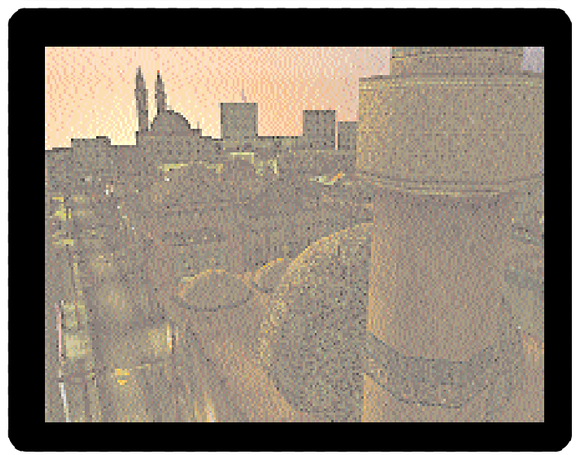
# SimsSimsSims

By Paul Harris

Modeling and simulation are leading the assault of new learning technologies that are winning favor with the U.S. military. Meanwhile, corporate training executives should keep an eye out for new techniques suitable for the workforce.

You've heard it said many times that Americans who participated in Operation Iraqi Freedom last spring were the best-equipped and best-trained military force ever assembled. Just how much better? Consider that a large number of the American servicemen and women who participated in that action honed their skills and assignments with the latest in computer-based simulation. By contrast, in Operation Desert Storm 10 years earlier simulation training was comparatively primitive.



## Simulation: The Game Is On

Because current recruits belong to the Nintendo Generation, it's logical for the U.S. military to leverage video games as a learning tool. That's the philosophy behind an Army contract with the University of Southern California to tap the resources of the entertainment and game development industries. The five-year contract created the Institute for Creative Technologies, which seeks to promote learning through immersive and interactive training simulation technologies.

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Surely the past decade has seen a proliferation of low-cost training systems throughout the military. No longer just a device for pilots, a wide range of inexpensive simulators is being used to train everyone from artillery troops to tank mechanics. By training in a virtual environment that replicates their assignments, soldiers arrive in theatre with skills that previously came only with actual tactical experience. Now imagine that the soldiers of the future will put current troops to shame from a training standpoint. They will carry with them all of the training materials they'll potentially ever need, say military planners. Training technology and systems will be embedded within vehicles and equipment that will accompany them everywhere.

It's not hard to figure. Relying primarily on COTS (commercial off-the-shelf) components, the Pentagon is realizing the power of investing in the compounding effect of Moore's Law. By riding the waves of "cheaper, faster, better," the Pentagon can plot a path for future commercial development. If computing power doubles every 18 months, as Gordon Moore first pronounced back in 1965, the performance curve is even steeper in the computer graphics domain, achieving 2.8 performance gains per year and 10 times for every two years, say experts.

Simulation technologies are also hitting new strides as a training tool for the private sector. Just ask the George Washington University Medical Center, which recently contracted with Denver-based Medical Simulation Corporation to establish a medical simulation system at the facility. The interactive SimSuite training system combines tactile force-feel simulation technology with procedures performed on a simulated patient. Even before U.S. Deputy Defense Secretary Paul Wolfowitz announced a high-profile plan to transform military training last year, producing the current drive to integrate service capabilities into joint training activities, the military services were exploiting advances in simulations and other learning technologies. The Pentagon's "revolution in training" is well under way, with clear ramifications for private industry.

Examples:

**Advanced Distributed Learning Initiative.** This collaborative effort between the public and private sectors is developing standards, tools, and learning-content software for future Web-based learning. ADL's SCORM (sharable content object reference model) has become the standard for granularity and reusability of content. It has recently released a draft of the SCORM Version 1.3, an application profile that introduces the IMS Simple Sequencing Specification and other standardization improvements.

**Navy e-learning.** More than any other military branch, the U.S. Navy is leveraging e-learning to reach the minds of its personnel. The chief of naval education and training (CNET) has created a Website navylearning.com to launch, track, and manage more than 2000 e-learning courses for more than 1.2 million sailors, Marines, retirees, reservists, and civilians. It selected the THINQ TrainingServer LMS to power the enormous system along with an armada of content vendors, all adhering to ADL's SCORM.

**eArmyU.** This initiative by the Army provides opportunities for higher learning and has assembled a collection of 21 colleges and universities so soldiers can earn degrees and certificates via Web-based courses earmyu.com. Soldiers receive up to 100 percent funding for tuition, books, and course fees, as well as a personal laptop, a printer, an email account, and an ISP account. IBM Global Services has the lead contract as program integrator. Other vendors include Blackboard, Saba, and PeopleSoft.

**Joint Strike Fighter.** This selection of Lockheed Martin's Joint Strike Fighter (F-35) for use by all branches of the U.S. military, as well as certain allies, points the way to future military training. It includes an unprecedented mandate for a common training system, as well as a requirement that training be embedded into the avionics of every aircraft. Training will become an integral part of design, with an emphasis where possible on simulation. Designers are seeking innovative ideas for all aspects of the project, including virtual, constructive, and live training systems.

# Computers That Reason and Learn

It has been called the greatest learning tool since the printing press. The Internet, the foundation of the so-called new economy, began with the vision of scientists working for the Pentagon's Defense Advanced Research Projects Agency, its basic research think tank. So, what learning and training-related research is DARPA pursuing now? Quite a bit, actually.

According to new strategic plan issued earlier this year, the agency (US$2 billion annual budget) has a variety of activities up its sleeve, including a Training Superiority Program to transform military training. It is also embarking on a strategic thrust called "cognitive computing," a new generation of computer systems that know what they're doing. The goal of the initial three-year training superiority program is to "start a paradigm shift" in military training by providing continuously available, on-demand, mission-level training for all forces at all echelons.

"This goal will be attained by providing a new kind of cognitive training experience for units and individuals based on continuously available wars," says the plan. To reach that goal, the plan is to create scalable last-meter training systems that will train judgment and cognitive performance under stress and provide a Two-Sigma improvement over classroom training in student, user, and unit performance. It will also create an architecture to populate with and link stand-alone LMT systems. "This will combine real-time generation, maintenance, updating, and modification of the training war scenario," says a spokesperson. Ingredients of the system include ubiquitous PC-class computers, storage, graphics, and networks; simulation infrastructure and standards; progress in advanced distributed learning; massive multiplayer games; intelligent computer tutors; and standard ontology reusable-plugable domain-specific knowledge bases.

The cognitive computing initiative is aimed at furthering the vision of DARPA scientists of the 1960s and 1970s. J.C.R. Licklider envisioned computers and people working together symbiotically, with computers seamlessly adapting to people as partners. DARPA's information processing technology office sees it as a return to its roots to pursue Licklider's vision for computers that can reason and learn. It will focus on several core research areas: computational perception; representation and reasoning; learning, communications, and interaction; dynamic coordinated teams of cognitive systems; and robust software and hardware infrastructure for cognitive systems.

"If DARPA succeeds in this strategic thrust just now getting under way, then in another 10 to 20 years much of Licklider's vision may finally be realized, sparking a second powerful revolution in information technology," says the plan's principal author, program manager Ralph Chatham. Lastly, DARPA is also involved in research into the next generation of the Internet.

# Simulation: The Game Is On

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Among the most promising results of the program to date are two video games designed specifically for the Army that blend entertainment and training, says an expert with the Simulation Technology Center for the Army's Research, Development, and Engineering Command Orlando, Florida, which is leading the ICT effort. Called *Full Spectrum Command* and *Full Spectrum Warrior,* the two games offer extremely realistic artificial intelligence, among other features, within a context that emphasizes real-time leadership and decision-making skills. *Full Spectrum Command* is a PC-based game in which the player commands an Army light-infantry company and must interpret the assigned mission, organize the force, plan strategically, and coordinate the actions of about 120 troops. Geared for future company commanders, it was developed by a team that included ICT, game developer Legless Productions, and Quicksilver Software.

*Full Spectrum Warrior* runs on Microsoft Xbox. Developed with the participation of entertainment software maker Pandemic Studios, it envisions the player as the leader of a nine-member squad that must complete a variety of assigned missions and return home safely. Both games are being perfected by subject matter experts at the Army's Infantry Center at Fort Benning, Georgia. The project's research into artificial intelligence is aimed at giving the computer-controlled soldiers the ability to explain their decisions made in interpreting and following the student commander's orders.

"This research effort draws on the field of explainable expert systems or expert systems that provide not only a solution, but also an explanation of that solution," says ICT. It includes an after-action review capability that enables instructors to learn what occurred during the game and when, and thus more fully evaluate the player-learner's performance.

The games are currently undergoing further evaluation throughout the armed forces before widespread rollout as teaching tools. In addition, the Army-led team has launched a joint venture with the Singapore Armed Forces to develop a platoon-level game to be called Full Spectrum Leader. It will feature an urban operations game based on platoon training, says an official with the Simulation Technology Center.

## A decade of training advances

What a difference a decade makes. In the period between Desert Storm and Operation Iraqi Freedom, dramatic changes have taken place in modeling and simulation. Every weapons system now has a modeling and sim component to it, supported by a bustling industry of contractors. Much of the research and development activity takes place in a huge Orlando, Florida complex operated by the Navy's Naval Air Systems Command and used by every branch. "We are seeing greater emphasis today on high-end training for flag and general officers, and an increased emphasis on joint training," says one official with the Pentagon's Defense Modeling Simulation Office. Credit the Navy for making the U.S. military's first foray into simulation. Its initial interest followed the Vietnam War, when Navy aviators first realized that if a pilot survived his first six combat missions, he had a very high probability of surviving the rest of the war. The training curve is described in "Training Superiority and Training Surprise," a report released in 2000 by a taskforce of the Defense Science Board. Investments in training that followed the discovery, including the Navy's Top Gun program and the Army's National Training Center, made a convincing case that military superiority benefited greatly. The first real output of that investment was Desert Storm.

"We stand on the verge of a potential training revolution," wrote the Defense Science Board's taskforce. It said the revolution includes an array of such elements as advanced computer learning, just-in-time/just-right training devices, electronic classrooms, distributed learning, advanced embedded training, virtual environments, training administration and resource management, automated courseware development, and automated auto-tutor development.

One expert on the front lines of simulation R&D is Michael Macedonia, chief technology officer of the Army's Program Executive Office for Simulation, Training, and Instrumentation. "The biggest change has occurred since 1992, as technology has convinced the Army to invest dramatically in simulations and simulators," he says. Since Desert Storm, PEO STRI has launched a variety of simulation systems, including the Combat Tactical Training Systems, which seek to develop, field, and sustain high-quality ground combat virtual training devices that meet or exceed the requirements of war fighters. Used around the clock in preparation for Operation Iraqi Freedom, the computerized instruction devices resemble the inside of tanks, fighting vehicles, and other equipment. They are linked together and used to train as a platoon, company, or battalion. Examples include an Engagement Skills Trainer, a marksmanship training system that enables soldiers to almost qualify for marksman in a simulator. They're in use at Udari Range, Kuwait; Bagram Air Base; and Kandahar Air Base in Afghanistan.

The use of simulation-based war gaming has become pervasive for almost every operation and was used extensively for Operation Iraqi Freedom, says Macedonia. For example, the Army shipped to Afghanistan and Kuwait a Mobile MOUT (military operations in urban terrain) site training environment. A "city" of manufactured homes can be stacked three units high, complete with instrumentation inside for recording and playback of events.

The Simulation Technology Center is even tapping the expertise of the entertainment and gaming industries to improve simulator-based instruction. It has contracted with the University of Southern California's Institute for Creative Technologies to pursue the latest in video games to entice and teach computer-savvy soldiers. In a separate contract, the Army has asked the Menlo Park, California-based online community and game developer There Inc. to produce a simulation-based game that will be designed as an anti-terrorist training tool that can be played by scores of far-flung individuals.

Yet, even as modeling and simulation technologies draw converts, critics point out cost-benefit shortcomings as well as larger failures. Among the latter is the Joint Training Confederation, an unsuccessful effort to link nonheterogeneous simulations within the military with software called Aggregate Level Simulation Protocol. Also, aviators frequently complain that simulators don't pass the realism test, and many fliers are prone to a condition called "simulator sickness" caused by overexposure to the training devices. "Affected pilots can't fly for three days, which can have a real-world effect on readiness," says one observer.

Nonetheless, simulation's future is assured. Each branch is aggressively seeking ways to embed training technology and systems into vehicles and gear that their personnel will carry. "This is a major breakthrough," says Macedonia. "Previously, training was an ancillary requirement of a system. But today it is a key performance parameter." Another sign of the times: Ten years ago, 80 percent of PEO STRI's training budget was spent on hardware. Now it's being spent on software, he says.

Networking is also on a steep growth curve, claims Macedonia. "When you combine the power of networking, computer graphics, and general purpose processors, there's a huge wave of technological change coming. We want to leverage those technologies, such as networking for distance learning and collaboration, and take advantage of devices that will become smaller and more powerful." Such developments as 3-D graphics chips in cell phones and small keyboards in PDAs will benefit military training, he predicts. And don't forget robotics. It will also be marching into training's future, part of a "ubiquitous learning environment" that will include intelligent tutors, mentors, and teammates, predicts Macedonia. TD

**Paul Harris** *is a freelance writer based in Alexandria, Virginia, and frequent contributor to* Learning Circuits
www.learningcircuits.com; *pharris307@aol.com.*

# Beyond Paper-Based Manuals

Marine Corps technicians performing maintenance on the Turret, TOW Missile, and Hellfire Missile Systems aboard the AH-1W Super Cobra helicopters at Camp Pendleton, California, are experiencing the ultimate in just-in-time learning. When they encounter unfamiliar repair problems, they have an option other than cumbersome technical manuals with confusing cross-references and often outdated information. Instead, they can flip open a rugged laptop computer at their side. The click of a mouse brings all of the pertinent information they could possibly need for the specific job required, including current manuals, parts lists, exploded drawings, and perhaps even a video of a veteran technician performing the same procedure. It's all broken down into individual data objects, integrated and formatted for use at the precise moment and location needed. Data is arranged according to a technician's natural work sequence rather than segregated by type as in traditional paper-based manuals. Although not currently part of the Cobra package, an MMS can be updated to real time via wireless LAN or the Internet.

Called the Maintenance Mentoring System, MMS is an electronic performance support system that integrates disparate data and procedures from a variety of media and formats into a seamless system. Its development began in 1998, when the U.S. Department of Defense, the National Center for Manufacturing Sciences, and a handful of private industry partners, including Chantilly, Virginia's L3 Communications Government Services (formerly EER Systems), sought to bring the Internet era's potential to locations where it was urgently needed, such as the shop floor. MMS represents one example of interactive electronic technical manual technologies now being pursued within government and industry.

The prime ingredient behind maintenance mentoring is "task-based instruction," says the L3 Communications unit. Complicated processes are broken down into a series of smaller tasks to enhance learning comprehension and information retention. Content is digitized and converted into data objects such as JPEG graphics, Shockwave animations, and flat ASCII text files. They're stored in a dynamic database that is searchable using standard SQL protocols. Studies show MMS reduces troubleshooting time by 30 percent compared with traditional paper-based technical manuals. Perhaps that's why it was the winner of the "Great Ideas" competition at the annual DoD Maintenance Symposium last fall.

Learning applications extend well beyond maintenance, contends Michael Gnam, an NCMS official who is the National Center's MMS project manager. Gnam says the single biggest issue faced by the DoD maintenance depots he deals with involves capturing the expertise of veteran technicians who are nearing retirement. MMS appears to be perfectly suited for the assignment, he says. For example, he says, NCMS recently videotaped one 60-year-old technician, recording for the MMS system precisely how he tears apart and repairs an aircraft engine, capturing every detail, including body contortions and other tricks. "Much of this is art, not science, and you won't find it in any maintenance manual," says Gnam. It translates into pure wisdom for the 25-year-old technician who views it on a laptop.

Other companies are offering commercial versions of the nonproprietary learning technology. L3's MMS program manager Brian Gritte says additional mentoring systems currently under development should promote greater adoption of the learning tool within the military.