unique from the technology transition standpoint because the technology base available can be incorporated into the engineering designs.

This ATF development process and the role that technology developed in the laboratory is allowed to play, provide an opportunity or luxury that other weapon systems are seldom allotted. Quite often the acquisition stages of major weapons systems are combined, conducted simultaneously, or omitted because of constraints levied on the program. When these conditions exist technology transition will be limited.

Other major systems have tried to transition technology at different stages of the acquisition process, usually full-scale engineering development, and met with poor results (21). Once the program has entered the full-scale engineering development stage, the design of the system should be baselined in terms of the best technology available to meet all performance, cost, and schedule constraints. The purpose of the full scale engineering development stage is applying technology (as close to production design as possible), testing the design against requirements, and establishing the design and configuration for production. During full-scale engineering development is not the optimal point to be introducing new technology (21). However, introducing new technology may be necessary if for some reason the preferred design is deemed undesirable or proves unable to meet specifications.

The Process. The ATF SPO and WRDC have developed a unique, ATF specific, transition process between WRDC and the ATF SPO that supplements the existing ASD SENTAR Panel. While the SENTAR process evaluates all laboratory programs for the Aeronautical Systems Division, the ATF SPO's technology transition process is focused only on ATF related programs. The purpose of this unique transition scheme is to reduce ATF program risk by identifying mature alternative technologies, and reducing transition time of relevant information to the ATF weapons and engine contractors.

The unique transition process between the ATF program office and WRDC is designed to increase the speed of technology and information exchange by creating direct links of communications between the SPO, WRDC, and ATF contractors. Moreover, the process creates management attention on complementary technologies and identifies the ATF priorities to the laboratories and the defense contractors. Thus, the "Right" problems for the ATF are provided to the labs and contractors who may wish to pursue research directed at these specified problems. However, ATF management is not allowing laboratory programs to become a crucial link in the ATF development, but using them to identify alternative technologies and contingency solutions for FSD.

During this process laboratory programs are assessed by an ATF technology review panel chaired by the ATF Director of Engineering, it also includes representatives from engineering and other directorates of the ATF SPO. The ATF panel reviews all the laboratory programs, at least annually, and identifies which programs are relevant to the ATF. After the selection of programs, the ATF board ranks the programs in categories of high, medium, and low interest based on ATF risk issues.

> WRDC programs ranked as high interest relate to high risk technical issues of the ATF program, or represent a high payoff technology likely to transition in time to impact ATF FSD. Moderate interest programs relate to ATF moderate risk issues, and parallel ATF DEM/VAL activities. Low interest programs relate to low risk issues or represent technologies unlikely to transition in time to impact ATF FSD. Programs unrelated to ATF requirements, or investigating technologies not developed by the ATF SPO are ranked no interest. (3)

The prioritized list is then distributed to WRDC, ATF contractors, and to the SENTAR secretary. The SPO then provides ATF management support for funding and protection from budget cuts for the high interest laboratory programs. WRDC then can use this prioritized list for budgeting and funding purposes. However ATF is only one of WRDC's customers, so ATF priorities must be weighed with SENTAR recommendations and other customer needs of WRDC. In addition to prioritization of programs, to maintain fairness and neutrality in DEM/VAL competition the government funded research data are made equally available to all contractors.

Another distinctive characteristic of this transition process is that ATF contractors are allowed to submit proposed changes to the laboratory programs in order to make them transitionable to the ATF, or they may make suggestions for new starts to fill potential or perceived technology voids. These contractor proposals are also ranked by the ATF technology board. The proposals ranked high to moderate interest are then forwarded to WRDC for their consideration for implementation.

To improve communications and speed up the transfer of information, points of contact for each prioritized program are established. The names and phone numbers of each focal point within the ATF SPO, and the Lab program manager are included in a document which is distributed within the SPO, WRDC, and to each contractor. In addition to facilitating personal communications, WRDC and the SPO jointly sponsor program reviews with ATF contractors on programs on the prioritized list. These efforts should provide for a single direct link to facilitate communications, and establish active/real time exchange of data between all the organizations.

Scope and Limitations of Research

The unique aspect of this study is the involvement of civilian contractors in a study of a military organization. However, the majority of R&D technology developed by the Air Force is contracted to civilian industry. Therefore, in nearly every technology development there is one or more knowledgeable contractors involved. Consequently, they play an important role in developing and transitioning Air Force technology. Contractors, for the purpose of this study, are defined as "private firms that perform efforts under contract with the government agencies addressed earlier, and are profit motivated" (5:18). Companies that are doing work in engine, avionics, and materials technology with WRDC and the ATF SPO will be included.

It must be clearly understood this study deals with technology transition to the ATF DEM/VAL. It is too early in the ATF development process to be able to know for sure which technologies will transition as far as actually being utilized in production. So, technology transition in this case means transition to the SPO to be tested and studied for incorporation into the FSD contracts for the ATF.

This research is a cross-sectional study of the technology transition process from WRDC to the ATF SPO. Although each Systems Command Product Division is given guidance from HQ AFSC, every product division has its own procedures and policies for transitioning their technology.

For example, the SENTAR process is unique to ASD, and the ATF transition process is unique to WRDC and the ATF SPO. Other product divisions have slightly different approaches to technology transition which are not addressed in this study. Therefore, the results and recommendations of this thesis apply only to ASD, specifically the WRDC--ATF transition process of 6.3A to 6.3B & 7.8 technologies. However, because of similar organizational structure, many generalizations can be applied to the technology transition processes from WRDC to other system program offices at Wright-Patterson, or other R&D organizations within the Air Force. Additionally, these results can be applied to the movement of technology from category 6.3 to 6.4 since the same organizations will be involved.

Thesis Organization

Chapter I introduced the general issue and detailed a statement of the specific problem for this study. It also contained definitions of key terms, a brief description of the R&D and acquisition process, the transition process at ASD and the ATF peculiar process was described, additionally the scope and limitations of the study were outlined.

Chapter II outlines the major highlights of the literature reviewed in preparation of this study.

Chapter III outlines the methodology used to solve the specific problem and details the data analysis procedure.

Chapter IV analyzes the data gathered for this research, and chapter V draws conclusions and makes recommendations based upon the analysis of data.

II. Literature Review

Overview

The purpose of this chapter is to examine literature related to the transition of technology within industry as well as the government in order to provide a better understanding of the process. The first section reviews the cultural differences of the R&D communities, and the formal and informal process of information exchange. The second section discusses three studies conducted within DoD that apply specifically to the topic of this research.

Scope of the Research Topic

Research on the subject of technology transition included a search of the literature listed in DTIC, DLSIE, professional journals, and texts within the libraries of the Air Force Institute of Technology and Wright-State University. Additionally, knowledgeable people within the field were sought out and asked about published or unpublished literature that would be applicable to this study. These resources included the GAO, SENTAR office, ASD/XR, the technology transition office at Hanscom AFB, the Federal Laboratory Consortium, and the office for Innovation and Management studies at Leigh-High University.

Discussion of the Literature

The success of an R&D organization depends upon many factors, effective transfer of technology is one of the most important (40:263). If research results are not transferred, the organization simply does not obtain a return on its R&D investment and research has failed to contribute anything to the organization.

The transition from research to development is often an ill defined process in any formal sense (42:30). Distinct interfaces, often called barriers, separate and isolate the phases of technical evolution.

"Research cannot operate effectively in isolation from the rest of the corporation (38:15)" if there is to be effective technology transfer.

> Technology transfer cannot be considered in isolation from the organization in which it occurs. Technology transfer is actually the dependent variable, and the organizational culture where it occurs, or more specifically, the process through which the culture develops, is the independent variable. (30:1)

Cultural Differences

To begin with, there is the "two culture" problem within the research and development organizations. An often cited impediment to the transfer of technology from research to development is the well established cultural differences. Each phase within the R&D process develops its own set of standards and personalities consistent with the specific goals and objectives of the organization (30:22). Therefore, to progress onto the next phase requires that the technology "transition" to a context quite different from its original context. These cultural differences, or demarcations, set up barriers that are difficult or impossible to cross.

The Research Community. By its very nature the research community, like any other community, has a set of well developed values, norms, customs, and practices. For example, the values of the people involved in research tend to evolve around such objectives as "rigor", "internal validity", and the pursuit of knowledge for the sake of knowledge (30:22). These values are generally shared within that community, consequently the researchers feel comfortable sharing and disseminating new information inside rather than outside the community. Yet a laboratory (research community) must somehow accomplish this transaction within its environment if it is to survive (2:142).

The Development Community. The development community has its own set of values norms and practices. The users of the scientific research put more emphasis on the relevance of technology, the cost involved, and the risk associated with using this new technology. They tend to place considerable weight on knowledge gained through experience rather that through research (30:22). They too have their own tightknit community, and are much more comfortable within that culture than within that of the researchers or even the using community.

Information Exchange

The most important aspect of technology transition is the need to maximize the transfer of information, while escaping chaos (22:13). Not everybody can talk to everybody, if they did it would soon be out of hand and chaos would abound. The key then is to figure out which communication should be maximized for the exchange of information.

To maximize the amount of information flow, an organization needs to establish effective lines of communication between the labs and outside organizations. These effective communication links are often referred to as "Linkages". "One fact regarding the successful conduct of industrial R&D has become quite clear--the vital importance of linkages" (41:23). There are a number of approaches to establishing linkages and increasing the amount of information exchanged, both intra- and inter-organizationally. The most general distinction which can be made about information exchange is whether the process is formal or informal.

The Formal Process. There are many formal processes of information exchange within R&D organizations. One formal dissemination process within an organization is using persons as knowledgeable transfer media to enhance the information exchange. The people serving in this capacity are called technology "brokers", "linkers", or "gatekeepers" (2:141, 22:13); they are charged with knowing what is going on in other parts of the organization so they can communicate it to those in their part of the organization. McCorkendale states that "the important role of the linker has been recognized by one term or another by everyone who works with technology transfer" (29:34).

The gatekeeper plays a very important part in technology transition. But where and how to find the linker can inhibit the transition process. Several studies have shown that people choose an information source based upon ease and quality of expected information (35:10). If the information is difficult to locate or the quality of information is expected to be poor, the individual will not seek it out and may never become aware of important technology. If the gatekeeper concept is formalized, then an engineer or manager would know where to turn for quality information about technology and customers. This is one of the reasons behind the SENTAR panel at ASD, discussed in chapter one. Furthermore, the formulation of the Technology Exploitation Directorate will help disseminate information by formalizing and focusing information sources.

<u>The Informal Process</u>. The informal process also plays a major role in information exchange within any organization.

> More important than any of this is the establishment of a social milieu in which people in various parts of the organization know each other and communicate; for example, an organization which has a very good informal gossip system through which technological information passes. Thus the word of something interesting, or important, or of a need, or a problem, will diffuse rapidly through the organization. (22:13)

The importance of the informal information exchange is widely recognized in the literature (2:160; 22:13; 30:110). Additionally, the informal process was shown to be instrumental in a 1986 study of technology transition within the Air Force Systems command (5:42). Professor Allen from MIT points out, "...management should be aware of the value of this activity and should see that the gatekeepers are appropriately rewarded" (2:161). Another author points out that knowing who is involved in this informal process is a very important way of finding out who ought to be involved in the "formal" technology transfer process (22:13).

DoD Studies of Technology Transition

Over the past several years many studies of technology transition within DoD laboratories have been conducted. Spurrier mentions three conducted since 1980, and the 1987 summer study on Technology Base Management notes sixteen conducted since 1966 (37). Additionally several Air Command and Staff College papers covering 1976 through 1987 were reviewed. The studies mentioned all recognized the need to strengthen the technology transition process within DoD, and had similar conclusions.

Three of the DoD technology transition studies are directly applicable to this research, and are summarized in this report. They are the 1981 Under Secretary of Defense for Research and Engineering (USDRE) Independent Review of DoD Laboratories, the Report of the Defense Science Board 1987 Summer Study on Technology Base Management, and a 1986 MIT masters thesis on Technology Transition within the Air Force Systems Command.

USDRE Independent Review of DoD Laboratories

In September of 1981, the Under Secretary of Defense for Research Engineering initiated a review of the Department of Defense Laboratories. The review was conducted by Dr. Robert Hermann, with the assistance of Army, Navy, Air Force, and DARPA. The report detailed their findings and made recommendations for DoD laboratories. One of the most significant problems was the problem of technology transition (12:1.2).

The Technology Transition process is further compounded by several other problems found in the report. The USDRE review states:

> It is evident to all observers that the process of technology transition to the operational forces is not working well and some (but not surely not most) of the problem is levied on the laboratories. (12:2.2)

A portion of this laboratory problem is that the lab seems to be working on the wrong problem in terms of technology opportunities or operational needs. However, much good work is being done in the laboratories, and technology developed in the laboratories is finding its way into the operational forces (12:2.1).

Perhaps the most serious problem pointed out in the study was the disconnect between the laboratories and the operational forces. There is a general problem of transitioning the products developed in the laboratories into weapon systems which are affordable, reliable, supportable, and fit with realistic operational concepts and tactics.

> A cursory review of the forces and systems now in the field and being fielded will lead to the judgement that we have been ineffective at both translating technology into the fielded systems and adopting doctrine and concepts to take advancage of modern technologies and techniques. (12:3-5)

Industry observes this disconnect as an annoying lack of coherence and direction on the part of the government which creates inefficiency through lack of consistency. Laboratory personnel are also frustrated at not being able to decipher what the operational authorities need to make some changes in their approach to reverse this situation. This also explains to a large part why the laboratories seem to be working on the wrong problem. Additionally, the operational commands need to form a better relationship with both the laboratories and Systems Command in general (12:4-25).

1987 DSD Summer Study on Technology Base Management

In December 1987 the DSB published its results on the 1987 summer study of technology base management. The Study focused on two main issues:

1) Is the technology base effectively producing technology options adequate in numbers and quality for DoD users and operations.

2) How can the transition of new technology to the field be accomplished most effectively. (10:1.1)

Both issues are important, but there was a general agreement on the panel that transition of new technology is a more pressing issue than the first (10:1). This review highlights only the information pertaining to technology transition.

The panel stated that it relied heavily upon past reports, and made recommendations similar to what had been made in the past. Additionally, they stated that most of the recommendations of the past have not been implemented (10:1). The 1987 DSB results greatly emphasize increasing advanced technology transition demonstrations (ATTD).

The study group stated that DoD is seriously deficient in rapid technology transition, and that this is the primary contributor to the crisis in military competition with the soviet weapons systems performance, which in some cases exceeds that of the United States. The DSB m intains that the greatest opportunity to improve this situation is to accelerate transition of technology to existing or emerging systems. The rate and effectiveness of transition can be accelerated in the early advanced development phase, ie 6.3A (10:3.3).

Improvements to existing systems are the easiest to accomplish within DoD because they are usually cheaper to implement, and present less risk than new systems. New systems using new technologies offer the greatest performance advantages over our adversaries; however, acceptance of these new systems is difficult because of high risk, and they often affect existing doctrine and/or tactics (10:3.3).

To overcome these acceptance barriers the study group believes the DoD should emphasize the following in 6.3A programs.

- Careful selection and timely execution of system(s) and major sub-system(s) Advanced Technology Transition Demonstrations (ATTD) to build and test experimental systems in a field environment. These ATTDs should focus technical feasibility, and field utility.
  Furthermore, ATTDs must be conducted before commitment to full scale engineering development.

- Use of selection criteria and management techniques that have proven successful in past development & demonstration efforts.

Technology Transfer within the Air Force Systems Command

Unlike the other studies that focused on DoD transition problems, this study looked at the barriers of effective technology transition within the Air Force Systems Command. It surveyed the responses of two product divisions as well as the appropriate laboratories under the product division.

The most important findings in this study were the importance of the contractor in technology transition, the SPO attitude toward the risk of new technology, and an adversarial relationship between the SPO, engineering, and laboratory groups (5:121).

Unlike organizations within industry which transfer technology development from their laboratory to the development or production division, the government has a third party involved in the innovation of technology, the defense contractor. "At both divisions studied the contractor was perceived as a major factor in the transition process" (5:110).

The SPO's perceived risk of the technology was found to be a barrier in the transition process. The authors stated:

> that there is a necessary conflict that must exist between the technical community's quest for technical excellence and the SPO community's adherence to cost and schedule constraints. (5:122)

Other authors argue that managers should take more risk to insure maximum technology transfer (30, 37).

Summary

The purpose of Chapter II was to present a few major topics in the literature related to the technology transition process. The literature covered R&D organizations in general, as well as a review of three specific studies pertaining to the transition process within the DoD.

The cultural differences between research and development organizations were highlighted. The formal and informal methods of communications between organizations were discussed, and the importance of formal as well as gatekeepers. Many barriers to transition can be traced back to the communications problems between organizations (22).

Three studies on the DoD transition process were reviewed, one study pertained specifically to the Air Force Systems Command.

The USDRE study findings stated there is a major "disconnect" between the laboratories and the operational forces. Additionally they stated there is a general problem of transitioning technologies that are affordable, reliable, supportable, and fit realistic operational concepts and tactics.

The '87 DSB Summer Study pointed out there is a significant problem with technology transition in DoD. It states there should be emphasis on proto-typing 6.3A technology for advanced technology demonstrations.

The study on Air Force Systems Command pointed out that the civilian defense contractor played an important role in the transition process. Other barriers were the perceived risk of the technology and the adversarial relationship between the laboratory and SPO.

III. Methodology

Introduction

To answer the investigative questions and the specific problem, the perceptions of people in the laboratory, SPO, EN, and contractors were measured. To measure these perceptions, an orderly approach, or research method, to establish the study criteria and collect the research data was first developed.

The research method used in this study consisted of personal interviews and a literature review to identify transition criteria applicable to the WRDC/ATF SPO environment, and to define the general and specific problem. A survey was developed, validated, pretested, and administered to the population of interest. When distance or some other problem would make a personal interview inappropriate, a telephone interview was conducted. The survey was designed to cover a broad range of questions and audiences, while the personal interviews allowed for a more detailed and in-depth study of the subject (20:160).

Thesis Sponsorship. During the initial phase of defining the thesis topic an interview was conducted with the Director of the Technology Exploitation Directorate of WRDC. During this interview the director expressed an interest in sponsoring this study. Further discussions with the Technology Transition Branch Chief narrowed and focused the study on the transition process between WRDC and the ATF SPO. After the study topic had been narrowed, the individuals in the ATF SPO who were tasked with the official responsibility of technology transition were contacted, an ATF unique function. Once an explanation of the study was given they too expressed an interest in sponsoring the study.

Briefings were then given to the Deputy Director of WRDC, and to the Director of the ATF SPO. Both individuals expressed their views on technology transition, and agreed that their organizations would co-sponsor this study. They also agreed to sign the cover letters for the surveys, and provide any additional organizational help that would be required.

Justification of Survey Approach

The purpose of this research was to identify the successful attributes as well as the barriers of technology transition with WRDC and the ATF SPO. In order to accomplish this, the perceptions of four groups of people were measured; SPO, EN, laboratory, and contractors.

The independent variables involved in this study were categorized as attitudes or opinions. Emory points out, that attitudes and opinions can only be measured through the survey method (20:158). "Surveying can be carried out by face-to-face interviewing, by telephone, by mail or a combination of these" (20:159). Therefore, a survey technique employing all three methods was chosen.

Identification of Population

It was first necessary to identify individuals in WRDC, the ATF SPO, EN, and the civilian contractors involved in technology transition with WRDC and the ATF SPO. Personal and telephone interviews with ASD and WRDC personnel aided in the identification of the appropriate population. WRDC/TX the Technology Exploitation Directorate, and Systems Engineering from the ATF SPO assisted in generating a list of the appropriate programs and people along with their office symbols and addresses.

Using the ATF/WRDC technology transition data base (18 Oct 88), and telephone conversations with laboratory program managers, the number of laboratory programs, program managers, lead engineers, branch and division chiefs involved in the ATF transition process were identified for WRDC. WRDC consists of five laboratories and four directorates; together they have approximately 50 people involved in the WRDC/ATF transition process.

The contractor population was defined as, the program managers of the laboratory programs that are of interest to the ATF SPO, and the technology transition focal points in each prime contractor team for the ATF. The size of the laboratory contractor population is approximately 35 program managers. The ATF contractors included the four prime contractors of the ATF demonstration/validation phase. They included the business managers and a cross-section of personnel from systems engineering, design/manufacturing, and advanced development. These people were chosen because of their familiarity with technology transition at WRDC and the ATF SPO. The combined group of laboratory and SPO contractors totalled about 60 people.

The ATF population of interest includes the ATF director, the chief engineer, and the directors of: Avionics, Engine Management, Manufacturing/QA, Acquisition Support, Acquisition Logistics, and Engineering. Additionally, a random sample of people working in each directorate was included. Together, all the people in the ATF SPO constitute a population of about 35.

The combined total of the population numbers (over 200) would seem to allow for some sort of sampling technique to be used. However, the numbers within each group are relatively small, particularly the ATF SPO, which could make a sample unrepresentative of the entire population. Because the population within each group is small a census was done on the entire population.

Survey Construction and Administration

The process of developing the interview and survey questions was divided into four phases: determining the criteria for the survey questions, insuring content validity and reliability, pretesting the survey instrument, and producing and administering the final product.

Determination of Criteria. The first step in the survey construction was to define the criteria for measurement of the population. Several personal interviews were conducted to gain insight about the subject from people involved in technology transition, as well as identify any studies of which they might have personal knowledge. In addition, a literature review was conducted.

A major step in this process was a review of the open literature. Many sources were identified through a literature search of AFIT thesis, DTIC, DLSIE, journals, Air University index and other appropriate sources. Important criteria were gleaned from the identified literature and tailored to the specific needs of this study.

During the literature search a previous M.I.T. study of technology transition within the Air Force Systems Command was identified. This study contained a survey which was administered to three different product divisions and their perspective laboratories during 1986, it is attached at appendix A. The survey was reviewed, and served as a basis in developing the survey instrument for this study.

The survey instrument developed for this study was divided into five parts, each addressing a different area:

(1) Demographic questions were asked to collect data on the organization, rank, education, number years of experience in present job, and past job experience;

(2) Identification of organizations and methods which were perceived as the most effective in the transition process;

(3) Designed to find which organization and methods were perceived to impede the transition process.

(4) Designed to collect general perceptual data that was not specifically related to the ATF.

(5) Comment section for any aspect of the technology transition process that the respondent would like to make additional comments.

Content Validity. Once the criteria for the questionnaire were established and the initial survey written, the content validity of the instrument had to be established. "The content validity of a measuring instrument is the extent to which it provides adequate coverage of the topic under study" (20:95). Ten surveys were sent out with an evaluation sheet that asked the respondent to rate the relevance of each question on a scale of 1 to 3; not relevant, relevant, and highly relevant. In addition to this they were asked some open ended questions:

(1) What mechanisms do you feel are the most effective means of enhancing technology transition from the lab to the SPO, (2) What do you feel is the most effective way of specifying technologies to the laboratories, (3) What other aspects of technology transition do you feel is important to this study. They were also asked to make any changes in the wording of the questions that they felt were appropriate. Six of the surveys were returned, they were examined by 4 members of the WRDC ATF Technology Panel, 1 member of the SENTAR panel, 1 ATF prime contractor involved in the technology transition process, and the technology transition lead engineer for the ATF SPO.

The numerical responses were then entered into STATISTIX, a statistical software package for microcomputers. The mean and standard deviation were computed for each question, and ranked in descending order. The scores ranged from a mean of 3 with a standard deviation of 0 to a mean of 1.8 and a standard deviation of 0.84. It was decided from those results that no questions should be dropped. The output from this software package is listed in appendix C.

Some minor corrections were made to wording and appearance, and several new questions were added.

Reliability. Reliability is concerned with the degree to which the survey supplies consistent results. Reliability contributes to validity, but it is not sufficient for validity (20:92). It is a statistical analysis using the

Crombach Coefficient Alpha, a measure of reliability. Coefficient Alpha can range between 0 for a completely unreliable measure and + 1.0 for completely reliable.

The values for reliability were determined by first creating composite variables by summing all variables of interest, then calculating the reliability for each composite variable. Composite variables were calculated for: effectiveness of moving technology, formal and informal methods helpful to transition, impediments to transition, specification of requirements, sources of information, and communication patterns. Alpha values ranged from 0.56 to 0.78. Each composite is reported in Chap IV as applicable.

Pretest. The second step was an effort to further increase internal validity of the survey, and test for readability and understandability of the questionnaire by conducting a pretest. The potential questionnaire was administered to 10 people within the survey population. The pretest sample was deliberately chosen to mirror the population under study, with the exception of contractors. The contractors were left out of the pre-test because of WRDC and ATF SPO contracting concerns.

The individuals were personally contacted and asked to complete the survey and asked to make any comments on the survey that they felt would improve it. Six were returned and two of the remaining four gave a verbal response to the questionnaire. All of the respondents were concerned with the following two questions: (1) Give an example of a WRDC technology that was available and the ATF has taken advantage, (2) Give an example of a WRDC technology that is available and the ATF has not taken advantage. The questions were intended to focus the respondents attention to a specific program and answer the questions based upon those specific examples. All the respondents commented that these were confusing questions, and detracted from their responses. In view of the overwhelming negative comments concerning these two questions they were dropped from the survey instrument.

<u>Administration</u>. The third and last phase was to incorporate the pertinent changes to the survey instrument which were identified in the previous phase. Finally, the survey was administered to the population by personally handing or mailing them the questionnaire.

Each identified respondent in the ATF SPO and engineering was personally contacted. The purpose and goals of the study were explained to each, and they were asked to complete the survey. The survey package for the ATF SPO personnel contained a cover letter signed by the researcher, with an addressed return envelope for the base distribution.

Before mailing the ATF contractors any surveys, the Chief Engineer for the ATF signed a letter urging the contractors to complet and return the survey. Additionally the ATF contracting office had some legal concerns; consequently, another letter was attached stating that completion of the surveys would not change contractor requirements which would warrant a change in contract price and/or a change in the delivery schedule or period of performance. The letters with the surveys and postage paid return envelopes were then mailed to 25 people within the ATF prime contractor companies.

Each respondent within WRDC was contacted personally or by telephone, and the purpose and goals of the study were explained. Many of the contractors were contacted by telephone. The laboratory and laboratory contractors were mailed the surveys with a cover letter from the Deputy commander of WRDC urging them to complete the study. The cover letter for the contractors surveys also stated that no cost should be incurred by the government for completion of the surveys. The laboratory personnel were given addressed return envelopes for the base distribution, and the contractors were given postage paid addressed return envelopes.

Four different groups within the population of interest were measured: the ATF SPO, EN, Lab, and contractors. The survey questions maintained an interval equality; therefore, the data is presumed to be and was treated as interval data.

Survey Returns

Because the population is so small, respondents who did not reply could have a profound effect upon this study. In order to reduce this uncertainty and increase the response rate: preliminary notification, and follow-up procedures were used.

Preliminary Notification. The evidence from previous studies indicates that preliminary notification by telephone accelerates and increases the return rate (20:173). Because the population was small, and most telephone calls would be local a combination of personal contacts and telephone calls were used to increase the return rate of the survey's.

For the ATF SPO population 36 people were chosen who were involved with laboratory technology for the ATF. A personal contact was made to each of the 36 respondents. Each person was given an explanation of the purpose of the study, and what the study was trying to accomplish. Thirty five of the respondents agreed to completed the study, the last respondent was going to be out of town for three weeks when the survey was being administered.

For the laboratory population everyone was contacted by telephone or contacted in person. Nearly everyone agreed to complete and return the survey. In addition, the laboratory program manager furnished the address of the contractors to be used for mailing the surveys to them.

Follow-ups. "Follow-ups, or reminders are almost universally successful in increasing response rates" (20:173). Because the population was small and most of the survey participants were located at Wright-Patterson AFB, personal visits and telephone calls were practical and inexpensive to implement.

Interview

The structured interview was used in this study because of its flexibility. The structured interview permited rigorous statistical methods, but also enabled verbal communication between the researcher and the person being interviewed. Another benefit of the structured interview was that verbal communication allowed misunderstandings or ambiguities to be resolved during the interview. The opportunity to clear up ambiguities was highly desirable because of the unique nature of the subject.

There were some problems with the personal interview in terms of cost, both time and money (20:165). Cost, in terms of money, was not a major factor because the majority of the respondents were in close proximity to the Air Force Institute of Technology. However, cost in terms of time was a notable constraint.

The most serious shortcoming of any structured interview is the amount of time required to contact and interview the necessary people. Thus, because of time constraints, the number of people who can be contacted and interviewed is usually limited. This time constraint was further compounded by the fact most of the people needed for the personal interview in this study had a heavy travel schedule, making their availability limited and meeting arrangements difficult.

Statistical Analysis

The data analysis was performed using the AFIT Classroom Support (CSC) or the Information Support (ISC) computer, and the Statistical Package for the Social Sciences, version 10 (SPSSX). SPSSX is an integrated system of programs designed for analysis of social science data. SPSSX supports descriptive statistics such as: simple frequency distributions, and crosstabulations. It also contains procedures for simple correlations of both ordinal and interval data, and one-way and n-way analysis of variances and regression. SPSSX provides a relatively simple programming environment for statistical analysis, and allows for a great deal of flexibility in formating data (31:1).

The data analyses incorporated several different techniques. Descriptive statistics consisted of a frequency count for each answered question, and crosstabulations of responses by demographics such as: rank, number of years experience, organization, etc. The mean and standard devation were then calculated, and listed in the appropriate tables. A one way analysis of variance (ANOVA) was used for multiple comparisons of the four populations to determine if the means of the responses differed more than would be expected by chance.

Analysis of Variances (ANOVA) methods deal with whether the means of an independent variable differ from one group of observations to another. Therefore, ANOVA is really an analysis of means, and employs ratios of variances to establish whether the means of the groups differ (26:8). ANOVA employs an F test which is a ratio that compares the variability between groups to the variability within the groups. The F test then assures us that the measured difference in variability between groups is "statistically significant." Consequently, ANOVA procedures were used to determine if significant differences in perceived effectiveness/ineffectiveness of technology transition mechanisms and organizations exist in the groups of contractor, SPO, laboratory personnel. If from the computed value the ANOVA showed that a difference in the means existed, the Tukey multiple comparison technique was used to determine which of the means differed from the others. SPSSX command ONEWAY computes a one-way analysis of variances and outputs the data in a summary table (31:422). for this research the alpha level of 0.05 was used.

The findings from the analyses of data is described in chapter IV.

IV Analysis of Data

Introduction

This chapter contains an analysis and presentation of data from the survey instrument. The analysis is grouped according to the sections within the survey, they included: demographics, transition effectiveness of organizations, and methods which impede transition, and general perceptual data concerning technology transition. Part V, which asked for comments, was used in chapter V to draw conclusions and make recommendations. Some respondent comments were included in the discussion as appropriate, and emphasized in bold print. The data are displayed in tables following a general discussion of the results.

For this study a total of 125 surveys were distributed, 36 to WRDC with 24 returned, 35 in the ATF SPO & EN with 28 returned, and 51 to ATF & WRDC contractors (25 ATF & 26 WRDC) with 20 returned. The number and percentage of responses are shown in Table 1.

Table 1

Survey Response

	Mailed	Returned	Percentage
WRDC	36	24	66.7
ATF SPO	17	17	100.0
Co-Loc EN	18	11	61.1
Contractor	51	20	39.2
Total	122	72	59.0

Respondent Demographics

Part I of the questionnaire asked for demographic information including: organization, rank, years of service in the government or company, and number of years in present position.

Organization. Of the 72 responses 28 were from the ATF SPO (referred to as SPO) or ASD/Engineering co-located (referred to as EN) at the ATF SPO, for a total of thirty nine percent. Thirty two percent were from WRDC and twenty eight percent of respondents were from industry. The make up of the total population that responded was: WRDC (33.3%), ATF & EN (38.9%), and Contractors (27.8%).

RANK. The government respondents ranged from GS-12 to Senior Executive Service (SES) for civilians, and Senior Master Sergeant (SMSGT) to Brigadier General for the Military. The majority of respondents from the government were GS-13 with 19 responding (26%), and 50% of the laboratory respondents were GS-13's (Table 2). Each organization's distribution was somewhat unique. From WRDC, there was only one military respondent; all the rest were civil service personnel. The ATF and EN has a more "normal" distribution from 1 SES civilian down to GS-12, and from one Senior Master Sergeant up to Brigadier General. As expected, all industry personnel in the study were contractors.

Table 2

Distribution of Ranks by Organization

RANK	WRDC N	WRDC %	ATF & EN N	ATF & EN %	INDUSTRY N	INDUSTRY %	TOTAL N	TOTAL %
NO RESPONSE	1	4.2	0	0	0	0	1	1.4
GS-12	3	12.5	2	7.0	0	0	5	7.0
GS-13	12	50.0	7	25.0	0	0	19	26.4
GS-14	7	29.0	1	3.6	0	0	8	11.1
SES	0	0	1	3.6	0	0	1	1.4
SMSGT	0	0	1	3.6	0	0	1	1.4
LT	0	0	2	7.1	0	0	2	2.8
CAPT	1	4.2	8	28.6	0	0	9	12.5
MAJOR	0	0	2	7.1	0	0	2	2.8
LT COL	0	0	2	7.1	0	0	2	2.8
COL	0	0	1	3.6	0	0	1	1.4
B GEN	0	0	1	3.6	0	0	1	1.4
CONTRACTOR	0	0	0	0	20	100	20	27.8
TOTAL	24		28		20		72	

Education Level. Of the 72 respondents, 36 or 50% had a bachelor's degree, and approximately 49% reported a master's degree or higher. One respondent had an associate degree. Education was then crosstabulated with the respondents rank. The two Lieutenants reported 1 Master's and one Bachelor's, 44.4% of Captains a Master's degree. Fifty percent of the Majors and Lt Cols reported a Master's degree or higher, one Lt Col possessing a PhD. Two GS-12's (40%), 63% of GS-13's, and 75% of GS-14 reported a Master's degree. Fifty percent of the contractors reported a Masters's degree or higher, two contractors reported a doctorate degree. The number and percentage of respondents by education and organization are shown in Table 3.

Table 3

Education Level of Respondents

ORG.	WRDC N	WRDC %	ATF SPO N	ATF SPO %	EN N	EN %	Contractor N	Contractor %	Total N	Total %
Associate	0	0	1	5.9	0	0	0	0	1	1.4
Bachelor	14	58.3	6	35.3	6	54.5	10	50	36	50.0
Master	10	41.7	9	52.9	5	45.5	8	40	32	44.4
Ph.D	0	0	1	5.9	0	0	2	10	3	4.2
	24		17		11		20		72	

Years in Government or Company and Years in Present Job. The data for years in government or company was crosstabulated by organization, then broken into four categories and displayed in Table 4. The majority of respondents for WRDC and the ATF SPO were in the 16 to 24 year category. The vast majority of EN was in the 6 to 15 year category, while the contractor's tenure was uniformly distributed across all categories.

The years within the government showed a wide variation with WRDC having an average tenure of 18.2 years, down to 10.3 in ASD/EN, Table 5. The respondents from industry had an average of 18.3 years with their company. The combined average of the government service was 15.3 years. GS-13's made up 36.5% of the government responses, and their average time in the government was 17.6 years. In addition, the respondents average time in their current position was calculated and listed in Table 5.

Table 4

Years Worked for Government or Company by Organization

Years	WRDC N	WRDC %	SPO N	SPO %	EN N	EN %	Contractor N	Contractor %	Total N	Total %
2 to 5	4	16.7	4	23.5	0	0	3	15.0	11	15.3
6 to 15	3	12.5	5	29.4	9	81.8	6	30.0	23	31.9
16 to 24	13	54.1	6	35.3	1	9.1	6	30.0	26	36.1
25 or more	4	16.7	2	11.8	1	9.1	5	25.0	12	16.7
	24		17		11		20		72	

Table 5

Average Years in Government or Company
and Average Years in Current Position

	WRDC	ATF SPO	EN	Contractor
Government or Company	18.2	14.7	10.3	18.3
Present Position	6.3	1.9	2.5	4.3

<u>Organizations and Methods Which are Most Effective</u>

Part two of the questionnaire was broken into three seperate questions. Question 7 asked how effective the listed organizations were in moving technology, and the respondent was given a sixth option of "Unfamiliar with the Organization" for question 7 as well as question 8. This option was included to keep the results from being corrupted by respondents who had no knowledge of the organization. In the computer analysis the recode command was used to change the unfamiliar response to missing data, thus excluding it from statistical analysis.

Question 8 asked how helpful the listed mechanisms were in moving technology from WRDC to the ATF SPO. Question 9 asked for the organization/s that was/were most instrumental in moving technology. Only 2 people responded and they indicated subcontractors, as well as Air Staff, and Air Force Logistics Command are sometimes involved in the process. These responses were noted, but excluded from analysis.

Organization. The data are listed in Table 6 with the means and standard deviations, listed in descending order. Additionally, the data was collapsed into two categories: Not Effective (NE) and Effective (E), NE = Extremely Ineffective + Somewhat Ineffective , E = Somewhat Effective + Extremely Effective , Table 8. Furthermore a composite variable was calculated by summing the responses for each organization, and then performing a reliability test on this variable. Alpha was calculated to be 0.59.

The overwhelming response for effectiveness was the ATF contractor which a mean of 4.29, and a range of effectiveness from 73.9% by the labs to 89.5% by the contractors, with an overall effective rating of 79.2%, Table 7,8. The ATF SPO was rated effective by 63.2% of the contractors to 100% by the EN group, with an overall effective rating of 73.6%. WRDC was rated as effective by

52% of contractors and by 82.3% of the ATF SPO, with an overall effectiveness rating of 65.3%, Table 8. It is interesting to note that WRDC rated itself lower than the rating given it by the other organizations. The responses concerning ASD/EN was somewhat lower with a mean of 3.48, and an overall effective rating of 52.8%. A significant difference was noted between the contractors and WRDC's perception, Table 7.

The development planning group (ASD/XR) scored lower than the other organizations in effectiveness, registering from 26.1% by WRDC to 36.8% by the contractor, and a mean of 2.74, Table 6. However a significant difference is noted between the contractor and the other groups, Table 7.

The using command (in this case the Tactical Air Command) is not charged with any aspect of technology transition. However, they are the ultimate customer so they were included on the list to determine their degree of involvement. The using command was rated by 52.6% of contractors as somewhat important and one respondent rated them as extremely effective. However, only 21% to 27% of the government respondents rated them as effective.

Table 6

Effectiveness of Organizations in Moving Technology

(1=Extremely Ineffective, 2=Somewhat ineffective, 3=Neutral, 4=Somewhat Effective 5=Extremely Effective 6=Unfamiliar with the Organization -- excluded from statistics)

	WRDC		ATF SPO		ATF/EN		CONTRACTOR		TOTAL	
Org.	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ATF CONTRACTOR	4.32	0.95	4.25	0.86	4.30	0.68	4.28	0.58	4.29	0.78
ATF SPO	4.00	1.00	4.32	0.60	4.46	0.52	3.72	0.75	4.08	0.81
WRDC	3.63	0.93	4.00	0.52	3.90	0.57	3.62	0.87	3.80	0.78
ASD/EN	2.86	1.15	3.80	0.94	3.80	0.63	3.81	0.91	3.48	1.08
USING COMMAND	3.31	0.93	2.86	0.89	2.89	0.60	3.41	1.06	3.16	1.15
ASD/XR	2.20	1.15	2.67	0.49	3.00	0.76	3.46	0.67	2.74	0.98
SENTAR	1.94	0.93	3.00	1.73	3.14	1.22	3.00	0.00	2.43	1.17

Note: Organizations listed in descending order of total mean scores.

Table 7

Analysis of Variance, Organizational Effectiveness in Moving Technology

Org.	ANOVA F	df	p	WRDC	ATF SPO	ATF/EN	CONTRACTOR
				(significantly differs from groups below)			
ATF CONTRACTOR	0.35	66	0.79				
ATF SPO	1.47	65	0.23				
ASD/EN	3.20	66	0.03				WRDC*
WRDC	1.46	65	0.23				
USING COMMAND	1.78	63	0.16				
ASD/XR	3.76	66	0.01				WRDC*
SENTAR	11.42	63	0.00		WRDC*		No Responses

* alpha = 0.05

Table 8

Effectiveness of Organizations in Moving Technology

(NE = Extremely Ineffective + Somewhat Ineffective, E = Somewhat Effective + Extremely Effective)

Org.	WRDC NE	WRDC E	ATF SPO NE	ATF SPO E	ATF/EN NE	ATF/EN E	CONTRACTOR NE	CONTRACTOR E	TOTAL NE	TOTAL E
ATF CONTRACTOR	8.6	73.9	5.8	82.4	0.0	81.9	0.0	89.5	4.3	81.5
ATF SPO	8.7	65.2	0.0	88.2	0.0	100.0	5.3	63.2	4.3	75.7
ASD/EN	30.0	35.0	11.8	65.0	0.0	64.0	10.5	63.0	15.7	54.3
WRDC	16.7	66.6	0.0	82.4	0.0	72.7	11.8	52.9	8.7	68.1
USING COMMAND	21.8	21.8	29.4	23.5	18.2	9.1	21.1	57.9	22.9	30.0
ASD/XR	47.8	13.0	23.5	0.0	18.2	18.2	5.3	36.8	25.7	17.1
SENTAR	54.5	4.5	6.3	12.5	27.2	27.2	0.0	0.0	23.8	9.0

One of the most surprising results of the survey was the high percentage of people who were unfamiliar with SENTAR. Because of this, the results for this particular question were broken out separately in Table 9. Overall 54% responded that they were unfamiliar with the organization, and 7% failed to respond, however the numbers in the SPO, EN, and particularly the contractors were much higher. Of the remaining 39% only 8.3% felt they were effective (6.9%) or extremely effective (1.4%), Table 9.

Table 9

SENTAR Effectiveness

	WRDC		ATF SPO		EN		Contractor		Total	
	N	%	N	%	N	%	N	%	N	%
Extremely Ineffective	6	25.0	1	5.9	0	0.0	0	0.0	7	9.7
Somewhat Ineffective	6	25.0	0	0.0	3	27.3	0	0.0	9	12.5
Neutral	3	12.5	0	0.0	1	9.1	2	14.0	6	8.3
Somewhat Effective	1	4.2	2	11.8	2	18.2	0	0.0	5	6.9
Extremely Effective	0	0.0	0	0.0	0	0.0	0	0.0	1	1.4
Unfamiliar with the Organization	6	25.0	13	76.5	4	36.4	16	80.0	39	54.2
No Response	2	8.3	1	5.9	0	0.0	2	10.0	5	0.0
	24		17		11		20		72	

<u>Mechanisms</u>. This part of the questionnaire was designed to look at informal and formal methods of transition. A formal mechanism for this study is defined as

> ... either an institutionalized group or process established with technology transition as a major objective or an identifiable communication mechanism. (5:34)

The respondent was asked which mechanisms are/were helpful in moving technology from WRDC to the ATF SPO. Each respondent was asked to classify how helpful each mechanism was in the transition process. Generally speaking the formal methods were not rated as high as the informal.

Formal Mechanisms. The data are displayed in three different formats. First the mean and standard deviations were calculated and listed in Table 10. Secondly the results of the ANOVA and Tukey test are displayed in Table 11. Then the data were collapsed into "Not Helpful at All" plus "Not too Helpful" and "Helpful" plus "Very Helpful," Table 12. Additionally, a composite variable was created by summing all the formal mechanisms, and then calculating the reliability coefficient. Alpha was computed at 0.66.

The highest mean rating was scored on the acquisition strategy of the" ATF including a DEM/VAL", as well as the highest standing in the combined score of helpfulness.

Contractually requiring the contractor to use technology through an RFP & specification also scored high in the combined ratings in Table 12. However it did not score as well in the overall mean, Table 10, since the engineering group rated it lower than the other three groups. The ATF Unique Transition Process also rated very high in the overall mean score as well as the combined score on helpfulness.

Two significant differences existed in the questions dealing with the usefulness of the TR, and technology transition plans, Table 11. Lab personnel being permanently assigned to the SPO were perceived to positively affect transition.

A TR is a "document written to communicate the results of technology development to the users (5:34)." The difference in the TR response is the ATF SPO rating it much higher than the other groups, and significantly higher than WRDC, although the SPO did have the largest number of "Unfamiliar with the Mechanism" responses, Table 12. Secondly, the use of TTPs were rated high for all groups except WRDC, and a significant difference existed between the SPO & WRDC. An interesting difference, reassigning lab personnel, showed a large percentage of the contractors (77.8%) rated reassigning lab personnel to the SPO as "helpful or very helpful," and only 27.3% of EN gave it that response, Table 12. The formal mechanism that rated the lowest was SENTAR's validation of technology, with a significant difference between the SPO and WRDC. Additionally, this response had a tremendously high number of respondents that were "Unfamiliar with the Mechanism." Since the contractors had 89% who were unfamiliar, any significance that is noted by analysis of variance is ignored.

Table 10

Formal Mechanisms Helpful to Transition

(1=Not Helpful at All, 2=Not Too Helpful, 3=Neutral, 4=Helpful, 5=Very Helpful)

MECHANISM	WPOC		SPO		EN		Contractor		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Acquisition Strategy include a DEM/VAL phase.	3.90	0.79	4.69	0.48	4.10	1.20	4.07	0.96	4.18	0.89
ATF Unique Transition Process	3.62	1.26	4.13	0.92	3.89	0.78	4.25	0.62	4.00	0.95
Lab Personnel Assigned to SPO For a Short While.	3.40	1.45	3.92	0.90	3.43	1.27	4.21	0.43	3.83	1.03
The Contractor was Contractually Required to Use Technology.	3.96	1.15	3.57	0.94	3.36	1.43	3.89	1.32	3.74	1.20
Former employee permanently Assigned to the SPO.	3.21	1.42	4.00	0.76	3.14	1.07	4.10	0.57	3.66	1.05
Joint Laboratory SPO Working Groups.	3.38	1.31	3.18	1.33	3.71	1.11	4.11	0.78	3.50	1.19
Technology Transition Plans Were Used.	2.49	1.33	3.50	1.38	3.10	0.88	3.64	0.93	3.07	1.27
A TR Was Provided to the SPO.	2.24	1.18	3.30	1.06	3.00	1.41	2.83	0.72	2.69	1.16
SEHTAR validated the technology.	2.07	1.00	2.50	2.12	3.50	1.20	3.50	0.71	2.65	1.26

Note: Mechanisms listed in descending order of total mean scores.

Table 11

Analysis of Variance, Formal Mechanisms Helpful to Transition

MECHANISM	ANOVA F	df	p	WRDC	SPO	EN	Contractor
				(Significantly differs from groups listed below)			
Acquisition Strategy include a DEM/VAL phase.	1.02	65	0.39				
ATF Unique Transition Process.	0.92	67	0.44				
Lab Personnel Assigned to SPO For a Short While.	0.13	69	0.94				
The Contractor was Contractually Required to Use Technology.	0.88	67	0.46				
Former employee permanently Assigned to the SPO.	1.71	64	0.17				
Joint Laboratory SPO Working Groups.	1.32	62	0.28				
Technology Transition Plans Were Used.	5.28	67	0.00		WRDC*		WRDC*
A TR Was Provided to the SPO.	3.72	65	0.02		WRDC*		
SENTAR validated the technology.	8.21	64	0.00		WRDC*		WRDC*

* alpha = 0.05

Table 12 *

Formal Methods Helpful to Transition

(NH = percent Not Helpful at All and Not too Helpful;
H = percent Helpful and Very Helpful, U = percent Unfamiliar with Mechanism)

	WRDC			ATF SPO			EN			Contractor		
MECHANISM	NH	H	U	NH	H	U	NH	H	U	NH	H	U
Acquisition Strategy include a DEM/VAL phase.	4.2	62.5	16.7	0.0	94.1	5.9	9.1	81.9	9.1	5.9	64.7	11.8
ATF Unique Transition Process	8.3	29.1	45.8	5.9	70.6	11.8	0.0	54.5	18.2	0.0	57.9	36.8
Lab Personnel Assigned to SPO For a Short While.	16.7	41.7	37.5	5.9	52.9	29.4	18.2	27.3	36.4	0.0	77.8	22.2
The Contractor was Contractually Required to Use Technology.	12.5	70.8	4.2	12.5	50.0	12.5	27.3	63.3	0.0	20.0	65.0	10.0
Former Employee Permanently Assigned to the SPO.	18.2	36.4	36.4	0.0	35.3	52.9	18.2	18.2	36.4	0.0	50.0	44.4
Joint Laboratory SPO Working Groups.	17.4	39.1	30.4	18.8	37.5	31.3	10.0	40.0	30.0	0.0	41.2	47.5
Technology Transition Plans Were Used.	56.5	21.7	8.7	11.8	41.2	29.4	27.3	36.4	9.1	10.0	45.0	30.0
A TR was Provided to the SPO.	62.5	20.8	12.5	11.8	35.3	41.2	27.3	36.4	18.2	23.5	11.8	29.4
SENTAR Validated the Technology.	39.1	4.3	87.5	6.3	6.3	87.5	18.2	36.4	27.3	0.0	5.6	88.9

* Note: The this table contains same data as Table 10, but displayed in a different format.

Informal Mechanism. The data relating to the informal mechanisms were displayed using the same format as the formal methods, Tables 13, 14, & 15. The composite variable consisted of summing all the informal mechanisms, then a reliability check was performed. Alpha was calculated at 0.78.

The informal methods were rated very high, five (50%) of the mechanisms were rated with a mean over 4 (ie, equal or greater than helpful).

The government organizations listed in this question are all "officially" involved in technology transition with the exception of the using command, in this case the Tactical Air Command (TAC). The using command is the final customer for any technology developed, but it is not charged with any responsibility for technology transition. Their role is one of defining weapon needs, not defining technology to fulfill the needs. However, TAC was included to see the extent of their perceived involvement or importance in technology transition. The using command had a higher rating than was expected, with the contractors giving them the highest score. Perhaps this is because of their influence on the budget.

Three of the five responses with a mean over four involved the role of the contractor. The contractors "pushing" the technology rated the highest with the SPO rating it lower than the other groups, significantly lower than WRDC, Table 13 & 14. It is interesting to note that all the groups, particularly the lab and contractor, rate the importance of "selling the SPO" on the technology. These two responses seem to indicate the importance of contractors "pushing" the technology by selling the SPO and Engineering. However "selling" the technology to SENTAR, a function within ASD/EN, is rated very low in importance by each group, with the contractor giving a 100% response "Unfamiliar With the Mechanism."

The low response of "selling" ASD/XR is consistent with their involvement in technology transition. ASD/XR was only involved in the early stages of the ATF development, and has not been greatly involved in technology transition at ASD since the inception of SENTAR in 1984.

The contractor being allowed the freedom to choose the technology scored very high, particularly within the ATF co-located engineering group. A significant difference in this was the rating the lab gave this question, Table 14. Although it still rated relatively high, it is clear that they felt it to be less important than the other groups, Table 13.

What seemed important to all groups was the informal contact of the lab personnel with non-lab personnel. WRDC gave this the lowest rating of the four groups, which was still very high. WRDC gave a combined rating of 62.5% for helpful plus very helpful, with 37.5% indicating very helpful. Additionally, this question had relatively small percentages that were "Unfamiliar With the Mechanism," Table 15.

Table 13

Informal Mechanisms Helpful to Transition

(1=Not Helpful at All, 2=Not Too Helpful, 3=Neutral, 4=Helpful, 5=Very Helpful)

MECHANISM	WRDC Mean	WRDC SD	SPO Mean	SPO SD	EN Mean	EN SD	Contractor Mean	Contractor SD	Total Mean	Total SD
Contractor "pushed" Technology	4.48	0.73	3.75	1.07	4.18	0.98	4.42	0.70	4.24	0.88
Contractor Allowed Freedom to Chose the Technology	3.44	1.27	4.44	0.63	4.82	0.41	4.36	0.81	4.12	1.05
SPO Management "SOLD" on the Technology.	4.00	0.97	3.67	0.78	3.67	0.71	4.53	1.19	4.06	0.97
Frequent Informal Contact between Lab and Non-Lab Personnel.	3.91	1.19	3.93	0.83	3.90	1.10	4.47	0.51	4.05	0.98
Contractor "SOLD" on technology.	3.88	1.11	3.64	0.93	4.40	0.89	4.46	1.33	4.02	1.34
Engineering "SOLD" on Tech.	3.31	1.11	3.40	0.52	3.55	1.13	4.55	1.21	3.66	1.12
ROAD SHOW presented to ATF SPO.	3.40	1.45	3.57	1.27	3.00	1.10	3.92	1.51	3.51	1.36
TAC Management "SOLD" on the Technology.	2.85	0.90	3.40	0.70	3.44	1.01	3.78	0.97	3.35	0.91
Presentation of "Industry Day" to ATF Contractors.	2.78	1.11	3.36	1.29	3.40	1.52	3.64	1.12	3.20	1.22
ASD/XR "SOLD" on Technology.	2.14	1.10	2.50	0.84	2.83	1.33	3.67	2.00	2.68	1.47
SENTAR "SOLD" on Technology.	1.86	0.77	2.50	2.12	2.83	1.17	*	*	2.18	1.05

Note: Mechanisms listed in descending order of total mean scores.
* Statisctics could not be computed -- all responses were "unfamiliar with mechanisim" or missing.

Table 14

Analysis of Variance, Informal Mechanisms Helpful in Transition

MECHANISM	ANOVA F	df	p	WRDC	SPO	EN	Contractor
				(significantly differs from groups listed below)			
Contractor "pushed" Technology	3.11	67	0.32	SPO*			
Contractor Allowed Freedom to Choose the Technology.	6.43	67	0.00		WRDC*	WRDC*	WRDC*
SPO Management "SOLD" on the Technology	1.15	65	0.34				
Frequent Informal Contact between Lab and Non-Lab Personnel.	1.74	66	0.17				
Contractor "SOLD on technology.	1.65	59	1.65				
Engineering "SOLD" on Tech.	2.72	62	0.05			Contractor*	
ROAD SHOW presented to ATF SPO.	0.82	64	0.49				
TAC Management "SOLD" on the Technology.	1.03	62	0.39				
Presentation of "Industry Day" to ATF Contractors.	1.84	65	0.15				
ASD/XR "SOLD" on the Tech.	1.80	66	0.16				
SENTAR "SOLD" on Technology.	10.55	61	0.00		WRDC*		WRDC, EN*

* alpha = 0.05

Table 15

Informal Mechanisms Helpful to Transition

(NH = % Not Helpful at All + Not too Helpful; H = % Helpful + Very Helpful)

	WRDC			ATF SPO			EN			Contractor		
	NH	H	U	NH	H	U	NH	H	U	NH	H	U
Contractor "pushed" Technology	4.2	91.7	4.2	12.5	75.0	0.0	9.4	81.8	0.0	0.0	85.0	5.0
Contractor Allowed Freedom to Choose the technology.	33.3	58.3	4.2	0.0	88.0	5.8	0.0	100.0	0.0	0.0	68.0	15.8
SPO Management "SOLD" on the Technology.	4.0	52.2	2.7	6.3	50.0	25.0	0.0	45.5	18.2	0.0	63.2	21.1
Frequent Informal Contact between Lab and Non-Lab Personnel.	12.5	62.5	8.3	6.3	68.8	12.5	18.2	72.7	9.1	0.0	78.9	21.1
Contractor "SOLD" on Technology.	9.5	61.9	19.0	6.7	40.0	26.7	0.0	40.0	50.0	0.0	52.9	23.5
Engineering SOLD on Technology	13.6	18.0	41.0	0.0	25.0	0.0	9.0	54.0	35.3	0.0	58.8	35.3
ROAD SHOW presented to ATF SPO.	18.1	36.4	31.8	5.9	29.4	58.8	39.1	18.2	45.5	5.6	33.3	33.3
TAC Management "SOLD" on the Technology.	18.2	13.6	40.9	6.3	31.3	37.5	9.1	27.3	18.2	5.9	35.3	47.1
Presentation of "Industry Day" to ATF Contractors.	37.5	29.0	25.0	11.8	41.1	35.3	9.1	27.3	54.5	11.8	35.3	35.3
ASD/XR "SOLD" on the Technology	30.4	4.3	39.0	11.8	0.0	64.7	18.2	9.0	45.5	10.5	15.8	52.6
SENTAR "SOLD" on Technology.	50.0	0.0	36.4	6.6	6.6	86.7	18.2	18.2	45.5	0.0	0.0	100

Note: This table contains same data as Table 13, but is displayed differently.

Selling The Organization. The remaining parts of question 8 referred to which organizations were responsible for selling the SPO management, Engineering and TAC management. The respondent was asked the importance of a particular organization being "SOLD," and then asked to fill in the blank which organization was responsible for selling the technology. The response rates to these questions were very low, and nearly all selected the same few organizations. Because of the low response no conclusion could be drawn, but this indicated a trend. All the responses are listed in Tables 16 through 19.

The organization most selected as responsible for selling the SPO management, an important mechanism identified earlier, was the contractor. The contractor received 19 responses and WRDC 16 responses, as shown in Table 16. One response said "the labs and the contractor must work together to sell outside organizations if they ever hope to transition the technology."

WRDC was identified as the most important organization in selling TAC management on the technology. An interesting response concerned the role of TAC/DRB and the ASD/TACSO. TACSO is a representative office from the Tactical Air Command at ASD. Responses for the other organizations are listed in Table 17.

The parts of question 8 dealing with organizations that sell Engineering also received several responses. WRDC was given the most credit for selling EN, followed very closely by the contractor. Additionally, the organizations who put on the "Road Show" were the contractor and WRDC -- a somewhat expected result. Again, the lab and the contractor were given the most responses. Probably because they are "outside" the SPO environment.

Table 16

Organization Perceived As Responsible For "SELLING" SPO Management

	RESPONDENT ORGANIZATION			
SELLING ORGANIZATION	WRDC N	SPO N	EN N	Contractor N
WRDC	5	6	3	2
ATF SPO	0	2	0	0
ASD/EN	1	0	2	0
CONTRACTOR	7	3	1	8
SUB-CONTRACTOR	0	1	0	0
TAC/DRB	0	1	0	0
ASD/TACSO	1	0	0	0

Table 17

Organization Perceived As Responsible For "SELLING" TAC Management

	RESPONDENT ORGANIZATION			
SELLING ORGANIZATION	WRDC N	SPO N	EN N	Contractor N
WRDC	[illegible]	3	2	2
ATF SPO	0	0	2	0
Contractor	1	1	0	4
TAC/DRB	0	1	0	0
TAC/TACSO	1	0	0	0

Table 18

Organization Perceived As Responsible For "SELLING" Engineering

	RESPONDENT ORGANIZATION			
SELLING ORGANIZATION	WRDC N	SPO N	EN N	Contractor N
WRDC	4	4	4	2
ATF SPO	0	0	0	0
ASD/EN	0	1	1	0
Contractor	2	2	2	6

Table 19

Organization Presenting A "ROAD SHOW' To The ATF SPO

SELLING ORGANIZATION	WRDC N	SPO N	EN N	Contractor N
WRDC	4	0	3	1
Contractor	2	2	2	6
TAC	0	0	0	1

Most Instrumental Organizations. Organizations that were most instrumental in moving technology from WRDC to the ATF SPO got few responses. They are listed as follows:

- getting other maintainability people involved
- ATF funding of Avionics lab 6.3 programs (VAMP,CSP, Pave Pillar)
- limitations of proprietary information hinders a full understanding of the ATF designs.
- Same Contractors on lab programs as ATF programs
- Prime contractors, IR&D and prior lab programs.
- Material lab personnel co-located in SPO
- ATF SPO facilitating flow of information
- SENTAR providing ground rules for technology readiness

Organizations and Methods That Impede Transition

Part III of the survey identified the perceptions of which organizations and methods impeded technology transition. The respondents were asked to indicate their agreement with the statements listed in question 10, and given the opportunity to indicate additional statements they felt appropriate. The data are shown in Table 20 and Table 22. Table 20 lists the means and standard deviations in descending order, and Table 21 shows the results of the ANOVA. Table 22 shows a combined rating of D for Disagree, and A for Agree: D = Strongly Disagree + Disagree, and A= Agree + Strongly Disagree. The reliability had a coefficient alpha of 0.72.

The biggest impediment to technology transition as indicated by the responses was as expected: Technology was insufficiently proven in terms of schedule, technical, and cost risk. When combining the responses into agree and disagree, a notable difference existed. The percentage of agreement with schedule, technology, and cost risk was much lower by the lab. The most dramatic difference is the question that dealt with technology proven in terms of "cost risk." The lab agreement was only 18.2 % while the other groups rated it significantly higher as a barrier to transition. Table 21 shows a significant difference exist between WRDC and the others concerning cost risk. The lab rating this so much lower seems inconsistent, because technical and schedule risk normally translate into cost risk. Nevertheless, this does indicate a difference of opinion by WRDC. Technology not being cost effective was also rated differently by the WRDC, with WRDC showing a significant difference with the SPO and EN. Forty-five percent of the lab indicated their disagreement with this statement, and the disagreement among the other groups ranged from 0 to 21%. The "Not Invented Here Syndrome" is when technology is developed somewhere outside the organization, and therefore resisted. Concerning this, the lab and contractors have a notable difference of opinion with the SPO and Engineering, Table 21. WRDC and the contractors both felt this was a hindrance to transition, while the SPO and EN disagreed.

Another difference was the response to the "SPO being informed but resistant to change." The SPO and EN both disagreed that this was a problem, while the lab and the contractor agreed, a significant difference. In a similar way ASD/YFE (ATF co-located engineering) was felt to be resistant to change by the lab and contractor, while the EN disagreed with this statement, Table 21.

The fear of failure inhibiting transition also showed a difference with WRDC and the contractors agreeing, and the SPO and EN disagreeing, Table 22. A significant difference exist between WRDC and the SPO & EN, and with the contractors and the ATF SPO.

All groups indicated their disagreement with the statement: the contractor was resistant to change. Also, the data showed all groups perceived that the contractor being unaware of technology was not a barrier to transition. The fact that the respondents so strongly disagreed with this statement is directly related to the ATF unique process.

"Insufficient time, staff, or funding to incorporate technology" showed a difference among the groups. The SPO, EN, and the contractors all indicated this was a problem in technology transition (70-75%), while only 18.2% of the lab personnel agreed it was a problem, Table 22. This is further borne out in Table 21 were WRDC is shown to significantly differ from the other groups.

Table 20

Statements Why Technology Has Not Transitioned

(1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)

MECHANISM	WRDC Mean	WRDC SD	SPO Mean	SPO SD	EN Mean	EN SD	Contractor Mean	Contractor SD	Total Mean	Total SD
Technology Insufficiently Proven in Terms of Schedule Risk.	3.50	1.30	3.77	0.90	3.82	0.98	3.65	0.88	3.67	1.04
Technology Insufficiently Proven in Terms of Technical Risk.	3.50	1.44	3.82	0.95	3.82	1.17	3.70	0.87	3.67	1.12
Technology Insufficiently Proven in Terms of Cost Risk.	3.09	1.38	3.71	0.99	4.00	1.10	3.70	0.92	3.57	1.16
Insufficient Time, Staff or Funding to Incorporate New Technology.	2.86	0.89	3.77	0.90	3.82	0.87	3.90	0.91	3.57	0.95
Technology Was to Costly.	2.77	1.02	3.53	0.80	3.73	1.19	3.42	1.17	3.31	1.08
Technology Not Cost Effective.	2.55	0.95	3.75	0.68	3.64	1.12	3.16	1.07	3.22	1.05
Using Command Was Resistant to Technology.	3.05	1.09	3.06	0.83	3.36	0.92	3.39	1.09	3.19	1.00
"Not Invented Here" Syndrome.	3.86	0.94	2.77	0.90	2.00	0.89	3.45	1.19	3.17	1.19
Contractor Not Sold on Technology.	2.91	1.26	3.00	0.73	3.00	1.00	3.21	0.86	3.06	0.96
SENTAR Panel Was Resistant to Technology.	3.30	0.80	2.93	0.48	2.80	0.63	3.00	0.39	3.05	0.64
The Fear of Failure Inhibited Transition.	3.55	1.01	2.12	0.70	2.55	1.13	3.30	1.08	2.97	1.14
The SPO Informed but Resistant to Change.	3.18	0.85	2.24	0.90	2.09	0.83	3.35	1.27	2.81	1.12
ASD/YF Engineering Informed but Resistant to the Change.	3.14	0.96	2.59	0.87	2.09	0.83	2.95	0.69	2.78	0.91
Contractor Resistant to Change.	2.59	1.05	2.59	1.00	2.82	0.98	2.53	1.26	2.63	1.06
ASD/YF Engineers Was Not Informed of Technology.	2.19	0.75	2.65	0.86	2.36	1.29	3.05	0.78	2.57	0.94
SPO Not Informed of Technology.	2.18	1.05	2.71	1.16	2.55	1.64	2.79	1.32	2.56	1.25
Contractor Unaware of Technology.	2.14	1.08	2.41	0.80	2.64	1.21	2.90	1.29	2.52	1.12

Note: Mechanisms listed in descending order of total mean scores.

Table 21

Analysis of Variance, Statements Why Technology Has Not Transitioned

MECHANISM	ANOVA F	df	p	WRDC	SPO	EN	Contractor
				(Significantly differs from groups listed below)			
Technology Insufficiently Proven in Terms of Schedule Risk.	1.30	65	0.28				
Technology Insufficiently Proven in Terms of Technical Risk.	1.21	65	0.31				
Technology Insufficiently Proven in Terms of Cost Risk.	4.81	65	0.04		WRDC	WRDC	WRDC
Insufficient Time, Staff or Funding to Incorporate New Technology.	5.95	66	0.00		WRDC	WRDC	WRDC
Technology Was to Costly.	2.84	65	0.04				
Technology Not Cost Effective.	5.59	62	0.01		WRDC	WRDC	
Using Command Was Resistant to Technology.	0.95	65	0.42				
"Not Invented Here" Syndrome.	9.91	69	0.0	SPO, EN*			EN*
Contractor Not Sold on Technology.	0.32	63	0.80				
SENTAR Panel Was Resistant to Technology.	1.42	55	0.25				
The Fear of Failure Inhibited Transition.	8.16	69	0.00	SPO*, EN*			SPO*
The SPO Informed but Resistant to Change.	6.74	66	0.00	SPO*, EN*			SPO*, EN*
ASD/YF Engineering Informed but Resistant to the Change.	4.28	65	0.01	EN*			EN*
Contractor Resistant to Change.	0.17	65	0.91				
ASD/YF Engineers Was Not Informed of Technology.	3.38	64	0.02				WRDC*
SPO Not Informed of Technology.	0.94	65	0.42				
Contractor Unaware of Technology.	1.75	66	0.17				

* alpha = 0.05

Table 22

Statements Why Technology Has Not Transitioned

(D=Strongly Disagree + Disagree, A=Agree + Strongly Agree)

MECHANISM	WRDC D	WRDC A	SPO D	SPO A	EN D	EN A	Contractor D	Contractor A
Technology Insufficiently Proven in Terms of Schedule Risk.	13.7	45.5	11.8	70.6	9.1	63.6	10.0	60.0
Technology Insufficiently Proven in Terms of Technical Risk.	22.7	45.5	11.8	70.6	18 2	63.6	15.0	75.0
Technology Insufficiently Proven in Terms of Cost Risk.	31.8	18.2	11.8	58.8	9.1	63.6	15.0	70.0
Insufficient Time, Staff or Funding to Incorporate New Technology.	31.8	18.2	11.8	70.6	9.1	72.7	10.0	75.0
Technology Was to Costly.	40.9	22.7	11.8	58.8	18.2	54.5	21.1	47.4
Technology Not Cost Effective.	45.0	15.0	0.0	62.5	18.2	54.5	21.1	42.1
Using Command Was Resistant to Technology.	27.3	31.8	17.6	29.4	18.2	45.5	26.3	47.4
"Not Invented Here" Syndrome.	9.1	68.2	41.2	23.5	81.9	9.1	15.0	50.0
Contractor Not Sold on Technology.	33.3	33.3	25.0	25.0	27.3	36.4	15.8	42.1
SENTAR Panel Was Resistant to Technology.	10.0	30.0	14.3	7.1	30.0	10.0	6.7	6.7
The Fear of Failure Inhibited Transition.	9.1	50.0	82.4	5.8	54.5	27.3	30.0	45.0
The SPO Informed but Resistant to Change.	22.7	36.4	58.8	5.9	63.6	0.0	20.0	40.0
ASD/YF Engineering Informed but Resistant to the Change.	23.8	38.1	41.2	11.8	81.8	9.1	15.0	15.0
Contractor Resistant to Change.	50.0	18.2	52.9	23.5	45.5	18.2	52.6	21.1
ASD/YF Engineers Was Not Informed of Technology.	61.9	0.0	47.1	17.6	63.6	18.2	15.8	26.3
SPO Not Informed of Technology.	63.7	13.6	41.2	23.5	63.7	36.4	36.7	21.1
Contractor Unaware of Technology.	68.2	9.1	64.7	11.8	45.5	18	45.0	40.0

Note: Contains same information and order as Table 20, but different format.

General Perceptual Data

Section IV of the study looked at general perceptions of the groups in the areas of specifying technology requirements to the laboratories, the importance of other organizations when new information is needed on the latest technology, and the communications pattern associated between organizations. Finally, the last section looked at general statements concerning technology transition, not just related to the ATF.

Specifying Technology needs to the Laboratories. These questions were again grouped into two type of mechanisms: formal, and informal. The informal methods of specifying technology again rated higher than the formal methods. The mean and standard deviations are listed in Table 23, and the results of the analysis of variance is shown in Table 24. The reliability coefficient alpha was 0.72.

Informal Method. Laboratory/SPO personal interface and working groups seem to have the most influence on communicating needs to the laboratory. While lab/EN personnel interface rated high there was a significant difference noted between the lab and EN, Table 23. The using command/lab interface was not rated as very effective in communicating needs to the LAB. This is consistent with the Hermann report which pointed out the most serious problem uncovered in their study was the disconnect between labs and the using commands (12:2-1).

Formal Methods. The formal method of a PMD specifying requirements to the labs was rated low by the labs and EN. This is an interesting result, because in laboratory programs the PMD usually influences or specifies the technology to be developed. In the SPO environment, where the EN group also resides, the PMD normally specifies the need to develop a program, and not any specific technology. Therefore, one would expect that all the groups, and particularly the lab, would rate this mechanism high, there was a difference noted in the lab and SPO response, Table 24.

The highest rating was given to the "SPO Prioritization" of WRDC programs. The SPO and EN rated this very high, with the lab giving it a moderate rating. A significant difference of perceived effectiveness was shown between the lab and SPO, and the lab and EN. This may be due to the fact that many lab program managers were not aware of this, even though the ranking was published and distributed.

The Technology Need (TN) document is designed to communicate user needs, but it received a low rating in effectiveness. TN documents are created by the users to identify system needs.

Technology Area Plans (TAP's) and Mission Area Plans (MAP's) received a low rating, but these have not been in effect for very long and may not have had the time necessary for a judgement of their effectiveness. TAP's are laboratory planning documents summarizing investments in technology using roadmaps for development. MAP's highlight present and future mission requirements, and systems under development. This is a laboratory process and the SPO's do not have any input to them.

The lowest rating again went to the SENTAR Panel for specifying technology needs to the labs. Two respondents noted the following:

> SENTAR is good at identifying technology important to the ASD Product Division overall, but does not identify specific needs for ATF. Because they do not track changes in ATF requirements on a continual basis.
>
> SENTAR is negative and unconstructive, once you brief them you never see them again.

Although WRDC differed from every group the author does not believe this is significant, but shows evidence of the unawareness of these organizations concerning SENTAR. Every contractor, one half of EN and three fourths of the SPO responded "neutral." This is consistent with previous analyses of SENTAR data.

Table. 23

Mechanisms Specifying ATF Requirements to Laboratories

(1=Not Effective at All, 2=Not Too Effective, 3=Neutral, 4=Effective, 5=Very Effective)

MECHANISM	WRDC Mean	WRDC SD	SPO Mean	SPO SD	EN Mean	EN SD	Contractor Mean	Contractor SD	Total Mean	Total SD
INFORMAL										
Laboratory/SPO personal interface.	4.09	1.35	4.18	0.81	4.27	0.79	3.90	0.81	4.09	1.01
LAB/SPO technology working groups.	3.96	1.29	3.65	0.93	3.82	0.75	3.78	0.73	3.81	0.99
Lab/ASD EN personal interface.	3.44	1.50	4.18	0.64	3.73	1.10	3.71	0.77	3.73	1.12
Lab/Using Command Personal Interface.	3.35	1.47	3.24	0.97	2.91	0.94	3.67	0.77	3.32	1.13
FORMAL										
ATF SPO prioritization of WRDC programs.	3.30	1.43	4.12	0.86	4.27	0.79	3.53	1.12	3.75	1.14
Using Command Statement of Need (SON).	2.91	1.51	3.18	0.88	3.36	1.21	3.82	0.88	3.28	1.22
Program Management Directive (PMD).	2.86	1.61	3.41	0.80	2.73	0.79	3.25	0.68	3.09	1.13
Technology Need (TN) documents.	2.68	1.67	2.73	0.88	2.82	0.87	3.53	0.72	2.92	1.21
Technical Area Plans(TAPS), and Mission Areas Plans(MAPS).	2.70	1.58	2.73	0.88	2.91	0.83	3.12	0.70	2.85	1.14
SENTAR Panel.	2.27	1.61	2.87	0.64	2.90	0.74	3.00	0.00	2.68	1.11

Note: Mechanisms listed in descending order of total mean scores.

Table 24

Analysis of Variance, Mechanisms Specifying ATF Requirements to Laboratories

MECHANISM	ANOVA F	df	p	WRDC	SPO	EN	Contractor
				(Significantly differs from groups below)			
INFORMAL							
Laboratory/SPO personal interface.	0.70	65	0.56				
LAB/SPO technology working groups.	0.11	63	0.95				
Lab/ASD EN personal interface.	3.27	63	0.03		WRDC*		
Lab/Using Command Personal Interface.	1.70	64	0.18				
FORMAL							
ATF SPO prioritization of WRDC programs.	5.25	65	0.00		WRDC*	WRDC*	
Using Command Statement of Need (SON)	4.32	63	0.01				WRDC*
Program Management Directive (PMD)	3.13	61	0.03		WRDC*		
Technology Need (TN) documents.	4.21	60	0.01				WRDC*
Technical Area Plans(TAPS), and Mission Areas Plans(MAPS).	1.78	61	0.16				
SENTAR Panel.	6.95	55	0.00		WRDC*	WRDC*	WRDC*

alpha = 0.05

<u>Sources of Information and Frequency of Contact</u>. The respondent was asked to rate organization importance in terms of an information source for new technology, and how often they actually communicated with that organization. The mean and SD's are listed in Table 25 and Table 27, and analysis of variances are shown in Table 26. The reliability coefficient for importance and frequency was 0.69 and 0.56 respectfully.

Importance. Two organizations which rated highest in importance were the contractor then WRDC, Table 25. Other ASD/SPO's and other AFSC labs had a moderate rating of importance. The lowest rating went to SENTAR and ASD/XR (a consistent trend), with Universities rating slightly ahead of ASD/XR, an unexpected result. The ranking of the university was mainly due to the rating by WRDC. An additional result was that the contractor rated ASD/XR significantly higher than the other organizations, Table 26.

Lastly it is obvious from Table 25 that WRDC and the EN group rate each other much lower than the other groups rate them. WRDC rates EN, in terms of importance, tremendously lower than the other groups, with a significant difference between EN and the contractor. Additionally, EN rates the lab somewhat lower than the other groups.

In terms of importance of organizations as sources of information, ANOVA analysis revealed a significant difference among organizations in perceptions of how important ASD engineering was. WRDC rated ASD engineering significantly lower than the SPO, EN, and the contractors as well. WRDC rated other ASD SPO's significantly lower than the SPO and EN, while both WRDC and EN rated ASD/XR statistically less important than did the contractors.

Table 25

Importance of Organizations as Sources of Information

(1=Not at All Important, 2=Not too Important, 3=Neutral, 4=Important, 5=Very Important)

	WRDC		SPO		EN		Contractor		Total	
ORGANIZATION	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Contractor/Vendor	4.33	0.87	4.38	0.50	4.60	0.52	4.35	0.58	4.38	0.67
WRDC	4.55	0.61	4.06	0.97	3.70	1.16	4.18	0.93	4.19	0.93
ASD Engineering	2.53	1.06	4.13	0.72	4.70	0.48	3.80	0.77	3.58	1.14
Other AFSC Laboratory's	3.38	1.10	3.40	1.24	3.20	1.03	3.00	0.97	3.27	1.09
Other ASD SPO's	2.78	1.04	3.75	0.78	3.80	1.14	3.06	0.78	3.22	1.00
University	2.87	1.14	2.47	1.19	2.00	0.67	2.53	1.18	2.53	1.11
ASD/XR	2.13	1.15	2.47	0.92	2.20	1.03	3.43	0.65	2.49	1.08
SENTAR Panel	2.09	1.20	2.15	0.99	2.33	1.00	2.73	0.65	2.26	1.04

Note: Organizations listed in descending order of total mean scores.

Table 26

Analysis of Variance, Importance of Organizations as Sources of Information

	ANOVA			WRDC	SPO	EN	Contractor
ORGANIZATION	F	df	p	(Significantly differs from groups listed below)			
Contractor/Vendor	0.40	66	0.75				
WRDC	2.29	62	0.07				
ASD Engineering	19.76	66	0.00		WRDC*	WRDC*	WRDC*, EN*
Other AFSC Laboratory's	0.48	61	0.70				
Other ASD SPO's	4.80	61	0.00		WRDC*	WRDC*	
University	1.50	61	0.22				
ASD/XR	5.60	59	0.00				WRDC*, EN*
ASD SENTAR Panel	1.02	52	0.39				

* alpha = 0.05

Frequency of Contact. All organizations, with the exception of ASD/XR, were rated higher in importance than was the frequency of contact. All organizations communicated with the contractor/vendor more than with any other organization. Although WRDC and contractor/vendors were rated relatively close in importance, the frequency of communications with WRDC is significantly less than that with the contractor/vendor. It is interesting to note that the SPO & EN talk somewhat more frequently to other AFSC laboratories than they do with WRDC. However, they did rate WRDC significantly higher in importance than other AFSC laboratories.

The communication pattern with WRDC and EN was consistent with the rating of importance. The actual communications between the two groups is significantly lower than would be expected. The SPO communicates with the lab much less than would be expected.

In frequency of contact with other organizations, WRDC had significantly more contact with its own organization than EN and the SPO reported, while WRDC reported significantly less contact than the SPO and EN with ASD engineering. The SPO had significantly more contact with other ASD SPO's than the contractors or WRDC, wile WRDC had significantly more contact with ASD/XR than the contractors.

Table 27

Frequency of Contact With Other Organizations

(1=Never, 2=Almost Never, 3=Neutral, 4=Almost Always, 5=Always)

	WRDC		SPO		EN		Contractor		Total	
ORGANIZATION	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Contractor/Vendor	4.17	0.78	4.31	1.25	4.11	0.60	4.10	1.00	4.15	0.94
WRDC	4.19	0.98	2.69	1.30	2.57	1.13	3.57	1.21	3.39	1.32
ASD Engineering	2.27	0.73	3.80	1.32	4.45	0.57	3.17	1.04	3.19	1.23
Other ASD SPO's	2.47	0.87	3.47	0.64	3.11	0.93	2.43	0.85	2.81	0.93
Other AFSC Laboratory's	2.65	1.91	2.93	1.14	2.57	0.88	2.79	1.12	2.73	1.11
University	2.62	0.87	1.62	0.87	2.33	2.18	2.07	0.80	2.18	1.17
ASD/XR	2.78	1.04	1.86	0.86	1.88	0.84	2.62	0.96	1.96	0.90
SENTAR Panel	1.76	0.83	1.50	0.91	1.18	0.83	2.30	0.95	1.78	0.88

Note: Organizations listed in descending order of total mean scores.

Table 28

Analysis of Variance, Frequency of Contact With Other Organizations

	ANOVA			WRDC	SPO	EN	Contractor
ORGANIZATION	F	df	p	(Significantly differs from organizations listed below)			
Contractor/Vendor	0.23	64	0.87				
WRDC	7.07	58	0.00	EN*, SPO*			
ASD Engineering	13.79	60	0.00		WRDC*	WRDC*, Cont.*	
Other ASD SPO's	5.73	55	0.00		Cont.*, WRDC*		
Other AFSC Laboratory's	0.27	56	0.85				
University	2.17	54	0.10				
ASD/XR	2.74	52	0.53				WRDC*
ASD SENTAR Panel	1.58	4[illegible]	0.21				

* alpha = 0.05

General Technology Transition Statements

The last section of Part IV asked for the respondents agreement on general statements about technology transition, not those just related to the ATF/WRDC situation.

Two major agreements were the "Willingness to Accept Risk is Important to Successful Transition," and "The Labs need a long term focus."

Product Division accepting contractor offered technology before lab technology was rated relatively high in agreement by all the government organizations. The labs strongly agreed, and a significant difference in response between WRDC and the contractors was noted, Table 30.

Product Divisions being enthusiastic about new technology had the greatest difference in responses. The laboratory response indicated they strongly felt the SPO's are resistant to new technology, and significantly lower than the other groups, Table 30.

The strongest disagreement was that "Technology Transition Mechanisms are Clearly Defined." Additional disagreement was over SENTAR helping the transition process; however, the contractor had 92.3% of them signifying neutral. This is consistent with previous responses concerning their unawareness of SENTAR. Therefore, this was not considered a significant difference with WRDC

Table 29

General Statements Concerning Technology Transition*

(1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)

STATEMENTS	WRDC Mean	WRDC SD	SPO Mean	SPO SD	EN Mean	EN SD	Contractor Mean	Contractor SD	Total Mean	Total SD
Labs need to have a long term focus.	4.54	0.59	4.18	0.95	4.00	1.00	4.20	0.62	4.27	0.77
Willingness to accept risk important to successful technology transition.	4.17	0.76	4.06	[illegible]	3.82	0.75	4.37	0.58	4.16	0.72
P.D.'s** accept contractor offered technology before lab technology.	4.00	0.72	3.47	0.80	3.36	0.92	3.25	0.45	3.58	0.78
AFSC labs are doing a good job of developing needed technology.	3.71	0.75	3.12	0.78	3.36	0.67	3.47	0.91	3.44	0.81
Product Divisions are so success oriented they can not do real R&D.	4.22	0.90	2.82	0.95	2.73	1.19	3.39	1.15	3.41	1.19
Product Divisions have mainly short term technology needs.	3.92	0.88	3.12	1.22	3.00	0.89	3.06	0.87	3.35	1.04
The Product Divisions Keep Abreast of Current Laboratory Research.	2.75	1.07	3.53	1.07	3.46	1.21	3.22	0.65	3.15	1.02
Product Divisions are Enthusiastic about using new technology.	2.13	0.90	3.82	0.64	3.55	0.93	3.17	0.99	3.01	1.11
Technology developed by the labs is usually timely.	2.96	0.95	2.47	0.80	2.73	1.01	3.15	0.99	2.87	0.95
IR&D develops more useful technology than lab programs.	2.39	1.03	3.47	0.80	2.91	0.70	2.78	1.00	2.85	1.00
The SENTAR Panel has helped the transition Process.	2.00	0.85	2.67	0.72	2.70	1.16	3.08	0.28	2.50	0.89
Technology Transition Mechanisms are clearly defined & easy to use.	1.83	0.87	2.12	0.93	2.27	1.01	2.00	0.75	2.00	0.87

Note: Statements listed in descending order of total mean score.
* Not just ATF related
** P.D.: Product Division

Table 30

Analysis of Variance, General Statements Concerning Technology Transition

STATEMENTS	ANOVA F	df	p	WRDC	SPO	EN	Contractor
				(Significantly differs from groups below)			
Labs need to have a long term focus.	1.61	68	0.20				
Willingness to accept risk important to successful technology transition.	1.47	67	0.23				
P.D.'s** accept contractor offered technology before lab technology.	4.22	64	0.01				WRDC*
AFSC labs are doing a good job of developing needed technology.	1.90	67	0.14				
Product Divisions are so success oriented they can not do real R&D.	8.17	65	0.00	SPO*, EN*			
Product Divisions have mainly short term technology needs.	4.06	66	0.01	Cont.*			
The Product Divisions Keep Abreast of Current Laboratory Research.	2.44	66	0.07				
Product Divisions are Enthusiastic about using new technology.	14.70	66	0.00		WRDC*	WRDC*	WRDC*
Technology developed by the labs is usually timely.	1.77	66	0.16				
IR&D develops more useful technology than lab programs.	4.48	65	0.01				
The SENTAR Panel has helped the transition Process.	5.69	57	0.00				WRDC*
Technology Transition Mechanisms are clearly defined & easy to use.	0.74	67	0.53				

* Not just ATF related

** P.D.: Product Division

V. Conclusions and Recommendations

Introduction

This chapter provides concluding remarks on technology transition, and how the specific problem and investigative questions in Chapter 1 were met. To reiterate, the specific research problem was to identify the helpful mechanisms, as well as the barriers encountered in the WRDC/ATF technology transition process, as perceived by four groups: WRDC, ATF SPO & EN, contractors. To accomplish that objective it was necessary to answer five investigative questions. They were

1. How has the Operating Command contributed in the development of and transition of technology for the ATF.

2. How well have the official and unofficial technology transition processes worked as perceived by laboratory, SPO, EN, and contractor personnel.

3. What organizations are considered important sources of information on new technology, and what is the frequency of contact with those organizations.

4. What influence is the contractor perceived to have on the success or failure of moving technology from WRDC to the ATF SPO.

5. Is the perceived risk of new technology by the SPO a significant barrier in the transition process.

Conclusions

Investigative Question One. The using command involvement is perceived important in the transition process, (Table 6, Table 13). The majority of respondents, with exception of the labs, believed "selling" TAC management was important. However, Table 17 shows those who responded to who was responsible for "selling" TAC management clearly saw WRDC as being responsible. This is not seen as an inconsistency due to the small number of responses, and in the authors opinion should not be considered significant. Although not significant this does indicate a trend and WRDC needs to be more aware of the using command. Additionally, the data indicate technology transition is impeded if the using command "resists" the technology, Table 20. Therefore insuring the using command understands the technology, and doesn't resist it because they do not understand -- seems important. However caution was recommended in one response, because selling technology to users can lead to some problems:

> **Users seldom differentiate between technology demonstrations, and fully developed systems. This could, and does, lead to over expectations.**

Several comments suggested "technology can only be incorporated into a system if you have contractor and user support." This becomes important because " users have (a) strong influence on (the) budget."

The budget influence possibly is an explanation for the labs rating "selling the using command" lower than the other groups. Because the using command is even further removed from the labs, their influence on the budget is not as pronounced as in the SPO environment.

A stronger explanation is that WRDC respondents felt they were more involved in basic research, and the using command input was not that important. One respondent commented that the using command is not seen as the next customer, although they are clearly recognized as the ultimate customer. In other words, because the lab is more research oriented the labs do not see involvement with the using command as part of their mission.

Investigative Question Two. The formal mechanisms and processes were not generally rated as effective, while the informal methods received an "effective" rating.

Formal Methods. For the purposes of this study a formal mechanism was defined as an organization or process which has been established for the purpose of improving the transition process. This included ASD/XR, the SENTAR Panel, Technology Transition Plans, Technology Needs Documents, TAP's and MAP's.

ASD/XR overall rated low in effectiveness. But the contractors thought they were more important than the other groups. This can be expected since many contractors have kept up with XR because they are often involved in starting new programs and SPOs. The low rating of XR was somewhat expected in this study since SENTAR, not ASD/XR, has been the technology broker since 1984. Nearly all technologies under consideration in the ATF DEM/VAL have transitioned since that time. Regardless, ASD/XR did play an important part in the early development of the ATF. There was one written comment from ASD/EN which stated:

ASD/XR was effective during concept exploration, when ATF resided in XR. Once ATF became a two letter SPO and entered DEM/VAL, XR was no longer a player in technology transition. Many of the technologies identified by XR, have been abandoned due to schedule slips, failure to mature, or changes in ATF requirements.

SENTAR was rated very low in effectiveness, with a number of people indicating they were "unfamiliar with the organization." Two explanations are offered for this very high number of unfamiliar responses. First the respondents may not have had any knowledge of SENTAR. This would explain the high number of responses from the contractors, and would further show that this transition process is largely an ASD process. However, 76% of the SPO, 36% of EN, and 25% of WRDC reported they were unfamiliar with the organization. Therefore this explanation appears to be inconsistent. Secondly, the respondents may have been unaware of SENTAR's role in technology transition for the ATF. This would explain the high number of responses from the lab, and particularly EN since SENTAR is part of EN. The second explanation would still be consistent with the first in terms of the contractor. However, if SENTAR is an active part of the transition process, more people should be aware of the role SENTAR has played.

During one interview, a concern was expressed that the S in SENTAR, which stands for senior, has no real basis. Although the board members are senior, the people who do the evaluations are junior -- thus, it should be more appropriately called JENTAR. However, this is consistent with Table 3 which shows that EN has much less experience than the other groups. He also noted that this perception hurts the credibility of the SENTAR process. Other thoughts were expressed that even within EN, if the right people, credible people were not on the board no one really took them seriously. This is consistent with McCorkendales discussion of credibility in chapter 3. Other comments were more harsh, such as, SENTAR is the last place you go if you want any transition. And, "If you want anything to transition, you must go outside the system."

The following are written comments from the questionnaire concerning SENTAR:

> The Lab has never liked SENTAR.
>
> SENTAR is a political body not technical.
>
> SENTAR's intent is good, but they are just another bottleneck, roadblock, checkpoint.
>
> SENTAR is an exceptionally damaging program, since they make life/death decisions on lab programs based on superficial briefing and superficial understanding of the technology issues. they should present their directorate's views on programs to the lab commander/director, but not have veto power.
>
> The SENTAR process does a good job at identifying technology, but they never follow-up.

Technical reports and documentation such as TTPs, TN, TAPS and MAPs were not shown to be effective. Allen, in a 1977 study, showed these types of formal mechanisms to be ineffective in technology transition (2). It is not surprising then that several respondent comments reflected this idea. Two of the comments were:

In most cases it not the organization or methods as a whole, but one or two zealots that pursue tech transfer. The original zealot sold the SPO & got a dem/val task for this technology in the ATF Statement of Work (SOW).

Transition was really controlled and forced by one man.

The above comments are consistent with the importance of gatekeepers and linkers within any organizational structure described in chapter 3.

The acquisition strategy was rated as the most effective of the formal methods. No analysis has been made of this except to say it further emphasizes that the proper acquisition strategy is crucial in government transition. Formal mechanisms that were rated as effective and helpful in the transition process were the lab SPO working groups, reassignments of lab personnel, and the ATF unique process (Tables 8,9). One respondent noted: **The key mechanisms are the ATF Avionics working group and relationships between SPO and Lab personnel.** Although reassignment of personnel temporarily or permanently was only done in the 63109 Program Element, it was rated as very effective. Why more emphasis has not been put into this is only speculation. However, from general discussions at the SPO and with lab employees many speculations were made: the organization would not let them go, there is too much other work to leave permanently or temporarily, they may never come back, or it might interfere with the next promotion.

The ATF unique transition process has been very beneficial. The WRDC Deputy Commander said, " this has been the best transition job that has ever been accomplished in ASD (9)." The reasons for success are: (1) WRDC and the ATF SPO have worked very closely with each other by identifying two individuals at the ATF, one from engineering and one from acquisition, who work closely with individuals identified in WRDC. (2) Contractors have been highly involved, and this process has facilitated getting new information to the contractors for their consideration. (3) The SPO has clearly identified their wants and needs to WRDC, and they have provided some support for the labs in getting funding.

Informal Mechanisms. The informal mechanisms were rated as effective. The lab having outside contact with non-lab personnel, lab/SPO, and lab/EN interfaces was rated as an effective means of identifying and transitioning technology.

The following comments were written on the questionnaires:

> **Effective tech transition can only occur when the labs, engineering development, and the contractor work together.**

A number of responses indicated that transition is done best informally. Written comments were:

> **Technology transition is done best on an engineer to engineer basis.**

The best technology transition occurs when the engineer trying to solve the problem visits face-to-face , one-on-one with the people developing the technology so that the details of the problem can be clearly understood and the limitations of the technology (including unknowns) are explained.

Technology transition is a delicate process which requires personal involvement/interaction before an understanding can be achieved between research and product communities.

<u>Investigative Question Three</u>. There was a large barrier identified in the general communications patterns between the laboratories and the SPO's, and laboratories and EN, Table 25 and 26. This may not be an overwhelming problem, but must be considered to optimize the transition process between WRDC and ASD SPO's. The ATF/WRDC process was implemented to overcome this communications problem.

The lab/SPO and lab/EN working groups were rated as a very effective transition mechanism, and very important in specifying technology requirements to the laboratories, Table 23. However, the results of the survey indicate that the organizations communicate very little with each other. Contrasting the rating of importance in obtaining information about new technologies listed in Table 25, with the frequency of contact in Table 28, a large difference is noted. In particular, the rating of importance of WRDC by the SPO and EN was ranked very high, but when looking at the amount of actual contact a tremendous difference is seen, Table 28. Concerning WRDC, they ranked the importance of new information from all other sources, excluding themselves, as <u>not</u> that important, and communicated very little with anyone except the contractor. The WRDC/EN relationship is serious and must be dealt with to facilitate successful transition.

One might expect the communications with laboratory and Universities to be much higher. This is generally the case with 6.1 or 6.2 technologies. However the people included in this study are generally involved in 6.3 area of technology.

<u>Investigative Question Four</u>. The contractor is perceived to have a significant impact on the success or failure of transition. Contractor support depends on awareness of the technology and the trust in it. The contractor was seen as a very important factor in technology transition. This was not an unexpected result since Cormier and Salvucci found similar results in a 1985 study. They found that the contractor is a third party in the transition of emerging technology from the laboratories to the product divisions (5:121). There was one comment from the SPO that addressed the very issue of the contractor role in transition:

> It still boggles my mind that the fundamental technology transfer mechanism from lab contractor to SPO product via the same contractor is not accepted by the lab management who seem to think they must only transfer technology directly to the SPO's, product division managers seem to think the labs aren't supporting them unless technology is seen to transfer directly from lab to SPO. It just doesn't happen that way.

The importance of selling the contractor on technology received a mixed response, and was not seen as a critical step. However, since the contractors were rated so important in transitioning technology they must be aware of the technology. This is even more important because the contractors are not perceived as being resistant to change.

The contractor being unaware of technology was not rated as a factor, but WRDC and the SPO have gone to great measures to ensure that the contractor is aware of the technology. Selling the contractor on the importance of technology is crucial, but was rated low because it happens easily in the unique process that WRDC and the ATF SPO have implemented. The ATF process has been rated overall very effective, and serves as a good model on how laboratory, EN, SPO, and contractors can work together to ensure better technology transition.

There were many comments concerning how contractors affect the transition process. The following are written responses concerning the contractors role in the transition process:

> The Contractor actually transitions new technology.

> The most effective way to transition is having the same company work the SPO programs as the labs. This way the company can transfer the technology "inside" and there is not any trouble with the contractor trust and obtaining program results.

> Laboratory sponsored programs which give the contractors enough confidence in new technology to propose it on new systems/subsystems is the most effective means of technology transition.

> **The real problem as I see it its making sure the prime contractors fully understands and "trusts" the new idea. Allowing them to get <u>details</u> of the concept/idea/demo is critical in this process. Any inhibitions to <u>full</u> understanding, leads to reluctance to adopt new technology.**
>
> **The ATF SPO have made a concerted effort to ensure that our contractors were aware of all laboratory programs that might be applicable, even those considered to be of marginal utility. SPO engineering has been the primary technology conduct to the contractors. The fact remains, however, that the final decision lies with the contractor whether the technology is utilized.**
>
> **For a technology that has reached the point where it is transitionable we, the government acquisition team, cannot specify its use. We can only be advocates and ensure that the contractor evaluates it as an alternative technology. But only he determines if it will ultimately be used.**

The ATF process is seen by the contractors as a beneficial process as well. A contractor viewpoint:

> **The ATF program has offered us an opportunity to understand and asses risks. Using this data base we have designed an advanced product that attempts to achieve the best balance of: Survivability; Supportability; Safety; Weight, cost, producibility, but it is our concept--our offer to the USAF--and our opportunity to win the production programs.**

The contractor pushing the technology, as well as having the freedom to chose the technology used, had a tremendous response as indicated in Table 9. But if the contractor pushing the technology is important to technology transition, who are they pushing the technology to? It certainly is not through the formal transition process since nearly all contractors are unaware of SENTAR. Allowing the contractors the freedom of design, and selling the SPO on technology are important. However, there seems to be an inconsistency with the response of having the contractors contractually required to use the technology. The following reasons can be applied for an explanation. There are two common ways of transitioning technology in the government: (1) let contractors choose technology to meet the needs of the users, (2) government furnished equipment (GFE) that is mandated to be incorporated into the system such as jet engines, missiles, etc. Consequently technology is transitioned by government requirements.

Investigative Question Five. Respondents agreed that the willingness to accept risks is important to successful technology transition, Table 29. The issue of risk aversion by the SPO was not perceived as a major factor, except by the laboratory, Table 22.

Within WRDC, 50% of the respondents agreed that the "fear of failure inhibits transition", while only 9% disagreed, Table 22. This was consistent with the question "Product Divisions are so success oriented that they can not do real R&D", furturmore WRDC perceived this as a significant barrier to transition, Table 29. Couple this finding with the SPO being resistent to change and unenthusiastic about new technology, which the labs and contractors both felt were significant. A barrier was perceived that the risk aversion by the SPO is a barrier to transition.

This difference can be explained by the inherent cultural and organizational goals of the laboratory and development communities. The lab operates in an environment where risk is a large part of the job. In fact the laboratory environment often pursues knowledge for the sake of knowledge (30:22). Consequently, the labs are much less risk averse than the developing organizations. If the risk is not large then serious consideration should be given to whether it should even be a laboratory program. A written response noted that

> ... lab program managers ought to have 50% success and 50% failures. If they are 100% successful, it means to me it didn't need to be done by the labs and could have been done in FSD.

One other comment was from a contractor who stated:

> Cost shared (fixed price) R&D programs (like ATF DEM/VAL) are a problem due to the high rate of investment and lack of payoff for the contractor (be he winner or loser) which inhibits technology transition. Conservative, short term business requirements preclude needed technology maturation and hence transition.

The drivers of risk were clearly identified with those associated with cost, schedule, and technical risk. The analysis of "risk" is beyond the scope of this study except to say, that appropriate risk analysis and risk management must be performed up front and throughout technical development. There was one interesting comment from a contractor which stated:

> I sensed a reluctance on the part of EN to embrace the technology possibly because of schedule, cost, and/or the need to ensure "success."

In order for risk management to work, it must be formal, systematic, and applied in a disciplined manner. To obtain the maximum benefit from risk management, it must become a systematic process (7:2-1). However, risk management should be thought of as a program management methodology, rather that an independent function (7:fw1).

Recommendations

SENTAR could be a very productive process for enhancing technology transition at ASD. The framework and guidelines have already been established, however SENTAR has not been aggressively implemented and utilized to its fullest extent. There is a tremendous unawareness of SENTAR transition procedures, and how SENTAR plays in the transition process. A few changes to the existing formal system should enhance its effectiveness. The following are recommended:

1. Personnel throughout ASD, WRDC and defense industry should be made knowledgeable of the SENTAR process. Program managers and engineering personnel in the SPO environment, laboratories, and the related contractors need to understand how SENTAR can benefit them.

A 1989 study showed 67.8% of WRDC and ASD felt they were inadequately trained in technology transition (33:44). A starting point would be mandatory briefings to working level WRDC, SPO, and EN personnel on the SENTAR process. Possibly a one or two day short course showing the use of TTPs within

ASD and the SENTAR process. A written briefing including regulations as part of a reading package for new personnel during an orientation process may also be helpful.

2. EN technology monitors need to be actively involved with the program manager throughout the life of the program. They should be included in major milestone and/or updated with significant events throughout the lab program. Team work should be emphasized throughout the SENTAR process. ASD/EN must take a much bigger advocacy role, speaking to the SPO's and industry.

3. In addition to SENTAR evaluations of "validated technologies" included in RFP packages, the SENTAR programs in process should be included.

4. Government program managers should be required to review lab programs that may be related to their new start, discuss the findings with the appropriate lab managers and engineers before preparing RFP's.

5. The establishment of an easy to use methodology which allows SPO's and ASD/Engineering to research laboratory programs to see if the technology is being or has been developed in WRDC. This should include identification of the lab program office. Possibly this could be a WRDC/TX function.

6. ASD/XR should be included on the SENTAR Panel. This is considered very important because they are involved in

long range planning at ASD. Members of the appropriate SPO or directorate should be included on an as needed basis.

In addition, the following general recommendations based upon the present study are offered.

7. The ATF/WRDC unique process should be implemented in concept exploration and dem/val phases in other ASD SPO's.

8. Improve and optimize working relationships of lab and product divisions by establishing informal ASD, ASD/XR, WRDC working groups.

9. Establishment of formal, discipline oriented, working groups with EN and WRDC, whose purpose would be reviewing the status of technologies and communicating technology needs and/or presenting problems to the labs.

10. EN and lab managers should encourage personnel exchange programs between the two groups to aid in the transition process.

Recommendations for Further Research

In the past, the ATF SPO has not considered preplanned product improvement (P^3I). They only supported technology available for the baseline program. Now that P^3I is being considered, a future study could investigate how this has affected the transition environment and process that existed during this study. Directing the lab toward P^3I for the SPO may be a way of improving technology transition.

An issue uncovered in this study was the adverse relationship between the laboratories and ASD engineering, and to a lesser degree that of the laboratories and the SPO's. A related issue to investigate would be the communications problem between the labs and the SPO's, as well as the labs and EN. Particularly the feedback mechanisms from the SPO environment to the labs, which many lab personnel thought was lacking.

Another aspect of the technology transition process that fell beyond the scope of this study was the independent research and development (IR&D) conducted within the contractor organizations. IR&D develops technology of interest to a specific contractor, and results are often "buried" in a file cabinet. IR&D may inhibit transition and be a poor use of government dollars because the technology is only retained by the developing contractors, and not shared with the rest of industry. Some possible questions to answer would be:

1. Does IR&D developed technology transition to other contractors?

2. Is IR&D a good investment if the technology is not transferred to other contractors?

Appendix A

MIT MANAGEMENT OF TECHNOLOGY PROGRAM
TECHNOLOGY TRANSITION SURVEY

1. ORGANIZATION/OFFICE SYMBOL:________________2.RANK/GRADE______
3. JOB TITLE____
4. EDUCATION:
   DEGREE(S)   YEAR OF DEGREE(S)

5. YEARS IN PRESENT ASSIGNMENT:______
6. LIST OTHER MAJOR ORGANIZATIONS IN WHICH YOU WORKED WITHIN THE LAST 10 YEARS: (LABORATORY, CONTRACTOR, SPO, ETC.)

____
____
____

7. PLEASE LIST A PROGRAM THAT, IN YOUR OPINION, TOOK ADVANTAGE OF THE LATEST TECHNOLOGY AT THE TIME. ALSO LIST ONE SPECIFIC TECHNOLOGY INVOLVED. (eg. F-16, FLY-BY-WIRE FLIGHT CONTROL TECHNOLOGY.)

PROGRAM   TECHNOLOGY

____

8. PLEASE INDICATE THE DEGREE WHICH YOU BELIEVE THAT THE FOLLOWING ORGANIZATIONS WERE EFFECTIVE IN MOVING THE TECHNOLOGY IN THE SUCCESSFUL CASE LISTED IN QUESTION #7 ABOVE. (1=NONE, 2=SOMEWHAT EFFECTIVE, 3=EFFECTIVE, 4=EXTREMELY EFFECTIVE, NF=UNFAMILIAR WITH THE ORGANIZATION).

a. AFSC LABORATORIES
b. SPO's
c. PRODUCT DIVISION/XR's
d. PRODUCT DIVISION A ENGINEERING
e. CONTRACTOR
f. PRODUCT DIVISION C TECHNOLOGY BROKER
g. PRODUCT DIVISION B ENGINEERING
h. PRODUCT DIVISION C ENGINEERING
i. USING COMMAND (TAC, SAC, ETC.)

9. PLEASE INDICATE THE DEGREE TO WHICH YOU BELIEVE THAT EACH OF THE FOLLOWING MECHANISMS WAS INSTRUMENTAL IN MOVING THE TECHNOLOGY IN THE SUCCESSFUL CASE LISTED IN QUESTION #7 ABOVE. (1=NOT INSTRUMENTAL, 2=MINIMALLY INSTRUMENTAL, 3=MODERATELY INSTRUMENTAL, 4=EXTREMELY INSTRUMENTAL, NF=UNFAMILIAR WITH THE MECHANISM)

a. THE CONTRACTOR WAS ALLOWED THE FREEDOM TO CHOOSE THE TECHNOLOGY USED IN THE DESIGN.

b. THE CONTRACTOR WAS PROVIDED THE LATEST TECHNICAL REPORTS (TR).

c. THE CONTRACTOR WAS CONTRACTUALLY REQUIRED TO USE THE LATEST TECHNOLOGY THROUGH THE RFP, SPECS, ETC.

d. THE USING COMMAND (TAC, SAC, ETC.) SPECIFIED TO AFSC THE NEED FOR THE TECHNOLOGY.

e. SPO MANAGEMENT WAS "SOLD" ON THE TECHNOLOGY. (WHO DID THE SELLING?____________________).
(ORGANIZATION)

f. P.D. A ENGINEERING WAS "SOLD" ON THE TECHNOLOGY. (WHO DID THE SELLING?____________________).
(ORGANIZATION)

g. A TECHNICAL REPORT (TR) WAS WRITTEN AND MAILED TO THE SPO.

h. THE TECHNOLOGY WAS PUBLISHED IN A NON-USAF JOURNAL

i. MILITARY HANDBOOKS, SPECS AND/OR STANDARD WERE UPDATED TO INCLUDE THE TECHNOLOGY.

j. TECHNOLOGY TRANSITION PLANS (TTP) WERE USED.

k. THE PRODUCT DIVISION/XR WAS "SOLD". (WHO DID THE SELLING?____________________).
(ORGANIZATION)

l. A P.D. ENGINEER WAS CO-LOCATED INTO AFSC LABORATORY DEALING WITH THE TECHNOLOGY FOR A SHORT TIME PERIOD.

m. FORMAL PRESENTATIONS WERE MADE AT SEMINARS ON THE TECHNOLOGY.

n. A "ROAD SHOW" WAS PRESENTED TO THE PRODUCT DIVISION. (WHO PUT ON THE "ROAD SHOW"?____________________________).
(ORGANIZATION)

o. P.D. B ENGINEERING WAS "SOLD". (WHO DID THE SELLING?____________________).
(ORGANIZATION)

p. P.D. C ENGINEERING WAS "SOLD". (WHO DID THE SELLING?____________________).
(ORGANIZATION)

q. SPO PERSONNEL WERE ASSIGNED TO AN AFSC LABORATORY FOR A SHORT TIME PERIOD.

r. THE P.D. A TRANSITION PANEL WAS "SOLD". (WHO DID THE SELLING?______________________).
(ORGANIZATION)

s. A JOINT LABORATORY/PRODUCT DIVISION WORKING GROUP.

t. LABORATORY PERSONNEL WERE ASSIGNED TO A SPO FOR A SHORT PERIOD.

u. THERE WAS FREQUENT, INFORMAL PERSONAL CONTACT BETWEEN LAB AND NON-LAB PERSONNEL.

v. FORMER EMPLOYEE OF AN AFSC LABORATORY BEING ASSIGNED TO A SPO.

w. THE ACQUISITION STRATEGY USED INCLUDED A FULL DEM/VAL PROTOTYPE PHASE.

x. OTHER (PLEASE SPECIFY:______________________________________)

10. PLEASE LIST A PROGRAM WHERE, IN YOUR OPINION, THE TECHNOLOGY WAS AVAILABLE BUT THE PROGRAM DID NOT USE IT.

PROGRAM	TECHNOLOGY

11. PLEASE INDICATE YOUR AGREEMENT WITH THE FOLLOWING STATEMENTS AS TO WHY TECHNOLOGY WAS NOT EFFECTIVELY TRANSITIONED IN THE CASE LISTED IN QUESTION #10 ABOVE. (SA=STRONGLY AGREE, A=AGREE, N=NEUTRAL, D=DISAGREE, SD=STRONGLY DISAGREE).

a. THE SPO WAS NOT INFORMED OF THE TECHNOLOGY.
b. THE USING COMMAND WAS RESISTANT TO THE TECHNOLOGY.
c. TECHNOLOGY WAS TOO COSTLY.
d. THE "NOT INVENTED HERE" SYNDROME.
e. SPO WAS INFORMED BUT WAS RESISTANT TO THE CHANGE.
f. THE TECHNOLOGY WAS INSUFFICIENTLY PROVEN.
g. THE CONTRACTOR WAS RESISTANT TO CHANGE.
h. P.D. A ENGINEERS WERE NOT INFORMED OF THE TECHNOLOGY.
i. P.D. B ENGINEERS WERE NOT INFORMED OF THE TECHNOLOGY.
j. P.D. C ENGINEERS WERE NOT INFORMED OF THE TECHNOLOGY.
k. P.D. A ENGINEERING WAS INFORMED BUT WAS RESISTANT TO THE CHANGE.
l. P.D. B ENGINEERING WAS INFORMED BUT WAS RESISTANT TO THE CHANGE.
m. P.D. C ENGINEERING WAS INFORMED BUT WAS RESISTANT TO THE CHANGE.
n. THERE WAS INSUFFICIENT TIME, STAFF OR FUNDING TO INCORPORATE THE TECHNOLOGY.
o. THE TECHNOLOGY WAS NOT COST EFFECTIVE.
p. OTHER (____)

12. PLEASE LIST THE NAME(S) OF THE INDIVIDUAL(S) AND HIS/HER/THEIR ORGANIZATION(S) THAT, IN YOUR OPINION, WAS/WERE MOST INSTRUMENTAL IN MOVING THE SUCCESSFULLY TRANSITIONED TECHNOLOGY LISTED IN QUESTION #7 ABOVE.

NAME	ORGANIZATION

13. PLEASE INDICATE THE DEGREE TO WHICH EACH OF THE FOLLOWING MECHANISMS, IN YOUR OPINION, ARE EFFECTIVE FOR SPECIFYING THE TECHNOLOGY REQUIREMENTS TO THE AFSC LABORATORIES. (SEE QUESTION 8 FOR THE CODES.)

a. TECHNOLOGY NEED (TN) DOCUMENTS.
b. VANGUARD PROCESS.
c. TECHNOLOGY TRANSITION PLANS (TTP)
d. P.D. A TRANSITION PANEL/LABORATORY AGREEMENTS.
e. JOINT LABORATORY/PRODUCT DIVISION WORKING GROUP AGREEMENTS.
f. PROGRAM MANAGEMENT DIRECTIVE (PMD).
g. LABORATORY/USING COMMAND PERSONAL INTERFACE.
h. LABORATORY/PRODUCT DIVISION ENGINEERING PERSONAL INTERFACE.
i. LABORATORY/SPO PERSONAL INTERFACE.

14. WHEN YOU NEED TECHNICAL ADVICE IN YOUR AREA OF EXPERTISE, WHICH OF THE FOLLOWING ORGANIZATIONS DO YOU CONTACT AND HOW OFTEN PER MONTH DO YOU MAKE THE CONTACT(S)?

a. AFSC LABORATORY.
b. PRODUCT DIVISION A ENGINEERING.
c. PRODUCT DIVISION C TECHNOLOGY BROKER.
d. PRODUCT DIVISION B ENGINEERING.
e. PRODUCT DIVISION C ENGINEERING.
f. OUTSIDE AFSC LABORATORY.
g. CONTRACTOR/VENDOR.

15. INDICATE YOUR AGREEMENT WITH THE FOLLOWING. (SA=STRONGLY AGREE, A=AGREE, N=NEUTRAL D=DISAGREE, SD=STRONGLY DISAGREE)

a. THE PRODUCT DIVISIONS KEEP ABREAST OF CURRENT LABORATORY RESEARCH.
b. PRODUCT DIVISIONS ARE ENTHUSIASTIC ABOUT USING NEW TECHNOLOGY.
c. PRODUCT DIVISIONS HAVE MAINLY SHORT-TERM TECHNOLOGY NEEDS.
d. MECHANISMS FOR TRANSITIONING TECHNOLOGY ARE CLEARLY DEFINED AND EASY TO USE.
e. THE AFSC LABORATORIES ARE DOING A GOOD JOB OF DEVELOPING THE NEEDED TECHNOLOGY.
f. THE TECHNOLOGY DEVELOPED BY THE LABORATORIES IS USUALLY TIMELY.
g. LABORATORIES NEED TO HAVE A LONG TERM FOCUS.

COMMENTS?

____

____

____

Appendix B

AIR FORCE INSTITUTE OF TECHNOLOGY
TECHNOLOGY TRANSITION SURVEY

The questionnaire is divided into four major parts. Part I ask for general background information, part II & III ask about mechanisms or organizations that facilitate or hinder transition, part IV ask general perceptions about transition, and part V ask for any comments.

Before every question a scale is provided to measure your response, please read the questions and circle the proper response for each question. Please feel free to make any comments that you feel necessary, on the questionnaire.

Part I: Background Information.

1. ORGANIZATION:

    1. WRDC (please specify which lab or directorate)
    2. ATF SPO
    3. ASD Engineering, co-located at the ATF SPO
    4. Contractor

2. RANK/GRADE____________
   If you work for a civilian company what is your title?

3. What is your highest educational level?

    1. High School
    2. Bachelor's degree
    3. Masters degree
    4. Doctorate degree

4. How many years have you worked for the government or company?

5. How many years have you been in your current position?

6. List other major organizations in which you worked within the last 10 years: (LABORATORY, CONTRACTOR, SPO, ETC.)

Part II. Which organizations and methods are the most effective in the technology transition process.

FOR EACH ITEM IN QUESTION 7 USE THE FOLLOWING SCALE TO INDICATE THE LEVEL OF EFFECTIVENESS.

EXTREMELY INEFFECTIVE	SOMEWHAT INEFFECTIVE	NEUTRAL	SOMEWHAT EFFECTIVE	EXTREMELY EFFECTIVE	UNFAMILIAR WITH THE ORGANIZATION
1	2	3	4	5	6

7. Please indicate the degree to which you believe that the following organizations are effective in moving technology from WRDC to the ATF SPO.

a.	WRDC	1	2	3	4	5	6
b.	ATF SPO	1	2	3	4	5	6
c.	ASD/XR	1	2	3	4	5	6
d.	ASD/Engineering	1	2	3	4	5	6
e.	ATF Contractor	1	2	3	4	5	6
f.	Using Command (TAC/DRB)	1	2	3	4	5	6
g.	SENTAR	1	2	3	4	5	6
h.	Other (Please Specify)	1	2	3	4	5	6

FOR EACH OF THE FOLLOWING ITEMS IN QUESTION 8, USE THE FOLLOWING SCALE TO INDICATE THE LEVEL OF HELPFULNESS OF EACH STATEMENT.

NOT HELPFUL AT ALL	NOT TOO HELPFUL	NEUTRAL	HELPFUL	VERY HELPFUL	UNFAMILIAR WITH THE MECHANISM
1	2	3	4	5	6

8. Please indicate, the degree to which you believe that each of the following mechanisms is/was helpful in moving the technology from WRDC to the ATF SPO.

a. The Contractor was allowed the freedom to choose the technology used in the design.	1	2	3	4	5	6
b. The Contractor was contractually required to use the latest technology through the RFP, SPECS, ETC.	1	2	3	4	5	6
c. The Using Command (TAC,ETC.) specified to AFSC the need for the technology.	1	2	3	4	5	6
d. The Contractor "pushed" the technology.	1	2	3	4	5	6
e. SPO management was "SOLD" on the technology. (WHO DID THE SELLING?__________________). (ORGANIZATION)	1	2	3	4	5	6
f. TAC management was sold on the technology. (WHO DID THE SELLING?__________________). (ORGANIZATION)	1	2	3	4	5	6
g. Engineering was "SOLD" on the technology. (WHO DID THE SELLING?__________________). (ORGANIZATION)	1	2	3	4	5	6
h. A technical report (TR) was written and mailed to the SPO.	1	2	3	4	5	6
i. Technology transition plans (TTP) were used.	1	2	3	4	5	6
j. ASD/XR was "SOLD". (WHO DID THE SELLING? __________________). (ORGANIZATION)	1	2	3	4	5	6
k. Formal presentations at TAC, AFLC, ASD/XR, HQ/AFSC, HQ/USAF. Please specify which organizations.	1	2	3	4	5	6

NOT HELPFUL AT ALL	NOT TOO HELPFUL	NEUTRAL	HELPFUL	VERY HELPFUL	UNFAMILIAR WITH THE MECHANISM
1	2	3	4	5	6

8 (cont). Indicate the degree to which you believe each of the following mechanisms is/was helpful in moving technology from WRDC to the ATF SPO.

l. A "ROAD SHOW" was presented to the ATF SPO. (Who put on the "ROAD SHOW"?____________________ (ORGANIZATION)).	1	2	3	4	5	6
m. Presentation of "Industry Day" to the ATF contractors.	1	2	3	4	5	6
n. The SENTAR panel was "SOLD" on the technology. (Who did the Selling? ____________________ (ORGANIZATION)).	1	2	3	4	5	6
o. The Contractor was "SOLD" on the technology. (Who did the selling? ____________________ (ORGANIZATION)).	1	2	3	4	5	6
p. Joint laboratory/product division working group.	1	2	3	4	5	6
q. The SENTAR panel "validated" technology maturity.	1	2	3	4	5	6
r. Laboratory personnel were assigned to the SPO for a short period.	1	2	3	4	5	6
s. There was frequent, informal personal contact between Lab and non-lab personnel.	1	2	3	4	5	6
t. Former employee of the laboratory being assigned permanently to the SPO.	1	2	3	4	5	6
u. The ATF unique transition process.	1	2	3	4	5	6
v. The acquisition strategy used in the ATF included a demonstration validation phase.	1	2	3	4	5	6
w. Other (PLEASE SPECIFY):	1	2	3	4	5	6

9. Pease list organization(s) that, in your opinion, was/were most instrumental in moving technology from WRDC to the ATF SPO.

Part III. Which organizations and methods impede the technology transition process.

FOR EACH ITEM IN QUESTION 10, USE THE FOLLOWING SCALE TO INDICATE THE LEVEL OF YOUR AGREEMENT OR DISAGREEMENT WITH EACH STATEMENT.

STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1	2	3	4	5

10. Please indicate your agreement with the following statements as to why technology <u>has not been</u> effectively transitioned to the ATF SPO.

a. The SPO was not informed of the technology.	1	2	3	4	5
b. The Using Command was resistant to the technology.	1	2	3	4	5
c. The SENTAR panel was resistant to the technology.	1	2	3	4	5
d. The technology was too costly.	1	2	3	4	5
e. The "NOT INVENTED HERE" syndrome.	1	2	3	4	5
f. SPO was informed but was resistant to the change.	1	2	3	4	5
g. Technology was insufficiently proven in terms of technical risk.	1	2	3	4	5
h. Technology was insufficiently proven in terms of cost risk.	1	2	3	4	5
i. Technology was insufficiently proven in terms of schedule risk.	1	2	3	4	5
j. The Contractor was resistant to change.	1	2	3	4	5
k. ASD/YF engineers were not informed of the technology.	1	2	3	4	5
l. ASD/YF engineering was informed but was resistant to the change.	1	2	3	4	5
m. The fear of failure inhibited transition.	1	2	3	4	5
n. The contractor was not aware of technology.	1	2	3	4	5
o. There was insufficient time, staff or funding to incorporate the technology.	1	2	3	4	5

STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1	2	3	4	5

10 (cont). Please indicate your agreement with the following statements as to why technology has not been effectively transitioned to the ATF SPO.

p.	The technology was not cost effective.	1	2	3	4	5
q.	The Contractor was not sold on the technology.	1	2	3	4	5
r.	Other (please specify)	1	2	3	4	5

Part IV General Perceptual Data

FOR EACH ITEM IN QUESTION 11, USE THE FOLLOWING SCALE TO INDICATE THE LEVEL OF EFFECTIVENESS OR INEFFECTIVENESS OF EACH ITEM.

NOT EFFECTIVE AT ALL	NOT TOO EFFECTIVE	NEUTRAL	EFFECTIVE	VERY EFFECTIVE
1	2	3	4	5

11. Please indicate the degree to which each of the following mechanisms, in your opinion, is/was effective in specifying the technology requirements of the ATF to the laboratories.

a.	Technology need (TN) documents.	1	2	3	4	5
b.	Technical Area Plans (TAPs), Mission Area Plans (MAPs)	1	2	3	4	5
c.	Lab/SPO technology working groups.	1	2	3	4	5
d.	Program management directive (PMD).	1	2	3	4	5
e.	Laboratory/Using Command personal interface.	1	2	3	4	5
f.	Laboratory/ASD engineering personal interface.	1	2	3	4	5
g.	Laboratory/SPO personal interface.	1	2	3	4	5
h.	The Using Command Statement of Need (SON).	1	2	3	4	5
i.	ATF SPO prioritization of WRDC programs.	1	2	3	4	5
j.	SENTAR Panel	1	2	3	4	5

FOR EACH ITEM IN QUESTION 12, USE THE FOLLOWING SCALE TO INDICATE THE LEVEL OF IMPORTANCE AND FREQUENCY OF CONTACT.

IMPORTANCE SCALE

NOT AT ALL IMPORTANT	NOT TOO IMPORTANT	NEUTRAL	IMPORTANT	VERY IMPORTANT
1	2	3	4	5

FREQUENCY SCALE

NEVER	ALMOST NEVER	NEUTRAL	ALMOST ALWAYS	ALWAYS
1	2	3	4	5

12. When you need technical advice or information on the latest technology, how important are the following organizations as sources of information? Also indicate the frequency of contacts per month.

		IMPORTANCE	FREQ. OF CONTACT
a.	WRDC	1 2 3 4 5	1 2 3 4 5
b.	ASD Engineering	1 2 3 4 5	1 2 3 4 5
c.	ASD SENTAR Panel	1 2 3 4 5	1 2 3 4 5
d.	Other AFSC Laboratory	1 2 3 4 5	1 2 3 4 5
e.	Contractor/Vendor	1 2 3 4 5	1 2 3 4 5
f.	University	1 2 3 4 5	1 2 3 4 5
g.	ASD/XR	1 2 3 4 5	1 2 3 4 5
h.	Other ASD SPO	1 2 3 4 5	1 2 3 4 5
h.	Other (please specify)	1 2 3 4 5	1 2 3 4 5

FOR EACH ITEM IN QUESTION 13, USE THE FOLLOWING SCALE TO INDICATE THE LEVEL OF YOUR AGREEMENT OR DISAGREEMENT WITH EACH STATEMENT.

STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1	2	3	4	5

13. Indicate your agreement with the following general statements concerning technology transition (NOT JUST ATF RELATED).

a. The Product Divisions keep abreast of current laboratory research.	1 2 3 4 5
b. Product Divisions are enthusiastic about using new technology.	1 2 3 4 5
c. Product Divisions have mainly short-term technology needs.	1 2 3 4 5
d. The Product Divisions are so success oriented, they can not do real R&D.	1 2 3 4 5
e. Mechanisms for transitioning technology are clearly defined and easy to use.	1 2 3 4 5
f. The AFSC laboratories are doing a good job of developing the needed technology.	1 2 3 4 5
g. The technology developed by the laboratories is usually timely.	1 2 3 4 5
h. Laboratories need to have a long term focus.	1 2 3 4 5
i. Product Divisions accept contractor offered technology before lab offered technology.	1 2 3 4 5
j. The SENTAR panel has helped the transition process.	1 2 3 4 5
k. Willingness to accept risk is important for successful technology transition.	1 2 3 4 5
l. IR&D develops more useful technology than the lab programs.	1 2 3 4 5

Part V. Please comment on any aspect of the technology transition process that you feel pertains to this study.

Thank you for your help. Please return this questionnaire in the enclosed envelope to Capt Jim Gummere, AFIT/LS, WPAFB OH 45433-6503.

Appendix C

Questionnaire Validation

Name:

Organization:

Please indicate the level to which you feel each question pertains to the study of the technology transition process from WRDC to the ATF SPO. Make any comments concerning that question in the space provided between the questions or in the general comments section at the end of each part.

not relevant	relevant	highly relevant
1	2	3

Part II. **Which organizations and methods were the most effective in the technology transition process.**

Question 7 1 2 3

Question 8

a. 1 2 3

b. 1 2 3

c. 1 2 3

d. 1 2 3

e. 1 2 3

f. 1 2 3

g. 1 2 3

h. 1 2 3

What organizations do you feel are effective in moving technology from the laboratory to the SPOs.

Please indicate the level to which you feel each question pertains to the study of the technology transition process from WRDC to the ATF SPO. Make any comments concerning that question in the space provided between the questions or in the general comments section at the end of each part.

not relevant	relevant	highly relevant
1	2	3

<u>Question 9</u>

a. 1 2 3

b. 1 2 3

c. 1 2 3

d. 1 2 3

e. 1 2 3

f. 1 2 3

g. 1 2 3

h 1 2 3

i 1 2 3

j. 1 2 3

k. 1 2 3

l. 1 2 3

m. 1 2 3

Please indicate the level to which you feel each question pertains to the study of the technology transition process from WRDC to the ATF SPO, and make any comments concerning that question in the space provided between the questions.

not relevant	relevant	highly relevant
1	2	3

Question 9 continued

n. 1 2 3

o. 1 2 3

p. 1 2 3

q. 1 2 3

r. 1 2 3

s. 1 2 3

t. 1 2 3

u. 1 2 3

What mechanisms do you feel are most effective means of enhancing technology transition from the lab to the SPO?

Please indicate the level to which you feel each question pertains to the study of the technology transition process from WRDC to the ATF SPO, and make any comments concerning that question in the space provided between the questions.

not relevant	relevant	highly relevant
1	2	3

Question 10 1 2 3

General comments on part II:

Part III. Which organizations and methods impeded the technology transition process.

Question 11 1 2 3

Question 12

a. 1 2 3

b. 1 2 3

c. 1 2 3

d. 1 2 3

e. 1 2 3

f. 1 2 3

g. 1 2 3

h. 1 2 3

i. 1 2 3

j. 1 2 3

k. 1 2 3

l. 1 2 3

Indicate the level to which you feel each question pertains to the study of the technology transition process from WRDC to the ATF SPO, make any comments in the space provided between the questions, or in general comments section at the end of part III.

not relevant	relevant	highly relevant
1	2	3

m. 1 2 3

n. 1 2 3

o. 1 2 3

p. 1 2 3

q. 1 2 3

General comments on Part III

Part IV. General Perceptual Data

Question 13

a. 1 2 3

b. 1 2 3

c. 1 2 3

Indicate the level that you feel each question pertains to the technology transition process from WRDC to the ATF SPO, make any comments in the space provided between the questions, or in general comments section at end of the section IV.

not relevant	relevant	highly relevant
1	2	3

f. 1 2 3

g. 1 2 3

h. 1 2 3

i. 1 2 3

j. 1 2 3

What do you feel is the most effective way of specifying technologies to the laboratories.

Question 14

a. 1 2 3

b. 1 2 3

c. 1 2 3

d. 1 2 3

e. 1 2 3

f. 1 2 3

g. 1 2 3

Please indicate the level to which you feel each question pertains to the study of the technology transition process from WRDC to the ATF SPO, and make any comments concerning that question in the space provided between the questions.

not relevant	relevant	highly relevant
1	2	3

Question 15

a. 1 2 3

b. 1 2 3

c. 1 2 3

d. 1 2 3

e. 1 2 3

f. 1 2 3

g. 1 2 3

h. 1 2 3

i. 1 2 3

j. 1 2 3

k. 1 2 3

l. 1 2 3

What other aspects of technology transition do you feel is important to this study?

General Comments on Part IV

Please make any comments you feel would help in the study of the technolcgy transition process from WRDC to the ATF SPO.

THANK YOU FOR YOUR COOPERATION AND TIME. PLEASE RETURN TO CAPT JIM GUMMERE AFIT/LSG.

Appendix D

SURVEY VALIDATION RESULTS

QUEST	MEAN	S.D.	SAM. SIZE	MEDIAN	MINIMUM	MAXIMUM
8E	3	0	6	3	3	3
8G	3	0	5	3	3	3
11C	2.833	0.4082	6	3	2	3
7E	2.833	0.4082	6	3	2	3
8A	2.833	0.4082	6	3	2	3
8D	2.833	0.4082	6	3	2	3
8B	2.667	0.8165	6	3	1	3
10D	2.667	0.5164	6	3	2	3
10G	2.667	0.5164	6	3	2	3
10H	2.667	0.5164	6	3	2	3
10I	2.667	0.5164	6	3	2	3
13G	2.667	0.5164	6	3	2	3
13K	2.667	0.5164	6	3	2	3
7A	2.667	0.5164	6	3	2	3
8S	2.667	0.5164	6	3	2	3
9	2.667	0.5164	6	3	2	3
10P	2.6	0.5477	5	3	2	3
12E	2.6	0.5477	5	3	2	3
7B	2.6	0.5477	5	3	2	3
8P	2.6	0.5477	5	3	2	3
10R	2.5	0.5774	4	2.5	2	3
10J	2.5	0.5477	6	2.5	2	3
11D	2.5	0.5477	6	2.5	2	3
11F	2.5	0.5477	6	2.5	2	3
11G	2.5	0.5477	6	2.5	2	3
13A	2.5	0.5477	6	2.5	2	3
13B	2.5	0.5477	6	2.5	2	3
13E	2.5	0.5477	6	2.5	2	3
13F	2.5	0.5477	6	2.5	2	3
7D	2.5	0.5477	6	2.5	2	3
8O	2.5	0.5477	6	2.5	2	3
10Q	2.4	0.5477	5	2	2	3
12A	2.4	0.5477	5	2	2	3
12B	2.4	0.5477	5	2	2	3
12G	2.4	0.5477	5	2	2	3
8F	2.4	0.5477	5	2	2	3
8L	2.4	0.5477	5	2	2	3
8P	2.4	0.5477	5	2	2	3
8W	2.4	0.5477	5	2	2	3
(del)	2.333	0.8165	6	2.5	1	3
11B	2.333	0.8165	6	2.5	1	3
13L	2.333	0.8165	6	2.5	1	3
10A	2.333	0.5164	6	2	2	3
10E	2.333	0.5164	6	2	2	3
10F	2.333	0.5164	6	2	2	3
10K	2.333	0.5164	6	2	2	3
10L	2.333	0.5164	6	2	2	3
10O	2.333	0.5164	6	2	2	3
11A	2.333	0.5164	6	2	2	3

11E	2.333	0.5164	6	2	2	3
11H	2.333	0.5164	6	2	2	3
13H	2.333	0.5164	6	2	2	3
13J	2.333	0.5164	6	2	2	3
8I	2.333	0.5164	6	2	2	3
8R	2.333	0.5164	6	2	2	3
(del)	2.25	0.8803	6	2.5	1	3
13I	2.25	0.6124	6	2	1.5	3
8K	2.2	0.8367	5	2	1	3
12F	2.2	0.4472	5	2	2	3
7C	2.2	0.4472	5	2	2	3
8J	2.2	0.4472	5	2	2	3
8N	2.2	0.4472	5	2	2	3
8V	2.2	0.4472	5	2	2	3
10B	2.167	0.7528	6	2	1	3
10C	2.167	0.7528	6	2	1	3
10M	2.167	0.7528	6	2	1	3
13C	2.167	0.4082	6	2	2	3
7G	2.167	0.4082	6	2	2	3
7H	2.167	0.4082	6	2	2	3
8H	2.167	0.4082	6	2	2	3
8T	2.167	0.4082	6	2	2	3
7F	2.1	0.5477	5	2	1.5	3
12C	2	0.7071	5	2	1	3
8C	2	0.7071	5	2	1	3
13D	1.833	0.7528	6	2	1	3
12D	1.8	0.8367	5	2	1	3

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This study examined the technology transition process at the Aeronautical Systems Division between the Wright Research and Development Center (WRDC), and the Advanced Tactical Fighter Systems Program Office (ATF SPO) at Wright Patterson AFB OH. Four groups were surveyed, they included: WRDC, ATF SPO, ASD engineering, and defense contractors. Five Investigative Questions guided the research:

(1) How has the operating command contributed in the development and transition of technology? (2) How well have the official and unofficial technology transition processes worked as perceived by laboratory, SPO, EN, and contractor personnel? (3) What organizations are considered important sources of information on new technology, and what is the frequency of contact with those organizations? (4) What influence is the contractor perceived to have on the success or failure of moving technology from WRDC to the ATF SPO? (5) Is the perceived risk of new technology by the SPO a significant barrier in the transition process? Theses. (SLW)

The study found that the using command was perceived important in the transition process, despite having no official involvement. The formal mechanisms and processes were not generally rated as effective, while the informal methods received an "effective' rating. There was a barrier identified in the general communications patterns between WRDC and the SPO, as well as WRDC and the product division engineering. Contractors were perceived to have a significant impact on transition. Respondents agreed that acceptance of risk was important to successful transition, and risk aversion by the SPO was considered a barrier only by WRDC.

This study recommended a number of changes to the Senior Engineering Technology Assessment Review (SENTAR), including informing and involving contractors. General recommendations were made based upon the study that included mechanisms to improve the working relationships between EN and WRDC.