DOD AT UCSB

In FY 2008, the federal government awarded $114 million of UC Santa Barbara's $194 million in extramural funding directly to the campus for research. Of this federal amount, $35 million — 31 percent of the federal total — came from Department of Defense agencies. The DoD is the second-largest sponsor of UCSB research, placing the campus eighth among U.S. universities in DoD funding for basic research and 4th among public research universities. All of the defense-related research at UCSB is unclassified and these fundamental research projects have significant civilian as well as military applications, such as creating life-saving medical interventions, providing more secure computer networks, and developing over 100-fold faster communications. DoD provides funding to a number of UCSB's research centers, including:

- Center for Advanced Nitride Electronics (Navy)
- Center for Nanoscience Innovation for Defense (DARPA, DMEA)
- Center for Polymers and Organic Solids (Navy, Army)
- Institute for Collaborative Biotechnologies (Army)
- Interdisciplinary Center for Wide Band-gap Semiconductors (Air Force, DARPA, Navy)
- Optoelectronic Technology Center (DARPA)
- Solid State Lighting and Energy Center (Air Force, DARPA, Navy)
- Center for Spintronics and Quantum Computation (DARPA, DMEA)

Soldiers serving in Iraq, as above, and Afghanistan have greater chances of surviving a traumatic injury thanks to UCSB researchers.
Photo by Army Spc. Richard Del Vecchio

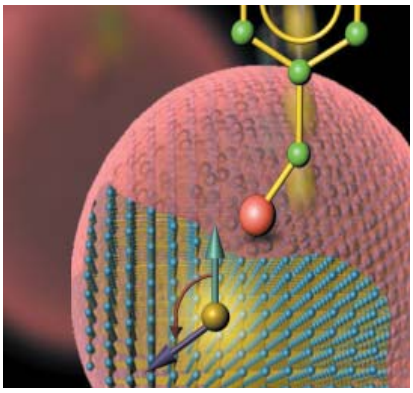
Mimicking Biological Efficiencies A plant converts sunlight into energy six times more efficiently than the best human-made photovoltaic cell. The human eye can perceive a single photon of light and moth antennae can detect a single molecule of scent, yet the most efficient human-made devices to detect dangerous organic substances are 100,000 times less sensitive than biological sensors. The Institute for Collaborative Biotechnologies, based at UCSB and funded by the Army with up to $50 million over five years, aims to discover the secrets of these biological processes. Caltech and MIT are partners in the effort. "Our intent is not to copy the appearance of biological materials," says molecular geneticist, biochemist and institute director Daniel Morse, "but to extract at the most fundamental level the principles unique to biology that have never been used in engineering-based manufacturing." These proven natural principles will lead to vast improvements in sensing and sensor speed, sensitivity and accuracy for medicine and homeland security, and new ways of producing superior semiconductors, optoelectronic materials and photovoltaics. One promising project under way in the labs of chemical engineer Jacob Israelachvili and mechanical engineer Kimberly Turner involves research that hopes to reveal the adhesion secrets of geckos. Geckos have the ability to adhere to virtually any type of surface using the millions of setae found on their toe pads. Using the knowledge gained through theoretical modeling and experiments on the gecko system, gecko-inspired adhesives are being synthesized using cleanroom-based fabrication techniques. (www.icb.ucsb.edu)

A moth's antennae are 100,000 times more sensitive than any human-made detection system.
Photo by Linda Murphy

Clay and Gauze — A Lifesaving Combination Severe battlefield injuries present unique problems in stemming blood loss, which is the primary cause of deaths in wartime. In 2004, inorganic chemist Galen Stucky was asked by the Office of Naval Research to improve a zeolite-based substance, QuikClot™, that promotes clotting and sealing of the wound until the injured can be taken to medical facilities. QuikClot™, though effective, had a tendency to cause second-degree burns around the wound. Stucky's team first resolved the excessive heat problem, then discovered that a simple substance, kaolin clay, eliminated the heat and added to the blood-clotting action. Originally a sandy powder that was dumped into a wound, now the product is a medical gauze treated with nanoparticles of kaolin clay called Qui-

kClot Combat Gauze™. QuikClot Combat Gauze™ is in use by the Army, Navy and Marines on battlefields in Iraq and Afghanistan. A civilian version, QuikClot 1st Response™, is becoming standard equipment with emergency providers nationwide. (www.engineering.ucsb.edu/insights2008/presentation_view.php?id=10)

Getting Down to Basics Basic research is as integral to technological advancement as a tiny seed is to an apple, yet many universities are cutting back on pure theoretical inquiry. In an effort to bolster basic research efforts, the Defense Advanced Research Projects Agency and Defense MicroElectronics Activity have given more than $25 million since 2002 to establish a three-campus center at UCSB, UCLA and UC Riverside to support research, training and rapid transfer of technology to industry. Called the Center for Nanoscience Innovation for Defense, or CNID, the center is headed by UCSB's David Awschalom, a condensed-matter physicist whose work in spintronics has revolutionized nanoscale research and understanding. Awschalom's work involves, among other areas, electrons' magnetic orientation, or spin, to move information, an important step in developing a quantum-based computer. The CNID involves the work of 75 researchers in 10 disciplines, including biochemistry, engineering, materials science, neurobiology and physics. (www.csqc.ucsb.edu)

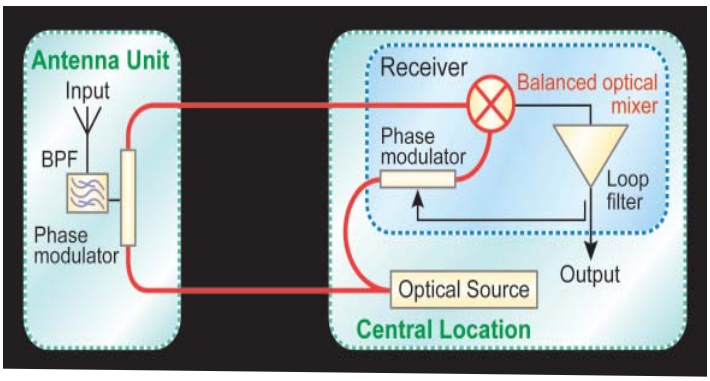


David Awschalom's work in spintronics has revolutionized nanoscale research and understanding. Illustration by Peter Allen

Map Interpretation: In the Eye of the Beholder Cognitive psychologist Mary Hegarty is studying how viewers perceive weather maps, with particular emphasis on how various learners are able to interpret the data included in most meteorological maps. The intent is to discover which techniques can be used in map development that will optimize the ability of the viewer to get the information they need quickly and accurately. "We are examining people's intuitions about the effectiveness of different complex displays, and how these intuitions match or mismatch the actual effectiveness of these displays," Hegarty explains. Hegarty's Cognition and Comprehension of Meteorological Displays project is funded by the Office of Naval Research. (www.psych.ucsb.edu/~hegarty/visual_displays.php)

Speeding Up the Internet Daniel Blumenthal, professor of electrical and computer engineering, and his colleagues are working on increasing the speed of internet transmissions by replacing the ponderous optical-to-electrical-to-optical computer routing process with a completely optical technology. The anticipated payoff is the distribution of rich data, voice and video content at vastly greater speeds and requiring less power. The team, known as LASOR, for Label Switched Optical Router, brings innovative research leaders from UC Santa Barbara's faculty together with faculty from Stanford University and researchers from several leading technology companies—Agility Communications, Calient Networks, Cisco Systems, Inc., and JDS Uniphase. The work is supported by DARPA Microsystems Technologies Office's Data in the Optical Domain (DoD-N) program. (http://ocpn.ece.ucsb.edu)

Looking for a Clear Chorus Electrical engineer John Bowers has been leading the CHOIR to produce faster and more cost-effective electronic transmissions for cell phones, radar, radiometry, global positioning systems and even household appliances like microwave ovens and televisions. Microwaves, which are used now, are, as Bowers describes them, "big, clunky and metallic, with fairly high signal loss." Bowers' research on CHOIR, or Coherent Optical Integrated Receivers, is perfecting glass-fiber transmissions by reducing signal distortion, a major barrier to widespread use of fiberoptics in the past. Glass fiber is minuscule compared to the metal fibers used to send microwaves: a hair's breadth across instead of two centimeters. And the cost of sending signals across glass fibers is less. The problem has been that fiberoptic transmissions are highly nonlinear waves and so create unacceptable signal distortion. Other research has focused on the problem from the sending end, with little success. So Bowers and his colleagues have developed a device that corrects the distortion on the receiving end. "We're at the beginning of a whole revolution," Bowers explains. "We all need information but at no greater cost. When you increase capacity and quality, it's surprising how good life can be." (www.ece.ucsb.edu/uoeg)



CHOIR: Perfecting glass fiber transmissions by reducing signal distortion. Graphic by John Bower Group and Dottie McLaren