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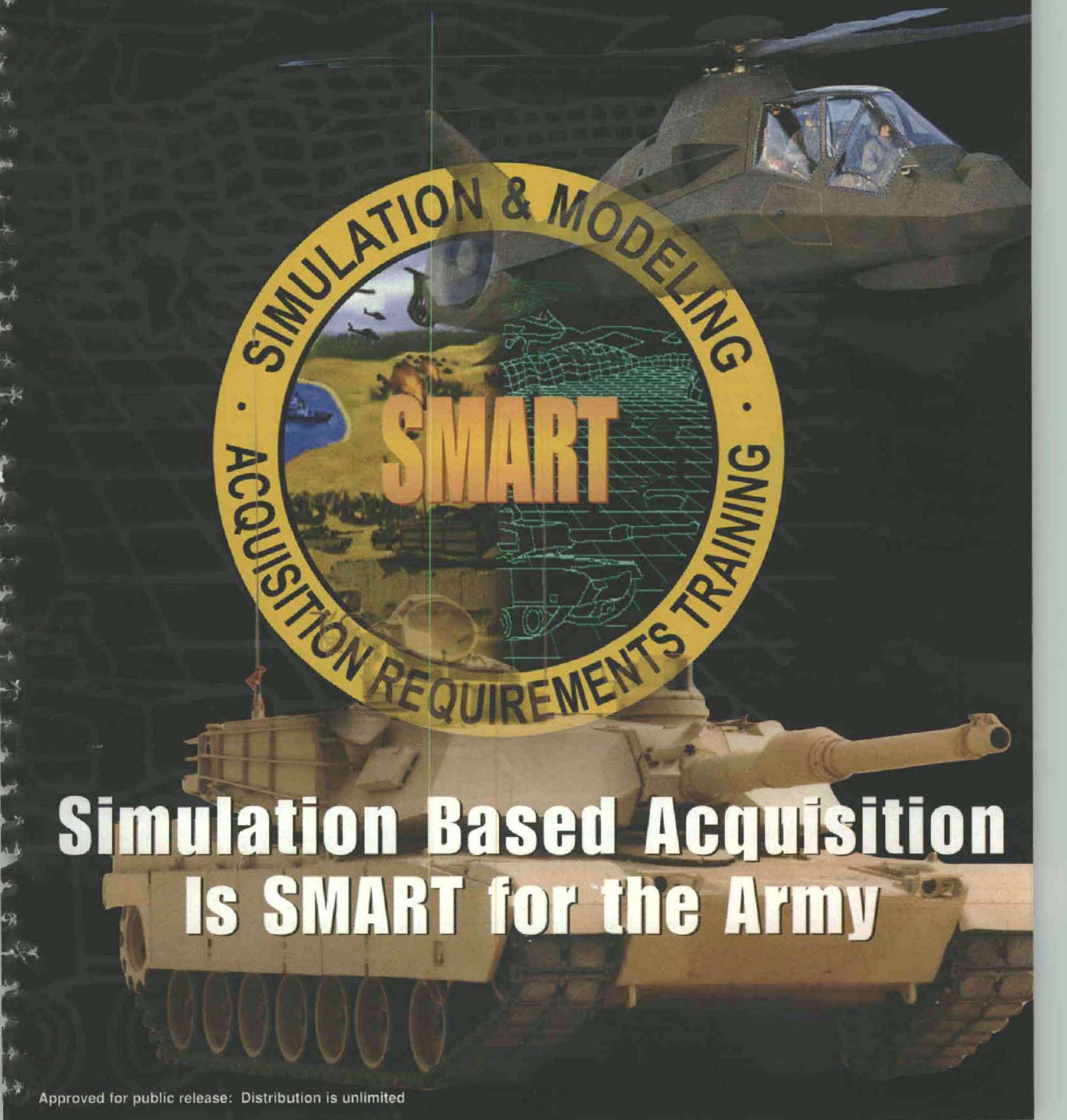
MAY–JUNE 1999



Simulation Based Acquisition Is SMART for the Army

FROM THE ARMY ACQUISITION EXECUTIVE

The Advantages Of 'SMART'

Imagine for a moment, a soldier in an urban environment wearing night vision goggles incorporating new technology that paints an image on the soldier's retina. As he looks around, the image changes. He realizes he is cut off from his unit and pinned down by a hidden sniper. He needs only 15 seconds of distraction to get away. Reaching down to a small unit strapped to his side, he punches a few keys and the unit emits a signal that is actually an audio decoy. The idea is to fool the sniper into thinking the soldier is somewhere else. Only it doesn't work. Or at least that is the feedback from the virtual reality simulation in which the soldier is participating.

This vignette is *one* example of how we in the acquisition community will use Simulation and Modeling for Acquisition, Requirements and Training (SMART) to give the 21st century soldier more protection, more relevant information, and more lethality than ever before. The capabilities we will gain in the next few years to simulate technology, scenarios, and environments will yield multiple benefits to our soldiers. Simulation also offers us the potential for substantial savings.

SMART is a strategy that uses simulation to evolve a weapon system from concept to design, to test, to production, to training, and ultimately to the field. Of course, we do these things now. We do them sequentially. What is different about SMART versus how we conduct these activities today is that aspects of each will be carried out simultaneously. Through modeling and simulation, we have a medium in which to ask tough questions early on and continuously. We will no longer rely *solely* on a hardware prototype to give us the information we need to make sound decisions. And, because we are not limited by hardware, our trade space will remain wide open. I don't mean just our design trade space, but also how we will develop doctrine for new or upgraded equipment and how we will train our soldiers to use that equipment.

SMART can be employed at the very beginning of the requirements process. Using simulation, we can, for example, explore the advantages that technology can deliver to a light infantry brigade. What pieces of equipment will be required? What will they do? In simulations, we are not bound by reality; therefore, we can propose capabilities that do not yet exist, model them, and then sit down and put the proposed equipment through its paces. From this, we can refine our requirements.

Once we know these requirements, we can create a virtual prototype that incorporates actual technological capabilities and, again using simulation, we can exercise the prototype to assess its performance and impact on the battlefield. If performance and impact on the battlefield are not adequate, we can make changes to the design when it's least expensive and still have at our disposal maximum opportunity for exploring other innovative solutions.

Simultaneously, while we are refining and designing our equipment to meet performance requirements, we can leverage many of the same simulations to develop the doctrine and tactics for employing the proposed piece of equipment as well as develop training techniques. Herein lies one of the most fundamental and powerful aspects of SMART. We are no longer bound by a linear process. Simulation can give us an "all-encompassing view" of the interrelated aspects of the proposed system. With simulation, we have the luxury to "build a little, test a little." That's what SMART will provide, the flexibility and the opportunity to explore all the attributes of the developing system. These attributes include not only the system's performance, but associated doctrine, producibility aspects, maintenance aspects, supportability, and training.

SMART is also important to our efforts to improve our ability to prove out and test designs and systems integration. At present, test design, planning, and rehearsal are limited because of the time and cost inherent in live test and evaluation. As weapon systems increase in cost and lethality, some attributes of systems are better tested in simulation because of affordability or safety issues.

Using modeling and simulation in accordance with our SMART vision gives Army program managers greater flexibility in managing cost, schedule, and performance. Cutting cycle time is hard to do, but it can be done. The "big three" automakers reduced from 5 years to 3 years the time needed to proceed from concept approval to production. In another example close to home, it took 38 Sikorsky drafters 6 months to come up with working drawings for the Super Stallion's outside contours. Using Computer Aided Design, it took one engineer 1 month to accomplish the same task for the Comanche helicopter. SMART will take this a step further. It will focus not only on cycle time, but on how the requirements are generated and how our soldiers can train on new or upgraded systems. This focused effort will help to drive costs down.

SMART is a concept that begins to harness the power of the digital information age. Through modeling and simulation, the Army community gains an "electronic agility" never before available to us. We can now visualize the effectiveness of a system as we write its requirements. The ultimate execution of SMART, as described in the vignette of the soldier and the audio decoy, offers the acquisition community an effective means of engaging the soldier directly in the acquisition process. Instead of learning lessons the hard way, on fatal battlegrounds like Mogadishu, the soldier in the vignette can develop insights into whether equipment designs need to be modified or changes in tactics are necessary, or both. The application of SMART will change our thinking, will certainly have a major impact on our future military capabilities, and will provide the means to field an Army After Next unmatched in capability.

Paul J. Hoeper

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DENNIS J. REIMER
General, United States Army Chief of Staff

Official:

Joel B. Hudson

JOEL B. HUDSON
Administrative Assistant to the Secretary of the Army
05815

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FEATURES

ABOUT THE COVER

Simulation and Modeling for Acquisition, Requirements and Training—commonly known as SMART—is an initiative to integrate modeling and simulation into the materiel acquisition process. The goals are to reduce the time required to field systems, reduce total ownership costs, and increase the military utility of fielded systems.

INTERVIEW WITH PAUL J. HOEPER ASSISTANT SECRETARY OF THE ARMY FOR ACQUISITION, LOGISTICS AND TECHNOLOGY AND ARMY ACQUISITION EXECUTIVE

Interviewed by Army RD&A Editor-in-Chief Harvey Bleicher

Army RD&A: **What would you like to accomplish during your tenure as the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT))?**

Hoeper: The key thing that every ASA(ALT) needs to accomplish is to provide soldiers the weapons and materials they need. As I noted in my swearing-in speech, our job is to supply the soldiers with what they need to get to the fight quickly, win decisively, and come back alive. I am serving as the ASA(ALT) during an interesting time, because as we transition to a different type of Army, we have new types of operational requirements. The way the Army operates now changes both our acquisition requirements and where we must fill the pipeline. This impacts our entire business process and our approach to doing business. In part, what I'd like to accomplish is to change those things in our business process that are required to meet future Army operational needs.

Army RD&A: **What qualifications do you bring to this position that you feel will be of greatest benefit in achieving your objectives?**

Hoeper: I believe that every executive must be able to manage and lead. In addition, DOD acquisition executives must understand DOD business processes because the acquisition business can be very difficult. My dad was in acquisition for the Air Force and I grew up hearing about acquisition around the dinner table. Actually, I've been interested in military acquisition all my life.

Army RD&A: **Having served in government, industry, and academia, do you think there is a common denominator for success regardless of where you are?**

Hoeper: Most successful people are probably successful because they combine different factors. However, I don't think there's any one formula that works for every person. I believe that an active mind is the most likely common denominator. My predecessor, Gilbert F. Decker, is a terrific guy with a very active mind, but somebody with completely different skills and experiences from mine; yet he is certainly very successful. I hope that I will be as successful in this position as Gil.

Army RD&A: **What priority do you place on career development programs for the Army Acquisition Corps?**

Hoeper: The decisions I make for the workforce are really the most important decisions I make as a manager. By assigning the right people to the right positions, managers actually determine how successful the future is going to be. In fact, one of our best ways to accomplish this is to develop the people who are currently in the system. We need to look at the available opportunities and make sure that the right people are placed in the right jobs because they will be here long after many of us are gone. I think that the most important decisions that any acquisition executive makes are human resource decisions—and career development is a big part of that.

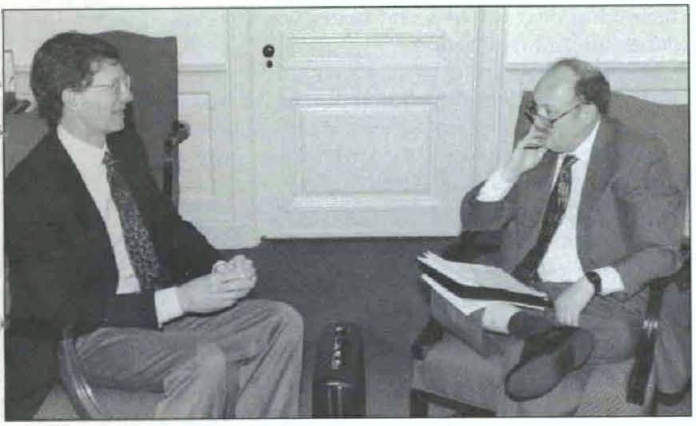
Army RD&A: **In view of the continuing DOD downsizing effort and, consequently, the shrinking pool of Defense contractors, what initiatives are necessary to promote competition and prevent materiel costs from skyrocketing?**

Hoeper: That's a tough question. I want to emphasize though, that most of our programs are not dependent on a single supplier. There is a lot of pretty good competition. We've had numerous economic studies and, empirically, these studies indicate that two independent competitors are adequate to achieve effective competition. We are in that situation right now.

A fairly short-term problem though is vertical integration. This is where one company buys other companies and the result is that one company makes a lot of the components and subcomponents of the finished product. In this scenario, some critical components, subsystems, or subcomponents may be produced as the result of inadequate competition. However, I do believe this is a very short-term problem and that most of the vertical integration will go away over time. But right now, we need to keep an eye on that situation.

Army RD&A: **So it's an issue that's been around for a while?**

Hoeper: Yes, although it's been tough recently because we have had so many big mergers. For example, one company might buy the only two suppliers of a particular type of photo-optical electrical component. We usually deal with this problem during the merger process. In fact, the Office of the Secretary of Defense (OSD) reviews mergers and sometimes concludes that they inhibit competition. OSD might then request the parent company to use particular techniques to maintain a competitive environment. There are mechanisms in place to ensure



competition, and I believe they are working well.

***Army RD&A:* Modernization through spares (MTS) is currently a very important initiative in the acquisition community. What is MTS and what do you believe it will do for the Army?**

Hoeper: I think it is one of the best ways to ensure that our current vehicles and components are compatible with the Army After Next. In other words, MTS allows us to modernize our current vehicles so that they work well with the vehicles we are going to buy in the future.

We are actually incorporating MTS concepts in planning for our future acquisitions. One of these concepts is called open architecture. It is where we try to keep the architecture of a system open so that "brain transplants" and other revisions can be made. In the past, this option was not available and technologies did not necessarily facilitate use of MTS. We still have a lot of equipment that may not lend itself to MTS. However, MTS is one of our key methods for keeping the force modern and keeping our current vehicles interoperable with the vehicles we plan to field between now and the Army After Next. We need to do more of it.

***Army RD&A:* The Army has a number of acquisition reform initiatives underway. Could you address those initiatives that you believe offer the greatest potential for improving the way the Army carries out its acquisition process?**

Hoeper: When I was in OSD, we looked at the various Services and compared them with each other. I had a lot of involvement with acquisition reform efforts when I served on the Acquisition Reform Task Force and the Defense Science Board. Years ago, when we initially began looking at acquisition reform, we believed the Army was far behind in its reform efforts. But during my last year in OSD, I realized that the Army had really leapfrogged over the other Services.

We have implemented acquisition reform efforts such as MTS and Value Engineering Change Proposals (VECPs) extremely well. In fact, we're getting a lot of value out of VECPs because of improvements to that program.

Additionally, a larger effort is Fast Track. The Fast Track involvement with the Future Scout Cavalry System (FSCS)/Tracer is a tremendous example of acquisition reform because it provides a much faster way to go from an S&T program to a fielded system. We can probably cut 4 years off the average acquisition cycle by using the Fast Track approach. For example, if the total effort for the FSCS/Tracer is 12 years, we could probably reduce it to 8 years by using the Fast Track approach. The Fast Track approach is really innovative. Another big Army acquisition reform effort is the Warfighting Rapid Acquisition Program (WRAP).

I want to emphasize that, in addition to the large acquisition reform efforts, there are numerous smaller efforts. People tend to look only at the big ones and assume that only someone of great genius can make a contribution. That's not the case.

The smaller efforts often result from average people just trying to do a little better everyday. If someone makes an 8 or 10 percent improvement in their work, and just keeps doing that every year, they make a lot of headway. As I noted in some of my speeches, Warren Buffett didn't become America's greatest investor by buying a lot of companies and hitting home runs in the stock market. He became America's greatest investor by consistently getting a little bit better return than everyone else.

I've highlighted a couple of our big acquisition reform efforts such as Fast Track and WRAP, but I think the smaller efforts are really going to pay off as well. Just because someone isn't involved with the bigger programs doesn't mean they still can't do something for acquisition reform; it's just a matter of figuring out how to do a job a little bit better this year than last year. That's how we'll get the most benefit for the Army and the Department of Defense.

***Army RD&A:* Some people contend that with former Secretary of Defense Perry's departure, the push for total and complete acquisition reform has subsided. What is your opinion?**

Hoeper: I was privileged to work with Secretary William J. Perry and his team—Paul G. Kaminski [former Under Secretary of Defense for Acquisition and Technology] and R. Noel Longuemare [former Principal Under Secretary of Defense for Acquisition and Technology]—and they were all great people who did great work. The current Under Secretary of Defense for Acquisition and Technology Dr. Jacques S. Gansler is also doing great work. I feel every bit as pushed by Dr. Gansler as I was by Kaminski and Longuemare. I really think that Dr. Gansler is going to make some important gains. He's trying to determine how our Defense Department can gain access to the total industrial base that's available, and he's using acquisition reform to help him achieve that goal.

***Army RD&A:* What are your thoughts on privatization and outsourcing?**

Hoeper: To get the best systems for our soldiers, and the best Army for America, we must use whatever organization is most capable of providing what we need. At times that's going to be a private company, and at other times, depending on the requirements, it will be a government organization.

***Army RD&A:* How would you assess the quality of personnel in the Army Acquisition Workforce?**

Hoeper: I think it's fabulous. The people I work with directly are top-flight thinkers and managers; they are altruistic and provide an extraordinary value to America. Additionally, the people I meet in the field, who I don't work with daily, have many of these same qualities. I think this is the result of the great leadership in the Army that permeates our acquisition community. I can tell you with all sincerity, I think this is a great organization.

You can go anywhere—to the PEOs, to the commands, or to Europe, and you will see top-flight people who are thoughtful, diligent, and creative.

When you get into these senior-level positions, particularly as the Army Acquisition Executive, no one ever comes to you with a lot of good-news stories. All the easy things are solved by the people below you. By the time something gets to my office, it's a big problem. It can be very frustrating to work on that problem, but the quality of the people I work with certainly makes my job much easier.

***Army RD&A:* You recently stated that maximizing operational capabilities in the digital battlespace is one of your highest priorities. How do you plan to achieve this, and how is the Army's overall plan for digitization progressing?**

Hoeper: Of course, it's not necessarily my priority because I take my lead from the Army Chief of Staff. The Chief says this is what the Army needs, and my job is to provide the equipment to make that happen.

There are some interesting changes to maximize our operational capabilities. We used to view equipment in terms of platforms, and talk about one platform in relation to another. In other words, we'd talk about a tank in relation to another tank and maybe an attack helicopter in relation to an opposing attack helicopter. It was a very platform-based approach and we used a platform-based acquisition strategy (this tank's getting old so go look for the next tank, or this helicopter's getting old so replace its platform).

We're now moving to a more capabilities-based approach where we look across all the platforms and say, "Here's the capability we want in the battle space. How does our whole system of platforms and our whole system of communication systems create that capability?" That's what digitization is really about. It's somewhat new but, for the first time, we're looking at capabilities that are provided by the interrelationships among the systems. We're basically doing that by working with, or through, the Army Experimental Campaign Plan and then saying here's what we can use from this system and this experiment. I think we're going to have a chance to go even further with that.

This issue of *Army RD&A* is largely devoted to Simulation and Modeling for Acquisition, Requirements and Training (SMART). SMART allows us to integrate many concepts simultaneously and explore requirements concurrently with system design, technology insertion, logistics, training, and so on. Basically, we say, "Here's what we think we want. Let's simulate it, and then let's start using it." We can explore the implications of using our systems in tandem with one another to accomplish a mission without actually exercising all the live systems at a training center. Because we conduct these assessments virtually, we can explore thousands of scenarios by changing the attributes of our existing and future systems. We may discover new ways to incorporate Second Generation Forward Looking Infrared across our aircraft, artillery, and armor system platforms to increase operational effectiveness. Using SMART, we can afford to gather all the data needed to discover new and better ways to exploit technological capability and digitization.

I believe we're going to have to do more of that type of thinking in a process we call spiral development. In fact, I think this process will prove that some of our weapon systems may have multiple applications. For example, at times we purchase an item for a specific purpose but later realize that it has other uses. Furthermore, we may find the purchased item is more valuable for the other uses than for what it was originally intended. I believe we're going to find that out with some of our weapon systems. We still have difficulty thinking about a system of systems because we're so used to thinking about one platform versus another platform.

***Army RD&A:* A number of years ago, a criticism of the Army's acquisition process was that when we developed something, we tried to make it do everything for everybody. But it now sounds like a good idea.**

Hoeper: It is a good idea. Granted, we don't quite know how to do it well yet. We talked earlier about 12-year acquisition cycles. At the beginning of that cycle, we establish some requirements, then award a contract to meet those requirements. What are these requirements based on? They are based on some perceived threat or operational scenario 12 to 15 years in the future. How accurate are our perceptions looking 12 years into the future? Because of this uncertainty, we're trying to develop an approach that allows us to both change what we build and to evolve the requirements over time.

Not too long ago, we actually built equipment that had obsolete parts before it was even fielded, mostly because of computer chips. For example, we designed in a chip, but the contractor stopped making it because newer chips had more capability, and people wanted more capability. However, we already had the older chip designed into our equipment. We have gotten a lot smarter about that.

We are now using open architecture so we can change those chips as newer ones become available. We've already done some of this with the Comanche.

***Army RD&A:* What advice would you offer to someone considering a career in Army acquisition?**

Hoeper: If someone has the ability, then Army acquisition is a good career move for a number of reasons. I've worked in both private industry and in government, and I can tell you that the government has excellent training opportunities. In fact, the folks we train are highly valued both within and outside the Army. We pick good people, train them well, and provide them opportunities to learn and grow in their jobs. From what I've seen, there are more opportunities in the Army than there are in the acquisition industry as a whole.

So if you're a young person coming into the Army acquisition field, you're going to get great opportunities and tremendous formal and informal training. We all know the importance of formal training, but how much of what you know was learned through informal training from your peers and co-workers?

All my life I've said that I wanted to work with smart people. That's one of the reasons why I sought this job and why I'm happy to have it—I get to work with so many smart people. Furthermore, everyone in the Acquisition Workforce gets to do that. These people are really sharp.

***Army RD&A:* Is there anything else that you would like to address?**

Hoeper: Yes there is. Like my associates, I find Army acquisition an exciting and challenging field. LTG Paul J. Kern, my Military Deputy and the Director of the Army Acquisition Corps, who is very involved in acquisition, has expressed similar views. In addition, Keith Charles, the Deputy Assistant Secretary of the Army for Plans, Programs and Policy, tells me that working in Army acquisition is the most gratifying experience of his career.

SIMULATION BASED ACQUISITION IS SMART FOR THE ARMY

LTG Paul J. Kern and

Ellen M. Purdy

Introduction

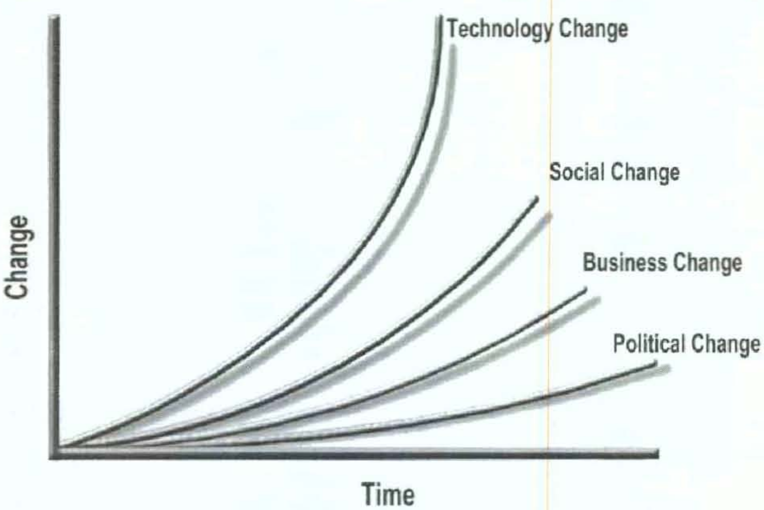
Earlier this year, the Office of Assessment and Evaluation, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology) hosted the second annual Simulation Based Acquisition (SBA) Symposium. The conference was billed as the Simulation and Modeling for Acquisition, Requirements and Training (SMART) Conference because for the Army, SBA is SMART.

SBA is an Office of the Secretary of Defense (OSD) initiative to reform the acquisition process so that the acquisition community uses modeling and simulation (M&S) robustly throughout the acquisition life cycle. The goals of SBA are to reduce the time to field systems, reduce total ownership costs, and increase the military utility of fielded systems. These goals are of primary concern to the Army, but we recognize that we cannot achieve them through the efforts of the acquisition community alone. It requires the combined, integrated efforts of the Acquisition Workforce along with the requirements and training communities, hence the name SMART.

SMART

SBA and SMART involve more than just the use of M&S in an acquisition program. SMART, as a concept, recognizes that several influential forces are continuously acting to shape how we conduct the business of acquisition. The first shaping force is the influence of the Digital Information Age. With the ever-expanding Internet and spinoff technologies such as electronic commerce, we are moving into an environment where more and more of our interactions are conducted by exchanging electrons.

The second force is the recognition that technology is evolving at a greater rate than ever and, because of the Digital Information Age, is available to larger segments of the global population. The third force is the continued "pinch" in the Defense budget. Although the economy is doing well, federal budget surpluses are earmarked for expenditures other than Defense, which means we need to modernize with the goal of reducing total ownership costs. When looking at these forces, we immediately recognize that an additional strain is the varying rates of change brought about by these forces (Figure 1). Typically, business, social, and political processes change incrementally, but technology in the last several years has changed at an exponential rate and will continue changing exponentially for the foreseeable future. Admittedly, this is a difficult environment in which to work, but by employing the SMART concept, we can harness these forces and put them to work for us.



Social, Political and Economic Systems Change Incrementally, but Technology Changes Exponentially!

From the book "Unleashing the Killer App" by Larry Downes/Chunka Mui

Figure 1.

Digital Information Technology

The Digital Information Age, which is characterized by the exchange of digital information over digital networks, will likely have a profound impact on how the Acquisition Workforce is organized in the future. One can project that organizations will evolve from focused weapon-system or mission-area acquisition programs and research, development and engineering centers (RDECs) to entities where individuals participate in integrated digital enterprises that are based on acquisition events. Currently existing "rice bowls" and "stovepipes" will become so integrated that organizational boundaries will blur and serve only administrative needs rather than facilitating the execution of specific acquisition missions.

The "operational concept" used to conduct acquisition will inevitably be shaped by the digital exchange of information. Operations traditionally conducted via the "waterfall" approach will become more iterative because digital information technology provides the means of simultaneously assimilating massive amounts of information. It is a fact of physiology that the human brain cannot integrate more than seven to nine concepts simultaneously. With information technology, the ability to integrate disparate concepts becomes nearly limitless. Collaboration among users, developers, trainers, logisticians, costers, etc., can occur continuously and concurrently.

Technology Opportunities And Budget Constraints

To address acquisition issues in a collaborative and concurrent manner takes on new significance when one considers the pace of technological development and the continued restrictions placed on the Defense budget. At first glance, it would seem the two are mutually exclusive. Without the budget, we cannot take advantage of technological innovation. Fortunately, that is not the case if we think SMART.

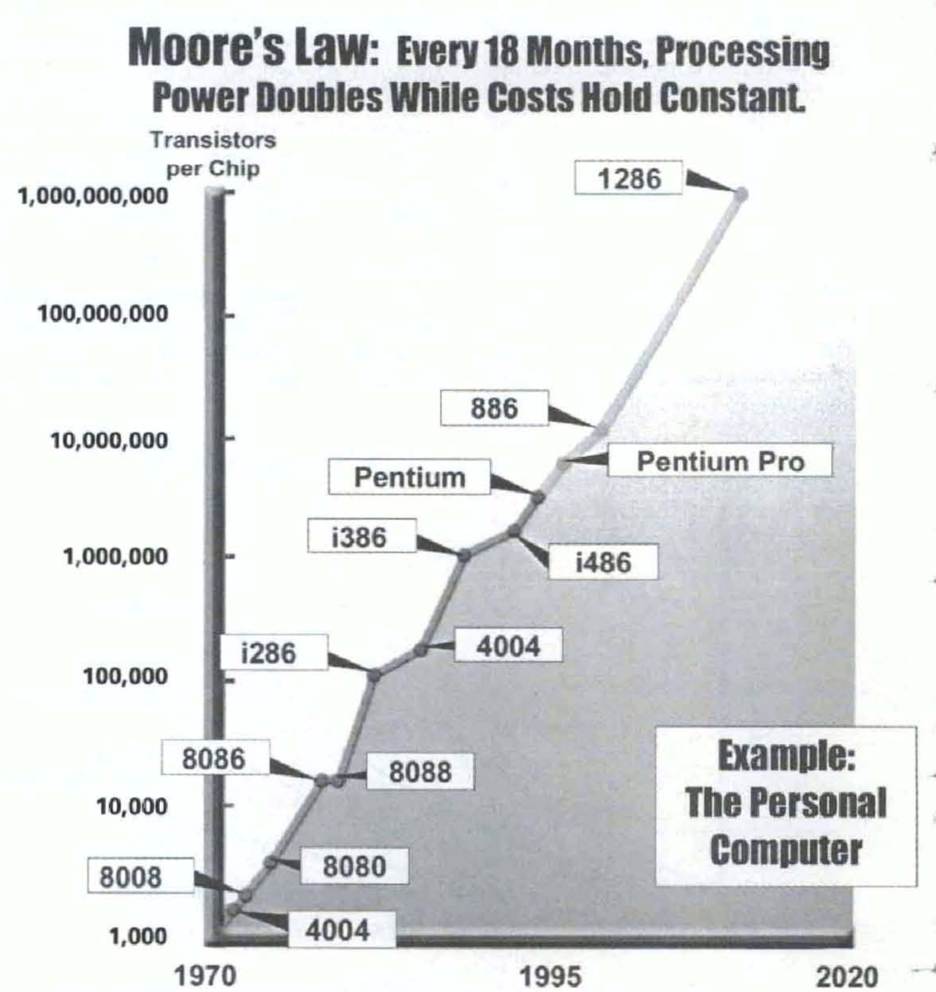
Models and simulations are very much products of the Digital Information Age. They provide us the very means needed to rapidly iterate through the various acquisition functions simultaneously. Instead of evolving a concept; creating a design to execute the concept; testing the design; creating the tactics, techniques, and procedures; and then training our soldiers on the manufactured equipment; M&S allows these activities to occur simultaneously through virtual prototypes. This significantly shortens the time required to conceive, build, test, and field a system.

Shortened acquisition time is key. We no longer have the luxury of the traditional 8 to 15 years needed to field a system. The Army After Next (AAN) is based on an overmatch capability. Maintaining overmatch becomes increasingly difficult in the face of rapidly changing technology. Moore's Law states that processing power doubles every 18 months, while costs remain constant (Figure 2). Overmatch capability depends on information dominance, which depends on information technology, which depends on processing capacity. Processing power is cheap and widely available, which means the opposition has access to the same "raw" technology. If we want to maintain our edge, we have to be SMART.

SMART Technology Leveraging

How does thinking SMART and being SMART allow us to leverage technological innovation within constrained budgets? It enables the user, developer, and trainer to collaborate by assimilating data digitally through M&S. All three communities become involved in all facets of the acquisition life cycle from the time a materiel solution to a needed capability is determined until the fielded system is retired.

Instead of building and testing in hardware, much of the acquisition effort is executed virtually. It is easier and quicker to make changes to electrons than it is to make changes to atoms. Virtual prototypes allow thousands of design iterations at little expense. Not only can we conduct our design and engineering in a more robust manner, but system stakeholders who traditionally have had little impact on the developing design now have tremendous influence. Logisticians, production engineers, and trainers, who were often the first to be traded against performance, have the opportunity to "weigh in" with proposed design attributes long before the first physical prototype is built.



From the book "Unleashing the Killer App" by Larry Downes/Chunka Mui

Figure 2.

We can afford to take a more iterative approach, allowing the requirements to evolve as the system evolves. Instead of overly specifying our requirements, we can "build a little, test a little, learn an awful lot." Such an approach keeps our performance-cost trade space at a maximum and allows for the adaptation of technological advances. What ideally results in the end is a fielded system in which all attributes, such as performance, cost, supportability, producibility, operability, and training, have been optimized. This applies not only to our new systems but to our legacy systems as well. If we look at AAN, it is highly likely that, in our constrained budget environment, probably 70 percent of AAN equipment exists in the field today. For AAN, existing systems will need upgrading, but very few brand new pieces of equipment will be added to the inventory.

For program managers building future systems and upgrading existing systems, adopting a SMART approach likely means a change in acquisition strategy and the program baseline. This is a painful prospect, no doubt. When viewed across the entire life cycle of the system, however, the upfront investment in the appropriate M&S tools will result in significant returns in terms of cost avoidance, greater military utility, and lower support costs. An additional significant benefit is a "leave behind" capability to efficiently and effectively identify the design changes needed to upgrade our systems in the future.

More Than A Vision

What is encouraging for the Army is that SMART is moving beyond simply a vision and is beginning to be executed in our acquisition programs, RDECs, battle labs, etc. Included in this issue of *Army RD&A* magazine are articles by the Product Manager for the Comanche Crew Support System, from the Army Materiel Systems Analysis Activity, the Test and Evaluation Command, and others. Each of these activities and many others throughout the Army are leveraging M&S technologies to collaborate and collectively work issues that traditionally were addressed in stovepipes. Also included in this issue is an article by Dr. Patricia Sanders, the DOD Director for Test, Systems Engineering and Evaluation, in which she discusses the steps OSD is taking to institutionalize SBA throughout DOD. Walter Hollis, Deputy Under Secretary of the Army (Operations Research) has provided an article that outlines suggestions for modifying current Army practices to transition use of simulation to a more robust, collaborative process that allows us to capitalize on the advantages of SBA. Adding industry perspectives are articles by Arthur Anderson, Senior Manager for Vehicle Architecture and Packaging, Advance Product Creation, DaimlerChrysler Corp.; and Bran Ferren, President, Research and Development and Creative Technology, Walt Disney Imagineering. Ferren is a member of the Army Science Board and has provided some thought-provoking suggestions for how the Army can capitalize on simulation technology. His comments are worthy of serious consideration given Disney's experience in leveraging M&S technology for their research and development when faced with a corporate policy that insists on returns on investment in the double- and triple-digit range.

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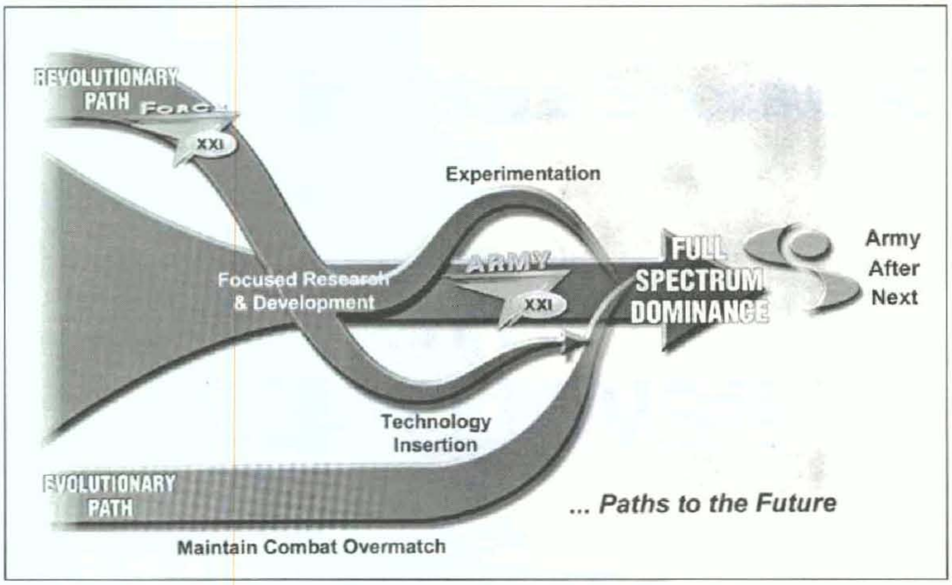


Figure 3.

Conclusion

When thinking about how to achieve AAN, we tend to think in terms of digitizing the force. What that digitization is really doing is integrating the force (Figure 3). We've already determined we need to operate in a system of systems, combined arms environment to be effective. Now we need to do the same for how we operate in our acquisition endeavors. M&S is the means for digitizing our acquisition activities and thus integrating our activities.

LTG PAUL J. KERN is the Military Deputy to the Assistant Secretary of the Army (Acquisition, Logistics and Technology), and Director, Army Acquisition Corps. He also serves as the Director, Acquisition Career Management.

ELLEN M. PURDY is a Senior Operations Research Analyst in the Office of Assessment and Evaluation, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology). She holds an M.S. degree in engineering management from The George Washington University and a B.S. in chemical engineering from the University of South Florida.

Simulation Based Acquisition:

THE REVOLUTION IS COMING!

Dr. Patricia Sanders

Introduction

The American Revolution ended Oct. 17, 1781, when British General Lord Charles Cornwallis surrendered his Army at Yorktown, VA. Thus began the new republic, breaking from past traditions. The rebellious colonials achieved victory against a military force superior in training, equipment, and manpower. Most historians credit the American victory to a combination of innovative tactics, willpower, and the aid of outside interests. The enduring revolutionary form of government of the United States of America is a unique and unqualified success.

Revolutionary change in our Defense acquisition process is essential. Our systems continue to cost too much, take too long to develop, and—once fielded—often require immediate upgrading of obsolescent technology. But revolutions take time, effort, and money; and a successful revolution requires dedication and commitment at the individual level, as well as innovation, willpower, and dedication at the organizational level. Making precisely that point while addressing the Army's Simulation and Modeling for Acquisition, Requirements and Training (SMART) Conference on Jan. 28, 1999, BG Joseph Yakovac, Assistant Deputy for Systems Management and Horizontal Technology Integration, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology), said: "To make a revolution a reality requires an entrepreneurial spirit." This also applies to Simulation Based Acquisition (SBA). Like the willpower that drove the American Revolution, SBA can succeed in revolutionizing acquisition only if we have the desire and perseverance to make it happen.

Vision

We have a constant vision driving SBA. This vision was carefully crafted and approved in September 1997 by the DOD Executive Committee on Modeling and Simulation Acquisition Council with input from an industry steering group operating under the auspices of the National Defense Industrial Association. The vision is as follows:

> *An acquisition process in which DOD and industry are enabled by robust, collaborative use of simulation technology that is integrated across acquisition phases and programs.*

Goals And Strategy

SBA is a strategy for change deliberately intended to satisfy three goals:

• Substantially reduce time, resources, and risk associated with the entire acquisition process;

• Increase quality, military worth, and supportability of fielded systems while reducing their operating and sustaining costs throughout the total life cycle; and

• Enable Integrated Product and Process Development (IPPD) across the entire acquisition life cycle.

The SBA strategy is driven by our belief that it is compelling that we meet these goals, that the effectiveness of modeling and simulation (M&S) applied to acquisition has already been proven, and that the technology is rapidly evolving to enable the requirements of this strategy.

The first two goals will result from the achievement of the third. IPPD evolved in industry as an outgrowth of efforts such as concurrent engineering to improve customer satisfaction and competitiveness in a global economy. But DOD has not reaped the full benefits of IPPD because we do not have the tools to allow respective users to "touch and feel" the item until a physical prototype is built. SBA enables IPPD by providing a collaborative, virtual context for system development. The underlying key technology is the computer, which provides a dimension described by Assistant Secretary of the Army for Acquisition, Logistics and Technology Paul J. Hoeper as "electronic agility."

This electronic agility is the enabling cornerstone of SBA, providing the following:

• Concurrent consideration. As early designs take shape, concurrent consideration by the different functional areas to analyze the design in terms of training, force lethality, deployment, maintenance, man-machine interface, manufacturing processes, materials, environment, etc.

• Rapid iteration. Because of the capabilities of simulation and computer technology, iterations of design trades can occur quickly and extensive evaluation of the trade space can occur before decisions are made. This is the power of electronic agility.

• Robust assessment. The design trades include operational performance across a wide spectrum of scenarios, human interfaces, system-to-system interfaces, life-cycle sustainment, production materials, manufacturing processes, cost, etc.

• Synthetic environment testing. The system is virtually "wrung out" in the computer before time and money are spent on physical prototypes. Hoeper has stated, "Whenever possible, we must reduce the need for costly, repetitive live testing."

Simply stated, when physical

prototypes are built, SBA will provide better form, fit, and function the first time without expensive rework. As Dr. Jacques Gansler, Under Secretary of Defense (Acquisition and Technology), said of SBA in the Feb. 1, 1999, issue of *Defense News*: [it] "gives you the ability to make lots of tradeoffs in cost and performance, early-on." Increased use of M&S by the U.S. commercial automotive industry, by the aerospace industry, and in Defense programs has produced dramatic results.

Roadmap

During the past year, DOD has developed a "Roadmap" for SBA—a list of recommendations for policy, education, technology development, and architecture designs for establishing SBA. The task force that drafted the document consisted of representatives from the military departments and Defense agencies. In addition, an industry steering group participated to identify the top priorities for SBA planning.

The Roadmap is undergoing extensive coordination within government and industry. Currently, a draft "strawman" implementation plan is used to assign responsibility and prioritize activities to establish SBA. The Roadmap and the draft strawman implementation plan do not contain all the answers. In fact, the precise templates and standards to implement SBA are evolving. We plan to have a series of preliminary and then follow-on SBA experiments to "build-a-little, test-a-little" to arrive at a common set of designs for SBA to be used throughout industry and DOD.

The essence of SBA is not limited to the technical environment, but includes the following:

• The technical engineering environment exploiting the power of computer and simulation technology;

• A reborn acquisition culture of new policy and regulation, direction, education, priority, and funding to take advantage of SBA; and

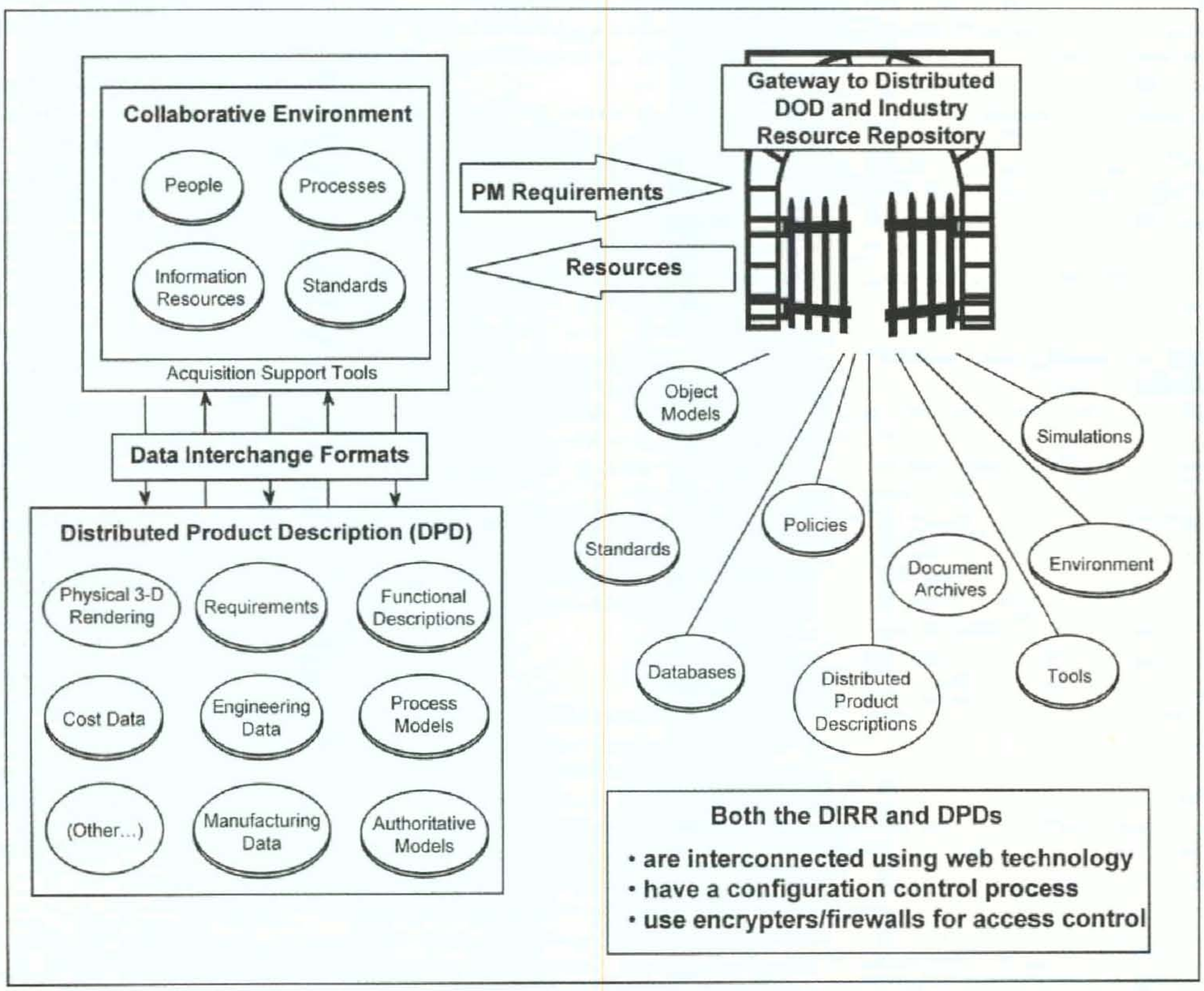
• A new process bringing together the separate system development functional areas of government and industry into a seamless, smoothly linked, and rapidly operating team.

The technical architecture in the Roadmap identifies the following basic features of SBA: collaborative environments (CEs), distributed product descriptions (DPDs), a DOD and Industry Resource Repository (DIRR), and standards. A brief discussion of these features follows.

Collaborative Environment

A CE is an enduring collection of resources, people, processes, and tools assembled to attack a given problem. Basically, a CE exploits information technology to permit people to work together and share common information, models, simulations, and data in real time.

CEs are designed to create groupings of tools, people, and processes to foster reuse and interoperability. The intent is



SBA reference systems architecture

to be able to work across functional areas, across acquisition phases, and across programs.

Distributed Product Description

The simple definition of DPD is a 3-D representation of a system that combines data and other characteristics associated with a given product and its inherent interrelationships to its environment. This includes associated process data (e.g., system function, requirements, manufacturing processes, and cost data) and features such as user selectable views.

The DPD, which is the responsibility of the project/program manager (PM), is the authoritative collection of program information. Users could view the DPD as a one-stop shopping center for any information about a product. The DPD will include one or more system representations for others to use as they "play" the system in their simulations.

Interconnected via web technology, the DPD elements appear (to the user) to be a single, logically unified product representation. As a product develops during initial stages, the DPD associated with the product matures in parallel with it. These product representations within the DPD will enable IPPD and integrated product teams (IPTs). When provided the appropriate automated support tools and schema, the IPT members will have access to and work with the same information resident in the DPD.

DOD And Industry Resource Repository

The DIRR is intended to be a collection of pointers in a web-technology-based, distributed repository of DPDs, tools, information, and generic infrastructure components for use within and reuse across programs—the union of capabilities provided by all CEs. The DIRR could be viewed as a card catalog. This virtual repository will be built on the existing Modeling and Simulation Resource Repository developed by the Defense M&S Office.

Standards

Certain formats are essential for interchange of information and interoperability. The Roadmap recognizes the need to establish an essential set of standards for M&S interoperability and reuse. The M&S community will need to develop a set of appropriate data interchange formats to support the interchange and flow of product information. The relationship among the key SBA architectural components is shown in the accompanying chart.

Service initiatives are underway to significantly improve SBA processes and understanding. Specifically, the Army has identified four "Flagship" programs for special attention and SMART application. They are the Crusader, Apache upgrade, Future Scout Cavalry System, and the Close Combat Tactical Trainer.

Program Assessment

The following questions can be used by individuals to assess progress in applying SBA principles to their programs:

- Does the M&S plan address the full system life cycle, with reuse across phases?
- Does the M&S funding profile support the M&S strategy?
- Does the acquisition strategy call for a DPD?
- Does the acquisition strategy place the DPD in the Modeling and Simulation Resource Repository?
- Is the program a part of any CEs?
- What M&S is leveraged from other programs?
- Does the program leverage High-Level Architecture and other standards?
- Is interoperability outside the program a priority?
- Is testing and evaluation integrated with the M&S strategy?
- Has the program formed government/industry IPTs, including one for M&S? Are IPT members empowered to make decisions to take advantage of SBA technology?
- Are incentives identified for industry to assist in, or develop, necessary products and services to support SBA implementation?
- Does the acquisition strategy call for sharing M&S with industry (via IPPD) beginning as early as source selection and continuing thoughout the program's life?

Conclusion

We have the constant SBA vision, the architectural concept announced in the Roadmap, the developing implementation plan, and an emerging set of experiments to refine the concepts. We are preparing the appropriate educational and regulatory changes. The military Services are beginning to move ahead in their programs, and we have identified several necessary actions, ranging from leadership commitment to technology development. In addition, we have assembled a list of questions to assess progress toward SBA. Have we covered all the bases? Remember BG Yakovac's basic requirement for a revolution? Entrepreneurial spirit is essential.

I challenge you to look for opportunities to apply SBA, communicate your interest, devise new methods, bring in outside interests, and strive to break from past traditions. The SBA Revolution is coming. Are you ready to be one of the revolutionaries?

DR. PATRICIA SANDERS is the DOD Director, Test, Systems Engineering and Evaluation. She is responsible for ensuring the effective integration of all engineering disciplines into the system acquisition process, and for oversight of DOD's Major Range and Test Facility Base and the development of test resources such as instrumentation, targets, and other threat simulators. She chairs the Defense Test and Training Steering Group, the Systems Engineering Steering Group, and the Acquisition Council on Modeling and Simulation. Backed by more than 24 years of DOD experience in test and evaluation, modeling and simulation, resource allocation, and strategic planning, Sanders is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA). She was awarded the 1998 AIAA DeFlorez Award for Modeling and Simulation in recognition of inspiration and relentless advocacy in implementing the disciplined use of modeling and simulation in the DOD weapon systems acquisition process. She has a doctorate in mathematics from Wayne State University and is a graduate of the Senior Executive Fellow Program at the John F. Kennedy School of Government, Harvard University.

SIMULATION BASED ACQUISITION: CAN WE STAY THE COURSE?

Walter W. Hollis
(with Anne Patenaude)

Introduction

Simulation Based Acquisition (SBA) is an Office of the Secretary of Defense initiative to promote the collaborative use of simulation in the acquisition process. The goal of this initiative is to reduce the time, resources, and risk involved in acquisition. The Army has extended that strategy to include the requirements and training communities in a concept called Simulation and Modeling for Acquisition, Requirements and Training (SMART). I am concerned that the current direction of SBA activities in DOD represents a new program start for the acquisition community, an impression that tends to distance the functional communities and program managers (PMs) who are using simulation well.

Many in these communities are already using simulation to accomplish their diverse missions and do not see the immediate connection between this extension of the SBA Program and what they do in their daily activities. More important, many PMs already use simulation to support their acquisition strategy. What we need is not a new start, but a means for PMs and functional communities to achieve collaboration. The required step, beyond the current application of modeling and simulation (M&S) in the acquisition of a weapon system, is to develop simulation technologies for more than one function (e.g., training or testing) or for multiple acquisition programs. Proper implementation of SBA requires a coordinated effort from each functional discipline and M&S domain.

In this article, I discuss why I feel SBA does not require a new-start level of effort and/or funding and offer suggestions for modifying our current practices to capitalize on the advantages of SBA. I make these recommendations to you, couched in the terms of our current acquisition process, and offer suggestions for policies and processes to increase SBA benefits.

Proper implementation of simulation based acquisition requires a coordinated effort from each functional discipline and modeling and simulation domain.

Benefits

The benefits of SBA and simulation technologies are easily recognized in concept exploration. For many years, simulation supported the concept exploration phase as a means of experimenting. The Combat Development Experimentation Center (CDEC) at Fort Ord, CA, designed experiments in which troops participated in concept design. These experiments were used to examine the effectiveness of new concepts and to develop tactics and techniques to improve the effectiveness of current systems. Although some of these concepts were poorly embodied with other hardware, the simulation experiments provided a means to explore tactics and techniques with competing equipment designs. Some of these designs eventually became prototypes such as helicopter-mounted missiles. In fact, this effort was the basis for deploying UH-1 helicopters with mounted Tube-launched, Optically tracked, Wire-guided (TOW) missiles to Vietnam.

Virtual Prototypes

The SBA strategy enables the extension of the CDEC experimental design concept in a computer. Concepts under evaluation can now be examined in a series of hundreds of quick experimental runs. The computer-simulated experiments can then provide a basis for deciding which concepts should be adopted as a virtual prototype, rather than actually developing hardware prototypes as was done in the past. Once we have a basis for computer experiments, we can create numerous options to run many experiments, in many environments, overnight if we like. This offers a tremendous opportunity to explore and analyze alternatives.

When we gather information from these simulation experiments and narrow requirements, we will have the seeds for new tools relative to the new hardware, which, if properly tended, will provide an engineering level of detail. Simple simulations can then be used to formulate a basis for a Cost As an Independent Variable (CAIV) analysis

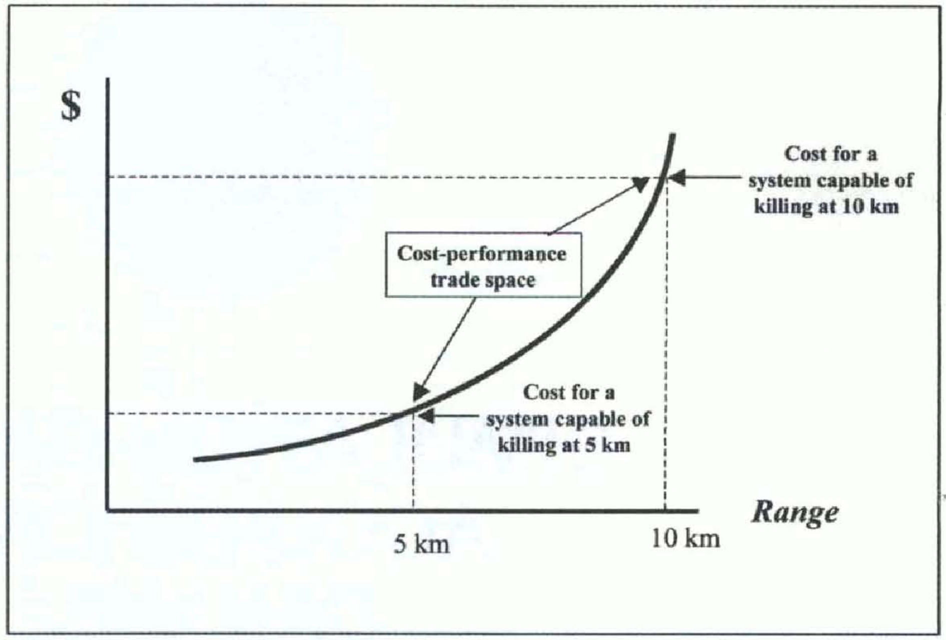


Figure 1.
Hypothetical cost-performance trade space for direct fire system

to arrive at requirements supporting the most cost-effective solution.

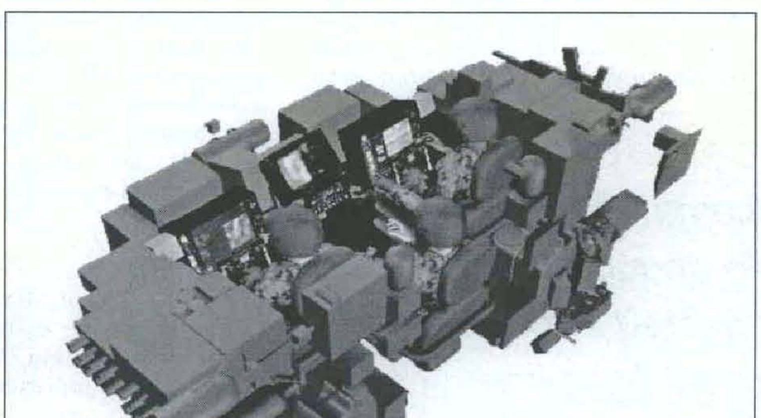
Performance Versus Cost

One of the concerns we have in the acquisition community is resolving system requirements when the design to meet performance requirements is not feasible in terms of cost, performance, or schedule. To state it more accurately, how do we determine the most cost-effective requirements? In our current system, the combat developer determines the requirements and produces an Operational Requirements Document that dictates what the materiel developer must produce. There would be a tremendous benefit to the PM and the combat developer if a crude cost-performance trade-off could provide information during the requirements evaluation in concept exploration. This would enable better concept evaluation by the developer and an ability to include life-cycle cost.

For this cost-performance trade-off to occur, our acquisition process must incorporate an early partnership between combat and materiel developers. This does not exist today. Under our current system, a combat developer (the ultimate user of a combat system) states that the requirement for a new weapon system is to "kill" at 10 kilometers (Figure 1). Clearly, from the user's perspective, the capability to kill at 10 kilometers is very desirable. However, the user has no real appreciation for what this capability will cost and how it will translate into combat effectiveness. The user can only make an informed requirement decision after the materiel developer defines the cost-performance curve and evaluates various performance alternatives in a combat simulation. Simply stated, the combat and materiel developer must partner earlier in the concept exploration phase of the acquisition process.

Using the CAIV concept, the PM and the system manager can evaluate how design and requirement decisions might impact program cost. The Crusader Program is an example of an

Figure 2.
The Crusader Program was able to evaluate requirements against available technologies in simulations such as this crew simulator.



acquisition program that used early analysis of the program's requirements and design to evaluate cost and performance issues. The PM and user representatives were able to make trade-off decisions by examining results of a model that showed changes in force effectiveness based on incremental changes in weight, cost, and performance (Figure 2).

Combat Development Tool

Now we are at that point in the process where SBA can be used as a combat development tool. In fact, it should be used jointly by government laboratories, U.S. industry, and, with the right security and proprietary safeguards, by foreign companies. One can imagine soliciting, from many sources, virtual prototype ideas of how the requirements can be satisfied. This could truly be a collaborative environment, one of the elements in the SBA strategy.

Which Approach?

At this point, we can pursue one of two approaches. One is to develop a physics model of what we want, some type of software that industry can use to develop virtual prototypes. The other approach is to develop specifications and then have prototypes built to these specifications. The process by which the government trades simulations with industry during this development process and the required resources for this effort need additional study before we can help the acquisition community implement SBA.

Physics Of Failure

As the process moves from concept exploration and requirements development into program development, my biggest concern is how much can we invest in "physics of failure." This is the "long pole in the tent." If predictions of reliability cannot be done in simulation, we will have difficulty implementing the SBA strategy. Physics of failure processes are reasonably advanced for electronic programs but embryonic for mechanical systems. We should be able to simulate a life-cycle process that can successfully predict failure in the field. The benefit of developing these extends beyond the testing process to include sustainment of the system.

This is one of the tenets of SBA—achieving early collaboration among the functional disciplines. How can logisticians use physics-based simulations to determine what might break? Traditionally, reliability engineers have predicted system reliability using statistics from historical failure rates. Through use of physics-based modeling techniques, we can better analyze the failure mechanisms and complex root-cause failure modes associated with our systems in the operational environment. One advantage of a physics of failure approach to reliability prediction is that it can be applied earlier in the design process to analyze failure frequency, failure cost, and criticality of failure, thus optimizing the design for reliability. This collaborative effort by the testing and logistics communities transcends individual processes.

To accomplish this, we need to decide early to evolve physics-based, stress-related failure prediction models that can be used to identify failure-prone components and redesign them to optimize reliability. Greater knowledge of the mechanics of failure will permit a more precise prediction of when a failure may occur. In addition, the logistics community benefits by being able to better predict spare parts requirements and by performing proactive maintenance on potentially faulty components, thus avoiding costlier and catastrophic failures. Every program should include physics of failure technology because of the advantages cited above.

The Army's Grizzly Program Office has made strides in designing a physics of failure plan to support the design, testing, and support of the Grizzly System (Figure 3). Because of budget constraints, the Grizzly PM is using a robust modeling and simulation approach to identify the critical parts, functions, and components; and using electronic "mock-ups" to address supportability issues.

Model Building And Maintenance

Another important issue is building and maintaining these models. Ideally, planning for simulation to be used robustly throughout the life cycle of a program should be done at program inception. Models should be developed as part of the acquisition strategy and incorporated in the evaluation strategy. By the time test, training, and logistics planners are involved, they should be designing the test and using simulations built by others. They should not be responsible for building the simulations themselves. This alone will shorten the development cycle of a program and benefit the program as well as the participating functional communities. For example, this year the Army is spending $10 to $20 million for live Apache training because flight simulators were not in place when the system was fielded. These unnecessary costs are not unique to large programs.

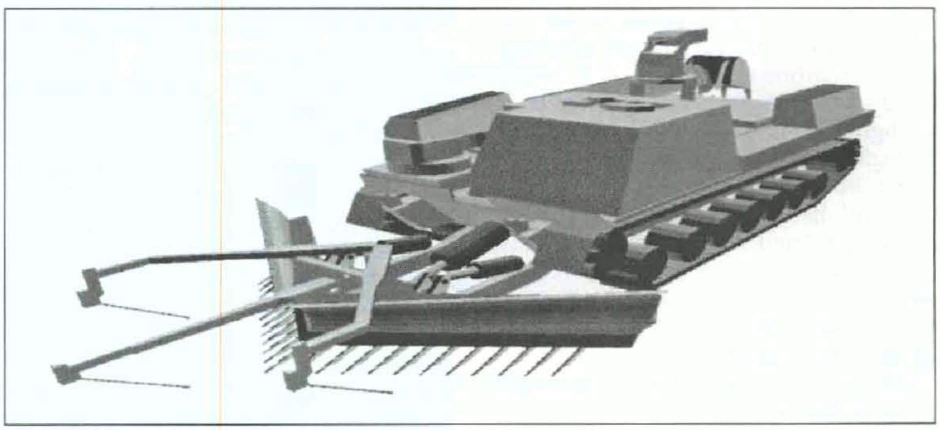


Figure 3.
The Grizzly Program has developed a physics of failure plan that includes robust use of modeling and simulation of weapon systems such as the Grizzly Combat Obstacle Breacher.

In the new parachute program, approximately 3,500 live jumps will be needed during operational testing to attain confidence in reliability requirements. If a high-fidelity simulation existed, some of these jumps could have been simulated in a virtual excursion.

Another challenge beyond building models to expand use of simulation technology is designating who maintains the models and keeps them current. The commitment to invest adequate resources in configuration control during (or throughout) the life of the program is an unresolved SBA issue. The configuration control and maintenance of models and simulations are critical in validating input to virtual environments, in interfacing with different threats, in interacting with other weapon systems, and in modernizing the weapon system. For example, if a piece of a kit is fielded and a training simulation is developed based on the currently fielded system, what happens if the kit is modernized through spare parts? As we build new systems, or modernize them through spares, it will become more critical to build "hooks" into the weapon system to enable us to stimulate the sensors or hook into physics models similar to a virtual proving ground.

Other Challenges

Other challenges that need to be explored are high-fidelity, real-world simulations; total ownership cost modeling; manufacturing; logistics; realistic training simulations (including fog of war) in virtual environments; dual-use simulations for acquisition and training; and continued development of representations of an entity as an object or as a set of performance tables in Warfighters Simulation 2000, an Army warfighting simulation.

One benefit of computer simulation that will be relevant to SBA, yet not actively pursued, is harnessing the latest processing capability onboard weapon systems for training, repair diagnostics, condition monitoring, etc. The automobile industry is applying this capability by using onboard diagnostics when servicing cars.

Summary

I've just provided several suggestions to modify our current acquisition process to capitalize on the advantages of SBA. Many of these cannot be achieved solely by a weapon system program office or another individual proponent. The DOD and the Services must work together to apply SBA to their programs. Some of that work has started; in fact, I've cited some of the current collaborative efforts to apply the SBA strategy. However, we must also capitalize on the efforts in the user communities by providing enabling policies and practices.

Ideally, planning for simulation to be used robustly throughout the life cycle of a program should be done at program inception.

Concurrently, we must ensure that policies are in place for the development and use of standards. I believe that the standards being developed for command, control, communications, computers, and intelligence (C4I) interfaces; functional descriptions of the battle space; object definitions; and terrain databases will eventually contribute to widespread collaboration and savings. The Army recently requested information from PMs on their largest modeling-and-simulation-related cost drivers. I want to ensure that the standards we are developing are, in fact, targeted against the real cost drivers.

What else is necessary? Continuing education of acquisition program office personnel and the functional communities is very important. We must get the word out on both the successes and the stumbling blocks. We also need to assist PMs in achieving the vision we've established. The Defense Systems Management College recently published an SBA handbook for program offices. Perhaps a simulation section in *Army RD&A* magazine would also be helpful. It could publicize some of the lessons learned from modeling and simulation.

Conclusion

SBA is SMART for the Army and is a very promising method for improving the process of acquiring weapon systems. There are many elements in the strategy being pursued. Collaboration and early identification of models are two of the keys. We need to take these elements and provide PMs and functional communities the direction and policies to implement them. Our challenge is to provide that direction couched in terms of how they transition their use of simulation now to a more robust, collaborative process. We must be prepared to "stick with" the SBA process and not be discouraged if first attempts do not meet all our expectations.

WALTER W. HOLLIS is the Deputy Under Secretary of the Army (Operations Research). He is a graduate of the National War College and holds a master's degree from The George Washington University. In addition, Hollis has received three Presidential Rank Awards, one Presidential Distinguished Executive Award, and four Department of the Army Exceptional Civilian Service Awards.

ANNE PATENAUDE is a Division Manager with the Test and Evaluation Group of Science Applications International Corp. (SAIC). She is a retired Army Field Artillery Officer who formerly served in the Office of the Deputy Under Secretary of the Army (Operations Research), and she has a master's degree in mathematics.

COMANCHE: VIRTUALLY REVOLUTIONARY

LTC Deborah J. Chase

Introduction

"The inventions of the past twenty years threaten to revolutionize Army organization and tactics" (*Roots of Strategy 2*, Stackpole Books, Harrisburg, PA, 1987, page 452). Such was the claim of noted military historian and strategist, Antoine Jomini, in his writings circa 1839. Jomini was by no means overzealous in his assertion. The magnitude of technological advances between 1815 and 1830 is credited with thrusting us into the Industrial Age (Paul Johnson, *The Birth of the Modern*, Harper Collins publishers, New York, NY, 1991). During the same period, Napoleon overwhelmed Europe with his revolutionary use of the military principle of "maneuver." We are currently engaged in a similar revolutionary period. Advances in technology are occurring at a breathtaking pace, providing the tools that allow Army leadership to conduct a Revolution in Military Affairs without sending soldiers into harm's way. An objective of the revolution is to create an environment in which the application of technology is driven by doctrine; the converse of what has held true historically. Our tool for achieving this particular objective is Simulation and Modeling for Acquisition, Requirements and Training (SMART).

Revolutionary Approach

Because the history of simulation is closely related to the history of aviation, it was "second nature" for the Program Executive Office for Aviation (PEO-Aviation) to include simulation from the inception of the Comanche Program. Until recently, however, the application of simulation has generally been limited to training devices. The advances in computer processing capability, especially those of the past 15 years, have allowed us to revolutionize the application of modeling and simulation throughout the Comanche Program. Computer-aided design (CAD) and computer-aided manufacturing (CAM) tools simplified a complex design challenge, and system integration labs aid our ability to evaluate system design. But most important, the warfighter now has an early opportunity to evaluate weapon system design through our ability to emulate crew station functions in the Engineering Design Simulator (EDS), demonstrate maintainability through live simulations, and model Comanche capabilities during Army Warfighting Experiments (AWEs). The evaluations are early enough in the development program to allow meaningful feedback during the design process and for the program strategy. The iterative process of garnering user input to fine-tune the weapon system design allows us to claim a virtually revolutionary approach.

Comanche Program

A joint venture between equal partners, the Comanche Program divides the workload equally between Boeing Helicopter, Philadelphia, PA, and Sikorsky Aircraft, Stratford, CT. Boeing designed most of the Mission Equipment Package (MEP), flight control system, and empennage (the tail assembly of an aircraft). Sikorsky is responsible for the majority of the fuselage, main rotor, landing gear, propulsion system, armament, and crew station design.

Design And Testing

The design process was dependent on Computer-Aided Three-Dimensional Interactive Application (CATIA), which integrates aircraft design, documentation, tooling and manufacturing, simulation tools, and Manpower and Personnel Integration (MANPRINT) input into a common digital database. The outcome of the prototype design using CATIA was that the fuselage and tailboom were joined with no requirement for either fixtures or rework, despite being designed and manufactured at two separate companies with different facilities and tooling. The accompanying figure provides a comparison of the benefits realized in the design process using CATIA compared to the standard design process without CATIA.

It is a relatively standard practice to test the design of flight controls in a system integration laboratory (SIL). Therefore, it should not be surprising that we have incorporated the practice into the Comanche Program. In fact, we have gone further than simple common practice. The Comanche Flight Control System Integration Laboratory (FCSIL) not only includes actual flight hardware and software, but also includes representation of the Comanche cockpit. The FCSIL is tied to the Comanche MEP SIL for maximum system integration. This configuration allows the test team to "fly" systems to evaluate their performance in a controlled environment before they are flown on the prototype aircraft.

The EDS at Stratford, CT, is another example of innovative application of modeling and simulation for acquisition because it provides an early opportunity to compare crew station functions to requirements. The EDS' six-degree-of-

	RAH-66 With CATIA	CH-53 Without CATIA
Tooling	Two-step process	Eight-step process
Components	95% first time fit	35% first time fit
Wiring harnesses	Limited rework	Extensive rework
Hydraulic lines	Limited rework	Extensive rework

Design process comparison

freedom hydraulic motion, seat shakers, and aural cues assist in creating a realistic physiological environment. In the EDS, Army aviators assigned to the Army Training and Doctrine Command (TRADOC) System Manager for Comanche are conducting a series of part-task evaluations of specific crew station functions. The part-task evaluations will culminate in the Cockpit Analysis Program, during which the full MEP will be emulated to evaluate pilot task loading. The timing of the evaluations allows for adjustments to the symbology and the software that controls crew station functions before aircraft design is final. Previously, warfighters did not have an opportunity to evaluate crew station functions or task loading until after first fielding.

Further, the EDS and the FCSIL are used together as engineering development tools to evaluate handling qualities during the design process and to assist in the design of a Comanche-unique envelope cueing system. The envelope cueing system will allow aviators to fly the Comanche at the extremes of its maneuverability and agility envelope without causing damage or reducing the life of dynamic aircraft components.

In addition to being tested in the EDS, the software for the crew station functions is ported to the Comanche Portable Cockpit (CPC). A CPC is located at the Aviation Maneuver Battle Lab, Fort Rucker, AL, where experienced combat aviators assigned to the TRADOC System Manager are developing and testing Comanche tactics, techniques, and procedures (TTPs). The timing of the effort will allow us to deliver TTPs with the aircraft.

AWE

In November 1997, a CPC was used to represent the Comanche in the AWE at Fort Hood, TX. The AWE allowed us to simulate a future aviation brigade mission with Comanche. We did this by creating a virtual simulation environment using a network of simulation devices and simulation models interfaced with the All Source Analysis System and the Maneuver Control System. The results of the AWE led us to conclude that we must develop interoperability between the Comanche and legacy systems. More important, the simulation of Comanche capabilities during the AWE created such positive feedback that it showed we must accelerate MEP development.

Prior to the AWE, we planned to provide six early operational capability aircraft with a limited, reconnaissance MEP for evaluation in FY02-03. Six additional aircraft containing the armed reconnaissance and armament components of the MEP would follow in FY04. The fire control radar (FCR) was not scheduled to be included until FY10.

From the AWE, we learned that the warfighters were most interested in seeing the full MEP as soon as possible. Consequently, we modified the engineering and manufacturing development process to accelerate MEP development and provide preproduction prototype (PPP) aircraft with production-representative MEP capability, including the FCR, in FY04.

Unmanned Aerial Vehicles

We are also using the CPC with the Advanced Tactical Combat Model in a three-part Manned-Unmanned Concept Exploration Program (MUM CEP), an Advanced Concepts and Technology II Program, to explore a link between unmanned aerial vehicles (UAVs) and Comanche. The intent of the MUM CEP is to explore teaming between rotary-wing and UAV reconnaissance platforms. Ultimately, we will explore the notion of controlling UAVs from the Comanche. Our application of lessons learned from the first two MUM CEPs includes an expansion of the Comanche crew station software functions.

Maintainability Development Test

In July 1998, an Integrated Product Development Test Team, comprised of representatives from the Comanche Program Management Office, TRADOC System Management Office, Boeing Sikorsky Supportability and Engineering, and contracting firms, in addition to aircraft mechanics, conducted the Maintainability Development Test (MDT), a live simulation using prototype aircraft no. 2.

The primary objective of the MDT was to reduce the risk associated with the maturation of maintainability by identifying and resolving issues prior to the PPP design phase. To that end, the MDT was designed to identify potential maintainability issues, influence design for maintainability, gather data showing mean time to repair, and validate maintenance procedures and tools.

The MDT identified 265 issues or concerns for which corresponding integrated product teams will propose corrective or mitigating strategies. Although many small design changes will be needed to implement the recommendations, there were no surprises among the items that arose from the MDT. The MDT is unprecedented both in its magnitude and in its timing so early in a development program. It is an excellent example of a simulation designed to gain input from soldiers who represent future Comanche crew chiefs. In addition, we collected the input in sufficient time to fine-tune maintainability before the aircraft is fielded.

Future Plans

Future plans include the addition of another CPC that will be used for a variety of purposes, including training aviators prior to Force Development Test and Evaluation and Limited User Test. Further, to address the need to establish interoperability with legacy systems, we are defining the nature of our involvement at the Central Technical Support Facility (CTSF) at Fort Hood, TX. Whether we participate in the CTSF via a virtual link with the PEO's Aviation Integration Facility or through a physical presence with a CPC, we will achieve interoperability with the Army Battle Command System prior to the arrival of the first production aircraft.

Conclusion

The Comanche Program has implemented a revolutionary approach to the application of modeling and simulation tools throughout the acquisition and requirements development process. We are not only using simulation for traditional training and design applications, but are also taking the design process to new dimensions. Our most innovative use of simulation allows the Comanche to participate in warfighting experiments that provide feedback not only for the doctrine development process, but also in the aircraft design and, ultimately, to the Comanche development program itself. The summation of our modeling and simulation efforts for acquisition, requirements, and training supports the claim that Comanche is a leader in a virtual revolution.

LTC DEBORAH J. CHASE is the Product Manager for the Comanche Crew Support System. She has a master's degree in aeronautical science from Embry-Riddle Aeronautical University and is a graduate of the Command and General Staff College and the Program Managers Course at the Defense Systems Management College.

From Industry . . .

DAIMLERCHRYSLER DIGITAL DESIGN

Arthur Anderson

Introduction

Fans of the Winter Olympics were the first to see them. In February 1998, Chrysler Corp. (now DaimlerChrysler Corp.) debuted a new series of advertisements during the Winter Olympics that took viewers on a "virtual" tour of how the 1998 Dodge Intrepid sedan was created. The advertisements showcased the fully digital design process now widely used to develop vehicles at DaimlerChrysler.

Digital, or "paperless," design is nothing new, but Chrysler was the first auto company to unite all of its design and development software on a common database—resulting in a *truly* integrated system. Before doing that, each department had different computers and software packages, which made it nearly impossible to unite the hundreds of thousands of design details in cyberspace.

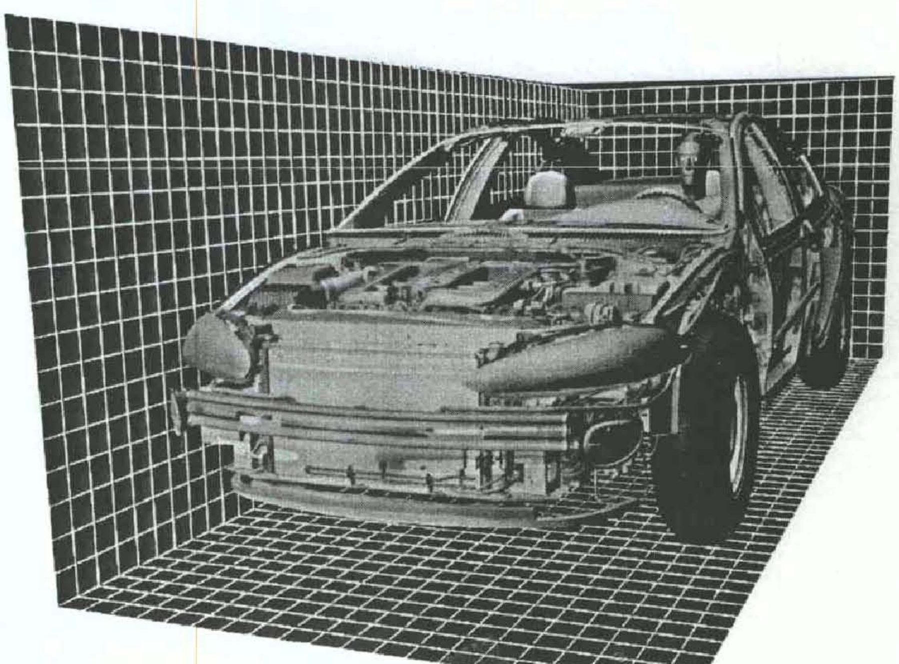
And before *that*, Chrysler, along with every other automaker, created and stored engineering data on paper drawings. But each time a design was amended, it was an extremely time-consuming process to update a master blueprint, distribute copies, and collect out-of-date drawings.

With a rapidly evolving design, blueprints literally became obsolete as soon as they were created. No wonder it took automakers upwards of 6 years to develop a single vehicle.

CATIA

In the 1970s, Chrysler began switching to computer-aided design (CAD) and computer-aided manufacturing (CAM) software to help speed up product development (although engineering "masters" were still kept on paper). But it wasn't until 1989, when Chrysler adopted Computer-Aided Three-dimensional Interactive Application (CATIA) software developed by France's Dassault Systemes, running on IBM workstations, that the cyber age really began to dawn at the company. Around that time, Chrysler also began benchmarking other companies that were using digital design extensively—most notably Boeing, which eventually designed its 777 jet entirely without physical mockups.

In 1995, during the development of the new Dodge Stratus compact sedan, Chrysler's engineering team used CATIA to create 3-D math models of one of the engines that would be used in the car. They made rapid progress without any physical mock-ups, and learned that it was critical to be able to share the data to discover whether components had problems fitting in the car. Data management, data control, and graphic display were key to the overall project, as was a data management system to handle problems while keeping everyone updated in real time.



The visualization of the Dodge Intrepid's overall vehicle system for engineering purposes proved to be graphically appealing enough to be used for product sales brochures.

Chrysler Data Visualizer

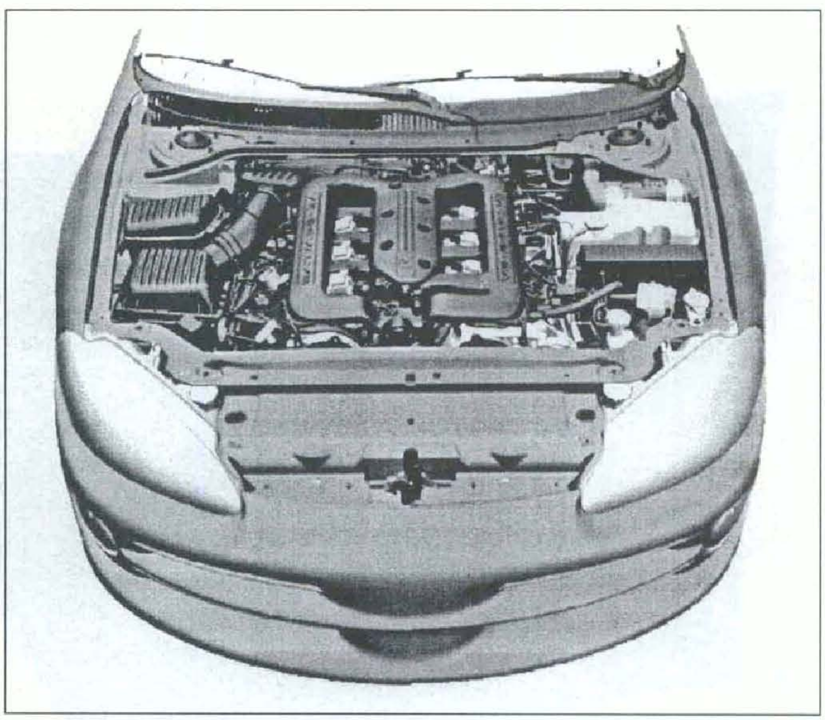
The visualization solution was developed by Hugh Cummings, a computer systems development supervisor at Chrysler. He created software called the Chrysler Data Visualizer (CDV), which applied the graphics power of Silicon Graphics workstations. In a nutshell, CATIA creates engineering models, and CDV visualizes them in a real-time, interactive format.

Initial Design Process

Here's how it all comes together. Designers create basic concept drawings using electronic sketchpads. Electronic sketchpads not only save time over paper drawings, but they actually provide designers greater opportunity for creativity. Changes are simple to make. Each design is a "living" document within the computer, and modifications are fairly simple to do or undo. The computer allows designers to create a multitude of design iterations in the same amount of time it previously took to do one paper drawing, thus optimizing the final design.

Once the basic designs are complete, they can be reviewed in full scale. In the case of exterior design, for instance, the full-scale shape of the vehicle is reviewed on screens that fill an entire wall. Before computers, it took days to redraw the exterior design in full scale on paper. Each design is reviewed, critiqued, and revised. Once that process is complete, digitized data of each design are sent to a CATIA database called CATIA Data Management (CDM). Once the CDM database has enough designs, the engineering staff begins building a Digital Model Assembly (DMA) of the entire vehicle.

At this point, a powerful graphics system is invaluable. It can generate interactive images for numerous models, with multiple processors for analysis. This is where the work of engineers responsible for different aspects of the vehicle comes together in cyberspace, as the overall vehicle truly begins to take shape. In addition, the suppliers who contribute components and systems for DaimlerChrysler's vehicles are *also* required to use CATIA and have the same access to data as the company's engineers. This communicates engineering data from numerous sources in a *single* language.



Images created for engineering visualization illustrate the level of detail in CATIA that was required for accurate analysis. Once created, these data are used to detect possible component interferences—such as with the intake manifold—as well as to ensure trouble-free assembly and service of various components and structures.

Design Zones

In the initial design process, a vehicle is divided into "geographical" zones. Meetings are structured around these zones, as well as around specific systems that may overlap different zones. In a single meeting, Chrysler would have up to 100 engineers (employees and suppliers) presenting ideas, making suggestions, moving components, and reviewing changes.

In the old days, when engineers got together in meetings with two-dimensional representations, they would have a lot of disagreement and debate, depending on the individual viewpoint and understanding of each engineer. Now, with 3-D visualization, it's immediately obvious what isn't working, and everyone can begin working on a solution.

Nowadays, design zones have individual certification of their parts and structures. After all zones make sure their parts fit together, there is an overall review to ensure entire systems fit, as well as meet other objectives such as styling, appearance, and ease of manufacturing.

CATIA Example

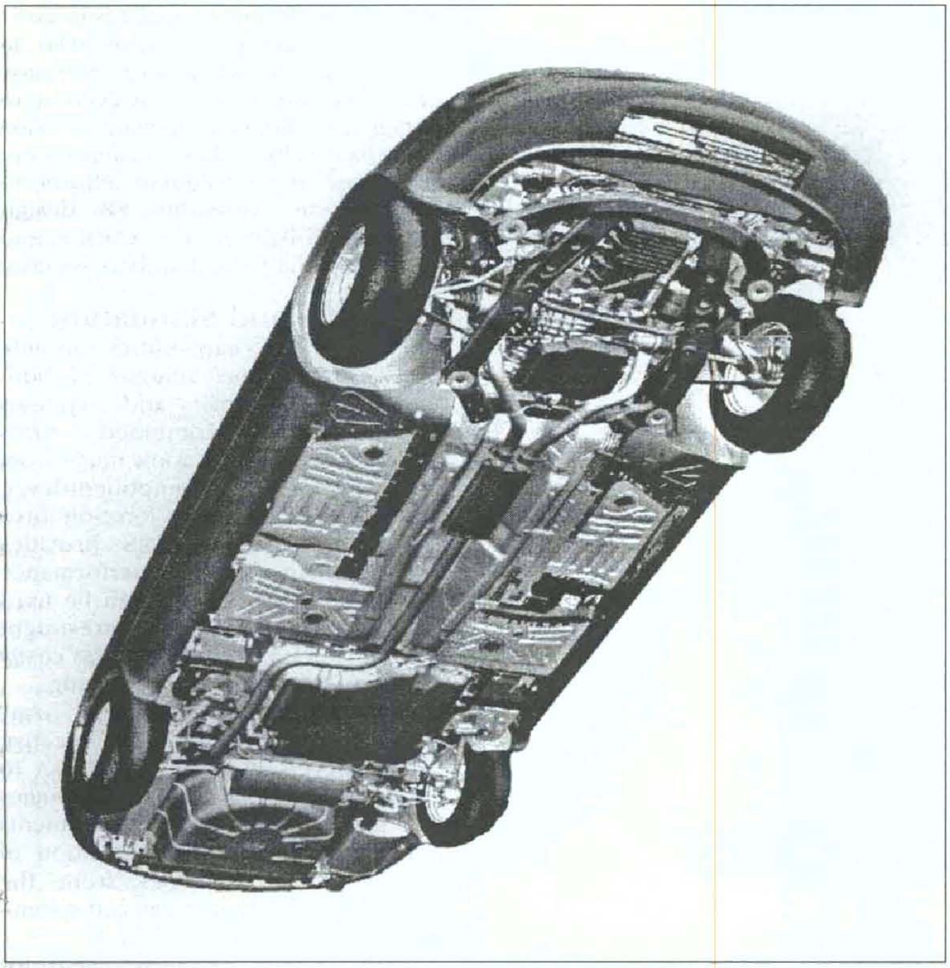
The impact CATIA has had on the design process can be seen in the development of the engine intake manifold. Engineers responsible for creating the manifold have open access to the "hard points" of the engine bay and hood structures and can create an optimal shape to fit within them. After the shape is developed, computer simulations are run to ensure the manifold really fits in the vehicle and has optimized airflow. Using real-time updates, if the design of the hood is changed, engineers can quickly modify their manifold design.

Before CATIA, each new component design required that a new physical prototype be designed, fitted, and tested. With CATIA, hundreds or thousands of simulations can be run before a single prototype is constructed. Using other computer tools such as airflow analysis software, engineers can create a design that optimizes the performance of the manifold—not just the shape.

Functional Prototypes

Making a functional prototype is also simpler using DMA. Electronic files containing the DMA engineering data can be transferred to one of two prototyping methods to make a physical model.

One is Fused Deposition Modeling (FDM), which uses a polyester or wax



Graphically complete visualizations prove to be very powerful communication tools to convey spatial relationships and design concepts relative to various "design zones" within the entire vehicle.

compound to create a 3-D shape. With a special vacuum metalization process that introduces metal-like properties to the surface of the model, parts made by FDM can sometimes be directly evaluated on a test car.

The other prototyping method is called Laminated Object Manufacturing, which uses thin layers of paper that are cut to shape and glued together to create a component.

Benefits

When all of the design iterations of each component and structure of a new vehicle are completed, they are fed back into CATIA to create an all-inclusive representation of the vehicle on the CDV. In other words, the whole vehicle can be called up onscreen to be assembled, rotated, inspected, dissected, and reassembled—all in an interactive environment. This saves time and, by derivation, money.

Fit, Finish, and Design. For example, one crucial step in the creation of any vehicle is installing—"decking"—the power train and chassis to the body. Using old-style design aids, it might take up to 1 month to install prototype components because of all the undiscovered interferences between parts and structures. In the case of the 1998 Intrepid, the DMA process resulted in successfully decking all prototype assemblies into the vehicle in 15 minutes the first time.

Another example from the Intrepid involved the placement of the oil filter. Once the Intrepid was completely "assembled" with the CDV, engineers discovered that, although the oil filter fit within the confines of the engine bay, it couldn't be unscrewed and removed. Years ago, in all likelihood this problem wouldn't have been discovered until late in the development process, when a physical prototype was constructed. However, with the CDV, the structure around the oil filter was quickly redesigned on the computer. The Intrepid now has one of the easiest oil filters in the world to remove.

DMA identified and resolved more than 1,500 interference, fit, and design issues in the Intrepid before the first physical prototype was built. Engineers learned how their parts interacted and fit, and parts were placed where they belonged long before any tooling was developed.

Simultaneous Engineering. Perhaps most important, CATIA and DMA allow different engineers to analyze components and structures in real time, making "simultaneous engineering" possible. This allows more design solutions to be created and evaluated during the early phases of product creation—not after a vehicle has been extensively (and expensively) tooled. In addition, this process allows more testing. Before accurate computer simulations were possible, physical prototypes had to be built to perform costly and time-consuming evaluations and tests.

Crash Testing. In the case of crash testing, computer simulations can accurately predict how a structure will behave under various conditions, which leads to improved structural integrity. These simulations are not only more informative than earlier methods, but also less expensive.

Aerodynamics. Engineers performing aerodynamic evaluations use data from DMA along with computational fluid dynamics to enhance wind-tunnel testing. The combination of theory and experimentation also helps hone an optimum design before tooling is ordered.

Conclusion

Actual vehicle prototypes are created and tested—hundreds of times, in all conditions and climates. Only when engineers are satisfied by the results are the vehicles ready for volume production. But even then, manufacturing is not as fraught with complications as it once was because structures and components are thoroughly "proofed" in cyberspace, instead of on the shop floor. The benefits of the DMA process—reduced development time, lower cost, and higher quality—are playing a big part in DaimlerChrysler's engineering successes.

ARTHUR ANDERSON is the Senior Manager for Vehicle Architecture and Packaging, Advance Product Creation, DaimlerChrysler Corp. He has a B.S. in mechanical engineering from Purdue University.

ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY'S SMART CONTRIBUTIONS

LTC Lindell Townsel Jr., Pat O'Neill, and Joon Lee

Introduction

Simulation and Modeling for Acquisition, Requirements and Training (SMART) is the process for integrating modeling and simulation (M&S) and technology into acquisition functions (requirements generation, design, development, test and evaluation, training, manufacturing, and fielding) and programs. The potential benefits of SMART are to reduce process time, required resources, and risks associated with acquisition functions, as well as increase quality and supportability of fielded systems. In simplest terms, M&S is used to support analysis and training.

The Army Materiel Systems Analysis Activity (AMSAA) provides timely, reliable, and high-quality materiel and logistic systems analysis throughout the acquisition life cycle (Figure 1). AMSAA develops M&S to support its analyses as well as analyses conducted for other Army agencies and DOD. For example, AMSAA supports M&S development for Army and DOD training by providing system models, certified system performance data, and M&S verification and validation (V&V) (Figure 2).

AMSAA's materiel system analyses focus on subsystem and system performance and examine cost, performance, and risk trade-offs. Performance analyses evaluate target acquisition of sensors; delivery accuracy; hit probability; lethality of direct and indirect fire weapon systems; air and ground mobility; reliability; and command, control, communications, computers, and intelligence (C4I) systems.

Crusader Analyses

AMSAA's analyses of the Crusader provided the program manager (PM) with valuable insight into the potential problems and payoffs of various automotive and armament design options. The analyses also enabled the the PM to make informed decisions as the Crusader entered the detailed design stage of Program Definition and Risk Reduction development.

In 1996, AMSAA conducted a series of Crusader performance analyses to assist the Department of the Army (DA) in justifying to the Office of the Secretary of Defense and Congress the decision to switch from liquid propellant to solid propellant (SP). These analyses were also used in subsequent efforts to reaffirm the Crusader SP design approach in light of other existing and developmental SP field artillery systems.

Modeling And Simulation

AMSAA's M&S capabilities provide tools that support analysis of both individual systems and systems employed in combined arms environments. These tools range from development of component-level, physics-based models to force-on-force simulations. This M&S provides comprehensive system performance prediction capability that can be used to make trade-offs and investment decisions prior to extensive and costly hardware development and testing.

Active involvement in the Army Science and Technology Objective (STO) process has enabled AMSAA to examine how emerging technologies can satisfy future Army requirements and support the timely transition of warfighting technologies from the technology base to materiel and system-specific applications.

As the Army's executive agent for verification, validation and accreditation (VV&A) of item-level performance models, AMSAA assists model developers with developing and executing V&V plans to ensure that M&S accurately represents actual systems.

Rapid Force Projection Initiative

AMSAA supported the Rapid Force Projection Initiative (RFPI) Advanced Concept Technology Demonstration (ACTD) in developing command, control, and communications (C3) algorithms and measures of performance; certifying performance data; and verifying and validating distributed simulations.

In the C3 area, AMSAA developed algorithms, validated stand-alone models, and established measures of performance. Simulations, both constructive (Combined Arms and Support Task Force Evaluation Model) and distributed (Modular Semi-Automated Forces), were updated to reflect the performance of the RFPI tactical Wide Area Network. The algorithms simulated the main functions and limitations of the Enhanced Position Location Reporting System. In addition, the U.S. Army

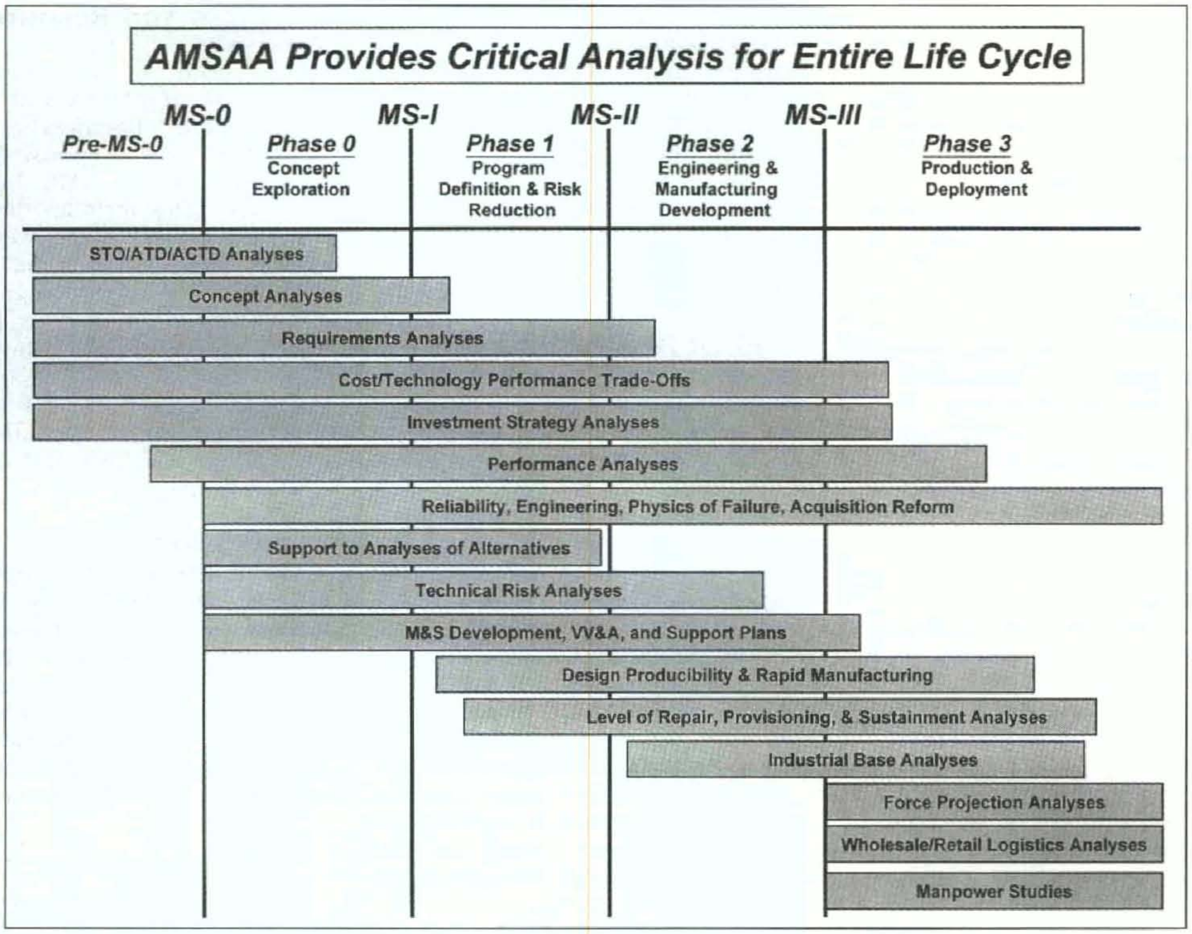


Figure 1.

Communications-Electronics Command's System Performance Model was validated.

The RFPI used live, virtual, and constructive simulations to evaluate the potential benefits of the RFPI force. AMSAA played a key role in verifying and validating simulators and computer-generated force simulations. AMSAA also designed interoperability tests, analyzed test results, and suggested changes to ensure terrain compatibility and a fair fight. In addition, AMSAA provided certified system performance data (target acquisition, delivery accuracy, and lethality).

Future Scout And Cavalry System

AMSAA's capabilities for integrated cost and performance trade-off analyses were used to support the Future Scout and Cavalry System (FSCS) Comparative Performance Exploratory Analysis (CPEA). The CPEA's primary objective was to determine whether the FSCS concept was potentially better at performing the Scout missions than current Scout baseline ground vehicles. The results of the CPEA were key to the

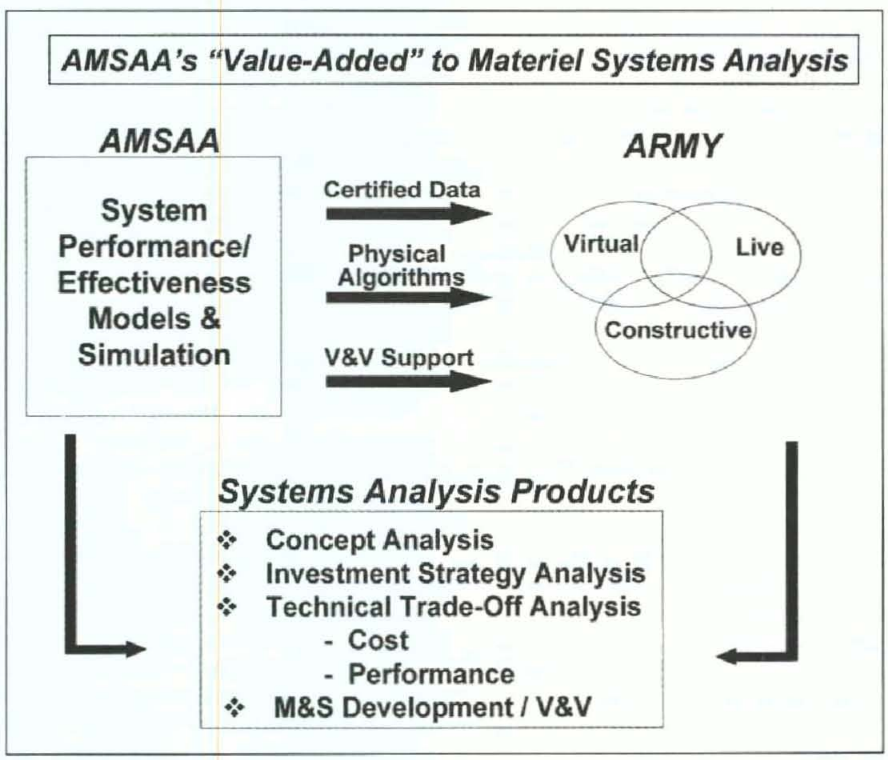


Figure 2.

Army's decision for a joint U.S.-U.K. Scout Advanced Technology Demonstration (ATD).

In cooperation with Army laboratories; research, development, and engineering centers; and the Army Cost and Economic Analysis Center; AMSAA used the analyses to develop item-level performance estimates, to assess the technical risk, and to determine expected life-cycle costs of each of the subsystem alternatives.

The Army technology base review resulted in significant insights, such as defining potential hardware alternatives in each of the subsystem areas. AMSAA integrated concept subsystem performance estimates using a figure of merit approach. The aggregate performance was correlated with cost and risk. The result was a better understanding of the cost, performance, or risk trade-offs that impact the final system requirements, cost targets, source selection, and ATD.

Logistic Systems Analysis

Wholesale, retail, force projection, and sustainment analyses, together with logistics methodology and model development, comprise the core functions of logistic systems analysis. These core functions cover the spectrum of Army logistic needs, from the development and refinement of new logistic models to the evaluation and analysis of innovative or modified logistic concepts.

War Reserve Computation

The Optimum Stockage Requirements Analysis Program (OSRAP) is a stockage computation model that allows the user to determine stock lists in support of weapon system readiness for wartime and contingency operations. The model calculates operating levels and reorder points for Class IX items, with the goal of producing an optimum cost solution while meeting the performance goals of the supply system. OSRAP is used to perform sensitivity analysis with user-adjusted input parameters that include failure factors, order shipment times, densities, intensity factors, and usage factors.

In addition to computing wartime or contingency packages for Class IX spare parts, OSRAP is being developed for the following applications:

- Incorporation into the Global Command and Control System;
- Expansion to other supply classes (Class I, II, IIIB, IIIP, and IV); and
- Incorporation into the Army War Reserve Automated Process.

Comparison of current war reserve computations with OSRAP results demonstrates the potential for significant cost reductions. For example, the current war reserves process—based on days of supply methodology—produced a requirement of $1.7 billion compared to the OSRAP requirement of $1.28 billion, which reduces Class IX costs 25 percent.

Level Of Repair Analysis

AMSAA performs a Level of Repair Analysis (LORA) to assist PMs and major subordinate commands (MSCs) in evaluating and supporting maintenance policy decisions on major weapon systems while minimizing total support costs. The Computerized Optimization Model for Predicting and Analyzing Support Structures (COMPASS) is the Army's standard model for a LORA.

COMPASS analyses are key to weapon system support decisions such as repair versus discard of components, contractor versus organic repair, and critical design trade-offs for manpower requirements. Other major applications include analyses of requirements for the Integrated Family of Test Equipment and for the Direct Support Electrical System Test Set.

Acquisition And Technology Support

In 1997, the Industrial Engineering Activity was incorporated into AMSAA. This provides AMSAA with a broad base of industrial engineering capabilities to assist PMs and MSCs.

In the production engineering area, AMSAA personnel assist PMs by serving on integrated product teams, performing assessments, and providing producibility engineering and planning support.

Acquisition Reform

In the acquisition reform area, AMSAA is the Army's executive agent for reliability and maintainability standardization reform. As such, AMSAA staff serve on the Army Materiel Command (AMC) Acquisition Reform Implementation Assessment Team and support both the DA and AMC Roadshows.

The AMSAA-pioneered Physics of Failure (PoF) Program develops design and analysis tools to predict reliability and to minimize potential redesign at the component level. PoF is based on the basic principle that it is important not only to understand how things work, but to understand how things fail under the intended operational environments.

Business And Resource Analyses

As a result of the October 1998 integration of AMSAA with the AMC Management Engineering Activity, AMSAA is now responsible for the execution of the AMC Engineering Program. This includes directing the Workload Based Manpower Requirements Program and the Workload Based Staffing Analysis Program, as well as ensuring that there is integrated, validated input to the Army Workload and Performance System. In addition, AMSAA is responsible for conducting and overseeing outsourcing and privatization analyses and commercial activity studies.

Conclusion

AMSAA developed an integrated set of models and simulations to perform materiel and logistic systems analyses to assist decisionmakers throughout the acquisition life cycle. Additionally, AMSAA supports the development, verification, validation, and accreditation of both Army and DOD models and simulations for analysis and training.

LTC LINDELL TOWNSEL JR. is a Senior Analyst and Team Leader in the Simulation Branch, Close Combat Analysis Division, AMSAA. He has a B.S. degree in business from Florida State University and an M.B.A. from Old Dominion University.

PAT O'NEILL is the Chief of the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance/Mobility Branch at AMSAA. He has a B.A. degree in mathematics and computer science from Loyola College and an M.S. degree in computer science from Johns Hopkins University.

JOON LEE is an Electronics Engineer in the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance/Mobility Branch at AMSAA. He has B.S. degrees in both electrical engineering and aerospace engineering from the University of Maryland.

SMART TEST AND EVALUATION: THE VIRTUAL PROVING GROUND

Rick Cozby

Introduction

The Virtual Proving Ground (VPG) is the tester's contribution to the Army's Simulation and Modeling for Acquisition, Requirements and Training (SMART) initiative. This article looks at some of the current and emerging VPG capabilities that enable the U.S. Army Test and Evaluation Command (TECOM) to do its part within SMART to reduce cost, cycle time, and risk during the acquisition process. TECOM is doing more with fewer resources, while increasing the quality of testing for its customer—the soldier.

VPG Assets

TECOM initiated VPG development as a means of leveraging the power of the computer to create battlefield environments for testing Army systems. VPG capabilities include development of synthetic battlefield environments; realistic battlefield stimulation of systems under test; data collection, reduction, and analysis; and automated test planning, control, execution, and reporting. The VPG battlefield environments include many physical and virtual domains. In the physical domain, we have created test fixtures and facilities that provide battlefield stress to hardware systems, including dirty electromagnetic environments for our command, control, communications, computers, and intelligence (C4I) system tests. In the virtual realm, we provide stress to software systems, information delivery systems, and to decisionmaking tools available to commanders on today's battlefield.

VPG Capabilities

Everyone involved in the acquisition process, whether they are program executive officers, program managers (PMs), testers, or evaluators, is charged with finding ways to use modeling and simulation to reduce acquisition cycle time and cost. Partnering with program executive officers and PMs is therefore a key component of the VPG Program. The following VPG-related capabilities are currently providing PMs and other customers with cost-avoiding simulation, test, and evaluation tools. These capabilities were developed to address specific customer requirements. Some of these tools are fully or partially funded by the customers, and many of the embedded simulations are provided by the customer. Because of the rapidly evolving nature of modeling and simulation, the list is not all-inclusive. TECOM innovations in test modeling and simulation support occur continuously to answer specific acquisition program issues.

C4I Synthetic Battlefield Environment. The distributed nature of C4I demands simulation and stimulation techniques simply to allow testing to be accomplished. The Virtual Electronic Proving Ground provides the necessary synthetic battlefield electromagnetic environments.

Simulation support modules use standard Army training simulations, such as the Corps Battle Simulation and the Combat Service Support Training Support System, to provide direct digital input stimulation into tactical command and control systems. To date, this capability has been used in numerous test and training events around the world, yielding more than $40 million in cost avoidance compared to the cost of live exercises.

The Simulation Testing Operations Rehearsal Model (STORM) is a brigade and below C4I simulation, stimulation, and instrumentation package. Initially developed in partnership with the U.S. Army Operational Test and Evaluation Command to test the Force XXI Battle Command Brigade and Below System using smaller numbers of live units, STORM will have many applications to testing and training at brigade and below echelons. Using STORM, we expect a cost avoidance of more than $1 million per test compared to the cost of conventional tests.

The Virtual Battlefield Environment Facility is a closed-loop facility that generates live signals to provide realistic inputs into systems under test and emulate those friendly, enemy, or civil signals that the test item would encounter in its operational environment. This capability achieves in 10 minutes what would normally require hundreds of flight hours in an open-range facility.

Air Defense Missile Flight Environment. Testing of air defense hardware and software is supported by models and simulations that reduce the requirement for launching targets, firing test missiles, and telemetering flight data. Most of the simulation tools discussed below are owned, maintained, and operated by the respective program office or its contractors as part of its overall simulation, test, and evaluation process.

The Guidance Test and Simulation Facility is a full hardware-in-the-loop (HWIL) guidance simulator for the Phased Array Tracking To Intercept Of Target (PATRIOT) System, providing endgame geometry and miss distance in lethality analyses.

The flight mission simulator provides a controlled environment of various simulated target signature and electronic countermeasure inputs to the system surveillance function, as well as simulated missile responses for the guidance function.

The multifunction simulation models PATRIOT search, track, and engagement capabilities under radar loading.

The PATRIOT Advanced Capability Simulation provides a high-fidelity digital simulation of the surveillance function, missile dynamics, and lethality function for preflight predictions and postflight reconstruction of flight tests.

The Counter Anti-Radiation Missile is a digital simulation of antiradiation missile performance against the PATRIOT System.

Tactical Missile Flight Environment. The Simulation/Test Acceptance Facility (STAF) is an HWIL simulator for nondestructive testing of "live" millimeter-wave radar-guided missiles using multiple computer-based test scenarios under simulated environmental conditions. Conventional, destructive acceptance tests of the LONGBOW missile, for example, cost \$12.5 million annually. The STAF simulation/test method only costs \$1.8 million per year. Data links with the Missile Research, Development and Engineering Center will soon allow importing models of missile subsystems and target environment and exporting test data for distributed testing.

Electro-Optical Environment. The Electro-Optical Sensor Flight Evaluation Laboratory provides a nondestructive environment for six-degree-of-freedom tests of missile infrared (IR) seeker and guidance subsystems throughout the life cycle.

The Electro-Optical Target Acquisition System Evaluation Laboratory provides an IR target environment for testing optical target acquisition and weapon-sighting systems.

The Dynamic Infrared Scene Projector displays realistic, repeatable, complex IR scenes in the entrance aperture of IR seekers, weapon-sighting systems, and night vision sensors, simulating a dynamic battlefield environment. Dynamic scenarios provide multiple moving targets, clutter, and countermeasures to assess target detection, recognition, and identification probabilities over most operational battlefield environments.

Chemical Threat Environment. Because of extreme hazards and severe restrictions associated with chemical and biological defense testing, all testing in live environments is conducted with agent simulants, and all testing with live agents is conducted in synthetic (chamber) environments.

The Detector Test System (DTS) is an environmentally controlled chamber system for automated testing of chemical point detectors. The DTS provides repeatable, automatic, dynamic dissemination of multiple agent challenges in reusable, transportable, environmental chambers. Tests are monitored electronically for real-time evaluation. The DTS in support of Automatic Chemical Agent Detector Alarm testing is credited with reducing the test cost by \$2.5 million.

Man-in-Simulant Test sampling patches placed between the chemical protective suit and the skin of the test operator capture simulant that has penetrated the suit. The sampling patches are assayed for quantity and location of penetration. A computer model predicts the human physiological response to commensurate live agent penetration.

Transport Environment. Rail impact modeling provides for multibody dynamic simulation of weapon systems undergoing the MIL-STD-810 rail impact test, using commercial computer software and hardware. Doing these tests in simulation early (at one-third the cost of a live test), in partnership with the Military Traffic Management Command, allows for any necessary redesign when it is most cost effective. The simulation is validated by substantial live testing.

Trailer stability modeling uses the Army Research Laboratory's high-performance computer tools and dynamic system models to predict the safety performance envelope of liquid-carrying tanker trailers in high-speed traffic maneuvers. Test data from safe, low-speed maneuvers are used to validate the model for high-speed, unsafe maneuvers, eliminating the need for physical testing beyond the performance envelope.

Test course terrain database models provide on- and off-road surface characteristics for application to HWIL or computer-based mobility, transportability, or other complex vehicle simulation efforts. TECOM terrain models have been used to drive the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) and the University of Iowa motion-based simulators. A recent program used Aberdeen Test Center terrain data to test a high-mobility trailer on the TARDEC simulator, avoiding 12,000 miles of live testing and a cost of \$240,000.

System-Environment Interface Models. The Flight Test Simulation Station (FTSS) runs the Boeing/Sikorsky Comanche dynamic flight model and provides synthetic test scenarios to conduct testing without flying the hardware prototype. Verification and validation are accomplished side-by-side with live testing of the hardware prototype. Enhancements to the FTSS include a link to receive telemetry data from live flight tests for real-time integration with the Comanche cockpit simulator.

The moving target simulator (MTS) provides for immersing a system with fire control software into a synthetic target environment. Computers project a controlled target onto the interior surface of an air-supported hemispheric screen. Instrumentation measures system inputs and outputs, monitoring the response of the system to characterize its performance, without a shot being fired. The MTS saves about \$40,000 per test, compared with field testing, while providing more and better data.

The combat vehicle engineering simulation immerses fire control system software, as a model, into a simulated test environment before a hardware prototype is built. Validated models of the test range, target motion, tank hull motion (from the TARDEC model), ammunition trajectory, gunner input, and atmospherics, interact with the fire control model, all in the computer. The simulation generates the same kind of tracking error data that a live test generates.

The firing impulse simulator (FIS) provides dynamic loading on large caliber gun systems (105 mm to 8 inch) to test the recoil system; gun cradle endurance; and the shock load on weapon, fire control, and auxiliary components. During the first year of its operation, the FIS resulted in cost avoidance of \$20 million to its customers compared with firing live rounds to obtain the same loading effect.

Conclusion

The VPG is essential to the success of the Simulation and Modeling for Acquisition, Requirements and Training initiative. TECOM welcomes the opportunity to share VPG capabilities with other commands, program offices, and research, development, and engineering centers to fully achieve the goals of SMART for the Army. For additional information, visit the VPG website at **http://vpg.apg.army.mil**.

RICK COZBY is the Chief, Simulation and Technology Division, HQ TECOM. He has a bachelor's degree in electrical engineering from Vanderbilt University, an M.S. in administration from Central Michigan University, and is a graduate of the Command and General Staff College. Cozby is Level III certified in test and evaluation and is a major in the U.S. Army Reserve.

Discussions Target Current, Future Issues . . .

OASA(ALT) ASSESSMENT AND EVALUATION OFFICE HOSTS SMART CONFERENCE

Paul D. Amos and William A. Reed

Introduction

The Office of Assessment and Evaluation, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology) (OASA(ALT)) hosted the second annual Simulation Based Acquisition (SBA) Symposium earlier this year in San Antonio, TX. The 2½-day conference, billed as the Simulation and Modeling for Acquisition, Requirements and Training (SMART) Conference, included senior leadership and industry CEO panels, requirements and training panels, and breakout sessions and outbriefings. In addition, Paul J. Hoeper, Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT)); Walter Hollis, Deputy Under Secretary of the Army (Operations Research); and BG Joseph Yakovac, Assistant Deputy for Systems Management and Horizontal Technology Integration, OASA(ALT) presented keynote addresses.

Opening Remarks

Dr. Herb Fallin, Director, Assessment and Evaluation, OASA(ALT), provided opening conference remarks by summarizing some of the key SMART events of the past year, including the notion that SMART is an expansion of SBA. He also outlined the conference goals to provide an update to the Army community on the progress toward implementing SBA initiatives and to expand the concept of SBA into SMART.

In his opening address, conference sponsor LTG Paul J. Kern, Military Deputy to the Assistant Secretary of the Army (Acquisition, Logistics and Technology) and Director, Army Acquisition Corps, highlighted the Army's entrance into the digital information age—an age that requires a radical change in how the Army conducts the business and performs the function of acquisition. Kern emphasized that modeling and simulation (M&S) is one of the most powerful digital technologies at the Army's disposal.

Industry CEO Panel. Left to right are Panel Moderator Dr. Herb Fallin, OASA(ALT); Tom Rabaut, United Defense L.P.; Michael D. Bolon, General Dynamics Land Systems; and Robert Thurber, Intergraph Corp.

Panels

Kern also chaired the Senior Leadership Panel, which consisted of LTG William H. Campbell, Director of Information Systems for Command, Control, Communications and Computers (DISC4); LTG Randall Rigby, Deputy Commanding General, U.S. Army Training and Doctrine Command (TRADOC); Walter Hollis; and Mark Schaeffer, Deputy Director, Test, Systems Engineering and Evaluation/ Systems Engineering, Office of the Under Secretary of Defense for Acquisition and Technology. Senior leadership recommendations included assigning a knowledge manager to publicize available tools (i.e., the modeling and simulation resource repository); devising a more effective process to involve TRADOC in simulation support plan (SSP) development; and working with the cost community to develop appropriate cost models and tools.

The Industry CEO Panel, moderated by Dr. Fallin, consisted of Tom Rabaut, President and CEO of United Defense L.P.; Robert Thurber, Co-Founder, Director, and Executive Vice President of Intergraph Corp.; and Michael D. Bolon, Division Vice President for the Advanced Amphibious Assault Vehicle (AAAV) Program at General Dynamics Land Systems. Rabaut provided an industry perspective on what requirements are needed to continue the evolution of SMART. Next, Thurber highlighted Intergraph's participation in the development of integrated product data environments (IPDEs) and noted that the IPDE process has been adopted by all Service organizations and several government agencies. Bolon concluded the Industry CEO Panel by noting that the AAAV Program has incorporated many of the technologies and processes prescribed by SMART. He also expounded on the continued need for a greater acceptance of this new process and its tools.

> **"The SMART concept provides a vehicle for executing the various acquisition reform initiatives that are part of the Army's modernization effort."**
>
> —Ellen Purdy
> OASA(ALT)

Keynote Addresses

In his remarks, ASA(ALT) Hoeper emphasized that acquisition reform is a continuing priority for America's Army. Hoeper referred to SMART as one of the Army's key initiatives, and he discussed how SMART supports building the future Army and benefits the soldier.

Hollis addressed the issue of M&S as an essential ingredient in the acquisition process. He noted that some of the recent advances in M&S have allowed the movement of testing and evaluation (T&E) previously conducted in the field, to the computer. He also cited some of the pitfalls in using simulation for T&E and concluded that making the right investment will allow us to capitalize on computer capabilities.

Yakovac proposed developing the technology to import virtual targets into live training ranges. This approach provides more realistic training than the "pop-up" targets used today.

Featured Speakers

Several additional subject matter experts from government and industry gave presentations during the conference. Charles Nietubicz, Acting Director, Corporate Information and Computing Center, Army Research Laboratory (ARL), acquainted the audience with some of the capabilities of the ARL. He noted that ARL is host to one of four DOD Major Shared Resource Centers for High Performance Computing (HPC) and provides the Army and the DOD research, development, test, and evaluation community with state-of-the-art HPC capabilities.

An address by Gary Jones, Director of Technology, Office of the Deputy Under Secretary for Defense (Logistics), highlighted the notion that in today's environment, decisionmakers are data rich and information poor. He proposed development of an integrated data environment that allows universal access to meaningful information.

Ellen Purdy, Senior Operations Research Analyst, Office of Assessment and Evaluation, OASA(ALT), presented a briefing on "Keeping it in Perspective." She noted, "The SMART concept provides a vehicle for executing the various acquisition reform initiatives that are part of the Army's modernization effort."

Two additional speakers provided luncheon addresses. Thomas Edwards, Deputy to the Commander, Combined Arms Support Command, used a humorous and thought-provoking format to deliver his remarks. His glimpse of the future brought home a very serious and real problem—the consistent lack of logistical representation during the early stages of system development.

LTC Nancy Currie, U.S. Army Astronaut, detailed her use of M&S during the mission planning and rehearsal stages of her December 1998 shuttle mission. As the Shuttle Arm Operator on this historical mission, Currie connected the first two U.S. and Russian components of the international space station. Currie trained for this operation solely in a synthetic environment. She pointed out that NASA conducts almost all mission rehearsals and a large portion of T&E using M&S.

Additional Panel Discussions

Vern Bettencourt, former Director of the U.S. Army Modeling and Simulation Office (AMSO), and current Scientific Advisor to TRADOC, chaired the Advanced Concepts and Requirements (ACR) Panel. He preceded the panel discussion with remarks on the role of the Army Standards Process in the implementation of SMART. After introducing members of the ACR Panel, Bettencourt initiated the exchange by addressing the need for a change in the requirements generation process and its acceptance by the acquisition community. The next speaker, Roy Reynolds, Director, TRADOC Analysis Center, White Sands Missile Range, reinforced the notion of a "tight" link between the ACR and the research, development, and acquisition (RDA) domains. Alan Resnik, Assistant Deputy Chief of Staff for Combat Developments, HQ TRADOC, provided the next presentation. He stressed that the SSP must begin during concept exploration and continue evolving throughout the system's life cycle. The final ACR Panel speaker was Dr. Hank Dubin, Technical Director of the U.S. Army Operational Test and Evaluation Command. Dubin proposed a new, better framework for linking requirements, performance specifications, and T&E.

The Training, Exercises, and Military Operations (TEMO) Panel was chaired by MG Leroy Goff, Deputy Chief of Staff for Training, HQ TRADOC. Goff reviewed the changing nature of the training environment and stated that the SMART challenge is to improve force readiness by fielding future M&S training support systems that incorporate trainability, usability, and fightability features. BG James J. Lovelace, Director of Training, Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS), emphasized the need for early implementation of SMART in the acquisition process. BG William Bond, Commanding General, U.S. Army Simulation, Training, and Instrumentation Command, concluded the TEMO Panel discussion by emphasizing the need to "Join the Pieces SMART-ly." He proposed that the RDA, ACR, and TEMO domains join (through a synthetic environment (SE)) to optimize SMART implementation and execution.

TEMO Panel. Left to right are MG Leroy Goff, HQ TRADOC; BG James J. Lovelace, ODCSOPS; and BG William Bond, STRICOM.

Breakout Sessions/Back Briefs

The conference culminated with back briefs summarizing the results of breakout sessions held during the conference. These working sessions were convened to solicit fresh ideas and encourage participants to identify issues and make recommendations for how to institutionalize SMART. Breakout session topics included Operations, Logistics, T&E, SE, Requirements, Training, Smart Enterprise Model (SEM), and Standards.

Participants in the Standards Session recommended greater participation by program managers (PMs) in development of SMART standards. In addition, they recommended that PMs identify program threat modeling requirements as early as possible and that SE stratification be reinvigorated to identify commonality across domains.

Those in the Logistics Session recommended that the logistics community be more involved in SSP development. They also recommended leveraging the Operation and Support Cost Reduction Program to support model development. Finally, they recommended that the Defense Acquisition University develop appropriate course content for inclusion in the logistics acquisition curriculum.

T&E Session participants said that the T&E leadership is "onboard" relative to the SMART effort, but the testers are not. They recommended that T&E participation be energized to support SSP development. They also recommended developing a process so that developers avoid using biased threat and environment models.

Participants in the Training Session recommended reinforcing AMSO's integrating role, exploring distributed simulation to create a synthetic training environment link to the Army Battle Command System, and having interoperability between legacy and future systems.

Those in the Operations Session found that there is a need for higher fidelity image generation to support night operations and for an automated terrain feature extraction capability. They recommended that training programs, leader development, and soldier support be embedded in the SMART vision.

Conferees in the SE Session recommended that command, control, communications, computers, intelligence, surveillance, and reconnaissance and synthetic natural environment M&S requirements be integrated. Finally, this session noted that the Army does not have a single agency monitoring the Army's synthetic natural environment activities.

Investigating an open team structure that includes industry, finding opportunities for funding pre-Milestone 0 activities, and changing Army regulations and TRADOC pamphlets to support SMART were three recommendations put forth from participants in the Requirements Session.

Finally, participants in the SEM Session recommended that the Army promote development of a digital product description (DPD) and SEM as early in the product development process as possible. They also recommended that the technical architecture the community uses to develop and employ the DPD/SEM be better defined.

Author's Note: An after-action review containing all the panels' recommendations was submitted to Kern and Hollis (in his role as Army M&S proponent) following completion of the conference. All recommendations were approved for implementation.

Conclusion

In his summation of the conference proceedings, Kern termed the conference a success, noting that it resulted in continued actions to institutionalize and evolve SMART. The next SMART Conference is tentatively scheduled for early 2000.

PAUL D. AMOS was an Acquisition Analyst with Science Applications International Corp., McLean, VA, when he wrote this article. He supported the Analysis Division, OASA(ALT). A major in the U.S. Army Reserve, Amos holds a B.S. in marketing from North Georgia College and is pursuing an M.S. in information management from Central Michigan University.

WILLIAM A. REED is a Senior Analyst/Engineer with Science Applications International Corp., McLean, VA. He is currently supporting the Analysis Division, OASA(ALT). He holds an M.S. in information systems from Golden Gate University and a B.S in computer science from Chaminade University in Honolulu, HI.

SMART AND DUAL-USE TECHNOLOGY

Dr. Thomas H. Killion

Introduction

Dual-use technology is defined as having both military application and sufficient commercial potential to support a viable industrial base. By increasing the use of these technologies in Defense systems, the Army can take advantage of the same competitive pressures and market-driven efficiencies that have led to accelerated development and savings in the commercial sector. This approach, which leverages commercial production capabilities, will benefit the Army through reduced development costs and potentially reduced production costs. The key is to identify where the Army and industry have mutual interests and can work together to develop technologies that meet both Defense and commercial needs.

Dual-Use Program Evolution

An early dual-use program, the Technology Reinvestment Project, provided clear evidence that DOD and industry can work together to develop technologies that meet both their needs. In FY97 and FY98, under the auspices of the Dual-Use Applications Program (DUAP), the Office of the Secretary of Defense and the Services cosponsored the establishment of a variety of dual-use science and technology (S&T) efforts. By law, these projects were executed through cost-sharing agreements with industry, which contributed at least 50 percent of the cost of each project.

The Army was an aggressive participant in the DUAP S&T effort, receiving funding for participation in 38 projects in FY97 with a total value of $88 million ($21 million from the DUAP, $21 million from Army agencies, and $46 million from industry). In addition, the Army received funding for participation in 42 projects in FY98 with a total value of $83 million ($20 million from the DUAP, $20 million from Army agencies, and $43 million from industry). An example of a project sponsored under the DUAP S&T effort is an initiative undertaken by ITT Automotive (now part of Continental Teves) to adapt automotive antilock braking systems and low-speed traction control technology for High Mobility Multipurpose Wheeled Vehicles (HMMWVs) and medium-duty trucks to enhance safety and improve low-speed maneuvering.

The use of modeling and simulation for product design, performance prediction, and upfront trade-off analyses can greatly accelerate the development process.

Dual-Use S&T Program

In FY99, funding and responsibility for the dual-use effort was transferred to the Services and the DUAP was renamed the Dual-Use (DU) S&T Program. Under the DU S&T Program, the Army will continue to pursue cost-shared technology partnerships with industry, combining DU S&T funding ($\leq$25 percent), Army agency core 6.2 funding ($\leq$25 percent), and industry funding ($\geq$50 percent). The matching funds from the DU S&T Program and from industry provide a strong incentive for Army agencies to adopt this new way of doing business. One of the central goals of the program is to attract nontraditional suppliers using "Other Transactions or Cooperative Agreements," which provide greater flexibility and fewer burdensome regulations than traditional contracts. The ITT Automotive effort cited earlier is an excellent example because this sector of ITT previously had never done business with DOD.

SMART And Dual-Use Technology

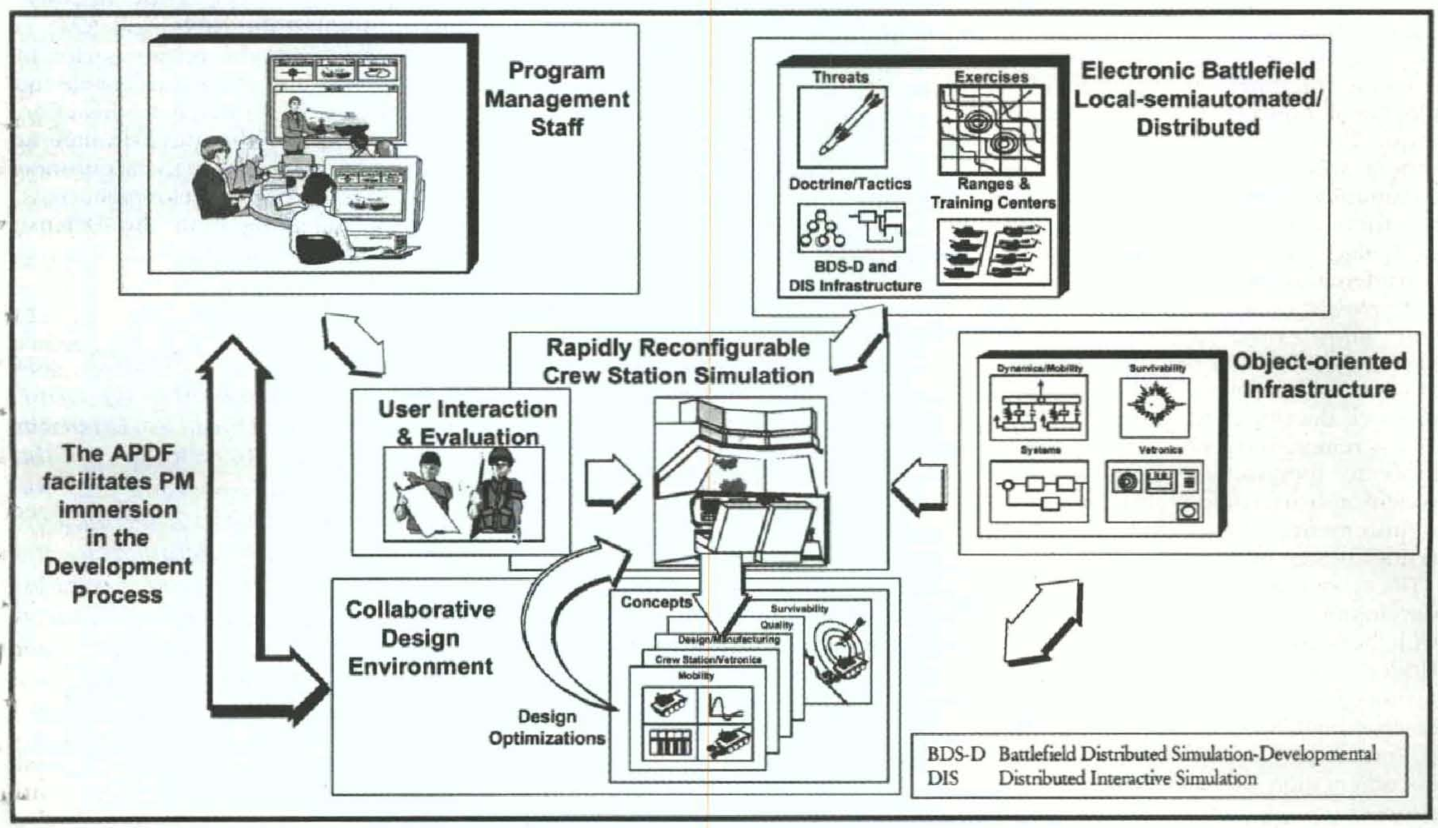
Both the Army and the private sector are exploring innovative methods for reducing costs and time for product development. Simulation and Modeling for Acquisition, Requirements and Training (SMART) is an essential component in the success of these acquisition reform efforts. The use of modeling and simulation for product design, performance prediction, and upfront trade-off analyses can greatly accelerate the development process. The investment by Chrysler Corp. (now Daimler Chrysler Corp.) in its new development facilities and simulation capabilities is just one example of the private sector's interest in applying SMART-type processes to reduce cycle time and development costs.

Under the DU S&T Program, the Army has sponsored a number of efforts involving the development or enhancement of SMART tools. The primary sponsors of these efforts have been the National Rotorcraft Technology Center (NRTC) at the NASA Ames Research Center and the National Automotive Center (NAC) at the Army Tank-Automotive Research, Development and Engineering Center (TARDEC). The NRTC (rotary-wing vehicles) and the NAC (ground vehicles) are major dual-use centers established by the Army to collaborate with and leverage the private sector in the development of critical technologies.

NRTC Projects

Representative SMART-related efforts at NRTC include two projects that are contributing to the development of a suite of Integrated Helicopter Design Tools (IHDTs). The projects are directed at developing and demonstrating an integrated conceptual and engineering design environment federation, based on common distributed object design principles that will support trade-off and sensitivity analysis throughout the development life cycle of a rotorcraft. The project's technology products include demonstration and validation of an integrated, distributed design engineering software environment for rotorcraft. Products will support interactive, multidisciplinary, plug-and-play engineering design tools, applications, and databases. This support will result in an estimated 30-percent design process improvement and a projected 25-percent reduction in component design and rework for development of military and/or commercial rotorcraft.

As requirements for rotorcraft designs have become more demanding, development costs have increased significantly, and development time has gone from years to as much as a decade. Sharply constrained budgets dictate a reversal of this trend if rotorcraft are to remain competitive



NAC automated product development framework (APDF) and affordable. The IHDT Program supports the vision of the Army Materiel Command's Task Force on Weapons Systems Acquisition Cycle Improvement, "[T]o field better and affordable combat materiel in the shortest time." Applying this technology to future platform programs, such as the Joint Transport Rotorcraft, may result in estimated savings of $250 million per year during a 3-year development life cycle.

NAC Projects

Similar to NRTC, the NAC is developing advanced modeling and simulation tools for product conceptualization and design and trade-off analyses. NAC has initiated an ambitious, integrated program involving four interlocking, intermeshed efforts that will, when completed, constitute an unequaled "man-in-the-loop" simulation and collaborative design capability to support the SMART process (see figure on Page 29).

The first project focuses on the development of an Automated Product Development Framework (APDF) for advanced ground vehicles. This project is directed at developing capabilities to fill the most critical technological gap inhibiting the creation and implementation of the SMART vision. This gap is the inability to effectively combine the different engineering and functional domains that make up the acquisition process. The resulting system will provide the Army design community with the equivalent of an Internet capable of handling the exchange of information that is considered essential for participation in tomorrow's commercial world. This will allow program/project/product managers (PMs) and program executive officers to be more involved in the product development process and to access remote modeling and simulation tools to monitor the progress of a system and its conformance to system requirements. This will ultimately reduce design time.

The second NAC project addresses the development of a Virtual Distributed Collaborative Environment (VDCE). Under this effort, an analytical prototyping and simulation environment is being developed, which is interactive and provides real-time documentation of each element in the process. The VDCE will allow distributed users supporting Army projects to have the ability to collaborate using realistic Army models in real time in an integrated data environment.

The integrated, efficient techniques and tools embodied in the SMART concept are readily applicable to both commercial and military product developments.

This project will also allow the inclusion of part visualization in the APDF described previously, providing a connection between the product data and design rationale developed in the APDF and the e-commerce network that will support products in the field. Part visualization will help realize the significant reductions of costs in sourcing and order processing already demonstrated in the commercial sector.

The third NAC project involves development of an Advanced Ground-Vehicle Research Visual System, which will provide a highly realistic and accurate depiction of a virtual world for simulation-based ground vehicle operations, testing, training, and related activities. This system will provide a realistic, interactive, "immersive" virtual simulation of the real-world environment for ground vehicle operators, allowing repeatable, easily instrumented testing of man-machine interfaces.

Implementation of this visualization capability will enhance TARDEC's ability to bring the customer (the soldier) into the design and development loop to evaluate system design and operation capabilities. Enhanced visualization capabilities will move system designers, developers, evaluators, and customers toward the time- and cost-efficient "virtual proving ground," and away from significantly more expensive and time-consuming functional testing done with prototype or production vehicle systems.

The final project, the Vehicle and Heavy Equipment Virtual Proving Ground (VHEVPG), seeks to create an internationally unique capability by linking four of the world's most advanced driver and "hardware-in-the-loop" simulators available at TARDEC with the University of Iowa, and by creating common high-fidelity, off-road VPG environments.

The Army will use the resulting environment as a synthetic battlefield, and other government agencies and industrial firms will use it for product development. The VHEVPG will integrate distributed interactive simulation, physics-based modeling, and virtual environments being developed by the NAC, the National Science Foundation, and the Industry/University Cooperative Research Center for Virtual Proving Ground Simulation, with both government and industry participation.

The VHEVPG project will include "proof of concept" demonstrations for systems design, acquisition, and life-cycle support processes. The linked capabilities of these simulators will allow modeling and simulation of a wide range of expected operating scenarios for nearly all heavy-duty military ground-based vehicle systems.

Conclusion

The integrated, efficient techniques and tools embodied in the SMART concept are readily applicable to both commercial and military product developments. The Army dual-use effort, through the NRTC and NAC, is coinvesting with the private sector in the development of tools to enable the SMART concept. Ultimately, this effort will provide new design environments and methods to shorten the acquisition process and reduce development costs, thereby benefiting both the Defense and commercial sectors.

DR. THOMAS H. KILLION has served since inception of the DUAP as the Army's Dual-Use Program Manager in the Office of the Deputy Assistant Secretary of the Army for Research and Technology. He was recently detailed to the Advanced Systems and Concepts Office of the Defense Threat Reduction Agency as an Operations Research Analyst. He has a Ph.D. in experimental psychology from the University of Oregon.

SOME BRIEF OBSERVATIONS ON THE FUTURE OF ARMY SIMULATION

Bran Ferren

Note: This article is an excerpt from an addendum to the 1997 Summer Study on Battlefield Visualization prepared by the Army Science Board, of which Bran Ferren is a member. It has been embellished somewhat to accommodate the form and style of this publication.

Introduction

There are two kinds of people in the world: Those who believe there are two kinds of people, and those who do not. Beyond this, I really do believe there are two kinds of people, who are divided by the way they approach new product development. Requirements people and Big Idea people.

Requirements folks believe in researching their subject thoroughly. They talk to their customers, do research, study the competition, build prototypes, hold focus groups, etc. The endgame to their efforts is a requirements document. Once agreed to by their management, this document is "tossed over the transom" to others tasked with building it. When the document is completed and delivered, everyone eagerly waits to see if the product is successful. If so, the requirements were met and everybody basks in the reflected glory of a job well done. If not, the search begins for the guilty party. The requirements process (and people) are familiar to most who are employed by, or work with, the Army. (You can tell if you are in a Requirements organization if you have viewgraph projectors in your conference rooms.)

Big Idea folks use an altogether different process. They firmly believe that it's a waste of time to talk to their customers. Doing this will never result in innovation, just incremental advances, and this bores them. Big Idea people are convinced that they know a lot more than anyone else about their subject and the best thing anyone else can do is follow *their* creative vision. The motion picture business depends on a Big Idea creative process. You don't ask the audience to direct the movie. You hire the best people with creative vision you can find, give them a lot of money, and basically trust their instincts (usually based upon their track record and the effectiveness of their "pitch"). (Instead of viewgraphs in these conference rooms, you find artwork, models, budgets, and often—great passion.)

It's important to note that neither process is intrinsically superior. Each can be appropriate to address a wide variety of challenges. In fact, some of the greatest organizations have learned how to accommodate the strengths of both kinds of thinking. The only little complication in merging the methods of these two kinds of people together is basically they hate each other! They approach the world from such different perspectives that they frequently don't share a common language, let alone mutual respect or compatible work methods. In my experience (coming from an organization that absolutely requires both types of thinking), the only way to get this kind of collaboration to work is to establish a clearly defined process. In this approach, both parties understand that they will eventually be heard and that their ideas will be given a fair hearing. Even then, it's still very, very tough.

Interestingly enough, the U.S. Army has on occasion had great success in utilizing both Big Ideas and Requirements on a single project. Take for example the former Chief of Staff of the Army, retired GEN Gordon Sullivan, who had the inspired vision to "Own The Night." That was a Big Idea. As he said, just give him a way to fight equally well at night as during the day, and he'd be happy. All Big Ideas can be expressed clearly in one sentence. His Big Idea was an easily understandable vision that in turn gave the Requirements people working in night vision, radar, communications, etc., what they needed to get to work.

This roundabout introduction is my way of suggesting that it's time for some new Big Ideas in Army Modeling and Simulation (M&S). Basically, I'm suggesting that there are techniques available that could significantly change the way we think about both the art and science and the value of simulation.

Overview

Clearly, there are significant M&S issues facing the Army as we move into the future. Many of these are being addressed by my colleagues with a wealth of accumulated experience in government M&S. I would like to extend the discussion a bit to include some topics that perhaps lie outside of what is generally discussed. I feel strongly that these topics could have measurable impact on both the direction, and effectiveness, of the Army's future mission.

Let's face it, simulation is a very new field. Even though some of us are still waiting for this "computer thing" to blow over, most are convinced that simulation is valuable and here to stay. Nonetheless, we need to remind ourselves that we are still pretty clueless about its full potential. Evangelizing about this stuff is a little like trying to convince the Wright Brothers that frequent flyer miles is going to be the path to their long-term success. It's instructive to note that we are just barely beyond the Kitty Hawk stage of Army M&S. The fun part is what lies ahead.

To get there, we must continue to invest in M&S research and development (R&D), and not fool ourselves into thinking that the research is done and that now it's simply a matter of productization. We've barely scratched the surface of what is possible. The good news is that there is real momentum building. The danger is that we are starting to believe that we have all of the right answers when it's not clear to me that we're even asking all of the right questions. Please take these observations in the spirit with which they are intended: an informal heads-up on some subjects that could have impact on our future success. As always, I will happily defer to people more expert than I about why it may, or may not, be sensible (or even possible) for the Army to pursue these approaches.

Approaches To Simulator Design And Development

So where are we in the evolution of simulators anyway? Is this a mature, well-understood science, or are we still learning and, if so, what? I'm afraid some people are so caught up in the successes of simulation that they may forget that M&S is an art and science in its infancy. While some of us need to spend our energies fielding the current generation of systems hardware, the rest of us need to keep dreaming. With the current pace of technology, if we can dream it today, we can build it tomorrow!

Our near-term issues tend to revolve around one central question: How good does a simulation have to be to be an effective training tool? For discussion purposes, I'd like to describe what seems to me to be the generational evolution of military training simulation—past, present, and future. Granted, the boundaries are fuzzy, but dividing our progress into these categories has helped me think about what may come next.

This issue of "what's next" has always been an elusive one. For example, in the entertainment industry, the pioneers of live theater never anticipated the success or impact of motion pictures. Later, the Hollywood studio people didn't appreciate the importance of a new invention called "Television." And in turn, the Network TV folks didn't think cable would be anything other than a technical means to provide programming to areas with weak reception. Instead, cable has turned out to be a narrowcasting medium, which is rapidly overshadowing broadcasting in both viewership and scope. It's anybody's guess today if you ask a cable executive, "What's next?"

Here's the list. (By my assessment, at this point in time we are just getting ready to move into the Sixth Generation of training simulation.)

Generation I: The first real training simulators arrive—The Link. Aviation terrain boards, and various teleoperated miniatures. Also, a whole collection of dedicated hardware-based "trainers" usually designed to perform one or more very specific tasks.

Generation II: Simulators incorporating electronic image generators, Infinity optics, multi-DOF motion bases, etc. These new technologies are employed to bring a new degree of realism to the simulations, as well as to provide much greater flexibility in model complexity and system dynamics. Somewhere between Generation II and Generation III, we start to see serious integration of weapons systems, avionics, sensors, and a variety of realistic threats.

Generation III: More immersive experiences, including virtual reality (VR) head-mounted displays and very wide field of view (FOV) imaging (i.e., multiprojector domes).

Generation IV: Multiple Generation II or III devices networked together using shared databases. Higher fidelity, Simulation Network (SIMNET), Distributed Interactive Simulation (DIS), etc. We start to see highly immersive interactive environments (VR, Core Automated Virtual Environment (CAVE), etc.) evolving to the point of usefulness.

Generation V: (This is where we are now). Introduction of stochastics to provide uncertainty, virtual reality synthetic humans, adaptive databases (e.g., synthetic "mud" that a tank can get stuck in and leave tracks), increased use of texture and dynamic lighting effects to enhance reality, early photorealism, early on-platform embedded simulation. Photorealistic and multispectral imaging capability have allowed simulation to move beyond training into becoming a serious mission rehearsal tool.

What's Ahead

Generation VI: Special environmental effects and "eight senses" multisensory coordinated stimulation to enhance reality. I say "eight senses" because it seems to me that we use this number to do the kind of work that is relevant to simulation-based training. These are sight, hearing, smell, taste, touch, temperature, orientation/balance, and our sense of the passage of time. Why on earth do we persist in saying that people have only five senses? This includes the use of complex-wide dynamic-range inputs and special effects to increase immersion and human sensory loading. The intent of all of this is to provide an emotionally rich experience that can increase the stress loading of the participants. There is an emphasis on story-based scenarios with a high degree of interactivity and unpredictability. It will employ fully embedded simulation with very realistic sensory channels. (This hasn't happened in training applications yet, but is easily in reach as it is a known art in entertainment industry simulators.) This approach was first seen several years ago in simulation-based attractions created for Theme Park entertainment venues. For example, Disney's "Star Tours™" or Universal's "Back to the Future™").

Generation VII: Embedded (on-platform) simulation capable of running hyper-real time scenarios to help the soldier make in-process battlefield decisions. (Not only possible, but nearly trivial, in 10 to 20 years—please see "BIG IDEA ALERT" in next section.) Storytelling methodology will come into common use for designing immersive simulation environments for training applications. By this point, immersive display technology and high-performance computing will now be readily available to the warfighter (individually or crew served).

Generation VIII: You believe the simulation is the real thing. The only difference to the trainee is he or she (hopefully) won't really die if they make a big mistake. (This will happen 30 years into the future, if we pay attention; 50 if we don't).

A little Q&A And An Argument With Myself

So, should we wish to, we could now do Generation VI training simulation. Why should we care? I think there is a real need in the Army for new "Generation VI" type of simulation to train our soldiers more effectively in conditions of human sensory overload (you know, like during battle). By definition, soldiers are professional sensor fusers. The modern electronic battlefield (not to mention military operations other than war (MOOTW)) is going to tax the overload recovery of the soldier and commander up to (and beyond) their limits. The ability for our people to effectively fuse information (not just data) is their only chance of making consistently correct decisions. It is important to note that while the amount of *information* is rising exponentially on the modern electronic Net-Centric battlefield, the amount of *knowledge* is remaining relatively constant. We have pretty much the same number of countries, bad guys, and issues as we always have. Imagine a haystack with a constant number of needles, but with exponential hay growth. A scientist would call it a rapidly deteriorating signal-to-noise ratio. That's the battlefield of the future and we need to train to be ready for it.

We MUST upgrade our simulation capability to give our troops a sense of what this will feel like before they have to do it for real. Our current simulators are woefully inadequate in this regard. On our best day, we provide the soldier with a largely intellectual experience. What's needed is an emotional one as well.

How do we know that technology beyond Generation V will help train solders better, faster, and/or cheaper? Should we stop the progress of next generation simulation R&D because what we have now is simply good enough to meet the Army's needs for the foreseeable future? One approach is to build some tricked-out "next generation" simulators, run people through them, and then do some performance tests to find out if training has been enhanced. Of course, it will take some real thought and time to figure out how to really measure simulator training effectiveness. I have my doubts that this can be done as easily as many would like to think. It's often quite frustrating to quantify human experiences. But I think there may also be a less analytical approach, more like the Core Business approach used by some in industry to decide what must be kept in house versus what's OK to farm out. If we believe that M&S is, and will continue to be, core to the Army's future business, then we must keep developing each next generation of simulators to understand their value. Besides, what if Henry Ford had thought the cars of his day were good enough and didn't start his own company? Or more to the point, what if no one had ever declared that our Army needed to "Own The Night"? The war in Iraq might have had a very different outcome.

Does the ARMY really need higher fidelity simulation? Don't tests show little or no benefit from higher fidelity? *It's been trendy over the past few years to claim we don't need a lot of bells and whistles in our simulators to do effective training. I've heard lots of talk like "things like motion bases and high definition imaging just add costs without benefits." Far be it for me to doubt the words of our experts, but let's not fall into the trap of thinking one can evaluate "success" by just looking at a few test scores. While this is certainly helpful information, it does not necessarily tell us what we really need to know. Just because a soldier can shoot a simulator well doesn't mean he can shoot a real gun well. And just because he can shoot a real gun well in training, doesn't mean he can do it on the battlefield, in combat. We need to have the world's best warfighters—not just the world's best simulator jockeys!*

Just what do we really mean by high fidelity, and what might the benefit of higher fidelity be? Also, are there alternatives to traditional approaches to increasing simulation fidelity? First of all, what is the Army's definition of fidelity in training simulation? I have yet to find one definition (but I have found many). Most people I've talked to equate fidelity with visual imaging quality (expressed as pixels, polygons, dynamic range, lumens, frame rate, etc.). I don't buy this. Life isn't just about pixels. It's about how accurately (technically, experientially, and emotionally) the simulator conveys the experience of doing the real thing. I think that there is an argument to be made that enhancing both sensory loading (beyond the visual channel) and *emotional* resolution (a key component of fidelity when you're talking about human beings) will provide a more effective training experience.

By emotional resolution I mean how the information being delivered is perceived by the observer. Think back to things you saw on TV that really moved you, things that created memories and feelings that were so moving as to be unforgettable. For me, watching Neil Armstrong set foot on the moon, watching President Kennedy's assassination, and witnessing the Challenger disaster all qualify.

Let's face it, simulation is a very new field. Even though some of us are still waiting for this "computer thing" to blow over, most are convinced that simulation is valuable and here to stay.

The technical resolution of all of these experiences was ordinary. The emotional resolution, however, was extraordinary and indelibly etched these events into my psyche.

I believe that the fidelity of a given simulation should be viewed holistically. That is, it should be thought of simultaneously from its technical and emotional perspectives to achieve a balanced view of its effectiveness. For example, if you want to use simulation to teach someone what it's like to drive an old Bradley under real battle conditions, you need to consider the entire experience, not just imaging accuracy and control response. In the real world, the Bradley crew will likely find that the weapon sight eyepiece fogs over (especially in July at Fort Benning—or in Bosnia), the controls are loose and slippery, the provided-by-lowest-bidder intercom stinks, and the diesel exhaust fumes flowing back into their faces aren't much help either. It's really noisy, it shakes them around, and the damn engine lugs down whenever they turn it hard. Also, when they shoot a 25 mm cannon or fire a missile about 2 feet from their heads (and they're effectively sitting in a tin can), it becomes VERY LOUD.

Our present Bradley simulators do not even attempt to duplicate this experience. They are calm, well mannered, and behave predictably. This is more than I can say for any of the five or six Bradleys I've driven. Today's simulation hardware really teaches our troops how to drive Bradley simulators, not necessarily Bradleys. Granted, this is valuable, but it could be so much more.

This higher level of fidelity that "real life" provides is increasingly (and cost-effectively) approachable in simulations by utilizing modern special effects technology. This expertise was developed by the motion picture, theater, rock & roll, and theme park communities to do more compelling, creative storytelling to keep pace or be ahead of an audience's rising expectations. The reason to apply these techniques and technologies to our training simulations is straightforward. It is to create simulation experiences that would expose the trainee to an experience that much more closely emulates the sensations of what actual warfighting is all about. If we believe that much of the value of simulation is to develop a good set of reflexes, then it follows that the stimulatory input to the trainee should be as rich and complete as is practical.

By employing Special Effects technology as an alternative to brute force elevation of audiovisual fidelity, I believe we can achieve a superior effect at a much lower cost.

The question remains: Will it train our soldiers better? Let's not spend too much time worrying about it and just quickly build one to find out. If it isn't readily apparent that it is substantially better, then we have our answer.

So how good is good enough? Is there no point of diminishing returns? Well, for most applications, reality is good enough. When our simulations reach the quality level at which they are indistinguishable from reality (to a calibrated human observer—or me!), we don't need to go any further. We aren't even close to this level of reality in most training simulations today. The good news is that we can do much useful simulation work with appreciably less than perfect results. But the debate surrounding how good is good enough will persist until we achieve perfection (and can then back off, should we so choose).

Are there fundamentally different ways of approaching simulation (such as those employed in the entertainment industry) or do all of us "skilled in the art" of simulation use the same process, approach, and methods? If you poke around, three different schools of designing simulations seem to emerge. They are as follows:

- **Scientific/Reality-Based Simulation.** By this approach, the scientific accuracy of the model rules. You try as hard as you can to faithfully reproduce what the real world system actually does (or would do). Accuracy counts more than aesthetics. Reality, rather than the perception of reality, is the goal. To make this stuff work really well, you need real scientists, experts with a lot of experience, good data, patience, and a big wallet. Physics rules, and it is generally agreed that everything in the simulation should be measurable and reducible to quantitative parameters.
- **Story-Based Simulation.** These people take a very different approach. They feel free to exercise complete theatrical license. Reality is often considered somewhat irrelevant, but the *perception* of reality is critical. We trade the ability to achieve big emotional responses for accuracy. Rich, complex sensory inputs are dominant. Adrenaline is good. You want to make it scary? Turn out the lights and bring in the boogie man. This is about master storytelling, not just technical resolution. It's Stephen King time rather than Albert Einstein. The relevant skill set is the very bedrock upon which Hollywood's success is built: storytelling. To make this work, you need all of the capabilities required to do physics-based simulation (although, granted, you can often lighten up on the scientists), AND a multidisciplinary team of great storytelling professionals. These folks include writers, special effects people, lighting designers, motion control engineers, sound designers, and theatrical control system specialists. Much attention gets focused on the "look and feel" and "environmental" aspects of the simulation experience. The motto is "Fake it—if you can get away with it."
- **Bad Simulation.** To some degree, this is what most of us in the simulation business do most of the time (sigh...). Although it's the most common form of simulation, it certainly isn't what most of us start out striving for! The resources and infrastructure necessary to do bad simulation are readily available worldwide. Perhaps not surprisingly, the costs can be even greater than successfully implementing either of the other two approaches. From an Army perspective, we've made great progress on the scientific simulation front. However, on the storytelling side, we've barely scratched the surface. This isn't surprising as storytelling has, to the best of my knowledge, never even been identified as a relevant dimension of training simulation. Let's fix this. I guess part of the problem is that we don't even have a good vocabulary to begin the discussion. Even the word storytelling seems too soft and fuzzy to use in polite Army company. This is too bad because every great military leader I've ever met or read about (as well as every great teacher for that matter) is (or was) a great storyteller. Effective storytelling is a core competency of leadership!

Could a storytelling-based approach to simulation provide training advantages to the Army? If you believe that creating a more compelling and realistic simulation experience could be valuable, the answer is yes. My gut (fully biased) instinct is that this is a productive direction to explore. Let's find out. Why not put together a diverse multidisciplinary team (including folks with strong storytelling skills) and try it. Doing more effective storytelling and training within today's technical limitations would be their objective. We might just get to see what happens when the best of the best in the Army, Industry, and Hollywood decide to collaborate. The key would be to bring together the right people in the right kind of facility to do a collaborative development project. It would be interesting to see what happens when you empower people who put storytelling first and ask them to create a simulated training experience, people who are concerned as much about the *impression* of reality as reality itself.

That's nice. But give me a real simulation example. Say you are in our new Bradley (or better still an M1A2) simulator and you want a great sound of an explosion (the nice "teeth rattling" kind). You basically have two choices. The "scientific" approach is to go into the field and faithfully record a real explosion and then play it back in the simulator. It might even sound OK. The storytelling approach is to go to a Hollywood sound effects studio and "build" an emotionally compelling effect from a collection of library noises, synthesizers, computerized signal processors, etc. When you hear the final result played back in the simulator (or movie theater), I *guarantee* the created sound will be more "real" than the original. If it's done right, the audience is never aware of the process. The final result just seems right for the situation.

Many (often most) of the decisions made by the simulator design team are compromises because our technology can't do everything we want it to as well as we would like, and when it can, we often can't afford it. This is certainly true of the imagery part of our simulators. With appropriate wallet power, they could get 10 times better and still not be close to the fidelity we humans experience every day by just waking up and opening our eyes. So we make value judgments based upon what we think is important, what we can do, and what we can afford to do. More often than not, everyone feels shortchanged and value engineered to death. I'm suggesting that as a partial solution to this dilemma, we could make more effective use of our limited resources by thinking less quantitatively and more qualitatively. This is where the skills of the storyteller come into play. I have heard more than one combat veteran proclaim that the first 20 minutes of Steven Spielberg's film "Saving Private Ryan" is the best depiction of war they've ever seen. This is an example of master storytelling—by a team of master storytellers.

As this skill set applies to Army training simulation, the "theatrical" result might be less technically accurate, but could still be a more effective training tool. I would argue that in many (but clearly not all) of the Army's applications, this would be an acceptable trade. We might get more bang for our buck, and better soldier motivation as well.

If you're at all tempted to dismiss the relevance of storytelling skills to the Army, keep in mind that *all* of our most compelling political and military leaders have been master storytellers. I believe that great storytelling skills are virtually synonymous with leadership skills (Lincoln, Reagan, Eisenhower, Churchill, and—God forbid—even Hitler, were brilliantly effective speakers/storytellers). All of these leaders had the ability to inspire millions and get them to do things they wouldn't otherwise be capable of, not to mention keep their ventures (or empires) well funded and positioned for success.

By employing Special Effects technology as an alternative to brute force elevation of audiovisual fidelity, I believe we can achieve a superior effect at a much lower cost.

Is the use of "Requirements" to define the development of certain M&S systems an outmoded concept, and if so, are any of the alternatives used by industry applicable to the Army? IF we all agree that we need to be able to get from the R&D phase to working hardware, it would seem worthwhile to consider transitioning from our current requirements-based development process to a rapid prototyping/partnering model for some of these experiments. An essential aspect of these collaborations is the effective use of rapid prototyping. Basically, you THINK OF IT > MOCK IT UP > TRY IT OUT > DO IT ALL OVER AGAIN (QUICKLY).

This process of rapid iteration turns out to be very effective in quickly discovering what research efforts work well enough to pursue for further development. It requires a special breed of "can do" people and great support technology, but it can work spectacularly well. Incidentally, the rapid prototyping approach seems to be suitable for both hardware- and software-based projects.

So how does one decide which approach is superior? A basic issue is the cost of failing versus the price of *guaranteeing* success. The government requirements-based contracting system is designed to prevent failure by defining what is desired in the minutest detail. While on the surface this seems like a sensible thing to do, it can have some big drawbacks:

- In that you will be held accountable for failing, the tendency is to be conservative. With long procurement cycles, this almost guarantees the delivery of somewhat outdated systems.
- To avoid misunderstandings and close loopholes, projects tend to generate staggering quantities of paperwork. This is expensive to produce, process, and respond to. It can add enormous cost and, due to excessive complexity, invites errors.
- Things change (faster than requirements documents can)!

What's the alternative? More and more commercial companies are successfully turning to a partnering work model. You select and qualify preferred vendors and then you proceed forward together to understand the problem and create solutions. When it works well, you can save enormous amounts of time and money and get a deliverable that is often a much better fit with the end user's real (as opposed to paper) requirements. It also allows you to react quickly to new discoveries and developments as you move toward completion. This approach has allowed Disney to deliver complex theme park attractions in the requisite 3 to 4 years, and effectively farm out 80 percent of the work to contractors.

The downside to this shared risk "going where no person has gone before" stuff, is that on any given project you will periodically fail—the dreaded (often career-ending) "F" word. Failure costs both time and money, occasionally lots of both. If it is a really fundamental screw up, it could jeopardize an entire program. So why take this chance? Because the upside savings in time and money (and performance gains realized) often can far outweigh the risks. In addition, there is often a value in failing. R&D isn't the same as war. To the contrary, the lessons learned by periodically failing at a really tough and challenging project can teach you a great deal, without being severely damaging. The key is to realize quickly when something isn't working and move on.

I believe that if an R&D enterprise isn't failing (and recovering) at a fairly regular rate, it isn't tackling problems that are hard enough.

New Simulator Technologies And Applications

Are there relevant sources of simulation technology outside DOD or the industries with which we are already connected? Can the Army leverage commercial technology development efforts to enhance the performance of its projects? Yes, and we should proactively design certain Army simulation systems to take advantage of new low-cost processes, tools, and hardware. Some facts to help calibrate our point of view: the Sony PlayStation II or Nintendo Ultra-64 home game machines each cost less than $200. Either will outperform a typical 5-year-old desktop Computer Graphics Interface (CGI) workstation, originally costing about $35,000. There are massive efforts underway in the gaming industry to create tools and authoring environments for these platforms that are scaleable and very user friendly. They were designed with DIS in mind. There is ongoing experimentation to place these systems in a multiplayer DIS environment via the Internet. Already, there is more simulation software (called games) written for these machines than has ever been written for any Defense Image Generation (IG).

Am I seriously suggesting that we convert the Army's simulation IG process to run on consumer and toy computation platforms? Well, kind of. Let's face it, it is becoming a PC-/game-based computation world. The Microsofts and Intels of the world have won. The faster we can get with the program and start leveraging this technology and TALENT pool, the faster we will be able to drive the costs down and the performance up. This stuff isn't ready to solve most of our problems yet. With our input, however, it could become usable in the very near future. We should be studying and experimenting with it NOW. Imagine the visual computation power of 200 Nintendo machines networked together to work as a single IG. This system could outperform ANY Army IG in use today. The consumer technology companies won't do this kind of development work. The government simulation market just isn't big enough to get them to pay attention. Besides, they're probably not the best folks around to run Defense programs. To make this stuff work, we will have to identify the appropriate new resources and develop new relationships and new mechanisms for collaboration. But if we can do so, the increase in our cost/performance ratio for applicable simulations will be huge.

Finding the right balance of COTS (Commercial Off-The-Shelf) Versus GOTS (Government Off-The-Shelf). Perhaps it's an unspoken law of nature, but it seems that our government has to be completely bipolar on major policy issues. The COTS versus GOTS debate is no exception. I would like to caution that while I believe there is enormous leverage to be gained from migrating entertainment industry storytelling skills and consumer electronics/gaming technology into Army simulation thinking, there will always be some Army-specific skills that should be kept in-house. For example, don't expect entertainment people to know about weapon systems, training, doctrine, intelligence, or warfighter strategic skills. However, knowing how to create compelling experiences; do low-cost, high-performance computing; support large-scale network simulations; build graphics-modeling software is (or will be) their stock and trade. In these areas not only will it be futile for the Army to try to compete, but a waste of energy and resources. We need to focus on understanding what the core Army simulation skills set is (and will be) and remain world class at that. We also need to be simply brilliant at getting other industries' technology and skills leveraged against our real-world challenges. For many who are more accustomed to doing the reverse, this will be a new experience.

If I had to guess at an ideal ratio for the future, it would be 10 percent GOTS and 90 percent COTS. Just don't underestimate how hard it will be to be world class at that Army 10 percent. In terms of attracting and retaining top talent, procurement, and systems integration, it will probably be among the toughest technical missions the Army will face.

Are there some huge new applications for simulation that we're simply overlooking? BIG IDEA ALERT! How about a distributed and adaptive battlefield C4I+S (Command, Control, Computers, Communications, Intelligence, *and Simulation*) architecture utilizing EMBEDDED HYPER-REAL-TIME SIMULATION (HRTS) to assist the warfighter while in theater and in battle? Why should simulation be limited to off-line mission planning applications? And for goodness sakes, let's stop thinking that the Holy Grail of simulation is to get it to run in *real time*. I want orders of magnitude better than real time! Here's why:

Consider a network of battlefield systems with enough computer horsepower onboard that virtually every component can run high-performance simulations as a background task. When I say high performance, I mean they can run at one hundred (or one million) times real-time speed, the sorts of simulations that now run at one hundredth of real time. With this capability onboard, you could run scenarios to predict the possible outcomes of a battle while fighting and quite possibly make decisions that would positively affect the outcome.

Now you're thinking "yeah right," you can't run simulations that fast even on our biggest supercomputers. I agree it's impractical now. But in 15 or 20 years, it will be technically trivial. Thanks to a whole variety of rules of thumb like Moore's Law, we practically know this for a fact. Given the lead time to field new technology in the Army, we should be working on the necessary topologies and architectures NOW.

Imagine a scenario where the battlefield C4I+S network is continuously reoptimized as it works. Areas of congestion or excessive latency would be automatically routed around. In this manner, the "stress" on the technical systems and warfighters could be better accommodated. Software-based control panels (touch screens?) would automatically label themselves and display the minimum amount of information necessary to do the *complete* job at hand. Spectrum would be intelligently and transparently reallocated where it would do the most good. Information Warfare attacks and computer virus threats would be automatically identified and fought with the software equivalent of a biologically immune system (running as a simulation background task) AND fielded hardware would have a much longer useful life because it could be "rebuilt and upgraded" remotely, on the fly.

Here are some other examples of what this could do for us:

- Make battlefield communications systems more survivable and self-optimized for speed and throughput, irrespective of configuration changes or battle induced damage.
- When much-faster-than-real-time simulation becomes practical, the warfighter would have a predictive tool available, online in the field, and integral to their weapons, mobility, and communication systems.
- Give commanders the ability to update or redefine the functionality of key attributes of their systems on the fly while deployed.
- Allow for a more seamless transition and handoff from the simulated environment to the real world.
- Allow the results of simulation to directly affect the functionality of a system while actually in use (rather than be limited to training and pre-construction design engineering roles).
- Break the cycle of delivering outdated systems to the field because of long procurement cycles. In a perfect world, if the field systems could be completely reconfigured by loading new software, it would have a much longer useful life with higher performance. If you could "upgrade on the fly," the benefits could be incredible.
- Java-esque object-oriented **applet technology** (or object-oriented programming (OOP) languages like Squeak—a follow on to Smalltalk) could let small, cheap processors embedded in future portable equipment perform like workstations do now. If the tank commander needs an animating 3-D graphic of the threat situation over the next hill, he would get the data and the graphics software necessary to display it. Once viewed, both the data and the display program are purged, ready for the next task. This approach would also enhance the security integrity of captured hardware, as little sensitive information would need to be stored in non-volatile system components.

Once we have this simulation technology embedded in our warfighting systems, we would also get the capability to log the data flow of the systems in active use. Not only would this provide a unique opportunity to review what actually happened, but also the same data could be used to "fine tune" the online simulations. This kind of heuristic self-learning behavior could enhance overmatch by making the "brilliant" battlefield systems smarter and highly adaptive to the specific threats and tactics faced in each new threat environment. *Believe me, I fully understand why this is going to be very difficult to make real. I also appreciate that adding this idea of HRTS to the battlefield could cause as much damage as it could good. Why do it? Because it's inevitable. It has to happen as our simulation technology continues to move forward. What I'm really suggesting is that the sooner we realize this, the sooner we can craft a vision of the future that will accommodate it. To do this sooner rather than later will hopefully allow us to do a more sensible migration to the next generations of M&S, the intent is to further empower our warfighters.*

Why now? What's the hurry with mocking up story-based training simulations and launching into a serious R&D program to investigate next generation embedded HRTS? Because we've recently reached the point in the evolution of computer and special effects technology where we **CAN** do it. To realize this vision would require radical changes in how our large-scale systems get designed and implemented. If we don't start thinking about this now (and the way we think is in part by spending serious R&D dollars), our enemies might very well get to use it in combat before we do. A strange artifact in the evolution of new technology in the military is that those who start last often have the greatest technological edge because they aren't burdened with aging legacy systems and the perceived (often mistaken) need to remain "compatible."

To quote Sun Tzu in his yet unpublished technological sequel to *The Art of War*, "Go Figure."

A Final Request

For those of you who make your living in Army simulation, I urge you to look into the future to create your own new vision of where M&S could be in 20 years. If you can imagine it now, it will then be possible. Go visit a theme park, or see a movie, or attend a rock concert, and think about how aspects of these experiences could make what you do more effective. Go hug an artist or other kind of storyteller and, together, go cause some trouble! Any one of you could invent the Big Idea that will initiate the next great generation of simulation technology. All it takes is some patience, creativity, vision, and a lot of passion to get it done. Don't believe my simple ideas; go invent your own. I know one of you reading this has what it takes, and then some. Remember, we've barely scratched the surface.

BRAN FERREN is President, Research and Development and Creative Technology, Walt Disney Imagineering. He is also a member of the Army Science Board.

VIRTUAL AIRCRAFT LOADINGS

Jennifer Napiecek and
Ford Cook

Introduction

The Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) performs virtual (simulated) aircraft loadings using motion analysis software and three-dimensional computer-aided engineering (3-D CAE) models of equipment and aircraft cargo bays. These virtual aircraft loadings aid in evaluating the compatibility between military equipment and military transport aircraft during the development phase of the acquisition process. In addition, when test loading is not practical, this procedure is used to develop loading procedures in video format.

In recent years, MTMCTEA engineers have applied this technology to transportability assessments of the Longbow Apache Attack Helicopter (AH-64D), the Non-Developmental Airlift Aircraft (NDAA), and Comanche Reconnaissance and Attack Helicopter (RAH-66) acquisition programs.

Longbow Apache (AH-64D)

In 1994, we used motion analysis software and 3-D CAE models to perform virtual test loadings of six Longbow Apaches in a C-5 aircraft and three in a C-17 aircraft. The 3-D CAE models of the Longbow Apache were provided by the contractor, and the 3-D CAE models of the aircraft cargo bays were developed by MTMCTEA personnel. The aircraft models were based on published drawings and were limited to box-like simplifications of the true interior of the aircraft. This required personal knowledge of the aircraft and repeated conversations with loadmasters to confirm or deny possible interference areas that were brought into question because of the limitations of the aircraft models. The motion analysis software, the 3-D CAE models, some tenacious gathering of raw data, and personal experience enabled MTMCTEA engineers to determine if the required number of AH-64Ds could fit into the aircraft, the disassembly and loading sequence required for each load, and the feasibility of restraining these loads to the aircraft floor. The resulting analyses showed that it was indeed possible, with limited clearances, to load and restrain six Longbow Apaches and all transportability ground support equipment inside a C-5 aircraft (Figure 1) and three inside a C-17 aircraft.

In April 1998, the Program Manager for the Longbow Apache conducted an actual test loading of six Longbow Apaches and all ground support equipment into a C-5 aircraft. As predicted by the virtual test loading, all six aircraft and ground support equipment fit into the C-5. Originally, the Program Manager had scheduled a test loading for the C-17 also. However, the integrated product team members decided that this test could be deleted from the test schedule because of the AH-64D's similarity to the AH-64A and because the MTMCTEA virtual test loading demonstrated that three AH-64Ds could be successfully loaded into a C-17 aircraft. Eliminating this test

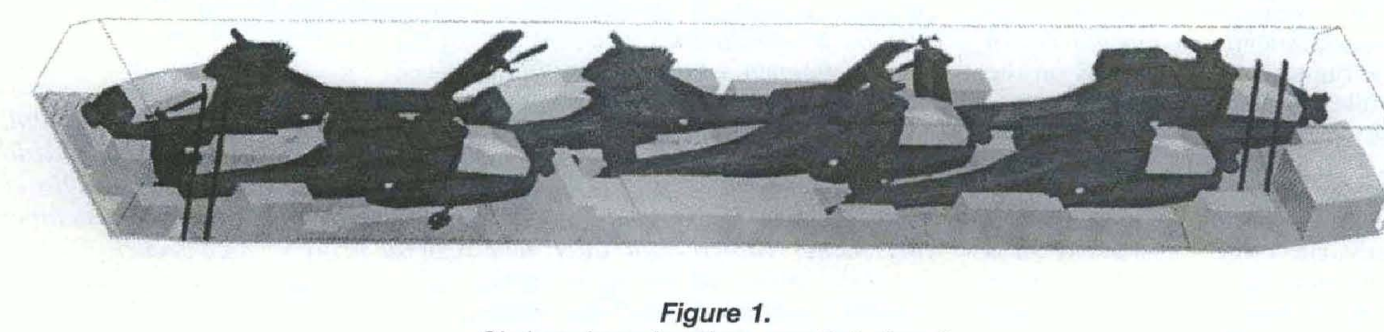


Figure 1.
Six Longbow Apaches on a C-5 aircraft

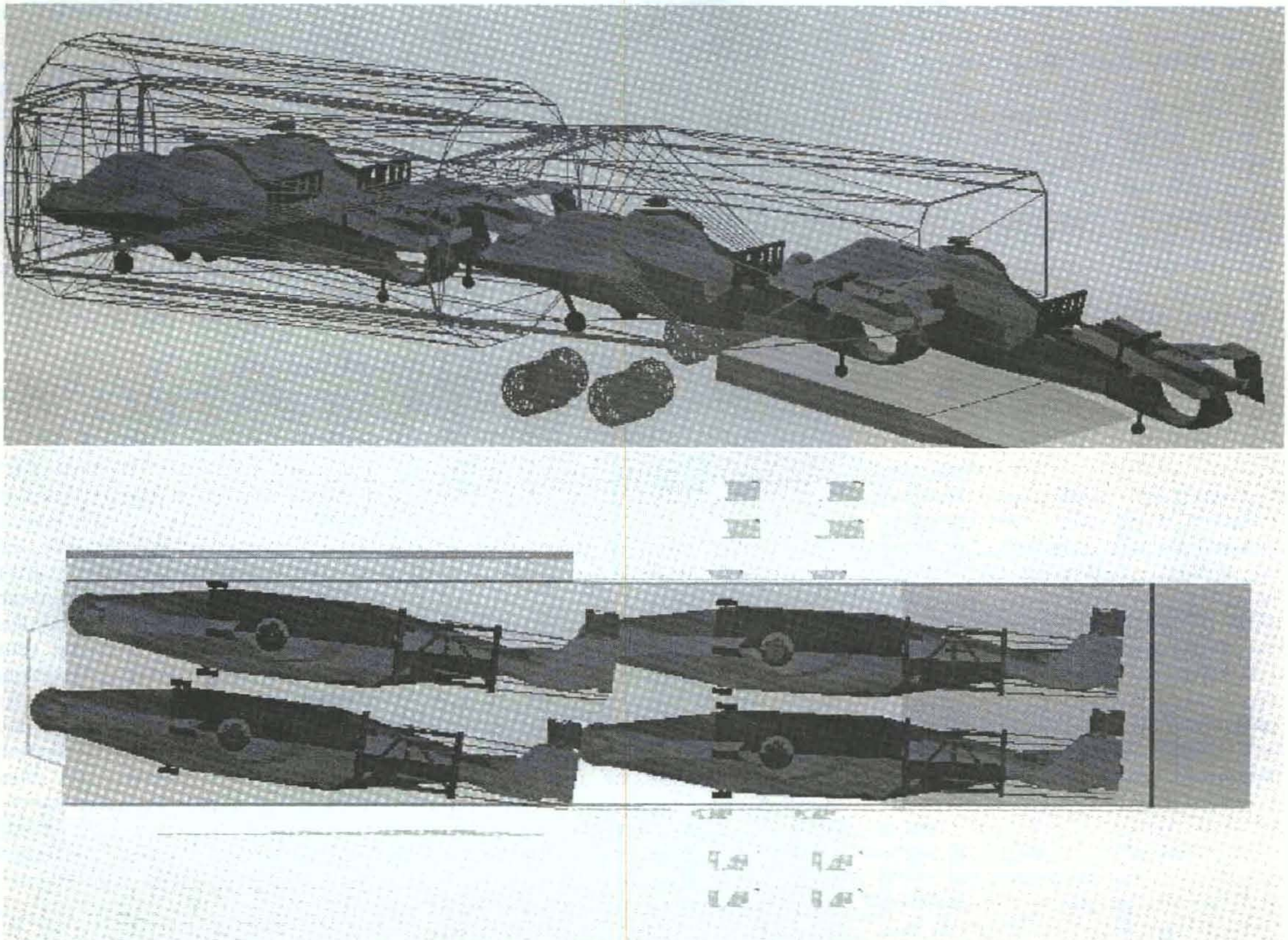


Figure 2.

Top graphic shows aircraft during loading process. Bottom graphic shows four Comanches loaded onto a C-17 aircraft.

avoided approximately $50,000 in costs for the Program Manager.

NDAA

In 1994, MTMCTEA used this virtual aircraft loading procedure to analyze the cargo capacity of two NDAA candidate aircraft. The purpose of the NDAA Program was to determine if slightly modified commercial aircraft could be purchased at reduced cost in lieu of the C-17. To be a viable airlift solution, these aircraft needed to be capable of transporting common DOD equipment requiring C-17 airlift. MTMCTEA engineers analyzed the feasibility of loading the Family of Medium Tactical Vehicles (FMTV) 5-ton truck, the M915 tractor, 20-foot International Organization for Standardization (ISO) containers, and other large items into two potential NDAA aircraft. The two aircraft had the same basic cargo bay structure, but differed in the width of the side-loading doors. By using 3-D modeling and motion simulation tools, we were able to verify and challenge claims made by the contractor about certain vehicles fitting inside the aircraft.

Our results showed that it was impossible to load the FMTV into the aircraft with the regular width door without the FMTV physically contacting the door, thereby requiring additional clearance allowed by an extra wide door. In addition, our results showed that two ISO containers could not be loaded side by side in either model. In another scenario, we were able to load two FMTVs side by side, but the procedure required lowering the overall vehicle height by several inches. The analysis determined this height and showed the resulting clearances between the FMTV cab and internal aircraft sidewalls. These virtual aircraft loadings allowed DOD personnel to make informed decisions regarding both the mechanical and operational feasibility of loading various pieces of equipment in the alternative commercial aircraft.

Comanche (RAH-66)

In January 1998, MTMCTEA engineers performed a virtual loading of a Comanche into a C-130 aircraft. The helicopter model used for this analysis was equipped with moveable joints at the main landing gear and the tail caster wheel to simulate the realistic rotational and translational movement of these mechanisms. The analysis showed that numerous main landing gear adjustments and tail caster wheel adjustments are required to load the helicopter into the aircraft to avoid contact between the helicopter and ramp during loading, and between the helicopter and the interior of the fuselage once it is inside the aircraft.

Because of the tight clearances between the helicopter and the aircraft at the floor and the ceiling, the helicopter must be in the fully "kneeled" position to be completely loaded into the aircraft. This results in clearances of less than 1 inch between the helicopter and both the C-130 floor and ceiling. Following the virtual loading of the Comanche into the C-130, a video showing the loading procedure was developed and provided to the Program Manager and contractor.

The virtual loading of four Comanches into a C-17 aircraft was performed in June 1998. For this analysis, the main landing gear and tail landing gear were locked in their fully extended positions. The tail caster wheel, which is an additional ground support item of equipment, was not used for this analysis. The analysis confirmed that four Comanches would fit inside the C-17, as required by the system specification (Figure 2). This analysis also determined the loading procedures necessary to fit all four helicopters into the C-17 and identified the need for shoring to increase ramp clearance to prevent the nose of the helicopter from physically contacting the ramp during loading.

Ongoing Virtual Aircraft Loadings

Currently, MTMCTEA is working on a virtual aircraft loading of eight Comanches in a C-5 aircraft. The landing gear will be fully extended for this analysis, as in the C-17 analysis. We are also working on a virtual aircraft loading of the Marine Corps Advanced Amphibious Assault Vehicle (AAAV). The same techniques as previous analyses will be used to load the AAAV onto the C-17 aircraft. These analyses will show if eight Comanches can be transported in a C-5 and if the AAAV will meet its C-17 transportability requirement. Most likely, actual testing will not be required.

With the rapid development of computer technology and the availability of skilled programmers, we expect virtual aircraft loading tools to become more user friendly and accurate.

Future Enhancements

The current cargo bay models, though fairly effective, are based on the Air Force published clearance drawings and are limited in detail to box-like simplifications of the true physical interiors. In some cases, this imposes false restrictions on cargo stowage areas. This problem is acute when evaluating tight-fitting load configurations such as the Apache and Comanche helicopter systems that exceed published clearances, but do not necessarily exceed true physical boundaries. To increase the fidelity of the aircraft models, MTMCTEA is developing highly accurate digitized 3-D models of each primary transport aircraft (C-130, C-5, and C-17). These new models will be used in our analyses instead of the current cargo bay models. Increased fidelity of the aircraft models will result in a significant improvement in the accuracy of our virtual aircraft loadings.

Virtual loadings currently require an in-depth knowledge of the 3-D modeling and motion analysis software packages. Virtual loadings also require considerable time to set up the correct parameters to simulate the actual movement of the item being loaded, repositioning of the aircraft ramps, knowledge of the sequence of the items being loaded, and substantial computer hardware resources not readily available to aircraft loadmasters. However, with the rapid development of computer technology and the availability of skilled programmers, we expect virtual aircraft loading tools to become more user friendly and accurate. With this goal, we are investigating emerging virtual environment technologies and building a 3-D model database of military vehicles, equipment, and transportation assets that will facilitate the realization of this interactive, high-resolution, load-planning tool.

Conclusion

Setting the pace for acquisition reform, MTMCTEA has developed and successfully applied a virtual aircraft test loading procedure. This procedure allows engineers to determine, early in the acquisition process, if, and how, a piece of equipment will fit into the intended transport aircraft. If a problem appears likely, designers can modify the equipment prior to physical prototyping and manufacturing, thus eliminating costly hardware redesign and test loadings later on in the acquisition life cycle. We have applied the procedure to several acquisition programs and demonstrated how modeling and simulation tools can be used to reduce costs and schedules and provide valuable insight in the design and acquisition of military equipment.

JENNIFER NAPIECEK is a Project Engineer at the Military Traffic Management Command Transportation Engineering Agency. She holds a bachelor's degree in mechanical engineering from the University of Virginia.

FORD COOK is a Senior Engineer working on mechanical system simulation at the Military Traffic Management Command Transportation Engineering Agency. He holds both a bachelor's and a master's in mechanical engineering from the Virginia Polytechnic Institute.

ACMO Announces 11 Selectees For Competitive Development Group Program

Year Group 2000 Competitive Development Group Selectees			
Name	**Organization**	**Location**	**Career Field**
Marietta Allen	OASA(ALT)	National Capital Region	Program Management
Thomas Benero	Corps of Engineers	Fort Worth, TX	Contracting
David Bundy	STRICOM	Orlando, FL	Program Management
Denise De La Cruz	TECOM/EPG	Fort Huachuca, AZ	Test & Evaluation
Chris Grassano	PEO-GCSS	National Capital Region	SPRDE
John Hart	STRICOM	Orlando, FL	SPRDE
Vicki Long	AMCOM	Dayton, Ohio	Contracting
Willard Meyer	IOC	Kerkrade, Netherlands	Manufacturing & Production
Michael Padden	TACOM	Warren, MI	SPRDE
Daniel Pierson	STRICOM	Orlando, FL	SPRDE
Kathy Salas	U.S. Army Korea Contracting	Yongsan, Korea	Contracting

Congratulations to the Year Group (YG) 2000 Competitive Development Group (CDG) selectees! The Acquisition Career Management Office is pleased to announce the YG00 CDG selectees as shown above. These individuals were chosen as a direct result of the YG00 CDG Selection Board that was held in December 1998.

The following article summarizes the CDG Program selection criteria, application process, and selectee demographics for the first three CDG Program year groups.

THE PAST, PRESENT, AND FUTURE OF THE COMPETITIVE DEVELOPMENT GROUP PROGRAM

Sandy Long

Introduction

Now in its third year, the Competitive Development Group (CDG) Program—sponsored by the Army Acquisition Corps (AAC)—is still going strong, and still "looking for a few good men and women." The purpose of this professional development program is to provide intensive leadership training and experience opportunities for competitively selected GS-12 and GS-13 Corps Eligible (CE) and AAC members. When an individual is selected for the CDG Program, he or she is placed in a position on the Army Acquisition Executive Support Agency Table of Distribution of Allowances for a 3-year period. During these 3 years, the CDG selectee is rotated through assignments and training opportunities as outlined in the CDG selectee's Individual Development Plan (IDP).

The CDG selectee develops his or her IDP in conjunction with Acquisition Career Management Office (ACMO) representatives, a Functional Acquisition Specialist (FAS), the selectee's new supervisors, and the Acquisition Career Management Advocate (ACMA). Although a promotion is not guaranteed as part of the program, the program is structured to make CDG selectees highly competitive for higher level responsibilities within the AAC and the Army. If a CDG selectee has not been competitively selected for a promotion at the completion of the 3-year period, the ACMO and U.S. Total Army Personnel Command will work with the selectee to locate a position that is appropriate for the selectee, the AAC, and the Army. Whether the CDG selectee leaves the program as a result of a promotion or completes the 3-year period, the selectee will be accessed into the AAC.

Even though the CDG Program is now in its third year as mentioned earlier, it is still undergoing changes. This article provides information on how personnel were selected for the CDG Program in the past, what qualifications they possess, and some of the changes being made to improve the program's application process.

Selection Criteria

Individuals are selected for the CDG Program through a competitive selection board process. The CDG Selection Board, which is comprised of five GS-15 AAC members and at least one colonel, receives guidelines from the Deputy Director for Acquisition Career Management (DDACM) for use in evaluating and recommending individuals for the CDG Program. The board member is also instructed to view the applicant's entire file and rate the applicant on his or her potential to become an effective future leader within the AAC and the Army.

Starting with YG01, instructions to the board will be changed to indicate that an applicant must be Corps Eligible, Level III certified, and possess two of the following attributes: an advanced degree, multiple certifications, experience in two or more organizations, or experience in two or more career fields. (See Table 1 on Page 44.)

Board Documents

The documents provided to the board are listed in Table 2 on Page 44. The board member reviews the application to assess and score the individual. Past boards have indicated that parts of the application are easier to review and provide a more accurate picture of the applicant than others. Based on this feedback, the DDACM has made adjustments to the documents provided to the board.

The Acquisition Civilian Record Brief (ACRB) is by far the document most frequently reviewed. It is usually the first document seen and is a snapshot of information on the applicant. Applicants should ensure that their ACRB provides the best possible picture of their achievements to date. Non-AAC members can obtain ACRB update support by contacting their local Acquisition Workforce Support Specialist (AWSS). AAC members can obtain ACRB update support by contacting the FASs.

The Senior Rater Potential Evaluation (SRPE) is a valuable tool that can be used by the senior rater to identify the applicant's potential ability. The board reviews this document extensively and relies heavily on the senior rater's comments and the ranking of the applicant as compared to his or her peers rated by the same senior rater. Board comments have indicated that this document is often not provided, not completely filled in, or does not clearly identify the top performers.

In an effort to gain feedback about the CDG Program from the CE population,

Survey Results Indicate

Did you know that you may be missing out on a wonderful career opportunity because of a misunderstanding about the Competitive Development Group (CDG) Program? A survey of all Corps Eligible (CE) members conducted in January-February 1999 confirmed that there are many misperceptions about the CDG Program. The purpose of the survey was to determine the reasons for the reduced number of applications to the Year Group YG00 CDG Program. The responses received by the Acquisition Career Management Office (ACMO) were very helpful and have revealed a need for clearer information about the CDG Program. The accompanying chart shows the statistical responses from the survey. This article also includes several of the recurring comments that were made by respondents.

The top three responses to question no. 4, *Reasons for not applying to YG00 CDG*, provided some insightful information about the misinformation or misunderstanding that surrounds the CDG Program:

I do not wish to relocate.

Relocation is not necessarily a part of the CDG Program. Once selected, individuals are relocated only when they cannot receive the experience necessary to meet the goals and objectives of the CDG and the Army Acquisition Corps (AAC). To date, only seven CDG selectees have been required to relocate and, in each instance, the selectee has agreed voluntarily to relocate.

I did not feel I had a chance at being selected.

To compete for a CDG position, an individual must be a GS-12/13 (or be at an equivalent pay band) and be a CE member. If you met these two basic requirements, you had a chance at being selected for the program. If you feel you are lacking a specific skill or qualification, there are numerous ways the ACMO can assist you in obtaining that skill or qualification. Seek out opportunities to make yourself more competitive.

I was concerned what my options and/or opportunities would be at the completion of the program.

At the completion of the program, the CDG members are accessed into the AAC and placed into a permanent position at an increased level of responsibility. While the program does not guarantee a promotion, by virtue of the training and experience received, CDG selectees will have the credentials necessary for a competitive edge when competing for vacant Critical Acquisition Positions.

Recurring comments from the survey included the following:

Comment: The program looks as if it discriminates against people over 40, or within specific ethnic categories.

Response: The CDG Selection Board considers individuals without information on race, national origin, age, sex, or other personal information. The average age of the CDG selectee is 46, and the race and national origin demographics on CDG selectees to date is approximately 49 percent female, 51 percent male, and approximately 25 percent minority.

Comment: The package is extensive and cumbersome to complete.

Response: If you completed an application package for an acquisition board the previous year, only updates to the package are required. The process has been streamlined as much as possible while still providing the board enough information on which to base a rating.

Comment: The CDG Program offers nothing that I can't get within my own organization already.

Response: This is correct for some individuals. All of the training and experience that is available to CDG members is available to other Army Acquisition Workforce personnel as well, and if your organization is willing to support an Individual Development Plan as intensive as that of a CDG, then you are correct. The CDG Program allows an individual the opportunity for some intensive training and it affords the CDG member an opportunity to obtain experience within multiple organizations and career fields.

Comment: I felt my supervisor would not be supportive.

Response: A CDG position is nothing more than a new position; the only difference is that you apply through a selection board process. You are *removed* from your current position and placed in a *new position* on the Army a survey of all CEs was conducted in February 1999. (See sidebar starting on Page 42.) One recurring comment received from this Corps Eligible Survey was that many CEs did not apply for the CDG Program because of difficulty obtaining an SRPE. Because this is such a valuable tool, new procedures for obtaining SRPEs will be implemented for the YG01 CDG Selection Board. The applicant will only need to submit the senior rater's name and e-mail address. The ACMO will request the SRPE directly from the senior rater. To improve the quality of the SRPEs, the DDACM will emphasize, during all briefings to senior leadership, the importance of the SRPE and the need for consistent evaluations by the senior rater.

Six performance appraisals and the associated support forms are also required with the application. These provide the board with a historical look at the accomplishments of the applicant from the supervisor's perspective. The board has indicated that support forms are not very useful, but the appraisals help provide a historical picture of the applicant's achievements. The boards have noted that for some individuals, appraisals from year to year do not change. This indicates that there is no growth on the part of the individual. Appraisals and senior rater comments should be specific to accomplishments

CDG Program Misperceptions

Acquisition Executive Support Agency Table of Distribution and Allowances. Once you are assigned to a CDG position, you are detailed to multiple experience opportunities and report to new supervisors. Application to the CDG Program and acceptance into the program does not require your current supervisor's approval.

Comment: I have applied in past years and have not been selected, and I'm not sure why.

Response: Although the ACMO cannot explain to each individual why they were not selected, this article provides some extensive statistics about those individuals who were selected. These statistics should be reviewed and increased attention applied where necessary.

Comment: It is too difficult to obtain a Senior Rater Potential Evaluation (SRPE) from my Senior Rater.

Response: The 1998 CDG Selection Board requested information about the Senior Rater only, and the ACMO requested the SRPE from the Senior Rater. This process seemed to make it easier for the applicant and resulted in everyone having an SRPE for the board. That process was not followed for the YG00 CDG Selection Board, but will be reinstated for future CDG Selection Boards.

The CDG Program was established to ensure the future leaders of the AAC and the Army are trained and provided as much experience as possible. The program is similar to other civilian sector programs that have been put in place to groom middle managers for future leadership positions within an organization. The CDG Program is intended to be a competitive process for all those who qualify. The applicant's package is reviewed and rated as a whole so that all qualifications count equally and the lack of one element is not a disqualifying factor. Applicants should take time to ensure that their packages include all information and present their best attributes. Assistance in building your packet can be obtained by contacting your local Acquisition Workforce Support Specialist (AWSS). He or she is willing and able to assist you in ensuring that you "look your best" for the board. Your career is your responsibility, but the ACMO stands ready to assist you in any way possible.

	Yes	No
1. Apply for YG00?	27	188
2. How learned about the opportunity		
CDG Announcement	34	
AAC Home Page	24	
Postcard notification	23	
AAC Roadshow	17	
Word of mouth	16	
ACMA/AWSS	12	
3. Apply for CDG previously?	61	156
If yes, what years?		
1997	29	
1998	32	
4. Reasons for not applying to YG00 CDG.		
Don't wish to relocate	113	
I had no chance of selection	76	
Concerned about options and/or opportunities at completion of program	68	
Don't fully understand CDG	52	
Too busy to complete my package or was on travel	52	
Don't want to commit to a 3-year program	48	
Don't wish to change organizations	42	
Don't wish to jeopardize current position	42	
Don't know what CDG is	26	
My supervisor was not supportive	18	
CE status not confirmed in time	15	
No SRPE	14	
I am considering leaving the government	13	
I'm being considered for promotion	7	

Table 1.
CDG Program selection criteria

	YG97	YG98	YG00	YG01
Positions Available	25	25	30	30
Minimum Requirements				
Eligible Population	GS-13 AAC/CE	GS-13 AAC/CE	GS-12/13 AAC/CE	GS-12/13 AAC/CE
Certification Level	Level II	Level II	Level III	Level III
Additional Selection Criteria	Desired	Desired	Desired	Must possess at least two of the Selection Criteria listed below.
Additional Selection Criteria *(Note: The CDG Selection Board will consider other factors in its deliberations as appropriate.)*				
Education Level	Master's Degree			
Certification Level	Multiple Level III Certifications			
Experience	Experience in two or more organizations			
Experience	Experience in two or more career fields			

Table 2.
Required documentation for CDG Program application process

YG97	YG98	YG00	YG01
ACRB	ACRB	ACRB	ACRB
Performance Appraisal/ Support Forms (last 3 required)	Performance Appraisal/ Support Forms (last 6 requested; last 3 required)	Performance Appraisal/ Support Forms (last 6 required)	Performance Appraisal/ Support Forms (last 6 required)
Signed AAC Mobility Statement	Signed AAC Mobility Statement	Signed AAC Mobility Statement	Signed AAC Mobility Statement
	Most recent SF50		Most recent SF50
Assignment History	Assignment History	DA Form 2302	DA Form 2302
Senior Rater Potential Evaluation	Senior Rater Potential Evaluation (ACMO requested from Senior Rater)	Senior Rater Potential Evaluation	Senior Rater Potential Evaluation (ACMO will request from Senior Rater)

during a given year and provide a clear evaluation of the applicant's major achievements that provide a basis for future increased responsibility and leadership roles.

DA Form 2302 is helpful to the board in that, if written well, it adds information to the experience block of the ACRB. The selection board recommends that applicants emphasize achievements and not just identify duties. The space on this form is limited for a reason. The writer must be concise when describing achievements. The board also requests that Times New Roman, 12 pitch print be used for this form, a practice that will be required for future boards.

A *mobility statement* must be signed and submitted with each application. This will be used in the event a CDG selectee chooses to move to gain the required or requested experience. The mobility statement is also required for accession into the AAC, which, as indicated earlier, occurs at the completion of the 3-year period. CDG demographics (Table 3 on Page 45) show that only 7 of the 50 CDG selectees to date have required geographical moves. All of those moves were voluntary.

In an effort to streamline the application process, the ACMO has standardized the application packets for all AAC selection boards. Future CDG Program applications need only include an updated and signed ACRB, a signed mobility statement, the six most recent performance appraisals, information on how to contact the senior rater, an SF50, and a DA Form 2302. If an application for the CDG Program was submitted the year before, a complete new package is not necessary, only updates to the package are required. Efforts are underway to establish central acquisition files on all CE members, which will contain this material and eliminate the "application process" in future years.

CDG Demographics

As you can see from the CDG demographics (Table 3), CDG selectees have some pretty impressive qualifications. Each selectee has at least a bachelor's degree. In addition, CDG applicants who show extensive experience in more than one career field or within multiple locations and/or organizations have been selected more often than those applicants who have remained in one job, in one career field, and at one location. A review of the CDG demographics also shows that almost

Table 3.
CDG Program selectee demographics

	YG97	YG98	YG00
Number of Applicants	~700	~400	~100
Number of CDGs Selected	25 (3.5%)	25 (6.2%)	11 (11%)
Promotions to GS-14 (as of March 23, 1999)	10 (40%)	2 (8%)	0
Qualifications–Education, Training, and Experience			
Highest Education Level			
• No Degree or College	0	0	0
• Bachelor's Degree	1 (4%)	2 (8%)	6 (55%)
• One Master's Degree	22 (88%)	19 (76%)	4 (36%)
• More than one Master's Degree	2 (8%)	4 (16%)	1 (9%)
Certification Level			
• No Level III Certification	0	1 (4%)	0
• One Level III Certification	14 (56%)	8 (32%)	5(46%)
• Two Level III Certifications	8 (32%)	14 (56%)	4 (36%)
• More than two Level III Certifications	3 (12%)	2 (8%)	2 (18%)
Experience			
• Experience in one organization	2 (8%)	4 (16%)	2 (18%)
• Experience in two organizations	6 (24%)	7 (28%)	0
• Experience in more than two organizations	17 (68%)	14 (56%)	9 (82%)
• Experience in one career field (CF)	5 (20%)	6 (24%)	6 (55%)
• Experience in two CFs	15 (60%)	13 (52%)	4 (36%)
• Experience in more than two CFs	5 (20%)	6 (24%)	1 (9%)
Primary Career Field Upon Selection			
• Acquisition Logistics	2 (8%)	1 (4%)	0
• Business, Cost Estimating, and Financial Management	5 (20%)	1 (4%)	0
• Communications-Computer Systems	0	1 (4%)	0
• Contracting (including Construction)	4 (16%)	4 (16%)	3 (27.3%)
• Manufacturing and Production (including Quality Assurance)	0	1 (4%)	1 (9%)
• Program Management	5 (20%)	10 (40%)	3 (27.3%)
• Systems Planning, Research, Development, and Engineering	8 (32%)	3 (12%)	3 (27.3%)
• Test and Evaluation	1 (4%)	4 (16%)	1(9%)

	YG97	YG98	YG00
Home Organization/Location Upon Selection			
Southern Region			
• PEO-AMD (Huntsville, AL)	1	1	0
• PEO-AVN (Huntsville, AL)	3	0	0
• PEO-TACMSL (Huntsville, AL)	1	2	0
• AMCOM (Huntsville, AL)	3	5	0
• COE (Huntsville, AL)	1	0	0
• COE (Ft. Worth, TX)	0	0	1
• SMDC (Huntsville, AL)	1	1	0
• STRICOM (Orlando, FL)	0	3	3
• TECOM (Ft. Huachuca, AZ)	0	0	1
• TEXCOM (Ft. Hood, TX)	1	0	0
Central Region			
• PEO-GCSS (Warren, MI)	1	0	0
• AMCOM (Dayton, OH)	0	0	1
• TACOM (Warren, MI)	0	2	1
National Capital Region			
• PEO-C3S (Ft. Belvoir, VA)	1	1	0
• PEO-GCSS (Arlington, VA)	0	0	1
• PEO-STAMIS (Ft. Lee, VA)	0	1	0
• CECOM (Ft Belvoir, VA)	3	0	0
• DSSW (Washington, DC)	1	0	0
• HQDA (Washington, DC)	1	1	1
• INSCOM (Ft. Belvoir, VA)	1	0	0
• MTMC (Alexandria, VA)	0	2	0
• SOCOM (Ft. Bragg, NC)	0	1	0
• SMDC (Arlington, VA)	1	0	0
• TECOM (APG, MD)	2	2	0
• USAG (Ft. Meade, MD)	1	0	0
Northern Region			
• PEO-C3S (Ft. Monmouth, NJ)	0	2	0
• ARDEC (Picatinny Arsenal, NJ)	1	0	0
• CECOM (Ft. Monmouth, NJ)	1	1	0
Other			
• IOC (Kerkrade, Netherlands)	0	0	1
• U.S. Army Korea Contracting Agency (Yongsan, Korea)	0	0	1
CDGs Requiring Geographical Moves			
• Voluntary Moves	2 (8%)	5 (20%)	TBD
• Involuntary Moves	0	0	0

TBD To be determined.

half of the YG97 and YG98 CDG selectees have experience in either multiple career fields or organizations.

Table 3 also identifies the various locations from which CDG selectees are chosen. As you can see, the locations are varied from areas like Huntsville, AL, and Fort Monmouth, NJ, to more distant locations like Korea and the Netherlands.

To date, the promotion rate of CDG selectees has been exceptional. Although a promotion is not guaranteed as part of the CDG Program, a large percentage of CDG selectees will have a competitive edge when competing for vacant positions. Currently, there are 11 YG97 and 3 YG98 CDG selectees that have been promoted to GS-14. Keep in mind that YG97 selectees have not yet entered their third year in the program and already 11 selectees have been promoted.

Conclusion

The CDG Program will continue to grow and prosper because the AAC and the DDACM are fully committed to the success of the program. Adjustments will be made to the CDG Program to ensure the quality of those selected remains at the same high level set by the first three groups of CDG selectees. Selection to the CDG Program is an outstanding opportunity for all CE and AAC members. Supervisors and senior raters should encourage their eligible subordinates to compete and take advantage of this exceptional opportunity to expand their knowledge and experience. The CDG Program is intended not only to benefit those selected, but the future AAC and the Army.

SANDY LONG is an Acquisition Proponency Officer in the ACMO. She holds a B.S. degree in information systems management from the University of Maryland and is within two courses of completing her master's degree in management information systems from the University of Maryland. She is certified in the communications/computers and program management career fields.

SWORD WEAPON SYSTEM CONCEPT FOR THE 21ST CENTURY

William C. Reeves Jr.,
Ronald A. Smith, and
MAJ Lawrence W. McRae Jr.

Introduction

How can leap-ahead technology get onto the battlefield of the 21st century and provide added value to the warfighter in supporting situations like the following?

The year is 2006. As the young soldier looks in the valley in the direction of the suspect enemy artillery position, another volley of rockets can be heard in the distance. The section leader yells, "INCOMING," as everyone jumps into their fighting positions and braces themselves for impact. With sweat running down his forehead and his heart pounding in his throat, he looks out and catches a glimpse of the outgoing rockets from the SWORD battery as they streak across the sky to intercept the incoming volley. Within seconds, all incoming rockets are destroyed and the all-clear signal is given. As he climbs out of his position and looks around, he knows his unit has cheated death. With a smile on his face, he takes a last look over his shoulder and sees the crew of the SWORD preparing for another attack.

This article describes the technology program evolution of a weapon system concept to address the 21st century warfighter's need as depicted in the above scenario. The resulting firing battery is the Short-Range Missile Defense With Optimized Radar Distribution (SWORD) weapon system concept.

Mission Need

The technology program process begins with a mission need or requirement. The Army has a limited cost-effective active defense capability against small radar cross section (RCS) threats such as short-range ballistic missiles (SRBMs), artillery, mortars, cruise missiles, antiradiation missiles (ARMs), unmanned aerial vehicles (UAVs), and rotary-wing launched air-to-ground missiles. This mission need is defined in the Enhanced Counter Air Capability (ECAC) Mission Need Statement (MNS) developed by the U.S. Army Training and Doctrine Command and the Eighth U.S. Army (EUSA) Operational Need Statement (ONS) for active defense to counter the North Korean 240 mm multiple rocket launcher threat.

The new threats of choice by the majority of countries in the world are the low-cost, low-observable, saturation-type artillery rockets that can be used in any weather. These threats have no guidance controls; therefore, the enemy must put a high number of threats on a target to get some level of performance. This combination of all-weather and saturation threats drives the proposed system concept definition.

The accompanying chart is an unclassified summary of mission requirements and ONS. As shown in the chart's objectives, both the ECAC MNS and the EUSA ONS will compel developers of the SWORD weapon system to institute specific operational capabilities.

Technology Development

To address the mission needs depicted in the chart, the Army is using hit-to-kill technology to achieve a significantly lower cost for killing those saturation targets having low-observable RCS. A high probability-of-kill missile is command guided by a radar communicating with the missile's small radio frequency (RF) transceiver all the way to the target intercept. The target is destroyed by the kinetic energy of the body-to-body impact. Throughout the last decade, the U.S. Army Space

ECAC MNS Requirements	EUSA ONS	SWORD Objectives
Primary Threats: Rockets, Mortars, Artillery, and UAVs Secondary Threats: Aircraft, Cruise Missiles, ARMs, and SRBMs	240 mm Rockets	>5 Intercepts of 240 mm Rockets per Second
Fielding: As Soon as Possible	As Soon as Possible	In 2006, Based on Adequate Funding Starting in FY99
No New Force Structure	Minimal Increase in New Force Structure	Maximize Use of Existing Force Structure
All Weather	All Weather	All-Weather Capable
Low Cost per Kill	NA	<$20K per Missile in Production Quantities

Mission and operational needs and SWORD objectives

and Missile Defense Command (SMDC) Weapons Directorate, Huntsville, AL, has developed this hit-to-kill technology, which is specifically applicable to this unique air defense mission.

Research and development for the interferometric acquisition and fire control radar (FCR) technology was initiated by SMDC as a result of the need for a fixed-site point defense of national missile defense assets against the re-entry vehicle submunitions threat during the 1980s. The concept consisted of X-band interferometric acquisition and FCR and a radar-guided gun-launched smart projectile for hit-to-kill engagements out to 25 kilometers. This radar subsystem concept uses the enhanced state-of-the-art digital, electrical, or optical signal processing to obtain a 1-gigahertz (GHz) processing capability. With this signal processing capability, the radar subsystem can obtain centimeter range resolution while mitigating most of the ground clutter and multipath.

The angular differential accuracy of the radar subsystem for the missile and target is obtained by using interferometer principles to measure Doppler imaging of the objects. This angular differential accuracy of the radar subsystem also allows the removal of a missile's seeker subsystem to perform hit-to-kill missions against specific threats at lower tier air defense ranges.

The U.S. Army Aviation and Missile Command's Missile Research, Development, and Engineering Center (AMCOM-MRDEC), Redstone Arsenal, AL, developed the missile interceptor technologies. MRDEC also developed propulsion motor cases, small command and guidance mechanisms, inertial measurement units, autopilots, and lethality enhancers to support multiple U.S. Army missions.

SWORD Weapon System Concept

Responding to the potential threat from hostile nations and terrorists with low-cost proliferated weapons such as cruise missiles, SRBMs, UAVs, and short-range rockets, DOD made theater missile defense (TMD) a top priority. SMDC responded to the need for a low cost-per-kill weapon system to negate the short-range capability of these threats by selecting an interferometric acquisition and FCR with an RF transceiver-guided, high probability-of-kill missile.

This weapon system concept requires the acquisition and FCR to have a very accurate endgame tracking of both the threat and the missile. The weapon system's ability to track both the target and the missile is dependent on their size, engagement geometry, atmospheric conditions, number of engagements per second, and other related parameters. Most of these parameters are not controllable; however, incorporating an RF transceiver as an active transponder with a ground-based acquisition and FCR subsystem can enhance the signature of the missile. This approach of command guiding a missile to perform hit-to-kill missions requires two important operations: determining the precise location of the missile with respect to the threat at all times during the engagement and providing delivery rate of guidance update commands to allow the missile to correct its flightpath toward the threat. The missile's onboard transceiver and radar electronic subsystems allow both of these essential operations to occur.

The SWORD weapon system concept consists of two major subsystems: an X-band interferometric scanning phased array acquisition and FCR, and a low-cost, command-guided 3.75- to 4-inch class missile. The operational SWORD radar is a 5-meter baseline X-band interferometric radar that is an all-weather class radar with the capability to perform 360-degree on-the-move search, detect, track, and classify functions, as well as simultaneously engage multiple threats. The SWORD missile will have a boost-sustain motor to provide the required lethal velocity and an inertial measurement unit produced by Honeywell Inc. to measure the missile orientation while in flight.

SWORD will also have a MOOG Inc. proven-design hot-gas generator to provide the missile divert capability and a Technovative Applications Inc. proven-design RF transceiver and off-the-shelf autopilot control subsystem for the missile command control capability. A proven lethality enhancer mechanism will be incorporated into the missile system to obtain a higher probability of kill.

The SWORD system weapon concept is an optimized sensor-shooter-killer combination that minimizes the time from threat detection to threat destruction. The SWORD can provide continuous protection of forward-area maneuver forces or can be strategically positioned to defend strategic and tactical fixed-site assets and critical command, control, communications and intelligence (C3I) nodes. The SWORD weapon system can operate autonomously or with existing C3I TMD and air defense architectures.

Because of its tactical size, the SWORD interferometric acquisition and FCR can be mounted on wheeled or tracked vehicles. A 3.75-inch class baseline missile design is required to provide enough firepower to counter high-volume saturation-type threats. The missile can be fired from a deep magazine launcher such as the Multiple Launch Rocket System.

Although the SWORD weapon system concept is optimized to address the stressing high-volume saturation threat mission role, the system's performance objectives include the capability to assist in other active air defense mission roles such as artillery, mortars, UAVs, ARMs, SRBMs, rotary-wing launched air-to-ground missiles, aircraft, and low-flying cruise missiles. For example, using the forward-area active defense C3I nodes, the SWORD radar can hand off its engaged threat launcher's predicted position to a counterfire artillery battery or other engageable shooters during the battle. The SWORD radar can be used during battle for cueing, precision pointing, and tracking data to compatible sensors and shooters for coordinated multitiered kinetic or directed energy theater missions.

Proposed SWORD ATD

To prove that an operational concept has merit, an advanced technology demonstration (ATD) consisting of two major phases is proposed. The first phase will use an existing X-band dish antenna with a 5-meter baseline FCR with elevation and azimuth servomechanism, and a 3.75-inch class hypervelocity missile (without the lethality enhancer subsystem) to command guide the missile to a surveyed stationary target at specific ranges. This phase will validate the FCR command-guidance algorithms and the missile's response to the FCR.

The first step consists of integrating the existing subsystem hardware (without the lethality enhancer subsystem) into a missile. The next step will integrate the interferometric FCR (with processor and electronics) and the missile into a complete operational system. Because the radar used in the ATD has a limited field of view and power output, the target's cross section will be enhanced. The enhanced target will match the RCS return expected from a fully populated scanning phased array X-band 5-meter baseline FCR and a 1-GHz signal processor (which will be completed for the second phase of this proposed ATD). The proposed exit criteria for the first phase includes obtaining search and track angular differential accuracy required for 240 mm rocket engagements and command guiding a missile to a stationary target within the required miss distance.

The second phase of the proposed ATD will use a fully populated scanning phased array X-band 5-meter interferometric acquisition and FCR with an enhanced 1-GHz signal processor and radar command-guided 3.75-inch class hypervelocity missile (with lethality enhancer). The objective of this phase is to command guide a missile to hit and kill an unenhanced surrogate 240 mm rocket. The proposed exit criteria include obtaining search and track angular differential accuracy required for hit-to-kill intercept, command guiding a missile to a stationary target within required miss distance, and command guiding a missile to a hit-to-kill intercept.

Conclusion

After a mission need or requirement is identified for mitigating a specific threat, the materiel developer defines the weapon system concept to meet the desired need. To prove that the weapon system concept has merit, an ATD with approved exit criteria from the Army combat developer and user community is proposed.

The proposed SWORD ATD is the first step by SMDC to introduce leap-ahead technology to meet air and missile defense needs into the tactical theater. If the proposed SWORD ATD is successful, and the Army goes forward with deployment, the SWORD system could transition into a fast-track acquisition program. This would begin with an engineering manufacturing development effort during the stationary target miss distance test scheduled in the second phase of the demonstration. The delivery of the first SWORD platoons could start in the fourth quarter FY06.

WILLIAM C. REEVES JR. is the Director, Weapons Directorate, Missile Defense and Space Technology Center, SMDC. He has more than 29 years of government experience in science and engineering. He earned his B.S. degree in physics and his master's degree in business administration from Alabama A&M University, Normal, AL.

RONALD A. SMITH is the SWORD Program Team Leader in the Weapons Directorate, Missile Defense and Space Technology Center, SMDC. He has 31 years of government service, including 16 years at SMDC working in survivability, testing, and systems engineering disciplines. Smith received a B.S. degree in mechanical engineering from Catholic University of America in Washington, DC, and an M.S. degree in engineering management from the Florida Institute of Technology.

MAJ LAWRENCE W. MCRAE JR. is the Test and Integration Officer in the Weapons Directorate, Missile Defense and Space Technology Center, SMDC. He received a bachelor's degree in business administration from Tuskegee Institute and a master's degree in procurement acquisition management from Webster University. McRae is also a graduate of the Air Command and Staff College.

From Industry . . .

THE Y2K CHALLENGE: A CORPORATE PERSPECTIVE

Phillip Curtis

Introduction

The challenge for supremacy on the year 2000 (Y2K) battlefield has been daunting to the military as well as to its partners in the corporate world. Today, every Army functional proponent, program executive office, program manager, and major command is working hard to meet Y2K milestones and ensure that their systems will be operable during the new millennium. TRW Corp. faces the same challenges.

The Environment

It is common knowledge that the Y2K problem stems from a computer programming convention that used two-digit year fields instead of four-digit year fields in software, hardware, and firmware. This could cause many computer programs and devices to fail as they attempt to calculate against the year "00," failing to recognize that the year is actually 2000 instead of 1900. In addition, many programs may interpret other coding or special instructions in an undesirable fashion, resulting in unpredictable calculations or a shutdown. The potential impact of this on TRW's operations is substantial and has already manifested itself on some systems that provide forecasting functions beyond the year 2000.

Obviously, the Y2K problem is not limited to a single area within TRW. Information technology is used to support or perform many of our operations. Therefore, we rely on a variety of computers, information systems, devices, and outside vendors to perform our internal business operations (finance, personnel, contracting, and facilities management) and those in support of our customers in DOD, other federal agencies, state and local government, and the private sector. While there are clearly significant technical issues associated with the Y2K problem, TRW sees Y2K as a distinct business and leadership issue to be resolved for our external customers, internal corporate systems and infrastructure, and our multiple supporting vendors. In addition to these Y2K issues, there is concern that the corporate world faces the prospect of litigation related to corporate products, services, and operations.

TRW Y2K Program Initiative

TRW relies on a Year 2000 Program Office to coordinate and support executive oversight of all Y2K compliance activities throughout the corporation. The general objectives of the Year 2000 Program include the following:

- Increase awareness of Y2K issues;
- Coordinate lessons learned among the business groups and corporate projects;
- Assess adequacy of ongoing Y2K projects;
- Provide best practices related to tools, processes, and strategies;
- Provide the framework for progress reports, issues, and plans; and
- Provide information and recommendations to corporate leadership on issues impacting TRW at the enterprise level.

TRW business units and corporate staff have specifically identified managers to orchestrate our corporate-wide Y2K efforts. These efforts generally equate to those identified in DOD's five-phased approach from awareness to implementation. The chain of responsibility extends from the corporate level down to individual managers. Major efforts currently underway include continuous monitoring and reporting, risk assessment and mitigation, internal audit and compliance, and vendor and partner management. Our program must continue to focus on ensuring the safety of our workforce, preventing business interruptions to our clients and the corporation, and minimizing our risk.

Millennium Readiness

TRW's Year 2000 Program Office is continuing to verify our internal systems, complete comprehensive reviews of our product lines, and manage our supplier and service compliance efforts. We are also reviewing our contract base to ensure compliance in areas where we provide system development and integration, information technology services, and engineering services to a diverse spectrum of customers.

Specifically, TRW is pursuing the following activities:

- Providing Y2K progress reports on a regular basis to the executive management committee and to general managers or managing directors within the business units;

• Continuing the strategies of replacing key computer systems in certain business sectors and remediating a number of other legacy systems (migration to Y2K-compliant versions and completion of testing);

• Sustaining our efforts for internal systems in five major areas: business computer systems (financial and material resource planning systems), research and development facilities (including automotive and systems development research centers), desktop systems, technical infrastructure (networks and telecommunications), and other infrastructure (elevators, environmental control, and security systems);

• Continuing to verify the Y2K-compliance status of TRW suppliers and service providers;

• Completing testing and implementation to prepare us for the century change in enough time to continue normal operations; and

• Communicating our Y2K progress.

Corporate Relationships

While most organizations are dealing with the principal systems under their direct control, they must also evaluate the capabilities of their partners and vendors. For example, a number of legal staffs may be exchanging carefully constructed documents relevant to their compliance status.

This exchange of knowledge requires the requester to identify and describe what compliance really means to their business operations. Realistically, this effort calls for collaboration among systems personnel, business subject matter experts, and legal staff to obtain the key information commensurate with appropriate legal safeguards. This is generally accomplished with official correspondence among partners. This type of dialogue allows the respective parties to determine where each stands regarding Y2K-specific criteria and to obtain assurances for continued functioning of corporate practices, systems, and devices. Companies must then evaluate risk areas and develop relevant contingency plans. Clearly, this effort requires independent assessment by the principal players of a specific business process as they judge the capabilities of their partners and determine future alliances. For example, TRW adheres to the Automotive Industry Action Group process for automotive supplier management. This process is based on the use of a broad (2,000-plus questions) Y2K survey and leverages the activities of automotive manufacturers to manage suppliers deemed to be high risk.

TRW's Year 2000 Program Office is continuing to verify our internal systems, complete comprehensive reviews of our product lines, and manage our supplier and service compliance efforts.

TRW is also identifying business practices that may be impacted by the Y2K issue. In general, this requires careful scrutiny of our contractual base to identify our responsibilities, measure specific Y2K clauses or concerns, and ensure that we meet acquisition requirements such as the Federal Acquisition Regulation Y2K contract language. This assessment also extends to various products such as those in our supply chain management, systems integration, and automotive sectors.

Y2K Customers

TRW is responsible for providing a variety of services that continue to increase because of customer demand. Initially, significant support was provided for end-to-end services such as assisting clients with Y2K awareness, inventory, assessment, migration planning, renovation, testing, and implementation activities. As Dec. 31, 1999, draws closer, client needs become greater and services reflect the requirement to focus on testing and validation support. Recently, many clients directed their attention to the general areas of risk management and continuity of business operations in a Y2K environment.

While many business enterprises have pursued some form of planning and identification of risk areas, it is important to consider the potential failure of various fixes and their impact. This approach provides the opportunity to establish policies and procedures to deal with the pending operational impact. If feasible alternatives are not addressed, the impact could be devastating to normal business transactions. In addition, problems outside the company's direct control may occur, such as power outages, supply chain management disruptions, or other provider services. Because most business enterprises do not have the luxury of conducting a comprehensive end-to-end test for Y2K compliance of their systems, senior leaders must apply their best judgment in dealing with potential problems. Various methods, processes, and tools can be employed, but the primary focus must be on identifying the greatest risks and having remedies in place should failures occur.

Conclusion

Will we really be finished with our work when the calendar changes to January 2000? Probably not. Collectively, the private sector and the government will face a number of challenges. These may include ongoing fixes or remediation actions for other systems previously set aside on a priority basis. In addition, time will continue to reveal system, interface, and device problems requiring modifications and maintenance. Both the government and the private sector can benefit from TRW's Y2K efforts. We now have a very powerful portfolio of knowledge from which to match our information technology assets against our fundamental business processes.

PHILLIP CURTIS is a Senior Manager in the Systems and Information Technology Group of TRW Corp., McLean, VA. He previously served in the U.S. Army in multiple command and staff positions. He has a B.S. degree from the U.S. Military Academy and an M.S. degree from the University of Southern California.

EXTREME VISION FULL SPECTRUM IMAGING FOR THE 21st CENTURY

David L. Jennings

Introduction

Digital imaging has *exploded* at Aberdeen Test Center (ATC) with a variety of visual systems used to document testing and research projects for DOD. From ultra high-speed imaging systems using laser light for illumination, to interactive test reports, ATC has some of the most diverse and sophisticated visual instrumentation capabilities in the Army.

Ultra High-Speed Imaging

The digital revolution has made it possible to capture a visual sequence of up to eight separate images at an equivalent 100 million frames per second. Ultra high-speed imaging is defined as recording speeds above one million frames per second. High-speed imaging is recording video images at faster than the normal 60 field, 30 frames per second, up to one million frames per second.

The recorded programmable images are displayed on a high-resolution monitor within half a second of capture. Variable exposure and interframe times to 10 nanoseconds allow accurate recording of the fastest events. This portable computer-controlled imaging system is rugged enough to withstand the shock and vibration associated with weapon systems testing.

One of the major benefits to engineers studying test phenomena is the ability to view the test results immediately. "Our productivity and customer satisfaction has increased tremendously with onsite verification of test data," states Mark Stern, Leader of the Technical Photographic Section of ATC. Combining ultra high-speed imaging technology with portable lasers enables engineers and scientists to *see the unseen*.

Aberdeen Test Center has designed a portable monochromatic laser illuminator system from commercial off-the-shelf items for recording high-explosive test phenomena remotely. Dr. C.L. Francis, a physicist at ATC, states, "We've taken a technique developed at Lawrence Livermore National Laboratory, by Larry Shaw and his colleagues, and moved it from the laboratory to the field with a portable system." The camera shutter in the portable version is synchronized with laser pulses to illuminate the subject. One example of how this application is used is to study the formation of a shaped charge from a viper warhead. A narrow bandpass optical filter centered on the laser frequency removes self-illumination, created by the warhead ignition, but passes the laser light to the camera. The result is a clear picture of the formation of shaped charges as they develop at speeds in excess of 29,000 feet per second.

Just as technology in weapons and soldier support systems has developed over the years, so has the ability to document and analyze these systems with high-speed and ultra high-speed camera systems. These visual records have enabled engineers and scientists to view the sabot separation of a projectile as it exits a gun muzzle or to study the effects of high-speed braking on the performance of tracked vehicles. The image acquisition process has progressed from waiting for hours to have a roll of film processed chemically to only seconds for a digital image to be displayed in near real time. Not only is this a tremendous savings of labor hours, but it also represents a benefit to the environment and cost savings in chemical handling, disposal, and waste water treatment.

All systems used by ATC are designed or built to specifications that permit them to be transported and used in the most extreme environmental and explosive conditions. Cameras are in the line of fire daily as they capture the downbore exit of a projectile as it leaves the barrel of a tank. The camera positioned in front of the gun records the image off of a mirror angled to view directly down the barrel. The subsequent image documents the flight of the projectile as it appears to come directly at the camera. Full motion is recorded at speeds up to 4,500 frames per second or up to 40,500 frames per second in split frame mode. Up to 5,120 images can be stored in digital memory for review.

A digital image converter system (capable of recording up to 24 images at an equivalent 20 million frames per second) has been used to provide critical information not previously available with conventional high-speed film cameras. This test involved firing a 120 mm projectile at a spaced armor target. A sensor placed behind the first armor plate provided data until the projectile destroyed it. It was not previously known if the projectile broke cleanly through the first plate or if the spall cloud from the plate was moving faster than the projectile, causing the sensor to be destroyed before the accurate data was received. One theory was the spall

A 35 mm remote camera records the type of environment in which digital and film imaging systems are used at the U.S. Army Aberdeen Test Center.

cloud could have been responsible for the sensor destruction, which if true, would seriously degrade the analysis. With the ultra high-speed imager, it was possible to record a visual image to verify that the projectile traveled 17 inches before it outdistanced the spall cloud and destroyed the sensor. The visual proof of the sensor destruction validated the data provided by the sensor to the point of destruction. This visual information had never before been available in a portable field environment with immediate onsite analysis. The camera produces an image resolution of 2,000 by 2,000 pixels. A pixel is the smallest resolvable picture element in a solid-state imaging device. The 2,000 by 2,000 pixel file is equivalent to an 11.4-megabyte digital file that can be downloaded to a Tagged Image File Format (TIFF). The image can also be recorded onto a 4- by 5-inch color negative from the phosphorus screen.

High-Speed Video

Another premier digital imaging system used at ATC records up to 1,000 frames per second in color with more than 5 seconds recording time at a resolution of 512 by 384 pixels. The camera produces an instant high-speed image that can be downloaded to analog or digital media for further image evaluation.

Ballistic range cameras are used daily at ATC to document the performance of projectiles. These production rounds are tested to ensure the integrity of ammunition lots being sent throughout DOD for use by our soldiers. The ballistic range camera records a single image at 1,134 by 486 pixels. The image is instantly transmitted to the test director or customer for immediate evaluation. A digital X-ray records the projectile inside the fireball while the infrared camera records any burning residue at the breech. Instead of waiting until firing has been completed, images are transmitted at near real time, along with target impact data, to the engineers and customer during the test for onsite analysis. The ballistic range camera produces a single black and white image unless the more sophisticated color system is used. The color system incorporates three prism cameras mixed through a central element creating the color image. The ballistic range camera has replaced the 35 mm smear camera on production acceptance tests.

Film Technology

Traditional photography and high-speed motion picture technology is still in use at ATC to augment and provide capabilities not available with digital imaging. Combining the best aspects of chemical film-based technology with the latest digital innovations, ATC provides customers throughout DOD with critical test information consisting of the best quality product available. The digital systems meet the immediate need for speed, while film technology meets the need for higher resolution.

Striving to increase productivity has also benefited the environment by reducing the amount of chemical waste used in film processing. Five years ago, nearly 1.75 million feet of motion picture film was processed each year. This was time consuming and costly. Entire gun crews and engineers had to wait until the film was processed to verify the projectile and other instrumentation was working properly before continuing with the test. Digital imaging has reduced the annual amount of film processed to less than 250,000 feet.

Digital imaging continues to revolutionize the way data are captured, transmitted, and stored at ATC. "We currently use a hybrid approach to documentation, combining the best of digital imaging and film technology, to provide the most cost-efficient and timely product for our customers," says Robert Hagan, Lead Visual Information Specialist at the Image Processing Lab.

ATC follows the data collection cycle with an excellent presentation and test reporting multimedia team. The team uses nonlinear digital editing suites to produce videotapes and also authors interactive test reports that include audio, text, video, digitized film, still images, and graphs. The multimedia reports are released on compact disc (CD). A web page is available at **www.atc.army.mil/iic** to keep updated on the latest developments at ATC's International Imaging Center.

Future Initiatives

As computers and communications evolve on a daily basis, the International Imaging Center continues its exploration of the breakthroughs in science and technology and how they can be adapted to test documentation. "One area that looks promising for the future is connecting the ultra high-speed imaging system to a microscope to document interactions," states William Nori, Senior Imaging Specialist under contract to ATC. Full flight video tracking, from firing to impact, is currently being developed to augment the array of visual instrumentation. Cine-radiography and underwater high-speed imaging of warhead and target interaction are two other areas in which ATC is working to develop another tool designed to *see the unseen*.

DAVID L. JENNINGS is the Leader of the International Imaging Team at the U.S. Army Aberdeen Test Center. He has a B.A. degree in journalism and mass communications from New Mexico State University and an M.S. degree in instructional technology from Towson State University. He is also a member of the Range Commanders Council, Optical Systems Group.

A Competitive Problem-Solving Acquisition . . .

DELTA CONTRACTING

Sharon R. Brown

Introduction

The Holston Army Ammunition Plant (HSAAP) in Kingsport, TN, was constructed in the early 1940s to manufacture large quantities of RDX/HMX high explosives. Now an element of the Industrial Operations Command (IOC), the plant was used significantly during World War II, the Korean War, Vietnam, and Desert Storm. However, peacetime usage has been declining significantly during the past 10 years, with a corresponding increase in the price per pound of RDXs/HMXs. As a result, more and more IOC customers are taking their business elsewhere (offshore), causing a further decline in production and a greater increase in price. At the same time, the replenishment mission for HSAAP remains high. Replenishment is the requirement to produce replacement stocks as directed by Defense Planning Guidance. HSAAP has the entire replenishment mission for DOD RDXs/HMXs. DOD peacetime requirements for high explosives range from 500,000 pounds per year to about 2 million pounds per year. This vast difference between DOD peacetime requirements and its replenishment capacity was the challenge facing IOC to keep and/or bring back RDXs/HMXs customers.

Explosives Management Alternatives Team

In March 1997, MG James W. Monroe, then Commanding General of the IOC, chartered a small multidisciplined team to "compete the problem" of the peacetime and replenishment missions surrounding high explosives and the HSAAP. The Explosives Management Alternatives Team (XMAT) was formed to develop and execute an acquisition strategy through contract award for the "peacetime and replenishment requirements of RDXs/HMXs and for management of the HSAAP facility." The XMAT was comprised of the contracting officer, who also served as the team leader; a program management engineer; two industrial base specialists; one production specialist; a contract specialist; and an attorney.

The Strategy

The XMAT developed a strategy that calls for maximum industry involvement in both defining and solving the problem, while maintaining

To maintain the Delta contracting environment, i.e., the competitive nature of this acquisition, the XMAT devised a two-step acquisition process where the best offerors would be selected in the first step, and the best offer selected in the second step.

One of the key elements in XMAT's successful Delta acquisition was practice. The XMAT practiced scoring oral presentations during the first phase of the acquisition, and the contractors practiced submission of their technical plans.

full and open competition. This contracting method is called "Delta" contracting. It is an outgrowth of the concept of Alpha contracting, which involves a sole-source contractor for development of the scope of work, the solicitation procedure, and the eventual contract. Delta contracting uses this same type of contractor involvement throughout the acquisition process, but maintains this relationship with multiple contractors on a competitive basis.

The first step in developing Delta contracting was to identify the problems to be solved. Four problems were identified that would remain part of the solicitation and be the eventual scope of contract performance: obtaining a suitable peacetime supply of RDXs/HMXs, ensuring replenishment for these items, developing a research and development plan for 21st century RDXs/HMXs, and developing a facility use plan for the HSAAP.

The second step was to solicit maximum industry involvement. The following approaches were used to advertise this acquisition strategy and invite participation: multiple announcements in the *Commerce Business Daily*, presolicitation conferences, call for concept papers, an Internet home page that displayed the acquisition strategy and served as a multipurpose communication tool, and XMAT interviews with trade journals and newspapers. As a result of the concept papers and questions and answers exchanged on the home page, the acquisition strategy was developed. The acquisition strategy would be a full and open competition, with the ability to solve the four problems as the primary criteria. To maintain the Delta contracting environment, i.e., the competitive nature of this acquisition, the XMAT devised a two-step acquisition process where the best offerors would be selected in the first step, and the best offer selected in the second step.

The initial solicitation was issued with the following criteria: experience, past performance, financial status, and the technical plans. These criteria were developed so that only the very best offerors with the very best chance of winning the eventual contract would advance to the next phase. A competitive range was established on this basis. For 6 months, the XMAT corresponded intensively with the successful offerors from the initial solicitation, inviting them to the HSAAP facility, sharing the maximum information about the products, the facility itself, and the problems. This strategy allowed the contractors to devise their own unique solutions to the four problems and did not provide a preset scope of work.

The second solicitation contained the contractual provisions of a facility-use contract (the RDXs/HMXs were on a separate requirements solicitation); however, the performance plans consisted of eight blank sheets of paper, two per problem. Offerors submitted their solutions on these blank sheets. A practice session was held where the offerors submitted their plans and the XMAT determined whether the plans would be sufficient to evaluate and be meaningful as a contract requirement.

The second set of evaluation factors were the overall cost to the government, technical plans, and an overall risk assessment.

Lessons Learned

One of the key elements to XMAT's successful Delta acquisition was practice. The XMAT practiced scoring oral presentations during the first phase of the acquisition, and the contractors practiced submission of their technical plans. Protection of information was also a key part of the XMAT success. A major reason that this was possible was the small size of the XMAT and the protocol that the XMAT developed to gather and provide information. All offerors had to be confident that the XMAT would not reveal their unique plans to another offeror and that the XMAT would advise each offeror fairly. During the open discussion phase, the XMAT published a protocol on how information would be shared. This provided a vehicle for all parties to understand how their information would be used and how the XMAT guaranteed accuracy and protection of the information.

A final lesson learned was that for a competitive Delta acquisition to be of most value for the buying agency, the agency must clearly discern from each offeror "what's in it for them." This was a premise of the XMAT acquisition and allowed each contractor to discuss what aspects of the problem solution best fit their corporate strategies and what the IOC could do to make the final contract more attractive for each of the offerors.

Conclusion

As demonstrated by this process, which took approximately 15 months, a competitive problem-solving acquisition can be accomplished in a timely and effective manner through use of Delta contracting techniques.

SHARON R. BROWN is the IOC Contracting Officer for both the Radford and Holston Army Ammunition Plants at Radford, VA, and Kingsport TN, respectively, and served as the XMAT Contracting Officer and Team Leader. She has a B.A. degree in English literature from the University of Nebraska.

THE ARMY'S ENVIRONMENTAL TECHNOLOGY OVERSIGHT PROCESS

Joseph S. Vallone, Donald R. Artis Jr., and Peter F. Tuebner P.E.

Introduction

The Army is committed to being a leader in environmental stewardship for its installations, facilities, training areas, and weapon systems. It must continue to use its resources wisely to meet its military and civil responsibilities without compromising its role as an environmental steward. Technology can help the Army meet these responsibilities by improving its ability to conserve natural resources, reduce environmental operating costs, and field systems with minimal or no adverse environmental impact.

In view of the Army's environmental responsibilities, the Assistant Secretary of the Army for Research, Development and Acquisition (ASA(RDA)) (now Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT)) and the Assistant Secretary of the Army for Installations, Logistics and Environment (ASA(ILE)) (now ASA for Installations and Environment) established an environmental technology management process on May 2, 1997. The goals are to focus environmental technology programs on user needs, support efforts to provide a science base for the future, and integrate the efforts of environmental technology principal investigators to support the Army's environmental strategy.

The Army's approach to managing environmental technology uses economic analyses to identify the best projects for funding based on the Army mission and environmental urgency, potential cost avoidance, investment costs, and program risk. This approach was developed and implemented in 1997.

Management Process

The Army's environmental technology management process was formulated to focus the Army's research and development (R&D) efforts on fulfilling requirements in a timely and cost-efficient manner. This process is evolving and will undergo refinement as it matures. The Army's goal is to achieve, through technology development and exploitation, environmentally compatible installations and systems without compromising readiness or training. Concurrent with establishment of the environmental technology management process in May 1997, the ASA(RDA) and ASA(ILE) established an Environmental Technology Technical Council (ETTC). ETTC members are senior Army leaders at the headquarters and directorate levels.

The mission of the ETTC is to provide guidance and direction to the environmental technology community, focusing on science and technology and demonstration/validation funded work to satisfy user research, development, test, and evaluation (RDT&E) requirements. This process will produce the Army's Environmental Technology Program Plan. The goal is to fund programs now to avoid future costs.

After the approval of program funding, the ETTC will provide oversight to ensure it is progressing to resolve requirements. Adjustments to the program will be made when necessary to ensure the requirements have been resolved.

Additional environmental technology oversight responsibilities will be administered by the Environmental Technology Integrated Process Team (ETIPT), which is a working group supporting the ETTC, and technology teams (TTs) representing each of the environmental pillars (compliance, conservation, pollution prevention, and restoration). The TTs are composed of members from the R&D community, as well as the eventual users of the new technology. The Plexus Scientific Corp., an independent contractor, provides economic analysis and program support to the ETIPT.

Requirement Identification

In October 1997, the TTs were asked to submit their program plans based on their top five requirements. The TTs identified requirements using the Army Environmental Technology Needs Survey (TNS), which documents and prioritizes requirements. The programs to resolve these requirements were formulated for inclusion in the Program Objective Memorandum (POM) 00-05 submission.

The Assistant Chief of Staff for Installation Management is the proponent for the technology needs process. The TNS documents technology needs from four user communities: users responsible for installation infrastructure, users from major commands (MACOMs) that develop and manage weapon systems, MACOMs that use those weapon systems, and agencies responsible for collecting and tracking needs related to infrastructure and weapon systems.

In November 1997, each TT submitted its high-priority requirements and identified resource needs (funded and unfunded) including RDT&E; procurement; and Army Operation and Maintenance funds needed to develop, field, and exploit technology to resolve R&D requirements. RDT&E funds were categorized as follows: program element, project, task, and work package.

Funding was identified for FY96 through FY05. Funded and unfunded efforts may exist simul-taneously for a particular requirement's resolution. In the near term (FY98 or FY99), no unfunded requirements were supported or reprogrammed. Unfunded requirements begin no earlier than FY00.

The TTs were asked to provide the operating costs to "live" with the current environmental problem and the operating costs once the corrective technology was fielded. These costs were used to compute the expected cost avoidance for each requirement and the payback period to recoup the investment cost. The cost data submitted for each of the requirements were analyzed by the ETIPT for consistency and reliability.

Prioritization Methodology

An economic analysis was performed on each of the requirements. Where data gaps existed, the TTs were asked to revalidate their data. The data were reviewed again and, in consultation with the Army Cost and Economic Analysis Center (CEAC), an economic analysis model named TurboBPR was selected to compute the payback period, return-on-investment, and net present value (NPV) of the potential cost avoidance for each of the programs. Three criteria were selected that represented the most important goals of the environmental technology management process. They were the ratio of cost avoidance to investment; pillar priority, which reflected the environmental and mission urgency of the requirement; and programmatic risk, which reflected the risk of success or failure of the requirement based on how the program for each requirement was developed. Each program was assigned a score in each of these areas and prioritized based on its score. The process and prioritization was presented to the ETTC, which then granted approval to present the proposed programs for funding.

TurboBPR

TurboBPR is a business process reengineering support tool developed for DOD by SRA International Inc. It was recommended by CEAC because it closely mirrors the goals of the environmental technology management process. TurboBPR is a Windows-based program that allows the user to build a strategic plan, linking mission, vision, goals, performance measures, and strategies. It gives the user the framework to analyze operating and investment costs and determine potential cost avoidance.

The TTs entered their data into TurboBPR. Required data were the operating cost of living with the environmental problem as it currently exists, the cost of developing and fielding the technology to solve the problem, and the potential cost avoidance if the technology is developed and fielded.

CEAC Involvement

The CEAC validated the prioritization process, reviewed the data, identified discrepancies and inconsistencies, oversaw the input of the data into TurboBPR, and recommended the final prioritization method. The CEAC concluded that the assumptions, constraints, and methodology used by each team were logical, reasonable, and complete; that each TT's estimate of costs and benefits appeared to be realistic and were derived after much thought, analysis, and discussion; that the approach used for estimating costs is consistent across the alternatives and across pillars; and the TTs used proper inflation and discounting rates.

Prioritization Criteria

Once the TurboBPR results were obtained, prioritization criteria were developed using the TurboBPR results or data submitted by the TTs. The criteria were total investment cost in FY98 dollars, total unfunded requirement (in "then year" dollars), cost avoidance to total investment ratio (CVIR), unfunded requirement to total cost avoidance ratio, programmatic risk, a check to see if each requirement complies with DOD guidance, and mission/environmental urgency.

Three of the prioritization criteria were selected because they closely represented the most important goals of the environmental technology management process: CVIR, mission/environmental urgency, and programmatic risk.

Prioritization Results

The results of the rating process produced a prioritized list of programs. All of the top two programs within each of the four pillars rank within the upper half of those efforts considered priorities in the Environmental Technology Program. This prioritization reflects the importance of the mission/environmental urgency factor. It was felt that this factor should dominate based on its importance as defined by the TTs.

Conclusion

The goals of the environmental technology management process are to focus environmental technology programs on user needs, support efforts to provide an adequate science base for the future, and integrate the efforts of environmental TTs to support the Army's environmental strategy. Meeting these goals requires a wise use of the Army's limited resources.

The results of identifying all the cost and benefit data, economic analysis, and prioritization efforts reveals that for an investment of $312 million (NPV, FY98 dollars), there is the potential to avoid spending $4 billion (NPV, FY98 dollars) over a 17-year period. This is a significant investment, but it reveals the potential to save considerable resources. More work needs to be done to refine these dollar amounts, but the analysis reveals that environmental technology is a wise investment. The realities of today's budgets make it unlikely that this program could be funded in its entirety, but the potential cost avoidances makes it imperative that some type of investment begin now. As the program matures, cost estimating will be refined, and the program's success will demonstrate the wisdom of this approach. The final result will be far fewer environmental problems, more efficient use of resources, and improved military readiness.

***Authors' Note:** Secretary of the Army Louis Caldera issued a policy memorandum Feb. 10, 1999, promulgating/codifying the Army's new Environmental Quality Technology (EQT) Program. In addition to his praise for the Army team responsible for this achievement, the memo challenges this new partnership to seek EQT resolution of high-priority requirements encompass-ing environment, safety, and health across the total Army.*

JOSEPH S. VALLONE is the Assistant for the Environment and Technology, Office of the Assistant Secretary of the Army (Installations and Environment), and serves as co-chair for the ETIPT. He has a bachelor of architecture from the University of New York School of Architecture and Engineering Design.

DONALD R. ARTIS JR. is the Technology Staff Manager for Environmental Quality, Battlespace Environments and Military Engineering Technology, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology), and serves as co-chair for the ETIPT. He has a B.S. degree in aerospace engineering from the University of Texas at Austin and an M.S. degree in public administration from Old Dominion University, Norfolk, VA.

PETER F. TUEBNER is a Project Manager for Plexus Scientific Corp., Silver Spring, MD. He has a B.S. degree from the U.S. Military Academy, an M.M. degree in business from Northwestern University, Evanston, IL, and an M.E. degree in civil engineering and environmental science from McNeese State University, Lake Charles, LA. He is a registered Professional Engineer in Virginia.

SOFTWARE TESTING ON THE M1A2 ABRAMS TANK

Kevin L. Houser and Donald B. Salsman

Introduction

The first Low Rate Initial Production M1A2 Abrams tank, produced by General Dynamics Land Systems (GDLS), was built in November 1992 and has been fielded since October 1995. This was the first Abrams tank system containing downloadable software vice firmware. Why publish an article on software testing of the M1A2 tank system when the tank has been in production for more than 6 years? The answer is because software development (or, more appropriately, software maintenance) for the M1A2 tank is an ongoing process that will continue well after the last M1A2 tank rolls off the production line; and with software maintenance comes software testing.

Abrams Tank Program

Program Manager (PM) of the Abrams Tank COL James C. Moran manages the development of M1A2 software that corrects prioritized software trouble reports, development of tanker (user)-generated enhancements, and fielding of a software release approximately every 18 months. As these software corrections and enhancements are developed, several iterations of testing are performed at a minimum of four levels before the software is ready for submission to the U.S. Army Aberdeen Proving Ground (APG) for software safety release (SSR) and beta (user) testing.

The software developer generates changes to enhance the capability of the tank or to correct bugs in the system software at its lowest level, the computer software unit (CSU), which is referred to as a package. A CSU is similar to a program that performs a specific operation. When the CSU is combined with several other CSUs that either directly or indirectly interact with each other, the resulting block of software is a computer software component (CSC). When the CSCs are combined with other CSCs that operate in one of the tank's "black boxes" or line replaceable units, the result is a computer software configuration item (CSCI). Finally, when all of the tank's CSCIs are combined, the result is known as system software. These four levels of software generation translate to four logical phases for conducting software tests as depicted in the accompanying chart.

Software Testing

As the software developer creates a new program or modifies an existing software unit, he or she also formulates and develops software test cases and procedures to verify that the completed software operates correctly. Once the CSU has been tested and verified, it is integrated with other CSUs. Together, these are logically cohesive to the modified CSU, thus creating a CSC.

At the CSC level, the developer again conducts a series of tests to verify that the modified software operates correctly and interfaces with other packages that are directly or indirectly associated with the modified CSU. The developer determines how comprehensive the testing must be to verify not only that the modified software functions correctly, but also that it interacts properly with other units that use the output from the modified unit. This is referred to as regression analysis, and the output of regression analysis is a matrix of tests to verify that modified software operates correctly.

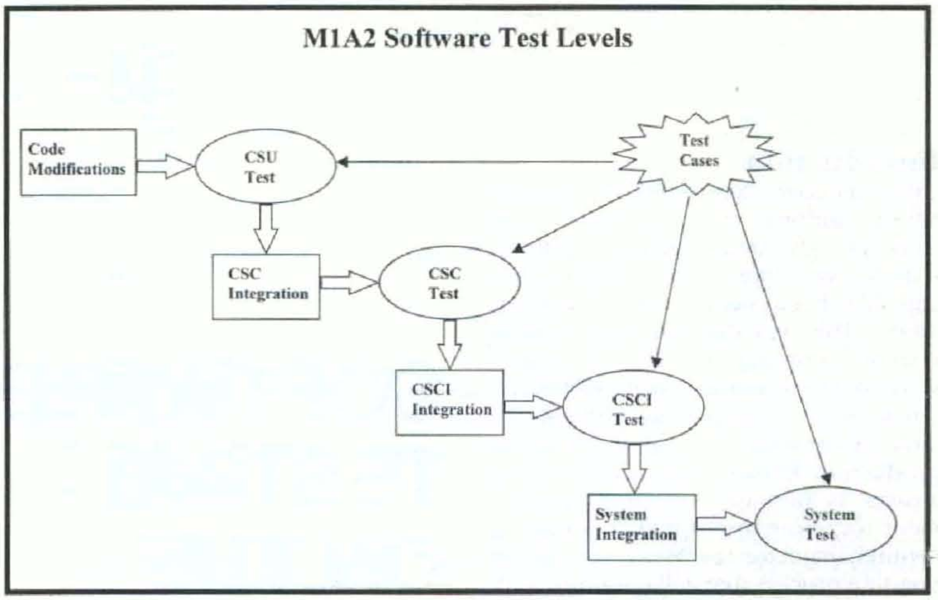
At a minimum, the developer must conduct tests to verify the correct operation of all units that are directly affected by the modified CSU. In other words, if a unit is dependent on another unit that has been modified, then the dependent unit must also be tested. In addition, the developer conducts tests on other integrated units that are indirectly affected by the modified CSU. For example, assume Package A is modified, Package B directly interfaces to Package A, and a third unit (Package C) directly interfaces with Package B, but not Package A. In this case, because Package B is directly dependent on Package A, it must be tested.

Additionally, because Package C is indirectly affected by Package A, the developer must decide whether Package C should be tested. Typically, the developer's decision whether to test indirectly affected units is based on the safety implications and mission criticality of the unit. Once the CSC is verified to operate correctly, it is integrated in an iterative process with the remaining modified CSCs until the entire configuration item, or CSCI, is rebuilt.

At the CSCI level, the software is downloaded and tested on the target hardware as an entire package using software test descriptions. These test descriptions verify that the completed software performs in accordance with the CSCI software requirements specification. Tests at the CSCI level are conducted by an independent group of engineers at GDLS and witnessed by both GDLS quality assurance personnel and government personnel.

After all CSCIs that constitute the M1A2 tank system software have been tested, a final developer phase of tests is conducted at the system level. System-level testing is performed with all CSCIs interfaced to each other and downloaded in the GDLS system integration laboratory, and on a full-up M1A2 tank that replicates the fielded tank configuration. There are more than 5,000 test steps at the system level to verify that the new software functions correctly.

Functional tests are performed on the entire system software to verify that the combination of all hardware and software operates correctly. These functional tests are categorized by the major operational capabilities of the tank such as command and control, fire control, diagnostics, power management, data management, and automotive and navigation. These tests are performed by a separate group of engineers at GDLS and are also witnessed by government personnel. Upon completion of the system-level test phase, the software is packaged on a CD-ROM and sent to APG for the final two government phases of the test process, SSR and beta (user) testing.



Software Safety Release

The U.S. Army Test and Evaluation Command at APG has the responsibility for issuing the SSR for the M1A2 tank. The objective of the SSR is to ensure that the vehicle is safe to operate with the new software and that there is no danger to the tanker or adverse impacts on the vehicle system.

Following delivery of the system software, the software is downloaded to the APG test tank. This tank has been fully instrumented to record all data and utility bus traffic to assist in fault isolation if an event occurs. Testing involves exercising a majority of the capabilities associated with the tank to verify correct and safe operation. These capabilities include moving and shooting live rounds at targets.

Upon completion of the SSR, a detailed test report is produced that identifies the strengths and weaknesses of the new software. If no major problems are identified, a safety release is issued. The safety release allows the new software to be installed on fielded vehicles; however, a beta (user) test is typically conducted as a final measure of the quality of the software.

Beta Testing

Up to this point, engineers and technicians conducted all testing, and all test steps were done "by the book." The difference in beta testing is that it is conducted by senior enlisted soldiers (brought to the test site from Fort Knox) who put the vehicle and software through its paces. These soldiers provide a flavor of how they are trained and how they use the tank by subjecting the tank to many of the scenarios experienced in a realistic mission.

Before using the tank, the Fort Knox personnel are provided a training session on the changes made to the software. The soldiers then perform all normal operations of the tank—from gunnery exercises to preventative maintenance. Training devices are also installed to ensure that no interference problems are encountered. If no major problems are found during the soldier testing, the PM Abrams, with the concurrence of the user committee, releases the new software for fielding.

Conclusion

The software test process on the M1A2 tank is detailed and comprehensive. Although the tank has been in production for years, software development and testing continue, and future software releases are planned. As long as the tank is fielded and in use, the necessity for software maintenance will be an ongoing requirement.

KEVIN L. HOUSER is a Senior Project Engineer at the U.S. Army Tank-automotive and Armaments Command in Warren, MI, and manages the U.S. and Foreign Military Sales M1A2 Tank Software Maintenance Programs. He holds a B.S.M.E. from Wayne State University and an M.S. in computer information systems from the University of Detroit, Detroit, MI.

DONALD B. SALSMAN is a Senior Test Engineer at the U. S. Army Tank-automotive and Armaments Command, Warren, MI, and manages the U.S. and Foreign Military Sales M1A2 Tank Software Testing Program. He holds a B.S. degree in marine engineering technology from California Maritime Academy, Vallejo, CA.

OPERATIONS AND MAINTENANCE OF IOWA AND MILAN ARMY AMMUNITION PLANTS

LTC Jyuji D. Hewitt

Introduction

The Army is undergoing a reengineering process to become more lethal and more mobile in the 21st century. Similarly, production of ammunition to support the Army's needs is also changing. During the past decade, funding for ammunition has decreased 50 percent. The ammunition production base could be characterized as one of declining workload, declining budget, and aging infrastructure. This funding decline, coupled with high infrastructure costs to maintain ammunition facilities, has resulted in the Army receiving fewer products for each procurement dollar spent.

In an effort to encourage wide-range consideration of this situation, the Industrial Operations Command (IOC), a major subordinate command of the Army Materiel Command (AMC), challenged both government and industry to help solve its munitions mission problem: "How does the Army optimize the cost of infrastructure required to maintain critical production facilities to achieve Defense replenishment and peacetime training requirements?"

One industry response to this problem is an innovative partnership between industry and government. Mason & Hanger Corp. (MHC) and General Dynamics Ordnance Systems (GDOS) proposed and formed a new joint venture called American Ordnance Limited Liability Corporation (AO LLC).

This unique partnership combined the operators of the Army's two largest government-owned, contractor-operated Load, Assemble and Pack (LAP) plants. Furthermore, it synergized the strengths of each entity's parent corporation—Mason & Hanger, with its more than 45 years of operating ammunition plants, and General Dynamics, with its domestic and international marketing network. This bold approach aligns with current acquisition reform initiatives, transfers more of the government oversight of plant management functions to industry, and addresses issues relating to infrastructure costs.

On July 22, 1998, the IOC awarded a 5-year, facility-use contract to AO LLC for the operation of two of its LAP plants, Milan and Iowa Army Ammunition Plants. This noncompetitive award takes advantage of the partnership formed by AO LLC and the government to reduce the cost of ammunition production while maintaining the highest standards of quality and safety.

The Joint Venture

AO LLC is a stand-alone company that is led by its own president. Its corporate structure, however, is unique, and its overhead functions are sized to its needs. By managing two

The ammunition production base could be characterized as one of declining workload, declining budget, and aging infrastructure.

TOTAL BENEFITS SUMMARY

GOVERNMENT	AMERICAN ORDNANCE
■ 5-Yr.Savings: $115M and Possibly More ■ Controls Production Capabilities ■ Future Firm-Fixed Pricing ■ Opportunity to Reduce Infrastructure ■ More Technical and Operations Expertise to Resolve Existing Problems ■ Optimize Technical Expertise From Noncompetition ■ More Flexibility and Agility ■ Potential for Less Oversight $ ■ Immediate Facilities-Use Contract at Both Milan and Iowa ■ Profit Sharing and Private Investment ■ No Equip Ownership Hassles ■ Commercial Practices ■ Opportunity for Total Customer Partnering	■ More Stability for Planning & Investment ■ Flexibility to Maximize Facilities Capabilities ■ More Competitive ■ Increased Technical Expertise ■ World Market Opportunity ■ More Incentive to Market Wider Range of Products and Capabilities ■ Opportunity for Total Customer Partnering ■ Serve as Stable Best-Value LAP Capability **American Ordnance Is A Win-Win For All Customers**

plants, AO LLC can leverage its overhead and smartly reduce the footprint using best-business practices. Common overhead staffs will reside as centers of excellence, with either the Milan or Iowa Army Ammunition plant as the lead center. Initial concepts include consolidation of communication and management information systems.

In an effort to keep overhead costs low, general and administrative functions that do not routinely support direct operations will be acquired through parent organizations on an as-needed basis via purchased service contracts. Typically, these types of services include marketing, legal support, and unique engineering support.

The arrangement with the Army is relatively straightforward: AO LLC manages and operates the Iowa and Milan Army Ammunition Plants, commits to a 20-percent guaranteed price reduction in the IOC workloaded LAP prices, and provides up to $10 million in private investment for continuous improvement. The Army agrees to indemnification and a 5-year facility-use noncompetitive firm-fixed-price contract with AO LLC. This undertaking by both parties presents a deal that shares both benefits and commitments.

Contract Specifics

The contract used to execute the agreement is the facility-use contract. This contract is comprised of a zero cost agreement characterized by the necessary plans that stipulate the overhead efforts. Additionally, an advance agreement and two basic order agreements (BOAs) are attached, one for supplies and another for services.

The overhead efforts are established in detail through six plans. These are maintenance, security, safety, property, environmental, and fire plans. These plans, funded by the contractor, describe the performance requirements of the contractor and designate the appropriate compliance regulations. Additionally, the contract sets forth the agreements for facility use conditions for other government work and nongovernment tenants.

The advance agreement sets forth the concepts to achieve quality, partnering, and pricing agreements. Price matrices are a unique feature of this agreement. The Army and AO LLC agreed to set catalog prices based on quantity for 24 ammunition products. Additionally, the advance agreement described performance guarantees and the conditions for AO LLC's $10 million investment over 5 years for efficiency and safety improvements for the Iowa and Milan facilities.

The BOAs are straightforward. The supply BOA lists the types of ammunition items that may be requested for production. The services BOA lists the various activities needed to maintain the facility. These include maintenance of inactive industrial facilities (MIIF) and active industrial facilities, layaway of inactive facilities, demilitarization, and environmental services that, because of their unstructured nature, are cost-plus agreements.

Cost Savings

A significant benefit of this arrangement is the use of firm-fixed catalog prices for 24 ammunition products that are budgeted in the Program Objective Memorandum (POM) and presented in the AO LLC president's February 1998 5-year budget submission. Savings accumulate over the course of the contract. Based on the projected workload of the two ammunition plants for 5 years, it is estimated that the Army will spend no more than $334.1 million on these products. AO LLC, because of its efficiencies and guaranteed catalog pricing, will save the Army $59.1 million during this time period. Through the use of the catalog and price guarantees, the Army can now issue contracts for these items without further negotiations, thereby saving time and resources.

AO LLC Business Plan

An analysis of the available products required reveals that clear opportunities exist for the industrial base. AO LLC intends to position itself to win a large portion of this available work, which should allow for more government savings.

The AO LLC business plan assumes considerable risk. The burden to competitively win production work in years 2001 through 2003 shifts heavily to the contractor. This knowledge of the marketplace creates an immediate need to attain cost efficiencies so that AO LLC will become the industry's best value to the Army and other customers. The basis for cost savings is crucial. These savings are predicated on government projections stated in the POM; for example, 1.6 million rounds of M107, 155 mm artillery for the contract period.

Reduction Of Prices Through Overhead

Price reduction is common throughout this joint venture. There are many ways to lower prices. A key point in the overhead reduction is that cost savings make all programs with AO LLC less expensive. Passing these savings to customers further reduces the cost of ammunition production. AO LLC has submitted the following plan for overhead reduction:

- Increase workload through U.S./ worldwide competition;
- Rent from commercial reuse;
- Reduce plant footprint;
- Improve productivity;
- Direct personnel cuts; and
- Reduce Army contractual prescriptions, regulations, and oversight that add to overhead cost.

Reduction Of Prices Through Services

AO LLC predicts it can save costs for services during the 5-year period of the contract. Services are not overhead; they are the functions necessary to care for the facility, such as MIIF or layaway of industrial facilities. Savings of more than $4 million are expected in this area.

More than $34 million of $70 million is subcontracted. Therefore, there is little opportunity for savings based on reduced overhead costs. For example, overhead impact is minimal for environmental restoration, production support, and equipment replacement projects. Furthermore, MIIF costs are only $3 million and are decreasing as most layaways become caretaker functions.

Price Savings On Other Work

The analysis of the available market mix showed that not only will the IOC benefit from these cost savings, but other government sectors will as well. By becoming more competitive, program executive offices and program managers (PMs) can choose to use AO LLC as a best value to their needs. Other work should benefit at nearly the same pace as workloaded items. However, the IOC cannot guarantee the rate of savings because the Army cannot control what prime contractors do, nor does the Army know if prime contractors will want to help reduce work requirements that drive overhead. Projected savings from other government work are estimated at $50.6 million. As stated for workloaded items, savings are predicated on government estimates during the 5-year period.

Applying Acquisition Reform

The joint venture effort challenged the Army and industry to create an innovative solution and use acquisition reform initiatives. Alpha contracting and partnering were the most prominently used initiatives to make this solution a reality.

Alpha contracting allowed the contractor and the Army to establish conditions that would meet the Army's requirements, simultaneously remove costly and unnecessary requirements, and incorporate commercial and best-business practices wherever possible. In using this process, the Army removed several nonvalue-added regulations and requirements. Many "how-to" scopes of work converted to performance-based scopes of work. The Army is shifting the risk of performance to AO LLC by stating what tasks are to be performed, not how to perform them.

Partnering was a crucial tool to accomplish this effort. First, MHC and GDOS partnered to form AO LLC. Second, partnering within the government convinced higher levels of management that a radical approach was a good deal. Third, partnering between the IOC personnel, the industry contracting team, and personnel at the two plants helped to work out the deal. Finally, partnering relationships were formed between IOC and AMC's PMs as the price matrix developed and was offered to other PMs.

Summary

The formation of AO LLC and the Army's acquisition reform initiatives provided the potential for $115 million in savings during the next 5 years. Through the efforts of the IOC, the requirements of the government are being met without compromising the industrial base. The Army, through the use of a price catalog, can receive ammunition items at a guaranteed price. Although it is not envisioned, the marketplace has the business responsibility to close unneeded facilities and to maximize use of retained facilities and lines that bring in a reasonable profit. The 5-year contract with AO LLC provides the government a stable technical workforce whose processes become integrated for both the Milan and Iowa Army Ammunition Plants. The chart on Page 60 summarizes the benefits to AO LLC and the Army.

LTC JYUJI D. HEWITT is Commander of the Iowa Army Ammunition Plant. He holds master's degrees in systems management from the Florida Institute of Technology and in physics from the University of New Hampshire. He has also completed the Ordnance Basic and Advanced Courses, the Army Management Staff College, the Army Command and General Staff College, and the Joint and Combined Warfighting School.

PMO FIELDS A COTS-BASED FIRE CONTROL SYSTEM

Rene C. Kiebler

Introduction

The Product Manager's Office (PMO) for the Paladin/Field Artillery Ammunition Supply Vehicle (FAASV) has developed a commercial off-the-shelf (COTS) replacement for the vehicle's Automatic Fire Control System (AFCS), saving millions of dollars and resolving obsolete part issues that have plagued the program for years. The original M109 self-propelled howitzer did not have an AFCS when it was added to the Army inventory. During the Paladin product improvement program, the AFCS was added as an upgrade to allow targeting without positioning procedures. Designed to military standards, the AFCS was expensive and, unfortunately, obsolete shortly after production began. Paladin faced a critical shortage of processor components, forcing one redesign and the possibility of a cost-prohibitive "lifetime buy" from the vendor.

AFCS XXI

The new COTS replacement, dubbed AFCS XXI, provides the Paladin (now the M109A6) with a computer having superior processor capabilities, COTS components, a commercial operating system, and software that is portable to—and compatible with—similar fire control systems. Most important, it allows the Army to upgrade the AFCS easily if future requirements mandate.

Paladin's original AFCS had five Line Replaceable Units (LRUs). The AFCS XXI upgrade combines the functionality of three previous LRUs (ballistics computer/weapon controller, communications processor, and control unit) into a single box—the AFCS XXI Computer Unit (ACU).

During full-scale engineering development, the Paladin was designed under strict military specifications, resulting in a fully defined Technical Data Package (TDP) at time of production. Developers believed that this methodology provided the highest quality and lowest price for both the weapon system and the spare parts required for field repair. Initially, AFCS production went well because all of the components used in the design were readily available. However, problems with obsolete parts began to surface. At first, the problems were minor, and alternate components were identified and incorporated into the production baseline. Unfortunately, the problems became more critical and the production vendor appealed to the government to consider a lifetime buy of certain processor components before they were no longer available. As an alternative strategy to this lifetime buy, the government redesigned the original AFCS at considerable cost.

After the redesign, production proceeded smoothly for about 2 years. As 1995 ended, however, concerns about obsolete parts for the AFCS resurfaced. The AFCS vendor proposed another redesign using the latest technology at a cost to the government of $24 million. With DOD embracing new principles of "streamlined acquisition," this proposal was not well received. The Paladin/FAASV PMO studied many options, including adapting a commercially available computer.

The COTS Approach

To study the feasibility of a COTS approach, an Integrated Product Team (IPT) was formed. The team was comprised of technical experts from the Paladin/FAASV PMO; the U.S. Army Tank-automotive and Armaments Command's Armament Research, Development and Engineering Center (TACOM-ARDEC) (Picatinny Arsenal, NJ); Mei Technology; Sechan Electronics; and United Defense L.P.-Paladin Production Division. In a few months, the IPT concluded that using commercial technology was indeed feasible. The team prepared performance specifications and contract language to develop, test, and incorporate a commercial ACU into Paladin production. Because performance (not military specifications) drove design requirements, COTS technology was permitted.

The IPT faced a 15-month deadline to complete an industry-comparative evaluation, down-select a single vendor, complete an integrated design, modify existing software for compatibility with the new processor, conduct software validation/verification, conduct integration testing, and produce production hardware. The principles of risk management were used to focus resources on issues the IPT felt had the highest risk. By establishing a single integration lab and an integrated test program, the IPT coordinated, re-created, and resolved problems at each member's location on similar test configurations. This saved travel time and expense previously required to resolve integration issues. Additionally, the IPT combined a lot of the preproduction verification, software integration verification and validation, and operator/independent evaluator testing.

Summary

As a result of the team's efforts, major component parts of the AFCS XXI are interchangeable with standard commercial components. The system architecture is open and meets both international and U.S. industry standards. The computer's operating system is commercially available, and the software to operate the system is portable. This allows the software to be reused on other indirect fire control systems. Additionally, there are no detailed TDPs. An LRU-level drawing is provided with a set of circuit-card performance specifications to purchase spare and repair parts.

The AFCS XXI computer unit received full materiel release by the TACOM Commanding General just 19 months after a COTS computer was proposed by the PMO. The total cost savings and avoidance was $27.3 million, not including life cycle operational and maintenance cost savings.

It is important to note that COTS technology has benefited the program in other ways:

- Higher capacity hard drives have been substituted at the same approximate price as those provided previously.
- Because of the expansion capacity in the COTS ACU, Paladin's commercial digital display, which presents situation awareness data to the section chief, can be upgraded.
- The open architecture of the AFCS XXI allows the Joint Light Weight-155 (JLW-155) Program Office to reuse software developed for the Paladin.

The Office of the Secretary of Defense commended Paladin's AFCS XXI IPT during a formal ceremony on June 11, 1998. Walter B. Bergmann II, Executive Director of Logistics Management at the Defense Logistics Agency, presented the team a citation and award for "outstanding performance in the implementation of the Defense Standardization Program." Carroll Gagnon, Product Manager Paladin/FAASV, accepted the award on behalf of his team.

RENE C. KIEBLER is the Associate Product Manager for Production and Engineering in the PMO for the Paladin/FAASV. He is a graduate of the Rochester Institute of Technology and holds an M.S. degree in engineering management.

Emulating Private Sector Practices . . .

MILITARY DISTRICT OF WASHINGTON ACQUISITION REFORM

Dr. Edna L. Diggs

Introduction

Picture this: It's 7 a.m. I arrive at the office to a desk piled high with work. On top is a "To Do List" that reads:

1. Manage imperatives.

2. Review Department of the Army's Functional Area Assessment recommendations.

3. Consider acquisition reform legislation.

All of this before my first cup of coffee! To say the least, this gives new meaning to the slogan "We do more before 9 a.m. than most do in a day."

Integrating various skill sets and backgrounds into task force teams to accomplish organizational goals is the strategy of choice. Therefore, my strategy for accomplishing these tasks is to use an integrated teaming approach. Ok, where do I begin? The first priority is that cup of coffee, very strong, no sugar.

Step 2 is to assemble a team, and step 3 is decisionmaking.

As "The Guardian of Our Nation's Capital," the U.S. Army Military District of Washington (MDW) conducts security or disaster relief operations in the National Capital Region (NCR), provides base operations support for U.S. Army and other DOD organizations throughout the NCR, and conducts official ceremonies and public events on behalf of the U.S. government civilian and military leadership. To support these missions, MDW contracting offices obligate approximately $200 million annually.

Just as the private sector reevaluates its business practices to remain competitive, so too does the Army. The Army's Force XXI initiative has prompted MDW to establish an MDW XXI. An FY96 functional area assessment study recommended the use of major command centers with satellite offices as the best structure for Force XXI contracting support. To implement this strategy at MDW, I assembled a team composed of the MDW Civilian Personnel Director and resource management and acquisition principals. This resulted in the establishment of the MDW Acquisition Center (MDWAC) at Fort Belvoir, VA, with satellite contracting offices at Fort Meade, MD; Fort Hamilton, NY; and Forts Myer and A.P Hill in Virginia.

Endorsed by Dr. Kenneth J. Oscar, Deputy Assistant Secretary of the Army for Procurement, MDWAC marked its official opening with a ribbon-cutting ceremony in FY98. Its three primary functions are processing centralized contracts (those valued at $250,000 and more), awarding Army-wide contracts such as information technology maintenance services, and identifying those contracting areas in which centralized processing would yield cost savings. Satellite offices would continue to perform contract administration, simplified acquisition, and some construction contracting. Their main focus would continue to be responsive customer support. This concept may yield savings of $12 million by FY01.

With the new organization in place, business practices such as empowerment, paperless contracting, partnerships, best value and oral proposals, and commercial item contracting were identified as models for reform. This article addresses a few of these initiatives.

Paperless Contracting

The decision to consolidate all contracting automated system hardware at the MDWAC with satellite offices having communication links to the central computer yielded an annual cost avoidance of $442,000. To gear up for paperless contracting by the new millennium, Standard Procurement System hardware was installed at MDWAC, and PCs were installed at satellite offices. A paperless process via the Internet was also developed. To test the concept, MDWAC teamed with the Information Systems Software Center to provide paperless transmittal of contract support documents. An "intranet" between both activities was created using a Windows NT server. Documents are placed in a secure folder on this server, and personnel from both activities have access codes for "read and write" permissions. Documents can be revised while work is in progress. Savings are measured in reduced processing time. Our plan for FY99 is to implement the use of the ACQUILINE purchase request system through a pilot program approved by Dr. Oscar and to expand on the use of the Internet.

Purchase Card Program

Empowerment and training of customers in micropurchasing ($2,500 and less) has resulted in greater efficiencies. The key to success is keeping the training simple and removing nonvalue-added procedures from the process. In FY96, 25,212 purchase card transactions were made; in FY97, the number jumped to 39,249 transactions (92 percent usage); and in FY98, more than 50,000 transactions were made.

Partnerships

Establishing a partnership with DynCorp, Reston, VA, was our acquisition strategy for "getting the installation-wide maintenance work back on track." The transfer of the contract to the MDWAC from another agency with unfinished contract administration functions resulted in work not being accomplished on schedule and strained relationships. Both parties could not agree on solutions. Finally, both parties agreed to participate in a partnering workshop facilitated by a consulting group. Problems were listed with suggested solutions. Smaller teams met consistently to work out problem areas. Within 6 months, progress was measured on a scale of 1 to 10. With 10 being highest score, the effort received an 8. To excel in using this concept, participants must have open and continuous communication, mutual trust, and respect for each other.

The lessons learned were as follows:

• Partner in tiers. Some of the most difficult problems can be resolved by just seeking solutions from the workforce. Involve all tiers of the workforce.

• Set measurable standards or goals; i.e., vacant quarters are turning over in 28 days versus 58 days. This may assist in developing new ways to improve original goals.

• Establish informal partnering sessions.

Best Value And Oral Proposals

We began our search for the best methods of contracting and "whittled down" the list during the year. We viewed ourselves as a competitive business, armed for entry into the 21st century. The result was a new method of contracting: best value and oral proposals. Oral presentations were first performed at our Fort Meade satellite office on the Job Ordering Contract (JOC). Because this was the first use of a JOC, it was briefed to the HQDA JOC Steering Committee. Following this briefing, various Army and civilian organizations requested additional information. Several goals have been accomplished, the most significant include a 40 percent reduction in acquisition processing time, elimination of lengthy written proposals, open communication between government and potential contractors, and a reduction in both government evaluation costs and contractor proposal costs.

Best value and oral presentations allow "face to face" interactions. In addition, they enable the government to distinguish between offerors with the expertise to fully satisfy the requirements and offerors whose "written professional" proposals are not representative of their ability to perform the work. It also forces the offerors to initially submit their "best" proposals. This method also requires extensive planning and preparation.

Lessons learned are compiled throughout the process. Some of the presolicitation lessons learned were to develop an independent government estimate, hold acquisition strategy meetings, appoint board members, and prepare training modules. Training should also be scheduled throughout the process.

Evaluation plan lessons learned:

• The evaluation plan is critical to the process, and the team should become involved during the early stages. Provide to the team a workbook describing evaluation procedures and an evaluation book about each offeror.

• Follow the evaluation plan explicitly and evaluate oral proposals immediately after the briefing.

• Ensure Sections L (evaluation factors) and M (award factors) of the solicitation package mirror those of the evaluation plan.

• The decision whether to use colors or numerical scores is crucial. Whichever is decided, the narrative for each rating must be clear and reflect the rating assigned.

Solicitation lessons learned:

• Charge a fee equal to the cost of reproducing the solicitation and unit price book.

• Schedule a presolicitation conference at least 3 weeks after release to industry.

• Provide spacious and comfortable facilities for the team.

• Answer all technical questions by amendment. Presolicitation conference minutes are included in this amendment.

• Allow at least 45 days from issuance of the solicitation for the date of receipt of proposals.

• Request past performance data 3 weeks prior to receipt date for proposals. This provides a jump-start to the evaluation process.

Oral presentation lessons learned:

• Provide clear instructions to ensure overhead slides are prepared properly.

• The Request for Proposal should highlight the fact that these slides should be the offeror's technical proposal and the government will accept no other written information.

• Provide spacious and comfortable facilities.

• Contractor personnel presenting the briefing must be the functional personnel; i.e., the project manager, quality control chief, and/or alternate project manager.

• Ratings are based strictly on content of the offeror's presentation and not the briefer.

• Videotaping the briefing is a critical decision. Freedom of Information Act requirements must be considered. The tapes were reviewed by the Staff Judge Advocate prior to legal approval of the contract. In addition, the Sole Selection Authority reviewed the tapes. Some of the contractors requested a copy of the tapes.

• Each offeror was given 2 hours to present his or her briefing. When the presentation was completed, the Sole Selection Evaluation Board met for about 1 hour and formulated questions for the offeror based on the presentation.

• Major problems cited by the board were its unfamiliarity with the evaluation process and scheduling difficulties. Therefore, the decision to use oral proposals should be carefully reviewed and made on a case-by-case basis.

• Debriefings should be held within 5 days after being requested by offerors.

Conclusion

Use of commercial business practices will modernize our contracting process. In fact, significant improvements have already been achieved since implementing these new practices. As the Army continues to reevaluate itself, MDW will also continue to redesign its processes, further strengthening its position as "The Guardian of Our Nation's Capital."

One year later at 5:30 p.m., and after a zillion meetings, a thousand reports, and hundreds of cups of coffee, the work is complete. Until tomorrow, 7 a.m. that is ...

DR. EDNA L. DIGGS is the Principal Assistant Responsible for Contracting for the U.S. Army Military District of Washington. She has both a B.S. degree and an M.S. degree in education from the University of Southern California, an M.B.A. from the Florida Institute of Technology, and a doctorate degree from Nova University, FL. An Army Acquisition Corps member, she is Level III certified in acquisition and is a member of the National Contract Management Association.

Short Range Unmanned Aerial Vehicle System . . .

SPARE PARTS CONVERSION

William L. Smithson

Introduction

Budget cuts and downsizing drive smarter decisions. Under the Joint Tactical Unmanned Aerial Vehicle (JTUAV) Project Manager's direction, the JTUAV Team initiated an effort to investigate taking existing unusable assets and with nominal additional effort convert those assets into usable needed spare/repair parts.

The Hunter Short Range Unmanned Aerial Vehicle (UAV) is intended for use in combat operations where near real-time information feedback is needed, manned aircraft are unavailable, or excessive risk or other conditions render use of manned aircraft less than prudent. Designed to operate more than 200 kilometers beyond the front lines for more than 8 hours, the 1,600-pound (takeoff weight) UAV enables commanders to look deep into enemy territory. Carrying day/night video sensors, the UAV transmits reconnaissance, surveillance, and target acquisition information in near real time back to ground control and mission monitoring stations. Additional payload capabilities include laser target designation and communications relay. These UAVs can operate under limited adverse weather conditions and are rugged enough to land on unimproved runways.

Acquisition of the UAV system began in FY89 through a competitive acquisition and subsequent award of two contracts for evaluation hardware with a follow-on competition for a single-production contract. After extensive technical evaluation testing (TET) and limited user testing (LUT), a low-rate production (LRP) contract was awarded. The two TET/LUT (Phase I) systems were then used to train soldiers who would be using the newer LRP (Phase II) systems. Once the newer LRP UAV systems became available, the older TET/LUT systems were placed in storage at Fort Huachuca, AZ.

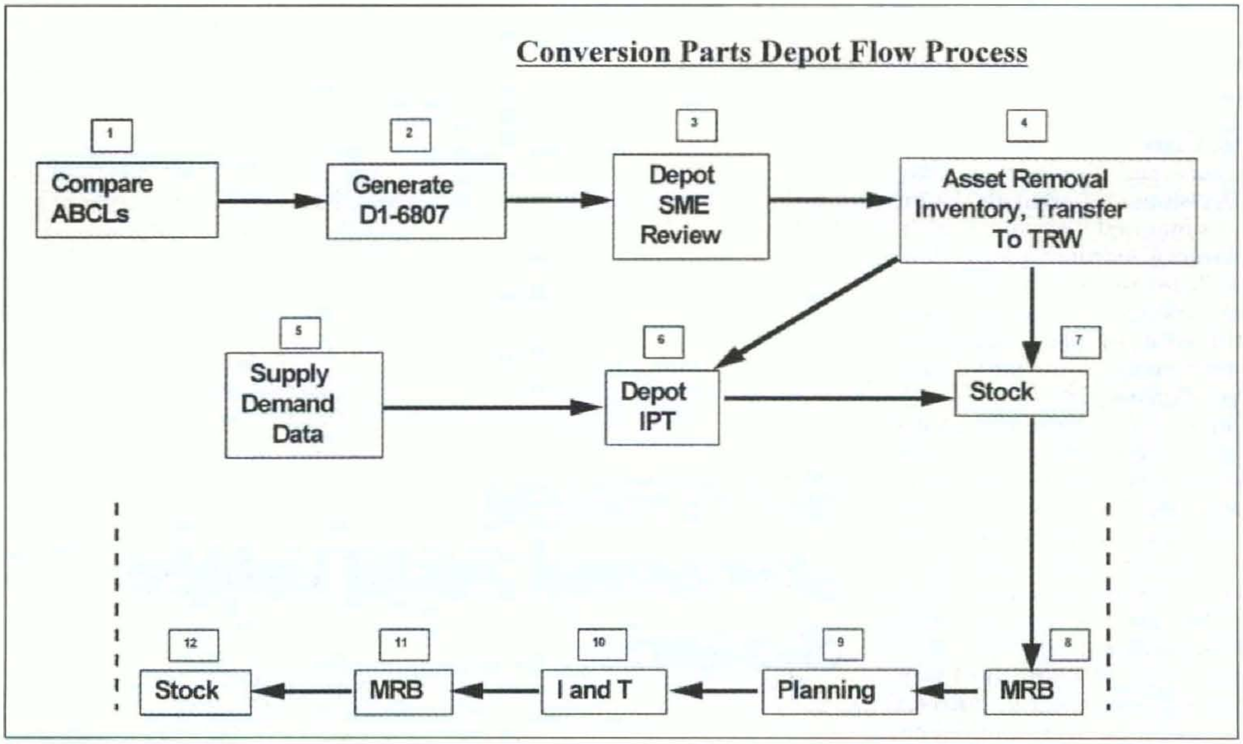
Seven LRP Hunter UAV systems were produced and delivered. Each consists of 56 subsystems and more than 4,800 line-replaceable units. Although the Hunter acquisition program was terminated in 1996, the Army is currently using the residual Hunter assets as an interim capability. One system is at Fort Hood, TX, and one system is at Fort Huachuca, AZ. The remaining systems are used for payload demonstrations and testing or are stored in operational condition at the contractor's depot.

TET/LUT Parts Conversion

UAV spare and repair parts were intended to come from the system's production lines. However, in an acquisition decision memorandum dated Jan. 31, 1996, the Under Secretary of Defense for Acquisition and Technology terminated the Hunter UAV acquisition program. As a result, the production lines were shut down, leaving spare and repair parts requirements largely unfilled.

Following termination of the Hunter UAV acquisition program, the JTUAV Project Office assessed the feasibility of putting the TET/LUT systems back into service. Because of their heavy use during soldier training and the significant changes in the hardware and software baselines that occurred between the Phase I TET/LUT systems and the LRP systems, the JTUAV Project Office determined that a complete refurbishment and retrofit of the TET/LUT systems was required prior to returning them to flight status condition. This expense was cost prohibitive.

Since the TET/LUT systems would not be used in an operational environment



GLOSSARY: ***ABCL:*** *As-built configuration list;* ***SME:*** *subject matter expert;* ***MRB:*** *materiel review board;* ***I&T:*** *integration and test*

again, the JTUAV Project Office began investigating converting these unusable assets into usable spare and repair parts for the seven LRP systems. The JTUAV Project Office and its contractor performed a comparison study to determine the number of parts that could be placed in the inventory and the cost trade-off to get them there. The results of the study determined that a large number of LUT/TET parts were identical to or interchangeable with LRP parts, and that converting the parts for use in LRP systems could achieve up to a 10 to 1 return on the investment.

Based on the outcome of this study, the JTUAV Project Office and its contractor, through the integrated product team (IPT) process, agreed on a Spare Parts Conversion Plan. On Oct. 30, 1997, the JTUAV Project Office's Supporting Contract Activity put the conversion effort under contract.

First, a spare and repair parts conversion candidate list was prepared by matching the TET/LUT and LRP systems in the configuration status accounting system. A team composed of contractor and JTUAV Project Office personnel began sorting TET/LUT system assets. Once the effort was underway, additional items were identified and added to the conversion candidate list. Tables were set up to stage and inventory the parts prior to moving them to the depot. After inventorying and marking the items, parts were delivered to the contractor's facility, documented as received, and transported to the depot warehouse for disposition.

After the parts went through the 12-step conversion parts depot flow process (see chart), they were placed into the spare and repair parts inventory and made available for distribution to support fielded and fieldable systems.

Return On Investment

The depot IPT monitors and tracks the success of the effort by determining a figure of merit. The figure of merit is the cumulative cost of the parts recovered (the cost of new Phase II parts) plus a 15-percent notional fee. This number is then divided by the total cost expended on the conversion process at any time.

The higher the figure of merit, the greater the value of recovered parts in relation to what was spent to accomplish the effort. A figure of merit of 4.6 means that for every dollar spent to accomplish the conversion, there is a gain of $4.6 in usable converted spare and repair parts. The spare and repair parts that have been retrieved to date have proven that the return on the investment is on track. As of May 1, 1998, the figure of merit was 4.6. At the time this article was written, the entire conversion effort was expected to be completed by the end of March 1999 and to yield the minimum return on investment of at least 10 percent.

Conclusion

This effort shows that with a little imagination, a little capital, and minimal but meaningful management guidance and support, significant operating and support cost savings can be achieved.

WILLIAM L. SMITHSON is a Configuration Management Officer in the Configuration Management Division, System Engineering and Production Directorate, Missile Research, Engineering and Development Center, U.S. Army Aviation and Missile Command, and is collocated in the Joint Tactical Unmanned Aerial Vehicle Project Office. He holds a B.S. degree from Athens State University. He is a member of the Army Acquisition Corps and is Level III certified in systems planning; and research, development, and engineering; and Level II certified in program management.

Ride Motion Simulator Ready To Rock . . .

NEW MOTION PLATFORM RECEIVES LONG-AWAITED MAN-RATING

Rae A. Higgins

Introduction

They're rockin' and rollin' in the U.S. Army Tank-automotive and Armaments Command's Tank Automotive Research, Development and Engineering Center (TACOM-TARDEC) Physical Simulation Laboratory. In late September 1998, engineers and scientists on the TARDEC Motion Base Technologies (MBT) Team received "man-rating" on their new ride motion simulator (RMS)—a goal achieved after much testing, analysis, and good, old-fashioned hard work. Man-rating a simulator means that a safety release that documents the equipment as safe for humans to ride has been obtained. That is, the occupant investigating the ride dynamics sits in a cab mounted onto the moving platform of the RMS. It rides just as if the occupant were in a real military vehicle traveling over real terrain.

AnnMarie Meldrum, an Electrical Engineer on TACOM-TARDEC's MBT Team, described the RMS as a new six-degree-of-freedom simulator housed in TARDEC's Physical Simulation Lab. It can reproduce the ride dynamics of any military ground vehicle over secondary roads and various cross-country terrains. A variety of vehicles, bump courses and seating configurations (gunner, commander, driver) can easily be simulated and re-created on the RMS. Basically, the operator programs it to simulate any vehicle traveling over any terrain to ascertain any number of user-machine interface factors.

RMS Design

The hexapod design of the RMS enables longitudinal, lateral, vertical, roll, pitch, and yaw motion positions. In fact, its performance specifications are quite impressive. Its lateral, longitudinal, and vertical displacement is capable of plus or minus 20 inches. Its roll, pitch, and yaw displacement is capable of plus or minus 20 degrees. It can accelerate translationally up to 2 g's. (The term g's refers to a unit of force equal to the gravity exerted on a body at rest.)

The RMS features a reconfigurable cab; visual capabilities with an Evans and Sutherland 3-Channel Image Generator 3000 High Density; and audio capabilities with AudioWorks2, a 3-D spatial sound-rendering hardware-software package. Its inside cab payload (the total weight of passengers, instruments, equipment, etc.) can accommodate up to 600 pounds.

Simulation Lab Testing

Soldiers can climb into the simulator before going to the field and gain a better understanding of how they and their hardware will perform while in motion. This includes an evaluation of audio and visual systems for high-fidelity, and real-time operator-in-the-loop simulations. According to simulation experts at TACOM-TARDEC, simulation testing is important because field testing is expensive, time consuming, and dangerous.

"You can work a lot of bugs out here [in the simulation lab] and focus field testing on some of the bigger problem areas," said Victor Paul, an Electrical Engineer on the MBT Team. For instance, engineers can't simulate or replicate a very important factor in the lab: the environment, according to Paul. "We can't simulate mud, dirt, rain, or other environmental effects," he explained. That, he added, must be investigated in the field. However, the user can be placed in a dynamic environment. Engineers can investigate how a user performs certain tasks such as reading a text display or pushing a particular button while in motion.

One of the outstanding characteristics of the RMS is that it not only replicates ride dynamics, but it can also replicate those ride dynamics repeatedly for more accurate test data.

The simulator has a reconfigurable crewstation environment, where engineers can study human-machine interaction with dynamic controllers, displays, and apparel (such as helmets or nuclear-biological-chemical equipment). The new RMS will also assist in soldier-machine interface development and crew workload and task-performance investigations. For example, engineers favor simulators like the RMS because they offer repeatability. The RMS helps determine a soldier's ability to perform tasks in a dynamic environment as well as how his or her performance would be affected by adding other tasks.

Man-Rating Process

The man-rating process required a meticulous adherence to a step-by-step checklist. Engineers and scientists on the MBT Team logged many hours of hard work. The first step in the process required the development of a System Analysis Report to document what the system is, what it is capable of doing, and identify its components. The report also contains an analysis that identifies every potential hazard that can occur while operating or riding the simulator and its cause, effect, severity, and probability.

Engineers on the MBT Team knew precisely how safe the RMS had to be for it to be man-rated. Safety, Paul said, was paramount from the beginning and was "designed" into the simulator.

MTS Systems Corp., Eden Prairie, MN, developed and submitted the RMS System Analysis Report in February 1998. The report then had to be approved. Safety Office representatives from both TACOM and the U.S. Army Test and Evaluation Command (TECOM), Aberdeen, MD, met to review and approve the report's findings. Next, TECOM as well as TACOM's Safety Office and the Human Use Committee (HUC) gathered to observe the RMS in action. This, Meldrum said, was called a Safety Release Meeting.

The Safety Release Meeting was held July 8, 1998. According to the chairman of TACOM's HUC, Robert Culling (TACOM-TARDEC), "The safety certification process used to recommend approval for volunteers to occupy the ride motion simulator is an excellent example of teaming. From the contractor who installed the equipment, the TECOM reviewer, to the TACOM Safety Office, to the Army Research Lab/Aberdeen's Human Research and Engineering Directorate and legal representatives, to the TACOM-TARDEC engineers who work (with) the simulator ... the focus is maximum safety for the volunteer."

Members of the HUC also include Tom Kirby and Al Reid, TARDEC; David Kuhn, Legal Office; Patrick Kelley, Safety Office; Mohsin Singapore, Army Research Lab/TACOM; and Ron Williams (ad hoc), TACOM Clinic.

"The [safety release] meeting was a big hurdle to overcome. The team went through a failure and effect sheet and then tested and retested every one of the RMS safety interlocks," Meldrum said. Safety interlocks are automatic safety mechanisms built into the simulator that will activate during any system failure or undesirable motion. Meldrum, Paul, and Engineer Harry J. Zywiol Jr. demonstrated how and when the interlocks are designed to engage. "Safety is No. 1," Meldrum said emphatically. Paul echoed this by explaining that a good portion of the work on the RMS thus far had been testing and retesting the interlocks.

The analysts then made suggestions about how to make the RMS safer. For example, they recommended using nonskid safety tape on the cab floor and installing a five-point occupant safety harness and ingress/egress handles.

TECOM then issued a memo to the TACOM Safety Office in mid-July stating that the system was safe for soldier use in accordance with its approved procedures.

Type And Test Protocols

"From there, we had to establish a 'type' protocol," Meldrum explained. The principal investigators submitted a memorandum listing specific test parameters and equipment to be used in testing. The HUC reviewed it and made additional recommendations. The 'test' protocol described the actual test to be performed, who would ride in the simulator, how long it would be operated, etc.

Paul described the test protocol as "fitting into" the type protocol. He also explained that once the TARDEC director approved a type protocol, subsequent test protocols could go directly to the chairman of the HUC. Paul also said that a test protocol would be mandatory for each test run on the RMS. Once the type protocol was established, TACOM's Safety Office also had to approve it. Moreover, if additional hardware was investigated, the Safety Office was responsible for approving any modifications to the structure.

Patrick Kelley, a Safety Engineer assigned to TACOM-Warren's Safety Office, explained that the type protocol outlined the operational limits for the RMS when human test subjects were used. "If a given test that is scheduled to be run with human test subjects goes outside those limits set in the type protocol, then the test protocol must be reviewed and approved by the TACOM Human Use Committee. As a member of the TACOM HUC, I review the protocols from a safety standpoint and provide my concurrence or nonconcurrence to the chairman of the HUC, Robert Culling," Kelley stated.

Once Kelley concurred and sent his input to the HUC, Meldrum and her colleagues began to see the light at the end of the proverbial tunnel.

On Sept. 18, 1998, TACOM-TARDEC Director Jerry L. Chapin met with the principal members of the MBT Team, Culling, and several members of the HUC to discuss the RMS man-rating process. Finally, 10 days later, Chapin authorized the RMS as a man-rated simulator. "This expanded capability allows us to raise the performance level of modeling and simulation within the Army," Chapin said.

The first simulation was run in late 1998. It demonstrated the system's hardware features, and full audio, visual, and motion capabilities in a synthetic environment.

Conclusion

The future of the RMS certainly looks bright and busy. The TACOM-TARDEC simulation teams are working on integrating a real-time soldier-in-the-loop environment with a vehicle dynamics model so that investigators can get feedback from both simulators and occupants. In other words, a driver will literally "drive" the RMS over a virtual terrain. Both the driver in the RMS and the occupants of the Crewstation/Turret Motion Base Simulator (commander and gunner) will feel every pothole, ditch, and bump along the way.

Engineers are interested in investigating ride and human use factors for the commander, gunner, and driver. This will be simulated in the virtual world so design teams can participate in distributed interactive simulation (DIS) exercises. Members of the MBT team and their colleagues in TARDEC's Vehicle Electronics area are developing software for the DIS.

RAE A. HIGGINS is a Public Affairs Specialist assigned to Headquarters, U.S. Army Tank-automotive and Armaments Command, Warren, MI. She holds a bachelor's degree in communication from Oakland University, Rochester, MI, and is a graduate of the Defense Information School's Public Affairs Officer course.

A New Era Dawns At TACOM . . .

HIGH-TECH CORROSION PREVENTION

Rodney T. Wilson

Introduction

The U.S. Army Tank-automotive and Armaments Command (TACOM) marked the dawn of a new era with its recently initiated High-Tech Corrosion Prevention Program for the Army's Family of Medium Tactical Vehicles (FMTVs). A vision for tomorrow and a paradigm for efficiency, reliability, availability, and maintainability, this innovative program fights "runaway" maintenance costs and deterioration of the Army's truck fleet caused by corrosion. This program, managed by the Project Manager's Office, Medium Tactical Vehicles (PMO-MTV), Program Executive Office, Ground Combat and Support Systems, will significantly enhance the durability of the Army's FMTVs into the 21st century.

This program is expected to extend the useful life of the Army's FMTVs from the current 10 years to 15 or more years while significantly reducing operation and maintenance costs. Applying cutting-edge technology, the program employs a variety of multifaceted processes and design methodologies to create a tiered defense against corrosion.

Corrosion Test

The FMTV contract with Tactical Vehicle Systems in Sealy, TX, a division of Stewart & Stevenson Services, Inc. (S&S), requires extensive corrosion testing during the low-rate production phase for the FMTVs. To accomplish this, the Transportation Research Center, an S&S subcontractor, conducted an accelerated corrosion test on a selected vehicle.

The vehicle was tested in two highly corrosive simulated field environments: 13 hours in a heat and humidity chamber and a 4-hour drive on a very corrosive muddy track consisting of wet sand and mud well saturated with salt. Following 10 test cycles, the vehicle was cleaned and a 1-hour corrosion and maintenance inspection was conducted. This testing phase continued for 7 months, 24 hours a day, until 200 test cycles were completed. More than 300 Test Incident Reports yielded valuable information regarding those areas needing improvement.

Corrective Action Plan

The PMO-MTV and S&S established a cross-functional integrated process team (IPT) to address the problems discovered during testing and to make suggestions on how to extend the useful life of the FMTVs from 10 years to more than 15 years.

The IPT took two major approaches: performing corrosion tests continuously to enhance validation, and

Among the attendees at the DD250 signing ceremony for release to the Army of the first FMTV truck with enhanced corrosion prevention were MG John F. Michitsch (far right), PEO, Ground Combat and Support Systems; C. LaRoy Hammer (second from right), Senior Vice President, Tactical Vehicle Systems, Stewart & Stevenson Services Inc.; and COL Kenneth R. Dobeck (fourth from right), PM, Medium Tactical Vehicles.

interfacing with industrial firms to explore current or emerging state-of-the-art corrosion prevention technologies. These firms included Ocean City Research Center, Chrysler Corp. (now DaimlerChrysler), General Motors Corp., and Bethlehem Steel Inc. Lehigh University also played a key role. Additional data were obtained from marine studies and the National Society of Corrosion Engineers.

The IPT examined nearly 500 potential corrosion prevention enhancements and developed a corrective action plan to incorporate corrosion prevention design enhancements into the current FMTV production line and change requirements for future contracts.

Enhancements

Enhancements included the use of new materials such as stainless steel, electroless nickel, chip-resistant panels, improved design processes, increased electrostatic deposition coat accessibility, elimination of dissimilar metals and component entrapment areas, increased controls on pretreatment and paint areas, use of high-temperature flexible rubber hoses in lieu of metal tubes, using a brass radiator tank and hose fittings, and installation of an aluminum surge tank. More than 400 changes to new parts and processes were incorporated by S&S and its vendors. In addition, a major block change to the configuration of the previously approved FMTV design occurred in late 1997.

The suppliers of each major component were tasked to implement or validate one or more of the above corrosion prevention measures in accordance with decisions by the IPT. This type of coordination ensured accelerated validation of corrosion prevention.

Galvanization

Galvanization, a process that features the use of hot-dipped sheet metal in manufacturing truck cabs, emerged as a major enhancement to FMTV corrosion prevention. The sheet metal cab, formed by traditional manufacturing processes, is later coated and sealed for additional protection. Thus far, approximately 4,000 cabs have been galvanized by McLaughlin Body Co. of Moline, IL, and Steyer Inc. of Austria, two S&S subcontractors. Of these 4,000, approximately 3,000 vehicles have been shipped to Hawaii and Korea. To galvanize the remaining fleet of approximately 75,000 trucks, the government will spend nearly $40 million. The projected operation and maintenance cost avoidance, however, is predicted to be at least triple that amount. This is truly a case of spending dollars wisely—upfront—to reduce overall life-cycle costs during the extended useful life of the FMTVs.

Related Effort

In a related effort, a 22-year accelerated corrosion-resistance test was initiated on two new production FMTVs in August 1998 at Aberdeen Proving Ground, MD. The purpose was to validate the more than 15-year FMTV longevity requirement and to study other possible efforts to improve corrosion prevention even further.

Conclusion

The TACOM-S&S IPT worked together to defeat a common enemy—corrosion. This pioneering effort, initiated by COL Kenneth Dobeck, Project Manager for Medium Tactical Vehicles, places the TACOM FMTV corrosion prevention program well ahead of other programs and holds promise for even greater strides in battling corrosion into the 21st century.

RODNEY T. WILSON is a Mechanical Engineer in the Technical Management Division, Office of the Project Manager for Medium Tactical Vehicles. He has a bachelor's degree in mechanical engineering from Tuskegee University and a master's degree in engineering science from the State University of New York at Buffalo.

Galvanized cab

ADOPTING COMMERCIAL TECHNOLOGY FOR SPIRAL MODERNIZATION OF ARMY TACTICAL WHEELED VEHICLES

MAJ Philip Schoenig, Jeffrey Hamel, Rick Engel, Eddie Garcia, Lynn Jones, and Regis Luther

Introduction

The Directorate of Combat Developments for Transportation, Combined Arms Support Command (CASCOM) and the Army Transportation Center are updating the operational requirements for tactical wheeled vehicles (TWVs) in support of Force XXI operations. These operational requirements mandate that Army trucks operate longer, go farther, and survive on the battlefield.

The Tactical Wheeled Vehicle Requirements Management Office (TWVRMO), Fort Eustis, VA, ensures that these requirements are adequately documented before the materiel development process begins. In fact, TWVRMO is the sole manager for TWV requirements for the U.S. Army Training and Doctrine Command. As new-start truck programs are phased out because of limited resources, materiel developers and their industry partners must be creative in meeting the Force XXI operational requirements. "Spiral modernization" using recapitalization of our legacy fleets is the process to meet these requirements.

Recapitalization is the replacement or retrofitting of an existing system as a result of mechanical aging, technological obsolescence, or excessive maintenance expense. The ultimate goal is to equip the Army with TWVs that are safer, more reliable, and less costly.

Program Manager's Perspective

Maximizing the use of commercial technologies and the benefits of commercial research and development (R&D) is a continuous challenge to the Army program manager (PM) in the materiel development of a TWV. Because of the ever-increasing cost of R&D, PMs are continually looking for ways to leverage their R&D funds by working with the commercial R&D establishment. This is becoming even more necessary as the number of new-start programs is reduced throughout DOD, effectively driving the cost of military R&D higher on a cost-per-unit basis.

One specific area in which the Program Manager for Heavy Tactical Vehicles (PM-HTV) has successfully used commercial R&D efforts is vehicle safety and restraint systems. In particular, the PM-HTV established a Dual-Use Application Program that uses

Maximizing the use of commercial technologies and the benefits of commercial research and development is a continuous challenge to the Army program manager in the materiel development of a tactical wheeled vehicle.

commercially available technologies to improve the safety of truck cabs. Two commercial systems that are being evaluated are the Inflatable Tubular Structure (ITS) and the Inflatable Tubular Torso Restraint (ITTR).

Similar to an air bag, the ITS is used by BMW as a "head-restraint system" in new-production vehicles. It protects the occupants during rollovers and prevents occupant ejection by inflating in a diagonal direction across the window. A sensor control detects impact or imminent rollover and inflates the system.

The ITTR employs the same concept as the ITS except it is installed in the existing shoulder harness. Upon activation, it controls the occupant's movement during a frontal collision or a rollover. The ITTR is 6 to 8 inches in diameter when inflated. This provides more positive control of the occupant and spreads the protection more evenly across the chest area than a standard shoulder belt.

Leveraging The Economies Of Scale

Freightliner Corp.'s military trucks are the closest to commercial-based items that the Army buys. The Army's fleet of more than 2,000 M915A2 line-haul tractors, M916A1 light-equipment transporters, and M917A1 dump trucks is solidly based on Freightliner's best selling commercial model, the FLD120 heavy-duty line-haul tractor. (More than 330,000 FLD120s have been sold since its introduction in 1988.) As such, the Army capitalizes on a proven, highly successful design that includes the latest in commercial truck technology. Furthermore, Freightliner's military trucks are built using the same production operations that manufacture hundreds of commercial vehicles per day—leveraging the economies of scale afforded by volume component purchasing and high-capacity production lines.

In 1998, Freightliner signed a new contract with the Army to build approximately 2,000 M915A4 glider kits. This innovative program adapts a standard commercial practice to meet an Army need of modernizing aging line-haul tractors. This extended service program (ESP) represents acquisition reform in action. Spearheaded by the U.S. Army Reserve, the Army and Freightliner team upgraded the existing fleet of 2,000 aging M915 tractors manufactured approximately 18 years ago. The M915A4 glider kit is based on the modern Freightliner M915A2 design and consists of a new cab, chassis, electrical system, antilock braking system, and automatic transmission. The only reused components from the old trucks are the original engine and rear-axle assembly. The kits can be built into finished trucks by either Army maintenance units or Freightliner. The new M915A4s are expected to provide the Army virtually new vehicles and considerable savings in future operation and sustainment costs.

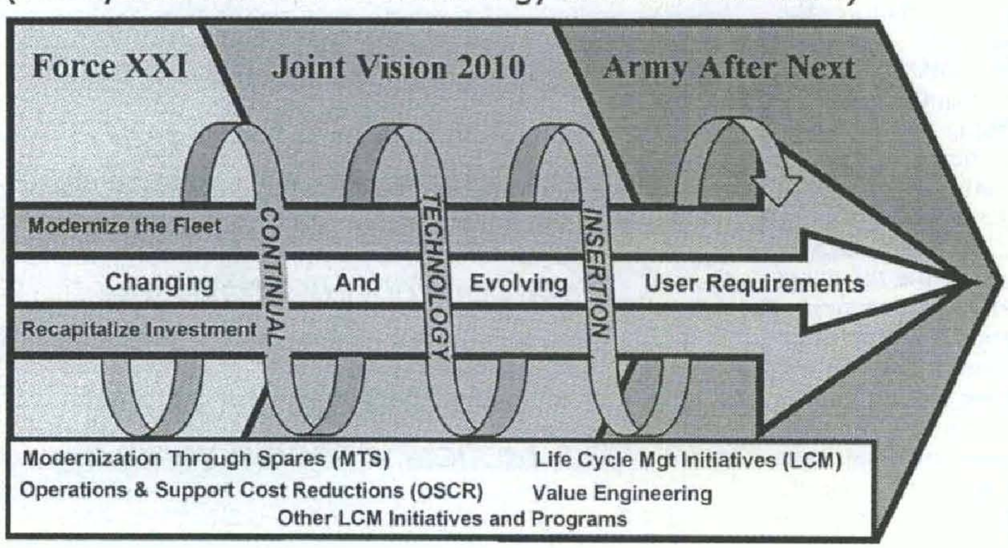
Integrated Nondevelopmental Items

Oshkosh Truck Corp. (OTC), another DOD contractor, engineers trucks for markets where unique, innovative designs outperform general-purpose equipment in all types of terrain. OTC uses commercial engines, transmissions, axles, suspensions, tires, valves, pumps, etc., but designs and builds them into severe-duty vehicles with capabilities much greater than commercial off-the-shelf vehicles. These commercial components have been developed, tested, and proven for an intended market and are then adapted for use in the unique or specialized applications. These can include concrete mixers, snow blowers, or tactical vehicles such as the Palletized Load System (PLS) Heavy Equipment Transporter (HET), or Heavy Expanded Mobility Tactical Truck (HEMTT).

The Oshkosh HET and PLS vehicles are classified as integrated nondevelopmental items. Because of their specialized applications, the commercial components such as engines, transmissions, axles, and

SPIRAL MODERNIZATION

(The cyclical insertion of technology and modernization)



tires were integrated into a chassis system that meets the Army's operational requirements. In newer OTC vehicle programs with PM-HTV, such as the HEMTT ESP and HET Technical Insertion Program, OTC again uses a number of commercially developed components and integrates them into an enhanced vehicle system. The use of commercial components reduces development and production costs and improves serviceability.

Commercial R&D Investigative Techniques

In late 1997, the Family of Medium Tactical Vehicles (FMTV) Program experienced isolated incidents of cracked flywheel housings, predominately on the 4x4 Light Medium Tactical Vehicle (LMTV). An investigation was undertaken to verify that there were no workmanship or quality issues with the cracked housings and to determine the environment where these vehicles were operated. The investigation of the flywheel housing cracks also revealed incidents of driveshaft failures, all on the 4x4 LMTV variants.

The team speculated that these failures were related and sought more information on the motion of the power train in a continuous high-speed highway environment. The method used to study the motion of the power train was a vibration modal analysis. This is the method used in the automotive industry to correct many noise, vibration, and harshness (NVH) problems. The conclusion was that controlling the dynamic drive-line imbalance and raising the powerpacks' natural frequency out of the operating range would correct the drive-line and flywheel housing failure modes.

In late 1998, the U.S Army Aberdeen Test Center at Aberdeen Proving Ground, MD, successfully completed validation testing of six Stewart & Stevenson FMTV vehicles. These vehicles were retrofitted with newly designed nodular iron flywheel housings by Caterpillar Inc. and newly designed driveshafts from Meritor. Each vehicle completed 12,000 miles of endurance and validation testing without incident. This testing culminated more than 8 months of work by a team of government and industry TWV and automotive specialists. Team members included representatives from the U.S. Army Tank-automotive and Armaments Command, Stewart & Stevenson, Caterpillar, Meritor, EG&G Structural Kinematics, Effective Technology Inc., Allison Transmission, and Michigan Scientific Corp. Commercial R&D techniques in NVH used in the automotive industry played a vital part in the investigation and subsequent repair of this FMTV problem.

Future Possibilities

To help maximize shrinking Army R&D dollars, the National Automotive Center (NAC), located at the U.S. Army Tank Automotive Research, Development and Engineering Center, Warren, MI, collaborated with the automotive industry to identify dual-use technologies that can benefit both Defense and commercial industries and structure cooperative programs. Stewart & Stevenson, Lockheed Martin Corp., and NAC have partnered to produce a hybrid electric version of a 5-ton FMTV cargo truck. A functional prototype hybrid electric vehicle (HEV) was displayed at the 1998 Association of the U.S. Army meeting in Washington, DC. Proprietary technology developed by Lockheed Martin for commercial trucks and buses will provide the FMTV HEV with significant improvements in fuel economy, acceleration, brake lining, and reduced exhaust emissions. OTC is also pursuing a similar dual-use R&D effort with NAC called the Oshkosh "Sealed Hood" concept. This concept will use commercial automotive technologies such as multiplexing and fully integrated flat panel displays.

Conclusion

Strategies to meet operational requirements that include leveraging the economies of scale, integrating commercial components, and partnering of government and industry will allow us to acquire as much capability as resources will permit. Ultimately, the strategy of teaming to efficiently adopt commercial technology in the "spiral modernization" of our legacy fleets will allow the Army's TWV to drive into the next millennium.

MAJ PHILIP SCHOENIG is a Combat Developer for TWVs in the Directorate of Combat Developments for Transportation at CASCOM, Fort Lee, VA. He has a B.S. degree in business administration from Fitchburg State College and a master's degree in management with a concentration in logistics management from the Florida Institute of Technology.

JEFFREY HAMEL is the Assistant PM-PLS for the Deputy for System Acquisition, TACOM, Warren, MI. He has a B.S. degree in mechanical engineering from the University of Buffalo and has completed the Advanced Program Management course at the Defense Systems Management College.

RICK ENGEL is Director of Government Vehicle Sales at Freightliner Corp. He served more than 26 years in the U.S. Army, retiring as a colonel in the Army Acquisition Corps.

EDDIE GARCIA is the Manager in the Government Marketing Department at OTC. He has a B.B.A. degree in marketing from Southern Methodist University.

LYNN JONES is the Marketing Administrator in the Government Marketing Department at OTC. She has an A.S. degree in business from Cardinal Stritch University.

REGIS LUTHER is the Director of Engineering for the Tactical Vehicle Systems Division of Stewart & Stevenson, Houston, TX. He has a B.S. degree in chemical engineering from Youngstown State University, an M.S. degree in chemical engineering with a concentration in thermodynamics and nondestructive testing from Johns Hopkins University, and an M.B.A. from the University of Houston.

From The Director Acquisition Career Management Office

With the rapid approach of summer comes the equally rapid approach of the June deadline for completion of the Individual Development Plan (IDP). I would like to take this opportunity to emphasize again the importance of updated personnel files. The Army Acquisition Corps (AAC) requires each member, military and civilian, to complete an IDP no later than June 30, 1999. I would like all supervisors to ensure that this happens. Designed to reflect your current and future training requirements for a 5-year period, the IDP is a critical document for acquisition professionals and their supervisors to identify and track their career objectives. We have created an automated process to facilitate the development and modification of IDPs. You can find the automated IDP at **https://rda.rdaisa.sarda.army.mil/idp/idpprod/idpstart.htm**.

The IDP is one of two critical components of your personnel file. The second is the Acquisition Civilian Record Brief (ACRB) for civilians, or the Officer Record Brief (ORB) for military personnel. You should update these forms annually. They are used by Army Acquisition Workforce (AAW) members to certify eligibility to compete for career-enhancing opportunities. The ACRB, like the ORB, is an automated record that consolidates personnel data, education, experience, certification level, assignments, and training data. If the information on your ACRB is not current, you restrict your ability to compete for exciting career opportunities. Effective July 1999, the automated IDP must be approved before students can apply for a course offered by the Defense Acquisition University. Additionally, the IDP will be the official repository for all your accomplishments under the continuous learning requirement. Revisions to the automated IDP will make it an even more valuable tool for identifying and tracking an acquisition professional's career objectives in the areas of experience, education, and training. The Mobile Acquisition Career Management Office (MACMO) is in place specifically to give you the information you need to understand these important records.

I would like to direct your attention to the Under Secretary of Defense (Acquisition and Technology) Continuous Learning Policy, effective Dec. 15, 1998. This policy requires civilian and military acquisition professionals to participate in continuous learning activities that augment the minimum education, training, and experience standards established for certification purposes for their career fields. Acquisition personnel who have completed the certification requirements for the positions they are in shall earn a minimum of 80 continuous learning points every 2 years, from the date of certification for the position held or from the date of the prior 2-year continuous learning certification. (Individuals who are not certified in the position they hold are expected to concentrate on obtaining certification.) You can get a copy of the policy at **http://www.acq.osd.mil/ar/#otherhot**.

We are pleased to announce the selections for the Year Group 2000 Competitive Development Group shown on Page 41 in this issue. As you may already know, this career development program provides leadership-intensive training and experience opportunities for competitively selected GS-12 and -13 Corps Eligible and AAC members. Be sure to read the article on the Competitive Development Group (CDG) Program on Page 41, which discusses CDG Program selection criteria and demographics as well as CDG career opportunities. I encourage supervisors of eligible personnel to emphasize the exciting benefits of this program for expanding knowledge and experience. I would also like to congratulate the 19 AAC officers selected to attend Senior Service College and the 40 graduates of the Materiel Acquisition Management Course at the U.S. Army Logistics Management College, Fort Lee, VA, who are listed on Pages 75 and 76 of this magazine. I also want to point you to the article on The Army National Guard Acquisition Corps Strategic Plan on Page 75.

As you may have heard, the 1999 Army Acquisition Workforce/Corps Roadshow series has a new name. Army Acquisition Workforce 2000 was chosen because it more accurately conveys that Keith Charles, Deputy Director for Acquisition Career Management, and the MACMO are communicating ongoing AAW and AAC initiatives. These communications provide one-on-one career counseling and feedback from the field.

My office is always available to provide the information you need to help advance your acquisition career. Our phone numbers can be found on the AAC home page at **http://dacm.sarda.army.mil/contacts/**.

AAC's 10th Anniversary

The Army Acquisition Corps (AAC) was established Oct. 13, 1989, by approval of the U.S. Army Chief of Staff. This year will mark the AAC's 10th anniversary, and the Director of Acquisition Career Management (DACM) LTG Paul J. Kern has announced plans to commemorate the occasion during the week of the 1999 Association of the U.S. Army (AUSA) Annual Meeting, Oct. 11–13, 1999. Planned activities include a pictorial review of the AAC's history displayed in the Pentagon's main corridor, a hospitality suite and exhibit at the AUSA annual meeting, and an AAC Ball.

The DACM requested volunteers to form a process action team (PAT) to plan the AAC 10th anniversary commemoration. Senior AAC personnel have enthusiastically responded to this request and their continued support is essential in conveying the "field perspective." In addition to forming a PAT, the DACM approved creation of an association for all Active component acquisition military and civilian personnel. The association will be a government organization that serves as a regional source of AAC information and history.

The PAT will define the goals of the commemoration, identify specific events associated with the campaign, recommend a strategy for implementation of plans, and establish the association. Additionally, the PAT will ensure that commemoration updates are provided to the Army Acquisition Workforce and that a website is created for posting information.

The AAC Ball will be held Oct. 10, 1999, in the Washington, DC, area. The association's inaugural ceremony will take place during the AAC Ball. Distinguished guests are expected to include members of the Office of the Secretary of Defense staff, the Secretariat and other Army staff, and senior AAC military and civilian personnel.

For additional information, contact Tony Echols in the Acquisition Career Management Office at (703) 604-7145, DSN 664-7145.

AAW Southern Regional Headquarters Established

To improve communications and career management support to the Army Acquisition Workforce (AAW), Keith Charles, Deputy Director for Acquisition Career Management, has established a pilot program for the Southern Region of the AAW in the Huntsville/Redstone Arsenal, AL, geographical area. The

Southern Regional Headquarters opened in March. Maxine Maples has been appointed as the Special Assistant/Regional Director for Acquisition Career Management Initiatives in the Southern Region.

This pilot program supports the AAW, acquisition career management advocates, program executive officers, program and product managers, and commanders in the nine-state area (Tennessee, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas) that comprises the Southern Region. This concept streamlines the acquisition support structure and will help enhance communication to and from the field to provide better and more accessible support to AAW members in that region.

For more information, contact Tony Echols in the Acquisition Career Management Office at (703) 604-7145, DSN 664-7145, or e-mail: **echolsa@sarda.army.mil**.

Competitive Development Group Successes

The Acquisition Career Management Office is pleased to report the Competitive Development Group (CDG) successes for Year Groups 1997 and 1998. The following CDG selectees have been promoted to GS-14 by the following organizations:

	Year Group 1997
Wayne Bruno	PEO-Aviation
Jennifer Chew	Test and Evaluation Command
Scott Crosson	Army Materiel Command
Catherine Doolos	Office, Assistant Secretary of the Army (Acquisition, Logistics and Technology)
Alvin Hopkins	PEO-Aviation
Ann Scotti	Army Materiel Command
Craig Spisak	Office, Assistant Secretary of the Army (Acquisition, Logistics and Technology)
Robert Szersynski	PEO-Air and Missile Defense
Rusty Weiger	PEO-Aviation
	Year Group 1998
Amelia Hatchett	PEO-Air and Missile Defense
Sharon Johnson	PEO-Aviation
Samuel Jones	PEO-Intelligence, Electronic Warfare and Sensors (temporary promotion)

Congratulations to all! Your accomplishments directly reflect our goal for the CDG Program—to develop the best leaders for the Army of the 21st century.

Change To ASI G1

The additional skill identifier (ASI) G1 has been changed from purchasing agent to contracting agent to more accurately reflect the duties that ASI G1 personnel perform. ASI G1 positions require soldiers qualified as contracting noncommissioned officers to assist in the planning and execution of purchasing and contracting tasks at posts, camps or stations, and on contingency missions.

To receive the ASI G1, soldiers must successfully complete the courses CON 101 - Basics of Contracting, CON 104 - Fundamentals of Contract Pricing, and CON 234 - Contingency Contracting. Courses must be completed at the Defense Acquisition University or at other accredited colleges and universities. The ASI G1 is restricted to use with military occupational specialties (MOSs) 92A (skill levels 3 and 4), 92Y (skill levels 4 and 5), and 92Z only. However, the Director, Acquisition Career Management Office may award the ASI G1 to soldiers with other than MOS 92A, 92Y, and 92Z on an exception-to-policy basis. If you have any questions, contact MAJ Phil Yacovoni (703) 604-7106, DSN 664-7106, or e-mail: **yacovonp@sarda.army.mil**.

40 Graduate From MAM Course

Forty students graduated from the Materiel Acquisition Management (MAM) Course, Class 99-002, at the U.S. Army Logistics Management College, Fort Lee, VA. The course ran from Jan. 11 to Feb. 26, 1999. The graduates included one allied officer from Senegal and five officers from Japan.

The Distinguished Graduate Award was presented to CPT Gerald Davis Jr., who is assigned to Fort Rucker, AL.

Research and development, testing, contracting, requirements generation, logistics, and production management are examples of the materiel acquisition work assignments offered to these graduates. The names of the graduates are listed below.

Rank	Name	Rank	Name
MAJ	James Blanco	CPT	Todd Lamb
CPT	Eva Branham	CPT	Robert Long
CPT	Eric Cathcart	CPT	Louis Mayo
	Ted Chelette	MAJ	Mamadou Mbaye
MAJ	Brian Cummings	CPT	Michael Murrah
CW2	Ronald Cutchember	CPT	Mark Neal
CPT	Gerald Davis	MAJ	Masahiro Okawa
CW3	Donald Dehnel	CPT	Mitsuru Osawa
MAJ	Ronnie Dix	CPT	Joel Phillips
CPT	Patrick Erickson	CPT	Susan Pooler
CPT	Johnny Figueroa	MAJ	Willard Robinson
CPT	Daniel Fuller	CPT	Edward Shepherd
	Jean Grotophorst	CPT	Allen Stephan
CPT	Richard Hall	CPT	Raymond Strickland
CPT	Michael Harris	SFC	Miranda Sumblin
CPT	George Holland	MAJ	Dorothy Taneyhill
CPT	Daniel Irwin	CPT	Paul Terrell
	Kenichi Kajikawa	CPT	Steven Wall
MAJ	Masahiko Kawasaki	CPT	Anthony Wizner
CPT	James Kennedy	MAJ	Hideaki Yonekura

Army National Guard Acquisition Corps Strategic Plan

In December 1998, MG Roger Schultz, Director, Army National Guard (ARNG), approved a strategic plan that will integrate the Army Acquisition Corps (AAC) and the ARNG. The ARNG fully supports the AAC and this new integration plan. The four-part strategy outlined in this plan is the result of a September 1998 meeting between Schultz and Keith Charles, Deputy Director, Acquisition Career Management, Office of the Assistant Secretary of the Army (Research, Development and Acquisition) (now Acquisition, Logistics and Technology).

The first part of the plan applies to acquisition position and personnel identification. Prior to the September 1998 meeting, the ARNG began analyzing acquisition-related positions and identifying personnel with acquisition education or experience who could leverage their skills to achieve ARNG's acquisition objectives. A number of acquisition-related positions have been identified. When individuals are identified, they will be notified and provided guidance on accession to the AAC.

The second part of the plan addresses the development of career paths and career progression for ARNG acquisition personnel. Some potentially qualifying positions within the ARNG structure include force integration and readiness officers, directors of information management, and contracting officers. The ARNG is also reviewing Title 10 positions with acquisition-related missions. Career paths for personnel will be developed to ensure both the effective implementation of the strategy and the officer's career development.

In the third part of the plan, the ARNG is pursuing use of temporary tours of active duty as the primary tool to place ARNG personnel in product and project manager (PM) offices. The intent is to place these personnel in organizations that will field significant amounts of equipment to ARNG units between 1999 and 2005. They will serve as coordinators and team chiefs for fielding equipment to ARNG units throughout the United States. Personnel from the receiving ARNG units will be assigned to PM offices whenever practical.

The last part of the plan is the most ambitious and aggressive and involves the request and approval from Congress for additional full-time personnel. Sixty individuals will be placed in various acquisition fields to meet ARNG requirements. These personnel will back-up state government and ARNG acquisition efforts during peacetime. In addition, they will serve on a rotational basis with those ARNG personnel projected for PM positions. Where feasible, a portion of these personnel will be assigned to work within PM organizations to gain experience in preparation for possible PM assignments. These personnel will be critical in enhancing the Army's capability to support the soldier. The PM organization will provide full-time career progression for ARNG Acquisition Workforce and AAC members.

The purpose of this four-part strategic plan is to provide the framework for ARNG participation in the AAC. When this article was written, an implementation plan had been developed, and finalization was expected by the end of the second quarter of FY99. Parts of this program are already being executed, and the ARNG plans to have it fully implemented no later than FY03.

Personnel Demo Project Underway

Effective Feb. 10, 1999, the U.S. Army Contracting Command Korea (USACCK) became the first Army agency to participate in the DOD Civilian Acquisition Workforce Personnel Demonstration Project.

Director of Contracting Perry Hicks was the first Army employee assigned to the Demo Project. Other initial participants are as follows: Diana Harmonson-Walls, Chief, Policy and Plans Branch; Bobbie Cole, Chief, Administration Branch; Henrietta White, Chief, Contract Support Division; Stephen Bradford, Deputy, Contract Operation Division; Carl Stubbert, Chief, Technical and Contract Admin Division; Kathy Salas, Chief, Services Branch; Joseph Arnaud, Chief, Compliance Branch; Pamela Hastings, Chief, Non-Appropriated Fund Branch; Ronald Parrish, Chief, Information Management Office; Brian Smith, Chief, Quality Assurance Branch; and Charles Wilder II, Contract Attorney.

USACCK is especially thankful for the expert guidance provided by Tony Echols, Army Project Officer, Acquisition Career Management Office, and Doby Nicklas, DOD Civilian Acquisition Workforce Personnel Demonstration Project Office, and for their willingness to travel to Seoul to train USACCK personnel on the project. In addition, Jerold Lee, support staff, was particularly helpful in providing advance information and setting up the training.

There are many who made the transition to the Demo Project successful. USACCK would like to recognize the following people: Rosetta McFall, Civilian Personnel Division; Scott McCue, Resource Management; Kim Y.C., Civilian Personnel Advisory Center; and Dave Gerdis, Ken Starke, Cindy Barnes, and Sarabeth Walker, Civilian Personnel Operating Center, Taegu; for expediting paperwork that allowed USACCK to be the first Army agency to implement the Demo Project.

Finally, Diana Harmonson-Walls, Project Leader for USACCK, and Bobbie Cole, Demonstration Historian, helped assist managers and supervisors with the transition and are commended for a job well done.

PERSCOM Notes . . .

19 AAC Officers Selected For Senior Service College

Congratulations to the 19 Army Acquisition Corps (AAC) officers selected to attend Senior Service College during academic year 1999–2000. The selected officers and the schools they will attend are listed below.

ARMY WAR COLLEGE, CARLISLE BARRACKS, PA

LTC Damian P. Bianca
LTC Steven J. Cox
LTC David B. Cripps
LTC(P) Charles F. McMaster
LTC(P) John A. Merkwan
LTC(P) David P. Miller
LTC Ainsworth B. Mills
COL Dwight E. Thomas

INDUSTRIAL COLLEGE OF THE ARMED FORCES, FORT McNAIR, VA

LTC(P) Joseph A. Durso
LTC Mark W. Jones
LTC Nickolas G. Justice
LTC Harry W. McClellan
LTC Robert D. Ogg
LTC Carl M. Tegen

ACQUISITION FELLOWSHIP, UNIVERSITY OF TEXAS, AUSTIN, TX

LTC(P) Matthew J. Fair
LTC Michael E. Johnson
LTC(P) James D. Wargo

AIR WAR COLLEGE, MAXWELL AFB, AL

LTC Phillip D. Macklin
LTC(P) Tommie E. Newberry

Changes At AMB

Yvette Handifield is the new Certification Manager at the U.S. Total Army Personnel Command's Acquisition Management Branch (AMB). Handifield previously worked at the Joint Personnel Property Shipping Office, Fort Belvoir, VA.

Several additional personnel changes are planned during the next few months. Two current assignment officers will be departing AMB. MAJ Steve Leisenring, the COL Assignments Officer, will assume new duties at the Defense Contract Management Command; and MAJ Dwayne Green, the LTC FA53/97 Assignments Officer, is headed to an assignment in Saudi Arabia.

Effective May 15, 1999, MAJ Steve Decato will become the Assignments Officer for both MAJ and LTC FA53s, and MAJ Jay Norris will become the Assignments Officer for both MAJ and LTC FA97s.

MAJ Kimberly Hancock will replace Decato as the Distribution Manager. Hancock was previously assigned as a Systems Automation Engineer at the U.S. Army Communications-Electronics Command.

Effective June 15, 1999, MAJ Paul Myrick will move from the LTC FA51 Assignments Desk to the COL Assignments Desk. The new LTC FA51 Assignments Officer will be MAJ Brian Winters. Winters was previously assigned to the Program Analysis and Evaluation Office in the Office of the Army Chief of Staff.

The AMB personnel chart, which lists phone numbers and e-mail addresses, is available on the Army Acquisition Corps home page at **http://dacm.sarda.army.mil/contacts/tapc.html**

The Operational Experience Program

Because of the continued downsizing of active forces, civilians are being tasked more frequently to fill acquisition positions once held only by military personnel. While this practice involves a major cultural change, it provides the Army more flexibility to meet future challenges and increases competition for senior level jobs, resulting in the best-qualified leader. Thus, the need to establish closer ties between the acquisition and warfighter communities is now greater than ever. The more insight acquisition personnel have of the warfighter in an operational environment, the more their understanding of soldier, weapon, and equipment interface is enhanced.

To further enhance this understanding, the Army acquisition community is offering an Operational Experience Program to all Army Acquisition Workforce (AAW) members. This program places great emphasis on soldier, weapon, and equipment interface in an actual field environment. AAW members will be given the opportunity to gain first-hand experience in operational environments. Future expansion of the program will include a greater variety of operational experiences, including professional military education opportunities.

The Army's Acquisition Career Management Office (ACMO) has partnered with several of the Army's premier warfighter training organizations to develop this Operational Experience Program. Some participating organizations are the National Training Center (NTC), Fort Irwin, CA; the Joint Readiness Training Center (JRTC), Fort Polk, LA; and the U.S. Army Contracting Command, Seoul, Korea.

Operational experience assignments will typically last from 1 to 3 weeks, with some lasting up to 6 months. Assignments will be in a tactical environment (with soldiers in a fielded unit). Typical assignments may include the following:

• Assignments at NTC include orientation visits with the opportunity to observe brigade and battalion force-on-force warfighting exercises, overnight bivouacs with the opposing force, and rotations through the Army Materiel Command's Science Advisor's Office located at NTC to serve as the communications link between the soldier and the research and development community.

• At JRTC, individuals will have the opportunity to observe and participate in readiness training exercises at the squad and platoon levels. Individuals will be issued TA-50 (field equipment) and uniforms, and will participate in overnight bivouacs in the field with soldiers.

• At the U.S. Army Contracting Command, Seoul, Korea, participants will have the opportunity to prepare and participate in contingency exercises, develop contingency contracts for requiring activities, work with personnel of the Contract Administrative Branch to resolve problem contracts, and support the Contract Services Branch in the preparation of contingency contracts and flood damage contracts within the command's entire theater of operations. Participants in these assignments must be able to endure wearing Mission Oriented Protective Posture IV gear (gas mask, protective clothing, etc.) for short periods of time.

The ACMO is accepting applications for operational experiences currently announced in the *Army Education, Training and Experience (AETE) Catalog*. The AETE catalog can be accessed under the Career Development section of AAC's website: **http://dacm.sarda.army.mil**. Operational experience assignments will be funded by ACMO; however, a participant's organization will still be responsible for funding the participant's salary. Announcements in the AETE catalog will provide additional information on each experience and detailed instructions on how AAW members can apply for their desired experience.

A board to select participants for current assignments is scheduled for June 22, 1999. Interested individuals must submit their applications by June 14, 1999, to be considered for this board. For further information, AAW members may also contact the ACMO points of contact listed in the AETE catalog.

NEWS BRIEFS

USD(A&T) Selects Three Army Section 816 Pilot Programs

The Office of the Under Secretary of Defense for Acquisition and Technology (USD(A&T)) has formally identified 10 pilot programs (3 from the Army, 3 from the Navy, and 4 from the Air Force) to fulfill the requirement of Section 816 of the Strom Thurmond National Defense Authorization Act for FY99. This congressional directive required the Secretary of Defense to designate 10 "Pilot Programs for Testing Program Manager Performance of Product Support Oversight Responsibilities for Life Cycle of Acquisition Programs." The 10 programs identified by the USD(A&T) were contained in a report submitted to the President of the Senate. The report identified management actions that are planned to improve program manager oversight and ensure proper life-cycle support for these programs. The three Army pilot programs selected are M-1 Abrams, AH-64 Apache, and the Advanced Field Artillery Tactical Data System (AFATDS).

The Abrams tank provides heavy armor superiority on the battlefield. The Abrams Program is unique in that it has products throughout its life cycle: M1A2 System Enhancement Program (SEP) in research and development, M1A2 in production, M1A1 in sustainment, and M1 in upgrade/disposal. The Abrams AGT 1500 engine and its mean time between failure is an operational concern and a major operations and support cost driver for the Army.

The AH-64 Apache attack helicopter's mission is to conduct rear, close, and deep operations; deep precision strike; and provide armed reconnaissance and security when required in day, night, and adverse weather conditions. Apache prime vendor support is a comprehensive approach to provide wholesale logistics support, which includes depot maintenance as well as supply support, for the entire Apache weapon system. The objective is to reduce the overall Army support cost, improve parts availability, maintain aircraft readiness, and provide funds for modernization.

AFATDS is the only heavily software-oriented command and control (C2) weapon system in the mix of 10 Section 816 pilot programs selected. AFATDS is the digitized Force XXI baseline fire support (FS) C2 system for Army and U.S. Marine Corps firing platoons through echelons above corps. It automates, coordinates, and integrates air-, land-, and sea-based fires optimizing FS solutions based on commander's guidance and all available FS assets.

An OSD-sponsored PEO/SYSCOM Conference was held in mid-April 1999 to focus on this new product support paradigm.

Raytheon Earned Value Management System Validated

During a ceremony late last year at the Pentagon, Paul J. Hoeper, Assistant Secretary of the Army (Acquisition, Logistics and Technology), presented an official letter of certification for a validated Earned Value Management System (EVMS) to Fred Hissong, President of the Raytheon Demilitarization Company (RDC).

RDC was recognized for its EVMS that has been implemented at the Johnston Atoll Chemical Agent Disposal System site, a demilitarization facility used to destroy lethal chemical agents and munitions stored at Johnston Atoll. RDC's EVMS is compliant with the DOD/industry EVMS guidelines. RDC is the first Chemical Demilitarization Program contractor site to be validated.

Other attendees at the Pentagon ceremony included James Bacon, Program Manager for Chemical Demilitarization; Dr. Theodore Prociv, Deputy Assistant Secretary of the Army for Chemical Demilitarization; and Shay Assad, President and CEO Raytheon Engineers and Constructors.

From The Acquisition Reform Office...

Acquisition And Logistics Conference

The Army's Acquisition and Logistics Initiatives Conference, sponsored by Headquarters, Army Materiel Command, was held late last year in Washington, DC. Conference hosts were Team Command, Control, Communications, Computers, Intelligence, Electronic Warfare and Sensors (C4IEWS), which includes the Army Communications-Electronics Command; the Program Executive Office (PEO), Command, Control, and Communications Systems (PEO-C3S); the PEO, Intelligence, Electronic Warfare and Sensors (PEO-IEWS); and an industry partnership consisting of The International Society of Logistics and SAVE International, "The Value Society."

For nearly 600 industry and government participants, it was an opportunity to interact with senior leaders in a series of discussions and panels about the continuing reform and evolution of Army business practices. Highlighting "The Journey to Reduce Operation and Support Costs" as its theme, the conference focused on the Army's efforts to institutionalize efficient and effective acquisition and logistic practices. The endgame is to develop a link among acquisition and logistics, overarching financial management, and partnering with industry to obtain and maintain high-quality, affordable equipment for the warfighter of the next millennium.

Several training sessions were conducted during the conference. The sessions were condensed versions of training courses developed to train the Army workforce and its industry counterparts about new ways of doing business. Equipment displays demonstrated that acquisition reform has taken hold and is producing positive results. One such display, the Control Display Unit (CDU) of the AN/PRD-12 Radio Direction Finder, was redesigned by Team C4IEWS as a modernization through spares initiative. The new CDU was purchased using performance-based requirements to obtain commercial technology and is field maintainable, user friendly, durable, and reliable. The unit cost has been reduced 48 percent. Operation and support cost avoidance are estimated at $11 million over 10 years.

Point of contact for this article is Kenneth Brockel, (732) 532-2394, DSN 992-2394.

Army Purchase Card Performance

The Army continues to lead DOD in purchase card dollars spent and number of transactions. For FY98, purchases on the Army card totaled $1.4 billion versus $1.1 billion in FY97, an increase of 27 percent. The number of Defense transactions totaled 7.4 million in FY98, of which the Army executed 42 percent, versus 27 percent each for Air Force and Navy, and 4 percent for other Defense agencies. The number of Army transactions went from 2.4 million in FY97 to 3.1 million in FY98, an increase of approximately 29 percent.

Use of the card has allowed the Army to meet mission requirements with fewer people and accommodate workforce reduction. The Army eliminated 76 spaces from contracting offices worldwide during Program Objective Memorandum 98-03 as part of the implementation of the Army Contracting Functional Area Assessment.

Goals for expanded use of the card in FY99 follow:

- Government-to-government transactions,
- Transportation payments,
- Commercial training through colleges and universities (up to $25,000),
- Payment vehicles for larger contracts, and
- VISA convenience checks.

In addition, development of the Electronic Data Interchange process for invoice reconciliation and payment will result in reduction of the Defense Finance Accounting System bill.

As we move into the new millennium, the card is expected to revolutionize the way government does business. The Army will continue to take the lead in finding ways to further streamline its purchasing process, buying supplies and services better-faster-cheaper, and still maintain the integrity of the procurement process.

Point of contact for this article is Dorothy Hindman, (703) 681-3417.

PATRIOT Spares Catalog ALPHA Contract

The PATRIOT Spares Catalog ALPHA Contract Integrated Process Team (IPT) used the Alpha contracting concept to develop, evaluate, negotiate, and award a fixed-price, redeterminable 5-year catalog contract covering 119 PATRIOT missile system complex electronic and mechanical spares items with Raytheon Co. The contract was designed to incorporate the key objectives of reduction of administrative lead times (ALT), production lead times (PLT), and administrative cost savings while maintaining a fair and reasonable price. The contract has an estimated potential value of more than $166 million over the performance period. The IPT negotiated significant savings of more than $65 million off the proposed cost and, through their knowledge of the government's requirements, were able to identify many areas of cost that could be eliminated or reduced.

The contract contains a unique pricing model developed by the Lead Price Analyst that provides a tool for pricing any quantity from one each to the maximum quantity for each line item, while taking into consideration residual minimum-buy material and required lot acceptance test residual material. This pricing model ensures residual material is held for future government requirements. The pricing model makes possible the reduction of ALT to 1 month for all items. Shortening the PLT by 10 to 20 months significantly reduces the quantity and dollars needed to support the PATRIOT missile system. The award of this contract will avoid costs to the government in excess of $6.1 million in ALT based on buying 1 each of 119 spare items during the first year. If the Army Aviation and

Missile Command buys three of each item each year, cost avoidance over the life of the contract through FY03 would be $90.9 million. The dedicated commitment of all participants enabled the team to complete the ALPHA process, making award 85 days from contract justification and approval.

Point of contact for this article is Dianne B. Landtroop, (256) 876-9855, DSN 746-9855.

Mentor-Protégé Program

The Army Small and Disadvantaged Business Utilization Office, Army Space and Missile Defense Command (ASMDC), and Mevatec Corp. are responsible for half of the Mentor-Protégé 8(a) pilot program agreements within DOD. The ASMDC awarded the first Army Mentor-Protégé agreement between a graduated 8(a) and another 8(a) firm in October 1997. In the 18 months since that award, Mevatec Corp., headquartered in Huntsville, AL, has entered into two more such agreements making it the largest supporter of this pilot program.

The DOD Mentor-Protégé Program provides incentives for major DOD contractors to assist small disadvantaged businesses in the development and improvement of their business capabilities. The mentor also assists them in increasing their participation as subcontractors and suppliers under DOD and other government and commercial contracts.

The latest augmentation to this DOD-wide program is the 8(a) pilot program, which allows graduated 8(a) firms to "mentor" companies still involved in the Small Business Administration's 8(a) program. This innovative part of the Mentor-Protégé Program allows for the transfer of a wealth of knowledge gained through the mentor's participation in the 8(a) program.

Mevatec's three Mentor-Protégé Agreements, valued at approximately $1 million, were executed with Analytical Services Inc., WESTEC International, and Soft Access. All three agreements are administered under the ASMDC Systems Engineering and Technical Assistance Contract (SETAC) in Huntsville, AL.

The three protégés are currently providing support to a variety of DOD programs. Under the Mentor-Protégé Agreements, these 8(a) firms plan to concentrate on improvement of their DOD-related engineering and analysis services, as well as acquiring training and support in the areas of business infrastructure and overall business development.

Mevatec Corp. estimates that between $500,000 and $3 million in subcontracting opportunities will be available for their protégés during the period of performance of the agreements. As a protégé, each company is eligible to be awarded a sole-source SETAC subcontract from Mevatec. It is Mevatec's intent to set aside SETAC work for each of these companies, as well as to assist them in securing future non-SETAC work.

Point of contract for this article is Denise Owens, (256) 955-3947.

BOOKS

Project Leadership: From Theory to Practice

By Jeffrey K. Pinto and others

Project Management Institute, 1998

Reviewed by LTC Kenneth H. Rose (USA, Ret.), a Project Manager with the Waste Policy Institute in San Antonio, TX, and a former member of the Army Acquisition Corps.

In project management literature, a generally accepted axiom suggests that projects usually fail not on technical merit, but on matters related to people. Authors then usually proceed to prescribe technical tools in great detail, giving short shrift to leadership skills that would counter the threat they just defined. *Project Leadership: From Theory to Practice* by Jeffrey K. Pinto, Peg Thomas, Jeffrey Trailer, Todd Palmer, and Michele Govekar breaks this mold and focuses on leadership in project management environments. The book offers a solid grounding across a broad range of theory, then walks the reader through application of the theory in the practical context of project management. At less than 150 pages, the book appears at first to be one of those easy reads that populate today's bookstores. It is not. It is densely packed with concepts and models for action that should be perused with great care, not for mere awareness, but for understanding, retention, and future application.

The authors discuss principal theories of leadership, bridging contingency and universal perspectives. They favor a transformational approach that enables a leader to link people and tasks to achieve success in dynamic, often chaotic environments. They describe accountability for results as a key to project success, and they provide a model and procedures for establishing and controlling accountability within the project team.

The project vision, which is often little more than motivational mush, receives serious treatment as an essential foundation for project success. The authors describe the role and effects of a project vision and provide a disciplined development approach that goes far beyond the cheerleading approach that often seems to be in vogue.

Team building and ethics both receive candid, direct treatment that addresses promises and pitfalls, and charts a course for negotiating a successful transit through these challenging areas.

The authors present an excellent integration of leading and managing, showing the essential role that each plays in project strategy. And, politics rears its not-so-ugly head as an eternal aspect of any project—one that, if handled well, can be a key to influencing others in achieving project goals.

The last chapter provides a synthesis of the book's important points, restating the basic premise that project management is a "leader-intensive undertaking" and that leadership is not a one-best-way task, but rather a many-faceted collection of decisions, attitudes, and actions.

Project Leadership: From Theory to Practice is a continuous journey, and the book should be taken as a whole to receive the full benefit. It offers a distinct contribution to project management leadership literature for new or experienced project managers.

LETTERS

Dear Sir:

I'm a GS-0346-13 Logistics Management Specialist at the U.S. Army Tank-automotive and Armaments Command, an AMC [U.S. Army Materiel Command] subordinate in Warren, MI. The articles on AMC's Logistics Reform Efforts [Page 7] and Supporting Training Systems Through Fixed Price Contracts [Page 12] in the November-December 1998 edition of *Army RD&A* were pretty exasperating.

For years we've been patting ourselves on the back for excellence and providing leaders the decisive edge, and suddenly, all our institutions and methods (depots, IMMCs [Integrated Materiel Management Centers], inventory and CCSS [Commodity Command Standard System]) are wasteful, cumbersome, and obsolete. Benevolent, smart contractors, operating under "flexible" contracts are going to fix everything, huh?

It would all ring truer if the talk of reform was not coming from the same top management that advanced their careers by creating and nurturing the current bureaucracy, which was an end unto itself—it justified their empires. It is wasteful, it doesn't work, and top management long ago abdicated control, accountability, and responsibility. Now, they're going to keep themselves in the top slots overseeing the process of giving away the farm to beltway bandits.

Before the AAE [Army Acquisition Executive] and the Secretary of the Army allow that to happen, I suggest a bold experiment: Contract out AMC management, keep the low-priced workforce and well developed infrastructure. Make it an offense punishable by dismissal to create an acronym or a named "reform" effort. Judge everything and everybody by what they DO. Let's define the JOB, let's DO the job. Perhaps the real job is smaller than we've long said it is (in truth, in peacetime it is). We seem to be ready to acknowledge the hollowness of the "excellence" of our logistics system as fostered by the forgiving conditions of peacetime and fat defense budgets. Now we need to also recognize that doing it for less total outlay (as might be the case with an entirely contracted-out logistics support system) does not necessarily mean that it is being done better, or even that you have a tenable system that can get the job done as well as the current system could if it was properly managed, or done at all in the crucible of a shooting war against a potent adversary.

John F. Czoykowski
TACOM

PERSONNEL

A Farewell From The ACMO Director

Shortly before this issue of *Army RD&A* went to press, I was selected to be the Senior Military Assistant to the Under Secretary of Defense for Acquisition and Technology, Dr. Jacques Gansler. I want to extend my heartfelt appreciation to all the people that have assisted me as Director of the Acquisition Career Management Office (ACMO). I look forward to our continued association in future endeavors.

COL Edward Cerutti

Consolidation Of Army Testing

As a result of an Army Science Board recommendation approved in June 1996, the Department of the Army has announced the consolidation and reorganization of Army testing commands. The consolidation of the U.S. Army Operational Test and Evaluation Command (OPTEC) and the Army Materiel Command's (AMC's) Test and Evaluation Command (TECOM) into the U.S. Army Test and Evaluation Command (ATEC) is not a downsizing initiative, but a step to improve the efficiency of Army testing and evaluation.

Effective Oct. 1, 1999, OPTEC will be shifted to ATEC and assume its name. The headquarters of ATEC will remain at OPTEC's current location in Alexandria, VA.

TECOM will now be a subordinate command of ATEC and will remain located at Aberdeen Proving Ground (APG), MD. TECOM will be renamed the Army Developmental Test Command (ADTC). AMC will retain installation management responsibility for APG and Aberdeen Garrison operations. The transfer of TECOM to ATEC will include responsibility for all TECOM test ranges (including Aberdeen Test Center) and for installation management of Yuma Proving Ground, AZ; Dugway Proving Ground, UT; and White Sands Missile Range, NM.

The Test and Experimentation Command (TEXCOM) will remain at Fort Hood, TX, and be redesignated the Army Operational Test Command (AOTC). The OPTEC Evaluation Analysis Center (EAC), located at APG, and the Operational Evaluation Command (OEC), located in Alexandria, VA, will be consolidated into a new subordinate command of ATEC, the Army Evaluation Center (AEC). AEC will be headquartered in Alexandria, VA. However, EAC personnel will remain located at APG.

The new organization will be responsible for all developmental and operational test and evaluation currently being performed by TECOM and OPTEC, and will report to the Army Vice Chief of Staff via the Assistant Vice Chief of Staff.

ARMY RD&A WRITER'S GUIDELINES

About *Army RD&A*

Army RD&A is a bimonthly professional development magazine published by the Office of the Assistant Secretary of the Army (Research, Development and Acquisition). The address for the Editorial Office is: DEPARTMENT OF THE ARMY, ARMY RD&A, 9900 BELVOIR RD, SUITE 101, FT BELVOIR VA 22060-5567. Phone numbers and e-mail addresses for the editorial staff are as follows:

Harvey L. Bleicher, Editor-in-Chief	bleicheh@aaesa.belvoir.army.mil	(703)805-1035/DSN 655-1035
Debbie Fischer, Executive Editor	fischerd@aaesa.belvoir.army.mil	(703)805-1038/DSN 655-1038
Cynthia Hermes, Managing Editor	hermesc@aaesa.belvoir.army.mil	(703)805-1034/DSN 655-1034
Herman L. Surles, Assistant Editor	surlesh@aaesa.belvoir.army.mil	(703)805-1036/DSN 655-1036
Sandra R. Marks, Technical Review	markss@aaesa.belvoir.army.mil	(703)805-1007/DSN 655-1007
		Datafax: (703)805-4218/DSN 655-4218

Purpose

To instruct members of the RD&A community relative to RD&A processes, procedures, techniques and management philosophy and to disseminate other information pertinent to the professional development of the Army Acquisition Workforce.

Subject Matter

Subjects may include, but are not restricted to, professional development of the Army's Acquisition Workforce, RD&A program accomplishments, technology developments, policy guidance, information technology, and acquisition reform initiatives. Articles containing footnotes are not acceptable. Acronyms used in manuscripts and with photos must be kept to a minimum and must be defined on first reference.

Length of Articles

Articles should be approximately 1,500 to 1,600 words in length. This equates to approximately 8 double-spaced typed pages, using a 20-line page. **Do not submit articles in a layout format. Submit text in separate files from illustrations.**

Photos and Illustrations

A maximum of 3 photos or illustrations, or a combination of both, may accompany each article. Photos may be black and white or color. **Illustrations must be black and white, in PowerPoint, and must not contain any shading, screens, or tints. Submit illustrations in separate files from text.** Not all photos and/or illustrations may be used and they will not be returned unless requested.

Biographical Sketch

Include a short biographical sketch of the author/s. This should include the author's educational background and current position.

Clearance

All articles must be cleared by the author's security/OPSEC office and public affairs office prior to submission. The cover letter accompanying the article must state that these clearances have been obtained and that the article has command approval for open publication.

Offices and individuals submitting articles that report Army cost savings must be prepared to quickly provide detailed documentation upon request that (1) verifies the cost savings; and (2) shows where the savings were reinvested. Organizations should be prepared to defend these monies in the event higher headquarters have a higher priority use for these savings. All Army RD&A *articles are cleared through SARD-ZAC. SARD-ZAC will clear all articles reporting cost savings through SARD-RI. Questions regarding this guideline can be directed to SARD-ZAC, Acquisition Career Management Office, (703) 604-7103, DSN 664-7103.*

Submission Dates

Issue	*Author's Deadline*
January-February	15 October
March-April	15 December
May-June	15 February
July-August	15 April
September-October	15 June
November-December	15 August

Submission Procedures

Article manuscripts (in MS Word) and illustrations (in PowerPoint) may be submitted via e-mail to **bleicheh@aaesa.belvoir.army.mil**, or on a 3 1/2-inch floppy disk via U.S. mail to DEPARTMENT OF THE ARMY, ARMY RD&A, 9900 BELVOIR RD, SUITE 101, FT BELVOIR VA 22060-5567. Photos may be e-mailed *for review purposes only*, but glossy prints must be sent via the U.S. mail. All submissions must include the author's mailing address, office phone number (DSN and commercial), and a typed, self-adhesive return address label.

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ARMY RDA
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FT BELVOIR VA 22060-5567

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