3-2008

The Effects of Commercial Video Game Playing: A Comparison of Skills and Abilities for the Predator UAV

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THE EFFECTS OF COMMERCIAL VIDEO GAME PLAYING:

A COMPARISON OF SKILLS AND ABILITIES

FOR THE PREDATOR UAV

THESIS

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AFIT/GIR/ENV/08-M22

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THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Information Resource Management

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March 2008

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AFIT/GIR/ENV/08-M22

Abstract

Currently, Predator unmanned aerial vehicles (UAV) are operated by pilots and navigators experienced with manned combat aircraft. With a projected increase in UAVs, more combat pilots will be needed to operate these aircraft. Yet, if the current ops tempo continues, the supply of combat pilots may not be able to meet the demand. Perhaps alternative pools of Air Force personnel could be considered for UAV duty in order to meet operational requirements.

Because the Predator UAV is a software-driven aircraft, video game players (VGPs) already possess and use many skills that may be similar to those of Predator UAV pilots. A variety of games can add situational awareness skills that a player/airman can bring to a new situation.

This research examines the applicability of video-games-based skills to the operation of the Predator UAV. Nine people were interviewed to determine the overlap between piloting skills, UAV-specific skills, and skills gained and developed from gaming. The results indicate that frequent VGPs have the confidence and the consistent ability to obtain and retain new skills, many of which are related to operating the Predator UAV in a 2-D environment while not relying on the visual and non-visual cues of the manned aircraft pilot.

Acknowledgments

I would like to express my sincere appreciation to Major Jason Turner, my thesis advisor, Mr. Richard McKinley, my sponsor, and Dr. Dennis Strouble, my reader, for their guidance and support throughout the course of this thesis effort. Their insight and experience was certainly appreciated during my research endeavor.

I would like to thank my wonderful wife of twenty years for her encouragement throughout this and many other accomplishments.

Johnny E. Triplett

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"We have more effective graphic presentations in a video game than we often have in today's command and control systems. Our kids go down to the corner and go into the virtual reality laser store and get information for decisions that is compelling and powerful and comprehensive. Why can't we deliver that kind of pertinent information to the cockpit, to the command and control area, to the logistics support area, and do all of these things in the same compelling way?"

LT. GENERAL JAMES A. ABRAHAMSON
(Abrahamson, Hosmer, & Horner, 1997)

I. Introduction

Today, the U.S. Air Force faces deep budget difficulties. The heavy operations tempo in countries around the world is stressing our older aircraft and pushing them past their anticipated limits (Eaglen & Horn, 2007). According to Chief of Staff of the Air Force, General T. Michael Moseley, repairing and replacing aging aircraft will cost an additional $20 billion per year (Eaglen, 2007). This fiscal need has forced Air Force leadership to eliminate more than 40,000 personnel by 2011 (Gettle, 2006).

While dealing with tight budgets and personnel cuts, the Air Force must continue to maintain the operational capability it has today by using manning and equipment in the most efficient manner. Consequently, the unmanned aircraft sector has been experiencing high demand and rapid growth (Department, 2005). In fact, General Moseley indicated that while the Air Force reduced the number of fighter aircraft in the inventory by 152, it will be adding another 113 unmanned aircraft system (UAS) platforms in the next few years (Randolph, 2007).

Background

A UAS consists of four unmanned aerial vehicles (UAV), a Ground Control Station (GCS), and a 55-person crew required to operate and maintain the system. The Predator MQ-1 UAV is a small multipurpose aircraft, 26.7 feet long with a wingspan of 48.7 feet, which is controlled remotely from a ground station through a direct link or through a relay site such as another aircraft or a satellite. General Atomics Aeronautical Systems manufacture the Predator UAV, which is also capable of firing Hellfire missiles and flying continuously at an altitude of 25,000 feet for over 24 hours (Department, 2005:4). The primary purpose of the Predator is for intelligence, surveillance, and reconnaissance (ISR) using several sensors and transmission devices to detect and relay information directly from an area of interest; though it has more recently served as a combat vehicle. The sensors consist of a color electro-optic and an infrared camera as well as synthetic aperture radar (SAR) (Department, 2005).

Currently, the Predator UAV requires a pilot who has completed manned aircraft training in the Air Force and has experience flying in combat aircraft. Even with this level of qualification, a new UAV pilot must take additional training that is UAV-specific (Ausink, 2005). Because the Predator is capable of launching weapons, a fighter/bomber pilot, or a Weapons Systems Officer (WSO) is required for an assignment to a Predator squadron. In fact, Garner and Villem (2005) calculate that 3% of all fighter pilots make up 45% of the manning for Predator UAV squadrons, a 3-year assignment. Although elimination of the UAV assignment requirement may help in the short term, Garner and Villem conclude that this requirement is not a long-term fix for the fighter pilot shortage due to the need for increased production and retention in the fighter pilot inventory.

Although combat aircrews have the experience of flying inside of powerful aircraft in the skies, the Predator is controlled from the ground. Therefore, many of the physical demands of piloting any manned aircraft such as motion, g-forces, or differences in atmospheric pressure, are not applicable to the Predator UAV pilot. Furthermore, the Predator does not have many of the flight capabilities of high performance aircraft (Squeo, 2002). Thus, it is reasonable to suggest that a fully qualified fighter or bomber pilot in this position might actually be a misplacement of overqualified manpower.

Medical certification is also necessary to ensure the physical ability of any Air Force pilot to manage the difficulty of the mission, sustain communications with other aircraft, and maintain the safety of those on the ground. Fighter and bomber pilots must meet the maximum medical certification requirements to fly manned aircraft. However, such medical requirements may also be beyond those necessary for a UAV pilot because, again, air pressure, motion, and control of the aircraft are not medically related factors that would impact a UAV pilot in flight (Williams, 2007). Reducing such stringent medical requirements from those of the fighter and bomber pilots might result in a larger pool of people that could be otherwise qualified for manned aircraft and thereby able to serve as Predator pilots.

Because of many such factors, it is possible that candidates for UAV piloting duty may not even need to be fully qualified manned aircraft pilots at all. However, such candidates must still be able to meet the basic demands of flight control and mission execution. Who then, might the Air Force seek to fill these positions?

Research Focus

Competence in certain fields may come from many areas of a person's environment or background. Individuals can gain skills (such as piloting an aircraft) formally through education, informally from on-the-job training, and through personal experience. One potential source of such experience is video gaming.

Game designers have created entertainment games for decades that, among other things, may require gamers to learn new skills and build on those skills (increasing their competence) to reach the end of the game. Commercial video games may incorporate many ways for people to learn various aspects of a game and improve their skills or abilities before they proceed to the next level. According to Gee (2003), video games are adept at creating a cycle of learning that he refers to as "automatization." In automatization, skills are learned and practiced until they become automatic. When a new condition arises, this automatization adapts so that a new skill can be learned and added to the inventory of skills that have been reached before. Furthermore, these new skills are practiced and mastered. This "cycle of automatization, adaptation, new learning, and new automatization" is necessary for thinking in today's fast-paced world

(Gee: 70). Thus, video game players learn new skills as they play a game, and such skills may be transferable to other parts of their lives, perhaps even to the virtual cockpit of a UAV. As an article in *The Economist* notes:

> Anyone who has learned to play a handful of games can generally figure out how to operate almost any high-tech device. Games require players to construct hypotheses, solve problems, develop strategies, and learn the rules of the in-game world through trial and error. Gamers must also be able to juggle several different tasks, evaluate risks and make quick decisions (Breeding, 2005:9).

Currently, there are programs in the military that are investigating simulations, online learning, and massive multiplayer online gaming to aid in real-world mission training. Such methods of training and education can be very expensive in both research and implementation costs. Commercial video games have the advantage of not having an extensive development time relative to custom-designed systems specifically for military training, and their popularity and market penetration may mean a potentially wider subject pool from which to draw the needed skills and abilities.

It is for these reasons that the following research question constitutes the focus of the present study.

Can skills/characteristics developed from different types of video games be applied to piloting tasks appropriate for UAVs?

If such skills can be applied or transferred easily, the Air Force could potentially select from millions of video game players to serve as pilots for UAVs, ultimately reducing the number of overqualified fighter and bomber pilots presently serving as UAV operators. The following investigative questions will be used as the foundations for the present study in the course of answering the primary research question:

1. What skills/characteristics do pilots identify as necessary to fly a manned aircraft?
2. What skills/characteristics do pilots find necessary to fly the Predator UAV?
3. What piloting skills/characteristics of manned aircraft are not used when flying the UAV?
4. What skills/characteristics do video game players develop while playing commercial video games?
5. Where might these various skills/characteristics overlap such that it would be reasonable to consider video game players as potential candidates for UAV piloting tasks?

Answers to these questions may help the Air Force determine who to recruit as UAV pilots, or provide an indication as to whom else might be appropriate UAV pilot candidates from within the service itself. In the following section, a more in-depth analysis of the relevant literature will be presented before detailing the specifics of the present study.

II. Literature Review

Background

As discussed in chapter 1, the Predator MQ-1 is a medium altitude aircraft that was initially designed for intelligence, surveillance and reconnaissance (ISR). However, the Predator is only one part of an Unmanned Aircraft System (UAS). A 55-member team must work in the Ground Control Station (GCS) to operate and maintain the four aircraft and their communication and control mechanisms involved in each system (Department, 2005). The *Unmanned aircraft systems roadmap 2005-2030,* published by the Department of Defense, explains the history of the Predator:

> The Air Force MQ-1 Predator was one of the initial Advanced Concept Technology Demonstrations (ACTDs) in 1994 and transitioned to an Air Force program in 1997. Since 1995, Predator has flown surveillance missions over Iraq, Bosnia, Kosovo, and Afghanistan. In 2001, the Air Force demonstrated the ability to employ Hellfire missiles from the Predator, leading to its designation being changed from RQ-1 to MQ-1 to reflect its multi-mission capability. The Air Force operates 12 systems in three Predator squadrons. The MQ-1 fleet reached the 100,000 flight hour mark in October 2004, and was declared operationally capable (IOC) in March 2005 (Department, 2005:4).

Despite a large cut in Air Force personnel, $2.3 billion is expected to be spent on the Predator program in the coming years (Munoz and Matishak, 2006). With this investment and a new capability for pilots to operate multiple unmanned aircraft, a total of 154 UAVs would allow the Air Force to increase the number of daily missions (Munoz and Matishak). For instance, Air Force Chief of Staff General Moseley has called for an increase from 12 to 21 daily combat air patrols (CAP) to take place by Fall

2008 due to the availability and capability of the Predator UAV platform ("Air", 2007). In fact, an additional 1,150 UAVs are expected to become part of the Air Force inventory in the 10 years between 2005 and 2015 (Fitzsimonds and Mahnken, 2007). "The mammoth buy of both the Predator A and B models will also allow the service to stand up Predator units in Air Force Special Operations Command and the Air National Guard as the Guard seeks to expand its emerging mission's portfolio." (Munoz & Matishak).

In order to supply UAV operators, more pilots are needed from manned aircraft cockpits (Fitzsimonds and Mahnken, 2007). "To fully man this new level for Central Command, the Air Force will maintain 160 "total force" Predator crews, up from 120 last year." ("Air", 2007; pA4) Total Force combines the assets of the active duty Air Force, the Air National guard and the Air Force Reserves ("Air"). Hoffman and Kamps (2005) projected the increase in necessary manning to 400 UAV pilots per year by the year 2012.

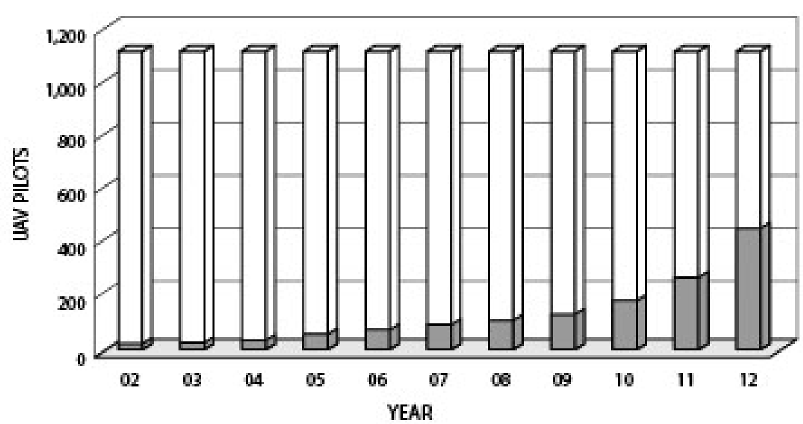

Figure 1. UAV Manning Requirements (Hoffman and Kamps, 2005)

In the Predator GCS, an experienced Air Force pilot operates the Predator UAV while another airman, who is likely to have intelligence analyst training, controls the sensors that aid in detecting targets and items of interest. The controls are identical for both the pilot and the sensor operator (Fig 1). A screen directly in front of the controller provides a view from one of the vehicle's cameras while another screen positioned above this one shows a map with an airplane symbol that represents the UAV's location.

Figure 2. Predator UAV Simulator (Schreiber et al., 2002)

Pilot Training Time and Costs

Currently, UAV pilot training is the responsibility of Air Combat Command and Predator instruction is accomplished at Creech AFB in Nevada (Rolfsen, 2006). However, the Air Education and Training Command (AETC) proposed a UAV training course in 2006 that would produce UAV pilots without previous flight experience (Hoffman and Kamps, 2005). The following is a comparison of the cost savings of the AETC-proposed plan to the established specialized undergraduate pilot training (SUPT), which is required to become qualified for specific aircraft.

Undergraduate pilot training (UPT) is required for all other Air Force pilots. However, if the requirement for combat aircrew experience (mentioned in Chapter 1) were removed, less overall training hours would be necessary to become a pilot of the Predator UAV. In fact, the initial 25-hour flight-screening course is the only common trait between the two tracks. After the initial flight screening, UAV candidates would go on to a formal UAV training unit to receive 3 months of basic predator flying before earning their wings and proceeding directly to an operational assignment. (AETC Initial Flight Screening grade sheet in Appendix C.)

On the other hand, manned aircraft training would require an extra 90 hours of flying in a T-37 or T-6 trainer during SUPT, where they are later chosen for a particular aircraft and later spend as much as 119 hours in those specialized aircraft such as fighters, bombers, or transports (Rolfsen, 2006). Messer (2006) goes on to explain the process of pilots getting their wings…"[Combat pilots must] successfully complete the training prescribed in the AETC Undergraduate Pilot Training (UPT) syllabus including completing 140 hours of flight in an aircraft, passing eight demanding check rides and enduring the scrutiny of experienced instructors" (p1). Along with this extensive training, the estimated cost of the current training for a B-52 pilot is $685,051 while the estimated cost of the proposed UAV training without the need for prior piloting experience is only $13,000. Therefore, training just 15 pilots in the proposed UAV training course would save over $10 million and reduce the need to use combat aircraft pilots for operating unmanned aircraft (Hoffman and Kamps, 2005).

Schreiber, Lyon, Martin, and Confer's (2002) study compared a wide variety of piloting experience with the ability to perform well on assigned Predator UAV tasks. Non-pilots, civilian private and instrument pilots, T-1 graduates and T-38 graduates, along with Predator selectees and experienced Predator pilots were given basic maneuvering, reconnaissance, and landing tasks. Experienced Predator pilots performed best, but the author found that the Predator selectees, with hundreds more hours experience, did not perform significantly better than the T-38 graduates and civilian instrument pilots. Based on this Schreiber et al. study, as little as 150-200 hours of recent flying time was adequate for flying the Predator simulation. Therefore, as Hoffman and Kamps (2005) point out, there is a need for a "new crop of air warriors who require far less formal pilot training and who do not owe primary allegiance to manned systems." Although this savings would seem to be enough reason for a change in the current UAV manning and recruiting policies, several other factors must be taken into account.

The Human Side of the Predator UAV

Because the Predator is a weapons system capable of firing Hellfire missiles, the Air Force has determined that pilots must have fighter or bomber flight experience to fly this particular aircraft. As suggested in the previous chapter, using such potentially overqualified aviators takes needed resources away from other manned aircraft cockpits for 3-year intervals (Colucci, 2004). With a shortage of combat pilots and an increase in the need for Predator operators, Garner and Villem (2005) suggest that, in the short term, the Air Force might benefit from recruiting candidates other than combat pilots for these 3-year assignments. Indeed, current policies and procedures associated with the assignment of combat pilots to Predator flying units have a multitude of impacts and implications on the ultimate health and strength of our piloting force in both positive and negative respects. Taken together, these many issues provide support for Garner and Villem's (2005) suggestion about alternative candidates for UAV piloting duty.

Career Field Impacts.

Using combat pilots in a UAV squadron may have an impact on the combat/bomber pilot career field in any of several ways. First, a commonly shared view among Air Force personnel is that pilots assigned to a UAV squadron are stunting their careers (Squeo, 2002). Essentially, our aviators consider an assignment to a UAV squadron as being "grounded," a tour resembling a staff position (Squeo). Second, 3 years without flying a manned aircraft may cause difficulty for pilots regaining the level of expertise and performance achieved in manned aircraft prior to reassignment (Squeo).

Interestingly, another of the potential impacts is a growing perceptual issue that results in decreasing motivation for our piloting corps. Specifically, pilots are taken from the adrenaline-pumping thrill of flying by the seat of their pants in a manned aircraft, sometimes a lifelong dream, and are relegated to working in a cubicle type environment without the visual and physical feel of the cockpit. For example, the commander of the

11th Reconnaissance Squadron, a former A-10 pilot, spoke about the loss of motivation when going from a manned aircraft to being assigned in a UAV squadron, "…someone like me, who is a manned vehicle pilot, is not as motivated to go to an unmanned system, because I grew up wanting to fly an airplane" (Peck, 2006:30).

Indeed, pilots may expect the UAS ground control station display and operation to resemble the cockpit of their manned aircraft counterparts. However, the feeling of flight and the panoramic view of the cockpit is missing when they physically get to the Predator station. Case in point, an F-15 pilot recently compared flying a UAV to sitting in a trailer and watching television while controlling the UAV (Squeo, 2002). A likely result of placing an unwilling pilot in UAV training might show negative transfer and a lower drive toward the mission. Although a combat pilot's experience should easily bring needed skills, being pulled from such a highly regarded position, such as that of a combat pilot, could cause low morale and loss of motivation during the UAV training and animosity in a follow-on assignment **(**Peck, 2006).

Health Issues.

Health is a serious consideration when choosing a pilot of a manned aircraft due to several factors. Temporary incapacitation of the pilot is likely if he does not maintain the good health that is required to sustain the forces of altitude and maneuvering of the jet aircraft that he controls. Therefore, a stringent medical certification is required to avoid health-related situations that could cause danger to the pilot himself, the aircraft, and the population on the ground.

Operators of unmanned aircraft must also meet a majority of these same medical requirements. However, access to rest cycles, lack of physical demands due to airplane motion or g-forces, and fewer on-the-job ("in-the-cockpit") risk factors provide health-related advantages for UAV operators that combat pilots do not have. In fact, a Federal Aviation Administration (FAA) study led to the implementation of a second-class medical certification into the standards for unmanned aircraft pilots. Some of the differences are the allowance of correctable vision and medical conditions that can be wavered with a "Special Issuance" medical certificate (Williams, 2007:6). For example, a lack of perfect eyesight is a health issue that has disqualified many would-be pilots over the decades. With the vision restrictions lifted for a class II medical certificate, simply wearing eyeglasses or contacts to achieve 20/20 vision would not constitute an automatic rejection to operate a UAV. Therefore, the reduced medical qualification can allow previously ineligible applicants to be considered for unmanned pilot selection. Changes in UAV pilot selection policies along with medical provisions such as these could help to reduce the load on combat pilot manning.

Selection Criteria for Manned Aircraft Pilots.

The Air Force Officer Qualifying Test (AFOQT) and Basic Aptitude Test (BAT) are the two tests used in the Air Force for testing aptitudes for pilot applicants. The AFOQT measures "general cognitive ability, verbal, math, spatial, aviation knowledge, and perceptual speed." Minimum scores on various parts of the AFOQT are required for pilot selection. The BAT was used to assess cognitive ability, psychomotor ability and risk behavior, but it did not have a minimum qualifying score. Instead, the two tests were combined into a composite called the Pilot Candidate Selection Method (PCSM) (Carretta, 2000).

Although a higher PCSM score indicates, "greater probability of completing jet training, fewer hours needed to complete training, higher class rank, and greater likelihood of being fighter qualified," the score is not the key consideration for pilot selection (Carretta, 2000:4). Similarly, there may be a better way to select people for piloting unmanned vehicles by looking deeper into how they think and how such thinking can help to quickly develop the skills needed for Air Force related activities (such as operating the Predator UAV).

Skills used when operating a Predator include using the radio for communication, managing information from various screens, instant messaging, and generally a number of different skill sets than that of manned aircraft pilots. In addition, combat pilots must concentrate on highly skilled maneuvers and may have planned executions during their bombing campaign; the UAV pilot is operating a slow-moving, light aircraft and performing reconnaissance during most of the flight. Because of the variations between piloting UAVs and manned aircraft, pilot selection could well be examined in a different manner. Current selection methods may in fact not provide the fit for Predator needs because they do not really test what the Predator pilot really requires to do their job. Note that although the UAV pilot has the capability of placing weapons on targets, the operator may not need to meet the specifications to be able to fly a fighter or a bomber aircraft. Learning the weapons facet of air combat is arguably a separate issue from the ability to fly these types of aircraft; therefore, weapons handling is beyond the scope of this research.

An Alternate Career Field?

Based on the skills and training needed for flying manned aircraft, it seems that the Air Force would benefit by leaving them in the cockpit where their expertise has been crafted. Avoiding the loss of proficiency needed in a very important position may be a reason to look at making UAV piloting its own Air Force career. Creating a separate UAV career would also take advantage of fully maximizing the unmanned aerial systems by creating UAV experts that can delve into various aspects of their career without the interruptions of being pulled from the field for reasons other than career broadening. In the words of the commander of the 15th Reconnaissance Squadron, Col John Harris:

> You have to design a Predator pilot and sensor operator so there is cradle-to-grave growth of this person. Right now, they come in, spend three years and then they're gone. All my experience walks out the door [because USAF] hasn't set down a career track (Fulghum, 2005;59).

A specific UAV career field could develop pilots so they become professionals for this unique type of aircraft operation. In 2005, the development of a new UAV career field was planned by the Air Education and Training Command and was to be instituted by 2008. After initial piloting training, these pilots would have followed on into a UAV squadron for further training specific to unmanned aerial vehicles (Fulghum, 2005a). In 2006, three junior officers were chosen and a syllabus reflecting the 6-month course work was written. This new plan would have saved a year and a half of the traditional method of manned pilot training. Unfortunately, the plan was discarded in January 2007 (Jenkins, 2007) which has presently left the Air Force without an alternative to using fighter and bomber aircrew in UAV positions--despite the fact that the notion of a separate UAV career field clearly had enough merit to warrant a formal investigation and consideration. Therefore, this plan may deserve further research.

Perhaps the difference between the operations of manned versus unmanned aircraft could also justify the notion that unmanned aircraft operation deserves its own career field.

> Some of the UA (unmanned aircraft)-related training is a fundamental shift away from the skills needed to fly a manned aircraft (e.g., ground-based visual landing). These differences can relate to the means of landing: visual remote, aided visual, or fully autonomous. They may also relate to different interface designs for the UA functions, or the level of control needed to exercise authority over an aircraft based on its autonomous capability (Department, 2005;F-6).

In order to give the notion of a UAV career field another look, it would be desirable to recruit members who show an interest in this type of career and show the inherent ability to do well in it. Because combat pilots are currently used for UAV duties, it is therefore logical to determine what skills are required that they bring to a UAV squadron upon assignment.

A Comparison of Combat versus Predator Pilot Skills.

While researching skills required for flying fighter aircraft, Messer (2006) developed a hierarchy of skills that make up a pilot's ability and classified them into three categories along with multiple subcategories. In addition, Messer also included student motivation as part of a pilot's ability:

- Basic skills - Control of an aircraft under normal conditions and perform basic tasks.

- Instrument skills - Operate under poor weather conditions following established procedures
- Mission skills - Maximum performance of self and aircraft while operating in a complex environment and maintaining situational awareness
- Student motivation - Desire to fly a particular aircraft (Messer;24)

Sub-skills in this hierarchy were developed by distributing an open-ended Fighter Core Skills Survey (FCCS) to the fighter population at AFIT followed by a working group for further modification (Messer, 2006). The resulting hierarchy of skills needed for flying fighter aircraft is shown in Figure 3.

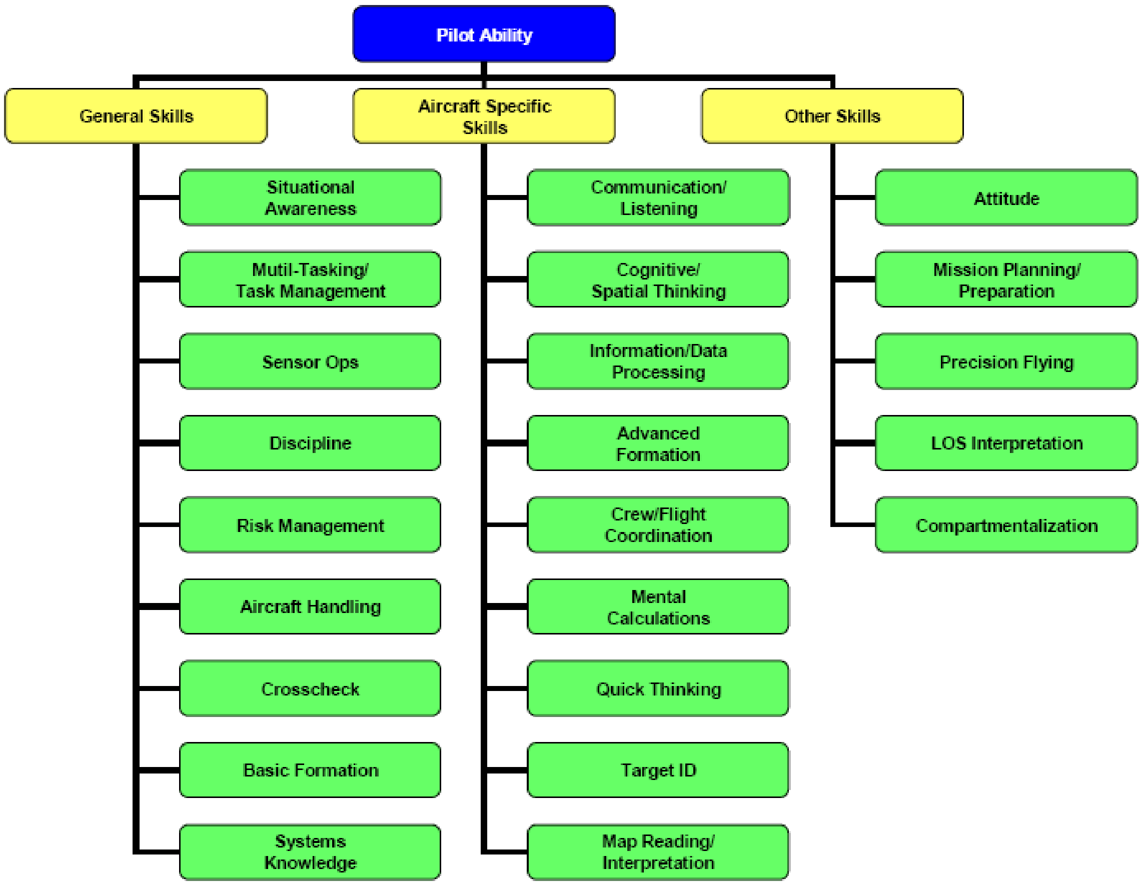

Figure 3. Combat Pilot Skill Subset Breakdown (Messer, 2006;28)

Hoffman and Kamps (2005) point out the need for a "new crop of air warriors who require far less formal pilot training and who do not owe primary allegiance to manned systems." Pilots in Predator squadrons require some of the skills and qualities as those of a manned aircraft pilot, but many of the skills necessary to fly the unmanned aircraft are in no way similar to an aircraft such as an F-16. As with manned aircraft, UAV piloting skills include operating the flight controls and managing information while in flight. However, unlike manned aircraft, the Predator pilot has access to many more sources of information that need to be dealt with while maintaining situational awareness and communications throughout the operation of the aircraft.

Another difference between manned and unmanned aircraft is dealing with the probability of losing the link that controls the aircraft. As mentioned, control of the Predator aircraft is from the ground or through a satellite link, which can be vulnerable to interference or complete loss of communications in many situations. Therefore, the pilot may be positioning the aircraft to gather optimum intelligence or plan for an attack while communicating with members of the crew, aircraft in the area, and troops on the ground (Colucci, 2004).

While these are similar tasks of the manned aircraft pilot, the UAV pilot must also deal with the operation of an aircraft with limited sensory inputs—limitations that must be overcome to avoid the loss of situational awareness. McAllister (1997:37) sums up the importance of situational awareness and communication…"If we look closely at the various factors involved in communication, we can see how they deal with the transfer of information vital to the recipient's understanding." In fact, several pilots in a Rand study, *Assessing the Impact of Future Operations on Trainer Aircraft Requirements*, stated that one of the most important factors of flying is managing information (Ausink, 2005).

Many aircraft accidents have occurred due to poor judgment from the pilot, highlighting the importance of managing information (McAllister, 1997). By late August 2007, 12 aircraft in training and one in combat were destroyed resulting in three fatalities. In a recent article by Major General Griffin about maintaining vigilance for safety, the three main contributors to accidents were cited as "questionable risk management, poor decision making, and inattentive maintenance and flying" (Griffin, 2007). It is reasonable to conclude that poor information management may lead to any of these three conditions. While this applies to both manned and unmanned pilots, the Predator pilot depends on the limited view of a camera while relying on many other available resources to maintain the safety of the aircraft.

The level of difficulty, the execution of the mission, and the mission outcome may be similar to both manned and unmanned aircraft. A manned aircraft pilot may also bring experience and knowledge of flying into the Predator cockpit. However, one of the chief concerns for Predator piloting skills may in fact be less related to typical aircraft handling and is instead related more to his or her ability to adapt to limitations of the aircraft while using a multitude of other resources to maintain situational awareness.

The Relationship between Learning, Cognition and Experience

Pulling combat pilots from the cockpit of a fighter aircraft is certainly one way to bring experience and skill, but at the high cost of training for a somewhat different and equally important mission. For an appropriate match of the skills needed for UAV operations, it is important to understand how learning takes place and what type of learners are appropriate for the tasks at hand. In fact, learning takes place in a myriad of ways and is different for each individual.

One reason for this difference is that adult learning is not only based on what is being taught, but more importantly, how the information fits into what we already know--our knowledge which has been previously obtained based on our experiences. Learning is the act of changing a behavior to allow a person to apply what has been learned in the form of a mental or physical skill to be used toward similar future tasks (Nelson 1983). The following is an excerpt pertaining to the learning process from *The Beginner's Guide to Flight Instruction*:

> 'Learning' and 'knowledge' cannot exist apart from a person. A person's knowledge is a result of experience, and no two people have had identical experiences. Even when observing the same event, two people react differently; they learn different things from it, according to the manner in which the situation affects their individual needs. Previous experience conditions a person to respond to some things and to ignore others. (Nelson, 1983: 39)

For real learning to occur, several factors must exist. Nelson (1983) states these factors as the six laws of learning:

1. Law of readiness - readiness is determined by the student's motivation along with a clear objective;
2. Law of exercise - what has been learned can be practiced and perfected multiple times in order to reach a goal;

3. Law of effect - determines the emotion of the learner giving feelings from satisfaction to frustration;
4. Law of primacy - the learner desires to get it right the first time;
5. Law of intensity - learning experience is not a boring experience, but as stimulating as possible;
6. Law of recency where the information is used as soon as possible after the initial learning

(Nelson, 1983).

Simply stated, motivation keeps a learner engaged so they will want to continue to practice and hone their skills to reach a desired goal, while skills that are not used will be lost. Therefore, it is necessary to discuss key sources of instruction for better learning.

Experiments involving cognitive skills have determined how learning can be accomplished in a more satisfactory manner. For example, multimedia and tracking objects involve the cognitive skills used when learning or performing a task. Instruction from multimedia may establish a degree of learning beyond traditional teaching, prolonging the length of time that information is maintained. According to Andres (2004), the presentation of information is likely to determine the degree of learning that occurs. Using multimedia to present information and the types of cognitive skills used in the multimedia process will be discussed in the following section. Gabriel (2003; p. 112) explains "Cognition is the process of knowing, understanding, creating, thinking, and problem solving." Andres further explains that cognitive skills are based on experiences of the past and the present and allow us to make decisions. Whether our decisions are effective or ineffective will depend on our awareness and understanding of the situation at hand.

Andres (2004) found that multimedia presentation as compared to text-based learning resulted in more "applied sustained attention and mental effort." When information complexity, that is to say ideas and concepts that require multiple paths in the brain for a physical or mental response, was increased, successful effort decreased. However, multimedia presentation lowered this problem by spreading the cognitive load across audio and visual portions of the brain (Andres). This reduced cognitive workload also has the implications of increasing the visual attention, thereby gaining greater comprehension and information quality when the material is given in a multimedia presentation (Andres). In addition, Andres noted that multimedia presentation also led to self-satisfaction leaving participants that felt they had a greater understanding of the material. Therefore, a richer communication medium that uses more ways to communicate a message may result in an improved learning situation for acquiring new skills and retaining more information.

Video Game-Based Learning

While multimedia is a key source of learning--a step beyond multimedia involves video game-based learning. For example, prior experience with video games was found to produce better situational awareness (Green and Bavelier, 2006). Frequent video game players were also found to exhibit strategic thinking skills more so than their infrequent game-playing peers (Blumberg, Rosenthal, and Randall, 2007).

McAllister (1997) describes best how skills are acquired and maintained through training and experience:

> As we progress and gain experience we see and know virtually automatically without intensive evaluation and thought. When this

> happens, we are moving from cognitive back to perceptual. By doing this we can begin to make good judgments. (McAllister, 1997:168)

McAllister's statement, which was written in the context of piloting aircraft, is very similar to Gee's (2003) explanation of automatization as it applies to video gaming. In particular, both of these concepts depend on the six laws of learning to reach mastery as follows.

First, Gee (2003) explains that skills are learned (1. law of motivation) and practiced (2. law of exercise). As the skills are being learned, they are usually "pleasantly frustrating" (3. law of effect) while the gamer is trying to beat the level for the first time (4. law of primacy). Players willingly spend hours per session participating in the gaming environment (5. law of intensity) and once they have learned a particular ability, they continue to use and refine it throughout the game (6. law of recency).

After the actions and activities associated with these six laws have been accomplished, McAllister (1997) describes the process of moving from cognitive to perceptual to maintain skills, while acquiring value-added skills to update those original skills, thereby creating new references and improving judgment. In the same way, Gee (2003) explains the automatization process whereby a person develops a skill and begins to use it automatically until an alteration of the skill is desired. At this point, the skill will be refined through cognitive processes and re-automated until another change is necessary. Therefore, continued practice and experience in the virtual worlds created by video games may allow the VGP to automatize some of their playing tasks while allowing them to make better judgments in future challenging situations. This process seems to demonstrate that there may be a close connection between a gamer and a pilot's acquisition, processing, and further development of perceptual and cognitive skills necessary to be successful in their operations.

Developing Video Gamers.

Millions of people are registered users of online video games. For example, World of Warcraft has reached a milestone of 9 million registered users (Bantick, 2007) and America's Army recently exceeded 8 million registered users (Pragmatic, 2007).

> More than 8 million registered users have played America's Army for more than 200 million hours since its debut. On average, players complete more than 120,000 hours exploring the Army in America's Army each day (Pragmatic, 2007).

Much time and money have been spent on research and development of games catering to a huge market of game players. For example, Sony, Microsoft, and Nintendo have increased the global video game market to nearly $30 billion (Surowiecki, 2007), which is expected to exceed $50 billion in 2007 (Strube, Schade, Schmidt, & Buxmann, 2007). This proliferation of video games has led to a large number of customers unlocking potentially seldom-used skills and creating new ones.

Because there are so many people willing to apply and potentially improve their skills playing video games, it may prove lucrative to recruit gamers to do real jobs that use similar skills required during video game playing. America's Army is one such example; the US Army has designed a game to emulate the operational tasks and missions they perform. In addition, the Army has tried to give their missions entertainment value, using an engaging experience to transfer army skills, or an experience of those skills, to the player. Nieborg (2004) summarizes the effort by noting, "The US Army has the enormous advantage of being able to tap into an existing leisure activity popular with male teens" (pg. 7).

In 2005, the Navy launched a similar game aimed at recruiting 17-24 year old gamers. The director of Navy advertising cited the need for sailors that are analytical and quick thinking and referred to gamers as having those skills ("Ready", 2005). Clearly, the military has recognized the value of video games for recruiting purposes. Such video games may well be attracting qualified people that possess desired skills for military careers; some of whom may even be appropriate candidates for UAV pilots.

Demands on Video Game Players.

Playing commercial video games often demand a variety of skills such as exploring the game area to find new objectives or reacting quickly to enemy fire when encountered. The drive to continue playing the game or moving to another level is often attributed to the perceived engagement of the player. An engaged player is thoroughly involved in the activity that is taking place (Gee, 2003). "Successful gamers must focus, have patience, develop a willingness to delay gratification, and prioritize scarce resources. In other words, they think" (Johnson & Schlesinger, 2007).

James Gee, professor of reading at the University of Wisconsin, compiled a list of 36 principles of learning which must take place in order for learning to occur. These include acquiring skills, transferring them to other areas that require similar skills, and gaining knowledge as learners become part of an experience. These principles were written to apply to learning in the classroom, as well as learning in video games (Gee, 2003). Gee examined how cognition is affected by video games to improve pattern recognition or system thinking that may be "mentally enriching." In some cases, patience leads video game players to challenge and exercise their mind "the way physical activity exercises the body" (Johnson and Schlesinger, 2007). Therefore, we may have a lot to learn from video games that can improve our performance in real-life situations.

In research on the subject of surgical skills (Rosser, Lynch, Cuddihy, Gentile, Klonsky and Merrill, 2007:181), video game-playing laparoscopic surgeons were compared to those who did not play video games. The skills that have been developed and exercised by the video games used in this study “included fine motor control, visual attention processing, spatial distribution, reaction time, eye-hand coordination, targeting, non-dominant hand emphasis, and 2-dimensional depth perception compensation.” The authors’ analysis concluded that surgeries and suture practice sessions were 27% faster with 37% fewer errors made with just 3 hours per week of video game use (Rosser, Lynch, Cuddihy, Gentile, Klonsky and Merrill, 2007:181). According to the authors, “Over-the-counter video games may constitute a training resource, not as simulation but as a gradual path of analogous or parallel skill acquisition” (Rosser, Lynch, Cuddihy, Gentile, Klonsky and Merrill, 2007:181). Clearly, this study indicates that a sufficient gain in skills from video games can be useful in real-life activities.

Impasse and Object Tracking.

Cognitive scientists suggest that people accomplish learning when they are able to come up with solutions to impasses during problem-solving activities (Blumberg, Rosenthal, and Randall, 2007). An impasse is a situation where a lack of experience or knowledge halts progression. Overcoming an impasse requires obtaining information that is not available at the moment. Such information can be obtained through education, training, changing strategy, or gaining experience in some other manner. Identification of risks can aid in the prediction of impasse situations, which can lead to learning before mistakes have been made. Video games are designed to present impasses so the Video Game Player (VGP) can learn from an obstacle to prepare for advanced stages (Blumberg et al.).

In their study, Blumberg et al. (2007) compared frequent with infrequent video game players to study the players' reaction to impasses. Their results indicated that frequent players appeared to have more focus and better insight to help generate a better reaction to challenging impasses. In comparison, infrequent players were not fully engaged and were not apt to progress. For example, during game play, frequent VGPs comments about "impasse, insight, game strategy and goals pertinent to mastering the game significantly…increased over the course of the game" (Blumberg et al., 2004:10). Therefore, frequent video game players showed patterns of "greater emphasis on problem-solving and greater engagement as the game progressed" (Blumberg et al.:10).

Green and Bavelier (2006) recently described how enumeration, or counting and object tracking, are also affected by the amount of time spent playing video games. The authors found that action video games have a strong influence on "visual working memory," which includes the modification of spatial attention, temporal attention, and object tracking. A series of experiments was conducted to compare VGP to non-video-game players (NVGP) on enumeration and multiple object tracking (MOT) tasks. As mentioned, enumeration is the number of items counted, while MOT is the ability of each participant to track several objects over a period of time. The results of the authors' experiments suggest that video game players demonstrated advanced abilities in enumeration and the ability to track multiple objects, which exceeded that of the non-video game players. Therefore, it seems that video game players might have the advantage of being trained while they are being entertained.

Furthermore, frequent video game players were able to use skills learned in other games to develop a strategy to avoid barriers. "Practice and accumulated knowledge in a given domain accounts for greater success in future problem-solving within that domain" (Bedard and Chi, 1992; Rumelhart and Ortony, 1977). Within the context of video games, frequent video game players performed strategic problem solving at a higher level than infrequent players. The results of Blumberg at al.'s (2007) impasse study seem to support Gee's (2003) general conclusions that there seems to be a large amount of potential in video games-based learning that could be brought into the classroom.

It is possible that capturing the result of the time and effort that video gamers use to perfect their skills could be used to the advantage of the Air Force. A former A-10 pilot referred to the Xbox generation, speaking of the multiple skills that are used during video games (such as multitasking) remarked, "That's what operating the Predator is all about.… [Operating the Predator UAV] doesn't require a lot of advanced flying skills…[Instead, it requires] monitoring systems, keeping track of where they are and what's going on, and answering the customer's request" (Peck, 2006). All in all, the preponderance of evidence and experimental results suggest that video games might well provide the necessary foundation for training as a Predator pilot.

Conclusion

As Johnson and Schlesinger (2007) remind us, "Even if Gee is right and video games are learning machines, one question remains: Do the skills learned in the virtual world translate into the real one?" The present study will examine this particular question in the context of piloting skills—specifically, whether skills developed during the use of commercial video games are transferable to UAV piloting tasks. Based on the results of the literature cited in the preceding sections, research suggests there may be other potential candidates for flying UAVs than combat pilots of manned aircraft, and there may be very good reasons for looking to such individuals to fill those positions. Manning to support UAV piloting could possibly come from those people who frequently play video games and subsequently have developed many of the skills that would be required on the job.

In addition, video games-based training may prove to be an appropriate alternative to the more costly and time-consuming pilot training programs currently in use today. Yet, before giving serious consideration to any such proposals, the suitability and transferability of video games-based skills and training to UAV piloting activities must be more thoroughly explored and applicable linkages between the two contexts established. The following sections of this report detail the specific methodology used to generate data necessary to address these overarching research concerns before proceeding to an analysis of that data and the recommendations and conclusions they support.

III. Methodology

Due to the exploratory nature of the research questions, a suite of interpretive and qualitative data collection and analysis methods was deemed necessary to allow maximum flexibility and open-ended analysis of the skills needed for operating UAVs with a crosscheck of those used by video gamers. As such, a case-study like approach using a series of semi-structured interviews was selected as the primary framework for data collection. Open coding and content analysis methods were then employed in the course of analyzing the obtained results to help answer each of the research and investigative questions appearing in Chapter 1.

Participants and Recruitment

Participants were drawn from one of two categories: Video Game Players (VGP) or manned aircraft pilots. Two UAV pilots were also interviewed as subject matter experts. VGP and manned aircraft pilot participants were recruited from those who successfully completed a separate experimental study (McKinley, 2006) conducted by the Air Force Research Laboratory (AFRL) approximately 6 months prior to participation in the current study. In the AFRL study, VGPs and pilots participated in an experiment demonstrating the cognitive workload and performance of each group during various video game type computer exercises and a Predator UAV landing simulation where each exercise lasted approximately 3 hours over the course of three separate visits. In the

AFRL study, pilots and video game players were chosen based on self-reported video game playing and piloting experience that met the study criteria.

In particular, self-reported video game players were required to have reported an average of at least 3 to 4 days of action game playing time per week with each session lasting an hour or more over the past six months. Pilots were simply required to have prior flight experience. Therefore, piloting experience varied from FAA licensed pilots to US Air Force pilots. There were no further requirements for participants in this study.

AFRL's study consisted of 18 volunteers: 8 pilots and 11 video game players. Recruitment for the current study was accomplished via email sent to all participants who completed the AFRL study requesting volunteers for a follow-on investigation. From this group, 3 pilots and 4 video game players volunteered to continue their participation; no additional incentives were offered or received. All participants were male between 24 and 43 years old with various backgrounds. All pilots were active duty in the US Air Force with various levels of experience ranging from civilian aircraft piloting outside the Air Force to 20 years experience in the AF aircraft fleet. The video game players consisted of 1 civilian student from a local university along with 1 contractor and 2 Air Force Company Grade Officers who are currently attending the Air Force Institute of Technology.

Length of Time Spent on Gaming/Piloting

Video Gamers.

Video game players interviewed in the study averaged 2 to 3 hours of game play per day—approximately 14 to 21 hours per week. At times, the length of play extended as long as 24 hours. The average length of time spent playing video games was between 15 to 16 ½ hours per week.

Pilots.

The average flying time for the 3 pilots interviewed was 1.3 to 2 hours per flight. The longest flights that pilots could recall in the actual cockpit of an aircraft averaged just a little over eight hours.

Age and Experience.

Video Gamers.

The average age of the video gamer was 27 ½. The video game players interviewed frequently played several genres of video games. The following is an example of genres based on those games that were stated in the interviews (Table 1).

Table 1. Genres of Video Game Reported by VGPs

Genre of Video Game	*Example*
Massive multiplier online role playing games (MMORPG)	Dark Age of Camelot, Lord of the Rings, and World of Warcraft
First person shooters	Half Life, Call of Duty, Bio-Shock, and Halo
Sports games	Madden Football
Strategy games	Command and Conquer, Supreme Commander, Civilization, and Age of Empires
Flight simulators	Microsoft Flight Simulator X, Falcon 4.0, and X-Wing

Pilots.

The average age of the 3 pilots in this interview was 32. One of the pilots was an Air Force Company Grade Officer (CGO) rated as an FAA rated civilian pilot (8 to 10 years), The second was a CGO flight-test engineer with an FAA license and experience in military aircraft as a flight-test engineer (350 hours, 10 years). When asked about experience flying military aircraft, he stated, “Usually the pilot’s flying and I’m taking data. But sometimes I fly.” The third pilot was a field grade officer with a wide variety of experience (4,000 hours, 24 years) in both civilian and military aircraft with most of his operational time in tanker aircraft, such as the KC-135. The various planes flown by the interviewees are shown in Table 2:

Table 2. Aircraft Flown by Manned Aircraft Pilots in this Study

Gliders	T-12	C-130s	N-1
Cessna 172	T-37 (UPT)	KC-10	L-39
Baron	T-38 (Jet Training)	KC 135	E-41
G-222	F-4	C-17	S-3
Costel 101	F-15s	Harrier	Other civilian aircraft
Viper Cherokee	F-16s	UH-1 (Helicopter)	

The flight-test engineer also had some experience working with the Global Hawk, Predator, and X-45 unmanned vehicles.

To recruit subject matter experts, a UAV pilot was contacted directly via a professional acquaintance of the principle investigator. Another UAV pilot was individually recruited based on a “snowball contact” recommendation from the first UAV pilot. Both UAV pilots are currently involved with Predator UAV operations and testing and had previous experience flying manned combat aircraft during active duty in the Air Force.

The first UAV pilot interviewed flew two tours in F-15 Cs, while the second spent his career flying tankers in the military and other large commercial passenger aircraft as a civilian. These aircraft are shown in Table 3. Both have experience flying the MQ-1 Predator UAV, and one has additional UAV experience flying the MQ-9 UAV.

Table 3. Manned Aircraft Flown by UAV Pilots in this Study

F-15C Fighter Jet	EC-135 Tanker	KC-135 Tanker	ISR/Rivet Joint
DC-9 Commercial Jet	727 Commercial Jet	757 Commercial Jet	RC-135

Protocol Development

The Interview questions were developed based on a review of cited literature on learning, piloting, and video game playing which was referenced in the literature review. A separate set of applicable but similar questions was devised to gather information regarding the perceived skills of video game players, manned aircraft pilots, and Predator UAV pilots during the course of the individual interviews. Discussion of the participants' experience and skills varied with the participants' interest and ability to articulate their perceptions of the skills they acquired.

Procedures

Interviews.

Nine interviews were conducted individually. The interviews with the AFRL participants were conducted face-to-face in a closed seminar room. The two UAV pilot interviews were conducted via telephone at their working location. A closed office/conference room and a speakerphone were used to aid in recording and avoiding interruptions. Each interview was recorded with an electronic recording device; the recordings themselves were later transferred to computer files for transcribing nearly word-for-word into separate documents. The average interview time was 42 minutes and ranged from 25 to 72 minutes. Overall, the transcribed interviews comprised 82 pages of single-spaced text.

Skill Coding.

Content analysis was used to discern emergent patterns/themes in the data; relevant passages from the transcripts were placed in an axial coding table titled with the corresponding research question to which the passages applied. Content analysis is defined as a "research technique for making replicable and valid inference from texts (or other meaningful matter) to the contexts of their use" (Krippendorff, 2004). Krippendorff describes the activity of placing portions of the text into categories in order to decrease the amount of data while allowing the pertinent themes or meaning of the information to "show through," thereby making the material more understandable for the researcher.

The emergent patterns and themes from the transcripts' codes were then examined and aggregated based on their relative applicability to four of the five investigative questions.

1. What skills/characteristics do pilots identify as necessary to fly a manned aircraft?
2. What skills/characteristics do pilots find necessary to fly the Predator UAV?

3. What piloting skills/characteristics of manned aircraft are not used when flying the UAV?
4. What skills/characteristics do video game players develop while playing commercial video games?

The themes and issues underlying the skills relevant to each group of interviewees was then compared to those required for the actual piloting of Predator UAVs as evidenced by the interviews. This information served as the foundation for answering the fifth investigative question:

5. Where might these various skills/characteristics overlap such that it would be reasonable to consider video game players as potential candidates for UAV piloting tasks?

Finally, the overarching research question was addressed based on the combination of the findings relative to each of the five investigative questions and the literature review conducted in chapter two.

Can skills/characteristics developed from different types of video games be applied to piloting tasks appropriate for UAVs?

Content analysis from the UAV pilots along with the pilots and video gamers that participated in AFRL's landing simulation was used as the basis for the skills that are required to operate the Predator UAV, predominantly in a non-combat environment. This included skills that Predator pilots bring with them from their experience in manned aircraft.

IV. Results

Chapter Overview

Using the method described in Chapter 3, interviews were conducted, transcribed and compared to reveal the skills and characteristics of each group of participants. The following sections describe in detail the results of the interviews relative to each research and investigative question.

Investigative Question 1

What skills/characteristics do pilots identify as necessary to fly a manned aircraft?

Flight Knowledge and Skills.

> "For the most part, you can teach people to fly mechanically. It might not be pretty, but you can make it safe." Manned Aircraft Pilot

Basic Flight

The solid foundation needed to safely fly an aircraft is formed in the flight training process. This includes factors concerning the ability to learn and understand how flight is accomplished and the characteristics of aircraft that is going to be flown by the student. During the flight training process, as one of the pilots described, "The first couple of flights you take, you learn to fly the airplane." After learning the basics, proficiency flying is used to further development of the skills learned in the training and learn from mistakes as well. As one respondent noted, “Proficiency flying is probably where you get most of your real learning over time.”

Good airmanship is the key to safe and successful piloting of any aircraft. One of the civilian pilots referred to the three priorities of flying as “aviate, navigate, communicate,” where the most important part of that phrase is aviate where you must “fly the airplane first all the time; if something goes wrong, you still have to fly the airplane. Don’t panic, you don’t try to do other things.” Navigation is the next part of the plan so that the pilot is aware of his status and location in order to maintain the aircraft on a route. The next step is to articulate this information in order to communicate with other aircraft or air traffic controllers.

Specifically for the Air Force, training is designed so that a portion is stressful. “You need to know your bold face,” where bold face refers to situations where critical decision-making skills are needed. Priorities include always maintaining the aircraft and thinking on your feet to produce remedies when problems occur. Remedies can come in the form of following procedures that were taught for emergency situations or using experience to understand new situations while applying a depth of knowledge. Situations such as failure of the engine, electrical system, or landing gear, are trained to Air Force pilots in stressful situations so that when an unsafe condition arises, they can react instantly. A pilot gives this example, “For spin or something like that, you’re going to know step-by-step--those kind of reactions, you learn those skills.”

Most planes have similar control mechanisms and therefore react similarly to each other. You have ailerons and rudders that divert the airflow to control the direction and orientation of the aircraft, “That type of stick and rudder stuff is pretty common from plane to plane…for the most part, if you learn one plane, you learn the principle of flying all the other planes, that basis is all the same.” However, when beginning to fly a different plane, there are usually minor differences in the control and feel of the aircraft that must be taken into consideration and require adaptation as needed.

Typical Flight

A typical flight consists of departure, enroute, and arrival. During departure, the pilot is preparing to get the plane off the ground. Preparations and checklist must be accomplished with attention to detail to avoid mishaps on the ground or on takeoff. This is the point where the pilot must make sure things such as maps, fuel, and plans that he will need are available and ready for use. During takeoff, the pilot is operating the controls of the plane in a routine maneuver while talking to air traffic control.

Barring any emergencies, the calmest part of a typical flight is during the enroute portion. However, the pilot must maintain awareness of the flight path, air space, and weather. At the same time, the engine, flight systems, navigation, and the aircraft in general must be monitored for any urgent situations that crop up. In addition, the pilot is talking to people on the radio at all times.

At the arrival point, the pilot is preparing for landing, waiting for clearance to land, and communicating with air traffic controllers on the radio. In addition, this is where one must have a safe place for the plane to stay until the next departure.

Situational Awareness.

Situational awareness was cited by participants as one of the most important factors of flying a manned aircraft. In normal weather, pilots have to maintain situational awareness of other aircraft in the area, stay ahead of their own aircraft by understanding where the aircraft is and where it will be in the next few moments, keep a proactive attitude, and generally must know what needs to be done next based on what is occurring. Bad weather brings further need for situational awareness to keep the aircraft safely in the air and prepared for its mission. For example, pilots do not want to fly in thunderstorms, so they must monitor their radar to avoid such activity. When low visibility situations, such as fog or rain, are unavoidable, the pilot has to rely solely on instruments because of the loss of visual cues. Therefore, perception of non-visual cues is a critical ability for pilots. Slight changes in the environment can alert the pilot so that he focuses on the instrument or cause of the unusual occurrences in the aircraft. These non-visual cues may be a difference in the feeling of vibrations, the smell in the cockpit, a sound that is not quite right, or the sensation that the handling characteristics have changed. Regardless of what the problem is, this supplementary sense of the indication is a critical ability that the pilot uses to recognize a problem as quickly as possible. In situations such as these, concentration must be increased in order to maintain the aircraft.

Information Processing.

Typical skills that are taught in Air Force officer training such as briefing, writing reports, and knowledge of the Air Force mission are important aspects of an Air Force pilot’s presentation skills in between flights. Information skills needed for flying an aircraft require that the officer be able to comprehend information being received in order to make decisions. From the basic skills of reading, writing, and basic math to more complex skills used for monitoring/adjusting navigation, altitude and airspeed, there is a conglomerate of skills that are important for understanding what is happening with the aircraft and its surroundings. Information about the aircraft's condition and whereabouts are constantly being presented to the pilot and he must be able to know what information is important at the time that it is needed. The pilot also needs to be aware of information that may or may not exist due to anomalies or other phenomenon. "Being able to manage lots of information, interpret it, and use it accordingly is a critical skill."

Communication.

An important part of information processing is communication, which allows information to filter through to the pilot about things such as weather, airport traffic circles, and other aircraft in the area. Letting others know what you are doing may also be very important for the safety of yourself and for other aircraft. When communicating, it is necessary to be clear and concise in order to send the message and keep the lines cleared for feedback from the tower or to allow other aircraft pilots to communicate as well. In an aircraft with a crew, crew resource management skills are needed so processes will be accomplished in an orderly fashion while being verified as the conversations progress. One of the pilots in the interviews remarked that you must have "good social skills to deal with other people to get the mission done."

Planning and Coordination.

Good planning is necessary to avoid getting into situations that are not desirable. The condition of the plane, an accurate route, fuel requirements, and an awareness of the weather in the area are some examples of the planning required during a flight. Not only is it important to realize where fuel stops are, you must also have alternatives because of their lack of close proximity. Therefore, the pilot must have accurate and alternate plans for every trip.

Decision Making.

Thinking on one's feet is the process of quickly gathering enough information to make a decision and acting on it in a fast and practical manner. Of course, this is a skill that can benefit the career of any member in the military. The difference for pilots is that they are traveling a high rate of speed and do not have as long to think about things as do their peers on the ground. A tanker pilot expressed this sentiment as such:

> "The difference is that you're sitting here at the table and you can pause and think about it a little longer as opposed to flying at 400 knots, you need to make a decision and live with it because you can't stop the plane."

In a pilot's situation, there is less time to get the whole picture. "If you wait until you have all the information, then it's too late to make the decision." A picture of the situation has to exist in the mind as a sort of spatial awareness where the pilot knows where the plane will be in the next few minutes and understands what inputs and corrections need to take place. "You always want more information but the plane doesn't stop moving, so you don't have the full picture, so you try to stay ahead of the airplane."

The type of decisions that must be made while flying concern safe operation, such as what to do about the thunderstorm that just appeared at the planned destination or discovering temperature fluctuations. Some considerations would be the amount of fuel in the aircraft, location of the next airport, the expected length and nature of the storm, and most importantly the risk to the pilot, aircraft and passengers.

When dealing with emergencies, a thorough knowledge of the aircraft and instant recall of the procedures for the situation is necessary. Armed with the detailed Air Force pilot training, experience, and developed skills, the pilot can keep his composure under pressure and overcome challenging situations. A pilot explains the situation, "I've had mechanical failures in flight that get the heart pumping a little bit, but you train for your emergencies, you fly the procedures, and then it's over, then you talk about it."

Experience: Practice, and Spatial Awareness.

As mentioned earlier, the foundation of flying is learned during flight training. However, further development of these skill come from practice and repetition. A common skill used during aircraft flight is hand-eye coordination, such as those small movements that cause the aircraft to react appropriately. In order to do this properly, the pilot must be spatially aware of his aircraft because it cannot be seen when moving the controls. Pilots generally refer to this type of ability as "hand skills" where they move the controls with a definite idea of how they want the aircraft to perform by using knowledge of the aircraft's abilities along with their experience and feel of the controls. Often, complacency must be overcome so that the skills of assessing situations and responding properly are not lost. For someone that does not fly often, these skills are likely to decline and must be regained with each return to flight.

Spatial awareness is also necessary when determining the location, speed, and direction of other aircraft in the sky. Looking at an airplane from a distance, pilots have the ability to notice small differences such as the location of the wings or the size of the aircraft to determine events such as the aircraft approaching or fleeing, or the angle of attack increasing or decreasing. Using this ability of thinking visually and geometrically, the pilot can see the differences in time and space between him and other objects. According to a pilot, "You develop a sense for the airplane; you have a sense about what's going on around you." Several important skills and characteristics that are used to pilot a manned aircraft are listed in Table 4.

Table 4. Skills/Characteristics of Manned Aircraft Pilots

Agility	Experience	Knowledge of your aircraft
Attention to detail	Fly the procedures	Principle of flying
Aviate, navigate, communicate	Focus & Concentration	Manage information quickly
Communication	Social skills	Manage, interpret, & use info
Coolheaded under pressure	Hand-eye coordination	Maneuvering the airplane.
Coordination	Manipulation & Hand-skills	Computations of air speed
Crew resource management	Judgment	Mathematical judgment
Decision making	Multi-tasking	Memory/FAA & AFI regulation
Discipline	Eliminate superfluous info	Mental acuity
Instinct & Intuition	Situational Awareness	Know your bold face
Monitoring your airplane	Monitoring your navigation	Visual capability
Sensory perception	Motivation	Depth perception

Investigative Question 2

What skills/characteristics do pilots find necessary to fly the Predator UAV?

> "I think it takes a special kind of person to strap into an F-16. I think it's going to take a different type of person to sit in front of a computer screen and do the same thing." Manned aircraft pilot

Predator Mission.

As explained by the Predator UAV pilots in these interviews, Predator pilots may perform tasks in either a Mission Control Element (MCE) or a Launch and Recovery Element (LRE), or they may be responsible for both. The launch and recovery crew typically operates the Predator from an overseas site. They are responsible for the UAV from the takeoff and climb to a determined altitude and location controlled from a line-of-site ground link. At this point, the link is transferred to a satellite and the MCE takes control of the aircraft and performs a mission. At the end of the MCE mission, the aircraft is returned to a location where the LRE controls the aircraft and reconnects the link to the ground station in order to land the aircraft. A UAV pilot describes the process as, "A typical launch and recovery crew does very rudimentary basic takeoff, launch, climbout, and then recovery, descent and landing." In addition to the typical job of the recovery crew, the LRE is also used to recover UAVs that are not functioning correctly by enacting emergency procedural techniques.

When the mission control pilot takes control of the aircraft from the LRE, he can pilot the UAV from a Ground Control Station (GCS) at any location, usually in CONUS. Once this shift of control has been accomplished, the mission control pilot is able to fly the UAV to carry out a mission. Much of the time that the Predator is being flown by the MCE, autopilot or mouse settings are being used to control the aircraft and the pilot is just updating the flight path on the chart "that is all via point-and-click or via keyboard."

The typical mission for the MCE pilot of the Predator is to circle a target while the sensor operator maneuvers the cameras to search for high valued targets or other suspicious enemy activities. Most of the time spent flying the Predator involves only this type of activity. However, if something suspicious is found, "you go through the procedures to shoot it."

Adaptability and Sensory Compensation

One of the manned aircraft pilots that participated in AFRL's UAV landing simulation explained that the limited field of view of the area directly in front of you was similar to "flying an airplane through a soda straw". There were many differences from other aircraft and aircraft simulators, such as watching the computer screen and understanding the human interface, which was much different from the standard-T display that pilots are accustomed to, and comprehending the location and meaning of the information in various parts of the screen. As one pilot explained, there is "…randomness all over the place…It takes a little bit of getting used to where to find the information." After getting past the unfamiliar and disagreeable presentation of information on the screen, flight experience helped in other areas, such as controlling throttle, controlled movements of the aircraft, controlling descent rate, and other instinctual activities when flying manned aircraft. According to pilots, many of the skills used in manned aircraft are also useful with the Predator simulation.

Awareness of the air space and the knowledge of flight are very important to carry out a mission in the UAV. Even so, the Predator UAV aircraft is different from most simulators of manned aircraft with a learning curve that is necessary to understand the system. Pilots often referred to relying on their knowledge of basic flight, previous flight experience and instincts that they acquired while flying. Much like flying a manned aircraft, the control of the UAV in the landing phase requires open-loop control where the pilot must make an adjustment, observe the reaction of the aircraft and continue to repeat this action throughout the process. A pilot explains, "You don't want to make quick and rapid movements to try to counter every little thing that happens to you…but the way you usually fly a landing is you look at the situation, you input and you assess."

Pilots said they automatically understood the throttle and other controls needed for landing and could avoid mistakes, such as over-steering, that someone with no flight experience might make. In this way, they were adapting to the UAV system. One pilot in the interviews clearly stated that what is "…most important is that you need to know how to fly, and then you're able to execute the mission." For instance, the landing phase for the Predator consists of small movements of gently correcting the course as the aircraft glides to the runway. As one pilot explained, "you still have to be able to do a crosscheck on your instruments and then be able to make a change and then go back to your crosscheck to see how your aircraft is doing. So, you actually have to go back and forth. It's a constant cycle, you need to connect what you're seeing and make a decision, make an input and go start all over again." Other pilots expressed a similar sentiment during the interview…"It's more manipulating the aircraft to the ground than tightly controlling it--smooth inputs." Another pilot spoke of the fact that landing the UAV was similar to manned aircraft simulators where the visual cues of manned aircraft are missing, which make it somewhat more difficult to fly.

Pilots did not find the controls on the Predator simulation to match those that they used in manned aircraft, much to their dissatisfaction. The positioning of information on the screen was another factor of dismay to manned-aircraft pilots because it was not displayed in the normal order that they were used to. One pilot explained that, "it takes a little time to gather all the information from the proper places." Many participants remarked that they could not discern whether their landing performance was smooth or if it could have been destructive to a real Predator UAV. This experience caused them to contemplate the consequences of the UAV environment in that, "It's kind of like flying a simulator. The problem is that if you screw up, you really are breaking an airplane." These types of circumstances demonstrate how the pilot must reluctantly change their ways of understanding and handling situations in order to adapt to the differences that exist in the Predator UAV.

One of the other difficulties of flying an unmanned aircraft for a previous manned aircraft pilot is that many senses that they had in the jet aircraft are just not there. Flying the plane depends on a small screen that contains all the information about the aircraft's activity and a much narrower field of view than a manned aircraft pilot is used to. The lack of normal cues has to be overcome by thoroughly learning the UAV system and maintaining crosschecks of the readings, which are the only indications of how the plane is performing. A UAV pilot reveals the difficulty in learning to fly the Predator, "Stress comes in the way of frustration because it's unlike anything that a manned pilot has done before."

The Predator is a software-driven aircraft and may rely less on hand skills and more on situational awareness and understanding the system. As mentioned earlier, much of the in-air flying uses automatic features (such as airspeed hold, heading hold, and altitude hold). At other times, the pilot is hand flying the aircraft in the landing phase, which is the most challenging aspect of the Predator UAV. Either way, it seemed very important to have an understanding of the software behind the hardware and to "understand the algorithms that make the plane fly."

> "The skills required to land the [Predator] airplane are quite challenging because it's a lightweight aircraft. It's basically a powered glider; it's very susceptible to winds. Because your only sensory perception of where you are comes through a very narrow field of view video screen, it makes it tough to land."

Situational Awareness.

The characteristics of the Unmanned Aircraft System (UAS) do not allow the pilot to maintain adequate situational awareness without using some method of understanding or visualizing what is happening. Therefore, building a mental model of three-dimensional situational awareness is necessary for the pilot to draw a parallel between the UAV and other objects in the area, such as people, other aircraft, and the ground. He must know his destination, the aircraft capability to perform as needed, proper identification of friendly troops, and proper reactions necessary if enemies are located. His thoughts may include the following:

> "Am I in a good position to go look at a friendly troop on the ground and protect him or take a shot at a bad guy, all those things have to be wrapped

> into one and because I can't look out the window I have to use other sources such as my moving map display and GPS coordinates that are given to me and plotted on that moving map."

During takeoff and landings, the operator must know and understand the aircraft. The Predator UAV has the characteristics of a glider in that it is susceptible to crosswinds.

Managing Information and Remaining Cool under Pressure.

Unmanned aircraft pilots described the ability to use various computer programs, such as voice chat and mapping software, as a necessity in the UAV ground control station. Although manned aircraft have computer-based instruments, they were described as "finite and limited to whatever he has to learn through his training for that aircraft." However, the UAV pilot in the ground control station has access to the Internet. This luxury is not afforded to the manned aircraft pilot who would likely not be able to deal with the extra information while operating such a high performance aircraft that demands so much of his attention. UAV pilots must have the ability to proficiently use a virtually unlimited amount of information that is available to them while also being proficient in the operation of the aircraft's own flight systems.

According to UAV pilots, the ability to multitask is very important when operating the Predator UAV. A large amount of information must be dealt with during routine operation of this aircraft. Situational awareness must be discerned from this information, so it is necessary to rely on sensors of the aircraft to relay the information to you through monitors on the ground. Meanwhile, the pilot must fight to avoid complacency and distractions that can easily take his attention away from the screen. "If something goes wrong, you've got to know exactly what to do."

Manned piloting training is useful for developing skills such as managing a crisis and remaining cool under pressure. Pilot candidates are required to study and perform their best under stressful conditions. This can be helpful when faced with real-life emergencies, such as a battlefield situation, because the pilot can concentrate on the task at hand while decreasing the distractions caused by panic. Armed with this ability, the pilot can react quickly and make good decisions within a limited amount of time. A Predator pilot summed this up as, "I think stressful environments is where you make your money [as a pilot]."

Communications.

UAV pilots consider communication as very important when flying the Predator aircraft. Operations of computers and being able to maneuver through the various programs are necessary for communication with members of the military community. There are chat programs where you can talk using voice chat technology or type information to share with many other people. Clear and concise conversation is necessary to get the point across without wasting valuable time while allowing others the opportunity to provide information. Otherwise, chats can become cluttered and useless in a short period of time. Missions may require the location of documents, orders, map programs, and other information. Therefore, familiarity with computers and networked communications can be advantageous for speeding up the process.

Planning and Coordination.

According to UAV pilots, the Predator UAV must be positioned in the right place at the right time in order to gain the biggest benefit for our military. Troops on the ground sometimes require the use of this aircraft before continuing certain parts of their mission. Therefore, the pilot must know where the aircraft needs to be, and its capabilities so the mission can be conducted properly.

Experience, Background and Motivation

Pilots in this study thought that flying remote controlled aircraft (model planes) would be an excellent background for flying the Predator unmanned aircraft. One of the pilots referred to his own background explaining, "Every chance that I would get, with model airplanes, radio controlled airplanes, anything that I could get my hands on. Guys that can master radio controlled airplanes can end up making very good aerobatic pilots." It appears that RC flying can be helpful in developing basic skills of flying and experiencing what an aircraft can and cannot do. Meanwhile, they are piloting without being in the aircraft with the extra sensory awareness of someone in a manned aircraft.

> "Those skills of being able to put something in a location where you want it to be without being in the aircraft are a good learning tool for building that awareness of trying to put yourself somewhere where you're not."

In the UAV pilot interviews, the Predator was described as being essentially a remote controlled airplane that has to be controlled from long distances, sometimes as far as halfway around the world.

One manned aircraft pilot responded that flying and getting into the flight environment seemed to be a very reasonable UAV background as well. Hobbies, such as sports, which are mentally stimulating and require team interaction, were also referenced. Additionally, computer gaming was perceived as a good hobby by the three pilots, with specific mention of flying video games.

Predator pilots had many other suggestions of the interest and activities that may be advantageous on the road to become a UAV pilot. A technical background and an interest in how things work would be advantageous for anyone that comes to the unmanned aircraft field. As mentioned before, the Predator aircraft is a software-driven aircraft so understanding computers could be helpful as well. Obviously, an interest in aviation can help both motivation and understanding of the reactions of the aircraft that is being controlled through instrument readings with indirect visual contact.

The two UAV pilots interviewed had mixed opinions about playing video games as a hobby.

> "I don't necessarily think that being a gamer is the best training because that's just pushing buttons."

> "As far as video games, I think it helps because it is a two-dimensional environment and you have to be able to [land, taxi, and maneuver] the plane off of a TV screen very similar to a Microsoft flight simulator kind of a picture."

One gamer noted that he referred back to his experience in a flying game to use as a reference during the UAV landing simulation. Other gamers that had played flight simulation games in the past noted that recent practice playing such games would have been helpful in AFRL's UAV simulation.

An Air Force pilot with over 20 years of experience did not think of a UAV assignment in a positive manner relative to both his personal interests and his career progression. Other pilot participants who were not eligible for assignment to Air Force aircraft welcomed the idea, although they too indicated they would rather be flying manned aircraft. However, the video game players did seem to be open to an assignment as a UAV pilot.

Finally, pilots stated that many of the skills that they had described for flying manned aircraft also applied to flying the unmanned aircraft. Table 5 shows a summary list of these skills and characteristics that both manned and unmanned pilots described as necessary to fly an unmanned aircraft.

Table 5. Skills/Characteristics that pilots find necessary to fly the Predator UAV

Compensate for missing sensory cues	Robust instruments/situation crosscheck	Know the UAV aircraft/system
Adapt to visual limitations	Adapt to new presentation of information	Recall and use of previous flying experience
Motivation to be a UAV pilot	Compensate for high expectations	Overcoming monotony
Using mapping and voice chat programs	Access information from various resources	Communication in GCS/ATC/other pilots
Maneuvering the airplane	Use knowledge of basic flight	Adapt to Predator controls
Awareness of air space	Adapt to Human Interface	Use instincts of flying
Mental acuity	Focus & Concentration	Eliminate superfluous info
Attention to detail	Hand-eye coordination	Situational awareness
Judgment	Manipulation & Hand-skills	Open-loop control
Coordination	Knowledge of your aircraft	Multi-tasking
Experience	Manage, interpret, & use info	Visual capability
Discipline	Decision making	Agility

Investigative Questions 3

What piloting skills/characteristics of manned aircraft are not used when flying the UAV?

> "You don't have the g's, you don't hear the wind going by, there's no depth in the screen, so all those things combined make it more difficult."

Investigative question 3 addressed the differences of flying manned aircraft with those observed and perceived during the flying experience of the UAV. A large portion of the results obtained from manned aircraft pilots pertained to limitations of visual and non-visual cues. Unmanned pilots referred to controlling an object that the pilot is not physically riding in during operation of the UAV. In order to overcome these limitations, UAV pilots must adapt and develop skills to overcome the limitations of the Predator UAV and its associated systems. Recognizing which pilot skills and characteristics are unnecessary is important when comparing the overlap of skills, while simultaneously finding advantages that video game players may have in these particular areas.

Experience: Human Interface, Field of View, and Non-Visual Cues.

The human interface in a UAV is very different from a manned aircraft. Maneuvering the unmanned plane is a two-dimensional activity. Unlike the full view of a manned aircraft pilot, the GCS gives a view that is more associated with a simulator. The landing view is limited so peripheral vision does not give the pilot the input they are used to. Because you cannot just look out of the window, it is difficult to see outside of the aircraft. Therefore, there is a very limited field of view, which makes situational awareness more difficult

Other senses that pilots are accustomed to do not translate to a UAV cockpit, likely causing frustration to the point of decreased morale and motivation (Squeo, 2002). This point was evidenced during the interviews for this study as well. For example, pilots discussed the limitation of non-visual stimuli. The environment is separate from the aircraft so there are several sensations that manned aircraft pilots are familiar with are missing such as tactile sensation, smell, vibrations, wind noise, even a “sinking feeling” upon descent for a landing. As one pilot declared, “Of your sensory skills that you usually have in a manned aircraft, you’re down to one.” There is no “seat of the pants” feel in the UAV like a pilot of manned aircraft feels, such as sudden sinking, vibrations of the aircraft, or changes felt in the engine variations when the throttle in increased or decreased. Additionally, there is no feel of a sequence of buffeting when making tight fast turns to know if everything is working the way it is supposed to. Without having this ingrained sense available, emergency situations may be missed if not adhering to constant monitoring.

> "Those kinds of things that kind of go naturally with the seat of the pants feel in a real airplane are missing and you have to sort of supplement them with a more robust instrument crosscheck in the UAV control station."

When describing the landing of a manned aircraft, the former combat aircraft pilot said, "I think a lot of it is by feel; and that's what is taken away from you in the UAV. You don't have the feel, you don't have a good sense of coming down to the ground, you don't have the peripheral vision out to the side to tell when you're just inches above the ground and ready to touch down." Instead, cues for landing have to be pulled from the changing image on the screen and the different parameters of altitude and airspeed to avoid stalls. When discussing the landing and the crosschecks, airspeed, and altitude, a UAV pilot suggested that the pilot would be asking himself, "Am I in a good position to land, or is this slowly getting uglier?" Similarly, the ability to identify aircraft direction, speed, and angle of attack depends on the pilot's visual depth perception, which is not useful in the two-dimensional environment of the ground control station.

Additional Considerations.

One major difference from manned aircraft is the access to information. Manned aircraft generally have limited access to information other than things that deal with that specific aircraft. In the Predator GCS, the pilot has access to the Internet to send and receive orders and information needed for further information to accomplish a mission. A manned aircraft pilot commented, "The Predator was interesting; it was different than a lot of other planes that I've flown."

Without the physical movement and g-forces, UAV pilots were also not affected by symptoms such as airsickness or other physical ailments. While these problems could prevent someone from flying a high performance manned aircraft, air-related physical problems would not, and did not, present a problem to the UAV pilot. Because there is no need to worry about airsickness or other body-related health concerns that pilots in fighter aircraft would experience, a larger pool of people could be chosen which might otherwise have been disqualified for manned aircraft flight. In fact, two of the four gamers in this study, also Air Force officers, were disqualified from Air Force pilot training because of health-related matters. Table 6 provides a summary overview of the issues raised by pilots in this study concerning limitations of the UAV and their impact on the skills or characteristics that go unused—or used in a different fashion—during UAV flight.

Table 6. Manned-aircraft piloting skills/characteristics not used when flying a UAV

Ability to control aircraft by sensing abnormal environmental changes	Ability to visually distinguish distant aircraft to determine their characteristics
Assessing landing performance using visual cues such as peripheral vision	Determine aircraft performance changes aboard aircraft with direct feedback
Overcome undesirable manned-flight effects	Scanning the area around the aircraft

Investigative Question 4

What skills/characteristics do video game players develop while playing commercial video games?

Today's video games are much more taxing than they were in the past. In fact, the frequent video game players in this interview spend about 20 hours per week building and honing their skills. Video gamers interviewed in this study gained their skills through practice and calling upon the experience of previous game play to increase their skills for the games they play today. Many of these skills seemed to be perceived as generally useful in many real life situations. As one video game player stated, "I don't think I would be who I am today without my gaming experience."

Situational Awareness.

In a typical Massively Multiplayer Online Role Playing Game (MMORPG) scenario described by a video game player, many issues are presented that clearly demonstrate the need for teamwork, followership, leadership and situational awareness.

> "You walk into a situation that typically has about 30 people on one side and 30 people on another side, ask for an assessment of the situation, figure out what's going on, and how is our side doing and how's their side is doing. Get to the location where something is happening. If someone is not currently in the lead and directing activities, take over that role. Otherwise, integrate with the current force structure and be a good follower under that throughout the entire situation,

> supplement, if I am the follower, inform the lead of critical situations that are coming up or our situational status of our own system. If I am the lead, then to encourage others to communicate to me the overall situation and to sub-delegate out all activities to those who are best adapted for them. And pretty much at that point…there are sort of in-between fights and there is a fight. Between fights is the strategic type thinking in which you determine/locate your series of goals, obtain them all. Then you come up with a list of options… and you choose how you want to go to achieve those goals. And then you have the tactical side of it, which is the actual execution of that plan, to achieve that goal. So both of those occur, so there is a lot of planning and managing of the battlespace."

As the passage indicates, situations can quickly become very complicated, demanding the communications, understanding, and thinking on your feet, which is necessary for successful missions. Sharing information to get an assessment of the situation is also very important; information such as knowing who is leading the group, and what resources are available is essential.

Information Gathering and Management.

When a video game player reaches a difficult point in the game (an impasse), there are several reactions. A temporary retreat may be necessary to go back to a point and investigate the situation to locate enemy forces, find new paths to meet the objective, or find information from more experienced players. In-game information can be found by understanding the game and discovering locations, weapons, and other resources that can help to gain the advantage over the adversary. Another way of gathering information is by communicating with friends and searching for a resolution on the Internet. There may be those with more experience and practice who have created a walkthrough and placed it online for anyone who desires the help. Video gamers also form communities where tips, hints, and tricks for getting through certain situations can be found. Other sources of information may come from reading magazines, replaying a previous part of the game, searching blogs, or referring to an instruction booklet.

Gamers have to be prepared against the unknown while gaining knowledge of the adversaries' forces, such as the numbers, locations, and skill sets which is important when developing a character. The gamer's character may need to have certain skills to overcome an adversary and the player will usually have to work to achieve these skills in preparation for the battles ahead. Having as much information that can be made available and working with other gamers can help the gamer define the skill sets that his character may need to possess to make both the individual and the team successful. Knowing yourself and your team can be as important as understanding the enemy.

In many video games, there are objects that can be picked up along the journey. There are required objects that must be taken to a certain point or the player may want to accumulate other items to increase their advantage in the game, such as gaining longer health, extra lives, and bonus points. One video gamer explained that after completing a particularly pleasing game, "I will buy the guide, I will go to gamefaqs.com and I will want to accomplish every single thing and get every single item that you can get in a game, I am obsessive compulsive in that way."

Communications, Planning and Coordination.

When playing most multiplayer games on a console or in the same room with others, there is communication that may be important to the situations at hand. For example, a player in a Massively Multiplayer Online Role Playing Game (MMORPG) performs in a persistent environment where he must work with a group of people with various character skills to accomplish continuing tasks. Because of the dependence on teamwork, there is a large amount of communication and crew coordination that occurs during a gaming session concerning the placement of people, the location of weaponry, and the actions of the enemy Gamers usually communicate over a voice chat as typing tends to be too slow, "When you're in a group and you're going against something that's kind of tough, there's not a lot of time to [type]…It's a lot easier if you can verbally tell, its much quicker, its clear and its concise." The organization of people in one of the more popular MMORPGs consists of groups that can range from 6 to 24 people. Considering the number of people, the need for keeping communication short and to the point is clear. A video gamer's description shows the necessity of clear concise communication.

> "To clearly articulate a situation with the least number of words and the least confusing to anyone listening. And being able to take the emotion out of it, which tends to cloud the issue….The sociological aspect of dealing with different personalities is useful, being able to, learning to mediate and resolve situations."

Decision Making Skills and Memory.

It is often necessary to make quick decisions without having the desired information. Situations that have not been encountered before require the gamer to use their past experiences in similar situations to come up with a way of reaching these new goals. In these cases, some gamers decide to retreat, gather weaponry, gain as much information as possible, and then proceed. However, at other times, the strategy may only be to guess and proceed by trial and error, sometimes failing and having to start over.

A pilot spoke of the dynamics involved in first person shooters, massively multiplayer online games, and real-time strategy games as being similar to those used when flying, where they "require you to [acquire and comprehend] information, make a decision, and act on it, so that's the same dynamic that you would have in an airplane." This type of "thinking on your feet" is echoed in a video gamers words such that, "You have to be able to take in information fast and react instantly with what you're given."

Once the adversaries' behavior has been identified, maintaining the memory of this behavior can be an advantage when approaching a similar situation. In addition, procedural actions may need to be accomplished and the knowledge must be readily available. For instance, when an enemy suddenly appears, they are typically not waiting on a reaction from the gamer. A decision must be made quickly and the gamer does not have the time to figure out which combinations of buttons to manipulate, these are memorized and eventually become automatic responses to certain situations.

Experience: Skills Influenced by Different Video Game Genres.

Video game players reported that having a good reaction time is certainly required in first-person shooters. Good reflexes and hand-eye coordination are abilities required to maneuver and avoid damage from the enemy while quickly aiming and firing your weapons to *destroy* enemy forces. In other games, such as flight simulators and racing games, more precise control is needed. Flight simulators require slower controlled and planned movements where too much overcorrecting can cause an erratic behavior in the aircraft. On the other hand, racing games require reflexes and precise instant changes, in response to rapid course variations.

Frequent video game players are persistent at accomplishing goals. They tend to keep honing and evaluating their skills until an objective is complete, always striving for victory. This persistence has led them to practice repeatedly until they have mastered the skills required to get to the next level. This increased performance drives them on to accomplish more difficult tasks. The experience gained in their previous gaming not only improves their skills but also helps them use the experience as a reference for the next challenge. As stated by a video game player, "I have been playing games so long that every time I play a game, the next game that I play relies heavily on the previous skills." Based on the participant interviews, a summary of the characteristics and skills of video game players are shown in Table 7.

Table 7. Skills/Characteristics of Frequent Video Game Players

Finding sources of information outside game (i.e. online)	Gathering Intelligence from within the game	Memory such as working with combinations of buttons	Processing information quickly	Managing inventory and resources
How to work with diverse cultures	Knowing when to gather more reconnaissance	Understanding the status of the situation	Making decisions in real life	Learning the skills of adversaries
Situational awareness	Pattern Recognition	2-dimensional operations	Progression and build up	Attention to detail
Rapid decision-making	Managing information	Anticipate situations	Sociological interactions	Knowing when to the back off
Assessing the situation	Spatial relationships	Knowing how the game reacts	Thinking on your feet	Hand-eye coordination
Analytical prowess	Engaging the enemy	Increasing attention span	Planning and coordination	Reaction speed Reaction time
Adapting	Precise control	Focus	Courage	Risk taking
Communication	Motivation	Leadership	Persistence	Mediation
Keeping track	Thinking	General skills	Timing	Staying awake
Judgment	Teamwork	Strategy	Logic	Competition
Reflexes	Followership	Experience	Multitasking	Persistence

Investigative question 5 will be reviewed in the next chapter's discussion as it relates directly to the research question.

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V. Discussion

"It is said that given enough hours and sorties, anyone can fly. The reality is there is not an infinite supply of training funds and there is a limit on time and space for training students in UPT" (Messer, 2006;48).

Discussion/Analysis

The ultimate goal of this study was to determine and explore the various skills and characteristics of video game players that would be useful or even necessary in order to consider such individuals as candidates for UAV-piloting duty in ground control stations. Again, the research question, as articulated in chapter one was:

> *Can skills/characteristics developed from different types of video games be applied to piloting tasks appropriate for UAVs?*

This research question required consideration and analysis of all the previous investigative questions, each of which were discussed in chapter 4, to find similar, overlapping, and unique skills and characteristics of each group of participants in the study. Investigative questions 1, 2, and 4, established the skills and characteristics of manned aircraft pilots, UAV pilots, and video gamers. Results of investigative question 3 discussed limitations of the Predator system that required adjustment or adaptation of certain manned-aircraft piloting skills and characteristics in the ground control station. Finally, investigative question 5 framed the results of each of the other investigative questions by concentrating on the overlap of skills and characteristics between video game players and UAV pilots:

> *Where might these various skills/characteristics overlap such that it would be reasonable to consider video game players as potential candidates for UAV piloting tasks*?

In order to answer investigative question 5, the results from the first three investigative questions concerning pilot skills were directly compared to the skills and characteristics of video gamers shown in Table 7. Participants clarified and explained the meaning of many of the terms appearing on the tables relative to the context of video game players and pilots. Pilots seemed to have a standard flying-community terminology and presented terms in a long list before following on with anecdotes of flying scenarios. Conversely, the terminology for video gamers did not appear standard but scenarios were often given that allowed the interpretation of their skills and characteristics.

Tables from investigative questions 1 and 4, which were developed from participants' descriptions of skills, were used in order to compare the skills and characteristics of manned aircraft pilots with those of video game players. For example, the ability to maintain situational awareness was one of the most important aspects that both groups possessed and upon which they depended. Pilots sometimes explained situational awareness as communicating with other aircraft pilots and air traffic control, monitoring the data from the aircraft sensors, and concentrating on the mission at hand.

Similarly, video game players also practiced situational awareness by communicating with other team members, monitoring gauges that determine their amount of life, health, weapons, and ammunition, as well as being aware of an opponent's activities. In an aircraft, the communications are likely to be very formal at times. Likewise, in game playing, the players must also rely upon communicative etiquette because they need to be clear and concise, keeping channels open at times in order to accomplish an objective in the fastest possible manner. The resulting similarities between video game players and manned aircraft pilots are shown in Table 8.

Table 8. Manned Piloting and Video-gaming Skills and Characteristics Overlap

Video Game Players	Manned Aircraft Pilots
Analytical prowess	Mental acuity
Anticipate situations	Instinct & Intuition
Attention to detail	Attention to detail
Communication	Communication
Experience	Experience
Focus	Focus & Concentration
Hand-eye coordination Timing	Hand-eye coordination Manipulation & Hand-skills
Knowing how the game reacts	Knowledge of your aircraft
Managing information Adapting / Keeping track	Manage, interpret, & use info Eliminate superfluous info
Memory such as working with combinations of buttons	Fly the procedures
Motivation	Motivation
Multi-tasking	Multi-tasking
Pattern Recognition	Visual capability
Persistence	Discipline
Planning and coordination Managing inventory and resources	Coordination
Precise control	Maneuvering the airplane.
Processing information quickly	Manage information quickly
Rapid decision-making	Decision making
Reaction speed / Reaction time	Agility
Situational awareness	Situational awareness
Sociological interactions	Social skills
Spatial relationships / Strategy	Mathematical judgment
Teamwork / Mediation	Crew resource management
Thinking on your feet/Judgment	Judgment

Based on these comparisons, video game players seemed to demonstrate some characteristics that may make them competitive candidates for operating unmanned aircraft. In addition, communicating in voice chat groups, and honing skills related to gaming are part of the extensive experience of video gamers where they spend about 1,000 hours in a year operating in a two-dimensional environment. Research has indeed demonstrated that video gamers are frequently able to accomplish complex tasks in the two-dimensional environment as demonstrated by the video game-playing laparoscopic surgeons in Rosser et. al (2007) study.

Gamers primarily rely on the information presented on a video screen to allow them to advance and achieve goals. In the cockpit of a manned aircraft, the pilot uses seat-of-the-pants feel, visual scanning and other sensing cues a great deal to maintain situational awareness and make decisions while they obviously do not have that luxury in the ground control station. The video game player does not rely on these feelings of the aircraft and gravity thus reducing the need to replace this characteristic of flight into UAV operation decisions Therefore, some skills that video gamers possess are unique relative to combat pilots and were, in fact, closer to those of the UAV pilots as shown in Table 9.

Table 9. Advantages of Video Gaming Experience in Predator

<table>
<tr><th>Unique Video Game Skills</th><th>Unused Manned-Aircraft Skills in UAVs</th></tr>
<tr><td rowspan="6">Ability to work in a two dimensional environment
1,000s of hours of experience per year
Not dependent on external cues
Able to rely on screen information
Various information sources
Internet
Voice/Type Chat
Telephone</td><td>Ability to visually distinguish distant aircraft to determine their characteristics</td></tr>
<tr><td>Ability to control aircraft by sensing abnormal environmental changes</td></tr>
<tr><td>Assessing landing performance using visual cues such as peripheral vision</td></tr>
<tr><td>Overcome undesirable manned-flight effects</td></tr>
<tr><td>Determine aircraft performance changes while aboard aircraft with direct feedback</td></tr>
<tr><td>Scanning the area around the aircraft</td></tr>
</table>

Video game players appeared to have many fundamental skills that are needed for the Predator UAV such as accomplishing objectives, spatial awareness, teamwork, information gathering, coordination, critical thinking, and good memory. For example, video gamers' explanations about teamwork included talking to people in the same room that are seeing the same information as well as operating in an online team environment where many people are communicating at the same time and working together to achieve a common goal. Likewise, a UAV pilot's reflection on teamwork included working with air traffic control, other aircraft, and troops on the ground. Differences may involve the quantity, quality, and formality of the communications, the task being carried out, and the reasons for accomplishing a task. However, the video game player may be doing very similar tasks to that of a UAV pilot while not following such communicative formalities.

As discussed in the literature review, Gee (2003), Blumberg et al. (2007), and Rosser et al. (2007) also described and demonstrated the advantages that video game players gain in situational awareness, strategic thinking, problem solving abilities, and other cognitive skills. As experiments have demonstrated, gamers may have developed an increased attention span that is proportional to the amount of time spent playing video games (Andres, 2004). In addition, VGPs are adept at gathering information from multiple sources, some of which are computing environments that may be comparable to those that are accessible by Predator pilots in the GCS.

Based on the obtained results, it appears that several genres of video games can be important for providing gamers with the challenges needed to improve their problem solving, multitasking, and visual processing abilities. A particularly strong source of video games-based learning that seemed to enhance the participants' communicative and teamwork skills was Massively Multiplayer Online Role Playing Games (MMORPG). In a MMORPG, video game players communicate in chat groups via voice or typing to gain and share information among team members much like the Predator operator.

Another advantage for VGPs is the ability to work independently of external sensory cues for making decisions. Although these sensory cues are an advantage for manned aircraft pilots, they are unnecessary and may even inhibit the ability to recognize and understand reactions of the unmanned aircraft system.

Video game players also appear to be appropriate candidates for UAV training because they possess many skills that are needed to quickly grasp the piloting and information management abilities needed to operate a UAV. As discussed in Peck (2002), the majority of Predator operation is not the flying but the ability to monitor, track, and communicate. Characteristics that appeared necessary to develop desirable skills in a VGP are frequent playing of various genres of video games. For example, the non-stop action in some first-person shooters generally promotes hand-eye coordination while simulators help establish realistic knowledge and understanding of precision controls. In addition, the MMORPG genre promotes teamwork and encourages members to learn information from other sources such as the Internet or networking through friends. These different approaches and gaming genres allow the video game player to practice, gain experience, and adapt.

Pilots often reemphasized that they used many of the same skills learned to fly a manned aircraft to fly the UAV. Based on this information along with additional skills that have been found to be useful for piloting the Predator UAV, the skills and characteristics that overlap between UAV pilots and video game players are provided in Table 10.

Table 10. Overlapping Skills and Characteristics of Gamers and Predator Pilots

Video Game Players	Predator Pilot
Finding sources of information outside game (i.e. online)	Access information from various resources - Internet - Mapping programs - Chat programs - Real-time video feed
Gathering Intelligence from within the game and processing it quickly	
Managing information and multitasking	
Situational awareness	Awareness of air space
Precise control, judgment, and timing	Open-loop control
Adapting to different controllers, games, and presentation of information on a two-dimensional screen	Adapt to new presentation of information
	Adapt to Predator controls
	Adapt to visual limitations
Communication, teamwork, & Sociological interactions	Communication with air traffic controllers, other pilots, and ground control station
Keeping track of inventory and location	Robust instruments/situation crosscheck
Motivation to accomplish objectives	Motivation to be a UAV pilot
2-dimensional operations experience	Adapt to Predator's human interface
Knowing how the game reacts	Know the UAV aircraft/system
Analytical prowess	Mental acuity
Experience with gaming environment	Experience in Predator aircraft system
Memory (working with combinations of buttons	Memory (working through procedures that apply to various tasks)
Attention to detail	Attention to detail
Hand-eye coordination	Hand-eye coordination
Spatial relationships/Strategy	Three-dimensional mental model

Overall, video game players also appear to have some skills that are similar to those of combat pilots along with other unique skills they can bring to the UAV ground control station's software-oriented operations. Video gamers maintain focus and practice situational awareness in each session of video gaming, just as a combat pilot must use these skills and characteristics to successfully complete sorties. However, video game players are also adept at interacting in the two-dimensional environment and gathering information from virtually unlimited sources, both of which can be useful in the Predator pilot arena. As Hoffman and Kamps (2005) discussed, the time has come to start training a new type of warrior that can embrace the highly desired UAV technology of today and in the future. Today's UAV pilot should be dedicated to being able to use the UAV to its full capability and improving controls in the ground control station to fit the needs of the UAV and its operator rather than trying to mimic manned aircraft controls. Based on the results of this study, Figure 4 demonstrates the apparent overlap between video game players, combat pilots, and UAV pilots, but exactly how much overlap is involved is a question open for further discussion and debate.

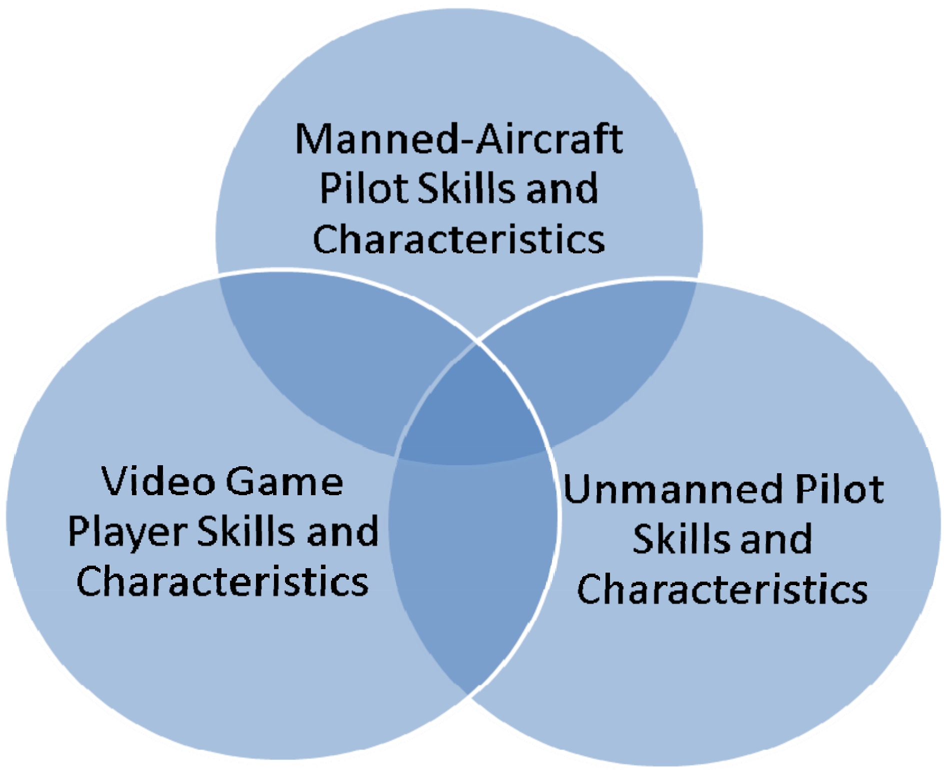

Figure 4. Overlap in Video Game Players and Pilot Skills and Characteristics

Although video game players have many of skills and characteristics that would be complementary to piloting unmanned aircraft, knowledge of basic flight would have to be established so that instincts and automatization, such as that discussed by McAllister (1997) and Gee (2003), would allow them to improve judgment and decisions when flying an unmanned aerial vehicle. In addition, a video game player would require a pilot's license, due to regulations for aircraft pilots operating unmanned aircraft, such as the Predator, to have an FAA license. Based on the comparison of the skills between gamers and pilots, the biggest source of the differences (not including weapons training) appears to be the knowledge of flight systems and specific aircraft characteristics. With a minimal amount of training required for an FAA license this factor would be eliminated.

Thus, in order for gamers to compensate a minimal flight training program, playing flight simulators, such as Microsoft Flight Simulator X and Falcon 4.0 could be useful. These types of simulator games could be a vital instrument to provide the knowledge of a plane's characteristics and reactions. For video game players to develop additional skills that are similar to those used by Predator pilots, it appears that they must frequently play a variety of games, such as MMORPGs, RTS, and FPS.

Limitations

Selected participants were interviewed at least 6 months after their participation in the AFRL Predator UAV landing simulation. This time lag may have led to deficiencies in the participants' memory of the three brief landing simulations during AFRL's study. For example, some responses from participants revealed that the positioning of the information on the screen and the use of various controls had been forgotten. It is therefore possible that participants could have had reported recollections based on their areas of experience with other aircraft and manned-aircraft simulations rather than that of the UAV landing simulation in particular. For a more controlled and deliberate comparison of piloting skills relative to video game players, UAV pilots were therefore interviewed to gain and understand some of the actual skills used during the operational flight of the aircraft, beyond training of any other aircraft. As Drucker (1993) states, "Those who actually do a job know more about it than anybody else…they do know what works and what doesn't." Therefore, a proper knowledge base and skill characteristics necessary to provide a contrast to the video game players in this study—in this case, Predator pilots—were, in fact, accounted for during participant selection, even if the Predator pilots themselves were not part of the original AFRL investigation.

Another potential limitation was the fact that the pilots who participated in the original AFRL landing simulation, and subsequently participated in this study, had various levels of experience from private piloting to 24-years of flying tankers. By Air Force standards, the pilots in this study did not appear to be representative of the types of fighter and bomber pilots who would otherwise be selected for Predator flight duty. It is possible that the views of these pilots could have possibly been different from those of combat pilots. However, this limitation was not necessarily critical because currently active UAV pilots were able to add relevant information based on their previous manned-flight experience. Furthermore, the information gleaned from interviews with both manned and unmanned pilots seemed to correspond well with Messer's (2006) study of combat pilot skills. For example, pilots in this study, regardless of their experience, described skills such as situational awareness and multitasking. Therefore, the disparity between the participants in the AFRL study (who were later interviewed for this study), and those of actual combat pilots who might be selected for UAV duty in the Air Force, did not seem to be responsible for producing any compelling differences in perception concerning UAV piloting skills and abilities. Table 11 illustrates a number of similarities between manned aircraft skills that were uncovered with similar terms in Messer's research.

Table 11. Participant Pilots Similarities to Messer's Combat Pilot Breakdown

Pilot's in this study	Combat pilot skills (Messer 2006)
Aviate, navigate, communicate	Task prioritization
Communication	Communications/Listening
Computations of air speed	Crosscheck
Monitoring your airplane	
Monitoring your navigation	
Coolheaded under pressure	Quick thinking
Mental acuity	
Coordination	Crew/Flight coordination
Crew resource management	
Decision making	Risk management
Judgment	
Discipline	Discipline
Fly the procedures	
Instinct & Intuition	Spatial Thinking
Know your bold face	Quick thinking
Knowledge of your aircraft	Systems Knowledge
Manage information quickly	Information/Data Processing
Manage, interpret, & use info	
Maneuvering the airplane.	Aircraft Handling
Manipulation & Hand-skills	Cognitive thinking
Mathematical judgment	Mental calculations
Multi-tasking	Multi-tasking/Task management
Principle of flying	Systems knowledge
Situational Awareness	Situational awareness
Social skills	Attitude

Another factor involved pre-screening criteria used in the original AFRL UAV landing simulation. Initially, the video game players in this study were thought to be action game players based on the self-reported survey in the AFRL study. However, interviews revealed that they had very diverse experience with many different genres of video game playing. Several had experience with MMORPGs and flight simulators. In fact, some of the video game players had some piloting experience themselves. This mixture of factors may have made it difficult for participants to determine which part of their experiences and backgrounds were drawn upon in the course of the interviews and their consideration or recognition of the relevant skills and characteristics that were necessary to achieve success in the AFRL landing simulation.

Suggestions for Further Research

This research has demonstrated that many of the skills and characteristics that are required for UAV pilots are also common to video game players. By using this research as a baseline, further studies can determine the importance of each of these skills or characteristics relative to operating the Predator UAV. With this list of skills and attributes that appear relevant to flying a UAV, measurement of these skills are necessary to determine their contribution. A landing simulation, similar to AFRLs study, could then be accomplished to determine how well people of varying degrees of these measured skills and attributes actually perform. By measuring the amount or degree of each of these skills between pilots and VPGs, we may ultimately be able to determine which are more important to the process of piloting unmanned vehicles.

Another potential research endeavor could narrow the types of pilots to only those who fly UAVs, and video game players who only participate in specific genres of games. Specifically, different genres of video games tend to produce or emphasize specific skills. By finding the amounts of specific skills needed for piloting the Predator, the various genres that would best be suited for building such skills might be determined. Examples of a genre that may be considered are those where players that participate in pilot simulations and MMOGs dedicated to air traffic simulations. Players in this category spend many hours directing, controlling, and flying aircraft in flight simulation groups. Several of the participants in this interview mentioned the air traffic control genre of gaming but were not heavily involved in them. Video gamers who play realistic flight simulations may in fact be a unique group that a researcher would want to include in a follow-on study, not to mention the fact that such simulations incorporate the real-life physics of the aircraft being operated.

The results of this study also indicated that a frequent video game player would need knowledge of basic flight and the actual aircraft system to be seriously considered for unmanned flight. Therefore, video game players who already have a private pilot's license could be a good consideration for follow-on research. In addition, participants of this sort would tend to have motivations and interests that may be more similar to Air Force pilots while bringing the basic knowledge of the physics of flying in order to better isolate the effects of specific video games or video game genres. The results of this study also suggest perhaps looking beyond the video gamer per se to consider the skills and characteristics of remote controlled (RC) aircraft enthusiasts. Pilots, video gamers, and UAV pilots often mentioned people that have an interest in aviation and an ability to fly and land RC aircraft could be helpful for a UAV pilot.

Conclusion

A solid foundation for the Predator pilot should undoubtedly include basic flight knowledge, an understanding or mental model of the aircraft's capability and performance, and the ability to work in a two-dimensional environment where the majority of feedback and critical information comes from screen readouts. This study demonstrated how frequent video game players could be an untapped potential that might, and probably should, be considered as UAV piloting candidates. In particular, video game players appear to have many of the skills needed to perform the tasks of UAV piloting outside of the specific flight and systems knowledge of the UAV itself. Therefore, the Air Force may be well advised to consider recruiting video game players to serve as pilots for UAVs and keep combat pilots where they perform best.

Appendix A. Recruitment Email

By participating in AFRLs study of UAV pilots, you are eligible to participate in a related study, “The effects of commercial video game playing skills in Air Force careers: A comparison of skills used to pilot the Predator” research study. The location of your participation may occur at AFIT or in Bldg 33 Wright Patterson AFB, OH. The purpose of this research is to identify and evaluate the skill sets of video game experienced individuals and manned/unmanned pilots. The time requirement of reach volunteer subject is anticipated to be approximately 2 hours in addition to the time spent on separate AFRL studies. Participants have already met requirements by being selected for AFRL study.

Appendix B. Sample Interview Questions for Pilots and Gamers

UAV pilots and other pilots

- Rank (Enlisted), (Officer),(Civilian)
- Age (18-22),(23-27),(28-32),(33-37),(38-42) (43-45)
- Interviews will be semi-unstructured and consist of questions regarding the participants experience and their perceived skills in those experiences.
- Flight status/experience (time and type of aircraft)
- What kind of skills does it take to be a pilot?
- What kind of skills are needed to fly a manned/unmanned aircraft?
- How do you develop these skills?
- What skills are the most important?
- What skills are used most often?
- What skills are not used very often, but are critical?
- What does a typical mission consist of?
- What happens the most during a typical mission?
- How long does it take to develop piloting skills?
- Where are the skills developed?
- Based on your experience, what is the difference between business as usual and combat situations?
- What aircraft specific skills are necessary for flying a manned/unmanned aircraft?
- What non-flying skills, such as managing information, teamwork, etc., are necessary for flying an aircraft?
- In combat, have you ever had to abort a mission? What was the reason?
- How important are reflexes, hand-eye coordination, and thinking on your feet?
- How much stress do you feel when you are flying in different situation? (Sunny, rainy, combat, etc…)
- How long is a normal flight?
- How long is the longest flight that you have ever piloted?
- What compels/compelled you to continue in the Air Force as a pilot?
- When you retire/leave the Air Force, do you plan to seek to become a civilian commercial pilot?
- Do you often make quick decisions while not having enough information?
- (Do you like) Would you like - an assignment in a UAV squadron? Why?
- What skills (do you need or) do you think you would need to be a UAV pilot?
- Was (flying a UAV or) the AFRL UAV landing simulation more difficult than you expected?
- What skills are used when landing a UAV/manned combat aircraft?
- As a UAV pilot, what do you miss about flying a manned aircraft?
- Video game activity (type of games played and time spent in this activity)?
- What other hobbies do you think would be a good background for a UAV pilot?

Video Game Players

- What kind of skills do you use when you play video games?
- What kind of skills are needed to play different types of games? (Simulation, action, first-person shooter, etc…)
- How do you develop these skills?
- What skills are the most important?
- What skills are used most often?
- What skills are not used very often, but are critical?
- What are the demands of a typical game?
- Do you feel pressure to perform?
- What happens the most during a typical game?
- How long does it take to develop gaming skills for different types of games?
- Do you use these skills anywhere else?
- Where are the skills developed?
- Based on your experience, what is the difference between different levels of a game?
- What games do you think can apply to real life?
- If you come to a point where the completing a level is difficult, how do you react?
- What makes you want to play video games? What compels you to keep playing?
- What is the longest that you have ever played a game in a single setting? (not including bathroom breaks)
- Are skills such as managing information, teamwork, etc., necessary for playing video games? Which ones?
- How important are reflexes, hand-eye coordination, and thinking on your feet?
- Do you often make quick decisions while not having enough information?
- What skills do you think you would need to be a UAV pilot?
- Was the UAV landing simulation in the AFRL study more difficult than you expected?
- Based on the AFRL UAV landing simulator, would you be comfortable operating a UAV for four hours at a time, every day?
- Do you believe that you would be a good candidate to become a UAV pilot? Why or why not?
- A typical assignment to a UAV squadron is three years. If you were selected to become a UAV pilot, you can expect to receive six-months training:
- Do you think you are an acceptable candidate?
- Do you think combat pilots are overqualified for flying the Predator UAV?
- Who do you think is acceptable? (Pilots only? Contractors? Officers? Enlisted? Other?)
- What hobbies would provide a good background for UAV operators?

Appendix C. AETC Initial Flight Screening Grade Sheet

From the AETC Syllabus Civilian Flight School IFS

INITIAL FLIGHT SCREENING GRADE SHEET

This IMT contains personal information protected by the Privacy Act of 1974. The IMT will be safeguarded from unauthorized disclosure and will be disposed of according to AFI 33-332.

STUDENT NAME	SSN	USAF SUPERVISOR NAME	DATE ENTERED IFT

CFI NAME	FLIGHT SCHOOL	MEDICAL CERTIFICATE DATE	FAA KNOWLEDGE TEST DATE

PRESOLO STAGE CHECK DATE	PRESOLO WRITTEN DATE	PATTERN SOLO FLIGHT DATE	AREA SOLO FLIGHT DATE

GRADING U = UNSATISFACTORY D = DEMONSTRATED P = PERFORMED S = SATISFACTORY

FLIGHT LESSON NUMBER															
DATE *(DD/MM)*															
LESSON TIME															
CUMULATIVE TIME															
STUDENT INITIALS															
INSTRUCTOR INITIALS															
GENERAL															
CHECKLIST USE															
CLEARING															
RADIO COMMUNICATIONS															
USE OF TRIM															
RISK MGT AND DECISION MAKING															
SITUATIONAL AWARENESS															
TASK MANAGEMENT															
EMERGENCY PROCEDURES															
GENERAL KNOWLEDGE															
SPECIFIC															
MISSION PLANNING															
PREFLIGHT INSPECTION															
GROUND OPERATIONS															
NORMAL TAKEOFF															
CROSSWIND TAKEOFF															
DEPARTURE															
LOCAL AREA PROCEDURES															
STRAIGHT AND LEVEL FLIGHT															
CLIMBS AND DESCENTS															
TURNS															
SLOW FLIGHT															
STEEP TURNS															
POWER ON/OFF STALLS															
S-TURNS															
TURNS AROUND A POINT															
RECTANGULAR COURSE															
BASIC INSTRUMENT MANEUVERS															
VOR/ADF ORIENTATION AND OPERATION															
SIMULATED FORCED LANDING															
ARRIVAL															
TRAFFIC PATTERN															
NORMAL APPROACH AND LANDING															
CROSSWIND APPROACH AND LANDING															
NO FLAP APPROACH AND LANDING															
FOWARD SLIP TO LANDING															
BREAKOUT/GO AROUND															

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
27-03-2008	Master’s Thesis	August 2007 – March 2008

4. TITLE AND SUBTITLE
The Effects of Commercial Video Game Playing: A Comparison of Skills and Abilities for the Predator UAV

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Johnny E. Triplett, Capt, USAF

5d. PROJECT NUMBER
None

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
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8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GIR/ENV/08-M22

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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AFRL/Biobehavioral Performance Branch
2215 First Street Bldg 33, WPAFB OH 45433

10. SPONSOR/MONITOR’S ACRONYM(S)

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

12. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Currently, Predator unmanned aerial vehicles (UAV) are operated by pilots and navigators experienced with manned combat aircraft. With a projected increase in UAVs, more combat pilots will be needed to operate these aircraft. Yet, if the current ops tempo continues, the supply of combat pilots may not be able to meet the demand. Perhaps alternative pools of Air Force personnel could be considered for UAV duty in order to meet operational requirements.
Because the Predator UAV is a software-driven aircraft, video game players (VGPs) already possess and use many skills that may be similar to those of Predator UAV pilots. A variety of games can add situational awareness skills that a player/airman can bring to a new situation.
This research examines the applicability of video-games-based skills to the operation of the Predator UAV. Nine people were interviewed to determine the overlap between piloting skills, UAV-specific skills, and skills gained and developed from gaming. The results indicate that frequent VGPs have the confidence and the consistent ability to obtain and retain new skills, many of which are related to operating the Predator UAV in a 2-D environment while not relying on the visual and non-visual cues of the manned aircraft pilot.

15. SUBJECT TERMS
Skills, Games, Cognition, Aircraft, Situational Awareness, Flight Simulation

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18