AIR FORCE ORGANIZATIONAL ADOPTION OF
REMOTELY PILOTED VEHICLES

GRADUATE RESEARCH PROJECT

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INCREASED USE OF REMOTELY PILOTED VEHICLES (RPVs)

AND

AIR FORCE ORGANIZATIONAL ADOPTION

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Thomas G. Falzarano

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Abstract

The DOD's Unmanned Aerial Vehicle (UAV) Roadmap outlines the timeline for a potential Revolution in Military Affairs (RMA) where the Air Force and the other military services will shift from a reliance on manned aircraft in combat to remotely piloted vehicles (RPVs). Considering the far reaching influence that manned flight has had on the battlefield, shifting from manned to remotely piloted vehicles is expected to have significant ramifications within the Air Force, potentially influencing the organization's structure, skill requirements, and culture. This research attempts to determine the complex organizational issues associated with the adoption of RPVs by studying past RMAs and related transformations in the civilian sector. The end result is a framework that can be utilized to achieve success in this and similar transformation efforts.

INCREASED USE OF RPVs

AND

AIR FORCE ORGANIZATIONAL ADOPTION

I. Introduction

Early airpower advocates like Billy Mitchell fought for the need for a separate service that specialized in the use of aircraft in combat. Furthermore, they argued that it was appropriate for this separate service to be led by the airmen who piloted the airplanes into combat (Builder, 1994). Given these ideas, the U.S. Air Force was founded. Those with the specialized understanding of the capabilities and limitations of airpower, most often those who piloted aircraft, were charged with training and equipping forces that could execute air operations in support of national objectives.

Technology has dictated that many of these operations be executed using manned aerial vehicles with the Air Force having a proud legacy of warriors that have flown aircraft into battle with the enemy. Over the years, however, the service's leadership has made efforts to incorporate evolving technologies into the force such that war-fighting capabilities could be bolstered and those that flew aerial systems into combat were better protected. While many of these technologies have reduced the number of airmen that are required to fulfill any particular need, manned aerial missions have been the central feature of Air Force operations. At the peak of World War II the Army Air Forces had an inventory of just under 80,000 aircraft (AFHRA, 2004). Today, vastly greater amounts of war fighting capability are provided with fewer than 10,000. A fixed target in World War II that took 9,000 bombs and 1,500 B-17 sorties to be destroyed can now be eliminated with 1 B-2 employing 1 precision weapon (OFT, 2004). However, even these

technological leaps forward have required a plane to be physically piloted and crewed by persons in the aircraft.

As technologies have continued to advance, there is the realistic potential for the Air Force and other agencies to shift largely from the use of manned aircraft to unmanned vehicles, termed unmanned aerial vehicles (UAVs) or remotely piloted vehicles (RPVs; the term used throughout this manuscript). In fact, the Department of Defense's (DoD) 2003 Unmanned Aerial Vehicle Roadmap has outlined a specific timeline to begin shifting their reliance on manned aircraft to RPVs. Unlike other technological advancements, this transition is expected to have significant ramifications within the Air Force. Considering that much of Air Force history and culture has been centered on manned aviation (Builder, 1994), a shift to RPVs might be expected to completely transform the organization's structure, skill requirements, and culture.

Accordingly, this research has several purposes. First, it will attempt to determine the complex organizational issues that are associated with the introduction of RPVs by examining multiple case studies. Military history is full of transformations, also referred to as "Revolutions in Military Affairs" (RMAs) that have revolutionized the way warfare is conducted. Many of these RMAs have been technologically based, dramatically increasing the combat power and efficiency of fighting units while attempting to minimize the risks confronted by those in combat. Some militaries throughout history have adapted better to new technology than others. Experts have argued that new technology continually shapes organizational practices and in turn shapes culture (Deetz, 2000). Many lessons, both positive and negative, can be learned from how organizations have adapted to new technologies. Most importantly, these lessons can give leaders

significant insights into the issues that will be encountered as their organizations embark on other RMAs like the large scale introduction of RPVs.

Second, this effort is designed to give leaders specific recommendations so that they better understand what steps should be taken to prepare for this RMA and how to make it successful. Given the far-reaching magnitude of the DoD's RPV transformation effort, there is a need to completely understand how it might influence the organization so that the transition will go smoothly and the services can realize the benefits that are desired. This effort is designed to explore this issue by drawing inferences from relevant transformations that come from the military and private sectors. However, before these cases are discussed, the concept of a Revolution in Military Affairs is discussed along with the insights that the organizational change researchers have provided regarding such transformations (Chapter 2).

After this review, the systematic process that was used to select, analyze, and draw inferences from both military and private sector transformation efforts is outlined (Chapter 3). The findings that were garnered as this process was applied are subsequently discussed (Chapter 4) culminating with a set of recommendations that leaders can apply to more effectively guide the introduction and diffusion of RPVs throughout the Air Force (Chapter 5).

II. Literature Review

Revolutions in Military Affairs

Great changes in societies and organizations have been universally characterized as revolutions. Looking back to the seventeenth century, Knox (2001) suggested that there have been five great revolutions within society and politics that facilitated similar revolutions in military operations. These include: (a) the creation of the modern nation-state which encouraged large-scale disciplined military powers to defend and support them; (b) the French Revolution which merged mass politics with warfare; (c) the Industrial Revolution which facilitated nation-states' ability to arm, cloth, feed, and move large armies; (d) the First World War which further combined the ideas of politics with industrial capabilities to guide war efforts; and, (e) the advent of nuclear weapons which led to the Cold War in the European and northeast Asian theaters. Each of these great revolutions, in turn, enabled many smaller "Revolutions in Military Affairs" to occur. For example, the advent of nuclear weapons enabled several technological innovations and tactics such as precision reconnaissance, precision strike, stealth, computerization, and networking (Knox, 2001). The key point is that these changes can vary greatly in scope but they all have significant impacts in how a military as an organization goes about its business.

The term "Revolution in Military Affairs" has been used in conjunction with many significant new military technologies and ideas. "Revolution in Military Affairs" is a term that does not originate from within the Pentagon or the Whitehouse. Knox (2001) has suggested that the idea of an RMA has two derivations. The first derivation, dating

back to the early seventeenth century, occurred when the warrior king of Sweden, Gustavus Adolphus, embarked on a military revolution. This revolution radically changed the military organization and military tactics by employing highly mobile, lightly armed foot soldiers, in a combined arms approach (Horowitz, 2004). This RMA encompassed innovative ways to use warfighting technologies and a strong organizational structure made it a reality. The innovations of Gustavus Adolphus were made possible through his brilliant leadership and facilitated by the Thirty Year's War, the War of the Grand Alliance, and the Dutch War (Horowitz, 2004).

The more contemporary derivation for the term RMA has been adopted by the United States and comes from the Soviet Union. Beginning in the 1960s, Knox suggests that the Soviet military leaders recognized RMAs within the context of a coming military technical revolution. It was the Soviet Union that first recognized the potential of precision guided munitions (PGM) from studying the use of laser guided bombs during the LINBACKER campaigns. They recognized the benefits of PGMs before the United States even though it was the United States that was employing them.

In the simplest terms, an RMA is a paradigm shift that renders one or more core competencies obsolete or creates one or more new core competencies (Hundley, 1999). This definition blends the concepts of a *dominant paradigm* with that of a *core competency*. Dominant paradigms exist in many human endeavors to include military operations. A dominant paradigm of the Napoleonic Warfare, for instance, was orderly infantry units maneuvering to engage through direct fire while in close quarters (Kretchik, 2002). As dominant paradigms are challenged with RMAs, the need for certain core competencies or fundamental abilities that provide the foundation for a set of

military capabilities come into question as well (Kretchik, 2002). Some authors have suggested the tank, manned aircraft, and the aircraft carrier represent core competencies of the military services (e.g., Hundley, 1999). Using this definition, a true RMA would be similar to replacing the battleship with the aircraft carrier. Transformations or RMAs can also be seen to have three distinct characteristics; they change the shape or appearance of the force, they change the character of the force, and they change the nature or function of the force (Horowitz, 2004). It is this definition that is of importance to this manuscript.

Clearly, many RMAs revolve around the introduction of new technologies. This is not to suggest, however, that all new technologies that are introduced are revolutionary in nature. Typically, new technologies are characterized as sustaining or disruptive. Sustaining technologies improve the performance of existing products (Christensen, 2003). In Air Force terms, a sustaining technology might be a new engine with higher performance or a communications satellite with increased bandwidth. In rare instances it may be possible for such technological advances to be disruptive. Typically though, no dominant paradigm or core competency is challenged because of these technologies. Instead, these technologies improve the dominant position of the organization that employs them. On the other hand, disruptive technologies are consistent with RMAs, eliminating a fundamental ability that provides the foundation for a set of military capabilities or establishes a completely new one (Christensen, 2003).

Past experiences with the introduction of the aircraft carrier have been categorized as disruptive in nature. Prior to the introduction of the aircraft carrier the battleship reined supreme within the Navy; however, the aircraft carrier rendered the

traditional battleship meaningless where they play no role in the today's modern United States Navy. This transformation can be illustrated by tracing several key naval engagements from the Battle of Trafalgar in 1805 to the Battle of Midway in 1942. In 1805, the classic wooden ship was the state of the art was which had evolved from earlier transformations. By 1916, at the Battle of Jutland, steam powered dreadnoughts completed the transformation from sail to steam powered iron clad ships. This revolution in technology and the tactics required to employ it were once again transformed as evidenced by the Battle of Midway. Here naval airpower proved to be the decisive weapon leading to victory (Horowitz, 2004).

RPVs: A Revolution in Military Affairs

Research in the civilian sector sheds light on the idea of sustaining and disruptive technologies. An extensive case study of the disk drive industry details some key but often overlooked characteristics of disruptive technology. A total of 116 cases of new technologies were studied with four of the cases involving disruptive technologies. In each of these four disruptive cases the industry leaders before the introduction of the new technology were no longer industry leaders after the new technology became established (Christensen, 2003). The ramifications of this are significant. There may be something industry leaders do or fail to do that makes them susceptible to disruptive technologies. Perhaps working hard and hiring the best people is not enough for industry leaders to maintain their dominate positions in the face of disruptive technology.

The story with sustaining technologies appears to be exactly the opposite. The other 111 cases involved sustaining technologies where the industry leaders maintained their dominant positions after the introduction of new disk drive technology (Christensen,

2003). These sustaining technology cases seem to offer credence to the popular notion that hard work and dedication will get you to the top and keep you there. However, this only appears to be true of industries that experience changes in sustaining technology rather than those that experience disruptive technology shifts. Once a disruptive technology is introduced the playing field is reset. An analysis of current national and international RPV programs reveals the United States is not the only player and its dominant military position should not be assumed.

As noted, the Air Force has been charged with the responsibility to carry out such tasks as precisely and rapidly striking enemy targets or delivering troops and supplies anywhere on the surface of the Earth to name a few. The Air Force has relied on a pool of exceptionally trained pilots and aircrews to operate aerial vehicles to fulfill this obligation. This dominant paradigm has been challenged with dramatic improvements in technology. That is, RPVs have challenged the requirement for piloted aircraft within the reconnaissance and surveillance arenas due in part to the success of systems like Globalhawk (DoD Roadmap, 2003). Although RPVs are not a new weapon system in the United States military, one could easily argue that the transition to use RPVs to the extent to which is being planned can be characterized as an RMA.

The first recorded use of modern Combat Unmanned Aerial Vehicles (UCAV) occurred during Vietnam. By 1976 though funding was completely cut despite promising results. Vietnam was also the first extensive test of precision guided missiles (PGM), a technology that will be discussed later in this paper. Ironically, it appears the full benefits of both these technologies were not fully realized until after the first Gulf War. In 1971, the first air-to-ground missile was fired from an RPV (Wagner, 1982). Also in

1971, an RPV was tested against two experienced Navy pilots flying F-4s equipped with sparrow and sidewinder missiles in air-to-air combat (Wagner, 1982). The RPV outmaneuvered these two pilots who were unable to shoot down the unmanned vehicle showing some of the technology needed for RPVs to succeed has existed for many years. While defensive basic fighter maneuvers are only a portion of the skill set required of a combat pilot, it did offer some evidence of the RPV's potential and offered that evidence over 25 years ago.

Since those early tests, the technologies have continued to improve and the DoD has become committed to the further diffusion and employment of these technologies in all areas of operation. The DoD's UAV Roadmap is a comprehensive DoD-wide vision for RPVs from today through the year 2027. It differs from the previous roadmap in that it is directive in nature. For example, the roadmap outlines that RPVs could be introduced into air refueling operations between 2015 and 2020. RPV counter air missions, currently handled by the F-14, F-15, and F-16 fighter aircraft, may be flown as early as 2020-2025. Figure 1 presents a summary of the missions being considered for RPVs, the manned aircraft that fulfill those missions, and the timelines that have been directed.

MISSION	CURRENT AIRCRAFT	INTRODUCTION INTO OPERATIONS					
		2005	2010	2015	2020	2025	2030
Payload with Persistence							
Communication Relay	ABCCC, TACAMO, ARIA Commando Solo	▮					
SIGINT Collection	Rivet Joint, ARIES II Senior Scout, Guardrail		▮				
Maritime Patrol	P-3		▮				
Aerial Refueling	KC-135, KC-10, KC-130			▮			
Surveillance / Battle Management	AWACS, JSTARS				▮		
Airlift	C-5, C-17, C-130						▮
Weapon Delivery							
SEAD	EA-6B	▮					
Strike	AV-8, F-117		▮				
Integrated Strike/SEAD	EA-6B, F-16			▮			
Counter Air	F-14, F-15, F-16				▮		
Integrated Strike/SEAD/Counter Air	F/A-18, F/A-22						▮

Figure 1. Timeline for Tranistion from Manned Aircraft to RPVs (DoD Roadmap, 2003)

The directions given are a reflection of current RPV capabilities and the predictions of future capabilities. As of 2002 the DoD's roadmap details 17 mission areas that require funding (see Figure 2). It is not just the dull, dirty, and dangerous but nearly every mission area that has been targeted. In addition to the introduction of new RPVS, some have studied the conversion of manned vehicles to RPVs. The capability to turn many current manned aircraft into an RPV has already been demonstrated, even for large aircraft. In 1985, NASA demonstrated the capability to remotely pilot a Boeing 720 (DoD Roadmap, 2003). Other research has explored the possibility of an unmanned version of the F-16 fighter, airlift aircraft, and air refueling systems. This research has shown that such concepts are feasible and may in fact reduce costs while at the same time increasing combat capabilities.
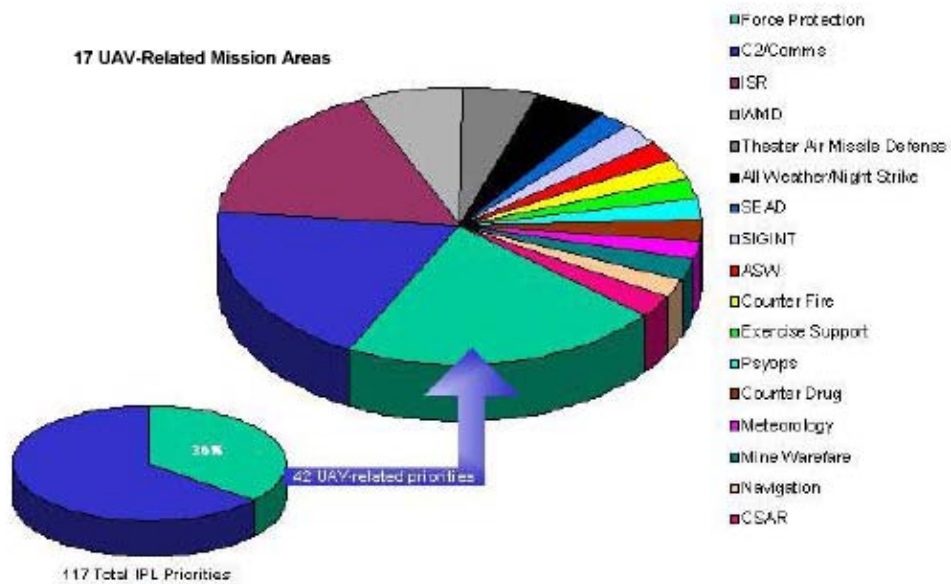
Figure 2. RPV-Related Mission Areas (DoD Roadmap, 2003)

Many of the proposals to modify existing airframes are designed to be interim steps while new RPVs are developed. One such proposal entails modifying F-16s to serve as an interim RPV. This modification could be used to bridge the gap to the next generation of weapon systems while at the same time provide a valuable learning platform. Modifying existing aircraft could provide a cost effective interim dual option vehicle (Thompson, 1998). This relatively low cost option could be used to provide valuable learning opportunities for the development of future RPVs (Thompson, 1998).

As noted, other research has also shown that RPVs are a feasible way to fill the strategic airlift shortfall. Manske (2003) concludes that the technology to make unmanned airlift a reality could be available within 20 years. Clearly, there are many psychological issues associated with this concept. We have not yet reached the point where people are willing to travel in an aircraft that does not have a pilot on board.

However, it does offer further evidence as to the scope of the potential change that is on the horizon.

Moreover, there are 32 countries developing or manufacturing 250 models of RPVs. These countries are in every geographic region of the world with diverse cultures and political systems (DoD Roadmap, 2003). The fact that so many nations are involved in developing, manufacturing, or using RPVs is a threat both in future conventional battles and in the brave new world of global terrorism. However, an equally great threat may come from within in the inability to develop an organization that can fully utilize the technology before our adversaries can.

Past Research

A study on RPV operator requirements was commissioned to determine who should control future RPVs. Should it be officers who are trained as pilots or is there another alternative? Unfortunately this study by the Air Force Research Laboratory yielded very little useful data.

> This study was initiated to examine questions raised at Corona South '97 regarding the type of training pipeline that would need to be established within the Air Force for training pilots of current (i.e., Predator) and future (e.g., Global Hawk and Dark Star) unmanned aerial vehicles (UAVs) and unmanned combat aerial vehicles (UCAVs). Although Air Combat Command now uses rated Air Force pilots to fly the Predator, a secondary issue addressed by the study is the feasibility of establishing an enlisted air vehicle operator specialty within the Air Force. The study employed a combination of a survey and focus group discussions conducted with Predator AVOs assigned to the 11th and 15th Reconnaissance Squadrons between August and December of 1997. The study sampled the opinions of virtually 100% of the trained Air Force AVOs, and the reliability on the written survey was extremely high (Spearman-Brown estimate of reliability equals .88). The

results of the study indicate that current Predator pilots believe that training requirements prior to Predator initial qualification training (IQT) are roughly equivalent to undergraduate pilot training (UPT) received by AF pilots of manned aircraft. Further, they believe that manned aircraft flying experience is essential to effective employment of the Predator. Although these pilots believe that a carefully screened portion of enlisted personnel could successfully complete such training, members of the focus group discussions unanimously expressed concern with giving enlisted personnel the decision-making responsibilities necessary for effective Predator employment. The study yielded very little useful information regarding the training requirements for future UAV and UCAV systems (Hall, 1998: Abstract).

Currently, there are differences across the services. Army, Navy and Marine Corps RPV operators can be enlisted personnel which is a significant departure from Air Force policy (Weeks, 2000). Foreign systems like the British Army Phoenix also utilize enlisted operators (Weeks, 2000). Regardless whether this is a negative or a positive difference there are ramifications on the organizational structure of the Air Force.

Col Mike Warden, known for his role in authoring the air war for the first Gulf War, has written extensively on technology and organization. His book, *The Rise of the Fighter Generals*, analyzes how technology places a decisive role in determining who rises to the senior leadership positions in the Air Force. This research is important because it offers evidence as to how technology can dramatically reshape an organization. From the start of the Air Force as an independent service until the mid 1960's the "Bomber Barons" ruled the landscape. Warden goes on to say this was because they controlled all the instruments of power that produced senior leaders. Today, a similar organizational structure is in place. Warden asserts, funding, number of flying wings, and number of aircraft are institutional barriers to advancement for anyone not

operating the dominant weapon system. Starting in the mid 1960s the balance of power began to shift towards the fighter community. This shift was driven by both a shift in doctrine and a shift in resources that fed upon each other. Spending for fighter aircraft overtook spending for bomber aircraft. The total number of fighter aircraft was now greater than bomber aircraft. This was also the last time the number of bomber wings would outnumber fighter wings, a direct result of the mismatch in numbers of aircraft. Warden further asserts the Air Force, more than any other service, seems to tie advancement to senior leadership positions to the dominant technology and whoever controls the dominant technology controls the Air Force (Builder, 1994). This research may have implications that are directly applicable to RPVs.

Theoretical Framework for Studying the Introduction of RPVs

Hundley has described several characteristics of RMAs in his work titled, *Past Revolutions Future Transformations*. Regardless of the nature of the RMA (i.e., the introduction of a new technology or tactic), RMAs are not typically brought about by dominant military players or fully exploited by the nation inventing the new technology. Furthermore, the first nation to take full advantage of the RMA is often rewarded with enormous benefits. Another common thread according to Hundley is the military utility of RMAs is very often controversial and met with skepticism and doubt right up until the moment it is first proven. Finally, successful RMAs share three common components: technology, doctrine, and organization. It is the organizational component of RMAs that is of consequence to this manuscript and it is this concept that will be fully analyzed.

In sum, an RMA and the transition to RPVs in particular are significant organizational changes. Many events in organizations are given the label organizational

change. These events include mergers, structural changes, top management changes,

technological innovations, and cultural change. In general terms, Daft (1998) defined

change as "the adoption of a new idea or behavior in an organization" (p. 291). The

organizational behavior literature has taken a similar tack, defining change as "the act of

varying or altering conventional ways of thinking and behavior" (Wagner & Hollenbeck,

1998: 345). With this in mind, I will turn to the change literature to gain some insights

into what leaders might expect as the DoD transitions to RPVs.

Between 50 and 70 percent of all organizations that undertake a radical innovation

fail (Utterback, 1994). There are many reasons for this and many experts have offered

theories to help leaders understand the consequences of technological innovation on

organizational culture. Nadler (1989) has developed a framework for understanding

specific types of changes. His model details how leaders of organizations can initiate

planned organizational changes successfully (see Figure 3). To understand Nadler's

model it is essential to understand the major components. First is strategy, which is the

pattern of decisions on how resources will be allocated in response to the external

environment (Nadler, 1989). Second is organization, which is simply made up of work,

people, formal structures, and processes (Nadler, 1989). These components work

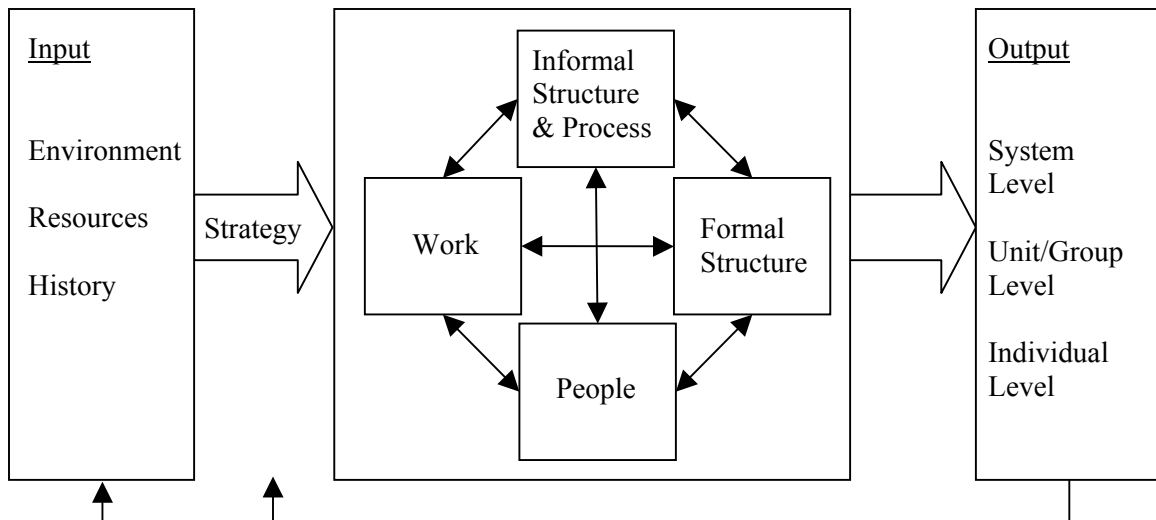together to change inputs into system, unit, and individual level outputs.

Figure 3. Organizational Change Process (Nadler, 1989)

Effective organizational change is realized when congruence is maintained within the system while implementing the change (Nadler, 1989). An effective leader realizes he can not change one of the parts of the process without having an effect on the rest of the system. In the end if change is managed properly the result will be an improved output of some type.

Nadler (1989) further segments organizational change into one of four different categories by evaluating the scope and the position of the change in relation to external events. Scope, refers to how pervasive the change is planned to be. Some changes will be narrow in scope and involve only specific units. Other changes may encompass the entire organization. Changes may be in response to a series of events, also called relative changes. Still other changes will be initiated in anticipation of external events to occur, also called anticipatory changes (Nadler, 1989). These definitions form the basis of the model used to categorize and define the types of changes organizations go through.

	Incremental	Strategic
Anticipatory	Tuning	Reorientation
Reactive	Adaptation	Re-creation

Figure 4. Types of Organizational Change (Nadler, 1989)

The four types of organizational change according to Nadler (1989) are tuning, adaptation, reorientation, and re-creation. This paper will focus on reorientation or "Frame Bending" changes. However, there are aspects of re-creation that will also come into play.

> *Tuning*: This is an incremental change made in anticipation of future events. It seeks ways to increase efficiency but does not occur in response to any immediate problem.
>
> *Adaptation*: This is incremental change that is made in response to external events. Actions of a competitor, changes in market needs, new technology, and so on, require a response from an organization, but not one that involves fundamental change throughout the organization.
>
> *Reorientation*: This is strategic change made with the luxury of time afforded by having anticipated the external events that may ultimately require change. These changes do involve fundamental redirection of the organization and are frequently put in terms that emphasize continuity with the past (particularly values of the past). Because emphasis is on bringing about major change

without a sharp break with the existing organization frame, we describe these as frame-bending changes.

Re-creation: This is strategic change necessitated by external events, usually ones that threaten the very existence of the organization. Such changes require a radical departure from the past and include shifts in senior leadership, values, strategy, culture, and so forth. Consequently, we call these frame-breaking changes (Nadler, 1989: 199-204).

One could argue that RPVs fit into the tuning or adaptation categories based on the incremental nature of the change. Adaptation is not a valid choice as the RPV transformation is better categorized as anticipatory rather than reactive. Decision makers do have the luxury of time when considering how to develop the technology and if needed adjust the organization. The choice is then between a reorientation and tuning change. It is true that most RMAs involve many incremental steps along the path to success. However, the point of this manuscript is to examine the long term strategic organizational issues. This will provide some insight into what issues the future organization will be faced with before they arise.

The intensity of the change is different with each type of organizational change. Re-creation has the highest relative intensity, followed by reorientation, adaptation, and tuning (Nadler, 1989).
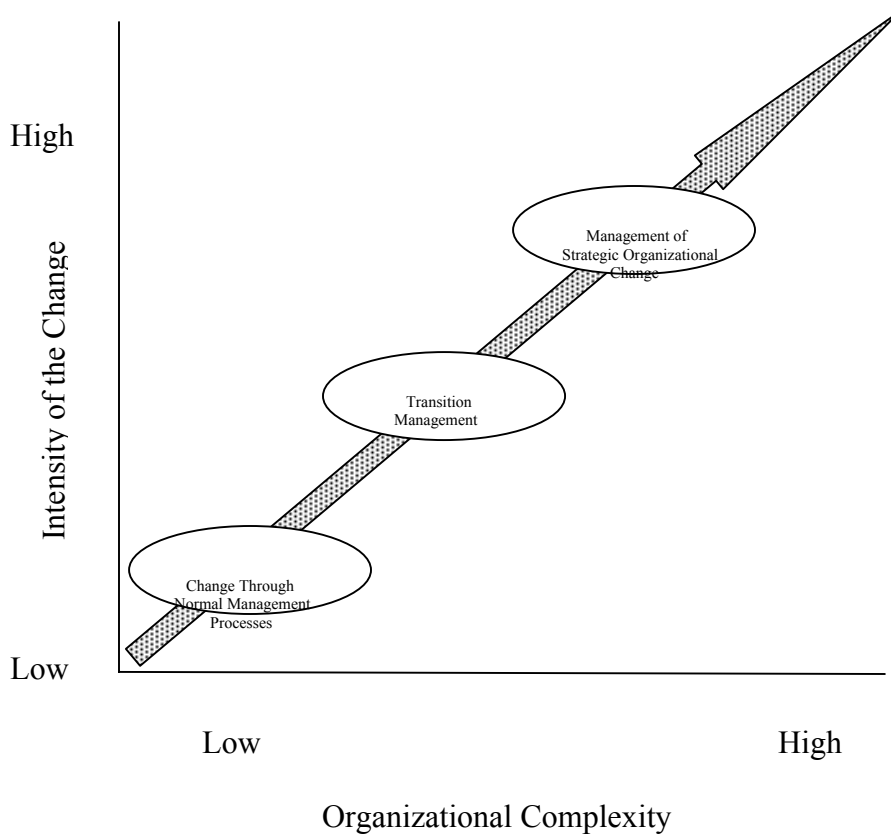
Figure 5. Types of Organizational Change (Nadler, 1989)

This also shows the extent that leaders must go to successfully lead organizations through strategic changes of the "Frame Bending" type. What exactly is a successful "Frame Bending" change? This question is essential to answer and Nadler has attempted to answer it in a series of nine principles.

Nadler refers to the first step in this process as the diagnosis principle. It involves analyzing the organizations strengths and weaknesses in relationship to the environment (Nadler, 1989). Simply benchmarking against the best military and civilian organizations is not enough to accomplish a thorough diagnosis. This practice typically ends up in

quick solutions that lack direction and also do not include critical success factors (Nadler, 1989).

The vision principle is next on the list. Vision is a blueprint of what the organization wants to become once it achieves the "Frame Bending" change (Nadler, 1989). Other experts have also written about vision. Without a strong vision, employees may fragment and begin working in many different directions (Daft, 1998). In reorientation changes, a vision becomes even more important. Leaders can't switch to a new vision without first getting the employees to buy into the change. However, it may not always be best to immediately share the new vision with the organization. The introduction of the new vision must be carefully timed and introduced to reduce skepticism and loss of management credibility (Nadler, 1989). An organization may simultaneously have to accomplish its original mission while at the same time work towards a dramatically different future.

Reorientation changes, by their nature, require a tremendous amount of energy. This energy must be directed and linked to the core strategic issues of the firm, company, or organization. These concepts are known as the energy and centrality principles (Nadler, 1989). If the process is planned properly, the early stages of the reorientation will be the most difficult. In the beginning most members of the organization may not even see a need for drastic change. In fact, many senior leaders may be the ones who can't see into the future. A sense of urgency must be created right up to the limits of tolerance (Nadler, 1989). However, this urgency must remain focused on the key issues and not become too broad in scope. Organizations will begin to ignore themes that appear to be too ambitious or too far off from the central theme. This is labeled the three-

theme principle (Nadler, 1989). Energy can sometimes be supplied by a champion of the change.

Nadler devotes several principles to the theme of leadership. However, his most important theme is probably his last which is titled, the investment-and-returns principle. The two parts to this theme are the no-free-lunch hypothesis and the check-is-in-the-mail hypothesis. Reorientation will require a significant amount of resources that may have been previously devoted to the organizations old way of doing business. It is a difficult balancing act to sustain the current organization and at the same time plan for the distant future. A "Frame Bending" change will take time to become reality as organizations go through the predictable states of change; awareness, experimentation, understanding, commitment, education, application to leveraged issues, and integration into ongoing behavior.

Theory is important but it still must be proven to have credence in real world situations. This is evident more than anyplace else in the National Aeronautics and Space Administration. Organizational culture was seen as a central factor in the crashes of the Space Shuttles Columbia and Challenger (McCurdy, 1993). It was a mechanical failure that resulted in the loss of both shuttles and their crews. However, it was a failed organizational culture that allowed all the contributing factors of each accident to come together to produce disaster. This is an extreme example where organizational culture failed to keep pace with technological achievements and contributed to the death of several people, the possible end of manned space flight, and ultimately may spell doom for the organization. It does though underline the significance of culture in accomplishing an organization's mission. By the time an organization realizes there is a

problem it may in fact be too late. In the military business, too late is not an option

especially when other forces and nations may ultimately want to see the United States

destroyed.

III. Method

A multiple case study approach was used to identify the issues Department of Defense (DoD) leaders should anticipate as they further introduce and diffuse the use of remotely piloted vehicles (RPVs) into military operations. The multiple case study was accomplished in three phases. In the first phase, criteria were selected and applied to choose the cases that would be studied. These criteria were selected for both theoretical and practical reasons. Theoretically, the criteria selected were designed to ensure that the cases were similar in scope and type to the DoD's RPV transformation effort. Practically, cases were examined only if materials (i.e., published and unpublished) were available to analyze. The second phase of the research was designed to examine the cases that emerged as they were evaluated against the criteria selected, exploring the methods by which these changes were introduced, the barriers encountered, and the implications these transformations had on the organizations involved. Finally, the third phase of the study was the culmination of the effort where the conclusions from the case analyses conducted were used to draw inferences concerning the RPV transformation effort on the DoD.

Phase I—Case Selection

The pool of cases for this research could have been limitless. The first step was to identify where to begin looking for relevant case studies. Multiple texts and reports on past RMAs were compared to narrow down the field of material. The initial pool of cases was made up of ones that authors seemed to be in agreement on. That is, multiple authors viewed the specific RMA as significant and representative of the concept. A

similar process was also followed for the civilian cases. However, the volumes of research on the topic made it more difficult to select a potential pool. The search was halted once it was clear that multiple cases were making similar points. The final step was to apply theoretical and practical criteria to the potential pool to arrive at the final cases.

Theoretical criteria. As noted, the theoretical criteria were designed to ensure that the cases used to draw insights were consistent with the scope and type of the effort to further introduce RPVs in the DoD. More specifically, the scope of the DoD's RPV transformation effort was consistent with Nadler and Tushman's (1989) concept of a reorientation where these reorientations were both strategic in nature and anticipatory. That is, the change effort took place over time and involved a fundamental transformation of the organization but at the same time maintained continuity with the organization's past values. Given Nadler and Tushman's underlying framework, several questions were used to evaluate potential cases. These included: (a) does the case involve a strategic organizational change made with the luxury of time? And, (b) was the case anticipatory in nature? This meant that cases were only included if they encompassed most or all aspects of the organization involved (i.e., large scale and strategic in nature). The cases had to involve changes that had a relatively long-term orientation that were to be fully implemented ideally 3-5 years into the future. However, it is important to note that many of these types of changes can take decades to come to fruition. In addition, the cases were evaluated and selected if they involved changes that were anticipated by leaders based on predicted events.

Next, the type of change effort that was involved in the potential cases was considered as each case was evaluated. Generally, organizational changes have been characterized as technological, production, structural, and cultural (Daft, 1998). The RPV effort was characterized as a technological change that was designed to enhance the effectiveness of the organization by introducing new or different technological methods to accomplish tasks (Daft, 1998). Beyond this, these technological innovations and the associated gains in effectiveness may render traditional labor sets obsolete. Therefore, cases were selected if they involved successful and unsuccessful efforts to introduce a new technology (to include information based and manufacturing technologies) that was designed to improve production and efficiency or save money. Moreover, cases that involved the replacement of traditional labor sets were given preference over those that did not.

Practical criteria. One final criterion was used to evaluate potential cases, namely, the availability of materials to permit analysis. While every attempt was made to investigate all potential cases, Yin (2003) suggests that cases should only be studied when sufficient evidence is available to consider alternative perspectives. Consistent with Yin's recommendation, cases were selected when multiple sources were available that described the events that revolved around the case. Ideally, these sources offered differing perspectives so that the interpretations and insights drawn were accurate, fair, and meaningful to the DoD's RPV effort. To determine whether cases met this criterion, searches were made using electronic databases in order identify books, journal articles, and documents available for analysis. Those cases that did not have sources available to analyze were rejected.

Phase II—Case Examination

Once the cases were identified an in depth examination of each case was conducted. Information gathered was consolidated into a table so that similarities and differences across the cases could be discovered easily. When possible multiple sources were used to corroborate the conclusions. In this phase of the research, the overarching goal was to gather information from the cases regardless if it supported any specific conclusions. Finally, the lessons learned were grouped together to ascertain similarities, differences, and the applicability to the Nadler model.

Phase III—Case Conclusions

The findings from the analysis in phase three were applied to the issue of concern in this manuscript (RPVs). Using the Nadler organizational change process model it was possible to draw inferences concerning how the widespread introduction of RPVs might impact Air Force culture and organization. These inferences were directly attributed to issues uncovered within the case analysis. Finally, it is important to point out that the inferences drawn are subject to an individual perspective and can be shaped by bias in one form or another.

IV. Results and Analysis

Potential Cases

This chapter contains a list of all the relevant cases examined for this research project. Table 1 summarizes the key issue surrounding each case and the pertinent lessons learned. There was no effort to study each case equally. Cases that appeared to be more relevant were studied in more depth than others. The most significant cases will be examined further in Chapter IV.

Table 1. Summary of Cases Studied

Air Force	
ICBMs (Builder, 1994: 167-176)	Research on the development of the first ICBMs and the organizational issues involved in adopting the technology <u>Lessons Learned</u> - Initial research in the 1940s suggested that long range ballistic rockets were feasible but only in the distant future and they should not take priority over manned air breathing assets - General Hap Arnold's retirement left the AF with no champion of ICBM technology until 1953. The AF culture saw manned aircraft as the only way to further the new separate service - ICBM development was hindered by organizational structures and belief patterns - Air planners during the 1950s agreed that ballistic missiles within any conceivable technology were unstoppable, yet development was persistently delayed - General Thomas D. Moore, Chief of Staff 1957-1961, "To say there is not a deeply ingrained prejudice in favor of aircraft among flyers would be a stupid statement…" - Bomber pilot culture became a way of life that had to be maintained…those advocating ICBMs were just engineers and scientists that would never understand manned flight - Since the AF officers not only understood bombers and knew they worked but often equated their own personal usefulness and well-being with that weapon it is not surprising that long range supersonic missiles were placed even further into the future - There was a cultural identification with manned aircraft and an organizational resistance to ICBMs - The AF's only interest in ballistic missiles was when the AF perceived a threat from a sister service to acquire them - For almost a decade AF leadership consciously retarded ICBM development by withholding adequate funding and imposing nearly impossible performance requirements - General Hap Arnold, "I see a manless Air Force," he told von Karman: "I

	see no excuse for men in fighter planes to shoot down a bomber. When you loose a bomber, it is a loss of seven thousand to forty thousand man-hours, but this crazy thing [V-2] they shoot over there takes only a thousand man-hours…" Arnold went on to ask von Karman to look into, "manless remote controlled radar or television assisted precision military rockets" - General White warned the AF in 1957 not to relive the mistakes of the battleship attitude and develop to much of a dedication to the airplane
Precision Guided Munitions (Knox, 2001: 3)	- 29,000 Precision Guided Munitions (PGMs) were dropped during the Linebacker campaigns in Vietnam out of over 227,100. In Desert Strom there were only 9,270 PGMs used…Some have blamed the tactical emphasis of Linebacker as the reason AF leaders were unable to see the benefit of PGMs. The Soviets who studied the Vietnam and Arab-Israeli conflict concluded otherwise.
General Military Cases	
General Observations from 21 case studies (Knox, 2001: 14, 174-180)	"In the spheres of operations and tactics, where military competence would seem to be a nation's rightful due, the twenty-one [case studies] suggest for the most part less than general professional military competence and sometimes abysmal incompetence. One can doubt whether any other profession in these seven nations during the same periods would have received such poor ratings by similarly competent outside observers." Lessons Learned - Military revolutions in the past have transformed with startling speed and force all aspects of war, from policy and strategy to tactics - Technology did not simplify war, as contemporary superstition now claims: it made exponentially more complex. Each new scientific development, each new weapon system demanded fresh thought and even-greater tactical, technical, and logistical expertise. - Changes in society and politics – not in technology alone – are the most revolutionary forces of all. It is those social and cultural forces, perhaps unleashed or amplified as in earlier periods by new technologies, that will determine the nature of any coming military revolution and will decisively affect how military organizations prepare for and conduct war…technology has rarely driven them. - No technological marvels can alter war's unpredictable nature as a "paradoxical trinity" composed of "primordial violence" politics, and chance - Technological development demands a culture that allows innovation and debate unfettered by dogma - Military revolutions always occur within the context of politics and strategy – and that context is everything - Ignorance of history even the history of the United States and of foreign cultures and languages is pervasive throughout both policy elites and the general population - Analysis of the past is essential…however it must be an accurate analysis…we can't shape the lessons learned to justify purchasing new weapons - The key technique of innovation is open-ended experimentation and exercises that test until breakdown not until validation of hopes or theories - Future RMAs lack coherence…we may be developing new technologies

	without thinking first about how we make them work together - Successful RMAs of the past all had an adversary to plan against…militaries that didn't have a clear enemy to plan against had a much more difficult time…we have an adversary now who is difficult to plan against - Pure technological development without the direction provided by a clear strategic context can easily lead in dangerous directions… - The most successful organizations avoided wild leaps into the future; their innovations remained tied to past experience, derived from conceptually sophisticated and honestly assessed experiment, and depended on the ability to learn from both success and failure. - Military culture and military education were important factors contributing to the success of the interwar RMAs
Desert Storm I (Knox, 2001: 5, 190)	- "America's crushing victory in the Gulf War raised interest throughout the U.S. armed forces in the revolutionary prospects of current and foreseeable technologies to an almost uncontrollable pitch. But it also had three decidedly negative consequences. First, the mastery seemingly demonstrated in the Gulf revived the very worst feature of U.S. defense culture: the recurring delusion that war can be understood and controlled in the mechanized top-down fashion of Robert Strange McNamara and his entourage in the 1960s. Second, victory provided the services with yet another argument in favor of procurement of new and enormously costly platforms such as the F-22, while unleashing claims from specialized pressure groups such as the "info-war" community. Finally, victory through technology appeared to promise the strategic freedom in an age of the masses seemingly lost in the paddies and jungles of Vietnam" - No organization made a serious attempt to examine the actual battlefield results on the Iraqi territory the coalition had occupied, and only the efforts of the Secretary of the AF ensured the creation of a Gulf War Air Power Survey…but few if any officers have read that report.
Past Revolutions Future Transformations (Hundley, 1999: 82)	Observations - New promotion pathways for junior officers practicing a new way of war are necessary - An organization climate encouraging vigorous debate regarding the future of the organization in needed - There is evidence to suggest that nobody within the DoD is deliberately setting out to challenge a core competency of one of the services…until this happens there will be no RMAs…the tank, manned aircraft, and aircraft carrier appear to be sacred.
Navy	
Battlefleet Revolution 1885-1914 (Knox, 2001: 114-129)	Research on the development of the modern navy from 1800s through the development of the modern aircraft carrier. Lessons Learned - The professional education system was in need of overhaul to keep up with the new technology…initially it was not updated to take into account the impact of the new technology - This RMA was incremental (very slow)…many smaller technologies combined to bring the reality of the modern navy into focus - Technology was not enough…it needed the leaders to recognize the benefits of the enabling technologies - Doctrine was slow to catch up to the technology

	- Navies still assumed you fought by lining up and delivering broadsides even as weapons outpaced doctrine - The dreadnaught evolution was not just technological…it also involved training institutions, officer recruitment, doctrine, fleet dispositions, and new strategic thinking - SELBORNE SCHEME…This was an effort to reform training and officer corps and to eliminate the 2 class officer system - There was an argument of potential increased combat power vs. the reliability of current systems - Career advantages were universally accepted as good but development was still neglected
Aircraft Carrier (Knox, 2001: 187)	Lessons Learned - William Moffet likewise possessed a vision: that naval aviation was capable of major contributions to the navy's combat power far surpassing its original roles of reconnaissance and artillery spotting for the Battlefleet. - Had to build the tactics and doctrine from the ground up - Education was key…The Naval War College was examining the possibilities of seaborne air power before the U.S. Navy possessed a single aircraft carrier - This might be the only case where a superior military power developed an RMA that upset one of its core competencies…it rendered obsolete the battleship core competency…naval aviators did not set out to do this though - Initially naval aviation was seen as a way to increase the effectiveness of the battleship by providing scouting, gunfire support, air defense - It takes a brave organization to render part of itself obsolete…this requires an extremely receptive organizational culture - Major force structure changes are needed for the RMA to be successful however these changes are typically the last things to happen
Smart Ship Project (Militello, 1998: 8-29)	Research on a concept commissioned by the Chief of Naval Operations on using technology to achieve manpower reductions aboard ships. Lessons Learned - Importance of managing the reengineering process disorganization during the implementation can lead to skepticism and resistance - There is a great need for user input…many times this is underestimated and the first user input occurs when the technology is first placed into the operational environment - Incremental change offers advantages - The barriers to implementation were culture and tradition and not the limits of technology - First use of the technology doesn't always go as smoothly as planned - Leader is vital to the success of the reengineering…despite the Captain's assurance to the crew to bring up innovative ideas many of them resisted…it went against Navy culture and took some up to a year to accept the new paradigm - Dual Mode…reengineering must take into account that people have normal duties and emergency duties. On the Yorktown the crew needed to reengineer processes like fighting fires to account for the reduction in manpower. The new technology was not enough by itself. - Training…as more and more automation comes into play there may be a reduction of skill sets that are actually vital like basic dog fighting skills as was seen in Vietnam…

	- Historical Precedent and Cultural Barriers…the crew of the Yorktown spent 2 hours every day polishing the ships bell because it had done so since 1782…the Officer of the Deck never sat down because of Navy culture. In fact there wasn't a chair on the Bridge for the OOD. It turns out the OOD can actually see better if he/she is seated. The OOD doesn't get tired and pays more attention. - Technology and Situation Assessment…the automation technology for fire detection actually reduced errors and sped up the process - Central Monitoring Systems…in health care the use of these systems allows a nurse to monitor several patients simultaneously and respond more quickly to those patients that need assistance. It has also reduced manning requirements Factors that Led to Success - Both a top-down and a bottom-up approach. Although the directive to create the Smart Ship came from the CNO and the project had much support in Washington DC, the crew of the Yorktown felt every bit as much responsibility for the success of the project as the Smart Ship team in Washington DC. Suggestions for reducing workload were generated at all levels. - Clear guiding principle: Reduce workload. This guideline had different benefits for different communities. For the Smart Ship team in Washington DC, reducing workload was a means to run the ship with fewer people and reduce costs for the Navy. For the crew of the Yorktown, reducing workload translated into working smarter, doing the job better, and having a better quality of life for sailors. However, for both communities the concept of reducing workload was a goal that made sense, and was concrete enough to drive the project. - Strong leadership. Clearly CDR Rushton's vision and leadership were strong contributors to the success of the Smart Ship project on the Yorktown. CDR Rushton was able to communicate his vision equally well to the team in Washington DC and the crew of the Yorktown. - Focused approach to introducing technology. The Smart Ship team in Washington DC culled through many suggestions for technologies that could be used on the Yorktown. A guiding principle in choosing which would be placed on the Yorktown was whether the technology would work toward the goal of reducing workload and running things more efficiently. - Iterative approach to change. No one expected to be able to redesign the ship a priori, determining which functions would be accomplished by technology and which would assigned to humans. The Yorktown was viewed as a testbed. This was a place to test new technologies and new procedures. With that frame, the crew was willing and eager to try new things and critically evaluate feasibility and progress toward the goal of reduced workload. There was not a sense of frustration and failure if things didn't work the first time.
LHA, Large Deck Ship (Militello, 1998: 7)	Lessons learned from a previous interview with a representative from NAVSEA on an automated engine room and its failure during its first sea trial with DVs on board Lessons Learned - A common mistake is that believing the first fielded version of a systems is the only system

	- It is critical in reengineering efforts to allow for test and evaluation to accommodate the unexpected
Civilian Sector	
The Innovator's Dilemma (Christensen, 2003: 180-190)	These are general conclusions from cases and research presented in The Innovator's Dilemma. Lessons Learned - Managers don't think rigorously about whether their organizations have the capability to successfully execute jobs that may be given to them - Resources are the most visible factor that contributes to what an organization can and cannot do. Resources include people, equipment, technology, product designs, brands, information, cash, and relationships - 116 cases of new technology were studied…In 111 cases involving sustaining technologies the companies that led in developing and introducing the new technology were the companies that had led in the old technology…5 of the 116 cases involved disruptive technologies. In each of these innovations none of the industry leaders remained atop the market after the disruptive technology was introduced. - Organizations have 3 choices when they realize they aren't suited for a new task - 1. Acquire a different organization whose process and values are a close match to the new task - 2. Try to challenge the process and values of the current organization - 3. Separate out an independent organization and develop within it the new processes and values that are required to solve the new problem - Organizations that have tried to develop new capabilities within established organizational units have a spotty track record - Toyota beat GM in the 1970s and 1980s by developing supply chain processes without investing aggressively in advanced manufacturing technology…GM on the other had did not change any processes and invested heavily in computer-automated equipment that was designed to cut cost and improve quality…they used state of the art resources in antiquated processes…Is this what we are doing with RPVs? - A separate organization is required when the mainstream organization's values would render it incapable of focusing on the innovation project. - CEOs that view spin out organizations as a way to get disruptive threats off their agenda are almost certain to meet with failure. - Managers should consider an autonomous organization and commission a heavyweight development team when the disruptive technology doesn't fit the organization's current process and values - The reason why organizations fail at innovation is that they employ highly capable people, and then set them to work within processes and values that weren't designed to facilitate success with the task at hand
Southeastern Nuclear Power Plant (Militello, 1998: 10)	Case study details the issues surrounding manpower reductions at a nuclear power plant as a result of deregulation and improved technology. Lesson Learned - The multi year "we'll-know-when-we-get-there" strategy lowered morale, motivation, and loyalty to the organization - The plant also lost many valuable, highly productive, experienced employees who preferred to work in a more secure environment (perhaps the AF has already learned this lesson) - Changes that are successful in one organization sometimes fail in another because the two organizations have very different functions and goals

Petrochemical Industry (Militello, 1998)	Report of interviews with engineers from Bellville Engineering, a human factors engineering firm in Dayton that works exclusively in the petrochemical industry. Lessons Learned - Emphasizes the usefulness of scenarios and simulators - It's important to assess the value of the activity but also important to assess the value to the organization of having a person available to do that activity and perform multiple - In the Petrochemical industry automation currently can't function with the same degree of flexibility that one gains with a human operator - The assumption that automation is always cheaper is not well founded…it is difficult for plant managers to grasp what they give up as well as what they gain when they automate
General Motors (Militello, 1998)	Research on interviews with a GM employee. Lessons Learned - The organizational culture was too risk averse which impeded progress - GM is still the high cost producer because they were too late in realizing how the world had changed - GM simply waited too long to implement change
Mechanical Excavator Industry (Christensen, 2003: 69-79)	Case Study on the disruptive technology of hydraulic excavators and why it took over 20 years for this technology to enter the mainstream of the industry. Lessons Learned - New technology was immature at first and did not compare favorably to traditional diesel and gasoline excavators - Most well established firms concentrated on sustaining technologies for their traditional excavator markets…new entrants to the sector exclusively built the new hydraulic type system and only 4 of 32 original manufacturers survived at all and in the end they were driven out of the sector into smaller construction businesses. The original companies faced a dilemma…they saw the new technology coming but it didn't have the capability to meet the customer requirements initially…by the time they figured out it was what the customers wanted they were too late.
IBM Credit (Hammer, 2001)	Case study about IBM credit division. They were trying to use technology to improve efficiency and cut costs. Lessons Learned - IBM mistakenly first tried to use automation of its process by itself to get the job done - The key is in examining the process and fixing it first…after that automation can be used as another tool to help the new process
Disk Drive Industry (Christensen, 2003: 10-14)	Case Study details the disk drive industry from its beginning until 1994 and how sustaining and disruptive technologies changed the industry. It also examines why certain companies flourished and other did not. Lessons Learned - Best firms succeed by listening to their customers…who are the customers of the AF? The American people…is it true that they want bloodless wars? If so will they begin to demand UCAVs at some point? - In almost every case dealing with sustaining technology the dominant established firms led the industry - Disruptive technologies did not usually involve new technology…they

| | used mostly off the shelf components |
| | - Disruptive innovations toppled the market leaders and were dominated by new firms…established firms had the resources to make the new technology but they were too late in developing a strategic commitment to the new technology |

RMAs or Transformations in the DoD

There are two significant military cases that contain many of the same elements as the RPV case. First, the "Battlefleet Revolution" was a case that culminated in the development of the modern aircraft carrier and the ultimately the death of the battleship. Second was the development of the Intercontinental Ballistic Missile (ICBM). In addition to these cases, there are many lesser cases like the Navy's smart ship concept which transformed the way a ship is crewed and operated. These cases paint a picture of what military organizations go through as they attempt to increase their combat power via an RMA. A process that leaders may or may not realize they are taking part in until the revolution is nearly complete.

Rise and Fall of the Fighter Generals

Air Force history does contain one significant RMA, the development of the ballistic missile which will be addressed later. A less revolutionary but still significant change in Air Force history was the shift from a bomber centric to a fighter centric culture. This is significant because over the course of time it appears the holders of the dominant technology are the ones who lead the Air Force. Col Mike Warden has analyzed the factors that determine the senior leadership of the Air Force and new research has been done to try and determine if the Air Force is on the verge of another shift in power. The conclusion is the same factors that signaled the decline of the "Bomber Barons" around 1966 are again signaling a potential change in Air Force

leadership. Changes in the personnel system, organizational structure, and budget may be signaling the dawn of a new Air Force culture (Danskine, 2001). One key factor, the specific types of wing level organizations, has changed over time and currently indicates the potential for another shift. The other indicators also paint a similar picture. Fighter systems clearly dominated from the mid 1960s but the trend is changing and the introduction of a new technology like RPVs will only complicate the landscape.
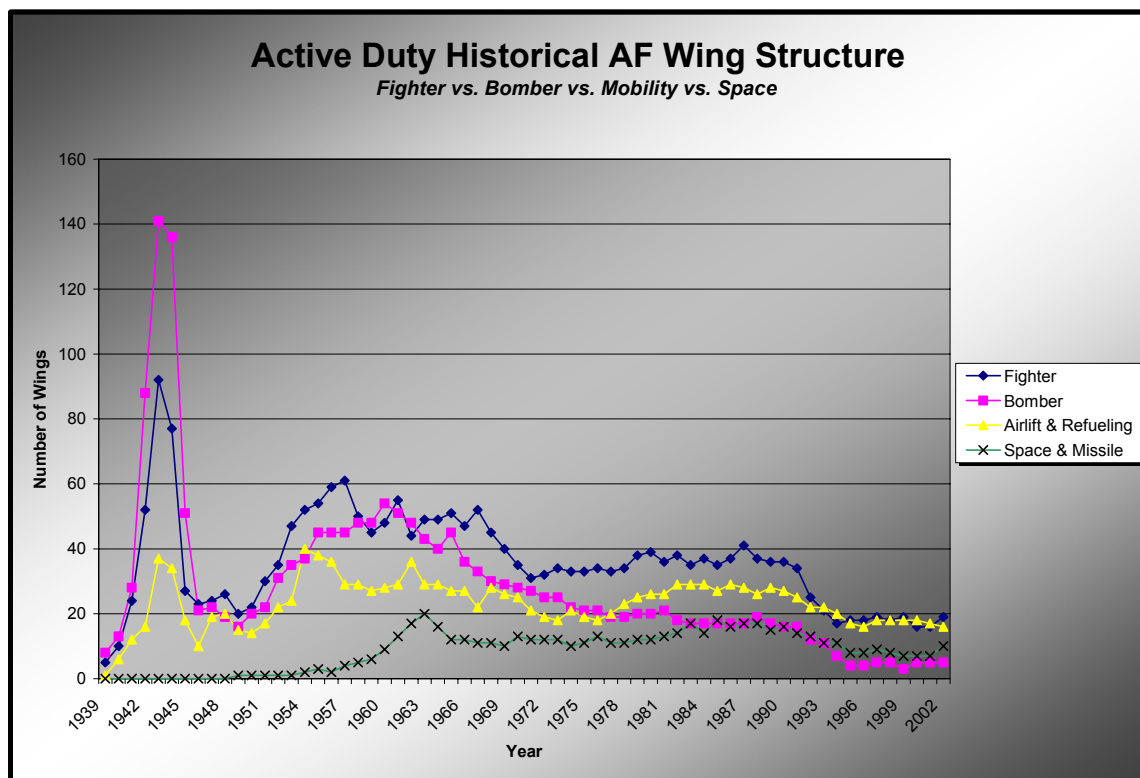

Figure 6. Historical AF Wing Structure (AF Historical Research Agency, 2004)

Battlefleet Revolution

The time period between 1885 and 1914 was one of truly revolutionary change for the concept of the modern navy. The state of the art warship at the beginning of the

revolution displaced a mere 9,180 tons, was armed with forty 68-pound guns, and had

5,270 horsepower. Construction began in 1912 on the Bayern class battleship, with a

displacement of 28,061 tons, 48,000 horsepower, and eight 15-inch guns each with a

maximum range of 20.4 kilometers (Knox, 2001). This change was analogous to

comparing the aircraft of World War I to those in the modern Air Force. The changes

however were not entirely technical. Revolutionary changes were also needed to allow

the people and the organization to keep pace. At the foundation of the successful

Battlefleet Revolution were radical reforms to training institutions, officer recruitment,

doctrine, fleet dispositions, and strategic thinking (Knox, 2001).

"Jackie' Fisher, who was appointed First Sea Lord of the Royal Navy in 1904,

was credited with much of the success of "Battlefleet Revolution" or the "Dreadnought

Revolution" as it was also referred to (Knox, 2001). Fisher was the one who saw the

need for radical thinking in how the Royal Navy was organized, trained, and equipped.

One of Fisher's first decrees was that executive officers, engineer officers, and Royal

Marine officers train and educate together (Knox, 2001). Along the same lines, he

established that engineers would no longer form a separate and less prestigious career

path than other officers (Knox, 2001). This change put an end to the two tier system

which had plagued the Royal Navy. The brilliance of Fisher's revolution is its simplicity

as none of the technical improvements were earth shattering by themselves. It was an

incremental process leading to constant improvements in technology and warfighting

capability. This incremental and methodical model is also exhibited in many of the

transformation case studies like the mechanical excavator industry and precision guided

munitions. It is not uncommon for revolutionary changes to take 30, 40, or even 50

years. Fisher simply recognized that change was happening and developed a formula for

success containing four ingredients:

> the adaptation of existing technologies to produce a new
> class of battleship and battle cruiser; the reorganization of
> fleet stations and commands in the service of a new
> strategy; the reduction of antiquated warships and
> representative yachts; and the recasting of officer education
> and training at Dartmouth (Knox, 2001: 124).

Fisher knew that innovative technologies will many times fail during their first test. The

key to success is getting the key members of the organization to accept this failure and

continue moving in a positive direction. In addition, restructuring of the organization

may be necessary to bring the culture in line with the technology. At some point, there

must be a break from the old. It may not be a sudden break but eventually the reliance on

old technology must come to an end. Finally, old ways of thinking must be purged from

the organization. A sailor in 1885 who was picked up and placed in 1914 would rely on

the tactics he was taught as a young man. There must be a way to break old paradigms

and get the old sailor thinking new.

However, the story is not entirely complete. There were many impediments along

the way to this successful revolution. After Fisher there were other leaders who had there

own views on revolutionary technology. Fisher's successor was a man who lacked a

sense of vision for the future. He displayed an ignorance of tactics, opposed needed staff

reforms, and could not see any future for technology like the submarine (Knox, 2001).

As is common with many new technologies, reliability became a factor. The fear was

and still is that leaders prefer reliable old technology over unproven, new, and potentially

more capable technology. This issue is common in many case studies and is still

prevalent today. Complicating the issue for military leaders is the fact that they will be required to put people into harms way.

This case could be continued right up until the introduction of the aircraft carrier, a revolution that truly did render a core competency obsolete. However, many navy officers failed to see the importance of the new technology. In 1919, the head of the Technical Branch of the Royal Navy's Air Arm complained bitterly: "The potential value of the weapon is universally recognized; the development, however, is almost universally neglected" (Knox, 2001). Initially the full capabilities of the new technology were misunderstood. It was seen as a way to increase the effectiveness of battleship through scouting, gunfire support, and air defense (Knox, 2001). As with the preceding "Battlefleet Revolution," education turned out to be a decisive factor. Officers at the Naval War College were drafting seaborne air power doctrine even before the United States had a single carrier (Knox, 2001). This case outlines the difficulty in achieving revolutionary change when that change involves the elimination of old work tasks and the introduction of new ones.

ICBM Revolution

The ICBM revolution is an interesting case in how organizational barriers can hinder a revolution from coming to fruition. Research in the 1940s suggested there could be benefits to long range ballistic missiles. However, ICBM development was hindered by organizational structures and beliefs and lacked a champion when General Arnold retired (Builder, 1994). The idea of a champion is a common thread throughout most of the case studies and appears to be a critical ingredient for success. So how could the development of a technology that many believed was unstoppable be retarded? General

Thomas D. Moore, Chief of Staff from 1957-1961 stated, "To say there is not a deeply ingrained prejudice in favor of aircraft among flyers would be a stupid statement" (Builder, 1994). The idea of unmanned systems dominating the landscape threatened the very existence of the newly independent service. Bomber centric culture became the established way and those officers who understood the technology often equated its success with their own well being (Builder, 1994). Truly ICBM technology was not suited for every mission and leaders were correct at the time to develop the bomber. However, it is also clear that missile technology was not developed as quickly as possible nor utilized to its full potential. A catalyst was clearly needed to push ICBM technology ahead and give it some momentum.

The Air Force became seriously interested in ballistic missiles after it perceived a threat from the other services to acquire them (Builder, 1994). This development could have drained resources away from the Air Force and ultimately bring into questions its need for existing. Air Force leaders grudgingly pursued ballistic missile technology but still maintained the dominance of the bomber platform (Builder, 1994). It was the means and not the ends that were in question. A bomber and a missile could perform many of the same missions but a bomber required a human crew throughout its entire flight. Spending on ballistic missiles and future systems never outpaced that of the manned aerial vehicle.

The results of this initial debate are still visible today. B-2s are flown on 30 hour bombing missions that someday could be accomplished in a tenth the time with a conventional ICBM, conventional submarine launched ballistic missile, or space based system. The F-22 is hailed as the solution to our future problems while at the same time

it appears the trend is towards less traditional warfare. Vigorous battles are being fought over the need for additional airlift and air refueling platforms while the need for such systems has never been greater or clearer. Without some catalyst military organizations do not typically take a radically different path on their own. In 1957 General White, former Air Force Chief of Staff warned against such a culture. "The senior Air Force officer's dedication to the airplane is deeply ingrained and rightfully so, but we must never permit this to result in a battleship attitude. We cannot afford to ignore the basic precept that all truths change with time." (Builder, 1994) In 1996, the Air Force Chief of Staff, General Fogelman and the Chief of the UAV Battlelab, publicly proclaimed the Air Force was at least 25 years from a lethal RPV (Walsh, 1997). Only six years later lethal RPVs were a reality in Afganistan, evidence that many times the senior leaders will not be the ones to see the coming revolution.

The ICBM revolution has left us with two distinct lessons learned. First, a revolutionary change typically involves a catalyst. Second, maintaining dominance of the current organization and technology is a powerful force that can sometime blind leaders to everything else.

Smart Ship Project

The navy's smart ship project offers some insight into technology aimed at achieving manpower reductions. This represented a revolutionary change in how the navy would crew a ship and how duties would be assigned. For hundreds of years the navy had established a way of doing things such as fighting a fire at sea and getting buy-in to changes wasn't easy. The culture and doctrine said crew size was set to be able to respond to emergencies (Militello, 1998).

The first lesson of the case is that success starts at the top. Leaders have to assure their subordinates and foster a culture where innovative ideas are continually flushed out. It is not enough for a leader to say he or she has an open door policy. In the Navy's experience the Captain had to get out and directly interact with the individual sailor to reduce skepticism. Disorganization is also a byproduct of innovation. It was vital for the Captain to carefully manage the initial phases of the process (Militello, 1998).

Another lesson is that tradition and culture are often the key barrier and not technology. Staffing aboard the bridge of the smart ship was reduced from 15-20 down to, 2 people by introducing new technology. In one instance a decision was made to allow the Officer of the Deck (OOD) to sit rather than stand. This change made many visitors to the ship very uncomfortable because it violated years of Navy tradition. Some visiting Admirals would even sit in the new OOD chair so the officer would be forced to stand (Militello, 1998). If such petty behavior is prevalent when implementing minor changes one can only imagine the resistance to revolutionary change.

Reengineering must take into account the dual mode personnel operate in. Crew members aboard the standard Navy ship had become accustomed to having normal duties and additional duties. Automation might make it possible to control a ship with two people on the bridge but the same technology couldn't fight a fire. Unintended consequences had to be thought through for the entire effort to be a success. This meant reengineering nearly every other process to account for the manpower reductions. Sailors were forced to rethink hundreds of years of standard operating procedure. Navy sailors had spent two hours per day polishing the ships bell because it had been done since 1782 (Militello, 1998). Some other skill sets that are actually vital may be eliminated in the

process. Careful deliberation is required to determine which skill sets can and can't be eliminated. At the same time one must remember that culture and tradition may bias this decision.

Many factors led to the success of the Smart Ship project that can be applied to future cases. A top-down and a bottom-up approach are required because the senior leader can only dictate so much. At some point buy in must be realized from all levels of the organization. A clear guiding principle is needed to focus the energy of the organization. Leadership is the central factor in focusing efforts toward achieving the desired goal. In addition, many revolutionary changes are the result of smaller incremental changes. Finally, the first fielded system will typically fail its first test. It is critical to make the organization aware of this process to keep them energized despite the many speed bumps along the path to revolution (Militello, 1998).

Transformations in the Civilian Sector

In the civilian sector, there are many organizations that have attempted to transform or reengineer in response to some threat. General Motors, the mechanical excavator industry, the petrochemical industry, and the disk drive industry all provide significant and relevant material to analyze. All of these cases involved either the introduction of a disruptive technology, a change to an automated process, or both.

General Motors

How did Toyota beat General Motors in the 1970s and 1980s? Toyota's organization was more receptive to process changes. General Motors organizational culture was too risk averse which impeded any progress. Furthermore, it viewed the solution as technology. Specifically, automated manufacturing equipment that was

supposed to cut costs and improve quality. Essentially they used state of the art

equipment in an antiquated process (Christensen, 2003). Automation also has other

unintended consequences. A case study of the petrochemical industry reveals some of

those consequences. First, automating does not always simplify processes. In many

instances automation and other technologies continually make processes more

complicated. In military terms, it can inject more fog and friction into the battle

especially if the organization is operating under the assumption that things will get easier.

Second, an accurate assessment must be made on the value of each person's contribution

to the organization. Employees do not typically perform just one task. In the Air Force,

a C-17 crew member can also serve as an airlift planner, professional military education

instructor, or a program manager. Eliminating a crew position would mean that person

would be unable to perform vital non-flying tasks. Automating one process clearly can

have unintended consequences that may be negative or positive to other processes

(Christensen, 2003).

Mechanical Excavator Industry

The mechanical excavator industry is another case study in patience, taking over

20 years to completely transform and involving 32 companies (Christensen, 2003). This

case involves many innovations along the path to a total transformation. Important

innovations included gasoline and electric motors. The established firms were able to

adapt to these innovations and meet customer needs (sustaining technology). However,

the invention of the hydraulic excavator changed the landscape completely (disruptive

technology). Initially, the hydraulic technology was promising but insufficient to meet

customer demands. Established companies could not afford to switch to a new

technology that could not yet meet their customer's requirements. By the time the

organizations made a commitment to the new technology it was too late. New entrants

had spent years adapting hydraulic technology to smaller alternative applications.

Eventually the new entrants perfected the technology and hydraulic excavators became

more capable than the gasoline-electric versions (Christensen, 2003).

Of the 32 original firms only 4 survived at all. Eventually even they were driven

into other smaller construction sectors. So how did well run companies who were

meeting their customers needs fail?

> Working harder, being smarter, investing more aggressively and listening more astutely to customers are all solutions to the problems posed by new sustaining technologies. But these paradigms of sound management are useless-even counterproductive, in many instances-when dealing with disruptive technology (Christensen, 2003: 83).

A disruptive technology had leveled the playing field and allowed minor

companies to take over the industry. The established firms essentially worked harder and

invested more into processes and technologies that in the end were doomed to fail.

Disk Drive Industry

The disk drive industry offers a unique opportunity to study the effects of

technological innovation. Clayton Christensen, details why the industry is an important

study area in his book, *The Innovator's Dilemma*. Fruit flies are used in the study of

genetics because of their short life span. Their life cycle is completed in one day

allowing completely new generations to be studied over and over again. In industry, the

best comparison to a fruit fly is the disk drive industry. Innovation occurs so rapidly

there are constantly new companies and cases to study from beginning to end
(Christensen, 2003).

The disk drive industry cases clarify some important differences between
sustaining and disruptive technologies. Each new development of sustaining
technologies simply maintained the industry's rate of improvement. Disruptive
technologies however, dramatically changed the rate of improvement in the capabilities
of the disk drive (Christensen, 2003). For example, let's assume that disk drive storage
capacity improves each year by 10 percent. Sustaining technologies are what keep that
10 percent rate constant. A disruptive technology results in much more dramatic and
revolutionary improvements. However, it is also important to keep in mind this does not
mean it's a new technology. It may be an existing off the shelf technology utilized in a
new manner or configuration that makes it disruptive.

Different types of organizations are best suited to each type of new technology.
Research shows that established firms (market leaders) always led the way in developing
and capitalizing on sustaining technology. Conversely, new entrants to the industry
always led in the development of disruptive technology (Christensen, 2003). On the
surface this seems to be exactly the opposite of what one might expect. How do well
established firms with tremendous resources and track records of success continually fail
at developing disruptive technology? The same organizational prowess that keeps the
company highly profitable is also the reason for its eventual demise. At some point the
established firms become too risk averse and begin to believe their own hype. New
entrants may not have the same resources but they are able to be more creative and take
more risks. They go into the market knowing they can't compete directly with the best

products from the top firms. They must innovate and provide something better. It is not

that established firms do not see the new technology coming, they are just too late in

making a strategic commitment to it.

Established firms were not lazy nor did they accept the status quo. On the

contrary, they were creative, aggressive, and customer-sensitive to sustaining

technologies (Christensen, 2003). Something clearly caused them to loose the same type

of edge with regard to disruptive technology.

Implications of Cultural Change and Similarities Across Cases

The implications of these changes have been shown to be of vital importance. It

is also clear that separating technology from the other elements of the system will not

work. Many common themes have been uncovered which can be fit into the

organizational change process model. This will help to better understand the implications
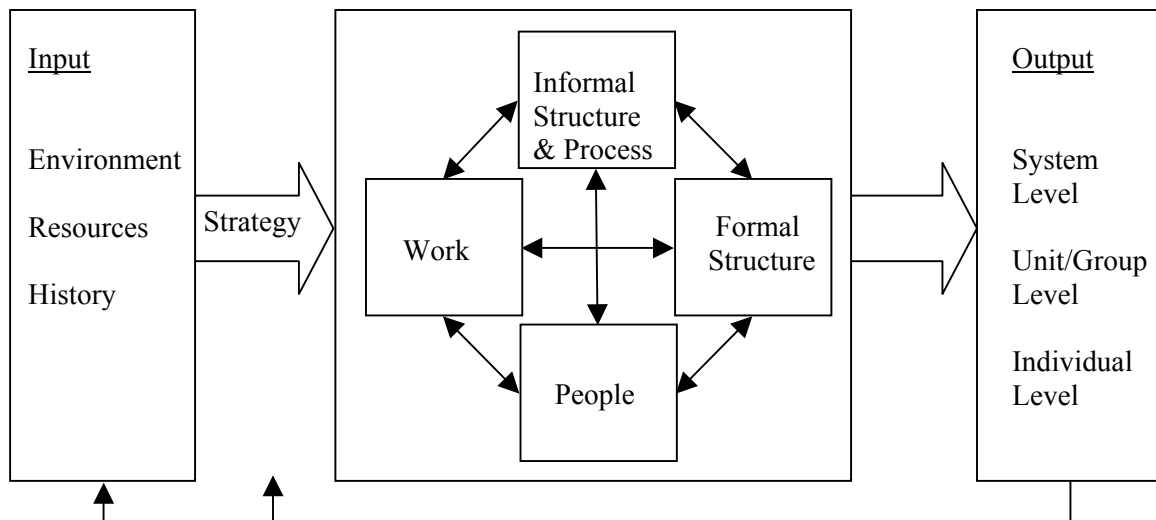
for an RPV revolution.

Figure 7. Organizational Change Process (Nadler, 1989)

There are several key discoveries regarding the work element of the model. It may seem logical to assume technology reduces the cost and complexity of work but this is not always the case. Research has shown that in many instances it does exactly the opposite of what was expected. Many of these technological advances have also been shown to be incremental in nature, taking years and decades to reach their full potential. Successful organizations realize that it is essential to foster a long term commitment to innovation. Throughout this process scenarios and simulations have been shown to be effective in developing new ways of doing work. In addition, it should be noted that there is a dual role involved in accomplishing many tasks. Workers may perform multiple jobs and eliminating one of those jobs will have an effect on other jobs.

The informal structure of an organization can be extremely difficult to manage and shape. Research supports the claim that a champion is essential to the transformation effort. This person acts as the focal point for innovation and leads the needed cultural transformation. Any changes to the culture must recognize the importance of innovation and reinforce it as a vital part of the organization while at the same time encouraging debate. Revolutions or transformations are most successful when members of the organization are allowed to question long standing traditions and ways of doing work. Most importantly, strong leadership is needed to establish a unifying vision that can convey a long term strategy. This is especially vital considering the fact that it is typical to see numerous failures along the path to success.

Changes to the formal structure start within the education system. Research also shows that this is a place where the new ways of work can be reinforced. Additional changes include new career paths and promotion pathways. These were shown to be

essential in cases such as the "Battlefleet Revolution." Many organizations also delay

force structure changes until the end of the process. However, the most successful

organizations typically address these issues early on in order to maintain congruence

between the organization and the transformation.

The factor that ultimately makes success a reality is the people element. It must

be recognized that the people within an organization will enter the process with certain

biases. Frequently, they may see new technology as a threat to their jobs. In addition,

many are unable to see the utility of new technology. Research shows this hampers the

development of a long term strategy and commitment to innovation. Perhaps the most

significant finding though is the impact of removing people performing dual roles.

Unless leaders undertake careful planning, eliminating a task and the person performing

the task has been shown to have detrimental effects on other minor tasks.

IV. Conclusions

Throughout the study of military history one thing remains the same. There is a constant shift in the balance of power as dominant militaries are conquered by those which were once less powerful. In the civilian sector the same lessons seem to hold true. Market leaders frequently do not maintain their dominant positions in the face of fierce competition. It would be a fatal mistake to assume the United States military is exempt from the same forces that have shaped the course of history. In today's world the consequences of such a failure should be enough to motivate powerful change. The conclusions of this paper offer recommendations and more questions that must be answered before a successful revolution can be achieved. According to Nadler's (1989) model these issues can be organized into four categories; work, informal structure and processes, formal structure, and people. Nadler's research and the evidence from the cases presented in this paper suggest that organizational effectiveness is maximized when congruence is maintained between the four categories. The ramifications for the Air Force are fairly simple. The widespread introduction of remotely piloted vehicles will impact each of the organizational elements. Success in the endeavor will require leaders to go beyond strategy, beyond technology, and address the full spectrum of the organizational change process.

People

Clearly, it is the people who will make this or any future RMA a success or a failure. Therefore, an organizational transformation will be required to ensure essential skill sets are not lost and other skill sets are transferred to different Air Force personnel. This will require maintaining a balance between retaining the right types of people to

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accomplish the current mission while at the same time establishing incentives for those who will be more important to the Air Force's long term future. Research has also shown that technological transformations often result in the elimination of personnel that perform dual roles within the organization. Further research is needed to determine the best way to reengineer processes and tasks currently performed by personnel who may be displaced.

One way to maintain congruence with respect to people may be to reform the formal education process. Eliminating functional stovepipes is the key to this endeavor. Currently, the Air Force is facing a similar issue concerning the elimination of navigators from cockpits. Many of these personnel fill vital non-flying positions once manned by pilots. However, at some point, the navigator pipeline will dry up. If RPVs lead to a further reduction in aircrews, the result may be a shortage in personnel. A plan is needed to address how current rated staff positions will be manned in the future. The solution could lie in restructuring and eliminating positions or in preparing different groups of personnel to fill those positions.

Certain aspects of the organization and culture will have to be questioned. Many of these questions may not originate from within the military but instead come from civilian and government leaders. It is vital that the Air Force anticipate these issues in order to be in a position to shape the debate. For example, why not have disabled Americans in the military controlling RPVs? Many of the physical standards may no longer be compatible with a military that heavily relies on unmanned and remote technology. These are just examples but similar questions should be flushed out prior to the widespread introduction of the technology.

Many answers to the issues surrounding people may come from ensuring the recruiting system is aligned with future technology. The new Air Force recruiting campaign is already targeting a new segment of the population by featuring remote and unmanned technologies. The type of person traditionally recruited into military service may or may not be the best ones suited to work in and lead the future Air Force. The important question is not whether the Air Force is meeting its recruiting goal but whether it's recruiting the right type of people. An analysis of the essential skill sets required for RPV pilots may set the Air Force on the path to success. The recruiting plan can be most effective once the essential skill sets are determined. Finally, after personnel are recruited and trained they must be retained within the organization. It will be necessary to examine what types of incentives motivate this new type of person.

Informal Structure and Process

A vision is required to get the Air Force to the future while at the same time maintaining the ability to fight and win the nation's wars in the present. Research shows that buy in is essential, specifically from those personnel who would be displaced. This could be accomplished through the publishing of an Air Force RPV roadmap even though the DoD has already done this. Once again case study research suggests that a vision is an essential element to success. Members of the organization will react more positively if the Air Force accurately communicates details about the future plans for RPVs. Continually downplaying the future role of RPVs may breed mistrust.

A new career development path must be examined. Should the Air Force continue with an all officer pilot corps when other nations and the sister services utilize enlisted personnel in the same positions to control RPVs? This question alone goes

against the very foundations of Air Force culture. However, questions of this nature are what transformations and RMAs are all about. A study of the career development path should examine such tough issues as the possibility of enlisted RPV operators and the establishment of a separate career field. Military members may not fully buy into the new technology until they see an opportunity for career advancement. At some point the Air Force must decide what role RPV personnel will play in the organization. Is an RPV assignment an excursion from the normal path or is it a path unto itself? These answers can only be answered by commissioning further studies to investigate each question fully.

Finally, the unwritten stratification of specialties may need to be reexamined. Leaders will need to decide if an RPV operator will have the same opportunity for advancement as a traditional pilot? Many of these opportunities will be determined by the force structure that is established to include the number and types of wing level organizations. This is of course assuming that a separate career path is established.

Formal Structure

There are organizational impacts associated with disruptive technology and the organization as a whole must be educated on these. Leaders must understand the law of unintended consequences, the impacts of disruptive technology, and the organizational change process model. Understanding these organizational dynamics will make for a more efficient and effective transformation.

The idea of centralized control and decentralized execution may not apply in the same way. Changes to the formal organizational structure may be needed to maintain congruence with a new construct. Automated technology may also allow senior leaders, including the President, real time input into targeting and other warfighting decisions.

The standard military organizational structure may not be compatible with this new way of conducting warfare. Fighting forces operating in this new environment will have to consider these changes. Now is the time to determine if these potential changes are positive or negative and how to bring them about. Wargames and other simulations can be an effective tool to study these impacts. Leaders should encourage the continued use of these tools and begin to examine and debate the findings.

Work

The final key is to realize that this transformation does not involve just the work element. To often organizations fail because leaders assume they can reengineer work in isolation from the other three organizational elements. Nearly every case presented in this manuscript entailed changes to work. Many times changes due to automation resulted in more complicated and costly processes. Leaders must be aware that RPV technology may not be able to produce many of the promised cost reductions. It is inaccurate to assume away manpower and other costs associated with the change from manned to remote flight. Increase need for satellite communications and navigation along with next generation RPV control stations are just a few of the elements that must be considered. An accurate study of the true costs of RPVs is needed to determine if the technology's benefits out way its costs. In reality it may turn out that RPVs are more expensive to operate due to the increased technology requirements. Finally, leaders only achieved success once they took a total systems view of the effort. To be successful an Air Force leader must step forward and champion this effort. It has been shown that this is another essential element to success.

Limitations

  The goal is to overcome the limitations and produce an outstanding finished product. Robert K. Yin in his book, *Case Study Research*, outlines the five characteristics which make an exceptional case study. The case study must be significant, complete, consider alternative perspectives, contain sufficient evidence, and be composed in an engaging manner (Yin, 2003).

  Developing a significant case study is a daunting task. According to Yin the critical needs are to choose cases that are unusual or of significant public interest. This research is of national importance simply because it deals with issues directly related to the future security of our nation. Cases were chosen that focused on unique and significant issues.

  Completeness is the desired end goal but it is not always attainable. Every attempt was be made to fully investigate potential data. The easiest way to ensure completeness was to rely on past research of pertinent cases in order to make the most efficient use of time and energy.

  Alternative perspectives need to be offered in two distinct ways. First, each specific case that is analyzed can be interpreted in many different ways. Analysis from multiple sources lends credibility to the conclusions drawn in this research report. In addition, there may be research addressing a similar research question that can be used to support the final conclusions.

  Sufficient evidence also lends credibility to the conclusions. The report must be properly annotated, contain accurate information, and treat all of the individual cases fairly. Failing to meet these standards will result in a sloppy product that is less likely to

be taken seriously. Finally, a boring report that contains fabulous information may never get read. The final report must keep the readers attention with a clear and engaging style.

Predicting the future is a difficult task. This paper assumes that the future will continue to unfold according to the projections of military leaders. It is entirely possible that some new technology or doctrinal change will effect current projections. However, this paper aims to discover what types of organizational obstacles may spring up based on the current set of assumptions concerning the future of RPVs as outlined in the DoD's roadmap. If this methodology is correct future researchers should be able to apply it using future data to draw the similar conclusions.

Determining the future will require an examination of the past. The accuracy of this paper depends of the applicability of historical events like the emergence of the fighter as the dominant Air Force combat platform or the battleship revolution. In addition, it is assumed that theories of organizational behavior can be successfully applied to a military organization.

Finally, it would be naïve to assume there is not a significant bias present in the Air Force concerning this issue. The very people who will decide to take Airmen out the cockpit are the people currently in the cockpits. Consequently, this may bias projections concerning RPV technology and any associated organizational impacts. It will be impossible to determine the extent of these biases.

Conclusion

All of these areas for consideration can be addressed but the path will not be easy. Ultimately the Air Force may end up challenging its very existence. The chances of a successful "Revolution in Military Affairs" will be greatly diminished if any of the

services is unwilling to question its reason for being. Future research should be

sponsored to fully examine how the Air Force will be impacted by each of the areas for

consideration no matter what the results may be. These conclusions also go beyond the

RPV effort. Every transformation effort can and should be examined using the

organizational change process model.

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14. ABSTRACT

The DOD's Unmanned Aerial Vehicle (UAV) Roadmap outlines the timeline for a potential Revolution in Military Affairs (RMA) where the Air Force and the other military services will shift from a reliance on manned aircraft in combat to remotely piloted vehicles (RPVs). Considering the far reaching influence that manned flight has had on the battlefield, shifting from manned to remotely piloted vehicles is expected to have significant ramifications within the Air Force, potentially influencing the organization's structure, skill requirements, and culture. This research attempts to determine the complex organizational issues associated with the adoption of RPVs by studying past RMAs and related transformations in the civilian sector. The end result is a framework for success that can be utilized to achieve success in this or any transformation effort.

15. SUBJECT TERMS
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