Army Space Education: Closing the Gap with Operational Space

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ABSTRACT

The Army has made great strides over the last decade to secure a solid foothold and reputation in the space community. Army space professionals have finally gained equity among their peers in the operational space community, and today we see a truly joint space cadre, dedicated to solving tough problems as a team. Unfortunately, the Army has done very little to try to gain equity with its peers concerning space education. This paper outlines the current state of Army Space education, attempting to identify the inequity of space education programs between the services, the impact of this iniquity, as well as to outline what is believed to be the best course of action in order to close this gap. This paper will consider all levels of education within the Army, focusing on the space educational programs of the three major service academies with respect to their specific missions. The paper will then illustrate the steps currently underway at the United States Military Academy to implement its very first regimented, multidiscipline, space educational program, designed to build the foundation for a permanently funded and resourced space educational program in the future.

INTRODUCTION

An inequity exists within the Army space community. While the operational space community continues to expand, driving forward in its pursuit of a solidified and well defined role in the joint space community, the Army has been slow in the refinement of its space education polices, causing the formation of an ever widening gap of inequity between operational space and space education within the Army. This gap, while not immediately threatening to Army space operations, will indeed have a negative effect on the overall operational effectiveness of the Army space community in the future. No longer can the Army simply ignore the importance of space education at the undergraduate and junior officer level, doing so will only threaten the quality of space professionals of tomorrow.

This paper outlines the current state of Army space operations and education, comparing and contrasting this to both the Navy and Air Force programs. Specifically, I will focus on the respective space education programs of operational forces as well as at each respective service academy. Upon comparison of these, I will highlight the areas where the Army falls short of the other service concerning space education, as well as discussing the Army's reasoning for the decision.

This paper will show that an inequity in the Army space community exists, and that this inequity will eventually affect the quality of its space professionals. It will show that while the Army does indeed do a good job at educating its space professionals, it does poorly at space below the level of Captain, the time at which its space professional, the FA40, are selected. While arguments can be made in support of this, I will show why this policy is short sighted, and how it will inevitably lead to a comparatively under qualified space professional.

I will show how, by a refinement in Army policies on space education, and by pushing space education to junior level leaders as well as to the undergraduate level, a bridge can be forged to close this gap, achieving a balance between operational space and space education within the Army. The formation of a space education program that would encompasses not only the current community, Captains and above, but also that of cadets and junior officers as well, will help develop a more robust Army space community, with an unprecedented depth of experience, inevitably leading to the development of a far more experienced and qualified space professional.

Lastly, I will propose solutions for bridging the gap between the Army's focus on operational space and space education. These recommendations, if enacted, are likely to increase the overall operational effectiveness of not only the Army space community, but that of the general officer community as well, putting Army space education back on even ground with operational space. To demonstrate how this can be accomplished, I will recommend a few courses of

action, as well as include a description of the initial steps taken at the United States Military Academy over the last year to enrich its space education programs to meet this need.

BACKGROUND

Army history in space

The Army has been involved in the exploitation of space since the end of World War II, where it led the United States in the development of rockets and satellites for nearly 10 years. The first US satellite was launched into orbit on an Army Redstone Rocket in early 1958. Later that year, due to redundancy in space research and development efforts across the three services, the National Aeronautics and Space Act was passed, laying the groundwork for the formation of NASA.[(1)] Many of the ongoing Army programs were then transferred over to NASA, and with subsequent DoD decisions in the 1960's and 1970's, the Army's involvement in space operations declined significantly, with the Air Force being appointed the proponent for the majority of military space development activities.

Even so, the Army maintained an active role in the development of many space technologies, specifically with respect to the operational exploitation of space technologies for the war fighter, as well as ground station operations. In the 1980's, with the rapid improvement of space based capabilities to the war fighter, the Army again began to take an active interest in the development of space based capabilities. The operational significance of these improved capabilities would come to bear in full force for the first time in 1990, during the Gulf War, demonstrating to the world a military capability that would change warfare forever.

Army focus on space

With the successful demonstration of many individual space based capabilities during the mid-to-late 1980's, the overall improvement to the combat effectiveness of its units, and the operational advantage they gave over our enemies were embraced by the Army. These combat multipliers included Satellite Communications (SATCOM); Global Positioning System (GPS); Satellite based weather and terrain data; Satellite based Imagery Intelligence (IMINT) and Multi-spectral Imagery; Signals Intelligence (SIGINT); and Theater Missile Defense, Detection, and Tracking. While these space based technologies had all been used before, it wasn't until the Gulf War that the full potential of these systems were synergistically brought to bear in a well orchestrated collaboration of space systems, providing the Army a technical and tactical leap in combat power never seen before.

These capabilities had many advantages for the Army. SATCOM greatly improved the speed, quality, and availability of information to the combat units on the ground. GPS, with its accurate positional and timing information, improved the ground forces ability to maneuver on the battlefield and react to enemy movements, as well as providing precision targeting information and fires. Weather and terrain data gave invaluable information to decision makers, allowing them to make decisions on real time data rather than predictions. IMINT provided timely, high-resolution imagery to ground commanders, and in conjunction with available SATCOM, could be disseminated widely across the battlefield, pushing a quality intelligence product to lower levels of command than ever before. SIGINT was used to monitor and locate enemy Command and Control (C2) nodes, as well as monitor enemy communications traffic. Theater Missile Defense, detection, and tracking systems were used to warn, protect, and defend our troops from potential long range biological and chemical missile attacks. Overall, the successful integration of these space based capabilities into the war planning for the Gulf War, would redefine how military forces around the world would conduct military operations.

Beginnings of the Army space professional

In the aftermath of the Gulf War, a pool of skilled Army space operators began to coalesce. This group, while not formally recognized at the time, would be the predecessors of an Army wide movement to formalize a body of skilled and experienced officers, capable of harnessing the potential of space. Recognizing the impact that space based technologies could bring to the war fighter, the Army realized that understanding space systems and capabilities was becoming an increasingly important part of a professional soldiers skill set.[(2)] Thus, in 1998, the Army "legitimized" its space professionals with the creation of the FA40: Space Operations Functional Area.

The FA40 space professionals would go through various re-organizations and classifications over the next few years. The primary goals of the new functional area would be in the refining and formalizing of the operational procedures from which they would follow, as well as defining the organizational structure that they would fill within the Army. During this time, the FA40 would define its mission, goals, and training requirements, undergoing a development process, and fighting to legitimize itself in the eyes of its peers and fellow space professionals across the DoD.

THE ARMY SPACE COMMUNITY

The Army Space Professional

Army space professionals are career space specialists, whose principle duties include planning, developing, resourcing, acquiring, integrating, or operating space forces, concepts, applications, or capabilities IAW DoD Directives.[3] These professionals are comprised of both military and civilian personnel whose primary role is to meet the operational needs of the Army by providing space based capabilities to the war fighter.

The majority of these professionals are FA40 Space Operations Officers, and form the core of the Army space professionals within the Army. FA40 officers are typically selected around the 5-year mark, after completion of their initial 1-2 tours in their primary branch. For example, after a Lieutenants or Captains assignments as Infantry or Field Artillery officers. After selection, these officers will be designated as FA40, and spend the remainder of their careers as such, with potential for promotion up through the rank of general.

In addition to this core group of officers, the Army has recently expanded its space cadre to include newly designated Army Space Enablers. Space Enablers are defined as soldiers and civilians assigned to positions whose primary career field is not space, but whom perform unique tasks or functions or may require specialized skills to apply space capabilities.[4] Typically, these space enablers will be given an Additional Skill Identifier (ASI) of 3Y (Space Activities) or 1C (Satellite Systems/Network Coordinator). Figure 1 below depicts the current strength of Army space professionals and enablers.

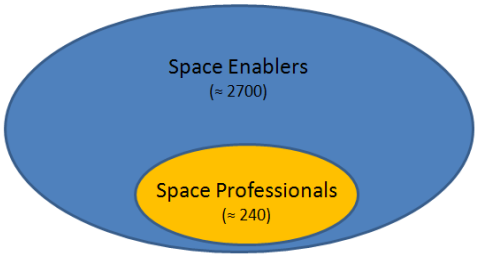

Figure 1: Army Space Professional Strength

Today, Army space professionals and space enablers can be found in almost every command across the Army, as well as in key roles in various joint and DoD organizations throughout the world. In order for these professionals to be successful in these positions, the Army must properly prepare them for the duties they will perform through space education and training.

Training and Education

The Army's purpose for space education is to develop and deliver training for Space Operations officers who will be able to provide a specialized capability for planning, developing, training and integrating space capabilities to support tactical, operational strategic military operations.[5] The Army has made some significant headway over the last 10 years in meeting this mission with the formalization of is training and education requirements. Through mandate, as well as joint efforts with the Air Force and other DoD agencies, a detailed training agenda was created to insure that the Army space professional receives the appropriate level and quality of training to enable them to execute their duties. This training, while not as broad as Air Force training requirements that will be discussed later, does indeed meet the needs of the Army, with a significant depth of focus matched to meeting the space capability needs of the operational Army. Below in Table 1, is a typical training outline that most Army space professionals would complete throughout their careers.

Table 1: Army Space Professional Training

What	How Long (When)
Graduate School (Space Systems Operations/Engineering)	2 Years (typically years 6-8)
Space Operations Officer Qualification Course (SOOQC) (includes Space 200)	7 weeks (typically after selection or graduate school)
Tactical Space Operations Course (optional)	2 weeks (before deployment)
Space 300	3 weeks (typically 15 year mark)

While this table is neither all encompassing nor a cookie cutter template, it is a good representation of what is expected of FA40 officers as the community continues to mature. While not every FA40 is currently given the opportunity to attend graduate school, a very high percentage are, and, as the selection process and training timeline continue to be refined, it is expected that most, if not all, will.

Concerns

Overall, the Army does a very good job at training and educating its selected space professional to meet the operational needs of the Army. FA40 officers and space enablers are well respected in the space community, and perform well in all roles in which they fill. The major concern I have is that the "operational" space training and education is not the only type of education with which the Army should focus.

The Army does little to no "preparatory" space training or education prior to the selection of its space

professionals. The Army seems to be the only service that has not recognized the value of training its junior leaders and cadets in space related fields prior to their selection as space professionals. This gap is equivalent to a 9-year window of missed opportunity, in which interest, experience and knowledge about space and the FA40 functional area could be developed, regardless of the basic branch of the officer, and without impact to the officer's ability to perform their primary job. The Army, for all intensive purposes, ignores this time, and focuses its efforts on training after selection. I believe that this has had an ill affect on the overall quality of Army Space professionals. Not that the quality of Army space professional is low, rather it is high, what I am saying is that the quality could be even higher.

The impact that this has had on the overall capabilities of Army space professionals is hard to quantify because we have no reference from which to compare. To do this, we must first explore the mission of the space professionals of the other branches with respect to their missions, and look at the education and training of their space professionals. After which, a general assessment of this impact should be feasible.

THE AIR FORCE SPACE COMMUNITY

The Air Force Space Professional

Like the Army, the space professionals of the Air Force are career space specialists, whose mission is to deliver space and missile capabilities to America and its war fighting commands by making space reliable to US war fighters by assuring access to space.[6] These professionals are comprised of both military and civilian personnel, with the mission to support operational needs of the Air Force by providing space based capabilities to is war fighting element.

However, the similarities stop here. The Air Force has a significantly larger community of space professionals, with over 39,000 people performing numerous Air Force Space Command (AFSPC) missions across the globe. While this may seem a sharp contrast to the strength of Army's space professionals, one must take in account the vastly different missions that Air Force personnel execute. The Army's focus on space, while focused on optimizing combat power in support of the war fighter, is relatively narrow in scope. The Air Force on the other hand, while similar in intent, has a much broader scope of operations, encompassing almost all aspects of space activities. A direct comparison between such different programs, while quantifiable, would not be accurate. Figure 2 below depicts the current strength of Air Force space professionals.

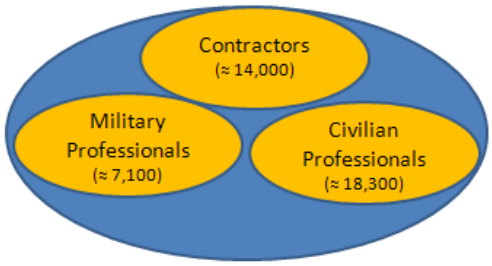

Figure 2: Air Force Space Professional Strength

The Air Force has a cadre of space professionals over 10 times larger than that of the Army because they have an exponentially larger stake in space technology development and operations. While the Army is vying for some of this market share, it is unlikely that the Army will ever make much of an impact. While the Army is interested in acquiring capability to improve its ability to support the war fighter, the Army has no desire in acquiring the majority of Air Force space activities. It is unlikely that the Air Force will ever control less than 90% of all DoD space based operations and research.

Due to its vastly larger need, as well as a much more structured organizational hierarchy, the Air Force has a much greater demand for space professionals. Thus, the Air Force has a much deeper career path for its space professionals. Unlike the Army, with its singular functional area and two skill identifiers, the Air Force has an entire Air Force Specialty Code (AFSC) for its space professionals, the Space and Missile Operations specialists (13S), which includes five different sub specialty codes. These professionals include all ranks of officers, not just Captain and above like the Army, as well as all ranks of enlisted personnel, which the Army has none.

Because the Air Force selects its space professionals at initial entry into service, rather than later in service like the Army, the Air Force is given an additional window of opportunity for training and education its space professionals which the Army has yet to tap. This window can be as long as 4-5 years, a great opportunity from which to develop junior leaders to be future space professionals.

Training and Education

The mission of the Air Force concerning development of its space professionals is not too dissimilar from that of the Army, to develop and deliver trained space professionals who are able to provide specialized space capabilities in order to support military operations. The Air force does this through a Space Professional Development Program (SPDP) with the mission of certifying and producing space professionals to meet

Air Force requirements.[6] These professionals, referred to as Credentialed Space Professionals (CSPs), form the core of the Air Force space cadre. The cornerstone of SPDP is a space education continuum including Space 100, 200, and 300, that reinforces USAF space cultural awareness throughout a CSP's career.[6] In addition to this training, numerous other short space educational courses are offered, both in-residence and distance learning.

Truth be told, no one does space training better than the Air Force. The Air Force has been the standard for space education for decades, formalizing the training and education requirements that many of the other services use today. Many of the Army and Navy education and training plans are based off Air Force lesson plans and course materials. This training is broad, and very deep, giving its space professionals a greater exposure to space, and yielding a much richer educational experience.

Air Force space education often includes cross training of its Airmen and officers in space fields that they may not be directly functioning in, a technique the Army is good at doing with its operational officers…i.e. training its Field Artillery Officers to serve as Infantry Officers, as I did in Iraq. However, the Army does not cross train space education, choosing to focus space education on a small set of selected space professionals in order to meet its operational requirements. Below in Table 2 is a typical training outline that most Air Force space professionals would complete throughout their careers. Notice the significant increase in breadth and depth compared to that of the Army.

Table 2: Air Force Space Professional Training

What	How Long (When)
Undergraduate School (Space Systems Operations/Engineering)	4 Years (prior to entry)
Officer Space Prerequisite Training (OSPT) Space 100	7 weeks (after entry)
Command and Control Warrior School (C2WS)	3 Weeks
Graduate School (Space Systems Operations/Engineering)	2 Years (typically years 6-8)
Space 200	4 weeks (8-10 Year Mark)
Space 300	4 weeks (12-15 Year Mark)

Air Force Space education is typically handled by both the National Security Space Institute (NSSI), which offers 3 space education courses, as well as the Advanced Space Operations School (ASOPS), which offers 12 space education courses. The majority of all DoD space education takes place within these two organizations. A few of these courses can be seen in the table above. As before, this table is not all encompassing, and may be dated, but it does give a good representation of the depth of Air Force space education to compare to the other services.

THE NAVY SPACE COMMUNITY

The Navy Space Professional

Unlike the Army and Air Force, the Navy does not have a dedicated core of career space professionals. Yet, the Navy is highly dependent on space based technologies and capabilities in order to meet its operational requirements. In order to meet this need, the Navy has developed a unique Naval Space Cadre Development Plan. Rather than designating Naval Officers and enlisted personnel as permanent space professionals, the Navy allocates its professionals in order to fill space professional billets as need arises, and then leverages Navy and Air Force training to prepare them to fill these positions.

These professionals are primarily comprised of military officers, but also include reserve as well as civilian personnel. The mission of the Navy space cadre is to posture a team of space professionals to maximize the value and protect the viability of current space systems, and influence the development of future satellite systems to meet Fleet requirements worldwide.[7] Figure 3 below depicts the current strength of Navy space professionals.

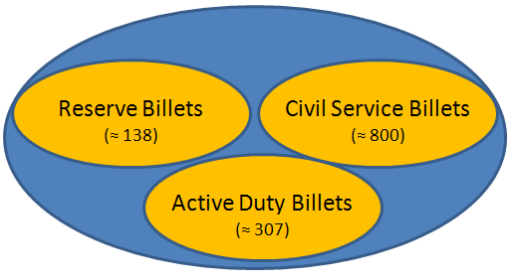

Figure 3: Navy Space Professional Strength

The Navy, like the Army, has a relatively small community of space professionals when compared to the Air Force, with just over 300 active duty space billets. These individuals perform a wide variety of missions in almost every component of the Navy in order to support Fleet operations. These include positions in surface warfare vessels, submarines, aviation squadrons, intelligence units, and meteorological specialties.

Like the Army, the Navy's needs for space professionals are met with a relatively small group.

While the continual training of its space professionals may seem cumbersome, and inefficient, it nonetheless meets the needs of the Navy, without requiring a permanent re-designation of its officers as space professionals. While this likely has an impact on the quality of its senior space professionals, namely through a lack of developed experience, junior officers are typically well trained to perform the space missions in which they were selected to perform.

Due to its lesser need, the Navy does not maintain a separate career field for its space professionals. Instead, it designates its space professionals with a sub-specialty code for space operations (6206).[8] Thus, the Navy has no need for a large management force structure to maintain its space cadre. This gives the Navy more freedom and flexibility than the Army, and much more than the Air Force in the management of its space professionals.

As before, a direct comparison between such different programs, while quantifiable, would not be accurate. While each service share very similar goals in reference to providing space capabilities to its war fighters, each service vary greatly in requirements for meeting the force mission.

The Navy, like the Army, due to the way in which it selects and utilizes its space professionals, selecting them later in their careers, are forced to focus the education of its space professionals into a relatively small window compared that that of the Air Force, and even the Army. Because the Navy does not maintain a persistent core of space professionals, a fairly high turnover rate must be addressed. To compensate for this, the Navy is forced to rapidly train its selected space professionals, and continually do so, refreshing its pool of ever changing space cadre. This requires a very high emphasis on education, costing much more time and money to develop its space professionals.

Training and Education

The focus of Naval space education concerning the development of its space professionals closely resembles that of the Army as well as the Air Force, to fill an operational need for qualified, space savvy leaders who have been trained to be able to provide specialized space capabilities. The Navy manages the training of its space professionals continuously, matching selected space professionals to educational opportunities as needed, as well as looking to the future and identifying officers for graduate studies in space systems, as well as their follow on tour in a space related position within the Navy.

Navy space professionals are expected to meet their educational requirements through a host of educational opportunities, the majority of which are offered through the Air Force ASOPS or NSSI. In addition to this training, many officers get the opportunity to attend graduate school to seek space related degrees from either the Naval Postgraduate School or the Air Force Institute of Technology. These space professionals represent the top level of space education within the Navy, incurring a utilization tour serving in the space community as pay back for the graduate degree. Unfortunately, once this utilization tour is over, the majority of these newly trained Naval space professionals will return to their original duty, and no longer serve a space role. Table 3 below shows a typical training outline that most Navy space professionals would complete throughout their careers. Notice the significant decrease in depth compared to both that of the Army as well as the Air Force.

Table 3: Navy Space Professional Training

What	How Long (When)
Graduate School (Space Systems Operations/Engineering)	2 Years (typically years 6-8)
Officer Space Prerequisite Training (OSPT) Space 100	7 weeks (after entry)
Space 200	4 weeks (8-10 Year Mark)

Naval space education typically includes a combination of Navy and Air Force courses in order to train and prepare its space professionals to perform their assigned duties. These courses include a host of courses, ranging from resident and distance learning courses, designed to rapidly prepare and develop its temporary space professionals. This education is typically conducted though its internal assets, namely the Naval Post Graduate School, as well as the Air Forces Advance Space Operations School and NSSI. As before, this table is not all encompassing, and may be dated, but it does give a good representation of the limited space education of the Navy's space professionals compared to the other services.

Comparison

Although each service has a very different approach to acquiring and training its space professionals, all generally utilize their space professionals in a manner which is conducive to meeting the mission and goals of the respective service. While most would agree that there is room for improvement, the consensus is that all three services have reached what each believes to be a standard for education and training of their space professionals.

With exception to a few personal views, namely the late selection of Army space professionals as well as non-permanent space professionals in the Navy, I believe that all three services are doing a good job in training their selected space professionals to perform the tasks in which they will be assigned. Thus, I must admit that a clear cause for the observed inequity between the Army's focus on operational space and that of its focus on space education is not visible within the Army's operational space community, and thus, not a function of how the Army educates its selected space professionals.

Because of this, the inequity must derive from elsewhere, prior to when the Army begins to select and train its space professionals. To verify this, I will look at the educational programs of the services prior to the selection of their respective space professionals, and determine if any inequity is visible here. In order to explore this, we will now look at the space education at the service academies, and consider the impact that these inequities have on the Army space professional.

UNDERGRADUATE SPACE EDUCATION

To determine the impact this inequity has had on the quality of space professionals the Army produces, let us first look at how the Army handles space education below the rank of Captain. This should demonstrate why I believe that space education at the undergraduate level may have potential as a likely way to fill what I believe to be an educational gap, and the cause for an educational inequity amongst the services. This will show how the focus with which a service puts on the education of its cadets and junior leaders directly influences the overall success of its space professionals. To do this, we will look at how each service academy attacks space education, and compare these to identify any possible shortcoming that the Army has.

Air Force Academy

As many know, the Air Force Academy has a very robust academic space program. Such importance is placed on space technologies and education at the Air force Academy, that since 1965, an entire department exists dedicated to space education and research, offering undergraduate majors in Astronautical Engineering, Space Operations, and Systems Engineering (Space Systems). The emphasis the Air Force Academy puts on education at the undergraduate level correlates well with the Air Force's demand for well-educated space professionals. Below in Table 4, a set of general statistics about the Air Force Academy has been accumulated in order to provide a tool for comparing the other two service academies.

Table 4: Air Force Academy Snap Shot

Criteria	Value
Space Related Departments	1
Space Related Majors Offered	3
Space Related Educational Courses	27
Space Research Groups / Centers / Programs	3
Full Time Space Faculty	18
Satellite / Payloads Launched	5
Student Body Involvement (Clubs/research/major)	60%

As you can see, the Air Force has a deep interest in the space education of its cadets. In addition to these basic stats, the Air Force has placed a large focus on integrating its cadets into its various space programs and research, namely with its FalconSat program, but others as well. The FalconSat program, throughout a cadets 4 years at the academy, will include nearly 2/3 of all cadets in some aspect of the programs mission management, planning, resourcing, design, development, integration, and testing of its satellite series. Currently, cadets at the Air force Academy are working on the sixth iteration of FalconSat.

All in all the Air Force Academy has a well developed, robust space education program developed to educate and train its cadets in space systems, better preparing them for meeting the needs of the operation Air Force upon their commissioning.

Naval Academy

Like the Air Force Academy, the Naval Academy has also put a significant emphasis on space education, but not nearly to the extent of the Air Force. At first, this might seem odd, but you must recall that the Navy has had a historic dependence on space systems for nearly 4 decades. This dependency has primarily referred to the Navy's need for satellite communication, but also includes ocean and weather sciences as well. This is understandable when considering the Navy as a sea faring force where line of sight at sea creates a high dependency on operational space systems. Over the years, due to the Navy's ever present need of providing space-based capability to its Fleet, this focus has also trickled down into the Navy's educational goals for its service academy. Thus, over the years, the Navy as developed a fairly robust space education program, deeper than most even realize.

Table 5: Naval Academy Snap Shot

Criteria	Value
Space Related Departments	1
Space Related Majors Offered	1
Space Related Educational Courses	15
Space Research Groups / Centers / Programs	2
Full Time Space Faculty	18
Satellite / payloads launched	8
Student Body Involvement (Clubs/research/major)	≈30%

As you can see from Table 5, the Naval Academy has a robust space education program, dedicated to a wide range of space research and technology development projects. Currently, following in the footsteps of its eight previously successful satellite and payload launches, the Naval Academy is working 5 additional satellite and payload projects, continuing there long history of space education and research, directly aimed at furthering the operational goals of the Navy.

While slightly smaller than the Air Force Academies program, it is easily on par in terms of focus in developing space education for its future leaders, allowing enough education and preparation for its future officers to be able to meet the needs of the operational Navy. Though the Navy has no dedicated space professionals, every Naval Officer will depend heavily on space-based systems, and thus, every officer must have a general understanding of the operational employment of such systems. These officers all have the potential for serving a tour in a space related field as a Navy Space Professional, regardless of their basic operational specialty.

West Point 2008

The United States Military Academy is the nation's oldest military academy, with over 200 years of dedicated service, having graduated some of the nation's most prominent historical figures. Yet, West Point has been slow to move into the space age, well behind the other two service academies in all aspects of space education. Being one of the largest users of space based operational products, it seems odd that the Army would allow such a large disparity to exist. The status of space education and research at the end of the 2008 academic year at West Point can be seen below in Table 6.

Table 6: West Point Snap Shot 2008

Criteria	Value
Space Related Departments	0
Space Related Majors Offered	0
Space Related Educational Courses	1
Space Research Groups / Centers / Programs	0
Full Time Space Faculty	0
Satellite / payloads launched	0
Student Body Involvement (Clubs/research/major)	<1%

As you can see, West Point offered very little in terms of space education, especially when compared to the other service academies. Only a single space related course was being taught, a physics elective, focusing on orbitalogy and space weather, and was only being offered once a year. This yielded a student impact of 18 or less cadets per year, a far cry from the hundreds and hundreds of cadets impacted at the other service academies.

Upon my arrival in the middle of the 2008 academic year, I quickly realized this fact. This is where I first identified a widening gap between space education and space operations within the Army. I was concerned that the Army had made a significant oversight, incorrectly placing no emphasis whatsoever on space research and education at its flagship educational facility. This was a huge contrast to the importance the Army otherwise puts on operational space capability and education. As the only qualified FA40 officer assigned to West Point, holding an FA40 billet that up to that point never been filled, I considered it my duty to make some movement towards rectifying this perceived inequity. Over the course of the next few months, I took the first steps in establishing a cornerstone from which the foundation of West Points space education and research efforts could be built, marking West Points entry into the space research and education race, taking its place among its sister service academies.

West Point 2009

As of the end of the 2009 academic year, significant progress had been made in the institution of a dedicated space education program here at West Point. Through external partnerships, as well as a remarkable amount of internal support, all of the initial goals I first laid out have been met, including many more that developed throughout the year, far exceeding my early expectations.

My initial plan was simple. First, to seek approval to develop and teach West Points first ever Space Systems Engineering course. Second, to seek approval and implement the academies first ever satellite design and

development program, focused on building and launching the academies first satellite. Thirdly, to establish the Small Satellite Research Group (SSRG) to serve as a permanent center of knowledge and coordination authority for all space related research and education activities at the academy. I am happy to report, that all of these objectives were met, as well as many more, and we are currently looking at additional improvements to the educational opportunities here at West Point over the next year. Below in Table 7, the current state of space education at West Point can be seen.

Table 7: West Point Snap Shot 2009

Criteria	Value
Space Related Departments	0
Space Related Majors Offered	0
Space Related Educational Courses	4
Space Research Groups / Centers / Programs	2
Full Time Space Faculty	2
Satellite / payloads launched	0
Student Body Involvement (Clubs/research/major)	1%

As you can see, over the last year we have made some significant progress, being able to expand many of these areas as well as starting work in addressing the others. While this is nowhere near the level of the other academies, it is a start. I hope that with proper stewardship and oversight from the Army, we will continue to see a growth of space education here at West Point in the years to come.

The first of the original goals met was in the institution of the Small Satellite Research Group (SSRG). The purpose of the SSRG was to provide the foundation from which all current and future space education and research endeavors would be launched, as well as being the "face" behind West Point's space program, providing a single point of knowledge, funding, and management. The best research centers are successful through the development of partnerships with other research centers and corporate contractors, helping to legitimizing themselves and their work within the community. Realizing this, we quickly establish partnerships to help fill the gap of knowledge and experience within West Point's fledgling space program. Current SSRG partners include the Naval Postgraduate School (NPS), CalPoly, and the Air Force Academy, some of the premier educational universities in the small satellite and space research fields.

The second of the goals met was the approval and establishment of a satellite design and development program. The great thing about university satellite projects is that, for a relatively low cost, they are excellent tools for teaching students a wide range of educational topics. From system level integration, to hard science engineering, to program management, these types of projects provide a vehicle from which many lessons would otherwise not be possible. The most important aspect of university satellite projects is that roughly 80-90% of all educational goals can be met without ever launching a satellite. This reduces the pressure for progress as in commercial satellite programs, which would otherwise overshadow the educational goals. While difficult in nature, the lessons learned through such projects can provide invaluable lessons for the future problem solvers and leaders of the Army.

Projects of this type also offer the Army other unique opportunities. Foremost, they offer the Army an unprecedented access to young and eager students willing to work on tough problems. By integrating Army operational needs into research programs at the academy, the Army is able to direct university level research towards meeting operational needs, at a much lower cost than it would otherwise be able to through normal outsourcing or contracting. For lower priority research, university research is an ideal alternative, with the potential of saving the Army a lot of money, as well as proving its future leaders with a more robust educational experience, better preparing them as future leaders…it's a win-win. Through Army direction and oversight, short-term research, coupled with interesting and relevant research topics, can easily be conducted with great success here at the academy, serving both the Army operational needs as well as its educational needs.

Currently the Black Knight 1 satellite design and development program, a 1U CubeSat, has completed its first year. The program has passed through both preliminary and final design and review, as well as completing the majority of subsystem development and prototyping. Next year, we envision completing subsystem prototyping and testing, and as well as subsystem and system level integration and test. The amount of interest in this project alone has more than justified the efforts we have put into bringing more space education and research to the academy. Simply put…students are interested space. Of all the senior design research projects offered last year, 70% of all cadets selected the Black Knight 1 project as one of their top choices, much higher than any other project. Figure 4 shows the current 3D CAD model of the Black Knight 1 Satellite.

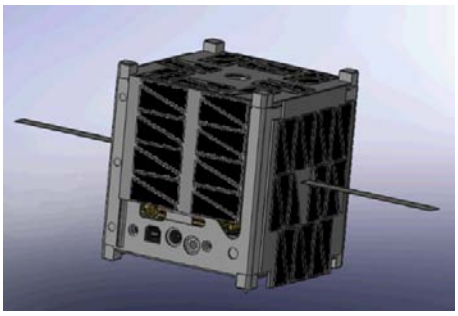

Figure 4: Black Knight 1

The last objective met was the development and approval of a Space Systems Engineering course. Due to the very restricted environment of the academy, new courses are often hard, if not impossible to be added to the already over loaded academic catalog. Fortunately, a high amount of interest as well as support form key department heads allowed for a relatively easy addition of this course. This course, now being offered as a Special Topics Course in the Department of Electrical Engineering and Computer Science (EECS), is set to have its first section taught this fall.

Based on the Air Force Academies SSE331, it is designed to introduce cadets to satellite mission planning and subsystem test and integration, with labs designed around the use of the EyasSat Classroom Satellite. It's offering has had high interest among the cadets, and is currently close to maximum capacity. Unfortunately, due to severe restrictions placed on cadets academically, it is unlikely that more than a single section would ever be taught at a single time. Typically, only cadets who have validated other required courses, have the freedom in their academic schedule for electives such as this.

Additionally, through a working group of like-minded space savvy educational professionals here at the academy, a few other significant actions took place this year. First, an agreement was made between West Point and the Army's Space and Missile Defense Command (SMDC) to stand up the SMDC Army Research Center (ARC) here at West Point. This ARC will be the principle tie back to the operational Army, and provide research and education guidance, allowing the work at West Point to better serve the operational needs of the Army. The SMDC-ARC will be permanently manned by a designated representative from Lincoln Labs, as well as funded. This ARC will receive additional funding and personnel to follow each year, slowly building the SMDC-ARC to working strength by the end of the 2010 academic year. As the current director of the SSRG, it is my intent that the majority of the operations currently performed by the SSRG, will eventually pass to the control of the SMDC-ARC. This will guarantee a level of continuity of effort in space education and research at West Point that was otherwise in question once my tour is over, and I leave the academy for my next space position.

Last year, we also added an additional course to the space education program of the academy. Offered through the Department of Mathematics, this course will focus on mathematical modeling of orbiting bodies, as well as exploring in depth the mathematical base for many of the advance modeling tools used for orbit determination and propagation. This course, in conjunction with both the orbitalogy and space weather course, as well as the space systems engineering course, have been packaged into a 3-Course Engineering Sequence in Space Systems, and forwarded for approval. If approved, this will allow a vastly larger population of cadets the opportunity to select a space based educational tract in conjunction with their respective majors.

Acting on our success here, the SSRG in conjunction with the SMDC-ARC is currently developing an additional course, taught through the Systems Engineering Department. This course, in addition to the original three course, in conjunction with the multi-discipline senior design satellite development project, is currently being development and vetted through the approval process to be instituted as a 5-Course Minor in Space Systems Operations. This is a long and detailed process, but if approved, it will be a huge victory for undergraduate space education, and mark the true begging to West Point's space program, the first step to a more robust, and dedicated space education program here at West Point, one that more closely matches the operational Army's interest in space.

CONSTRAINTS

Without a doubt, the US Military Academy is far behind the other academies in term of space education and research. Now, before any recommendations can be made, we must first address and consider the operational constraints placed on the Army so as to better understand the problems the Army faces in trying to rectify this inequity.

First and foremost, we must consider the fact that the Army is not in the business of developing space professionals, it is in the business of training and developing combat leaders of the future. This is not saying that we should not develop space professionals; it is simply stating that it is not the Army's primary mission. This coupled with the fact that we are currently a nation at war, has put on hold many changes that would have otherwise taken place over the last 8 years as the Army focuses on preparing its leaders for

an extremely high operational tempo. Another constraint is that the Army has no immediate need for operational space professionals until the 5-year mark. This fact makes it very hard to justify the resourcing requirements needed to institute significant changes to both educational policy, as well as educational programs at the Academy. These are valid points that must be considered when looking at potential fixes to the apparent educational difference between the service academies.

Other constraints exist that are products of the organization and policies of the academy as well. As many know, the service academies have very little room in the academic schedules for cadets to pursue their own academic interests. In fact, the majority of cadets who are able to take space electives must have validated out of other course in order to do so. Without a dedicated major or department to represent space education at West Point, it is very difficult to insert space education for students. As you can guess, this severely limits the pool of available cadets, regardless of their interest in these courses. This lack of access to cadets is one of the largest obstacles facing our ability to bring space education to cadets, negatively affecting our ability to expand space education at West Point. This low educational opportunity of space-related courses to cadets leads to a low pool of potential FA40s in the future.

THE WAY FORWARD

Soldiers, cadets, and officers alike, regardless of basic branch, share a common thread…they are interested in space. Let's be honest, space is sexy…the Army needs to use this fact to better prepare, train, and select a higher quality space professional to match its increasing focus on providing the best possible space support to the war fighter. With the inequity between the Army's focus on operational space and its focus on space education identified, it is time to focus our attention on closing the gap for good.

Considering the operational requirements and constraints of the Army, as well as the mission of its space professionals, I have identified two primary areas where I believe that the Army can make the most impact in space education. First, the Army needs to increase its focus on space education to junior level leaders, officers and soldiers, prior to their selection as space professionals. Second, the Army needs to expand its educational focus to include space education at the undergraduate level, namely at the US Military Academy. By doing so, the Army can effectively increases its educational opportunity to train potential future space professionals by over 8 years. Even though these officers and soldiers may not be working space, there is no reason they cannot be learning space.

Resident and Distance Learning

As of now, the Army offers a host of space related educational opportunities, namely through short-term residence courses and distance learning courses offered through SMDC as well as the Air Force ASOPS. These courses are typically less than 2 weeks long, and thus, in a relatively short period, can cover a broad range of space-related topics. Over the course of a couple of years, a junior officer could take a few of these courses, greatly improving his/her overall understanding of space. These courses could provide a solid foundation from which to educate junior leaders and soldiers in space and operational space topics.

To accomplish this, there needs to be a major "reemphasis" on space education within the Department of the Army. First, educational opportunities must be increased for a larger group of interested officers, giving a greater access to space education than currently allowed. For this to work, the Army must take a new tact in emphasizing the importance of these educational courses to unit level commanders, as well as providing a central source of funding for this education. By doing so, commanders, with solid Army wide guidance, will be much less likely to disapprove training of junior officers. With DA level pressure, as well as funding, only current operational needs will remain as potential roadblocks.

These courses, with the addition of some courses offered by the Air Force ASOPS, could be packaged into a set of training requirements, and used to better train junior officers prior to their application for FA40. Eventually, this course package could even be used as a pre-requisite for selection for officers applying to be FA40s. The utility of these programs need not be limited to just the officer corps alone. They could also be used as a standardized training template for Army Space Enablers. This would formalize the training requirements in both junior officer as well as enlisted soldier space education, filling the educational gap in space education prior to the training of space professionals. While these courses would not represent a complete education, they would provide invaluable experience to officers and soldiers early in their careers that they would otherwise not have.

Undergraduate Education at West Point

Why focus on undergraduates? Well, West Point offers a great opportunity for the Army to do interesting, important, and relevant space research. This can directly affect the needs of the operational Army, at a much-reduced cost, as well as meet the educational

needs of undergraduates. Thus, undergraduate space education can serve the Army space community in many ways. First, in can inform future Army officers about space, producing a more competent and space savvy leader. Second, it can inspire cadets to seek out more advanced degrees, emphasizing the need of the Army for educated officers to solve real world problems. Thirdly, undergraduate space education will serve as a formal introduction to the FA40 functional area, informing and inspiring a larger pool of cadets to pursue the FA40 functional area as a potential career. Lastly, a greater amount of relevant research can be conducted, with direct interaction and oversight, that could have immediate operational significance to the Army.

These factors can all drastically affect the space awareness of cadets graduating from West Point. Consider the size and quality of this pool if we increase the focus of space education at West Point. Consider the impact this pool could have on future space operation within the Army. By increasing the cadet impact through space education from its current level of about 1%, to something near the other two academies, say 20%, we can drastically increase the pool of educated, trained, and better-prepared officers from which to select the future FA40s. This will also yield a more educationally robust junior officer, capable of grasping advanced space concepts and utilizing this knowledge to better serve in his/her primary branch. This increase in educational opportunity would also increases the ability of FA40s to advertise, effectively introducing cadets to the functional area very early in their careers, giving them more time to seek additional training and education, as well as a detailed understanding of the Space Operations Functional Area well before they can apply to become FA40s.

CONCLUSION

The Army's focus on operational space transcends the entire structure of the Army, regardless of level, personnel, or operations. Space operations are embedded in everything the Army does, in all aspects of war fighting, and this is unlikely to change. For its selected space professionals, the Army does a good job at educating and training them for the roles which they will perform. Here, operational space efforts as well as space education efforts are closely matched, sharing a common focus and equality. It is here that the Army is truly successful.

Unfortunately, the Army's focus on space education does not transcend the Army. Thus, at any place other than the Army space operations community, there is a significant lack of space knowledge. This gap, or inequality, is apparent at all levels of the Army, specifically at the enlisted and junior leader levels, as well as at the US Military Academy.

To close this gap, the Army must take a more active interest in space education, expanding its focus to include all educational opportunities. While focusing space education solely on its selected space professionals does meet the immediate operational needs of the Army, it does not take in account the positive impact that improved space awareness of its cadets, junior officers, and soldiers could have. Additionally, current policies fail to consider the potential benefit to the FA40 functional area in the long term, nor the positive impact to Army research endeavors.

While failure to address these concerns will likely have a small effect on the day-to-day operations of Army space operations, the cumulative impact has the potential to be quite large. Even though the overall impact on the Army's ability to conduct space operations is minimal, consider how much better the Army's space professional community could be if its members had been exposed to space educational topics and training as junior leaders and undergraduates, prior to selection. What possible impact could space education and research during this 8+ year period have had on their potential quality?

The Army must make a commitment to fully support space education not only in the community of its space professionals, as it has done thus far, but within the pool of junior leaders and cadets as well. By making an organizational decision to support a broader space education plan, one encompassing both the education of its space professionals, junior officers, soldiers, and cadets alike, as well as space research opportunities at the university level, the Army has an opportunity to greatly influence the overall effectiveness of the entire Army in terms of space capability. By building an even larger pool of space educated and aware officers and soldiers, the Army of the future will be better positioned to meet its operational needs, producing more capable soldiers and leaders of tomorrow.

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DISCLAIMER

The views expressed in this paper are those of the author and do not reflect the official policy or position of the U.S. Military Academy, the U.S. Department of the Army, the U.S. Department of Defense or the United States Government.

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