3-2003

Towards a Framework for Understanding Innovation Implementation in the Air Force

Howard E. Byrd Jr.

TOWARDS A FRAMEWORK FOR UNDERSTANDING INNOVATION IMPLEMENTATION IN THE AIR FORCE

Howard E. Byrd, Jr., Captain, USAF

AFIT/GAQ/ENS/03-01

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U.S. Government.

AFIT/GAQ/ENS/03-01

TOWARDS A FRAMEWORK FOR UNDERSTANDING INNOVATION IMPLEMENTATION IN THE AIR FORCE

THESIS

Presented to the Faculty

Department of Systems Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Strategic Purchasing

Howard E. Byrd Jr., BS

Captain, USAF

March 2003

AFIT/GAQ/ENS/03-01

TOWARDS A FRAMEWORK FOR UNDERSTANDING INNOVATION IMPLEMENTATION IN THE AIR FORCE

Howard E. Byrd, Jr., BS
Captain, USAF

Approved:

//Signed//	12 Mar 03
Stephan P. Brady, Lt Col, USAF (Chairman)	Date
//Signed//	13 Mar 03
Timothy S. Reed, Maj, USAF (Member)	Date
//Signed//	13 Mar 03
Dr. Alan Heminger, Associate Professor (Member)	Date

Acknowledgements

I would like to take this opportunity to thank all who have assisted me in the writing of this thesis. I would like to thank my advisor Lt Col Stephan Brady who provided guidance, answers and encouragement throughout my efforts. Additionally, I would like to thank the other members of my committee Dr. Alan Heminger and Maj Timothy Reed for their support and guidance. A special thanks goes to those who took time out of their busy schedules to assist in answering my interview questions.

Next, I would like to thank the AFMC ACE for their assistance and support in this effort. Finally, but certainly not least, I must thank my wife and son. They both have provided the strength and support needed to complete this arduous task of writing a thesis.

Howard E. Byrd, Jr.

Table of Contents

Page

Page

List of Figures

FIGURE Page

List of Tables

TABLE Page

Abstract

Innovation is a major way organizations deal with changes in their competitive environment. The Department of Defense (DoD) too is facing incredible changes and challenges within its competitive environments. This situation is requiring the adopting and implementing of many new innovations in an effort to transform the forces to meet the challenges. A key component of the DoD's efforts to transform is in Air Force acquisition and sustainment processes. Digital technical orders are an example of such a sustainment process. The Air Force has mandated it will transform from a paper based technical data environment to a digital one. The success of the implementing such transformational innovations such as digital technical orders is critical to the Air Force's ability to support the overall DoD force transformation efforts. Despite the critical need for successful innovation implementation few studies are found exploring factors that facilitate innovation within DoD, or the Air Force.

A framework to examine such factors could assist the Air Force and DoD in their innovation implementation efforts. This thesis explores the usefulness of Innovation Diffusion Theory as such a framework. More specifically, this researcher's goal is to assess the implementation of a transformational innovation of digital technical orders within the context of Innovation Diffusion Theory. This thesis explores current and recent digital technical order implementation efforts.

TOWARDS A FRAMEWORK FOR UNDERSTANDING INNOVATION IMPLEMENTATION IN THE AIR FORCE

I. INTRODUCTION

Overview

With the advent of a new threat landscape the Department of Defense (DoD) is required to adopt and implement new and transformational innovations. The Air Force is not immune from these efforts. Despite the obvious need and motivation driving these efforts little or scant research could be found addressing the process of innovation in the DoD or the Air Force. Further, current research in the field outside of DoD points to the implementation stage of the innovation process as a key-inhibiting factor in many cases. The focus of this research will be to explore the implementation stage of a transformational innovation (digital technical orders) within the Air Force. The study will seek to do so within the framework of Innovation Diffusion Theory. The outcome will ideally yield a better understanding of the implementation stage of innovation within the Air Force. The researcher seeks to provide some insight towards a framework highlighting key aspects of implementation to be used for future implementation efforts.

This chapter begins this effort by highlighting that organizations depend on their ability to innovate to deal with an ever changing operating landscape and ultimately sustain their very survival. The chapter then explains that this research will seek to facilitate the Air Force in implementing innovations as an imperative component of the DoD's ability to maintain a military edge over enemies. The chapter continues with an

outlining of the research objectives to be accomplished by this study, a statement of the problem to be addressed, and the investigative questions the study will seek to answer. Several definitions key to understanding the research are then presented. An outline of the qualitative case study methodology employed to fulfill the research objectives is then introduced followed by the limitations of this type of research. Finally, the anticipated contribution is presented. The chapter concludes with a snapshot of the remainder of the following chapters of the thesis.

Background

Commercial firms are dealing with dramatic increases in competition, technological turbulence, and uncertainty in a quickly evolving business landscape (McGrath & MacMillan, 2000). Successful innovation adoption as a means to deal with this landscape is key to a firm's survival and competitive advantage (Damanpour & Evan, 1984). The importance of firms' acquisition and sustainment processes has made them a focus of fundamental change. There is clear evidence in the prevalent movement to supply-chain integration, supplier alliances, just-in-time inventories, e-commerce and other present-day business methods necessitating fundamental changes in acquisition and sustainment processes.

The Department of Defense (DoD) has been forced to respond to comparable types of changes in its environment: newly emerging asymmetric threats, technological advancements, and uncertainty. These factors have made it necessary for DoD to "Transform". This was the case even prior to September 11th but post September 11th the urgency to respond to these changes and threats through transformation has taken on greater importance. This urgency was stressed in comments by Secretary of Defense

(SECDEF) Donald Rumsfeld when he challenged the Armed Forces and the department that serves them "to put aside their comfortable ways of thinking and planning, take risks and try new things to prepare our forces to deter and defeat adversaries that have not yet emerged…" (Rumsfeld, 2002). Throughout this same speech, Secretary Rumsfeld alluded to DoD's need for concepts, ideas, weapon systems, and processes that are fundamentally different from those used today. These fundamentally different ideas, systems, and processes constitute radical or transformational innovations.

Just as the commercial sector has realized the strategic importance of acquisition and sustainment processes to their competitive survival and success, so too has the DoD. "Recently, we find that acquisition and sustainment has been achieving an increasing level of strategic importance in the DoD" (Nissen, 2001:2). Nissen (1998) asserts the military began to realize how these processes could constrain battlefield performance during the Gulf War. Within the Air Force specifically, these areas have received greater attention as constraints to warfighter effectiveness and have become prime targets for the transformational innovations called for by all levels of the DoD and Air Force.

Importance of Research

AFMC has nine top-level mission objectives (AFMC, 2002):

- Product Support
- Information Services
- Supply Management
- Depot Maintenance
- Science and Technology
- Test and Evaluation
- Information Management
- Installations and Support
- Combat Support

These mission objectives make AFMC a critical component in the Air Force's ability to successfully transform. Many of the concepts, ideas, systems, and processes will be

generated, acquired and implemented within AFMC. Of particular importance will be implementation of selected transformational processes to satisfy mission requirements.

One such implementation effort is the move from paper based technical orders (TOs) to digital TOs for which AFMC has been designated the lead command. The down sizing of budgets and personnel, along with the ill effects caused to the warfighter due to the inefficiencies of managing the TO system, led the Air Force to establish a Technical Order Vision in 2000 (CONOPS, 2002). The ultimate goal of this vision is a transition from a cumbersome paper based system to one fully maintained digitally (CONOPS, 2002). "To transition successfully to this digital end-state, significant cultural and process changes will be required" (CONOPS, 2002). The Air Force Technical Order Concept of Operations (CONOPS) provides a plan of how the Air Force expects to reach its vision of: "All Technical Order users being provided quality, up-to-date, technically accurate, and user-friendly Technical Orders at an acceptable price" (CONOPS, 2002).

A research framework with the ability to capture the elements leading to the successful or unsuccessful creation, adoption, and implementation of such an innovation as digital tech orders and others could prove helpful. Moreover, the ability to study various innovations within a common framework could lead to better processes for diffusing innovations within which adoption and implementation are included.

For years the theory of innovation diffusion has provided researchers a framework in which to study the adoption and implementation of various innovations. Further, Diffusion Theory has been used to help explain the factors that affect innovation from their formulation, adoption, and implementation in agriculture, corporations, government, education, etc.

Despite the variety of study environments, no research could be found studying innovations in either DoD or the Air Force within the context of Diffusion Theory specifically. Though studies were found providing analysis of the success or failure of particular innovations within the DoD and Air Force the studies did not use the same terminology or framework making the comparability of the works difficult.

Utilizing Diffusion Theory to examine innovation in the Air Force would provide a common framework and terminology needed to understand the facilitating factors of successful innovations within the organization. This understanding is particularly important as the Air Force attempts to transform through the implementation of various product and process innovations. Further the literature suggests that much of the diffusion research has focused on adoption and less so on implementation. The omission of implementation neglects what many in the field such as Klein and Sorra (1999) feel is the key stage of a successful innovation diffusion process. This research seeks to address the gap left by a lack of Diffusion Theory in Air Force research and to add to the Diffusion Theory research body of knowledge through a focus on implementation.

Problem Statement

After September 11th the need for change in all areas of DoD including acquisition has become more pressing. The issue of has drawn much attention at all levels of the department that there is a need for the DoD to adopt and implement new and transformational innovations. However, the idea is not new. Under the guise of acquisition reform the Air Force has been, and continues to be, required to implement innovations. The result of these attempts is a system that continues to "plague the Defense System and constrain battlefield mobility, information and speed" (Nissen

Snyder and Lamm, 89: 1998). There has been a mandate that the DoD will change itself through transformational innovation, but how will it happen? Such change requires a huge amount of new knowledge and as Nissen (1998) asserts, research is the most neglected of all the forms of knowledge sources in DoD acquisition. Innovation Diffusion Theory has provided a framework to provide such knowledge of innovation efforts outside of DoD. The purpose and objective of this effort is to assess the theory's feasibility for use within DoD to evaluate innovation implementation specifically, in the Air Force's efforts to digital TOs. Using Diffusion Theory research and focusing on the antecedents of effective innovation implementation to study the digital TOs innovation may provide insight into future innovation implementation efforts within the Air Force imperative to transformation.

Definition of Key Terms

Innovation-The adoption of an internally generated or purchased device, system, policy, program, process, product or service that is new to the adopting organization (Damanpour, 2001).

Transformation-Defined by the Air Force as fundamental change involving three principal elements and their interactions with one another: 1) advanced technologies 2) new concepts of operation 3) organizational change (Deptula, 2001).

Acquisition Process-The process that pertains to the strategy, planning, procurement, contracting, program management, logistics, and other activities that are required to develop, produce, and support systems and other material to accomplish the mission of an enterprise (Nissen, 1998:90).

Process Innovation-Those that improve organizational means of turning inputs into outputs (Damanpour, 1988).

Innovation Adoption-The decision to make full use of an innovation as the best course of action (Rogers, 1995).

Innovation Diffusion -The process by which a new idea is communicated through certain channels over time among the members of a social system (Rogers, 1995).

Diffusion Theory- A theory that purports to describe the patterns of adoption, explain the mechanism, and assist in predicting whether and how a new innovation will be successful.

Investigative Questions

The following investigative questions look for answers to meet the objectives of this thesis:

1. What are the major tenants of Diffusion Theory?
2. What factors are identified in the literature as antecedents to effective innovation implementation?
3. What do implementers of innovations identify as characteristics of innovation implementation within the Air Force?

Methodology

To support the objectives outlined this research will use primarily a qualitative methodology. An examination of relevant literature will be conducted to establish a theoretical basis. Additional data will be gathered through the examination of secondary

data, and interviews with key informants in organizations at different stages of digital TO implementation. The data will then be analyzed using pattern-matching techniques to identify themes and trends common to the implementation efforts studied. A comparative analysis will be conducted between the collected data and the theory to determine the strength and validity of the findings.

Scope and Limitations of the Research

The research effort presents some limitations. The use of the case study methodology limits specific findings to the cases under study. This fact does not preclude these findings from being generalized beyond these cases. The aim is to provide ideas of how better to carry out the implementation phase of innovation diffusion based in the case findings and theory. With that aim this research could serve to focus more attention on implementation during future transformational innovation efforts within and outside the Air Force.

Anticipated Contribution

The literature suggests that innovation implementation is how an organization adapts to its environment, or preempts changes within its environment, in order to increase or sustain competitiveness (Damanpour, 2001). For an innovation to be successful it must go beyond initiation to implementation, diffusion is the process by which this occurs. Additionally, the literature advocates that understanding the characteristics of innovations as well as the characteristics of the adopting organization can facilitate successful implementation. Secretary Rumsfeld has identified the necessity for the DoD to adopt both transformational product and process innovations. As Rogers

(1995) and Gopalakrishnan and Damanpour (1997) posit, the innovation process can only be considered a success to the extent that the innovation is accepted and integrated into the organization. This occurs during implementation.

The current acquisition and sustainment processes in the Air Force are among the strategically important targets for transformational innovation. By examining the implementation of digital TOs the contributions of this research may help facilitate the successful implementation of additional necessary transformational innovations necessary within the Air Force.

Organization of the Study

Chapter II provides a synopsis of the literature review conducted for the research effort. Topics addressed include the definition of innovation, a brief overview of the tenants of Innovation Diffusion Theory, innovation types, and briefly competing theory. The chapter then focuses on the works of Everett Rogers, Katherine Klein, and Joanne Sorra. This section seeks to construct the theoretical basis for the study. Finally the chapter briefly outlines the innovation to be studied, digital TOs. Though important the focus of this effort is the implementation efforts not the technical intricacies of the innovation thus, the discussion of this area is less robust. Chapter III outlines the research methodology and includes background to the development of the interview instrument, the process of data collection, and the data analysis techniques. Chapter IV presents the analysis of the collected data and a discussion of the results. The final chapter contains the conclusions drawn from the data analysis and provides practitioner recommendations as well as recommendations for possible future research.

II. LITERATURE REVIEW

Introduction

The theoretical basis of this research effort will be grounded in Innovation Diffusion Theory. The literature revealed many research efforts dealing with innovation adoption. However, the literature suggested that current research is revealing innovation implementation as the cause for many innovation failures. Despite this, research dealing with the determinants of innovation implementation has only recently begun to receive serious attention. Moreover, literature discussing innovation in Air Force organizations within the contexts of Diffusion Theory could not be found. The focus of this research will be to bridge this gap in the literature.

This research seeks to further Everett Rogers' innovation decision model by focusing on the implementation stage of the innovation diffusion process. This review will seek to first give a general overview of Innovation Diffusion Theory by exploring the following areas: innovation, innovation type, and Innovation Diffusion Theory. Secondly, the review will provide context for the research model by investigating the determinants of innovation implementation. Finally, the review will give a brief overview of the innovation of interest in this study the Air Force Technical Order system and the need for innovation within that system.

Innovation

According to Damanpour, (2001) innovation in the context of organizations is "the way an organization adapts to the environment, or pre-empts changes within its

environment, in order to increase or sustain competitive advantage" (Damanpour, 2001:47). What specifically are these "ways" of adaptation and pre-emption? Rogers posits that innovation is "an idea, practice, or object, that is perceived as new by an individual or unit of adoption" (Rogers, 1995:11).

Rogers' is but one of many innovation definitions found in the literature. Perhaps more appropriate for the purposes of this research, "innovation" is defined as: "the adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization" (Damanpour, 1991:556). This definition allows the researcher to focus more on the innovation rather than being restricted to only the process to create or adopt the innovation.

Innovation in Bureaucracies

As researchers such as Klein (2002) and Lloyd (1998) point out change in the context of a bureaucratic organization is unique. These organizations display a high level of a paradoxical relationship between needing to innovate to survive and yet resisting change. Complex structures, multiple layers, and more importantly unique cultures and values systems characterize these organizations. By definition a bureaucracy is designed to standardize activities to allow an organization to be more efficient. This standardization can hamper innovation. Innovation by nature is usually synonymous with change and some level of risk. The culture of the government is described by Klein (2002) as filled with employees that are adverse to risk and the environment of innovation and with managers that build consensus, not radical persistent change.

Klein (2002) explores the issues found in bureaucratic organizations trying to implement process innovation. Two key points critical to this research are the fact that all decisions in bureaucratic organizations must pass through widespread scrutiny, and that members are risk and change adverse.

Klein and Sorra (1996) explore the effects of the multiple layers found in a bureaucratic organization. They posit that differences in the perceptions of an innovation at different levels of an organization can have adverse effects on the success of the innovation (Klein and Sorra, 1996: 1064). Further, Damanpour (1991 & 1996) explored the moderating effects of organizational structure on innovation in organizations. Among other factors complexity and size are two variables Damanpour (1991 & 1996) found that in fact have a moderating effect on innovation in organizations. It is important to note that these variables tend to increase with bureaucratic organizations.

Classification of Innovation Types

Essential to understanding diffusion of innovation theory is recognizing the different classifications of innovations. Downs and Mohr (1979) point out "not all types of innovations have the same attributes or implementation characteristics." Further a number of studies within the field have investigated the effects of innovation type (Damanpour, 1991, 1996, 2001; Sciulli, 1998; De Propris, 2000). Prevalent in the literature are three distinct pairs of innovations types: radical and incremental, technical and administrative, and product and process. It is important to note that although these pairs facilitate the researcher in evaluating innovation characteristics, a particular innovation may encompass a combination of the three pairs.

Radical (Transformational)/Incremental. Innovations can be classified by the degree of change they seek to implement to an existing product, practice, or process within an organization (Damanpour, 1991:561). Radical or transformational innovations are those that seek to initiate fundamental departure from current projects, products, or procedures of organizations. De Propris (2000) citing Freeman and Perez (1998) states that radical innovations are discontinuous events, which are the result of a deliberate research and development activity. Conversely, incremental innovations are those that seek smaller scale departures from existing organizational practices (Damanpour, 1988:550). "Incremental innovations emphasize the importance of economies of scale and do not result in noticeable changes in product or process" (Sciulli, 1998:14).

Technical/Administrative. Technical innovations are those that pertain primarily to products, services, and production process advancements within an organization, and they are related to the basic work activity of the organization (Damanpour, 1988:548). Administrative innovations are those that deal with the organizational structure. Damanpour, Szabat, and Evan (1989) describe administrative innovations "as those that occur in the administrative component and affect the social system of an organization". Abrahamson (1991) furthers Damanpour's definition of administrative innovation as structural and cultural changes that organizations prescribe for mediating between organizational inputs and outputs.

Product/Process. Product innovations are improved or new products, equipment, or services introduced to meet an external user or market need (Damanpour, 2001: 47). Process innovations are those that improve organizational process. They introduce new elements into organizational operations to support the production of a product or service

(Damanpour, 2001; Ettlie and Reza, 1992). These innovations often require the leveraging of technology to improve the efficiency of product development or use (Ettlie and Reza, 1992).

Innovation Diffusion Theory

The field of Innovation Diffusion Theory investigates the mechanisms of how and why an innovation is successful. Diffusion research can be found in numerous fields of study including anthropology, sociology, education, public health, communication, marketing, and geography. Innovation Diffusion Theory began with investigations of development programs in agriculture, family planning, public health, and nutrition in developing countries (Rogers, 1995: xvii). Research specifically utilizing Diffusion Theory has been conducted for over fifty years. During this time, the theory has expanded to study the spread of new technologies such as the Internet and corporate strategies such as business process reengineering. However, a review of the extant literature revealed no "general theory" of innovation diffusion. A cause for the lack of an "accepted" theory may be the sheer number of "research traditions" or fields represented in diffusion research. Researchers such as Downs and Mohr (1976) note this in their criticisms of diffusion research.

A primary objective in this field of study as it relates to organizations is to specifically identify the innovation characteristics, organizational characteristics, and the external influences that affect innovations and their success or failure. As with any research field, there are a number of competing hypotheses such as Critical Mass (Oliver, Marwell, and Teixeira, 1985), Fads and Fashions (Abrahamson, 1991), and Bandwagons

(Abrahamson & Rosenkropf, 1993) to name a few. Though their approaches differ, they all seek to provide explanation for why particular innovations fail or succeed.

Innovation Decision Process Model

In the fourth edition of his seminal work *Diffusion of Innovations* Rogers synthesizes a half a decade of diffusion research. He provides a comprehensive picture of innovation diffusion while also highlighting shortfalls of his theory and past research. In this work Rogers captures many of the relevant aspects of existing theories to construct a detailed model of how an innovation diffuses through an organization. Four key aspects of Rogers' theory are characteristics of the innovation itself, communication channels through which the innovation is spread, the characteristics of the diffusing social system, and how time effects the innovation. Though Rogers primarily addresses these aspects in terms of the adoption of innovations, the primary focus of this research will be to examine these aspects in the implementation stage of Rogers' process model. The aspects of particular of note to this research are the innovation's characteristics, characteristics of the social system, and the effects of time on the innovation.

Rogers' model is called the "Innovation Decision Process" (Rogers, 1995:163) (Figure 1). Rogers' definition and model are grounded in the notion "that innovation diffusion is how a new idea is communicated through certain channels over time among the members of a social system" (Rogers, 1995:5). The characteristics of the innovation and diffusing social system as well as communication and effects of time on the innovation determine the success of each of the stages of Rogers' model.

Many scholars of Diffusion Theory including Hall (1973) and Frambach and Schillewaert (2002), purport that innovation and change within an organization is not instantaneous but is in fact a process and Rogers' model accounts for this. Rogers posits that there are five stages of the process:

Knowledge: When the decision-making unit learns of an innovation's existence and gains some understanding of how it functions.

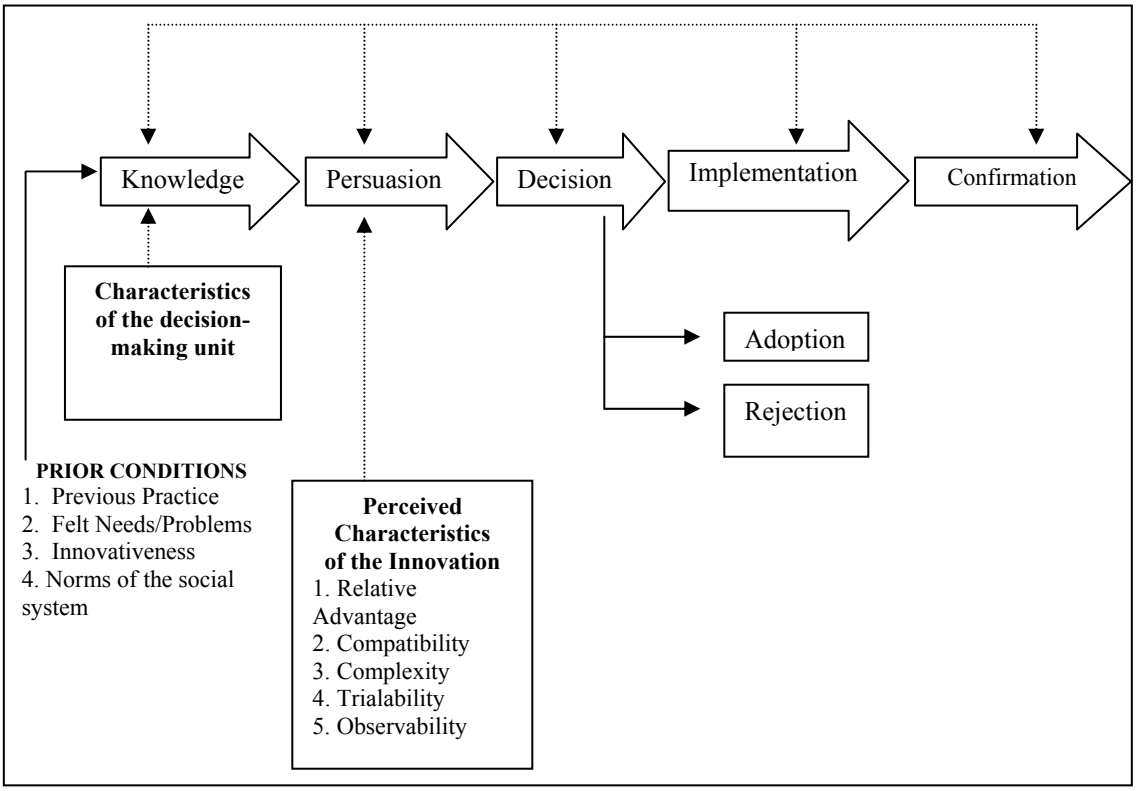
Persuasion: When the decision-making unit forms a favorable or unfavorable attitude toward the innovation.

Decision: When the decision-making unit engages in activities that lead to a choice to adopt or reject the innovation.

Implementation: When the decision-making unit puts an innovation to use.

*Confirmation***:** When a decision-making unit seeks reinforcement of an innovation decision that has been made.

Figure 1. Innovation Decision Process Model



The first three stages of the model deal primarily with the organization's decision to adopt an innovation. The decision to adopt or reject a particular innovation can fall into three categories optional innovation decisions, collective innovation decisions, and authority innovation decisions (Rogers, 1995:29). In both the optional and collective adoption cases organizational members (users) have direct input into the adoption decision.

However, in the case of authority adoption decisions the first three stages of the process (knowledge, persuasion, and decision) are accomplished primarily by those in leadership positions (Rogers, 1995:29). Users of such innovations are still required to carryout the implementation process despite the lack of adoption input. Innovation implementation effectiveness is a key concern in authority adoption decisions. Further,

as Damanpour's 1991 meta-analysis illustrates there have been many research efforts dealing with the determinants of innovation adoption. Despite the numerous efforts pertaining to adoption, there are a relative few dealing with the determinants of innovation implementation (Klein and Sorra, 1996:1056).

Determinants of Innovation Implementation

This lack of research in the implementation area of the diffusion model is very important. Increasingly, researchers in the field point out that the innovation implementation stage as the cause for many innovation failures, post adoption (Klein and Sorra, 1996: 1056). The innovation process can only be considered a success to the extent that the innovation is accepted and integrated into the organization (Rogers 1995; Gopalakrishnan and Damanpour 1997) and the targeted users demonstrate commitment by continuing to use the product over a period of time. Rogers' concept of authority based adoption decisions becomes extremely relevant as these decisions place a focus on an innovation's users and their ability to implement as the key to the innovation's success.

Klein and Sorra (1996) address both this user focused view and innovation implementation they separate Rogers' singular model of innovation diffusion. They offer two separate innovation models; one source based and one user based. The source-based model Klein and Sorra describe assesses an innovation from the perspective of the innovation developer or creator. The source-based model is similar to the first three adoption stages of Rogers' model. The user-based model focuses on the initial incorporation of an innovation within an organization (Klein and Sorra, 1996:1056). The

user based model is similar to the implementation and confirmation stages of Rogers' model. The user-based model is the topic of focus for Klein and Sorra's 1996 work and will be the underlying perspective of this research.

Further, Klein and Sorra's (1996) research focuses on innovations that require the concerted use of multiple organizational members to benefit the organization. Innovations of this type have a widespread affect on multiple organizational members. Moreover, these types of innovations are implemented following an adoption decision made by senior leadership (Klein and Sorra, 1996:1057). Innovations of this type equate to those stemming from authority adoption decisions in Rogers' model. Implementation of these innovations can be particularly difficult due to the separation of those making the adoption decision and those tasked with implementation (Rogers, 1995:173).

In their research, Klein and Sorra (1996) address this difficulty by focusing on the determinants of effective innovation implementation. Implementation is defined in their work as the transition time when targeted organizational members ideally become skillful, consistent, and committed in their use of an innovation (Klein and Sorra, 1996:1057). Damanpour posits implementation "consists of all events and actions pertaining to modification in both, an innovation and an organization, initial utilization, and continued use of the innovation when it becomes a routine feature of the organization" (Damanpour, 1991:562). Further, effective innovation implementation stems from the consistent and committed use of a particular innovation (Klein and Sorra, 1996: 1057). Moreover, without effective implementation an innovation is unlikely to yield the desired benefits to the adopting organization (Klein and Sorra, 1996:1057). According to Klein and Sorra implementation effectiveness resides at the organizational

level and reflects the combined consistency and quality of targeted users' innovation use (Klein and Sorra, 1996:1057). The level of implementation effectiveness is determined by the dual influence of an organization's implementation climate and innovation values fit.

Implementation Climate. "The implementation climate is considered to be the targeted organizational members' shared summary perceptions of the extent to which their use of a particular innovation is rewarded, supported, and expected" (Klein and Sorra, 1996:1058). Summary perceptions are formed through members' collective experiences, observations, and discussions about the organization's implementation policies and practices. Implementation climate in this context however, does not relate to members' satisfaction with the innovation, the organization, or their jobs (Klein and Sorra, 1996:1058). Moreover, implementation climate does not refer to members' perception of their organizations' openness to a change or innovativeness.

A strong implementation climate assists in competent innovation use, provides incentive for innovation use, disincentive for nonuse, and removes obstacles inhibiting innovation use (Klein and Sorra, 1996:1059). Klein and Sorra (1996) posit an organization's implementation climate is made up of various parts. These parts such as training (Holden, 1991), support services (Rousseau, 1989), trialability (Zuboff, 1988), incentives (Lawler & Mohrman, 1991), disincentives (Klein et al., 1990), and communication channels (Rogers, 1995) have been studied individually. However it is the collective effect of these parts that comprise the implementation climate of an organization. The specific level of importance of each of the pieces making up the climate may vary from organization to organization.

To emphasize the importance of climate Klein and Sorra (1996) cite research (Zohar, 1980; Abbey & Dickinson, 1983; Kolzlowski & Hults, 1987) that supports the notion that climates structured to bolster particular strategic outcomes (i.e. innovation effectiveness) do indeed influence positively that outcome. The stronger the implementation climate for a particular innovation in an organization the more likely the desired benefits will be attained, through greater and more effective use.

Innovation Values Fit. Klein and Sorra (1996) introduce a limitation of implementation climate to solely determine the effectiveness of innovation. This limitation is similar to Rogers' adoption characteristic of compatibility; the degree to which an innovation is perceived as being consistent with existing values, past experiences, and needs of the adopting organization or individual (Rogers, 1995:15). Klein and Sorra refer to this as innovation-values fit and is supported by Karahanna and Detmar (1999) research focused on post adoption beliefs in organizations. In their discussion of innovation-values fit Klein and Sorra cite Schein (1992) who describes organizational values, as "an organization's implicit or explicit views, shared to a considerable extent by the members of that organization, about both the external adaptation and internal integration of the organization" (Klein and Sorra, 1996:1061).

Also important to the examination of values is the fact that organizational values can change in response to environmental events. Additionally, organizational values can vary in intensity; high intensity values are those that encapsulate strong, fervent views (Klein and Sorra, 1996:1061). Conversely, low intensity values describing matters of relatively little importance and passion for organizational members (Klein and Sorra, 1996:1061). Klein and Sorra stress the importance of value fit when they posit, "that the

commitment to use an innovation is a function of the perceived fit of the innovation to employees' values" (Klein and Sorra, 1996:1061). The "fit" is considered to be good when users regard the innovation as highly compatible with their values. A good fit allows users to internalize, commit to, and be enthusiastic about the use of a particular innovation. The level of values-fit moderates or enhances the strength of a strong implementation climate. However, both characteristics are key determinates of effective innovation implementation (Klein, 1996; Bushe, 1998).

Level of Implementation Effectiveness

Peter Senge in his work *The Fifth Discipline* argues that shared vision is the ability of leadership to successfully translate their vision for an idea into a vision that is shared by the entire organization (Senge, 1990:206). This shared vision for the end result of innovation efforts should have a regulatory effect between the anticipated outcome of a change and the actual results. As Senge (1990) asserts, when shared vision is truly obtained it provides a common focus and energy within members of the organization (Senge, 1990:206). This energy and focus facilitates the organization's ability to successfully implement an innovation or change. The ability to create this shared vision determines whether organizational members' attitude toward a change is committed, enrolled, compliant, noncompliant or apathetic.

Senge's effect of shared vision is similar to Klein and Sorra's (1996) effect of level of values fit. Klein and Sorra (1996) describe values fit as a caveat to implementation climate (Klein and Sorra, 1996). The level of implementation effectiveness is a result of implementation climate and moderated by implementation

values fit. Klein and Sorra cite Kelman (1961), O'Reilly and Chatman (1986), and Sussman and Vecchio (1991) in the field of commitment and conformity research to distinguish between compliance and internalization. Compliance is described as the acceptance of something in order to gain some reward or avoid some punishment. Internalization is described as the acceptance of something because it is congruent with ones values and beliefs (Klein and Sorra, 1996: 1061). In the context of innovation implementation these concepts go to reassert the moderating effect of values fit on implementation climate. Organizational members who perceive an innovation to be aligned with their values are likely internalized--committed and enthusiastic--in their use of the innovation. Conversely, organizational members who perceive the innovation use merely as a means to obtain rewards and avoid punishments are likely to be at best compliant and uninvested in their use of the innovation (Klein and Sorra, 1996:1061).

Just as many leaders have personal visions, which never get translated into shared visions; many authority-adopted innovations are not congruent with organizational values and beliefs. These visions and innovations at best facilitate compliance, not commitment. When a strong values fit is present innovation use is carried out not because organizational members are told to, but because they want to. And to ensure the full benefits of innovation implementation an organization must be aware of both of these variables (Klein and Sorra, 1996:1061). The interaction of these two variables on the level of innovation use and in turn implementation effectiveness is illustrated in Table 1.

Table 1. Effect of Values Fit and Implementation Climate

	Innovation-Values Fit		
	Poor	**Neutral**	**Good**
Strong Implementation Climate	Employee opposition and resistance Compliant innovation use, at best	Employee indifference Adequate innovation	Employee enthusiasm Committed, consistent, and creative innovation use
Weak Implementation Climate	Employee relief Essentially No innovation use	Employee disregard Essentially no innovation use	Employee frustration and disappointment Sporadic and inadequate innovation use

(Klein and Sorra, 1996:1066)

Technical Orders

What is technical data? One definition provided by Blanchard (1998) is "Technical data includes system installation and checkout procedures, operating and maintenance instructions, inspection and calibration procedures, overhaul procedures, modification instructions, facilities information, drawings and specifications, and associated databases that are necessary in the performance of system operation and maintenance functions" (Blanchard, 1998: 159). Another definition more tailored to the DoD environment is "Technical data is scientific or technical information (recorded in any form or medium) necessary to operate and/or maintain the defense system" (DSMC Acquisition Logistics Guide). Combining these two definitions technical data can be looked at as any data used in the support, maintenance and operations of a system. This data can come in many different forms and be recorded on a variety of medium including paper or compact disks (CDs). Examples of technical data include schematics, drawings, blueprints, technical manuals, flight manuals, checklists, time-compliant TOs. Within the

Air Fore the most common and visible form of technical data is the TO. Technical Orders (TOs) are technical data used by weapon system operations and maintenance crew to keep systems operationally functional and ready.

Each Weapon System Program Office (SPO) has a Technical Order Manager (TOMA) that is responsible for the system's TOs. TOs are written at three different levels that correspond with Air Force maintenance levels: depot, intermediate maintenance and organizational maintenance. Thus, in addition to the overall SPO TOMA, there is a TOMA at the depot, intermediate and organizational levels. Each of these 3 level TOMAs is responsible for maintaining their respective system TOs. The SPO TOMA has oversight of all TOs and maintains a copy of every TO for all three levels.

The Need for Innovation. "Innovations in the context of the Air Force acquisition process have been undertaken under the guise of reengineering, reinvention, and reform have been expressed in many terms including: cycle time reductions, cost savings, higher efficiency, higher quality and a myriad of other buzz terms" (Holland 1998:235). A number of articles (Lloyd, 2000; Holland, 1998) can be found addressing why these and other innovations have failed despite well-intentioned authority adoption decisions. Further, many researchers in the field point to implementation as the cause of these innovations failing to yield intended results (Bushe, 1988, Reger, Gustafson, DeMarie, & Mullane, 1994, Klein and Sorra, 1996).

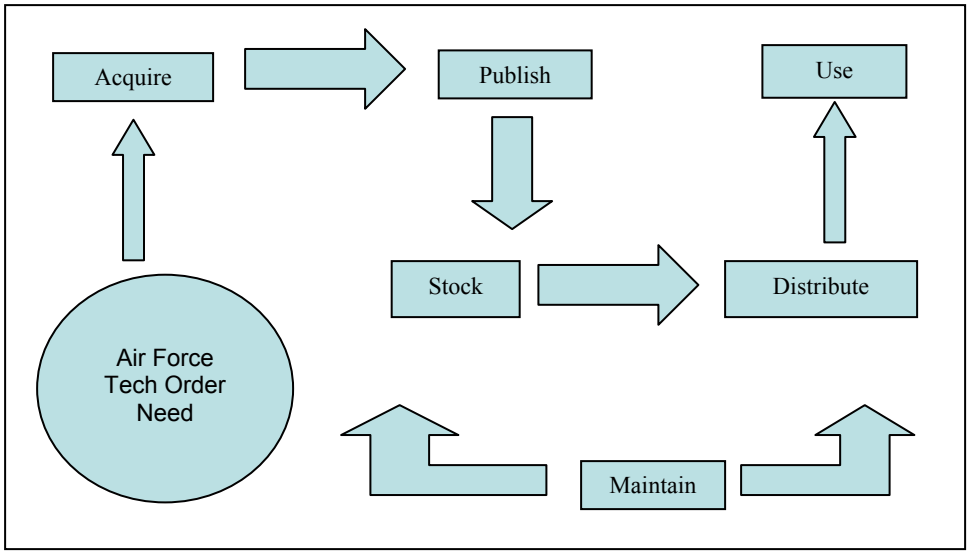
The current Air Force TO process is based upon the distribution of TOs in paper and compact disk (CD) or digital-versatile-disk (DVD) format (CONOPS, 2002). The processes of acquiring, publishing, stocking, distributing, using, and maintaining TOs in

these formats have resulted in the propagation of inefficiencies throughout the system. These inefficiencies ultimately are passed to the warfighter through longer maintenance cycles, high personnel resource usage, and a larger deployment footprint. Although efforts have been made to "fix" the TO system these efforts have fallen short and motivated the Air Force to initiate TO modernization activities by re-engineering the entire TO system. To do so the Air Force is looking to leverage the latest in digital technology. The goal is to create a system through which the processes of creation, distribution, modification, storage and overall sustainment of TOs can be done digitally. This new system will be classified for the purposes of this research as a Transformational (radical), Administrative, Process Innovation. To implement this system the Air Force created the Air Force Technical Order Transformation Office (AFTOTO). The AFTOTO Website cites cultural barriers informed stakeholders, user educational and training, and leadership support as keys to successful implementation.

The Joint Computer-aided Acquisition and Logistic Support (JCALS) and the Air Force Common Viewer (AFCV) are two major efforts being initiated in support of the AFTOTO's CONOPS. The JCALS system is slated to subsume three older Air Force Technical Order Systems: Automated Technical Order Management System (ATOMS), Automated Technical Order System (ATOS), and Air Force Logistics Management of Technical Orders System (LMTOS/DSD G022) (JCALS, 2003). JCALS is projected to provide single point access (i.e. one computer terminal) to weapon system data. As of November 2001 JCALS was installed at 48 Air Force sites and has become the Air Force standard (JCALS, 2003). JCALS users are primarily TO managers, equipment specialists and TO librarians the system will interface with numerous Air Force and DoD Systems

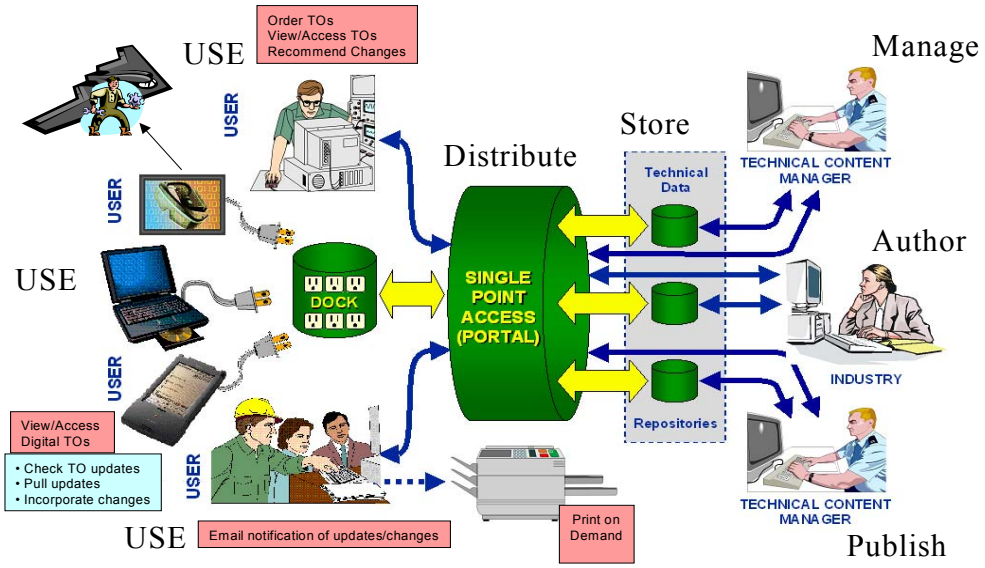
that allow field users to retrieve and use digital TOs in all areas of the field environment as necessary. Further the Air Force recently released its Enhanced Technical Information Management System (ETIMS) Preliminary Operational Requirements Document (ORD). The purpose of this document is to expand and update requirements contained in the existing Air Force's Product Data System Modernization program and Joint Computer Acquisition and Logistics System (JCALS) (ETIMS, 2002: 1). A visual depiction of the current TO process and the proposed ETIMS system is presented in Figures 1 and 2.

Figure 2. Current Technical Order Process



(CONOPS, 2002)

Figure 3. ETIMS Operation Concept



(ETIMS, 2002: 2)

Summary

This chapter exposed the reader to some of the existing literature on the subjects of innovation and Innovation Diffusion Theory. It also informed the reader of key terms and provided a brief overview of the TO system, which will be the topic of the case studies outlined in subsequent chapters. The objective of this chapter was to provide a background of Diffusion Theory and to identify the gap in literature which will be addressed by this research. That gap is the lack of Diffusion Theory research in the Air Force environment and the need for additional study on the implementation of innovations.

III. METHODOLOGY

Overview

This chapter outlines the methods used to meet the researcher's study objectives. The chapter will seek to accomplish the following: restatement of the research objective, present the research model constructed from the literature review, and then provide explanation as what a case study is and reasoning for its selection as a methodology. Specifically, the works of Robert Yin (1995) and Kathleen Eisenhardt (1989) will be used to address such issues as method selection, case definition, design, and reliability and validity. The chapter will conclude with a summary.

Research Objective

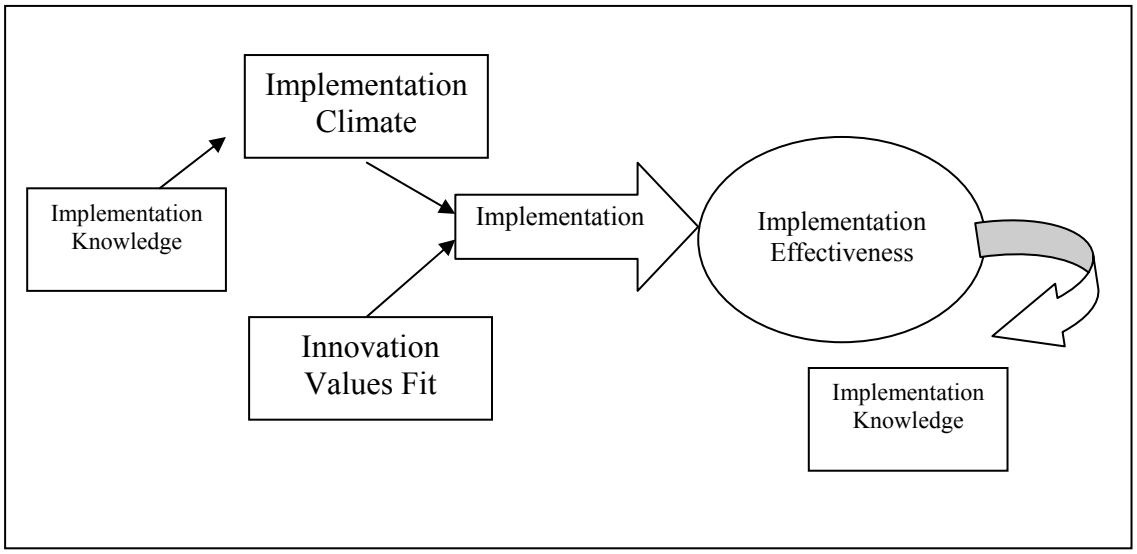
As stated in chapter 1, the objective of this research is to evaluate the Air Force implementation of a transformational innovation; specifically, digital TOs within he context of Innovation Diffusion Theory. The literature suggests that little has been done in the way of providing a common framework for successful innovation implementation in the Air Force. As addressed in chapter 2 the Air Force is, and will be, called on to implement numerous transformational innovations as part of DoD's force transformation efforts. With this will come the need for insight into what factors facilitate successful innovation implementation within the Air Force. Through analysis of the cases and the accompanying research questions this research seeks to begin to illuminate these facilitating factors.

Research Model

Rogers' Innovation Decision Model discussed in chapter 2 provides a comprehensive framework illustrating the stages through which an innovation passes from initial knowledge of the innovation through its implementation. Rogers discusses at great length the factors which affect the adoption of innovation, however he discusses very little about the factors affecting innovation implementation. Rogers does acknowledge the imperative nature of this stage to the process (Rogers, 1995:172). Klein and Sorra's (1996) research compliments Rogers' work and goes to fills the void in the implementation stage of his model.

The research model will seek to draw from Rogers' foundation themes of time, innovation characteristics, and social system characteristics, and combine these with Klein and Sorra's implementation climate and values fit theories. To further Klein's definition of implementation climate the works of Damanpour (1991), Rogers (1995), and Kivimaki, Hannakaisa, and Marko (2000) will be used. Additionally, this research will attempt to incorporate observational and enactive learning from social cognitive theory. The theory states that learning is accomplished through variety of experiences and through observation of the actions of others (Money, 1996: 65). Important to this research are the temporal aspects of this theory. It will allow the research model to assess the importance of time to implementation climate via feedback from prior implementation efforts. Through the combination of these theories the researcher seeks to provide a combined theoretical framework (Figure 3) that can be used to investigate innovation implementation within the Air Force. The research model will be used to provide theoretical basis for comparison of case study results.

Figure 4. Research Model



Method Selection

The case study methodology has been chosen to accomplish this research. The selection of a research methodology is dependent upon: the type of research question posed, the extent of control the researcher has over actual behavioral events, and the degree of focus on contemporary versus historical events (Yin, 1994:4).

This research seeks to answer questions such as how the Air Force is currently implementing transformational innovation and what are the factors that lead to successful implementation. For such questions the literature suggests the use of case study methods is appropriate (Yin, 1994:4). Further, this study will lend the researcher little if any, ability to control behavior within the study parameter. Finally, current implementation of digital TOs within the Air Force is grounded in the AFTOTO CONOPS originally released in 2001. Thus, making the concept contemporary and extending the applicability of the case study methodology.

Defining the Case Study

An understanding of this research's methodology hinges on the reader understanding the definition of case studies. The case study is a strategy whose focus is on understanding the dynamics present within a single setting (Eisenhardt, 1989:534). A more rigorous definition offered by Yin states:

> A case study is an empirical inquiry that:
>
> • investigates a contemporary phenomenon within its real- life context, especially when
>
> • the boundaries between phenomenon and context are not clearly evident.
>
> (Yin, 1994:13)

Further, case studies deal with distinctive situations where there are many more variables than data points (Yin, 1994:13). Thus, case studies typically combine multiple sources of data including documentation, archival records, interviews, questionnaires, observations, and physical artifacts data from which a triangulated research strategy is formed. The use of these multiple data sources support both Yin and Eisenhardt's view that case study research should not be thought of as strictly qualitative. Yin suggests case studies often collect a mix of both qualitative and quantitative data. Eisenhardt (1989) states that the combination of data types and sources creates a synergy. Further, combining data types assists in bolstering the results of data collected. This study will attempt to attain this synergy through the use of interview instrument and the examination of secondary data.

Case study research can seek to accomplish various aims: to describe, to test, or to generate theory (Eisenhardt, 1989:535). Moreover, the case study strategy can evaluate a single case or multiple cases. The aim of this research will trend toward generating theory and it will use multiple cases.

Design

The research design can be looked at as a blueprint of sorts. It provides the researcher a structure to get from the initial research questions to a set of conclusions based on the collected data. Yin suggests five imperative components to case study design, they include:

1) The study's questions.

2) The study's propositions, if any

3) Its unit of analysis

4) The logic linking the data to the propositions

5) The criteria for interpreting the findings (Yin, 1994:20)

The initial research questions are imperative to the research since they provide the foundation on which the study is built. These questions were outlined in chapter 1 and serve as a measure to the scope of this research and provide direction. Eisenhardt (1989) suggests to the greatest extent possible a researcher refrain from initially making propositions relating to a study to avoid the possibility of biasing and limiting findings (Eisenhardt, 1989:536). This research will subscribe to that philosophy. However, it will seek to specify a number of important constructs with reference to extant literature. A review of the literature and identification of the variables is documented in chapter 2 and

will be captured in the research model outlined in this chapter. More importantly, this study does have two specific purposes:

1) To asses the Air Force implementation of Digital Technical Orders in the context of Innovation Diffusion Theory and;

2) To evaluate the feasibility of a broader use of Innovation Diffusion Theory in future Air Force innovation implementation efforts

The unit of analysis component seeks to answer the question what is the "case" and can be a person, persons, event or process. In this research the unit of analysis will be the Air Force implementation of digital TOs and more specifically the chosen cases of implementation. At this point it is important to understand that the cases of study are to be selected not randomly but by utilizing a technique outlined by Eisenhardt (1989), theoretical sampling, to allow the research to focus efforts on theoretically useful cases. To perform the theoretical sampling, cases will be selected to provide a selection of varied programs in different stages of the acquisition life cycle. This will allow for the assessment of the effects of time on the implementation process of digital TOs in a variety of different programs.

The logic linking the data to the propositions is the next component. Yin is a proponent of pattern matching. Pattern matching is a process by which information and findings from each case are "matched" to relative theory. In this case study, the researcher will use the technique to relate information from each individual case to the questions and objectives described in Chapter 1 as well as the model developed from the literature review. The results of this process will be captured in the conclusions and recommendations found in chapter 5 of the thesis work.

Yin's final suggested component is the criteria for interpreting the findings. The nature of case studies makes this component challenging because there are so few data points available. Despite the fact that so few data points usually preclude the use of statistical analysis the application of the case study methodology suits the premise and objectives of this research. Finally, it is important to reiterate that a case study's product is an articulation of why an instance occurred as it did, and what may be important to explore in similar situations and thus may not be generalizable.

Validity and Reliability

There are two measures of the quality of research design: validity and reliability (Dooley, 2001:76). Dooley defines validity as the appropriateness, meaningfulness, and usefulness of the specific inferences made from the measures. Reliability is defined as the degree to which observed scores are free from errors of measurement (Dooley, 2001:76). All credible research must consider internal and external validity, as well reliability. In his positivistic view of case study research Yin addresses these areas. Internal validity deals with the establishing of a causal relationship by where certain conditions lead to other conditions (Yin, 1994:33). As most case studies deal with prior events one must use inferences to establish causality. This will be addressed in this research through the use of multiple sources of evidence to include the literature review, key informant interviews and the examination of secondary data.

External validity deals with the findings of a study being applicable or generalizable beyond the specific unit of analysis. In this area case study research has drawn much criticism especially those studies utilizing only one case. This research will

address this issue using Yin's suggested replication logic on multiple cases. Replication logic is the same logic that underlies the use of experiments that scientists use to generalize from one experiment to another (Yin, 1994:36). Replication logic differs from sampling logic, which is used to represent an entire universe. With replication logic, Yin (1994) suggests cases are selected so as to predict similar outcomes or varying outcomes. The use of replication logic supports the lack of any broad statistical generalizations in this research. It will however, prescribe to Yin's view of analytic generalization to illustrate its relation to the universe.

Finally, reliability must be addressed in credible research. High reliability suggests that the same results can be obtained in another study if the same data collection methods are employed. Yin (1994) addresses the subject of reliability in his suggested development of a formal case study protocol. This research will use the following outline as a guide in developing this protocol:

Overview of the case study project- stating objectives, issues, and general presentations about the topic under study

Field Procedures- reminders about procedures, credentials for access to data sources, location of those sources

Case Study Questions- the questions that the investigator must keep in mind during data collection

A guide for the case study report- the outline and format of the report.

A protocol was established to provide a systematic and structured process for each case. Each participant was initially contacted via phone followed by an e- mail (Appendix A). A scripted interview instrument (Appendix B) designed to elicit both closed and open-

ended responses was developed and used in each case. The instrument was developed based on the work of Salant and Dillman (1994). Instrument questions linked directly to the study's research questions and sought to explore the constructs of innovation implementation climate, innovation values fit and innovation implementation effectiveness in support of the research model. The constructs, variables, as well their definitions are illustrated in Table 2.

Table 2. Definition of Constructs and Variables

Construct	Variable	
Implementation Climate		
	Innovation Characteristics	**Definition**
	Trialability	The degree to which an innovation can be experimented with on a limited basis
	Relative Advantage	The degree to which an innovation is perceived to be better than the idea it supersedes
	Accessibility	The ability of organizational memebersto obtain useful information relating to the digital tech order system prior to its implementation
	Innovation Accessibility	The ease for members of the implementing organization to obtain information concerning the innovation prior to the innovation's full implementation.
	Characteristics of Social System	
	Leadership Attitude Toward Change	The perceived attitude of the organization's leadership toward the innovation
	Innovation Training	The availability of formal or informal instruction with the aim of educating organizational members on the innovation to be implemented
	Post Implementation Support	The availability of continued sustainment activities after initial implementation aimed at maintaining organizational members' knowledge and proficiency of the innovation
	Effects of Time on Innovation	
	Knowledge Loop	The sharing of prior implementation knowledge by one organization with another organization.
Innovation Values Fit		
	Level of Fit	
	Compatibility	The degree to which an innovation is perceived to be compatible with existing organizational beliefs and values
Innovation Implementation Effectiveness		
	Compliance	Perception that the use of an innovation comes primarily from the expectation of leadership
	Commitment	Perception that the use of an innovation comes from the alignment of the innovation with the values and beliefs of an organization and its use stems from a genuine enthusiasm about the innovation

Summary

This chapter has sought to provide the reasoning for the proposed case study methodology, and the details of that methodology. Despite much criticism many

researchers are proponents of this type of research in certain situations. Yin in particular has developed a positivistic outlook to the case study methodology and has determined that with thoughtful planning and formal procedures case study methodology can produce valid and reliable results. The following chapter will document the results of this methodology. Through analysis of the findings documented in chapter 4 the researcher hopes to identify common themes useful in presenting recommendations and conclusions in chapter 5 of this work.

IV. DATA ANALYSIS AND RESULTS

Introduction

The purpose of this chapter is to present the information gathered during the data collection phase of this research. Each case analysis is divided into two main sections. First, is an overview of each case study including secondary data obtained from each case. The overview will provide the reader a general idea of where each subject case is within the digital TO implementation process as well as the positions and responsibilities of the key informants interviewed. Secondly, an analysis of the key informant interview will be presented in sections corresponding to the constructs defined in Table 2. Following the individual case analysis a collective comparative analysis will be performed on the results as they relate to the research model using pattern matching. It is important to note that this chapter does not posit to be a complete and exhaustive presentation of all facets of the Air Force's digital TO implementation efforts, nor all the efforts of the individual cases, since it would be difficult for all these details to be captured adequately in one thesis effort. Rather this chapter's primary objective is to provide the details necessary to reveal the conclusions drawn by the researcher presented in chapter 5 of this work.

Global Hawk System Program Office

Case one consisted of interviews and secondary data analysis. Specifically, an interview was conducted with two key informants in the TO management agency within the organization. Together these individuals are the program leads for the acquisition,

sustainment, and distribution of their weapon system platform's technical data. This case explores a program in the initial stages of implementation. They have not yet fielded the weapon system for which the technical data will be used. Being early in the life cycle of the program affords the program the opportunity to build the digital TOs system from the ground up. Currently, the program is attempting to implement a fully digital TO system. The acquisition of TOs will be based on the Association Europeenne Constructeur de Materiel Aeronautique or Association of European Aircraft Contractors and Manufacturers (AECMA). Distribution of the TOs will utilize the Joint Aviation Technical Data Integration (JATDI) program headquartered at the Navel Aviation Systems Command.

Specifically the AECMA Standard 1000D (S1000D) addresses the standards for the documentation of any civil or military air vehicle or equipment. It is based on international standards such as SGML/XML for the production and use of electronic documentation the standard is built on a Data Module concept (Reynolds, 2000). The current DoD specification covering this area is the MIL-PRF-87268/9, which is based on a generic layer concept (Reynolds, 2000). The DoD is currently working with AECMA and The Aerospace Industries of America (AIA) to revise and enhance the S1000D and to make it the standard for future IETM development.

"JATDI is an engineering and logistics data environment aimed at integrating and delivering up-to-date and continuous technical data and maintenance expertise to maintenance personnel" (Intergraph, 2003). Updated information is housed at a central repository and "pushed" via servers to a network of mid-tier servers. Maintenance personnel and the unit level "pull" the updated data by docking their Personal

Maintenance Aide (PMA). A PMA or e-tool is any piece of electronic equipment that can be used to access technical data and can include laptops, desktops, or personal digital assistant type devices. This process occurs on a nightly basis ensuring the latest information is always available. This case gave a unique insight into early implementation efforts and plans in an unfielded weapon system.

Interview Analysis

Training. The respondents indicated that there were no plans to implement a formal training program at this time. The training that would be instituted will come in the form of airframe familiarization courses. They indicated that upon the initial activation of their airframe support, there would not be the typical three levels of maintenance for airframes. Thus, users of the TO system will initially come from already fielded airframes. In the above mentioned familiarization courses these experienced personnel will be introduced to the layout of the airframe's TOs and basic navigation characteristics of the TO system.

The respondents indicated that the TO system will be an intuitive system very similar to navigating the Internet or a Windows based computer. However, as the airframe is fielded longer and the traditional three levels of maintenance emerges, more specialized training is planned especially in the area of The Joint Aviation Technical Data Integration (JATDI) distribution tool to be used for the TO system. JATDI has some collaborative capabilities that will allow users to submit actual changes to TOs. In addition, JATDI will afford the ability to utilize Joint Photographic Experts Group (JPEG) and Moving Pictures Experts Group (MPEG) files to assist engineers in

troubleshooting efforts or problem identification on an aircraft and may require training beyond the familiarization courses planned in such areas.

Post Implementation Support. The program is planning to have multi-faceted approach to post implementation support broken into two segments one data acquisition and sustainment and one data distribution. Within the data segment the prime contractor who is responsible for the actual creation of the data and the program office responsible for TO currency will provide post implementation support for actual TO issues. Within the distribution segment of the TO system the Naval Air Systems Command who is the host of the JATDI distribution tool will be responsible for second tier support and the Main Operating Base (MOB) of the aircraft will be responsible for first tier support of the distribution network.

Trialability. The program is currently in the process of bringing the JATDI distribution infrastructure on line. The program has not fielded any aircraft and will not until later in 2003. The program's TOs have not been delivered and the contract calls for the TOs to be incrementally delivered. As the TOs are accepted the program plans to populate the TO database with them and allow users to view and "play" with the available TOs in the actual distribution and viewer systems and provide feedback to the program office. Time may become a factor during this trial period due to the aircraft's fielding schedule and the need for the system to be operational.

Relative Advantage. The respondents indicated that the top three motivating factors leading to the Air Force's initial decision to implement digital TOs to as being:

1. Paper's expense

2. The large amount of time consumed in keeping data current with changes in a paper environment.
3. The promise of the reduction of mobility footprint from possibly an entire room of paper to a single CD, DVD, or depending on connectivity in the Area of Responsibility (AOR) connecting to the Internet.

***** An additional motivating factor cited was the increased ease of usability in the digital environment for both maintainer and operator.

The respondents indicated that they felt the digital TO system they were implementing would rank a 5 on a scale from 1 to 5 with 5 being extremely better and 1 being extremely worse in relation to the previous paper based system used in the Air Force.

Leadership Attitude. The respondents indicated that their System Program Office (SPO) leadership support for their implementation efforts would be classified as being "remarkable." On a scale from 1 to 5 with 5 being extremely supportive they would receive a 5. However, above the SPO level the support has not been as forthcoming. Leadership at this level tends to have a differing vision of the digital TO environment than the program. Their vision is a system that supports both a paper and digital environment. The program's vision and CONOPS calls for a strictly digital environment. The respondents indicated that attempting to accommodate the two has been cumbersome for the program office and the prime contractor. The respondents gave an example of their decision to pursue an AECMA as the standard for the delivery of their digital TOs versus the current Air Force standard detailed in MIL-Spec 87269. The decision created obstacles created by levels above the SPO. They indicated their SPO leadership provided the support necessary for their decision to be approved at the appropriate level of

leadership at the Air Force level. Despite the resistance to the program's use of the AECMA standard the DoD is currently coordinating with AIA and AECMA to revise the existing AECMA S1000D standard for use as the DoD target format for future ITEMs by 2004 (TM-86, 2003).

The respondents indicated that their input to their leadership at the SPO level regarding implementation planning as being high. They rated it a 5 on a scale from one to 5 with 5 being high. They characterized their input as being very important to the implementation efforts. They have been given the ability to guide the direction of the digital TO system within their program. Because the program has yet to field aircraft however "the verdict" on the success of the decisions made is still out.

Accessibility. The respondents indicated that they had sought and found useful information from primarily the Internet to assist in their digital TO implementation efforts. Due to the primary source being the web for obtaining this information the respondents rated their ease of obtaining this information as being a 4 on a scale from one to 5 with 5 being extremely easy. The rating was not a 5 only because of issues inherent with obtaining information from the Internet, such as connectivity. On a scale of 1 to 5 with 1 being not important and 5 being extremely important the respondents indicated the importance of the information gathered as a 5**.**

The respondents indicated their leadership was instrumental in facilitating the availability of pre-implementation information. The respondents cited as one example their leadership's willingness to provide resources to attend tradeshows, conferences, and meetings on the topic of digital technical data.

Learning. The respondents indicated that they had interacted with other programs that had previously implemented some form of digital TOs concerning their implementation efforts. Specific examples included the F-117, whom the respondents said were instrumental in their decision to pursue the AECMA approach to their digital TOs. The F-117 is in a Total System Performance Responsibility (TSPR) environment, where the contractor has complete control of sustainment activities and data. This made it necessary for the respondents to contact the F-117 end user directly for information rather than maintenance personnel. This contact provided valuable feedback on relevant portions of the digital TO system being implemented on the F-117. Also the respondents indicated that they had interactions with the F-22 program but due to the proprietary nature of the digital TO-viewing tool employed not much information could be used. Overall the respondents indicated that the interactions discussed from a background and lessons learned standpoint were very important to the path they have taken in their implementation. They rated the interactions a 5 on scale from 1 to 5 with 5 being extremely important their implementation.

Values Fit. The respondents indicated that on a scale of 1 to 5 with 1 being not compatible and 5 being completely compatible their program would rate a 4. They stated that there is a bit of reluctance on the part of their organization both on the maintainer side and the operator side of the program. The maintainers seem to be embracing the change a bit better, indicated they thought it may have something to do with the age differences in two segments with the operators' side being older. Both segments are still dealing with the shift in mindset required when moving from a paper-based system to a fully digital one.

The respondents noted that the entire Air Force system of TOs, from creation to distribution and use, has been geared for paper for years. They stated that the requirements for operating in a digital environment are just now being "looked at". The respondents alluded to an example of the checks and balances in place to notify users in the current system of changes to technical data. In the new system these checks and balances will still be present but their form will be different. Instead of an extensive paper trail to notify users of changes an email may be sent to inform users to connect via a network to download updated technical data.

Keys to dealing with the "values fit" obstacles in their program include numerous demonstrations and numerous technical interchange meetings amongst the TO community. The respondents indicated that time will also be a factor in alleviating some of the values fit issues as more of the "Nintendo generation" comes of age and replaces older program personnel.

Effectiveness. The respondents stated that there would be instances even after implementation when the digital TO system would give way to paper. But these instances would primarily be due to operational requirements and constraints rather than user reluctance. For instance the respondents indicated they are evaluating a digital viewing tool (PMA) to be used on the flightline to allow maintainers to receive and access the most current technical data for the aircraft. Despite the PMA being ruggedized and waterproof in the instance of a chemical attack it would not be feasible to just "wash off" the PMA. In this instance the use of paper would allow the user to burn the contaminated paper technical data for safety**.**

Other instances of non-digital TO use include TOs employed in flammable areas such as aircraft fuel cells, and the likelihood for safety reasons that paper would remain more advantageous. The program did caveat this by saying that they are continuing to pursue digital solutions to even the obvious instances (i.e. Chemical attack and fuel cell work) where paper may seem the most logical approach now to come up with digital solutions. The respondents indicated that there were no formal policies within its organization to discourage the use of paper in the new TO system.

Commitment vs. Compliance. The respondents indicated that their digital TO implementation efforts are aligned with the culture and values of the organization and that there was a genuine committed attitude toward the innovation. The respondents cited the character of their program, the program's mission, and the program's leadership as key factors fostering an innovative environment and facilitating implementation efforts.

Final Thoughts. The respondents expressed a need for Air Force technical data specifications to "catch up with today's technologies". The obstacles faced by the respondents' program stemmed from a rigid system at levels above the SPO attempting to force a standardized system upon the program. The respondents indicated that this was not conducive to innovation or their implementation efforts. Further, the respondents indicated that leadership at the Air Force level is expressing concern over what is described as "stove piped" digital TO efforts. However, the respondents cited the fact that the Air Force does not have a sample system available that allows acquisition programs to approach a contractor and indicate a definite configuration and architecture for a digital TO system. The respondents indicated that this further hampers innovation as they feel innovation should be coming from the top down rather than the bottom up.

F-16 System Program Office

Case two consisted of interviews and secondary data analysis. Specifically, an interview was conducted with two key informants the first with a technical interface manger with responsibilities of assessing technical data use on the flight line. The second is an information technology manager with the responsibility of assessing and recommending the infrastructure and architecture for distribution of technical data to Foreign Military Sales (FMS) customers of the weapon system.

This case explores a program in early stages of implementing digital TOs on a weapon system, which has been fielded for twenty-four years and is sold to no less than seventeen (17) FMS customers. Being in the latter stage of the weapons system's life cycle and having a large FMS customer base, the program faces unique challenges in moving to a digital TO system. The program is currently in the midst of digitizing their paper technical data to an Air Force approved format of tagged SGML. This conversion effort began in 2001 and initially was to take two and a half years but is now projected to be completed in 2004.

The digital TO system they are pursuing is based on the concepts driving the development of the Air Force Common Viewer (AFCV). The AFCV is due to complete development in the first quarter of 2004. The AFCV translates Air Force compliant SGML data tagged technical data into XML format, and displays the data in Internet Explorer. "The AFCV will publish and facilitate the reading of technical orders regardless of location the application will run on an electronic device (PMA) that permits user interface with technical data" (AFCV, 2003). To this point no digital data has been

released but sample data has been loaded in the Air Force Common Viewer database to allow for spot testing in the form of Field Service Evaluations (FSE) and introduction at various maintenance meetings within the program. The respondents indicated that they did not have a formal implementation plan per se and that they were in the process of working on the details found in such a plan.

Interview Analysis

Training. The respondents indicated they hoped that a formal training program would be established prior to digital TO implementation in 2004. However, they indicated the parties responsible for such training have not been notified of the requirement. Thus, planning is lacking and no resources in the way of dollars have been made available or set aside. They questioned the ability of the program to institute any type of training prior to fielding digital data in April 2004. According to the respondents, a potential reason for this situation is the low priority that training and technical data receive on major programs. Another potential cause could be the feeling at various leadership levels that because of the mainstreaming of digital tools in everyday life (i.e. Personal Computers and Internet Explorer) that using digital technical data and the accompanying tools will be intuitive to its users. This situation is occurring despite the sentiment that training would be very important to the use of the proposed digital TO system expressed by subjects in two FSEs.

Post Implementation Support. The respondents indicated that the post implementation support planned would resemble the telephone support a consumer receives from Microsoft. There will be no training involved and no on location support

available. The phone support will be available 24 hours a day. The respondents indicated that his would be critical in the initial deployment phase of digital data on their program. The respondent also indicated due to the complexity of the system they felt deployable support would also be needed though none is planned.

Trialability. The respondents indicated the there would not be an opportunity for users to tryout the digital TO system prior to its implementation due to the fielding plan. The plan calls for no TOs to be released in a digital format until all are digitized then the digital TOs are to be released a Flying Wing at a time. No wings except those to which the data is released will have the computer infrastructure to utilize the digital TOs.

Relative Advantage. The respondents indicated that they felt the top three motivating factors driving the Air Force's decision to implement digital TOs are:

1. The Reduced cost of digitally formatted data versus paper.
2. The increased speed of delivery of digital TOs versus paper. An example was given of a number of the program's Foreign Military Sales customers not receiving TO change information for 25 to 365 days after the change occurred. With TOs in a digital format these changes could be relayed overnight.
3. Flexibility gained. In a paper environment the maintainer of an aircraft usually will take only the TO that is required to perform the task at hand. If another issue is discovered during the performance of that task, and the individual is experienced, they may correct the issue minus the TO to guide them. In a digital environment the maintainer has all the necessary TOs to

perform most tasks. Given the same situation the individual would have the TO at hand to correctly perform the corrective task.

The respondents rated the digital TO system they were implementing compared to the current system a 4 (administratively) on a scale from 1 to 5 with 5 being extremely better and 1 being extremely worse. The respondents indicated that in the process of creating a CONOPS they have discovered that many of the human interactions necessary in the current system will remain in a different form in the new digital system (i.e. a person once responsible for filing paper TOs will now be required to perform system administrator types of duties). From a user standpoint the respondents ranked the system a 5 and cited the two FSEs already conducted where out of 120 subjects, only one indicated they did not prefer the digital system to the paper system.

Leadership Attitude. In the area of leadership attitude the respondents indicated that the leadership at all levels was very supportive and ranked them a 5 on a scale of 1 to 5 with 5 being extremely supportive of their digital TO implementation efforts. They did caveat their 5 with the indication that the pace of decision making at leadership levels above the program sometimes causes "roadblocks" as the advancement of certain program issues are interdependent to these decisions. This issue directly affects the program's ability to meet schedule.

The respondents conveyed that their input level to leadership on implementation issues would rank a 5 on a scale from 1 to 5 with 5 being high and 1 being low. They indicated that the input they provide is critical because the requirements flow is top-down and leadership may have the tendency to embark on paths not desirable to the practitioner

and the input they provide is extremely important. The input goes to ensure the user has say into the path taken.

Accessibility. The respondents indicated that they have and do seek external information to better explain the use of digital TOs. They ranked the ease of obtaining this information a 5 on a scale from 1 to 5 with 5 being very easy and 1 being extremely difficult. They indicated that this information was easy to come by due to the fact that within the program they had a lot of experienced personnel knowledgeable of where to find it. The respondents indicated that the information obtained has been extremely important to the program, and ranked it a 5 on a scale from 1 to 5 with 5 being extremely important. One example of a source of this information that has been used to guide program decision-making is the World Wide Web Consortium (W3C). The respondents indicated that their leadership has been very supportive in their role to facilitate the availability of this type of pre implementation information. They described leadership's efforts in this area as empowering them to do their jobs.

Learning. In the area of learning the respondents indicated that they had interacted with programs that have in some way previously implemented digital technical data. They indicated that the interaction would rank a 5 on a scale from 1 to 5 with 5 being very important to their implementation efforts. In describing the nature of the interactions the respondents indicated that their current program manager has extensive knowledge of the F-22 efforts of implementing a digital TO system and provides great insight. Additionally, the respondents described a network of other programs to include the E-3 and C-130 connected through email groups that provide valuable insight into their implementation efforts.

Values Fit. In the area of values fit the respondents indicated that the innovation of digital TOs would be compatible with the values and culture of their organization. They ranked it a 5 on a scale from 1 to 5 with 5 being completely compatible. The major cultural compatibility issue in relation to the implementation of the digital TO system the respondents cited was the move from an established paper process to understanding the components of a digital process. Specifically, an issue mentioned was where to find help for problems that occur within the digital system. Additionally, they cited that there would be instances of cultural resistance from older personnel not so technically savvy. "Just because everyone has Internet Explorer on their desk does not mean they do or know how to use it." In addressing these values fit issues the respondents summed their approach in a statement, "get on board or get out of the way".

In a follow up to the values fit question the respondents also indicated that their program would have to be sensitive to FMS customers. Some of these customers because of their socioeconomic status do not want users in their country to have access to the digital tools found in a digital TO system.

Effectiveness. The respondents indicated that there would be situations where digital TOs would not be used on their program even after implementation. They cited operational situations where the PMA used to access digital TOs on the flightline would not be able to be used due to "hazardous" conditions. Additionally, the FMS requirement is so large and diverse on their program the respondents indicated that they would have to remain sensitive to any restrictions on digital technical data in that arena. The respondents indicated that there were no written policies within their program to

discourage nonuse of digital TOs. They did indicate that the program's structure would be such that it will be more advantageous for users to use digital versus paper TOs.

Commitment vs. Compliance. The respondents described their implementation efforts as being committed due to the alignment of the innovation with the organizations mission, goals, and mentality.

Headquarters Air Mobility Command Logistics Plans and Integration

Case three consisted of interviews and secondary data analysis. Specifically, two separate interviews were conducted with key informants at the command level organization. The organization's mission is to direct the development of logistics policies, plans, procedures, financial, and information systems. Further, the organization provides logistics planning and mobility programming guidance to subordinate command and staff elements of the Directorate of Logistics. For the purposes of this study it is important to note that the organization is responsible for digital TO implementation within its command. The first respondent is a Logistics Information Manager and the second a Senior Consultant Contractor. Since these interviews were conducted separately the answers to their frame questions including current implementation status will be presented at the beginning of each interview analysis.

Interview Analysis Respondent 1

The first interview was conducted with a Logistics Information Manager. The respondent described his responsibilities as facilitating the integration of digital technical data to include digital TOs within command units and the facilitation of the funding for

the necessary infrastructure to support that integration. The respondent described the commands current status as being at differing stages. He described platforms such as the C-141 that would not be implementing any type of digital technical data because it will be headed to the "graveyard" in 2005. Also described were programs that were receiving digital technical data on DVDs that are updated monthly such as the C-17 and the C-5. Currently, the command prefers the DVD delivery method because entire technical libraries can be maintained on one disk versus multiple disks when the information is placed on CDs. The respondent offered an example of the C-17 whose digital TOs were previously on twenty (20) CDs and now are contained on one DVD. The respondent indicated that there was no formal implementation plan in place.

Training. Within the area of training he respondent indicated that there were no plans to institute any formal training programs to support implementation. The respondent cited two examples to explain why there were no training plans. The first example dealt with how maintenance data was previously collected on a form 339. When the collection of the same data was transitioned (from a form 339) to an electronic collection system there were training issues due to the user having a lack of digital savvy. The respondent indicated that this is not the case anymore. "Most personnel in the Air Force are digitally savvy enough to use the viewing software Adobe Acrobat and the digital TO will resemble the paper TO." These two factors according to the respondent would lessen the transition issues seen in the move from the form 339 to electronic collection.

The second example dealt with the initial introduction computers to personnel and the lack of designated training personnel at each desk to assist new users. The respondent suggested the new users incrementally learned through trial and error and the digital TO

system would be the same way. Moreover, the respondent indicated that individuals already exposed to digital technical orders within the command have not called for any specific training. The respondent added that in their opinion even in the most advanced IETM the need for formal training would be limited because the same organization structure would be used in the digital TOs as is used with paper TOs. However, for maintenance systems that integrate Point-of-Maintenance (POMX) functions (viewing tech data, ordering parts, updating maintenance data system, etc.) the command is looking to contract for Type I training for users.

Post Implementation Support. The respondent indicated that there would be, and is, support provided to users at each unit. The support comes in the form of a logistics network office (LOGNET). The future support plan calls for an increase of personnel at these LOGNET offices equal to 1 technician for every 100 PMA. The function of these personnel will be to provide local repair, and warranty administration.

Trialability. The respondent indicated that due to the incremental approach to fielding digital TOs users, by default, would and do have the opportunity to use the digital TO system prior to its full implementation. "Though no formal trial opportunity is defined trialability is inherent in the system. On the C-130 to paperless 900 PMAs would be needed." 900 PMAs cannot be just shipped at once and the TO system declared digital." The respondent cited in a case such as the C-130 the PMAs would come incrementally and as they arrive users would have an opportunity to use them and provide feedback at each increment.

Relative Advantage. The respondent identified the following as the top three motivating factors driving the Air Force's decision to implement digital TOs:

1. Technology Availability
2. Environmental Issues due to the reduction in paper use
3. Efficiency Increases promised in the way maintenance technicians are able to do their jobs

The respondent rated the digital TO system being implemented compared to the current system a 3 on a scale from 1 to 5 with 5 being extremely better and 1 being extremely worse. The ranking was a 3 because according to the respondent, the full benefits of the digital technical system currently being implemented have yet to be achieved. The respondent stated that digital TOs are not fully integrated on any of the systems command-wide. However, the respondent posited that the benefits would rate a 5 on the same scale after full implementation.

Leadership Attitude. In the area of leadership attitude the respondent indicated that the majority of leadership was supportive and gave them a 4 on a scale of 1 to 5 with 5 being extremely supportive of command digital TO implementation efforts. However, there are some at higher levels who feel the high initial investment cost in required infrastructure (i.e. PMAs) makes it more advantageous to stay with paper, thus the 4 and not a 5.

Input level to leadership on implementation issues was ranked a 5 on a scale from 1 to 5 with 5 being high and 1 being low. The respondent stressed that their office was "the integrator" and with that they help shape implementation. The office takes requirements from the weapon system mangers and shapes them in an effort to integrate them into the existing infrastructure. Thus the respondent indicated the input provided was extremely important to ensure requirements are not "hit or miss."

Accessibility. The respondent stated that external information to better explain the use of digital TOs has been and is sought. The avenue used the most to gather information is the Internet (the web). In addition to the Internet, information gathering takes place at trade shows, and the respondent indicated the office has a number of magazine subscriptions that provide valuable information. The ease of obtaining this information was ranked a 5 on a scale from 1 to 5 with 5 being very easy and 1 being extremely difficult. The respondent reported that the exposure to such information provides perspective in the implementation efforts and how to better proceed with a solution. The respondent ranked it a 5 on a scale of 1 to 5 with 1 being not important and 5 being extremely important.

"The information provides lessons learned and this type of information from industry is invaluable in that respect."

The respondent indicated that leadership provided all the necessary resources to make it possible to gather such information. Funding was provided for trips to attend conferences and trade shows as well as, ordering magazine subscriptions. The respondent stated that gathering such information is part of the culture and is expected as a part of the job in the organization. "If you are not gathering that information then something is wrong."

Learning. The respondent indicated that interaction with other programs or organizations that had already implemented some form of digital TOs system did occur. The importance of this information to current implementation efforts was seen as imperative and rated a 5 on a scale from 1 to 5 with 5 being very important and 1 being not important. The respondent stated that the lessons learned were the most important

thing gained from this type interaction. The respondent gave an example of an important lesson taken from interaction with programs both in the command and outside the command.

As a general rule the command discourages the purchase of PMAs with weapons systems now, favoring the acquisition of the tools separately. The strategy stems from prior programs that did purchase PMAs in conjunction with the weapon system. These programs have found many times that the delivered tool is technologically not up to date, is built on a closed architecture hampering upgrades, and just does not function as required.

Values Fit. The diversity and number of programs at the command level lead the respondent to classify the compatibility of digital TOs as varied. On a scale form 1 to 5 with 1 being not at all compatible and 5 being completely compatible the respondent indicated the command would rank somewhere between 2 and 4 around 3 overall. A 2 example would be the first PMA released within the command. The PMA could not be read in direct sunlight because of the screen type. Users would have to seek the cover of an aircraft wing in order to read the screen in the daytime. In this situation the compatibility directly conflicted with the culture of the organization, and since the digital TO system is not fully capable as of yet there continues to be conflicts such as this. On the converse the respondent gave and example of a PMA that was just recently delivered with day/ night viewing capability that has been received exceptionally well. This instance would rank a 4 on the compatibility scale.

The respondent noted that there would always be the need for a paradigm shift with those who are very attached to a tangible paper product. These people usually resist

when an electronic tool is place in front of them. According to the respondent though, when a tool is delivered that meets the needs, and requirements of users' jobs and the benefits are witnessed, the resistance is greatly reduced.

The respondent stated that the effect of this cultural issue on implementation would be high. The paradigm shift of going from a paper to a digital environment lies at the core of the digital TO effort and is imperative to the success or failure of its implementation. In dealing with this important cultural issue the respondent indicated that it is imperative to sell the positives. Further, it is important to show how the new system will benefit the organization by allowing individuals to better do their job. The respondent cited the importance of change agents in the process of communicating the benefits and positives of the system.

Effectiveness. The respondent indicated that there would continue to be instances when digital TOs would give way to the use of paper even after their full implementation. The major reason given as to why paper would still be present was TO currency. "Today we are still paper based and there is a process to distribute changes to TOs." In an environment where data is to be burned to a DVD the disk is only current at the time of its creation and if a safety supplement is released after the creation of the disk it has to be distributed somehow." The respondent indicated that the means to distribute a supplement such as this would be through paper. To alleviate this problem a new DVD would have to be burned everyday and this is not feasible according to the respondent.

Another issue that will require that paper remain in the system is operational requirements. The respondent cited the fact that fuel cell operators still do and will need paper to perform their jobs safely. The electronic tools currently available cannot satisfy

the requirement form a safety standpoint yet. Currently, within the command there is no policy specifically addressing the nonuse of digital TOs. However, according the respondent the command is moving in that direction but "it is still too early to force it (digital TOs) down anyone's throat." In answering this question the respondent stressed the importance of change agents in the process at this point versus policy. This importance is compounded by the fact that paper is still needed in the current system.

Commitment vs. Compliance. In addressing whether the use of digital TOs was due to compliance or commitment the respondent indicated stated: "Even in a military environment if something doesn't work you will find a work around." According to the respondent, in this case the work around would be the use of paper. The respondent felt the people using digital TOs are doing so because they are committed because they work, not because of policy or someone is mandating they do.

Final Thoughts. It is important to look at digital TOs as only a component of a system that links the entire logistics network including, but not limited to, supply and maintenance. To obtain the greatest benefit the entire logistics system must interface**.**

Interview Analysis Respondent 2

The second interview was conducted with a Senior Consultant Contractor who had 40 years total experience in the command as a military member and as a contractor. The respondent stated his responsibility as facilitating innovation within the command's logistics organization. The respondent provided an example of a current innovative project he was involved with that was being shipped the day of the interview. The project was the deployment of Global Reach-Reach Back Kits. Each kit contains a

laptop, Iridium phone, and a digital camera, among other items. The purpose of the kits is to afford deployed units the capability to dial back to the Global Information Grid and access email, management information systems, technical data, and anything else accessed on a desktop.

The respondent's reply to the current state of the command's digital TO implementation began with a recount of how the efforts began. "The command started to put infrastructure and technology in place fifteen years ago to field digital technical data." The respondent indicated the commands first attempt at fielding digital TOs came in the early nineties on the C-5 aircraft. This first attempt was scanning TOs with a raster scanner and saving them to CDs. This process allowed 600lbs. of paper to be eliminated from the aircraft previously designated for TOs. This attempt evolved into the next generation of digital TOs, which came on the C-17. The C-17's TOs were converted from paper to an indexed Portable Document Format (PDF) allowing all the aircraft's data to be contained on 12-13 CDs. Recently, according to the respondent, 1 DVD replaced the 12-13 CDs on the C-17 aircraft.

Additionally, the C-5 TOs are now published on 1 DVD and efforts are underway to convert the paper based TOs of the KC-135 to a DVD format, while the C-130 airframe is pursuing a high level IETMS structure. The respondent indicated that the Air Force track record with these IETMS is not a good one. To support that position the difficulties of the Joint Surveillance Target Attack Radar System (JSTARS) attempt at implementing an IETMS citing specifically the cost overruns encountered. Despite the bad track record the Air Force has with IETMS, the command continues to analyze various approaches and different technologies.

The respondent indicated the command was following the AFMC Digital Roadmap/ Comprehensive Air Force Technical Order Plan (CAFTOP) for each platform. The respondent stated that the command rather than a formal implementation plan has a near-term spending plan that lays out where funds will be expended.

Training. On the issue of training the respondent indicated that there was no formal training plan nor is the command preparing one for the future addressing digital TOs. The reasoning provided was that the digital TO in the current system is "simply a picture of the paper TO in an indexed PDF format." According to the respondent there is very little to be learned "when you've just taken the paper TOs and put them out there in PDF." The respondent did indicate the there was a problem with the assumption that all personnel are comfortable with the tools that digital TOs are delivered with (i.e. computer, Adobe Acrobat, and Internet Explorer). The respondent stated that they felt nowhere had the topic of general office automation been addressed in the users of the TO system training.

According to the respondent the Air Force is making a big assumption that because the tools are available people are using them. The assumption is furthered by the fact that the Air Force feels that if digital TOs are delivered in a commercial off the shelf format (i.e. PDF) there use will be intuitive. That assumption may be valid for a majority of the population but there are persons that are not familiar with these tools and their effective use of the TO system may be hampered. The respondent felt that a lack of general automation training would not only effect the implementation of digital TOs but also the pervasive movement towards the "web-centric" warfighter.

Trialability. In the area of trialability the respondent indicated that the TOs were not changing only the way it was viewed. This fact eliminated the need for users to have a trial period prior implementation. The assumption has been made that everyone is using some form of digital automation and by doing so they are qualified to use digital TOs. According to the respondent the assumption makes trialability unnecessary because of the intuitiveness of digital TOs.

Relative Advantage. The respondent identified the following as the top three motivating factors driving the Air Force's decision to implement digital TOs:

1. Cost Savings-the respondent indicated that despite this being a top motivating factor it may be a falsehood. Some of the plans within the digital TO arena will cost more than maintaining a paper-based system. Despite being skeptical of the actual cost savings, the respondent concedes that the savings could come from productivity gains. But the respondent states we don't know if this is the case or not because the Air Force has not documented it, and there have been no definitive studies. Further, the respondent indicated that many of the costs associated with the paper-based digital TO system are fixed such as on base storage. Without study the effects of these costs cannot be measured.
2. Increase in Mechanic's Productivity - The respondent stated that productivity must be looked at in context of total cost of ownership because cost is an issue.
3. Improved Documentation-The Air Force assumes by going to a digital format that the mechanic is going to follow the TO explicitly and automatically keep

track of all that he or she does, and report it. The big underlying assumption is that the mechanic uses the TO all the time: "they don't and won't." The respondent indicated that when sortie launches become critical, "you put your brightest most experienced people that have done this 100 times and know how to do it on the job."

The respondent rated the digital TO system being implemented compared to the current system a 5 on a scale from 1 to 5 with 5 being extremely better and 1 being extremely worse. To support this rating the respondent offered a comment made by the maintenance superintendent at Charleston Air Force Base shortly after the DVD release of the C-17 TOs. "This is the best thing you have done for me in my career." The system is one DVD, it is updated every thirty days and the personnel at the base do not have to thumb through page upon page to maintain the data.

Leadership Attitude. In the area of leadership attitude the respondent indicated that leadership was very supportive and gave them a 5 on a scale of 1 to 5 with 5 being extremely supportive of command digital TO implementation efforts. Within the command the respondent indicated that support for digital TOs is positive because the transition from paper to digital is "doing something good for the airplanes." Although not every maintenance superintendent at all twelve of the command's bases perceives digital TOs as good.

Input level to leadership on implementation issues was ranked a 5 on a scale from 1 to 5 with 5 being high and 1 being low. The respondent cited that leadership at the command level have a lot of noise level information thrown at them, they are pushed in

many directions. The input provided is key as it provides a pragmatic view on how to sort through the information and maximize benefits now with available resources.

Accessibility. The respondent indicated that information was and is sought to better explain digital TOs. The respondent highlighted a contract with an independent researcher where the command conducted a benchmarking effort of sorts to obtain industry's view of the current state and future of digital TOs. The ease of obtaining this information was ranked a 5 on a scale from 1 to 5 with 5 being very easy and 1 being extremely difficult. The respondent stated that the Air Force tends think it must always invent. With digital TOs the concepts are not new we should be focusing on implementing available technology. Obtaining industry information assists in this effort, making the accessibility of information very important. The respondent indicated that the information goes to keep the program grounded in the reality of what is occurring outside of the program. This information would rate a 5 on a scale of 1 to 5 with 1 being not important and 5 being extremely important.

The respondent indicated that leadership is key in facilitating the availability of the information obtained by the organization. The respondent indicated that leadership allows the organization to be innovative, keeps the infrastructure strong, and maintains an interest in the status of how things are going, and continually pushes innovation.

Learning. The respondent asserted that the Department of Defense "never publicizes its failures (e.g. you can't go and find any articles on why JSTARS is moving away from object oriented database development)." Many times to obtain this type of information or even to know that the project exists one has to be on the inside of a program or know someone in the program. Lessons learned are very hard to find in the government

because the government does not "talk" about failures; failure is not acceptable. The respondent noted attending the John F. Kennedy School of Government. The school stressed for innovation to be successful failure must be accepted to some extent. To employ such a mentality in the military takes special leadership and is not commonplace.

However, the respondent did indicate that interaction did take place with other programs or organizations concerning the command's digital technical implementation efforts. The importance of this information to current implementation efforts was seen as imperative and rated a 5 on a scale from 1 to 5 with 5 being very important and 1 being not important. The respondent cited an interaction with an independent researcher. The command contracted with the organization to assist them in determining the right path to take on digital TO technology indexed PDF on DVD or a more advanced IETM system. The results of this interaction assisted in the decision made to place the C-17 TO data on DVD.

Values Fit. The respondent indicated that the compatibility of digital TOs would be ranked a 3 because users fall at two ends of the spectrum. On one end lay those that feel the approach taken is too "amateurish" and that a more aggressive approach resembling a fully digital IETM should be pursued. Then there are those in the command who feel that the approach being taken is correct and are very satisfied. According to the respondent the command is planning to continue to move forward exploring new ideas but with an understanding of where they are going. The respondent coined the approach an "evolution not a revolution". People with a high comfort level with paper create the most prevalent cultural issue faced by the command because they are reluctant to use digital tools. The respondent stated that this situation would become less an issue as people

change and the age group shifts. The result of this shift will be people who are more familiar with technology and are more comfortable using the web and other digital tools.

However, the respondent stated that this cultural issue is not limited to users being technically savvy. An example was offered outlining how the role for the maintenance superintendent would be diminished once the entire flightline is connected to a network. Functions which currently have to be coordinated through the maintenance superintendent such as reporting tail numbers down for maintenance, ordering parts, etc., will be able to be accomplished via the network. The respondent felt that these changing roles in various segments of the logistics process would create resistance.

The respondent cited an example from a contracted study the command initiated. The study investigated potential improvements to flightline operations with the implementation of wireless Local Area Network (LAN). The outcome of the study was an extensive list of seemingly potential improvements. One of the findings dealt with phone messages taken for personnel in the unit. These messages sometimes contain such information as "Have Charlie bring home some milk and bread on the way home." Messages such as these require that someone record them and insure they are delivered or require the member to leave the flightline to retrieve them. If the flightline were connected to a wireless LAN this message could be directly sent via email. This was cited as an advantage by the study. The respondent stated that the "reality of the situation is, the maintenance personnel affected want to leave the flightline to take a break, get a cup of coffee, etc." Thus, introducing a digital environment would have a major cultural effect on people in many ways. The same way people had to adjust to an office where

managing email became the norm rather than paper memos so will be the case with a digital flightline; it will be a cultural challenge.

In responding these cultural issues the respondent indicated that it would be important to communicate the benefits of shifting from paper to digital. According to the respondent the difficulties and challenges, cultural and otherwise are outweighed by the positives, and once people see this they will accept it though it may take time.

Effectiveness. The respondents indicated that there would be and are instances that digital TO use succumbs to paper. Citing the inability to currently use PMAs in fuel cell work, the respondent indicated that digital TO use in all environments had not been fully addressed. Despite the current limitations the respondent indicated that the environments will and are being addressed but there will continue to be paper present. In response to the question of whether there were policies to discourage the nonuse of digital TOs within the organization, the respondent indicated that there are personnel in the system that do discourage it through "internal persuasion." However, the command is not the point where policies are being developed mandating digital TO use.

Commitment vs. Compliance. In response to whether the command's efforts toward the use of digital TOs could be classified as committed or compliant, the respondent indicated they were committed as a whole. However, there are pockets of users that are simply compliant with there use and implementation efforts.

Comparative Display

In Tables 3 and 4 are displayed a comparative summary of each of the interviews. These tables should assist the reader in comparing the analyses above. Further, the

tables should go to facilitate the identification of the patterns that emerged in the case analysis. The tables however, are not intended to take the place of the above write-ups as not all information can be captured.

Table 3. Summary of Frame Questions

	Position and Responsibility	**Synopsis of Implementation Status**	**Formal Plan**
GH*-R-1**	**Tech Data Program Co-lead.** Responsible for acquisition, sustainment, and distribution of technical data	In the acquisition phase platform not fielded. Acquisition based on AECMA standard and distribution with JATDI. Populating trial databases	No
GH R-2	**Tech Data Program Co-lead** Responsible for acquisition, sustainment, and distribution of technical data	Same as GH R-1	Same as GH R-1
F-16 R-1	**Technical Interface Manger**. Responsible for assessing technical data use on the flight line	Program currently digitizing paper technical orders into Air Force standard SGML format for use with the Air Force Common Viewer	No
F-16 R-2	**Information Technology Manger**. Responsible for recommending the infrastructure and architecture for distribution of technical data including FMS	Same as F-16 R-1	Same as F-16 R-1
AMC R-1	**Logistics Information Manager**. Responsible for the integration of digital technical data within command units	Command has programs at different stage of implementation. Some platforms have no digital data (C-141) and some are implementing higher level IETMs (C-130)	No
AMC R-2	**Senior Consultant Contractor**. Responsible with facilitating innovation within the Command's logistics organization	Same as AMC R-1	Same as AMC R-1

*** GH-Global Hawk**
**** R –Respondent**

Table 4. Summary of Quantitative and Qualitative Questions

	Global Hawk	F-16	AMC R-1	AMC R-2
Training				
Will there be a formal training program available prior to the implementation of your digital tech order system?	No, System is thought to be intuitive and not requiring specialized training	No, currently no resources allotted and no planning taken place to institute a training program	No, system seen as intuitive to digitally savvy workforce	No, the layout of the TO is not changing just the means to view it, intuitive
After implementation will are you planning for a formal support system to provide users with needed updated training and support? (i.e. helpdesk)	Yes, the SPO and contractor will handle acquisition and sustainment issues while distribution (JATDI) issues will be handled by NAVAIR	Yes, resembling the telephone support a consumer receives form a software company	Yes, in the form of a logistics network office at each unit	
Trailability				
As a part of your implementation efforts will users be able to use the digital tech order system either in parts or in its complete state on a trial basis prior to its implementation?	Yes, as TOs are delivered they are populated into the TO database and users will be able to use the system to familiarize themselves	No, the fielding plan calls for data to be released to the field only after all TOs have been digitized	No, formal plan to allow for trial usage, though incremental fielding plan inherently incorporates some aspects	No, assumption is being made that all users are familiar with digital automation and trials are not needed
Relative Advantage				
In your opinion what you would identify as the top three motivating factors leading to the initial Air Force decision to use digital tech orders?	1. Paper's Expense 2. Administrative Efficiency 3. Reduced Mobility Footprint	1. Paper's Expense 2. Delivery Efficiency 3. User Flexibility	1. Technology Availability 2. Environmental Concerns 3. Efficiency	1. Cost Savings 2. Increased Productivity 3. Improved Documentation
On a scale of 1 to 5 with 1 being extremely worse and 5 being extremely better: How would you rate the digital tech order system you are implementing as being in relation to the tech order system previously used?	5	5	5	5
Leadership Attitude				
On a scale from 1 to 5 with 1 being not at all supportive and 5 being extremely supportive. How would you characterize your leadership's overall attitude towards the implementation of digital tech orders?	5	5	4	5
On a scale from 1 to 5 with 1 being low and 5 being high. How would you describe the level of input to leadership you have in implementation planning?	5	5	5	5
How would you characterize the importance of this input discussed in the previous question on the actual implementation of the digital tech order system?	Very Important given the ability to guide the direction of the digital TO system	Critical, input ensures user has say in path taken	Extremely Important ensures requirements for the units are not "hit or miss"	Input provides a pragmatic view and helps leadership deal through large amount of information

	Global Hawk	F-16	AMC R-1	AMC R-2
Accessibility				
To your knowledge has your organization sought to obtain information (from magazines, books, web information, trade information, etc.) to better explain the use of the digital tech order system?	Yes	Yes	Yes	Yes
On a scale of 1 to 5 with 1 being extremely difficult and 5 being extremely easy How you describe your organizations ease of obtaining this information?	4	5	5	5
On a scale of 1 to 5 with 1 being not important and 5 being extremely important Please indicate the importance of the information discussed in the previous question to your implementation efforts.	5	5	5	5
Finally, how would you describe your leadership's role in facilitating the availability of this information?	Instrumental	Very Supportive	Important as they make it a part of the organization's culture	Key
Learning				
Has your organization had any interaction with other organizations or programs that have already implemented digital tech orders concerning your implementation efforts?	Yes	Yes	Yes	Yes
On a scale from 1 to 5 with 1 being not important and 5 being very important How important has this interaction been to your implementation efforts?	5	5	5	5
Values Fit				
On a scale of 1 to 5 with 1 being not compatible and 5 being completely compatible. Indicate how compatible you feel the implementation of the fully digital tech order system will be with the beliefs and culture of your organization.	4	5	3	3
In your opinion what will be the major cultural compatibility issue during the implementation of your digital tech order system?	Reluctance to change due to the age of some of the users	Reluctance to move form established process some caused by Age of personnel FMS customers	Shift in mindset of those who are very attached to a tangible paper product	The reluctance of those with a high level of comfort with using paper to use digital tools due to age
Can you briefly discuss how the issue was addressed?	Time and communication through demos and interchange meetings	"Get on Board or Get out of the Way"	Communicating the positive aspects of the system, utilizing change agents	Time, and communicating the positives of the system

	Global Hawk	F-16	AMC R-1	AMC R-2
Innovation Effectiveness				
Do you feel there will be situations where digital tech orders will not be used even after implementation?	Yes	Yes	Yes	Yes
What do you foresee as being the primary factor causing these situations?	Operational constraints such as fuel cell use and chemically contaminated areas	Operational constraints and FMS restrictions	Updating process and operational constraints	Operational constraints such as fuel cell work
Are there policies being developed in your organization to discourage nonuse of digital tech orders?	No	No	No	No
Would you describe your organization's attitude and efforts towards your digital tech order system as compliant or committed?	Committed	Committed	Committed	Committed

V. CONCLUSIONS AND RECOMMENDATIONS

Clearly apparent from this study is that digital TO implementation is critical to the future of the Air Force and its warfighting capability. The service is fielding systems that are highly sophisticated such as the as the F-22 and JSF while sustaining older airframes that require complex upgrades such as the F-16 and C-130. The ability to efficiently acquire, publish, stock, distribute, use, and maintain maintenance data for all these systems is, and will continue to be, critical.

The contents of this chapter seek to address the objectives of this research directly. The first part of the chapter will highlight the common themes derived from chapter 4. Then the investigative questions outlined in chapter 1 will be directly addressed. The chapter will then present the researcher's recommendations followed by research limitations and potential topics for future research.

Common Themes and Important Topics

Training

Despite the relative novelty of digital TOs none of the programs under study had clear-cut plans to institute any type of formal training program. All the respondents whether they agreed or not with the fact that no training was planned alluded to the intuitiveness of the system as a reason for not having training. In one case the respondents indicated that the program was actively seeking a training program. In this instance resources had not been made available and the organization responsible for such training not been even initially contacted. All three organizations indicated their

intentions to have some form of post implementation support. The robustness of this support varied in each of the three programs. In at least one case the respondent indicated that in their opinion the support would not be enough as planned.

Trialability

In three of the programs studied no trial period was planned into the implementation of the digital TO system. In the one case where the program planned to have a trial period the respondents indicated that the success of that plan might be jeopardized due to fielding requirements of the aircraft.

Relative Advantage

Cost savings and increased efficiency were the two most common responses to why the Air Force decided to adopt a digital TO system. All respondents indicated that the system they were implementing was extremely better than the system they were replacing.

Leadership Attitude Toward Change

At the program level all the respondents indicated that leadership was highly supportive. However, in at least three of the interviews the respondents indicated that leadership at levels above their program was not as supportive as at the program level. In at least two instances the respondents indicated that leadership above the program actually adversely affected their implementation efforts. All the respondents indicated they had a high level of input to leadership. Additionally, all the respondents stated that

the input they provided was important to the path of implementation taken by their respective programs.

Accessibility

In all the cases under study outside information was sought to better explain the use of digital TOs. In all cases the information was easily obtained and was seen as extremely important to the implementation efforts of the program. Further, in each of the cases the respondents indicated that leadership played an important role in facilitating the availability of the information.

Learning

In all the studied cases there was interaction between the programs and outside organizations regarding implementation efforts. This interaction varied from emails to contracted independent study efforts. In at least two instances the respondents indicated that they had difficulty exchanging information "intra-Air Force." In one case the respondent indicated the difficulty stemmed from contractual barriers and prohibited the exchange of information. In a separate instance a respondent cited the military's unwillingness to publicize failures. This cultural issue required one to either know someone inside the program or be on the inside to obtain any "lessons learned" type of information. All the respondents indicated that the information obtained from interacting with outside organizations was very important to their implementation efforts.

Values Fit

The responses to the values fit questions though somewhat unclear by the quantitative answers highlight two major themes. One that the age of the users of digital TOs is an issue and that the programs are being confronted with personnel reluctant to make the mindset shift need to implement digital TOs. In at least three cases the respondents cited communication as a key means to dealing with the cultural issues facing their implementation efforts. In at least one case the respondent indicated the importance of change agents to the communication process.

Innovation Effectiveness

In all the cases the respondents indicated that they thought there would be times after full implementation that digital TOs would not be used and paper would be. All of the respondents cited operational constraints as a major reason. None of the respondents indicated that their programs had instituted official policies to discourage the nonuse of digital TOs. In two cases the respondents indicated that the organization utilized internal means to encourage the use of digital TOs over paper. In all cases the respondents indicated that in the near term that there would be a need for paper in the TO system. All respondents indicated that their organization's implementation efforts stemmed from a committed view toward digital TOs.

Investigative Questions Addressed

What are the major tenants of Diffusion Theory?

Chapter 2 addresses this question in depth. The key tenant of Innovation Diffusion Theory is that it is a structure by which to assess innovation characteristics, organizational characteristics, and the external influences that cause innovations to be successful or unsuccessful. Important characteristics highlighted in chapter 2 include: defining innovation, innovation types, stages of the diffusion process, and keys to innovation implementation.

What factors are identified in the literature as antecedents to effective innovation implementation?

Once again this question was addressed in the literature review. Relying heavily on the works of E.M. Rogers (1995) and Klein and Sorra (1996) this study has identified the constructs of innovation implementation climate and innovation values fit as antecedents to successful innovation implementation. The definition of these constructs and the variables that make them up can be found in Table 2. It is important to note that the study is theory building and did not set out to define what a successful implementation effort would be. Further, the innovation under study, digital TOs, in its truest form is relatively new and not fully implemented yet. This makes a determination of its success or failure premature. From the case analysis however, one can assess the potential of a successful implementation per the theory.

What do implementers of innovations identify as characteristics of innovation implementation within the Air Force?

Taken form the common themes identified in the case analysis, important implementation characteristics include: Supportive leadership at the program level, input to leadership regarding implementation efforts, accessibility to outside information related to the innovation being implemented, the ability to interact with programs that have already implemented the innovation, and communication to relay the positive benefits of the innovation to reluctant users.

Recommendations

The goal of this research was to assess innovation implementation in the Air Force within the context of Innovation Diffusion Theory. The study has sought to focus on the antecedents of effective innovation implementation to study an innovation (digital TOs). This effort may provide insight into future innovation implementation efforts within and outside the Air Force. The most important contribution to these efforts is general framework within which to study and assess these efforts. The recommendations that follow in this chapter come from analysis of the cases presented in chapter 4 and other sources.

Using the research model constructed from the Diffusion Theory literature yielded several areas worth investigating. It is important to note that the variables that make up the model neither ensure effective or ineffective implementation by themselves. It is as Klein and Sorra (1996) suggest the collective effect of all the variables.

Implementation Plan

It is recommend that at the program level that an implementation plan be created. The plan even at a high level should outline the issues assessed by the research model. This could facilitate the effective handling of such issues as training and compatibility.

Training

The innovation of digital TOs remains novel. All of the respondents alluded to the fact that a broad assumption has been made. The assumption is that because the digital TO system is based on the use of commonly available tools and software that the users of the system will intuitively know how to use it. This assumption remains to be tested, but the fact is that the users of the TO system are expected to perform a very important job; to keep aircraft safely flying and combat ready. The significance of these tasks and the potentially adverse effects of their inability to perform them seem to warrant training on all facets of the system. Resources should be made available and a training program introduced covering at least the basics of the tools and software used in the digital TO environment. The broad structure of such a program could be outlined at the command level with specifics left to the units. This type of program could go to facilitate a higher level of innovation effectiveness and more importantly address some of the values fit issues caused by reluctant users.

Trailability

The cases studied revealed that no formal trial period to allow users the opportunity to familiarize themselves with the system is planned in most instances. There are many program constraints, which may create this situation. Regardless, the

implementation climate of an innovation is the combined affect of a number of variables including trialability. Thus, when possible the opportunity for users to utilize the digital TO system prior to its full implementation should be explored and built into the implementation schedule. This will become even more important as the digital TO system evolves to a fully integrated maintenance system such as the ETIMS concept.

Learning

Though relatively new the implementation of digital TOs is widespread, programs are at different stages of the process. The utility of lessons learned on prior implementation attempts became evident in the cases studied. The difficulty of obtaining such information from Air Force programs for a variety of reasons cultural and otherwise was also highlighted in the cases. One means to address this issue could be the formation an official digital TO implementation library. The library could contain brief case synopses on various program implementation efforts along with contacts and locations for additional information. The library should be maintained at the responsible command in the case of digital TOs, AFMC. Very limited information such as this is available at the website of the Technical Data Division of the Business Information SPO.

The expansion of the Air Force Portal should be maximized as a dissemination source for such learning information. The implementation library would address a portion of the learning issue. The other portion which has to be addressed in the area of learning is the cultural aspects which prevent this information sharing. The notion that failure is not acceptable must be addressed. Leaders must feel comfortable in sharing mistakes they have made to prevent the same from happening to others. This is not the

case now, and the Air Force and DoD cannot capitalize fully on our own experiences thus, the prevalent move to study industry. Many of our most relevant lessons learned may be internal but because of cultural barriers remain unnoticed. This must change. Leadership at the DoD and Air Force levels has cited this as a goal within force transformation and is necessary for true organizational learning to occur.

Communication

Though the role of communication in this research was not specifically identified as a construct in the initial research model, the reliance upon Rogers' works makes it an important aspect. This importance was clearly illustrated in the case analysis. Communication was cited as both an important factor in the implementation climate and values fit portions of the case analysis. Communication is the premise on which Rogers' innovation work is built. The Air Force should examine the intricacies of his model to assist in authority adoption decisions. For instance, Rogers suggests using Communication Gap theory generated by Tichenor (1970) to asses the effects of communication on gaps between different groups within an adopting organization (i.e. older TO users versus younger users).

This theory could be utilized to assess the effects of different communication channels, sources, messages, etc. on altering the mindset of older personnel. Ultimately, this would be an assessment of how well different types of communication are on bridging the highlighted apparent mindset gap that exists between different groups of users of the digital TO system. This but one example of the many communication topics addressed in Rogers' work, others include communication channels, structure, networks,

opinion leaders, change agents, and communication campaigns. All which could assist in Air Force efforts to communicate the benefits of authority adopted innovations or even how to establish better intra-service communication networks to facilitate the type of exchange occurring with the Global Hawk JATDI program. Ultimately the benefit could be increased implementation effectiveness and better resource usage.

Bureaucracy

The bureaucratic nature of government work breeds a certain culture with unique values and beliefs. In many organizations and especially in government work there is a paradox of sorts with the need for innovation and the resistance to change. The top-level pressures highlight this in the cases. These pressures did not seem overwhelming in the studied cases. However, they do indicate the potential for stifling innovation and reducing innovation implementation effectiveness. The concept of the Air Force Acquisition Center of Excellence is intended to give practitioners a means to remove unnecessary roadblocks from the path of innovative thinking. The success of this concept has yet to be measured, but in theory it is sound. Innovations such digital TOs would be served well to have an advocate such as the ACE at the highest level of leadership. This advocacy would go to counter the inherent nature of bureaucracies, as being risk adverse and resistant to change does not impede necessary transformational innovations. The AFTOTO is a perfect fit for this duty; however the legitimacy of such an office would have to come from Air Force level leadership.

An additional area of interest in this category is the struggle between the need to maintain standardization in a bureaucracy and allowing sufficient latitude for innovation.

Though standardization is inherent and needed in authority adoption decisions in order to truly foster innovation within an organization its members must not feel stifled by the standard. Innovations do not have to be newly developed products or processes, thus with digital TOs the Air Force specific requirements may be inhibiting the use of other digital TO tools. An example of this was seen in the Global Hawk use of JATDI a program developed for the Navy. Perhaps the standards should be at a level which requires a certain interface requirement but not be so specific as to prohibit the use of tools which could serve to inject innovation.

Limitations

As previously stated, this research contains some clear limitations. As a case study, the specific findings are limited to the individual cases under study. This does not preclude the conclusions from being generalized to other situations. Further, additional time and resources may have allowed for a larger sampling and more diverse data type collection.

The intent of this research was to investigate innovation implementation in the Air Force within the context of Innovation Diffusion Theory. The primary purpose was to facilitate the establishment of a framework to evaluate future innovation implementation efforts. The researcher hopes that the findings of this study will facilitate a framework useful not only to future Air Force digital TO implementation efforts but other innovation implementation efforts across the DoD as well.

Recommendations for Future Research

The Air Force should explore the expanded use of Innovation Diffusion Theory in its innovation process. Of particular note should be Rogers' works and those building on them. The comprehensive nature of his works coupled with its communication base could provide insight to the Air Force's innovation process.

The Air Force should study its barriers to internal organizational learning. The organization's inability to effectively learn from its internal experiences could be costing a substantial amount of money. Money that is spent on studying industry may be able to be saved if the organization could effectively learn from its own endeavors.

Further research should be conducted to quantify the research model developed in this thesis. The level of contribution each variable has on the constructs should be addressed. Such an effort could go to assist leadership using the model trade space and to focus scarce resources on its most important aspects (e.g. training over trialability).

A study to determine the effect of digital TOs and other innovations have on organizational cultures should be conducted. Rogers (1995) alludes to something called Pro-Innovation bias. This bias occurs when the adopting organization becomes enamored with the innovation and fails to see the effects the economic, social, or environmental effects of the innovation.

APPENDIX A: INITIAL CONTACT EMAIL

TO: AMC/LGXI
C-17
F-16
Global Hawk

My name is Capt. Howard Byrd and I am a student at the Air Force Institute of Technology, Graduate School of Engineering and Management, AFIT/ENV, Wright-Patterson AFB OH. My e- mail address is: howard.byrd@afit.edu. I am working on my thesis entitled Innovation Implementation in the Air Force. My sponsor is the AFMC Acquisition Center of Excellence.

Will you be able and willing to assist me in providing data? Specifically, answering some general questions about the implementation of digital technical orders in your organization and providing any implementation documents such as an implementation plan, training plans, and any unique information/documents that is related to the implementing of digital technical orders in your organization, etc.

Please let me know as soon as possible if you can help via response to this e- mail or by telephone at 255-3636 ext. 6396.

Additionally, if you can help, please provide the aforementioned materials either via e-mail or send to:

AFIT/ENV
Graduate School of Engineering & Management
ATTN: Howard Byrd, Student
Wright-Patterson AFB OH 45433

My timeline: Pending your response, I will contact you for a short interview via telephone. I expect to contact you and complete the questions in early to mid January to allow ample time for analysis.

Thank you for your time.

Again, please let me know if I can count on you to provide data for my thesis your participation is greatly appreciated.

Capt. Howard Byrd, AFIT/ENV
Wright-Patterson AFB OH

APPENDIX B: INTERVIEW SCRIPT

Name of Organization: Date:

Name of Participant:

Phone:

Email:

Position/Title:

Good Morning/Afternoon. My name is Howard Byrd and I am conducting this interview as part of my master's thesis effort at the Air Force Institute of Technology. I am studying innovation implementation in Air Force organizations. This morning/afternoon I would like to talk to you about your perception of your organization's implementation of fully digital tech orders. This interview is completely voluntary and confidential if at any time you would rather not answer a question please say so. The information will be used for a report but I will not include your name. The interview should last about 30-40 mins and with your permission will be taped. With your agreement I will proceed with the interview.

Frame Questions

Can you please state your position and briefly describe your responsibility in your organization?

Can you give me brief synopsis of where your program is with implementing its digital technical order system?

For the remainder of the interview if I refer to your "implementation efforts" this is what I am referring too.

This is a yes/no question.

Do you have a formal implementation plan that outlines specific aspects of digital tech order implementation?

1. Yes
2. No

Training

I will now ask you a few questions concerning training as it relates to your digital tech order system.

This is a yes/no question.

Will there be a formal training program available prior to the implementation of your digital tech order system?

1. Yes
2. No

If Yes

Please briefly describe.

If No

Any particular reasoning? Please briefly describe.

After implementation will are you planning for a formal support system to provide users with needed updated training and support? (i.e. helpdesk)

Trialability

The next questions deal with the ability to try-out aspects of your digital tech order system prior to its implementation.

This is a yes/no question.

As a part of your implementation efforts will users be able to use the digital tech order system either in parts or in its complete state on a trial basis prior to its implementation?

1. Yes
2. No

If yes

How so?

If No

Why not? (not needed, option not available)

Relative Advantage/Incentive

This question is concerning the Air Force's initial decision to implement a fully digital tech order system.

In your opinion what you would identify as the top three motivating factors leading to the initial Air Force decision to use digital tech orders?

On a scale of 1 to 5 with 1 being extremely worse and 5 being extremely better:

How would you rate the digital tech order system you are implementing as being in relation to the tech order system previously used?

Would you like to explain?

Leadership Attitude Toward Change

This set of questions will deal with your leadership's general attitude toward and support for the implementation of your digital tech order system.

On a scale from 1 to 5 with 1 being not at all supportive and 5 being extremely supportive
How would you characterize your leadership's overall attitude towards the implementation of digital tech orders?

Can you provide a specific example of how this attitude is or was exhibited?

On a scale from 1 to 5 with 1 being low and 5 being high.
How would you describe the level of input to leadership you have in implementation planning?

If High (4 or 5):

How would you characterize the importance of this input discussed in the previous question on the actual implementation of the digital tech order system?

Can you briefly describe how so?

If Low (1-3):

In your opinion would having a higher level of input into the implementation planning process have facilitate your implementation efforts?

Can you briefly describe how so?

Accessibility

The next set of questions relate to your organization's ability to obtain useful information relating to the digital tech order system prior to its implementation.
This is a yes/no question.

To your knowledge has your organization sought to obtain information (from magazines, books, web information, trade information, etc.) to better explain the use of the digital tech order system?

1. Yes
2. No

If so:

On a scale of 1 to 5 with 1 being extremely difficult and 5 being extremely easy
How you describe your organizations ease of obtaining this information?

On a scale of 1 to 5 with 1 being not important and 5 being extremely important
Please indicate the importance of the information discussed in the previous question to your implementation efforts.

Finally, how would you describe your leadership's role in facilitating the availability of this information?

Learning

This set of questions deals with your organization's use of feedback from organizations that previously implemented a digital tech order system.

This is a yes no question.

Has your organization had any interaction with other organizations or programs that have already implemented digital tech orders concerning your implementation efforts?

1. Yes
2. No

If so:

On a scale from 1 to 5 with 1 being not important and 5 being very important
How important has this interaction been to your implementation efforts?
Can you briefly describe the nature of this interaction?

If not:

Would this type of interaction been helpful in facilitating your implementation efforts?

Values Fit

These questions will seek to address how compatible the implementation digital tech order was with the existing beliefs, values, and culture of the organization.

On a scale of 1 to 5 with 1 being not compatible and 5 being completely compatible
Indicate how compatible you feel the implementation of the fully digital tech order system will be with the beliefs and culture of your organization.

In your opinion what will be the major cultural compatibility issue during the implementation of your digital tech order system?

Is the issue discussed in the previous question affecting the progress of current implementation efforts?
Can you briefly discuss how the issue was addressed?

Innovation Effectiveness

The next questions are concerned with how you foresee the overall effectiveness of your digital tech order system.

This is a yes/no question.

Do you feel there will be situations where digital tech orders will not be used even after implementation?

1. Yes
2. No

This is a yes/no question.

Are there policies being developed in your organization to discourage nonuse of digital tech orders?

1. Yes
2. No

For this set of questions I will read you two definitions and I would like you to indicate in which category your organization's use of the digital tech order system fits.

Compliance: The use of an innovation comes primarily from the expectation of leadership
Commitment: Use of an innovation comes from the alignment of the innovation with the values and beliefs of an organization and its use stems from a genuine enthusiasm about the innovation

Would you describe your organization's attitude and efforts towards your digital tech order system as compliant or committed?

For the final question I would like to know if there is anything you feel is important to add to the information you have already provided.
(Air Force Implementation efforts, your implementation efforts, etc.)

This concludes the interview. I would like to sincerely thank you for taking time out of your busy schedule to answer my questions. Do you have any questions for me at this time?

If not:

Have a nice day.

BIBLIOGRAPHY

Abrahamson, E. "Managerial Fads and Fashions: The Diffusion and Rejection of Innovations," *Academy of Management Review*, 16: 586-612 (1991).

Abrahamson, E., and L. Rosenkopt"Institutional and Competitive Bandwagons: Using Mathematical Modeling as a Tool to Explore Innovation Diffusion," *Academy of Management Review*, 18 (3), 487 (1993).

[AFCV] Air Force Common Viewer Description. IDE Website http://www.ide.wpafb.af.mil/AFCV/what_is_it.htm. February 2003.

[AFMC] Air Force Material Command Fact Sheet. AFMC Website http://www.afmc.wpafb.af.mil/HQ-AFMC/PA/fact_sheet/afmcfact.htm. October 2002.

Barney, Jay. "Firm Resources and Sustained Competitive Advantage", *Journal of Management*, 17: 99-120 (1991).

Bushe, Garvase, R**. "**Cultural Contradictions of Statistical Process Control In American Manufacturing Organizations", *Journal of Management*, 14: 19-32 (Mar 1988).

Carter, Joseph R. and Ram Narashiman, "Is Purchasing Really Strategic?", *International Journal of Purchasing and Materials Management*, 20-28 (Jan, 1991).

Damanpour, Fairbornz. "Organizational Innovation: A Meta-Analysis of effects of Determinants and Moderators", *Academy of Management Journal Studies*, 38: 555-590 (1991).

Damanpour, Fairbornz, "Innovation Type, Radicalness, and the Adoption Process", *Communication Research* 15: 45-65 (Oct 1988).

Damanpour, Fairbornz, "Organizational Complexity and Innovation: Developing and Testing Multiple Contingency Models", *Management Science,* 42: 693-716 (May 1996).

Damanpour, Fairbornz and Shanthi Gopalakrishnan, "The Dynamics of the Adoption of Product and Process Innovations in Organizations", *Journal of Management Studies*, 38: 45-65 (Jan 2001).

Damanpour, Fairbornz, Kathryn A. Szabat, and William M. Evan. "The Relationship Between Types of Innovation and Organizational Performance", *Journal of Management Studies*, 26: 587-601 (Nov 1989).

De Propris, Lisa. "Types of Innovation and Inter-firm Co-operation", *Economics of Innovation & New Technology*, 9: 421-447 (Sep 2000).

[CONOPS] Department of the Air Force. *The Air Force Technical Order Concept of Operations*, Revision 7 Dec 2002.

Deptula, David A., "Air Force Transformation Past Present and Future", *Aerospace Power Journal*, (Fall 2001).

Dooley, David. *Social Research Methods* (4th ed.), Upper Saddle River, New Jersey: Prentice Hall, Inc., (2001).

Downs, G.W. and L.B. Mohr. "Toward a Theory of Innovation", *Administration and Society*, 10: 379-408 (Feb 1979).

Eisenhardt, Kathleen M. "Building Theory from Case Study Research," *Academy of Management Review*, 14: 532-550 (1989).

[ETIMS] Department of the Air Force. *Preliminary Operational Requirements Document ETIMS*, Version 5.2: 25 Sep 2002.

Ettlie, John, E. and Ernesto M. Reza,. "Organizational Integration and Process Innovation", *Academy of Management Journal*, 35: 795-827 (Oct 1992)

Frambach, Ruud T. and Niels Schillewaert. "Organizational Innovation Adoption: A Multi-Level Framework of Determinants and Opportunities for Future Research", *Journal of Business Research*, 55: 163-177 (Feb 2002).

Hall, G. E., R. C. Wallace and W. A. Dossett. A Developmental Conceptualization of the Adoption Process within Educational Institutions, Austin, TX: Research and Development Center for Teacher Education, The University of Texas (1973).

Holden, Len. "European Trends in training and development", I*nternational Journal of Human Resources*, 2: 113-132 (Sep 1991).

Holland, Lauren. "The Weapons Acquisition Process: The impediments to Radical Reform", *Acquisition Review Quarterly*, 235-251 (Spring 1998).

[Intergraph] Joint Aviation Technical Data Integration (JATDI) Program Description. Intergraph Solutions Group Website http://www.intergraph.com/solutions/profiles/JATDI.asp. February 2003.

[JCALS] Joint Computer-aided Acquisition and Logistic Support (JCALS) Program Description. IDE Website http://www.ide.wpafb.af.mil/jcals/Air%20Force%20JCALS%20Program.doc. February 2003.

Karahanna, Elena and Detmar W. Straub. “Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs (N1)”, *MIS Quarterly*, 23: 183-214 (Jun 1999).

Kivimaki, Mika, Hannakaisa Lansisalmi, and Marko Elovainio. “Communication as a Determinant of Organizational Innovation”, *R & D Management*, 30: 33-43 (January 2000).

Klein, Katherine J. and Joanne Speer Sorra. “The Challenge of Innovation Implementation”, Academy of Management Review, 21: 1055-1070 (Oct 1996).

Klein, Ron. “DoD Enterprise Solutions, Structural/Cultural Issues Remain Major Impediment”, *Program Manager* (January-February 2002).

Leifer, Richard, Gina O’Conner, and Mark Rice. “Implementing Radical Innovation in Mature Firms: The Role of Hubs”, *Academy of Management Executive*, 15: 102-113 (Aug 2001).

Lloyd, Robert, E. “Government Contracting Pathologies”, *Acquisition Review Quarterly*, 245-258 (Summer 2000).

McGrath, Rita Hunter and Ian MacMillan. *The Entrepreneurial Mindset*. Boston Massachusetts: Harvard Business School Press, 2000.

Money, William H. “Applying group support systems to classroom settings: A Social Cognitive Learning Theory Explanation”, *Journal of Management Information Systems*, 12: 65-81 (Winter 95/96).

Nissen, Mark E., Keith F. Snider, and David V. Lamm. “Managing Radical Change in Acquisition”, *Acquisition Review Quarterly,* 89-106 (Spring 1998).

Nissen, Mark E. *Contracting Process Innovation*: Technical Report, Number NP-GSBPP-01-001. Navel Post Graduate School, Monterey California, March 2001.

Oliver Pamela, Marwell Gerald, and Teixeira Ruy. "A Theory of the Critical Mass, I. Interdependence, Group Heterogeneity, and the Production of Collective Goods.” *American Journal of Sociology*, 91: 522-556 (1985).

Reger, R.K., L.T. Gustafson, S.M. DeMarie, and J.V. Mullane. “Reframing the Organization: Why Implementing Total Quality Management is Easier said than Done.” *Academy of Management Review*, 19: 565-585 (1994).

Reynolds, Don. “Interactive Electronic Technical Manual Standards and Classes” Address given to NATO ITEP Exchange, Bonn Germany, 31 January 2000.

Rogers, E.M., *Diffusion of Innovations* (4th ed.), New York, New York: Free Press, (1995).

Rogers, E. M., and F. F. Shoemaker. *Communication of innovations: A cross-cultural Approach*. New York: Free Press (1971).

Rumsfeld, Donald H. Secretary of Defense, United States. "21st Century Transformation" of U.S. Armed Forces. Address given to The National Defense University, Fort McNair, Washington, D.C., 31 January 2002.

[TM-86] Draft Appendix to TM-86-01J for Interactive Electronic Technical Manuals.

Salant Priscilla and Don A. Dillman. *How to Conduct your own Survey,* New York, New York: Wiley, (1994).

Yin, Robert K. *Case Study Research: Design Methods*. Thousand Oaks, California: SAGE Publications, (1994).

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
25-03-2003	**Master's Thesis**	Jun 2002 – Jan 2003

4. TITLE AND SUBTITLE

TOWARDS A FRAMWORK FOR UNDERSTANDING INNOVATION IMPLEMENTATION IN THE AIR FORCE

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Byrd, Howard, E., Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(S)

Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 P Street, Building 640
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GAQ/ENS/03-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

HQ AFMC/AE
Attn: Ms. Nancy Gentry
4375 Chidlaw Road DSN: 986-0824
WPAFB OH 45433-7765 e-mail: Nancy.Gentry@wpafb.af.mil

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Key components of the DoD's efforts to transform are in Air Force acquisition and sustainment processes. Digital technical orders are an example of such a sustainment process. The Air Force has mandated it will transform from a paper based technical data environment to a digital one. The success of the implementing such transformational innovations such as digital technical orders is critical to the Air Force's ability to support the overall DoD force transformation efforts. Despite the critical need for successful innovation implementation few studies were found exploring factors that facilitate innovation within DoD, or the Air Force. A framework to examine such factors could assist the Air Force and DoD in their innovation implementation efforts. This thesis explores the usefulness of Innovation Diffusion Theory as such a framework. More specifically, the thesis utilized a case study methodology and included a survey instrument and secondary data analysis to assess the implementation of digital technical orders within the context of Innovation Diffusion Theory.

The results of this effort suggest that Diffusion Theory is feasible as a framework to study innovation implementation in the Air Force and presents a model identifying important factors to implementation.

15. SUBJECT TERMS

Innovation, Implementation, Innovation Diffusion Theory, Digital Technical Orders, Case Studies, Survey

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Stephan P. Brady, LtCol, USAF (ENS)
U	U	U	UU	108	**19b. TELEPHONE NUMBER** *(Include area code)* (937) 255-6565, ext 4367; e-mail: Stephan.Brady@afit.edu

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18