STRATEGY
RESEARCH
PROJECT

EDUCATING ARMY OFFICERS FOR THE 21ST CENTURY

BY

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ABSTRACT

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The challenges faced by the Army of the 21st century will be vastly different than those faced over the last two hundred years. As society continues to change ever more rapidly, new weapons and systems will be introduced into military arsenals at a greater rate. Officers of every branch will have to deal with high tech weaponry, information systems and yet unpredicted technologies. Effective leadership in the future environment will demand a wide range of skills, from technical expertise to cultural awareness. As the body of knowledge required of an officer grows, the existing educational system will initially be stressed and eventually fail to provide adequate development. This paper examines officer education from undergraduate programs through Senior Service Colleges. Undergraduate education must provide the underpinnings for a career of learning across the spectrum of disciplines. This can only be accomplished by maintaining sufficient breadth in these programs and by developing learning skills and motivation required for continued development. Post-graduate programs can afford to focus on particular areas once an officer's career path is determined. Universal resident schooling at the Command and Staff College and Senior Service College levels will improve officer education levels, but will not relieve officers of the requirement to pursue continued self-development. The focus of educational institutions must change. Periods of formal education must provide foundations and serve as launching points, not destinations. The Army's continued success depends on its ability to become a learning culture.

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EDUCATING ARMY OFFICERS FOR THE 21ST CENTURY

The 21st century has arrived. The world we live in is changing ever more rapidly. Schools struggle to turn out graduates who can compete effectively in a modern society that increasingly demands technological sophistication at an unprecedented level. More to the point, the Army depends more than ever upon technology to maintain its dominance. Now is the time to reconsider the education of the Army's officers.

The educational opportunities over the course of a career are limited. Pre-commissioning education generally consists of four years of undergraduate study. Following commissioning, the next opportunity for formal education for most officers, occurs at the Command and Staff College (CSC). The final opportunity is at the Senior Service Colleges (SSC). Some officers are afforded the opportunity to pursue civilian graduate education, but the programs are far from universal. Focused training, as opposed to general education, occurs in pre-commissioning programs, at initial entry in officer basic courses (OBCs), and at the career courses, officer advanced courses (OACs) and Combined Arms Services Staff School (CAS^3). Some training is also integrated into CSC and SSC. The time allocated to educational programs is unlikely to increase given recent shifts in priorities increasing the emphasis placed on manning the warfighting force at one hundred percent.

The onset of the Information Age and the increasing importance of rapidly evolving technological capabilities demand consideration of how officers will be prepared to lead effectively in a force highly dependent upon technology for its superiority. Studies discussing the increasing importance of information and knowledge at the end of the 20th century, in both peace and war, abound. From futurists like Alvin and Heidi Toffler to the authors of Joint Vision 2010 and members of the Army After Next panel, categorization of the changes as a revolution in military affairs (RMA) are unanimous. The changes in the educational system have been far from revolutionary. The Army has recently implemented major changes in officer personnel management under OPMS XXI. While OPMS XXI implements some changes in the post-commissioning portion of the educational system, it does not address the relationship between pre-commissioning education, officer personnel management and the RMA.

This paper assesses the potential for success of the current educational programs, given fixed education periods, and offers suggested improvements for the Army to meet with success in the Information Age and beyond. The next section of the paper examines the direction that the current RMA has taken us, using the perspective provided by previous RMAs. One trend is that revolutions are occurring with greater frequency. The next revolution may only be years or months away. Consequently, the paper then examines the implications of increasing rates of change. The third section addresses educational philosophy. The fourth section studies the single largest block of formal education in an officer's career, the undergraduate education system, focusing on the service academies as primary examples. The fifth and sixth sections discuss education in the period from commissioning through completion of CSC, and from CSC until retirement, respectively. Finally, recommendations are offered and potential counter-arguments addressed.

FUTURE WARFIGHTING

There are many sources of insight into the question of where warfare (Alvin and Heidi Toffler would also include anti-war) is going. Developments in warfare during the Agrarian and Industrial Ages and a comparison with the changes experienced recently at the dawn of the Information Age will provide an azimuth on which to orient the study of officer education. The direction, magnitude, and pace of changes in warfare will dictate the necessary modifications to the education system.

Before the domestication of plants and animals, no societal entity had sufficient personnel resources to permit specialization of tasks within the society and no vested interest in having any of its members do anything other than hunt and gather. The domestication of plants and animals marked the first time that a population could produce more food than required to feed its members. With excess production capability arose the availability and manpower to protect the food stores, which were no longer consumed as they were produced. This transition, from intermittent engagements over hunting/gathering grounds to organized offensive and defensive operations, took place around 10,000 years ago.[1] Warfare continued in a primitive mode until approximately 300 years ago. The industrial revolution "triggered a second wave of change; and ... we, today, are feeling the impact of a third wave of change."[2] The second wave of change precipitated the need to educate military officers in ways previously unimagined. Agrarian skills diminished in importance. The changes of the Industrial Age were manifold. The introduction of the internal combustion engine as the primary source of mobility on the battlefield drove the development of mechanical engineering and supporting science and math programs and foreshadowed the demise of education in horsemanship. While some stubbornly held to the importance of horsemanship for ideological reasons, the disappearance of the horse, from both war and the education of wartime leaders, were tied together.

The horsemanship example also gives us important insight into the linkage between war and peace. The Tofflers maintain that the forms of war and anti-war (peace) are inextricably linked. Indeed, the weapons of the Agrarian Age were derived from the peacetime tools of the age, plowshares beat into swords, and horse-powered mobility. The relationship between the tools of peace and war is undeniable. It is difficult from the current perspective to determine whether developments during the Agrarian Age came first in the peace form or the war form. The last half of the Industrial Age is recent enough for us to observe that, in most cases, developments in war preceded those in peace. The development of powered flight is but one confirmatory example of the premise. The trend has reversed itself, however, with the arrival of the Information Age. Rather than the development of military hardware leading the development of peacetime economies, the explosion of communications and information technology in the civilian sector is proceeding at a pace the military can barely match. If land control was at the heart of the Agrarian Age, and industrial production the center of gravity of the Industrial Age, then surely the hub and source of power in the Information Age is knowledge and control of information.

The Information Age is recently upon us. The Gulf War represents a boundary event between the Industrial Age and the Information Age.[3] During the Agrarian and Industrial Ages, changes in warfare usually preceded changes in peacetime economies. In the Information Age, the trend has been reversed. Purveyors of a future vision are now able to look at the developments in the world economy and project those onto the war form. The first prerequisite, if national security is to keep pace with the transformation of peacetime economies, is the development (maintenance) of a high quality force. A National Security Strategy for the Next Century states:

> Quality people—military and civilian—are our most critical asset. The quality of our men and women in uniform will be the deciding factor in all future military operations. In order to fully realize the benefits of the transformation of our military forces, we must ensure that we remain the most fully prepared and best trained fighting force in the world. Our people will continue to remain the linchpin to successfully exploiting our military capabilities across the spectrum of conflict. To ensure the quality of our military personnel, we will continue to place the highest priority on initiatives and programs that support...*the training and education of our men and women in uniform* (emphasis mine).[4]

The strategy goes on to say "persons with advanced training in information technology are a prominent example."[5] The overarching capabilities identified in the strategy are intelligence, surveillance and reconnaissance, space, missile defense, national security emergency preparedness, and overseas presence and power projection.[6] The latest National Security Strategy, released in January 2000 states

> We also are committed to maintaining information superiority – the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting and/or denying an adversary's ability to do the same. Operational readiness, as well as the command and control of forces, relies increasingly on information systems and technology. We must keep pace with rapidly evolving information technology so that we can cultivate and harvest the promise of information superiority among U.S. forces and coalition partners while exploiting the shortfalls in our adversaries' information capabilities.[7]

One step below the presidential statement of overall national security requirements, is the guidance of the Secretary of Defense, in the Report of the Quadrennial Defense Review, and of the Chairman (CJCS) and the Joint Chiefs of Staff (JCS), in the National Military Strategy. Both documents describe a vision for the future dependent on the current military strategy of "Shape, Respond, Prepare Now." In particular, the "Prepare Now" portion of the strategy depends heavily on the vision of the Chairmen expressed in Joint Vision 2010 America's Military Preparing for Tomorrow. The Chairman succinctly put the importance of change in perspective: "How we respond to dynamic changes concerning potential adversaries, technological advances and their implications, and the emerging importance for information superiority will dramatically impact how well our Armed Forces can perform its duties in 2010."[8] The changes embedded in technological advances and the methods of attaining information superiority clearly indicate a need to prepare future leaders to deal with new and evolving technologies. While the changes with respect to potential adversaries could encompass sociological and cultural aspects of future enemies, it is the technological capabilities of potential adversaries that the Chairman chose to focus upon. The Army is not in the business of educating engineers or technologists. Effective leaders in a high technology environment will require the ability to project the effects and limitations of weapons used under a wide range of circumstances. Many systems will be used under vastly different circumstances than those for which they were developed. Without an understanding of the underlying principles, leaders will be unable to adjust for the situation (METT-T) under which the weapon is to be employed.

Throughout the capstone guidance and vision documents, three technology areas repeatedly surface, precision, stealth, and information dominance. These three areas are intimately linked. Stealth denies the enemy information, and hence protects dominance in that domain. Precision leverages information dominance and accomplishes missions at minimum cost. It is also clear that potential adversaries are likely to possess technology that allows them to compete against us in these disciplines. Only through in-depth understanding of the capabilities and limitations can the Army maintain its advantage.

Each member of the JCS has published their own vision of the future. One might expect that the visions would reflect service cultures and hence contain widely varying conceptions of the importance of technology, and its understanding, to the future success of the services. Common wisdom is that the Air Force is the service most closely linked to technology, the Army and Marine Corps are the most detached and the Navy lies in between. Yet Army Vision 2010 devotes nearly a third of the document to the technology required to accomplish the five paths to full spectrum dominance. Repeatedly, the technologies found are related to stealth, precision and information processing and transmission.[9] Predictably, air and space superiority, precision engagement and information superiority build upon technological capabilities inherent in each of these areas. To balance presumed technical competence, the Air Force proposes a post-commissioning course for all leaders focusing on history, doctrine, strategy and operational aspects of air and space power.[10] The balance between technical skills and abilities will be difficult to maintain as the growth of technology explodes. Surprisingly, the Department of the Navy vision makes relatively little reference to technology itself or the capabilities required of its service members.[11] Perhaps this is more a statement of the longstanding importance of technology and its understanding to the accomplishment of the naval mission, than an indication of their lack of importance in the future.

The Army has continued its look into the future beyond the near term (2010), looking not at the next force, but the one to follow the next. The Army After Next (AAN) Project, established in February 1996 by the Army Chief of Staff, assists the Army leadership in developing future requirements, thirty years in the future. One focus of the AAN Project is technology, and its ability to give the future force knowledge and speed, two requisite capabilities of the future force. Knowledge derives from information gathering and information processing assets. Speed depends on materials, power sources and energy storage.[12]

As a final attempt to look into the future, consider the recent past. General Robert H. Scales writing about Operation Desert Storm observed, "Complex equipment cannot be transported to a theater and flung across a battlefield with the velocity and intensity of Desert Storm unless it is crewed by soldiers who understand how it works and how to keep it going when established procedures fail."[13] Development of such abilities implies that the Army must invest increasingly in educating soldiers and especially leaders in the technologies, and more importantly the underlying science, that form the basis for modern weapon and information systems. Only with such preparation will the Army be able to employ of these systems to its advantage in the fury of war.

THE DILEMMA OF CHANGE

Change is speeding up. The curricular change process has been unable to keep up with the rapid advancement of technology. If the rate of change continues to increase, will the Army be able to continue adapting the education system to stay current with the important concepts of the decade, year or month? A closer look at the nature of change is warranted.

The genesis of the problem lies in the rate at which change is occurring in the world today. Many of the changes being experienced today are a result of advances in integrated circuit (IC) technology. Gordon Moore's well-known prediction about the number of transistors in an IC—or equivalently the processing power of computers—provides a good analogy to describe the more general change process being experienced across a broad spectrum of technology areas. Moore said that the number of transistors found in an individual IC would double every year. Assuming a thousand transistors in 1970, the state-of-the-art should reach about a trillion transistors in the year 2000. Shortly after his initial prediction, Moore corrected the time required for doubling the power of processors to eighteen months. That would result in a billion transistors in 2000. Current predictions indicate that it will actually take until around 2010 to reach a billion, indicating that the time to double is really about two years. This discussion, however, focuses not on the number of transistors, but the rate of growth (change). Consider the growth in the periods 1970 to 1972 and 2010 to 2012. From 1970 to 1972, the corrected version of Moore's Law correctly predicted a growth from one thousand to two thousand transistors, or five hundred transistors per year. By 2010, the law predicts one billion, and hence two billion in 2012 or a growth of five hundred million per year. By 2030 the rate of growth will be 500 billion per year. The insidious result is that if the number of transistors grows exponentially with time, the rate of growth also grows exponentially. In fact, the rate of growth increases just as fast as the number of transistors, doubling every two years.[14]

An obvious extension of this simple mathematical relationship is to apply it to numbers of different technologies, or basic scientific principles needed to explain the weapon and information systems of tomorrow. Not only is the world changing faster than ever before, it will change faster next year than it did this year, and even faster the year after. If the number of technologies, and the science upon which they are based, continue to expand, how can educators continue to fit curriculum necessary to support that demand into fixed-length periods of education?

One way to expand the coverage of science and technology, while keeping the length of the programs constant, is to reduce the coverage of the other topics. The basis for that course of action could only be established by showing that the relative importance of the sciences is growing in proportion to the number of new technologies and that the other areas are not experiencing a similar growth. This paper does not attempt to make either case. Instead, the military must seek to maximize the value provided by synchronizing educational opportunities and coverage with changes in scope of an officer's responsibilities over the course of a career.

Part of the solution to the problem lies outside the confines of formal education programs. The Army must find better ways to take advantage of the full length of the officer's career. Officers must be prepared and motivated to continue learning beyond the confines of educational institutions. Because the direction that technology will take is not predictable, the root elements that *enable* learning must be identified. Officers will become more dependent on individual development in informal settings. Moreover, the Army will no longer be able to ignore technology in education presented at the CSC and SSC levels. Regardless of the rate of change, the objective of the educational experience remains to produce effective leaders in a high tech force, not engineers or technologists who have some leadership training and experience.

EDUCATIONAL PHILOSOPHY AND THEORY

The military pursues two distinct forms of individual development, education and training. Training is designed to enable a soldier to perform a well-defined task, under specific circumstances, to a given standard. When the task, conditions or standard change, the performance of the soldier must be assessed under the new criteria. If a shortfall exists, the soldier must be retrained. Education, on the other hand, provides knowledge and skills that enable the soldier to perform a variety of related tasks, under uncertain conditions, to a flexible, but relevant, standard. It is important to distinguish between education and training given that the Army faces a rapidly evolving environment. Training has its greatest value when the task will be performed in the near future, and conditions have the least opportunity to change, or when the task is simple by its very nature. When the tasks must be performed over a long duration, under changing conditions, or, when the tasks are complex, education becomes essential.

Educational theorists pose that learning occurs in four domains, social, cognitive, affective and psychomotor. Leadership and physical development programs logically focus their efforts in the social and psychomotor domains, respectively. Moral/ethical development falls under the affective domain. The excellence of the military programs in these areas is widely acknowledged. Academic curricula are not limited in scope, however, to the cognitive domain. The academic programs address communication skills (social domain), value development (affective domain) and information processing, critical thinking and problem solving (cognitive domain.)[15] In each of the four domains, it is possible to classify the level of difficulty (or conversely the amount of development required) of each of the skills. Within the cognitive domain, information processing is requisite to critical thinking, which in turn must precede problem solving.

A curious question arises concerning learning ability; how does one learn to learn? Are learning skills unique to domains? Common sense indicates that the ability to learn itself is an ability that spans multiple domains. At the same time, the word learning implies a cognitive process. The self-referential description of this process is "learning to learn," sometimes referred to as meta-learning or meta-cognition. Most experts contend that the ability to learn is domain-specific. Different skills are required to learn in the affective domain than in the cognitive domain. Even further, within the cognitive domain, the learning process differs by discipline; development of learning abilities in the social sciences does not imply development of mathematical learning ability. The United States Military Academy formally recognizes these differences in the publication Educating Army Leaders for the 21st Century.[16] This publication identifies nine academic program goals and specifies a learning model for each of the goals. The learning models delineate the structure, content and process of cadet experiences that contribute to the accomplishment of the goals. The importance of this consideration cannot be overstated. With a limited period of time to pursue formal education, there is insufficient time to accomplish all educational objectives. If all learning required a common baseline skill set, there would be no need to probe further. Educational programs could simply develop the (common) skills and attitudes that officers would need to continue learning over the entirety of their careers at a universally high level. Unfortunately, this is not the case. While some skills are common to many areas, most disciplines require additional learning skills that are unique to that discipline for learning in depth.

UNDERGRADUATE EDUCATION

The first phase of development for officers over which the military exercises some degree of control is undergraduate education. The amount of control that the services have varies by program and development objective. Training activities are more controlled due to the requirement to enforce task definition, conditions, and standards. Educational development usually offers the opportunity for greater latitude. For the military, the undergraduate education programs are subject to the greatest variance. The military has little control over the education of officers accessed through Officer Candidate School (OCS) and direct commissioning. The military has no direct control over the curricula at schools offering Reserve Officer Training Corps (ROTC) programs, but can influence the education of students directly by establishing criteria for commissioning, and indirectly by choosing the schools at which ROTC is offered.[17] The service academies fully control pre-commissioning education, and hence offer an ideal opportunity for study of the best preparation for leadership in the offered environment and careers as officers in the U.S. military services.

A HISTORICAL PERSPECTIVE

A brief history of the academies and their objectives is in order. USMA, founded in 1802, addressed the need of a fledgling army for two categories of officers, engineers and artillerists. There were already well established institutions of higher education offering traditional, liberal educations. There was not, however, another source of officers educated in the design and construction of field fortifications and bridges, or artillery pieces. Note that the founding of USMA roughly corresponds in time to the beginning of the Industrial Age. The establishment of advanced military educational systems on the European continent also corresponds to the onset of industrialization, École Polytechnique in 1794 and St. Cyr in 1802. The United States Naval Academy, founded in 1845, shortly after USMA, addressed a need for officers in the naval services with service-specific engineering skills. During the time preceding the rapid industrialization of society there was apparently no need of academies to educate officers in the technologies of war. The onset of industrialization drove the militaries to establish academies to educate officers in technologies important to the military. Over time, technology evolved slowly, permitting slow changes at the academies. New technologies induced evolutionary changes to the educational curricula. For instance, the arrival of the internal combustion engine on the battlefield was followed by the addition of mechanical engineering studies. The only technological development of the Industrial Age sufficient to prompt more revolutionary change was the introduction of the airplane into military doctrine. This development resulted in the creation of a separate service and finally its own academy in 1954.

An important characteristic of the Industrial Age is that the development of new technologies was in general precipitated by demands from the military sector. Put more succinctly, the methods of war led the methods of peace. Under these slowly evolving conditions, major wars and the accompanying developments were relatively infrequent; the academies had little problem keeping pace. Indeed, with the initial lead of the academies in engineering education, the academies even found the opportunity to diversify their educational objectives as the civilian educational sectors began to provide sufficient engineers to meet the needs of the country. The first century of the academies' existence produced the core of the nation's engineering capability. During the second century, graduates worked hand in hand with graduates of civilian institutions to develop "weapons" of war and peace, radar for example. In the future, officers will be largely free of engineering duties, but will have the responsibility to effectively employ technologies, deployed at an ever-growing rate, during both peace and war.

REVIEW OF CURRENT CURRICULA

Given the long history of engineering education at the service academies, and the accreditation of their current programs, one might mistakenly assume that the programs should adequately prepare all graduates for leadership in the 21st century, but less than half of the graduates major in engineering. Consequently, the examination of the service academies focuses on the *core* of their academic programs, those portions taken by *all* cadets or midshipmen. If the services are to benefit universally, the preparation must be contained in the core.

United States Military Academy (USMA)

Educating Army Leaders for the 21st Century states the vision that the military of tomorrow must "respond to dynamic changes concerning potential adversaries, technological changes, and information systems."[18] Three of the nine academic program goals address topics covered under the purview of humanities and social science curricula. Recognition of moral issues and application of ethical concerns, as well as communication skills, both oral and written, span the breadth of the program, as does the development of ability to think and act creatively, and desire to continue learning throughout life. Two of the goals are primarily the purview of the math, science and engineering programs. They are:

1. Understand and apply the mathematical, physical, and computer sciences to reason scientifically, solve quantitative problems and use technology.

2. Use the engineering thought process by which mathematical and scientific facts and principles are applied to serve the needs of society.[19]

The core curriculum is designed to satisfy these goals. Figure 1 shows the overall structure of the curriculum.[20] Note that there are sixteen courses in the humanities and social sciences and fifteen in math, science and engineering, of which five are the "Engineering Sequence." Each cadet takes five courses in a single engineering discipline (electrical engineering, computer science, mechanical engineering, civil engineering, systems engineering, nuclear engineering or environmental engineering) to satisfy this core requirement. Engineering majors are typically required to take courses from outside of their own major to enhance breadth. The key factor here is that non-engineering majors take all of their engineering courses in only one discipline.[21] Therein lies the dilemma. Three of the engineering

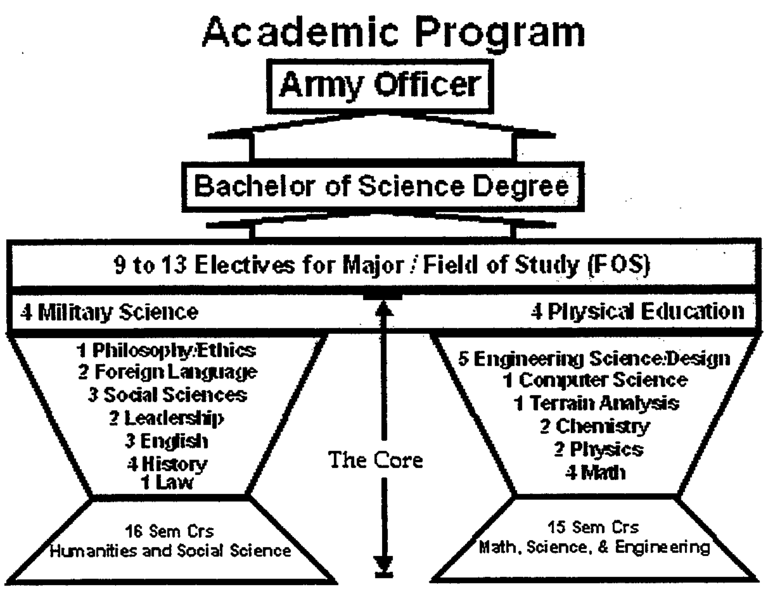

FIGURE 1, USMA ACADEMIC PROGRAM[22]

sequences have little or no relationship to the technologies that are keys for the future Army. Systems, nuclear and environmental programs offer no coverage of information systems, precision delivery technologies, stealth, or any other key areas. The remaining four sequences are far from comprehensive with respect to these areas, but at least offer coverage of some topics. If an understanding of these areas is essential, ought not the core programs address them?

There is some coverage of the topics identified as critical in the core science program. The core physics program addresses electromagnetic wave propagation, one of the keys to stealth. CS105, Introduction to Computing has a superficial coverage of information technologies and their application to military problems. Chemistry covers some of the science underlying materials essential to technologies enabling the rapid mobility envisioned for the future force, although it is far from being a sufficient background in materials science.

The five-course engineering sequence is one single area where the breadth preparation of future leaders can be increased. Simply returning to a breadth-first approach would guarantee that leaders who must use, but have no need to design, weapons, will understand potential limitations of systems and be able to maximize the effectiveness of their employment.

United States Naval Academy (USNA)

The curriculum at USNA "has been developed to provide each midshipman with the skills and knowledge necessary for the performance of duties as a junior officer in the U.S. Navy or the U.S. Marine Corps."[23] The academic program consists of three parts, core courses, divisional electives and major electives. As at USMA, the purpose of the core portion of the program is to provide a broad education in mathematics, science, engineering, social sciences and humanities. Majors are grouped into three divisions, which could broadly be characterized as engineering, mathematics and sciences, and humanities and social science.

All midshipmen complete three semesters of calculus and a fourth mathematics course in either differential equations or probability and statistics, depending on their major. The third calculus course has two variants. Like the fourth math course, the version taken depends on the student's major. All students complete one year (two semesters) of both chemistry and physics. The mathematics, chemistry and physics portions of the curriculum very closely parallel those of USMA.

The engineering requirement at USNA is different than USMA's. All midshipmen receive a broad-based approach to engineering. There are two options. Engineering, mathematics, chemistry, and physics majors complete two courses in naval engineering, two courses in electrical engineering and two courses in systems engineering. All other majors take the two naval engineering courses and an integrated sequence of three electrical and systems engineering courses. Both the naval and systems engineering courses apply fundamental principles to naval weapons and shipboard systems. The total number of required courses in math, science and engineering is fifteen.

In the humanities and social sciences, midshipmen are required to take two courses in rhetoric and literature, three in history, one in government. They must also take two courses of their choice from the humanities and social science offerings. Additionally, they must take an ethics course, two leadership courses and a law course. The total number of required courses in this area is twelve.[24]

While the focal point of consideration here is the core program, USNA's major program must also be considered. USNA also links the midshipman's major with their post-commissioning assignments. Consequently, they also place ceilings and floors on majors, to insure they have sufficient numbers of officers in each of the technical services. They are the only service academy to have such a program.

In summary, the program requires relatively greater proportion of engineering. The engineering is also distributed across the breadth of the engineering disciplines. Notably missing from the program is any requirement to study information systems or the concepts and science underlying the single most ubiquitous asset of 21^{st} century forces, naval or otherwise.

United States Air Force Academy (USAFA)

The curriculum at the USAFA also includes a core requirement, one that is larger than that of USNA, but slightly smaller than USMA's. Like the others it has a split of courses between various divisions. There are four divisions at USAFA, basic sciences, engineering, social sciences and humanities. There are nine required courses in basic sciences: biology, two chemistry, two physics, three math and one computer science. There are six required engineering courses, engineering mechanics, aeronautics, astronautics, electrical engineering and two general engineering courses. There are fourteen required social science and humanities courses.[25]

Like the USNA program the distribution of engineering and science courses forces a broad coverage of technical topics appropriate to the service mission. Of the three academies, USAFA clearly has the program most supportive of the technical requirements outlined in the first part of this paper. The focus on mathematics and basic science is almost identical. Unlike USNA, USAFA requires a course in computer science. There is one important difference between USAFA's computer science requirement and the Introduction to Computing course at USMA. USAFA's course focuses on basic science, while USMA's is a mix of introductory level programming and applications.

Another difference between the USAFA and USMA programs is that the USAFA program requires all students to take electrical engineering (as does USNA) and aeronautics. The latter requirement obviously meshes with the objective of educating Air Force officers. The former serves to make the engineering broader, leading to less fully developed design ability, but better understanding of a variety of topics, and hence technologies.

Curricular Summary

Each of the three curricula offers a similar split between two major groups of courses, math, science and engineering on one hand and social science and humanities on the other. Although minor differences exist in the latter group, the number of required courses is between twelve and sixteen. All three academies adhere to the breadth-first approach in the design of the curriculum dealing with history, language arts, foreign cultures and behavioral and social sciences

Similarly, the design of the math and science portions of the programs builds breadth and prepares students for further study and learning in a variety of areas. The USMA engineering program deviates from this philosophy. As a result, all non-engineering majors are deprived of any development of breadth in the engineering sciences. Many have *no* component of engineering science that links physical sciences to the modern battlefield. Technologies are changing too rapidly to justify an unending attempt to follow the current trends with curriculum changes. This is one further justification to diversify the coverage. Permitting students to choose an area of depth (inside of the core program) defeats the primary purpose of the core. The core should establish a baseline of competence. If there is insufficient room to accommodate breadth, then depth should be sacrificed. The majors programs are specifically for the purpose of giving students a depth of study.

The benefit of covering basic science first, as at USAFA, is that students are better prepared for further learning beyond the undergraduate curriculum, learning that is requisite for continued success. The goal is not to produce the student capable of doing the most useful work during the six months after the course. It is, rather, to design a course that facilitates the most production over the course of a career. Most frequently this means preparing for further learning. This is truer in rapidly changing disciplines like computer science. Teaching the technology of the latest piece of hardware will have little value for the long term. Knowledge of underlying concepts and ideas will stand the lifetime student in good stead for a career of learning.

CURRICULAR CHANGE

Recent developments in the missions assigned to Army and Marine Corps officers seem to indicate that land forces will be more likely to act as police forces they are to fight major, high-intensity conflicts. Even naval and air forces appear just as likely to face low tech enemies as they are to encounter a technological peer. The recurring guidance is that the military be prepared to fight and win the nation's wars. This requirement begs the question of what wars will be. Police actions may become the most important "wars" of the 21st century. Regardless, as information technologies and service-based economies come to dominate the world of peace, they will also dominate the world of war. It is imperative that the Army use the limited opportunities to offer officers of the future the education they will need to be successful in their quest to win the nation's wars, whatever form they may take.

If information technologies will dominate the first few decades of the current century, what technologies and scientific principles will rule the following decades? Until now, the service academies have been able to adapt their curricula to keep pace with changes in technology. Maybe the information revolution is a bubble in the rate of change and the Army has fallen behind only to catch up, and keep up in the years ahead. This, unfortunately, does not appear to be the case. The rate of change in technology, at least in the last forty years, has continued to increase exponentially. With the current mechanisms for changing curricula, the education system will only fall further behind technology in the future absent a shift in educational philosophy.

The long-term solution lies in a change of educational philosophy as radical as the changes in technology and society. One might even refer to the necessary change as a revolution in educational affairs (REA). The key lies in recognition of the fact that it will no longer be possible to fit all of the required education, as defined in the traditional sense, into four years. The Army must consider education a continuous process, much as it treats training today. The educational foundation laid in the undergraduate program must motivate and prepare the officer of tomorrow for a career of learning. The preparation necessary to accomplish this goal involves learning in multiple domains, cognitive and affective in particular. The Army must also recognize that preparing an officer to learn in one discipline may differ substantially from the preparing to learn in another. The learning skills and the prerequisite knowledge may vary widely from discipline to discipline.

BEYOND UNDERGRADUATE EDUCATION

The Armed Services offer a comprehensive educational and training system beyond commissioning. Following a broad general education, officer basic courses (OBCs) provide branch specific training to insure the lieutenants are prepared to function as junior leaders and staff officers in their accession branches. Frequently, OBCs are supplemented with courses designed to provide necessary skills for a specific job at a first assignment. Officer advanced courses (OACs) and CAS3, usually attended between the fourth and sixth year of service train officers to command at the company level and perform staff functions at battalion and brigade. Some officers are offered the opportunity for fully funded graduate schooling between their seventh and tenth years of service. Attendance under this program is governed by the Army Educational Requirements System. Each year around 400 officers begin schooling based on validated requirements for holders of advanced degrees.

The first opportunity that most officers have for full-time education is at Command and Staff College (CSC). Under the previous personnel management system, about fifty percent of each year group attended CSC in residence. The remainder of the year group completed the course by correspondence. The Army recently implemented major change in personnel management known as OPMS XXI. One major change under OPMS XXI is that all active component officers will attend CSC/MEL4 schooling in residence. OPMS XXI introduces MEL4 schooling based on assigned functional area instead of a common course for all. The course for officers assigned to the Operations Career Field (OCF) will continue to look much like it does today. Officers in the other three career fields will attend MEL4 schooling based on their particular field and possibly their functional area. It remains undetermined what universal resident schooling means for reserve component officers.

There are several second order effects deriving from OPMS XXI. Officers who desire to stay in their accession branches, and the OCF, will be disinclined to seek opportunities for graduate civil schooling. Civil schooling generally requires at least forty-two months, and up to sixty months, out of the officer's branch. This will lead to a concentration of officers with graduate education in the career fields other than OCF. Second, MEL4 schooling will become more training-like. As the requirements demanded of its graduates narrow, CSC will be tempted to sharpen the focus of its curriculum, removing inherently valuable breadth. A third order effect is that even officers who might prefer a non-OCF career field, will avoid graduate schooling, to improve their chances of success should they be forced to remain in OCF.

The attack on educational diversity is two-pronged. The Institutional Support, Operational Support and Information Operations Career Fields will have a cohort of better-educated, but more narrowly focused officers. The Operations Career Field encourages single-minded focus on development in the officer's branch. OPMS XXI will inevitably create a force better prepared to deal with the next crisis. The question that must be asked is how well prepared the force will be to deal with the crises of the next twenty years.

A LAST CHANCE

Senior Service College is the last opportunity for formal education. At the last educational stop of a career, senior officers prepare to deal with the most complex problems they will face during their service. For many of the students, their next several assignments will be their last. Consequently, they find themselves looking for focused instruction that will prepare them to finish their careers strongly. As the curriculum stands, the three terms provide a balance between requirements for breadth and depth of study. Term 1 consists of four required courses, representing the three departments. Terms 2 and 3 effectively integrate elective choices that permit students to focus on learning material that will help them in their next job or to diversify and prepare for the longer range future.

A pressing question for SSC is the distribution of slots with respect to OPMS XXI career fields. Historically, less than 5% of the seats in the Army War College class have been reserved for officers not managed by the Officer Personnel Management Division (non-OPMD).[26] If the SSCs are viewed as preparation for general officer leadership requirements, then a disproportionate share of seats should be awarded to Operations Career Field officers, as it appears likely that OCF will be that source of most general officers.[27] As with the non-OPMD officers there will continue to be a need to educate some non-OCF officers to provide the senior leadership in their career fields and functional areas.

The issue of universal Military Education Level One (MEL1) for all colonels poses additional problems. There are currently about 300 total slots per year for Army (active and reserve) at the various SSCs in residence. Non-resident programs provide another 300 slots. There is still a shortage of 250 slots per year. Given a constrained resource environment at the SSCs, meeting the requirement for 100 % MEL1 will require resort to innovative strategies. Development of distance education materials fits well with the concept of learning and education being lifetime pursuits.

RECOMMENDATIONS

The first area to address is undergraduate education. The core programs at the service academies should serve as models for breadth of education desired for all officer candidates. While ROTC programs may not be able to match the academies because of the depth requirements of majors at civilian institutions, ROTC candidates should be encouraged to maximize the breadth of their programs subject to the constraints of the school. Consistent with this recommendation, the service academies should maximize breadth consistent with the ability to offer accredited majors. Several actions are indicated.

As a first step, the Military Academy should standardize the engineering courses taken by all non-engineering majors. The courses required should cover the engineering science required to understand the principles of operation of Army systems projected for use over the next ten to fifteen years. There are six courses, five from the engineering sequence and one from computer science, to accomplish the purpose. If courses remain unused after this requirement, they should either be used to increase breadth of the core program in other areas or offered to the majors program. This prospect is unlikely given the current rate of technological change. The number of math and science areas that underpin effective use of Army-centric technologies has been expanding rapidly, not contracting.

The "futures documents" clearly identify the areas of primary interest. In the short term, it is clear that the science underlying information and communication technologies is a first priority. A first level mastery of computer science fundamentals is essential. All company-grade officers are likely to find themselves responsible for establishing and maintaining their own communications systems for both data and voice. A basic understanding of the science underlying radio systems and computer communications will insure that leaders are able to employ information systems effectively under the wide range of conditions they will encounter.

Electromagnetic wave principles dominate other areas of the battlefield as well. Stealth depends almost entirely on the denial of reflected electromagnetic energy to enemy collection systems. Similarly, many sensor systems depend on effective use of the electromagnetic spectrum to gain the maximum amount of information about opponents on the battlefield. Electromagnetic waves ranging from high frequency radio waves used to communicate with distant reconnaissance forces lacking satellite access to ultra-violet sensors for detecting missile launch are the single most pervasive aspect of the modern battlefield. Only a thorough understanding of this phenomenon will allow commanders at all levels to effectively employ smart weapons, communication systems and sensors.

The first attack on the growth of technology is to eliminate depth components of engineering courses and cover greater breadth in the basic and engineering sciences. As an example, consider the possibilities offered by LTC Lonnie Henley in a recent article in Parameters:

> In a relatively short time, 10 to 15 years, we could be well into a technological transformation even more profound than the information revolution that is the focus of current attention. This transformation will be based on the convergence of information processing, biological sciences, and advanced manufacturing techniques. The result will be radically different approaches in the application of physical force against an enemy, as well as in collection and processing of information.[28]

The requirement appears obvious: consider introducing some aspect of biological science into core curricula totally devoid of it presently. Note however that there is no reduction in the requirement to understand information sciences under the proposed scenario. Advanced manufacturing techniques may well depend on the properties of emerging materials. The core curricula found today also lack any required coverage of material sciences currently.

It should soon become apparent that at some point there will no longer be enough room to cover all the science, even if all engineering design is sacrificed. The efforts to cover all science will eventually become diluted themselves. The solution is to find methods that allow us to concentrate the curriculum on enabling learning over a longer period than the four years in which the students are resident in the academies.

The way to accomplish this formidable task is to focus efforts on the learning process. Admittedly, the learning process varies by subject. The skills needed to learn history or social sciences are not the same as those for learning math and physical sciences. Therefore, while teaching the baseline knowledge in math and the sciences, the scope of these courses must expand. The product is no longer just a student who has mastered a particular body of knowledge. In fact, that is secondary. The most important thing to take away from any course is the skills needed to continue learning in that particular discipline. This learning knowledge is part of the cognitive domain. A second and equally important aspect of learning occurs in the affective domain. Students must internalize the concept that learning is a lifetime endeavor.

One issue to be addressed is when officers should begin specializing their education. Admiral (Ret.) William A. Owens recommends acquainting "cadets and midshipmen with paradigms and systems found in other services."[29] He goes so far as to recommend establishing a rotation among the academies so students from one academy would spend their second and third years at the other two. Finally, he says, "Specialization in the mores, systems, and operational doctrine of a particular service will come with experience, and additional training."[30] At the opposite end of the spectrum is the USNA system of establishing both quotas for particular majors and a relationship between major and "branch" assignment. Under OPMS XXI, the Army directs that all officers will serve their initial assignments in the operational Army. Without earlier selection of branches or establishment of a link between major and branch, focusing on preparing officers for leadership in the Army as a whole is the best course of action.

The question of how to address other commissioning sources remains a problem. Unless the services are willing to place curricular requirements on students in other pre-commissioning educational programs, ROTC in particular, it will be difficult to bring all officers to similar levels of competence in the areas important to the services. Given declining ROTC enrollments without scholarships, placing additional restrictions on the programs of students is not a viable alternative. Most institutions do not require the breadth of study required in the core programs at the academies. Moreover, ROTC students, who have additional demands placed on their time, are usually not enrolled in math, science and engineering majors. It is suggested, therefore, that the programs of the service academies are doubly important. They may provide the only source of scientifically grounded officers in the future force.

Officers will have to take advantage of informal educational opportunities throughout their careers. As new technologies enter the battlefield environment, officers will take advantage of their education in the learning of science and technology, and pursue self-education. The rapidly increasing amount and quality of material available on line will facilitate this process. TRADOC should continue to expand their distance education efforts. CSC and SSC should take advantage of opportunities to update officers on science and technology consistent with the increasing focus of those schools enabled by OPMS XXI. As officers move from tactical to operational to strategic focus, their need for understanding of individual systems will diminish. They will continue to be responsible for directing the use of a system of systems. Thus science and technology education at the upper levels of military education should remain broad. Training on individual systems or components should be left to specialty training environments.

COUNTER-ARGUMENTS

There exist two, divergent, opposing points of view. The first would suggest that as technology improves, the user is freed from a requirement of understanding how, why and when it will work because of the ability to embed all such information in simple instructions regarding the use of the technology. The most rabid of those holding such a view claim that the basis for teaching engineering, be it at the science or the design level, has passed. The recommendation of such individuals is to slash engineering content from the core programs, clearing the way for additional humanities and social sciences. While the necessity for an understanding of how the nation arrives at war and how to avoid war is important, history has shown us that war is inevitable. The fog of war will inevitably present to every officer conditions that no technical manual could foresee. Without a foundation for understanding the capability of the systems employed, effective use of those systems will be forfeited.

A personal experience serves to highlight the dilemma this approach faces. In 1981 at Fort Lewis, WA, I ran a rifle qualification range. At the time, a relatively new component of qualification required firing ten rounds while wearing a protective mask. Many soldiers had trouble sighting in the normal way because the mask prevented them from taking the normal firing position and establishing the "stock weld." The battalion that I was in had arrived at their own adjustment. To enable good contact between the mask and the weapon, and still be able to sight, the soldier rotated the weapon ninety degrees. To my amazement, no one in the unit could figure out why all soldiers routinely shot low and to the left at all targets further away than fifty meters even with correctly zeroed weapons. In spite of the fact that most officers and all NCOs understood the procedure for zeroing the weapon, none apparently understood the basics of projectile motion sufficiently to understand that turning the weapon would change the resulting trajectory.

The second point of view holds that none of the basics are important. Simply learn the current technology. This method suffers on two counts. Understanding based on exploration of technology alone is superficial. Rarely will knowledge of the trick of the day, extend beyond the current day. Such knowledge is not easily extensible. The second failing of this method is that it fails to address the exponential growth of technologies. As the number of technologies grows exponentially, the duration of education bound to technology grows at the same rate, an intolerable characteristic.

CONCLUSION

"... themes of continuity emerge from this story. The first lies in the paradox that change itself is constant. Armed forces in the past have had to change their doctrine in order to respond to new technologies."[31] General Scales has it right but for one part, it is the presence of change that is constant, not the nature or speed of change. Past successes have relied on "schools that developed officers and noncommissioned officers by motivating them to pursue self-development, rewarding competence, and giving them the confidence to lead."[32] The acceleration of change requires refocusing efforts to both prepare and motivate officers for future learning and training. That focus will demand that removal of other content from the curricula. The knowledge learned today that will expire in five years, or that gained ten years from now that will expire ten minutes later, is the obvious choice for elimination. The truly difficult aspects are finding the material that will have enduring value and developing the ability to motivate self-study and enhance learning efficiency across a broad range of disciplines.

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ENDNOTES

[1] Alvin and Heidi Toffler, War and Anti-War Survival at the Dawn of the 21st Century, (Boston: Little, Brown and Company, 1993), 9.

[2] Ibid.

[3] Toffler, 64.

[4] William J. Clinton, A National Security Strategy for a New Century, (Washington, DC: The White House, 1998), 24.

[5] Clinton, 24.

[6] Clinton, 24-27.

[7] William J. Clinton, A National Security Strategy for a New Century, (Washington, DC: The White House, 1999), 12.

[8] John M. Shalikashvili, Joint Vision 2010 America's Military: Preparing for Tomorrow, (Washington: Department of Defense, 1996), 8.

[9] Dennis J. Reimer, Army Vision 2010, (Washington, DC: Department of the Army), reprinted in Course 1 Strategic Leadership: Selected Readings, Vol II. (Carlisle Barracks, PA: U.S. Army War College, 1999), 383-390.

[10] Ronald R. Fogelman and Sheila E. Widnall, Global Engagement: A Vision for the 21st Century. (Washington, DC: Department of the Air Force), reprinted in Course 1 Strategic Leadership: Selected Readings, Vol II, (Carlisle Barracks, PA: U.S. Army War College, 1999), 409.

[11] Hon. John H. Dalton, Admiral J.M. Boorda, and General Carl E. Mundy, Jr., Forward ...From the Sea Preparing the Naval Service for the 21st Century, (Washington, DC: Department of the Navy), reprinted in Course 1 Strategic Leadership: Selected Readings, Vol II. (Carlisle Barracks, PA: U.S. Army War College, 1999), 432-443.

[12] Dennis J. Reimer, Knowledge & Speed The Annual Report of the Army After Next Project, (Washington, DC: Department of the Army, 1997), 23-25.

[13] Robert H. Scales, Certain Victory, The U.S. Army in the Gulf War, reprinted in Course 3: Joint Processes and Landpower Development Student Readings and Assignments, (Carlisle Barracks, PA: U.S. Army War College, 1999), 29.

[14] Larry Downes and Chunka Mui, Unleashing the Killer App, (Boston, MA: Harvard Business School Press, 1998), 20-23.

[15] Daniel K. Apple and Karl Krumsieg, Process Education Teaching Institute Handbook, (Corvallis, OR: Pacific Crest Software, Inc., 1998), 51-57.

[16] Fletcher M. Lamkin, Jr., Educating Army Leaders for the 21st Century, (West Point, NY: United States Military Academy, 1998), 16-50.

[17] Note that educational criteria have failed in the past. The Final Report of the Army Science Board published in 1996 reported that ROTC failed to meet the goal of 35% science, math and engineering majors, achieving only 23%, p. 25.

[18] Lamkin, 7.

[19] Lamkin, 9.

[20] Lamkin, 10.

[21] Academic Program, AY1999-2000, (West Point, NY: United States Military Academy, 1999), 7-8.

[22] Lamkin, 10.

[23] Robert H. Shapiro, The Majors Program Class of 2000, ACDEANINST 1531.72, (Annapolis, MD: United States Naval Academy, 1997), 2; available from <http://www.nadn.navy.mil/AcDean/Majors/2000/00Program.pdf>; Internet; accessed 2 February 2000.

[24] While the number of courses in math, science and engineering is the same as at USMA, there is no requirement for a terrain analysis course, and the engineering requirements are distributed across a range of subjects more appropriate to the technologies of the 21st century.

[25] United States Air Force Academy, 1998 Curriculum Handbook, (Colorado Springs, CO, 1998), 63-65; available from <http://www.usafa.af.mil/dfr/dfrc/Handbook98.doc>; Internet; accessed 2 February 2000.

[26] US Army War College DCSOPS Working Group, "Framework for Senior Level Education (Military Education Level 1) Strategic Education Plan," draft briefing slides, Washington, DC, 11 Jan 99, 18.

[27] Timothy D. Harrod, Secretary, U.S. Army War College, interview by author, 2 March 2000, Carlisle Barracks, PA.

[28] Lonnie D. Henley, "The RMA After Next," Parameters, 29 (Winter 1999-2000): 47.

[29] William A. Owens, "Making the Joint Journey," Joint Force Quarterly, No. 21 (Spring 1999): 95.

[30] Ibid.

[31] Scales, 26.

[32] Scales, 30.

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