Defense research agency seeks to create supersoldiers

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Critics maligned the idea as "unbelievably stupid," "bizarre and morbid," and even "an incentive" for someone to actually "commit acts of terrorism." Once members of Congress and the media in July got wind of FutureMAP -- a plan by the Pentagon's Defense Advanced Research Projects Agency (DARPA) to create online futures markets where traders could speculate in the likelihood of terrorist attacks -- it was only a matter of hours before the project was sacrificed on the altar of political damage control.

But even this, it seems, was too little, too late to appease an outraged Congress: House and Senate appropriations conferees working on the Defense budget have since voted to abolish large portions of the agency's Terrorism Information Awareness program. The program -- of which FutureMAP was a small part -- was designed to mine private databases for information on terrorist suspects.

DARPA, meanwhile, soldiers on with the kind of "blue-sky" thinking that is its charge. Indeed, the Pentagon agency that underwrote the development of some of the world's most advanced technologies, such as the Internet, the Global Positioning System, and stealth aircraft, is now looking at technologies that will help U.S. troops soldier on, and on, and on.

DARPA thinkers are saying that maybe humans themselves need an upgrade. "The human is becoming the weakest link," DARPA warned last year in an unclassified report. "Sustaining and augmenting human performance will have significant impact on Defense missions and systems." A review of the agency's latest budget request reveals a host of projects aimed squarely at making soldiers smarter, tougher, faster, and stronger -- in short, superhuman.

DARPA-funded researchers, for example, have recently begun to crack the brain's neural codes. This research provides glimpses into a future when people will be able to manipulate complicated machinery, or remote-controlled weapons, just by thinking. No touching required.

In an early success for the two-year, $19 million, Brain Machine Interfaces program, a research team led by Duke University neurobiologist Miguel Nicolelis outfitted the brain of a small, South American owl monkey with 100 hair-like sensors. The sensors allowed the researchers to analyze the monkey's neural impulses as the animal manipulated a joystick to match a cursor with a series of lights displayed on a nearby computer screen. The impulses were then converted into code that computers could understand. The monkey repeated the motion -- only this time, two robotic arms (one in an adjacent room and another 600 miles

away in a Boston laboratory) also moved in response to the wireless signals sent straight from the monkey's brain.

In a similar, more recent experiment, the same scientists taught a macaque to direct a cursor to illuminated targets on a computer monitor. When scientists disabled the joystick, the monkey gradually stopped moving its arm altogether and learned to do the experiment just by thinking. "Our immediate goal is to help a person who has been paralyzed . . . to operate a wheelchair or a robotic limb," wrote Nicolelis and fellow researcher John K. Chapin in the October 2002 issue of *Scientific American*. "Someday, the research could also help such a patient regain control over a natural arm or leg, with the aid of wireless communication between implants in the brain and the limb."

The military implications are also numerous and revolutionary. Imagine, for example, pilots who could fly high-performance fighter aircraft from the ground using only their thoughts, or soldiers who could communicate with one another telepathically, downloading the latest tactical intelligence directly into their brains. Researchers in other parts of the program are even testing the viability of storing human memories on implantable microchips, a Matrix-like advance that would eliminate the need for training by allowing soldiers to upload someone else's technical know-how or combat experience. Without question, such radical advances are still decades away (at the very least). But DARPA's research is already challenging contemporary notions of what is possible.

Even as some programs concentrate on strengthening the mind, others are focusing on the body. One such DARPA effort -- Exoskeletons for Human Performance Augmentation -- could transform today's infantry "grunts" into high-tech supersoldiers similar to those imagined by Robert Heinlein's 1959 science-fiction classic *Starship Troopers*. The $40 million program -- already midway through its six-year run -- is experimenting with power suits meant to increase by orders of magnitude the toughness and lethality of the average foot soldier. DARPA's plans call for the exoskeleton to be built around a "haptic interface," a series of sensors distributed throughout the suit to read and amplify even the smallest of human muscle movements. According to the agency's Web site, soldiers encased in this futuristic battle armor will be able to "handle more firepower, wear more ballistic protection, carry larger-caliber weapons and more ammunition, and carry supplies greater distances." They might also be able to jump to extreme heights and even fly short distances. Peter Parker's "spidey sense" is tingling just thinking about it.

The exoskeleton research has met with at least a few notable, if modest, successes. At the University of California (Berkeley) Human Engineering Laboratory, a team of researchers has built what might ultimately become the legs of tomorrow's robo-warrior. According to the lab's Web site, the "Lower Extremity Enhancer" gives its owner the "ability to carry weights on the order of 120 pounds over any sort of terrain for extended periods of time without undue effort."

But even bionic legs may be overshadowed by other exoskeletal advances. Another DARPA contractor -- a small, California-based outfit called Trek Aerospace -- used its $5.1 million federal research grant to develop and test an awkward-looking flying machine that could one day render the term "ground troops" obsolete. The company envisions a one-man rotor-driven craft that could cruise at 60 mph at an altitude of up to 6,300 feet, or could

hover over a battlefield for up to an hour and a half.

Revolutions in brain-machine communication and physical performance would radically change the nature of warfare, but even these technologies would be confined by the natural boundaries of human endurance. After all, war fighting is a tiring business, and armies have always been slowed by the need for sleep. Since World War II, American pilots have relied on stimulants to sustain them through long combat missions. Fighter pilots in the 1991 Gulf War and the more recent wars in Afghanistan and Iraq were routinely issued "go-pills" (usually about 5 to 10 milligrams of Dexedrine) to be used at their own discretion. But amphetamines, while effective in the short term, have nasty side effects that can seriously impair a pilot's judgment. Just last year, for example, two pill-taking American F-16 pilots nearing the end of a 10-hour mission over Afghanistan dropped laser-guided bombs on a group of Canadian troops that they mistook for a hostile Taliban unit. Four Canadians died and eight were wounded in the incident.

Avoiding these sorts of accidents while simultaneously prolonging the combat effectiveness of American troops are the animating forces behind DARPA's ongoing effort to break the sleep barrier. The $20 million Continuous Assisted Performance program "is investigating ways to prevent fatigue and enable soldiers to stay awake, alert, and effective for up to seven consecutive days without suffering any deleterious mental or physical effects and without using any of the current generation of stimulants," said DARPA Director Tony Tether last spring in a written statement to the House Government Reform Committee.

In early investigations, some scientists have shown particular interest in learning how other animal species (such as dolphins, whales, and birds) routinely forgo sleep. Meanwhile, researchers in other parts of the program, such as Yaakov Stern, a neuropsychologist at Columbia University, are exploring ways to stimulate the brain to forestall feelings of fatigue. Stern and his colleagues envision a time when sleep-deprived pilots might be able to "zap" their brains with electronic currents at the push of a button, instantly stimulating key neurons and regaining full alertness by fooling the brain into feeling rested.

Wading through DARPA's budget request feels like entering an alternate universe, a fantasy world of sorts, where anything and everything is possible. It is, therefore, easy to forget that an estimated 85 percent of DARPA projects end in failure. But that is not necessarily a problem, according to DARPA spokesperson Jan Walker. "Our mission is to look outside of the box, to be revolutionary," she told *National Journal*. "You can't be revolutionary by being conservative. They're contradictory."

Dr. Paul Saffo, research director at the Institute for the Future in Menlo Park, Calif., agrees. "When you do [DARPA's] kind of work, if you're not failing part of the time, you're not in the right place," he said. "By definition, you've got to be on the ragged edge of chaos, and a significant percentage of your projects have to fail in interesting ways."

That said, others have wondered whether DARPA doesn't sometimes wander too far off into the realm of "what-if" -- such as it did with FutureMAP. The agency's bioresearch programs, for example, could pack a far larger ethical punch than FutureMAP because they raise fundamental questions about what it means to be human. A reader of DARPA's latest budget request easily becomes desensitized to terms such as "human augmentation" and "assisted

performance," which, through sheer force of repetition, begin to lose their philosophical complexity. Dr. Steven G. Wax, acting director of DARPA's Defense Sciences Office, said that the agency prefers to view such programs in terms of "maintaining the type of capability that the soldier arrives with." In other words, research about exoskeletons and sleep deprivation seeks mainly to prevent the degradation of soldiers' natural capabilities in the field.

But serious moral and ethical concerns about these projects remain. DARPA itself recently invited a bio-ethicist to speak to program managers about issues associated with human augmentation, and Wax says that the agency carefully weighs these concerns when choosing which projects to fund. Steven Aftergood at the Federation of American Scientists suggests that Congress also has a vital role to play. The Armed Services committees that authorize the agency and the defense appropriations committees that fund it, he said, "need to do some internal self-assessment as to whether they are getting enough information from DARPA and whether they have the internal staff resources to devote to carefully scrutinizing DARPA programs."

Still, futurists warn against the temptation to become overly cautious. "Human augmentation is coming; the only question is how soon," said Saffo. "This stuff is being worked on in all sorts of places all over the world. I'll give you three options. We can stay in it and be state of the art and deal with the moral issues. We can get out of it completely and be bystanders. Or we can do this half-assed thing in the middle. Now, of those three options, which one do you think is rational?"

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