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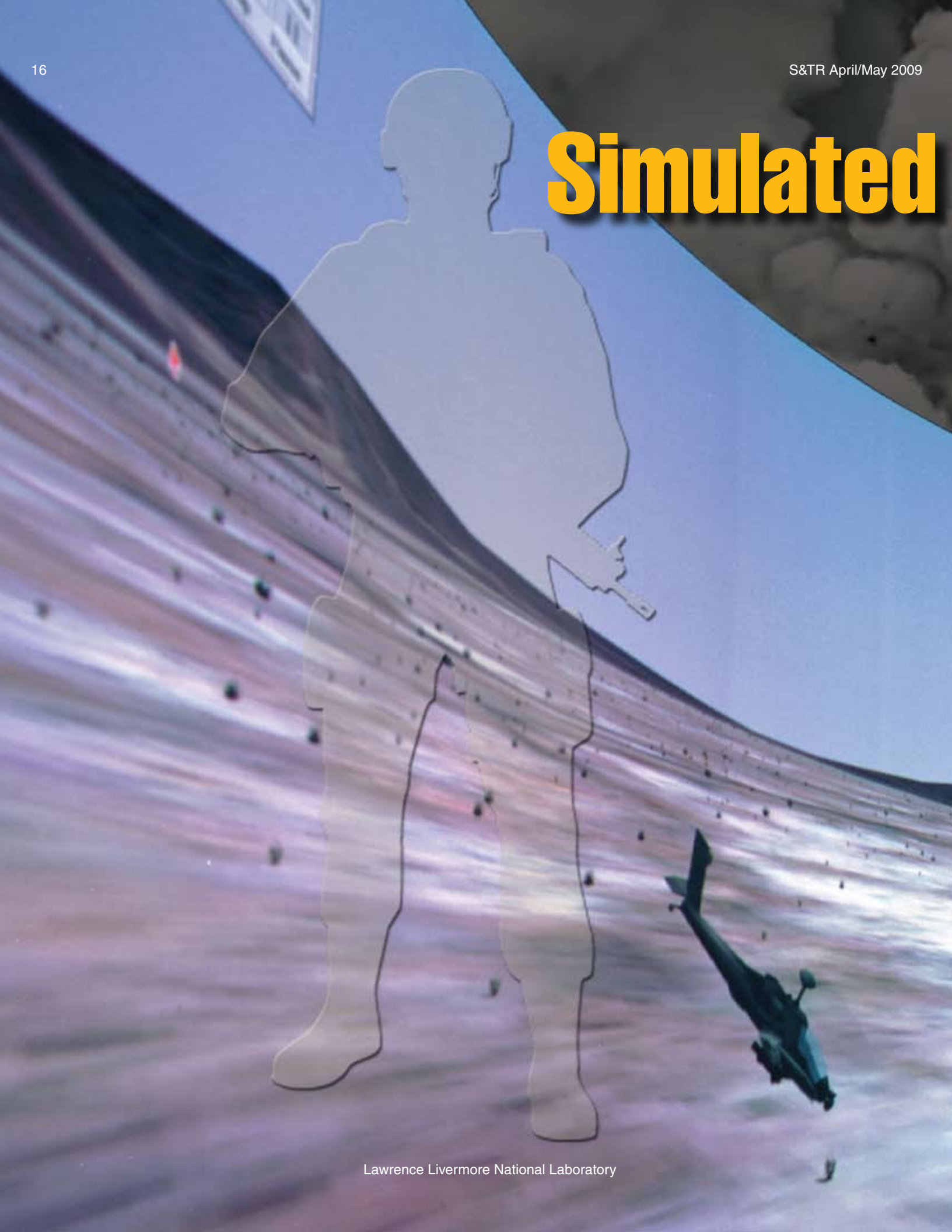
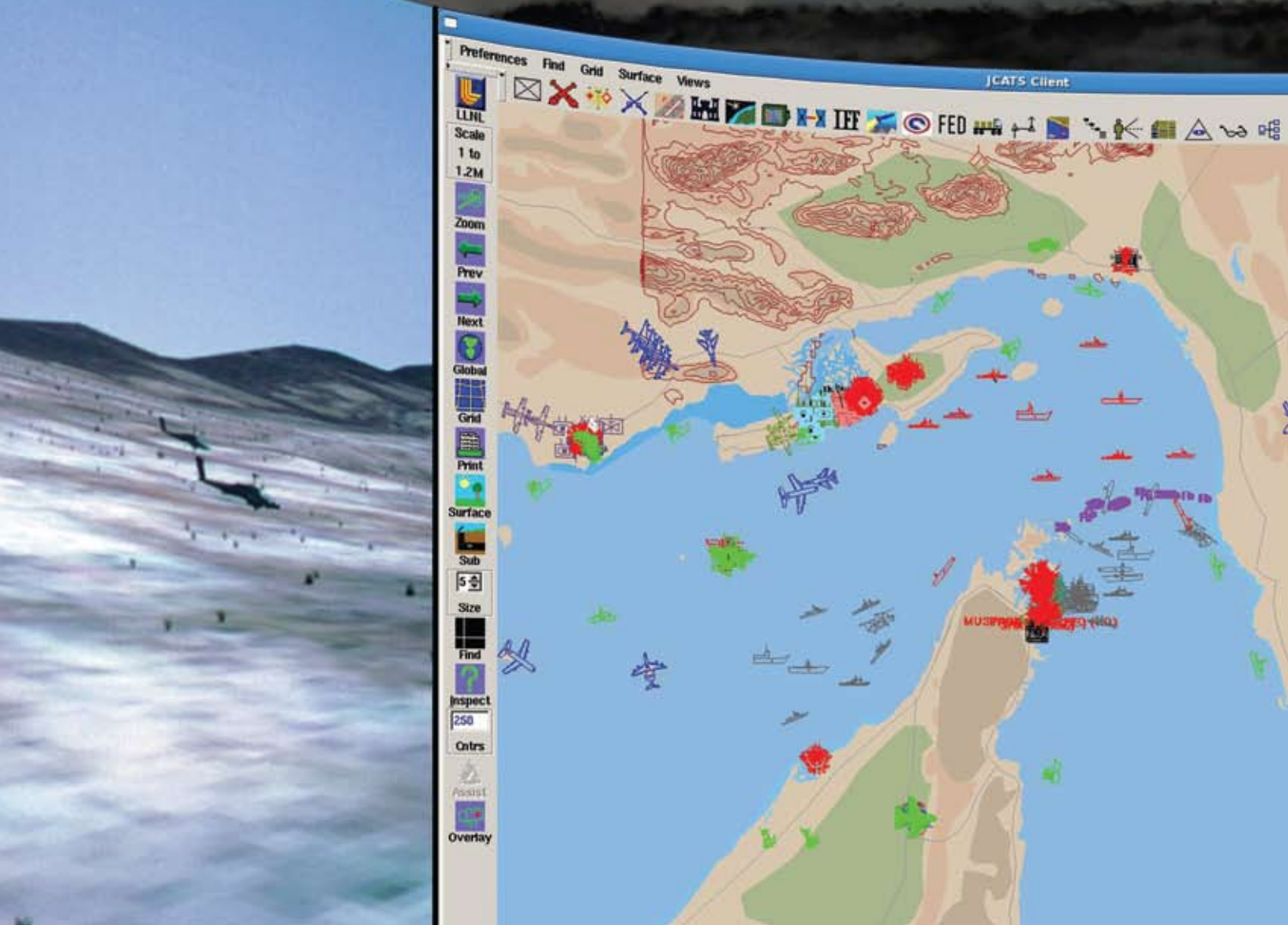


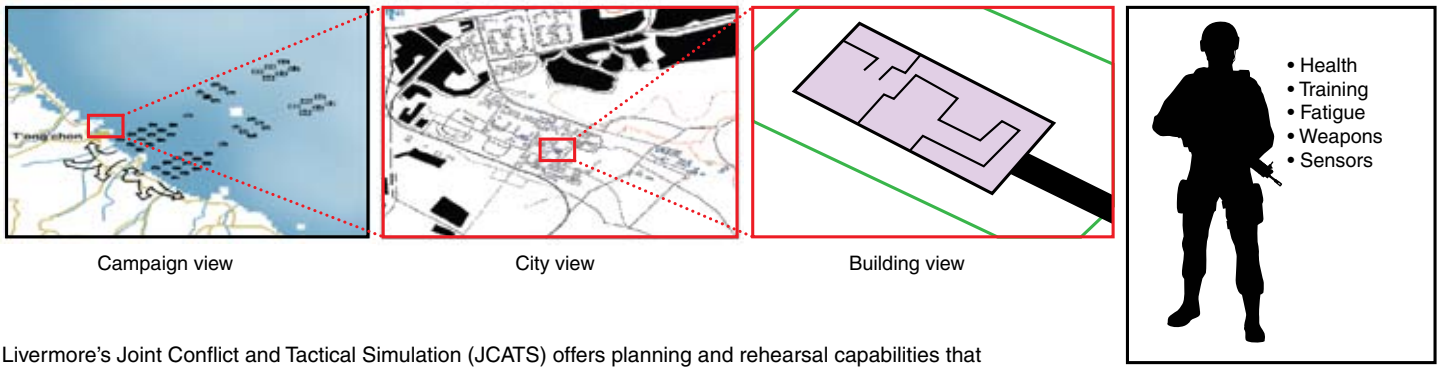
Rehearsal for Battle

A conflict simulation developed at Livermore is used around the world for warfare training, planning, and rehearsal.

MANY military officers headed for deployment in Iraq and Afghanistan get to know Livermore's Joint Conflict and Tactical Simulation (JCATS) whether they realize it or not. JCATS is the most widely used tactical model in the world. It simulates soldier-on-soldier combat with opponents that replicate known enemy tactics and responses.

Leaders of Army and Marine brigades and battalions receive training on laptop and desktop computers where they react to incoming digital information while executing a commander's tactical plan. JCATS's capability for modeling ground maneuvers is supplemented by other models that simulate fire from friendly and enemy artillery, air defense, logistics, intelligence data, and so on.





Livermore's Joint Conflict and Tactical Simulation (JCATS) offers planning and rehearsal capabilities that extend from the Joint Task Force level to that of the individual soldier.

This "federation" of networked modeling tools—which may also include links to live forces on the ground—creates a remarkably accurate picture of battlefield operations.

A recent example of JCATS at work was the October 2008 final phase of the Unified Endeavor 09-01 Mission Rehearsal Exercise, the last training exercise for units slated to deploy in early 2009 as the core element of Multinational Corps in Iraq. Exercise participants were networked from locations throughout the U.S., including Fort Lewis, Washington; Fort Hood, Texas; Fort Leavenworth, Kansas; Camp Lejeune, North Carolina; Hurlburt Field, Florida; and the U.S. Joint Warfighting Center in Suffolk, Virginia. Allied partners in the United Kingdom also participated.

The exercise focused on training joint task forces and major subordinate leaders to meet the expected requirements during their deployment. Data was pulled from the theater of battle to replicate a two-week period in Iraq. The goal for these leaders was to understand—before they arrived in Iraq—the various cells and working groups on the ground, the feel of combat, and the rhythm of battle.

JCATS is sponsored by U.S. Joint Forces Command (USJFCOM) and managed from the command's Joint Warfighting Center. The center uses JCATS and other modeling programs to ensure that all branches of U.S. armed forces work together effectively and that U.S. services can operate with those of other nations as a joint team. (See the box on p. 19.)

The military uses JCATS for training, analysis, and mission planning and rehearsal. The model integrates ground, air, and sea operations as well as real-world command, control, communications, computers, and intelligence—known as C4I. It simulates operations in urban terrain, supports nonlethal as well as conventional weapons, and allows users to quickly assemble and disband units.

JCATS can control more than 100,000 entities, which may be individual soldiers, planes, or mob participants, at more than 150 player stations. The model provides a wide range of operations in a variety of dynamic simulated environments. Modeling the dynamics of individual soldiers, vehicles, and weapons, rather than groups, increases the realism of the simulation and allows more direct participation. JCATS has been integrated into numerous federations in support of U.S. Joint Forces, U.S. Army and Marine Corps, and the North Atlantic Treaty Organization.

"JCATS is totally data driven," says Lauri Dobbs, program leader for Livermore's Conflict Simulation Laboratory, which first delivered JCATS in 1997 and continues to improve it. "Any input will work for any scenario, either military or civilian. JCATS is extremely versatile."

The Department of Energy uses JCATS to assess the security of its nuclear sites. The Naval Postgraduate School (Monterey, California) and the U.S. Military Academy at West Point (West Point, New York) use JCATS for training military leaders in tactical decision-making processes and analyses. In addition, the model is used by numerous Department of Defense (DoD) contractors to develop and analyze new technologies and equipment. DoD has sold JCATS to 20 allied countries who apply it to military and civilian scenarios. The program is in use at more than 350 sites worldwide. Since 2003, the Livermore simulation tool has provided support for operations in Afghanistan and Iraq.

JCATS is also an effective tool for emergency response planning, drug interdiction, and border patrol operations. "Simulations such as JCATS are a huge cost saver for both the military and other users," notes Dobbs. "They can explore

various options, see what happens in each, and then make an informed choice. Exercises with actual soldiers or first responders are very expensive." Over 2,000 exercises with JCATS occur every year across the user community.

JCATS is the latest incarnation of Livermore's combat simulation tools, which first appeared on computer screens 35 years ago. The landmark Janus program in the late 1970s was the first conflict simulation to use a graphic user interface. Succeeding generations have exploited the latest advances in computer hardware and software. Livermore's close working relationship with DoD has been instrumental in understanding and meeting their simulation needs. Over the years, JCATS has evolved from a training tool into an operational planning and rehearsal tool.

"Clutter" Enhances Capabilities

Livermore recently enhanced JCATS's capabilities considerably with the addition of the JCATS Low Overhead Driver (JLOD). According to Tom Kelleher, JLOD's primary designer, this program fills the gaps for U.S. Joint Forces Command exercises. "JLOD very inexpensively 'puts a wrapper' around an area of interest," he says. "Now a JCATS play area does not have a knife edge around it. We can add civilian activity, merchant ships, or vehicle traffic." JLOD's specialty is adding the "clutter" that makes simulations more realistic.

"JLOD is Tom's brainchild," says Dobbs. "He saw the gaps in simulation capabilities and came up with a solution for filling them." The beta version of JLOD has been tested for several years. Version 1.0 will be issued in June 2009.

JLOD first appeared in an exercise covering the area from San Francisco, California, to Seattle, Washington. JLOD was programmed to display civilian vehicle traffic such as tractor-trailers and cars during the day in the inner city. After the simulation was set up, no additional human intervention was required for the duration of the exercise. A similar exercise needed to include boat traffic, and JLOD was able to accommodate that requirement at minimal expense. "JLOD can replace one or two other simulations that require computer hardware and people to operate them," says Kelleher. "Our goal for the program is to reduce computational requirements while training the same number of soldiers."

With JLOD, last-minute changes in the design of the exercise are easy to make, even midstream during an exercise. "For example, we had a problem with ship entities during an exercise," notes Kelleher, "and we shut off JLOD to fix the problem without the trainees being aware of it."

NATO Forces Train with JCATS

During the first two weeks of November 2008, Livermore conflict simulation experts were on hand in Stavanger, Norway, and Grafenwoehr, Germany, to provide technical assistance to officials of the North Atlantic Treaty Organization (NATO) and U.S. Joint Forces Command with Exercise Steadfast Joiner. Steadfast Joiner is a computer-assisted, command-post exercise to train and evaluate NATO's Response Force 12. The 2008 exercise showcased the first use of the Joint Multi-Resolution Model Federation, which consists of the Joint Theater-Level Simulation (JTLS) and Livermore's Joint Combat and Tactical Simulation (JCATS). This federation allows an organization to train from the operational level of war down to the tactical level. Lauri Dobbs, program leader for Livermore's Conflict Simulation Laboratory, says, "By combining the two simulations, units could be passed into JCATS and dealt with at the individual level and then moved back to JTLS."

The mission involved training forces to plan and conduct a NATO Crisis Response Operation that would restore peace and security, prevent further destabilization in the designated region, and support post-conflict reconstruction and humanitarian assistance. Training audiences were in Rome, Naples, Valencia, Corsica, and Madrid. Two experiments were embedded in the exercise. One was to divide control between two locations. Some of the interagency role players and tactical units were in Norway with the remainder in Germany. The goal was to achieve a capability that will allow NATO to distribute training and education across various alliance locations and enable nations to train together from home locations using the same decision points. The other experiment was to conduct civil emergency planning and improve processes for military coordination with civilian agencies regarding requests for assistance and support of peaceful operations.

With a split-based control group and training audiences in multiple dispersed locations, the communications support challenges made this the most extensive and robust exercise ever conducted by NATO.

The U.S. government has sold JCATS to 20 countries (shown) for civilian and military use.

Not a Video Game

The analogy of JCATS to a warfighting video game may seem obvious, particularly because the terminology is so similar. In setting up an exercise, users define a gaming area, and participants are players. But this analogy is highly inaccurate. In a video game, a soldier may jump off a 10-meter cliff without a scratch. In JCATS, however, the soldier who makes the same leap will be seriously injured. Commercial games do not take into account basic physics concepts (such as acceleration of a falling body) or variables such as fatigue, inclement weather, low food supplies, and poor visibility. These crucial factors affect how an individual soldier or platoon behaves.

"Video games automate much of the activity you see on screen," says deputy program leader Will Belue. "The game does most of the thinking for you. In JCATS, there is very little automated action. Moving just one soldier from point A to point B requires consideration of a lot of factors: his or her posture and fatigue level, how he or she is armed, and so on." Belue, who has been at the Laboratory for just three years, is a valuable asset to the Conflict Simulation Laboratory team. He is retired from the U.S. Army where he had many years of experience using JCATS and its predecessors as well as training others in their use. Kelleher refers to Belue as their resident "graybeard" on all things military.

Upcoming enhancements to JLOD distance JCATS even more from video games. Work is under way to incorporate some of the "nonkinetic" effects of military and civilian operations. Nonkinetic effects include population moods, such as public perception, willingness to fight, and sense of security. For example, if food is given to this village, will its inhabitants help us? Or, what will happen if we bomb a mosque? Epidemics and their ramifications will also be included, adding yet another layer of complexity to the simulation.

Inside JCATS

JCATS Version 8.0, issued in April 2008, includes a number of new features. One is an interactive three-dimensional (3D) view so users can control entities in either 2D or 3D. Another is a missile fly-out model to simulate tactical ballistic missiles, cruise missiles, and tomahawks—a critical requirement for current wartime efforts. Artillery improvements allow simulated entities in JCATS to request fire support from the Army's real-world fire control computers. Traffic checkpoints also have been added.

They slow movement through controlled areas and allow for the addition of search-and-arrest systems. Graphic images of real people and places can be linked to a simulation, replacing stick-figure images. In addition, building damage can be restored if necessary. According to Dobbs, "When the U.S. Joint Forces Command asked for 45 enhancements in Version 8.0, we gave them 90."

JCATS describes environments such as terrain, buildings, bridges, and minefields. It incorporates data sets that have been verified by the military for construction of both large gaming areas and detailed urban areas. Terrain data include properties such as height, mobility, and line of sight, all of which are critical for determining how a soldier or vehicle might move, where the enemy will appear, and what weapons are appropriate for use.

Terrain significantly affects movement of troops, aircraft, tanks, and maritime operations. For example, a rescue helicopter cannot safely land in a forest, amphibious landing craft must negotiate rocky shores, vehicles move slowly through swamps, and soldiers slow considerably when marching uphill. Environmental factors such as adverse weather, nightfall, dust from sandstorms, and smoke from combat also affect mobility.

Players can import blueprints of specific buildings for urban warfare and site security exercises. Alternatively, users can create their own town or building, as is often done for drug interdiction training. In these cases, JCATS offers a palette of menus to create everything from windows and doors to streets and parks.

An enormous range of vehicles and weapons can be simulated, from tanks, helicopters, and Humvees to mortars, rocks, pepper spray, and fists. Details on all vehicles and munitions come from validated military data and algorithms. Nonlethal weapons are increasingly important as the military engages in peacekeeping duties around the world.

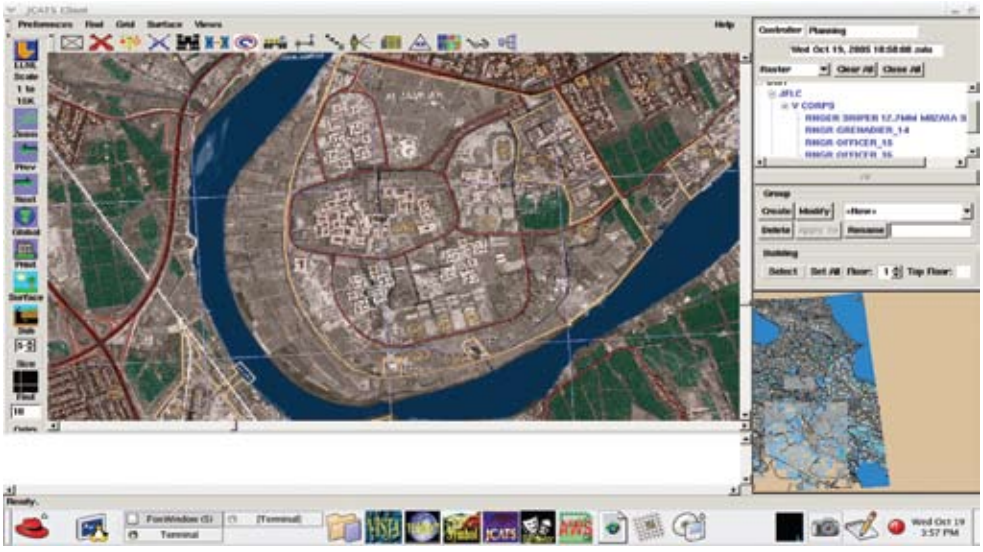
Spanning the Globe

JLOD expands the area that can be played to the entire world. For example, the model offers a view of global operations while players can focus on individual soldiers in such locations as the coliseum in Oakland, California, and the airport in Baghdad, Iraq.

Broad-scope exercises may incorporate three kinds of environments. In a live environment, real people use real equipment in a real training area to simulate their real actions. In a virtual environment, real people use a mock-up of a piece of equipment, such as a flight simulator, to determine if the operator is properly using the equipment. In a constructive environment, real people use simulated people and equipment in a simulated environment. JCATS is an example of a constructive environment. These three environments were first integrated into a single exercise in 1997, and their combined use has grown more sophisticated ever since.

December 2006 saw the rollout of the Joint Live-Virtual-Constructive (JLVC) Federation for the annual Terminal Fury exercise. Terminal Fury is a two-week exercise for the Pacific Command. Personnel from all military services in Japan and Hawaii test their ability to come together as a joint task force to manage emergencies in the region. The task force was designed to be deployable aboard a ship and capable of command and control of Pacific and stateside assets in a war or natural disaster.

"JCATS and JLOD were two of the four constructive simulations used during the 2006 Terminal Fury," says Dobbs. "They accounted for more than 90 percent of the simulated forces on less than 25 percent of the workstations. Livermore is pushing the technology and driving the development of federations."



Modeling terrain in JCATS is based on actual maps of the area of interest, in this case the "International Zone" in Baghdad, Iraq.

(a)  (b)  (c) 

The JCATS Low Overhead Driver (JLOD) supplements JCATS and other conflict simulations by expanding a game's scope to the entire world with little added computer time or human intervention required. A single war game can include (a) a worldview and detailed information of sites as far apart as (b) the coliseum in Oakland, California, and (c) the airport in Baghdad, Iraq.

Version 9.0 of JCATS (April 2009) includes an improved three-dimensional viewer.

JLOD was used for the first time in a homeland security exercise in May 2007. Ardent Sentry–Northern Edge was a Northern Command training event for U.S. and Canadian civil authorities. This exercise stretched from Japan in the west to Bermuda in the east to Central America in the south. JCATS and JLOD together modeled about 95 percent of the 80,000 simulated entities. JLOD alone modeled more than half of all forces, including merchant ships, National Guard, Coast Guard, and Air National Guard. According to exercise planner Dave Hall, "This was the most integrated Northern Command exercise to date."

"JCATS keeps getting better and better, bigger and bigger," says Belue. "The program is now a huge step beyond its capabilities as a stand-alone simulation." The model is seeing increased use for evaluating readiness of National Guard units. JCATS is also expected to replace other long-used programs that simulate artillery and missile fly out. New features in Version 9.0 of JCATS, rolled out in April 2009, include a further improved 3D viewer, more information for planning amphibious and air assault landings, and dynamic reports that inform players of tardy transports and missing cargo during an assault. "JCATS 9.0 also addresses the bandwidth problem that occurs at big exercises, when users need to push a lot of data quickly," says Dobbs.

The U.S. military is clearly happy with JCATS. Says Brian Gregg, chief of joint modeling and simulation at the Joint Warfighting Center, "We give the hard problems to Livermore."

—Katie Walter

Key Words: conflict simulation, Joint Combat and Tactical Simulation (JCATS), JCATS Low Overhead Driver (JLOD), Joint Warfighting Center, North Atlantic Treaty Organization.

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