

CMU GOES TO WAR

MARINES ASK CMU TO DEVELOP A FEW GOOD ROBOTS

The first Marine that scrambles to take a hill may someday be a six-wheeled robot. A team led by Carnegie Mellon University's National Robotics Engineering Consortium has won a contract to develop a prototype of such a vehicle, which the U.S. Marines hope to put in the field as early as 2006. Less than 7 feet long and about 4 feet wide, the Tactical Unmanned Ground Vehicle, called Gladiator, would be about the size of an all-terrain vehicle. It could carry weaponry or serve as a scout that might check for chemical or biological agents or identify targets for a mortar platoon. It would be remotely operated by a Marine, but could also operate autonomously to avoid obstacles or retrace its path. The Office of Naval Research awarded a \$2.3 million, 14-month contract to Carnegie Mellon's Team Excalibur to develop Gladiator. It will compete with Team Retarius, led by Lockheed Martin, which received a \$2 million contract. Jeff Bradel, the Gladiator program manager at the Office of Naval Research, said it hasn't been determined whether the Marines will select one of those designs for production, or re-open the competition. But some version ultimately will be placed in production. "The Marine Corps is excited about the increase in war-fighting capability," said Bradel, a Pittsburgh native. Unmanned ground vehicle technology has been under development for years and has reached a point where it can be used in the field.

Gladiator is similar in some ways to another military robotics project, the Unmanned Ground Combat Vehicle, which Carnegie Mellon is developing with a \$5.5 million contract from the Defense Advanced Research Projects Agency. That robot, called Spinner, is much larger than Gladiator -- about the size of a Humvee. The six-wheeled, 15,000-pound robot can carry a 4,000-pound payload.

Spinner, now undergoing testing, is designed to clamber over 4-foot-high steps and keep operating even if it flips over. Should it ever land on its back, Spinner would be able to reposition its wheels, lift itself off the ground upside down and turn its payload compartment right side up.

Dimi Apostolopoulos, project manager for Team Excalibur, was guarded about what capabilities would be included in Gladiator, but noted it will take advantage of some of the lessons that are being learned with Spinner. "This will be a very robust, crashworthy vehicle that will be able to recover from rollovers," he said. The mechanical leatherneck would work closely with troops, serving as an expendable team member to assume risky assignments, such as being first over a hill held by hostile forces or peeking around buildings during urban combat, said John Bares, co-principal investigator. Team Excalibur also includes some of the same subcontractors as Spinner, including the Boeing Co., which builds composite hulls for the robots, and Timoney Technology of Meath, Ireland, which builds the suspensions and electric drive units. Other members of the team are Tadiran Electronic Systems of Holon, Israel, and UQM Technologies of Frederick, Colo. Spinner is being built for DARPA, the Pentagon's research and development arm, primarily to push the technology, not necessarily to be placed in production.

The Marines, on the other hand, expect to field Gladiator. If the Marines choose the Carnegie Mellon design for eventual production, one of the other team members, likely Boeing, probably would take over as prime contractor, Apostolopoulos said. In another parallel between the two programs, Lockheed Martin also is working for DARPA on a smaller, robotic reconnaissance vehicle. Though that vehicle doesn't compete with Spinner, it is similar in scale to Gladiator. And Lockheed's design is competing against Carnegie Mellon's in the Gladiator program. "They're already two years ahead of us," said Bares, who also serves as project manager for Spinner. *Tuesday, May 27, 2003 -By Byron Spice, Post-Gazette Science Editor*

Software for "Soft Wars"

*CMU's Software Engineering Institute doesn't make weapons directly.
But making sure weapons are better weapons is the Institute's lifeblood.*

On Jan. 26, about 100 people lay on frozen Fifth Avenue in front of the Software Engineering Institute in Oakland, holding a "die-in" to protest the role this Carnegie Mellon University research center would play in the pending war with Iraq. They charged that SEI has been helping the Department of Defense develop weapons systems, and therefore is complicit in any U.S. war.

Protesters have targeted the SEI since its founding nearly two decades ago -- objections, CMU officials say, that are not deserved. But CMU officials continue to be reluctant to answer specific questions about SEI's work for the Department of Defense. They deny that the hundreds of millions the DoD gives SEI is for making weaponry. But while SEI doesn't link itself publicly with weapons makers, weapons makers are happy to link themselves publicly with SEI.

How connected are SEI and the DoD? Entirely. It was founded as an official federal research and development laboratory by the DoD, as CrossTalk: The Journal of Defense Software Engineering notes, "because the Defense Department didn't always want to go with the lowest bidder on software development projects." The DoD wanted software that would work well and that was far enough advanced to be useful and not quickly obsolete. It created and then contracted with SEI to develop a software testing and rating system -- the Capability Maturity Model -- that every military contractor using software must now pass to be eligible for DoD contracts. SEI thus has a hand in making sure the software in the most sophisticated weapons systems -- in everything military that requires software -- is worth the DoD's investment.

In 1993, when the Department of Defense subpoenaed all CMU records related to DoD funds it had received during the previous seven years, SEI's then-director Larry Druffel told the Pittsburgh Post-Gazette: "It literally is every piece of paper in the institute." SEI had \$34 million in defense contracts that year alone.

The DoD's "Research, Development, Test and Evaluation Budget Item Justification Sheet" for February 2002, in explaining its expenses, describes SEI most directly: "The SEI focuses on software technology areas judged to be of the highest payoff in meeting defense needs." It lists DoD funds slated for the SEI at \$19.393 million for 2002, projecting small increases up to a \$23.901

Software for "Soft Wars" (cont.)

million allocation for 2007. SEI is "an R&D Laboratory Federally Funded Research and Development Center (FFRDC) sponsored by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics," the DoD document explains.

Many weapons manufacturers boast in press releases about achieving high ratings from SEI, including everyone from the largest defense contractors in the U.S. -- Lockheed Martin, Raytheon, General Dynamics -- to Northrop Grumman Corporation's Air Combat Systems and Joint Strike Fighter (JSF) program for radar development; CACI International's Submarine Launched Ballistic Missile Program; and TRW's Command, Control and Intelligence Division.

SEI also gives approval to defense groups: The Weapon System Support Center, part of the B-2 [bomber] System Program Office at Tinker Air Force Base in Oklahoma, received SEI's second-highest ranking, according to the base's Jan. 31, 2003 newsletter: "The achievement represents two years of work by the Air Force and Northrop Grumman, the prime contractor for the B-2," it enthuses.

Companies working for defense programs in other countries also boast of passing muster at SEI: ModIOS Technology of Scottsdale, Ariz., working on its Dismounted Soldier Simulator as an "urban battlefield" simulator for Canada, and Elbit, an Israeli defense contractor, to cite just two examples. SEI hosts TIDE conferences (Technology Insertion, Demonstration, and Evaluation) to help "small manufacturers ... become a supplier in the Department of Defense supply chain." A Government Accounting Office representative last year told Congress that SEI's oversight was needed to help the U.S. improve the "investment decisions" for the Crusader, a self-propelled 155-millimeter howitzer that has its own resupply vehicle. "Software Engineering Institute and Defense Acquisition University Form Strategic Partnership to Improve Software Education, Training Opportunities," announced a government press release two years ago. SEI also teams with other universities in their defense work, joining recently with Johns Hopkins University's Applied Physics Laboratory to improve communications among weapons and weapon-wielders.

Even though weapons manufacturers who need software must now get SEI's blessing to proceed, there is no direct connection between SEI's work and particular weaponry, SEI officials maintain. SEI performs no classified research, CMU officials have long said, although last year CMU president Jared L. Cohon told Sara Henneberger of the student newspaper *The Tartan* that "some fraction is" now classified. More than a decade earlier, CMU spokesperson Don Hale had given the company line to *In Pittsburgh Weekly* most succinctly: "We don't do any research that is directly related to weapons systems. Clearly we have a lot of defense department funding. But basic research" -- SEI's focus -- "is far different than applied research. ... It's very hard to say whether, down the road, any of the things we work on here might end up in the military."

CMU officials have long touted this distinction between types of research as justification for defense work in an academic setting. In 1989, then-SEI director Druffel told the *Pittsburgh Press*: "Clearly, we're involved with people who build weapons systems. I hope we're helping them build them better. But we still don't build them here." At the time, Druffel confirmed, SEI was writing code for the Tomahawk missile's guidance system, but added that it would never be used to guide the missile such work was only a way of testing a design.

As President Cohon explained to *The Tartan* last year: "We don't know how to build tanks -- we don't build weapons systems. But what we do very well is develop technologies that will be part of such a vehicle or weapon."

Such distinctions are mere semantics to protesters and other SEI critics; making the trains run on time is not a crime, even during wartime, unless those trains are headed for Treblinka. SEI is not directly involved in weapons production for the current war against Iraq in the sense that there's probably no bullet factory in the basement. (SEI spokesperson Kelly Kimberland would not offer a peek inside SEI, nor answer any questions about the institute -- not even to specify the number of students and faculty who work at SEI.) But with today's digitalized, "smart" weaponry, software engineering is the stomach on which today's Army travels. While SEI does not appear to be headquarters for some new Manhattan Project, its work has for some years been integral to weapons-systems manufacture. Weapons manufacturers work better today, and so weapons are better, because of SEI.

As Cohon also told *The Tartan*: "War is a bad thing. ... But I believe what we do is ethical, in that if you're going to wage war, and build weapons systems, and you're going to be reliant on software, shouldn't you be using the best software available?"

SEI has had critics since its founding in 1984, both inside and outside CMU.

"At the beginning I felt it was not appropriate for the university to do work for the defense department," says CMU physics professor Lincoln Wolfenstein, who has spoken out against SEI's work on campus. "I still certainly feel that way. They argue of course that the work can have other applications. But it is work in a sense that has to be directed toward specific defense department needs."

He believes his fellow professors, apart from those who have done direct work for SEI, haven't paid much attention to the institute over there in its building separate from the main CMU campus.

Local activist Vincent Eirene has found the SEI hard to ignore. He was an early and unavoidable foe of the place, chaining himself to it, holding a hunger strike in front of it and even celebrating his 40th birthday there, getting himself arrested for his protests numerous times. In February 1989, he named several CMU professors as participating in research for the Strategic Defense Initiative (the so-called "Star Wars" missile defense shield that had its origins under President Ronald Reagan), though most denied it to *The Tartan* or said the contracts had already expired and that the research had multiple uses.

"We've learned that SEI is definitely an intimate part of the smart weapons, the command-and-control weapons, all the weapons developed for the Gulf War" -- the first Gulf War, Eirene says, in oft-repeated charges. He also decries SEI's influence on students and faculty who work there. SEI's real power, he says "is their power to persuade people who are forming their political philosophy to become more conservative, because of who pays the piper."

The piper's paycheck, of course, comes signed by the Department of Defense, which founded SEI in 1984 with more than \$100 million. Just three years later, a Penn State study ranked CMU third in the nation among universities for defense contracts, at \$41.5 million, the *Pittsburgh Post-Gazette* reported in 1988. Among all national nonprofit organizations, it ranked 10th in defense dollars, with \$13.7 million that year going to individual SEI projects.

In 1992, the *Pittsburgh Business Times* listed the SEI as tops in receipt of research dollars among local universities: \$156 million from the Department of Defense, from 1989 through 1994.

In ensuing years, SEI and CMU have continued to rake in the military money. The DoD's own records make that clear -- sometimes, however, without providing very many details. Among the contracts CMU has received in the past decade, mostly through SEI:

* A five-year Air Force contract for \$197,376,893 for "software and engineering research and development," in 1994, contracted by the Electronics Systems Center, Hanscom Air Force Base, Mass.

* Part of a \$32 million award as a member of one of four teams selected by DoD's Advanced Research Projects Agency (DARPA) to work on "the Affordable Multi-Missile Manufacturing Program," in 1994.

* \$9,478,375 to work "in support of the High Performance Distributed Services Technology (HPDST)," contracted by the Naval Command, Control and Ocean Surveillance Center Research, Development, Test and Evaluation Division, San Diego, Calif., in 1997.

* "A \$217,480,241 (maximum) cost-reimbursement contract to provide for software research and development support through June 2005 in support of a range of Department of Defense and non-Department of Defense government-sponsored programs," contracted by the Electronic Systems Center, Hanscom Air Force Base, Mass., on June 16, 2000.

* At least \$1.7 million to be a part of a team working for DARPA "to build a prototype vehicle in phase II of the Unmanned Ground Combat Vehicle Program" by Dec. 31, 2003.

* "A \$5,547,934 cost-share contract to provide for the Integrated High Performance Turbine Engine Technology Program Phase III and the Coordinate Industry and University Research Program in Forces Response." Purdue University was slated to perform 30 percent of the work, CMU the rest, under contract from the Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio, on April 10, 2002.

n SEI's own Web site, current SEI director and CEO Stephen Cross has left notes for a June 5, 2001, presentation about SEI, given to unknown parties. In the presentation, Cross writes that the SEI's work is a kind of war -- a "soft war," in his words. "Observe that the modern United States army learns from past wars," say the notes. "Assert that we need to learn from our 'soft wars' too."

Anti-SEI activist Vincent Eirene says he has learned a couple of things about SEI over the years. Its involvement with weaponry "is so extreme that someone needs to write a book on it," he says. "As [anti-nuclear activist] Phil Berrigan said before he died, 'We'll never be out of a job.' shield that had its origins under President Ronald Reagan), though most denied it to The Tartan or said the contracts had already expired and that the research had multiple uses.

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SEI GOES TO WASHINGTON

"MR. DRUFFEL: Thank you, Mr. Chairman, members. I've also submitted a position statement and I'll just summarize the major points that I made in that statement.

The SEI is relatively new among the FFRDCs and certainly among the smallest. We were established in 1984 after a competitive procurement process initiated by DOD. That was started after an industry-led panel reviewed the situation and decided that -- recommended that an SEI be established and that it be at a major university because they did not believe that industry would be willing to do the kind of work that they wanted done. And the SEI is managed by CMU, as with MIT Lincoln Laboratory, without fee. I won't presume to lecture you on software, but let me just spend a moment talking about the importance of software to our defense systems.

When I speak of software, I'm not talking about the software that resides in a PC. I'm talking about software that's in a radar, in the avionics of an airplane, flight controls, missile control, all of our weapons systems. In fact, it's difficult to find a weapons system that doesn't have software embedded in it. And the reason why defense has been so aggressive at pursuing the use of computing in this way is it provides enormous flexibility. Let me just use as a couple of examples first the dramatic example in the Gulf War where the Patriot missile, which is fundamentally designed as an anti-aircraft missile, was -- the software was changed so that it could be used to combat SCUDs, and we know the effects of that. Other examples abound that I'm sure my colleagues from Aerospace and Lincoln Laboratories could talk about, systems

that are in space and the ability to change the software in those systems and change the functionality. So when we're talking about systems is software that's embedded in weapons systems. The DOD systems are very complex. Building software for something like the F-22 is an enormously complex undertaking, and

the purpose of the SEI is to make sure that the technology that's evolving, whether in this country or abroad, whether from industry or the university research community, is available to the Department of Defense." continued at>>>

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CMU Blurs the Line On Weapons Research

Unmanned combat vehicle: \$5.5 million.

Turbine engine research: \$5.5 million.

Cybersecurity investigation: \$35.5 million.

Intimate connection with the Department of Defense: Priceless?

In the past 5 years, CMU has reaped over \$350 million in Department of Defense (DoD) research contracts. During 2002, the DoD will provide Carnegie Mellon with \$71.5 million 40 percent of the University's total federal research funding. President Jared Cohon said that much of the University's DoD-funded work involves basic technological research, not direct weapons applications. However, structural changes within the Defense Advanced Research Projects Agency (DARPA), which previously provided funding to the University for general research, could alter that trend. They have shifted to a much more focused, mission-oriented approach, said Cohon. They're giving out their money in smaller chunks. In July, DARPA awarded CMU's National Robotics Engineering Consortium (NREC) a \$5.5 million contract to develop a robotic unmanned ground combat vehicle. The agreement calls for the completion of a tank prototype by the end of 2002. Boeing will eventually produce the combat vehicle at its Seattle facility. I will acknowledge that this is as close as we've come to working on a weapons system or a potential weapons systems, said Cohon. Its arguable whether we'll actually be building a tank. We don't know how to build tanks we don't build weapons systems. But what we do very well is develop technologies that will be part of such a vehicle or weapon.

The wide range of University work sponsored by the DoD during the past five years has included turbine engine research, integrated circuit design, x-ray photo analysis, and general software development. Carnegie Mellon's emphasis on computer science often makes it a prime candidate for military money. One of the problems of the University is that the government has chosen to put most of computer science research under the Defense Department, explained physics professor Lincoln Wolfenstein, who has been a vocal opponent of military research during his 54 years at CMU. If you want to do computer science research, you mainly have to get contract as from the Defense Department. According to Cohon, the University administration does not play a role in the solicitation of DoD research funding. Instead, professors and researchers lobby for contracts. The Office of Sponsored Projects, led by associate provost Susan Burkett, must approve all contracts proposed by professors. University research policy limits the scope of military contracts that can be approved. It is a general policy that we do not accept work that is for restricted publication, said Burkett. In other words: We don't do classified research on campus, said Cohon. Software Engineering Institute The off-campus Software Engineering Institute (SEI) opened in 1984 under Carnegie Mellon management and DoD sponsorship. As one of the nation's few federally-financed research and development centers, SEI's primary reason for being is to serve the Department of Defense, said Cohon.

SEI operates under one overarching contract with the DoD that is renewed every five years. Cohon plays a general role during the contract negotiation process. I'll meet with high-level DoD people to see if they have any issues and to reaffirm the University's commitment to the institute, said Cohon. After the contract renewal, specific projects are worked out between [SEI] and the DoD without the University administration getting involved.

Burkett reviews SEI's DoD contract during the renewal process but does not examine the specific assignments later added to the agreement. Nor does she read classified research projects undertaken by SEI. I don't review things that fall under security clearance, said Burkett.

Despite repeated requests for comment, SEI officials refused to disclose the nature or amount of classified research performed at their facility. I don't know how much of SEI's work is classified, said Cohon. Not all of it is, but some fraction is. None of it, that I know of, is directly related to any particular weapons system.

SEI focuses much of its work on the application of capability maturity models, which is an advanced method of determining the logistics behind manufacturing processes. SEI is the leader in this field and provides extensive research and training to both private businesses and government agencies.

David Smith, a Navy program analyst stationed in Mechanicsburg, Pennsylvania, received on-site training at SEI during the mid-90s in the application of capability maturity models. He then taught the concepts to colleagues in the Navy and used the software to organize shipping schedules around the world.

The application of the software is not limited to financial and business processes within the DoD. They can be used for weapons systems, said Smith. Anymore, weapons systems are like software. I know the Air Force used capability maturity models to build the F-22 [fighter plane].

Another focus area of SEI, cybersecurity, has lent itself to cross-departmental University collaboration. Last February, the SEI's Computer Emergency Response Team (CERT) and the department of Electrical and Computer Engineering created a center for Internet security and data storage research. At the beginning of October, the new Center for Computer and Communications Security (C3S) received a 5-year, \$35.5 million grant from the DoD.

The grant will give Carnegie Mellon a tremendous edge in the area of cybersecurity, said Cohon, who acknowledged that the University's DoD ties produce additional funding, faculty, and overall opportunities for the school. SEI brings a lot of benefits, said Cohon. It is really a very important part of Carnegie Mellon. Academic Integrity The University's affiliation with the DoD has historically drawn attention from community activists. The general nature of much of the work done both at SEI and on campus does not prevent some campus and community members from criticizing the long-term implications of the work. One can only imagine all the money and brain power used to build a tank, said Vincent Eirene, a Pittsburgh resident who has helped organize anti-SEI demonstrations for nearly two decades. We don't need to find new ways to destroy and maim. We need new ways to sustain creation and to help people.

Eirene believes that the professors and staff members who engage in DoD-sponsored research are too far removed from the final application of their work. We're less sympathetic because we can't see the people we kill, said Eirene. Wolfenstein is also concerned that the dependency of Carnegie Mellon professors upon DoD money may deflect attention from the final consequences of their work.

You have to make a distinction as to whether the money from the defense department is really just part of the basic research that the government supports, or whether you're doing blind research for a military purpose, said Wolfenstein. Most people don't take the time to analyze. Wolfenstein questions the employment of students at SEI and has been a long-term advocate of academic freedom in the face of DoD influence. Former University President Richard Cyert established a faculty committee shortly after the creation of SEI to ensure that the interests of the DoD would not jeopardize the academic freedom of professors.

Wolfenstein served on the now-defunct committee and knows of no current mechanisms to uphold academic integrity while under military influence. Despite these concerns, Cohon says that he feels comfortable with the University's level of DoD-sponsored research. War is a bad thing. But I believe what we do is ethical, in that if you're going to wage war, and build weapons systems, and you're going to be reliant on software, shouldn't you be using the best software available?

The university should not be serving the military, said Wolfenstein. The role of the University is to teach all the things we know to a new generation and create new knowledge for mankind. I don't feel that it is the purpose of the University to provide the best technology to the military. -by Sara Henneberger, Contributing Editor