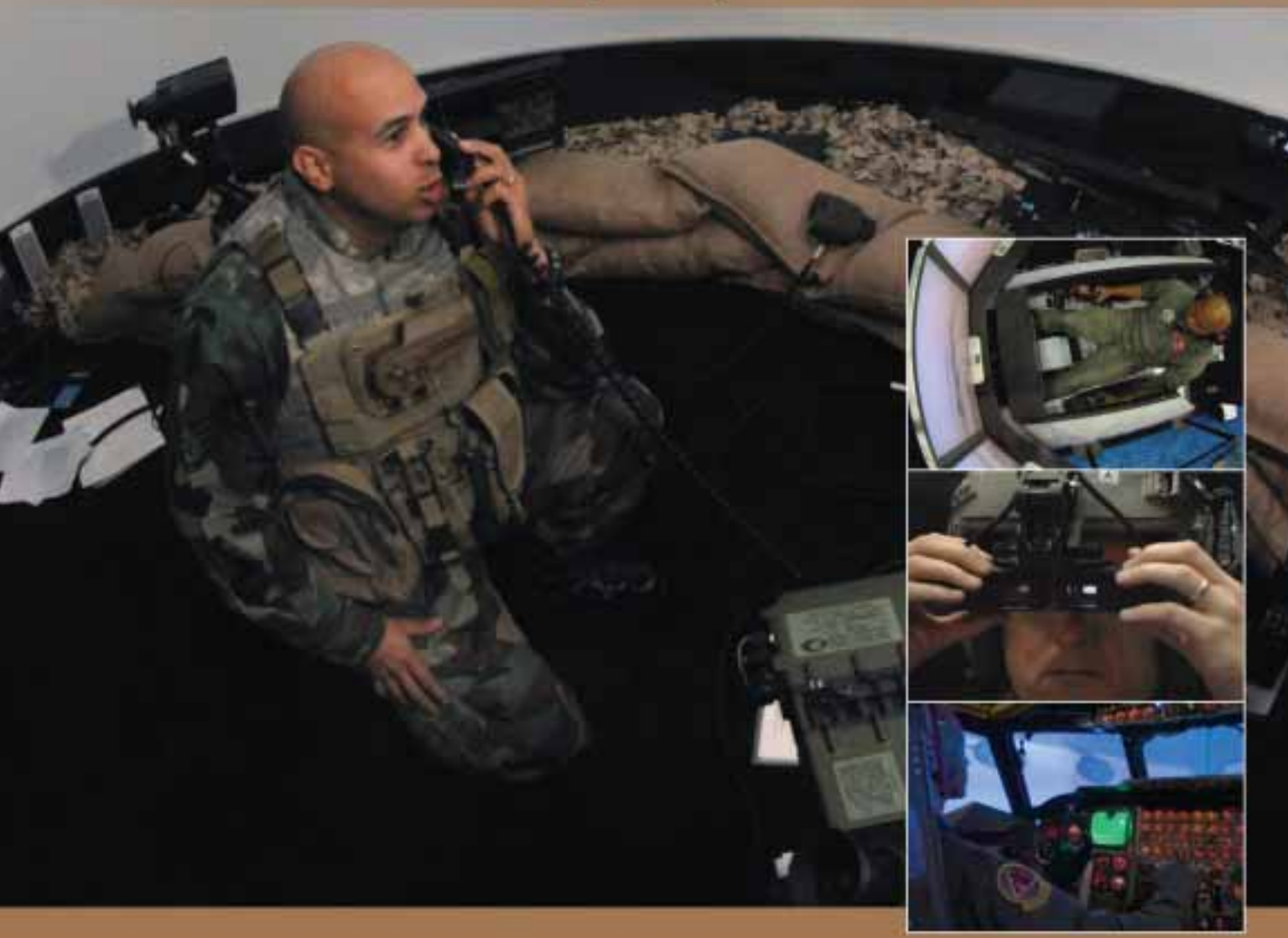
1105 Government Information Group Custom Report

Defense Simulation & Training

Improving Readiness & Performance



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Simulating Reality

In today's military, IT both leads and supports simulation programs giving soldiers, sailors and airmen the training needed to be ready for any eventuality.

Dr. John Parmentola is the Director for Research and Laboratory Management for the Army.

In that capacity he directs lab management policy for all the Army laboratories, research development and engineering centers. His principle focus is on Army basic research and applied research programs. The basic research programs are very diverse, performed nationwide in universities and Army laboratories. Among the 21 labs and research development engineering centers Dr. Parmentola oversees are the Simulation and Training Technology Center, the Army Research Laboratory and the Army Research Institute.

The Simulation and Training Technology Center is the lead in the technology area for simulation in training according to Dr. Parmentola. A large component of their activity is at the University of Southern California at the Institute for Creative Technologies.

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>
> *Dr. John Parmentola,*
> *Director for Research and Laboratory Management, US Army*

"That institute was set up to bring virtual reality training to the Army," said Dr. Parmentola in an interview with 1105 Custom Media.

"To do that the Center integrates animation and graphics, artificial intelligence technologies, sound reproduction, Hollywood storytelling, and tries to bring these together to create virtual environments for training purposes."

Creating Virtual Humans

One of the main challenges the Center is addressing is the creation of virtual humans Dr. Parmentola explained. "The reason is that we want to embed virtual humans in these environments that can interact with humans just like humans interact with humans," noted Dr. Parmentola. "And to provide as realistic training environments as if a soldier was actually immersed in an actual real environment. The goal is of course idealistically is to make them indistinguishable from reality."

Many technologies have to come together to make this work. There are graphics and animation which have to reach levels of sophistication that will try to create virtual humans that actually look like humans. It also involves the development of sophisticated speech recognition capabilities, not just in English but in other languages. It involves natural language processing. When you speak to a virtual human, the virtual human has to understand the meaning of what it is that you are saying and then try to respond in an appropriate manner.

"That takes dialogue management, being able to build into the virtual training environment a means of managing the dialogue between humans and virtual humans as well as virtual humans amongst themselves," Dr. Parmentola said, "and building into these perceptions cognition, emotion and also cultural attributes. Then we can reflect, for example, the types of environments that a soldier might encounter in a battle field in a foreign country."

It is a great challenge because it requires us to really understand who we are as humans and then try to be able to represent that in a way in which training can be both efficient and effective for our soldiers noted Dr. Parmentola.

"We are building into these environments what we call intelligent tutors. So if we want a soldier to be trained to a certain skill level, we have a skill model that's built into the training environment; and then as the soldier trains towards a set of tasks and objectives the software monitors the soldier's progress and sees how fast the soldier is training up to that standard."

That helps the Army adjust the training environment to better meet the variability in the rates at which people train and the effectiveness with which they train. And it is moving the Army away from the one size fits all training where you have a classroom, a whole bunch of students and you just train them all according to the same course.

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train our soldiers," said Dr. Parmentola.

In The Year 2020

The Army sees seven major areas that will shape a great deal of technological innovation in the future.

"I truly believe that what will come out of that will be disruptive – major changes, game changing technologies," said Dr. Parmentola.

According to Dr. Parmentola part of the key to this is for example neuroscience, which relates directly to training, but it relates to other things as well.

"If we can understand the software of the brain, if you want to call it software, how the brain operates, how it does things, and then once we understand that, we can embed that into a fairly wide range of systems, for example robotics."

"We would like to have robotic systems that have human-like qualities so that they can operate safely and secure on a battlefield. One of the things that humans do extremely well is pattern recognition. And pattern recognition has applications not just to robotic systems but to a wide range of sensors, but also to virtual humans. If I embed pattern recognition in a virtual human, that virtual human can recognize humans, specific ones, in fact."

There is a synergy between doing basic research in neuroscience and its impact on robotic systems or autonomous systems, said Dr. Parmentola, "because if I can develop artificial intelligence that is sophisticated like humans, I can embed that in all kinds of things."

Today's Supercomputers – Tomorrow's Pocket Calculators

Nanotechnology is the drive towards new materials, but it is also the drive towards miniaturization and molecular electronics – trying to go to smaller feature sizes in computer chips so more and more functions can be put in smaller and smaller volumes.

"If I can create or continue to create high performance computers, that will enable me to simulate what is going on in the brain and really try to understand whether we really understand how the human brain works, it will also embed itself in robotics systems," explained Dr. Parmentola.

"It will embed itself in everything, processors will be ubiquitous; it will be embedded in all kinds of devices and will be embedded in communications."

In the field of high performance computers, an application of nanotechnology is quantum computers. "That's an example of nanotechnology where we are trying to use atoms and collections of atoms to simulate calculations. If we can do that based on the principles of quantum mechanics we can develop a new range of computers that would make current day supercomputers look like pocket calculators," marveled Dr. Parmentola. ❑

Leveraging 4 Billion Years of Evolution

"I usually refer to Biotechnology as leveraging 4 billion years of evolution," explained Dr. Parmentola. "And I keep on reminding people that you can make a lot of product improvements over 4 billion years."

According to Dr. Parmentola, the human brain has an enormous capacity for computation and it translates itself into these amazing pattern recognition capabilities. However the way we store information is very different than the way we do it in computers today.

"The way the brain does it, we don't quite understand, it's very hierarchal in the way that it does it. What it does is it looks for common things and then it tends to utilize a very small portion of the brain's capability to store those common things," explained Dr. Parmentola.

"As you become more differentiated, more and more of the brain gets involved in the storage of that information. And so it does it in a very efficient way. Now the question is: how does it do the associations that it does? That is something that I don't think we quite understand. But I think with time we will understand how the brain operates and this will give rise, I believe, to new computer architectures and this will supersede what exists today."

100X Power

According to Dr. Parmentola, the human brain is about 100 times more powerful than the most powerful supercomputer on the planet today. That might not seem like a lot until you appreciate the fact that the world's most powerful supercomputer weighs 100,000 pounds while the human brain weighs just 4 pounds.

The world's most powerful supercomputer takes up 5000 cubic feet. The human brain takes up .06 cubic feet. The world's most powerful supercomputer uses 2 million watts of power; a half a million of that is devoted just to cool off the processors. The human brain only uses 15 watts. So you are talking about a very efficient computational device. The human brain is an enormously compact, highly efficient, energy efficient, computational device said Dr. Parmentola.

"I think that we are on a growth curve and if we continue on the growth curve that we have been on, then by probably 2025 you will have computers on your desk top that have the computational power of the human brain," noted Dr. Parmentola.

"If you continue to 2045, somewhere in there, on your desktop you will have the equivalent of all the human brains on the planet – on your desktop." ❑

Simulating Flight

Flight School XXI provides helicopter flight training simulators and related aviation support activities that helps the Army maximize its use of computer-resident training while lowering the training's costs.

An Army helicopter pilot makes a sharp maneuver to avoid enemy fire at night, in the pouring rain. Suddenly, he gets hit and smoke fills the cockpit. What does he do? How does he learn what to do in a split second, ingrained actions to take to save his crew?

The answer: Graduate from the Army's Flight School XXI, where a suite of flight simulators prepare a new generation of aviators for combat.

Just outside the Army Aviation Center at Fort Rucker, AL is the location of the Army's Flight School XXI managed by Computer Sciences Corporation (CSC). The contract allows the service to meet its long-term training objective of several months of 60 percent simulation and 40 percent live training according to the CSC website.

As part of the contract CSC provides helicopter flight training simulators and related aviation support activities and helps the Army maximize its use of computer-resident training while lowering the training's costs.

Real Life Replication

At FSXXI, simulators offer all the flight dynamics of a real helicopter with six degrees of freedom motion and a cockpit that precisely replicates that of the real aircraft. Simulation also includes environmental conditions, such as weather, time of day, lights and lighting reflections and emergency conditions like smoke in the cockpit that could be encountered in the real world according to CSC.

"The Flight School XXI contract really came out of this concept where soldiers graduate from initial rotary wing flight training and then they would go to the transition course in their advanced aircraft and then they would report out to their units," said P.J. Penny, CSC director of Flight School XXI.

But because of the pace in which advanced weapons systems were being deployed in the field, it became much too expensive to train the soldiers in the aircraft that they were going to fly.

CSC was hired to do analysis on how do you train initial entry rotary wing students because as Penny said, "it was a function of the fact that we have people that flew every type of modern aircraft in the Army and been in every fire fight since all the way back to Viet Nam."

"With people that have actually flown and fought with the Army in Afghanistan and Iraq, we had the experience to sit down and literally looked at every task that needed to be accomplished, working backwards from what soldiers needed to do when they got to the field and had to fly their advanced aircraft."

New Flight School

Penny said when planning the new Flight School at Fort Rucker, the idea was to get people up and capable of hovering and doing the basic things that you need to do to fly a helicopter as soon as possible, "but what they needed to do was to get them flying their advanced aircraft so that when they graduated they were proficient in an Apache or a UH60 Blackhawk."

Simulators offer all the flight dynamics of a real helicopter with six degrees of freedom motion and a cockpit that precisely replicates that of the real aircraft.

As a result the government came back and asked CSC to expand it to all of the flight training that was going on at Fort Rucker. "So in conjunction with our military cohorts, eventually we laid out for the commanding general all of the flight training at Fort Rucker and what needed to be done to train soldiers to do the sorts of things that they needed to do," explained Penny.

The cost of modernizing Fort Rucker was expensive. The solution was to use a private initiative where a company would build, maintain, upgrade and own the facility in exchange for a long term contract which was awarded to CSC in 2003.

The contract stated that CSC would provide the Army with a family of simulators that would enable them to do all of the individual crew and collective training that happens at Fort Rucker.

"We provided simulators in three configurations," explained Penny. "One is what we call an operational flight trainer with 360 degrees of freedom. We provided instrument flight trainers. And then we expanded upon the

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Gaming Warfighters

The military is growing its use of gaming technologies to build simulations that train these soldiers in virtual reality, so they'll be as prepared as possible for battlefield reality.

Millennials, the new generation of soldier, sailor and airmen – have grown up in the digital age. They take computing and gaming technologies for granted.

"At DOD they've been very forward thinking in the advancement of eLearning," said Steve Kerschenbaum, Chief Technology Officer of Vertex Corporation.

"The whole area is referred to as ADL – Advanced Distributive Learning – and there is actually an entity known as the ADL co-laboratory, a DOD sponsored entity that focuses on the specifications for standardization."

Vertex provides a variety of eLearning services to government and has worked with the Air Education & Training Command (AETC), DHS, Agriculture and other government agencies.

Back in the old days – 15 to 20 years ago – someone would come up with some digital training that could be anywhere from 45 minutes to 12-14 hours and they would think of that as one chunk of training. But from a reusability standpoint, how are you going to use 14 hours and plug it in somewhere asks Kerschenbaum.

An effective game or simulation requires an analysis of the task to be performed and the training system used; and then allowing gamers to put the story together in an intuitive way that creates a high degree of user acceptance.

According to Kerschenbaum that's where SCORM – Sharable Content Object Reference Model – comes in. Instructional theory says you could really boil content down into a number of nuggets known as SCOs – Sharable Content Objects – that can be separately indexed and reused. That's one of the big goals of the ADL SCORM standards.

At DOD content developed for delivery on a learning management system needs to be SCORM conformant, so that when it's launched from the DOD systems, the student can be given credit for the course and mark their progress.

"DOD has done a great job of providing guidance and standardization," added Kerschenbaum, "and SCORM has emerged as the de facto content standard for eLearning."

Wanted: High Fidelity Training

The services want training that is as "high fidelity" as possible said Dennis Wikoff, former Air Force program manager and Vertex gaming expert.

"So to a pilot, for example, the highest fidelity training is getting in his jet and flying it and conducting a scenario based exercise in the sky. Dropping dummy weapons or doing air to air engagements or a refueling mission, in the plane he's going to fly. That's the highest fidelity training. And that's considered training."

Conversely the lowest fidelity training would probably be sitting and listening to an instructor with power point slides and pictures of airplanes and explaining the different parts of an airplane.

Wikoff explained there are many stages in between. "Consider the weapons systems trainer, which is a full 3 degrees of freedom, full motion simulator – a $40 million visual system where they fly the aircraft. In commercial industry, the first time that pilots fly the actual aircraft, is when they are carrying passengers. They get certified fully on the simulator and their first actual aircraft flight is with passengers on board."

So basically what you have then is the trainees and their bosses want the highest fidelity training possible. However, because of the expense of aircraft maintenance and the number of airplanes and jet fuel, they can't always fly around to do their training. Weapons systems trainers say they can do emergency procedures, however you may run 5,000 students a year through a training program and only have three or four full up weapons systems trainers, so you can't train everyone in those. So then they have cockpit procedural trainers.

And it's the same in the Army, you can only do so many field exercises where you deploy everybody in the field where you have the armor and the infantry guys show up for a big exercise.

Highest Fidelity On Lowest Level Device

So, how do you get high fidelity training to the lowest level device possible, to the most commonly distributed device possible, like a PC?

Thus you see this big push towards simulation and gaming in the military according to Wikoff.

"They have what's called distributed mission training now, where you can have an observer who is trying to identify and lays a target and then calls for close air support to drop a bomb on that target," explained Wikoff.

"So it's an Army guy in the field with his binoculars filling out his form, and his laser designator and he is working with some Air Force guys. So you can have a guy flying an airplane over a range; you can have somebody else in an aircraft simulator; you can have another guy working a simulation on a PC of the laser designator; and they can all be communicating together and nobody really knows who is who; who is in the aircraft or who is in the simulator. Is the guy actually out in the field designating a target, or is he just using a PC simulation of that?"

They are all linked together and are all communicating together just the way they would be in the mission. "So that's the top end of an integrated simulation system, or as the military calls it, a system of systems," said Wikoff.

Another element Wikoff is working on is "screen real estate". PCs may be the most common computing device, but younger generations are more accustomed to using hand held gaming devices and are more used to that kind of screen real estate.

Wikoff said research shows you need to have a certain visual acuity level to see moving objects on the small screen and the audio. Some of the simulation audio has three dimensional sound as well so that you can hear where the different input is coming from.

"With Millennials, with the younger folks, it's not only that they use technology, it's the way they learn. The way the content is presented has to change and we are going to have to think a little bit more about how we deliver effective high fidelity training to those devices."

"The Army right now has 8 inch screens for all of their digital combat systems," explained Wikoff. "With an iPhone, you've got a 2x3 screen. It's surprising how much data you can display on that size screen, so it's a matter of rethinking how we display a course where you are not going to have text and with the forward and back button and a bunch of menus at the top and some graphics pulling up on a mobile device." ❑

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collective simulator concept that the Army has and we proposed to provide them reconfigurable simulators for what they call leadership training for the young lieutenants, captains, and non-commissioned officers who are coming back here for the basic and advanced courses."

Warrior Hall

The hub of CSC activities is "Warrior Hall" near Ft. Rucker.

At this huge simulation facility CSC provides support to all the flight training at Fort Rucker. Additionally, CSC keeps the simulators current with the simulators that are in the field. "That's turned out to be a very challenging task because there are aircraft spread all over the world in different configurations, but we do that," Penny noted.

The good news from all this is the Army is saving $30 million annually. The better news according to Penny is "the reports coming from the field are that the new aviators, when they get to the divisions and the brigades out there, are so much better prepared than they were in the past. So much so that in a matter of several weeks most of them are ready to support their mission training with the things that they are going to do for the unit. And that's a major step forward."

Penny said he "did the numbers" on how much money they would save in the field and instructor pilot time and whatever and guesstimated that just because the aviators are so much more proficient that there may be as may be as much as 20,000 hours of instructor pilot time that's released out there so that they can do their mission training.

"From my perspective I would tell you that the training that we do for these units is the most exciting and probably the best training that we support here at Fort Rucker," Penny said. "And by far it's the best training that any unit gets anywhere in the world from a simulation perspective." ❑