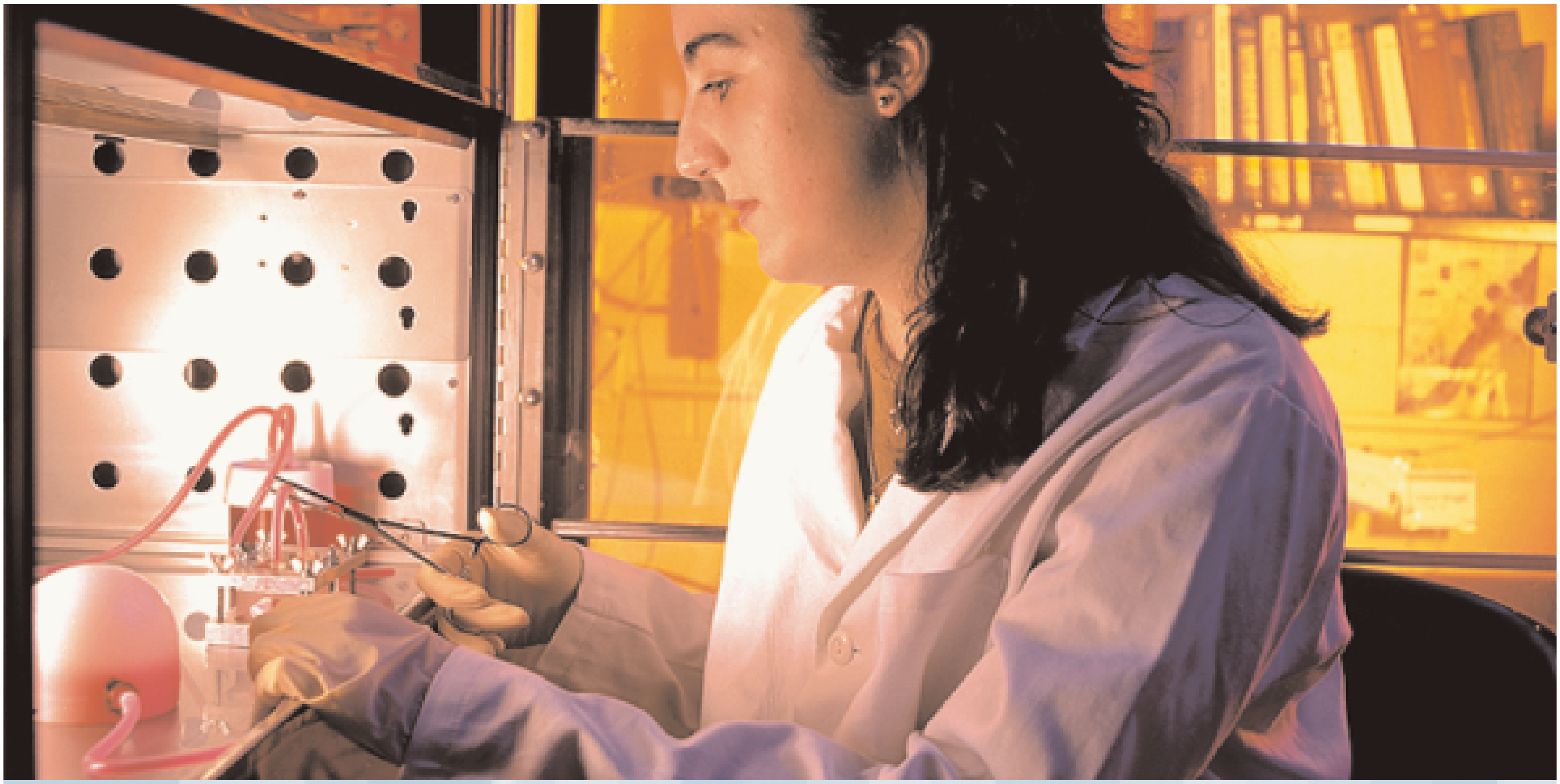
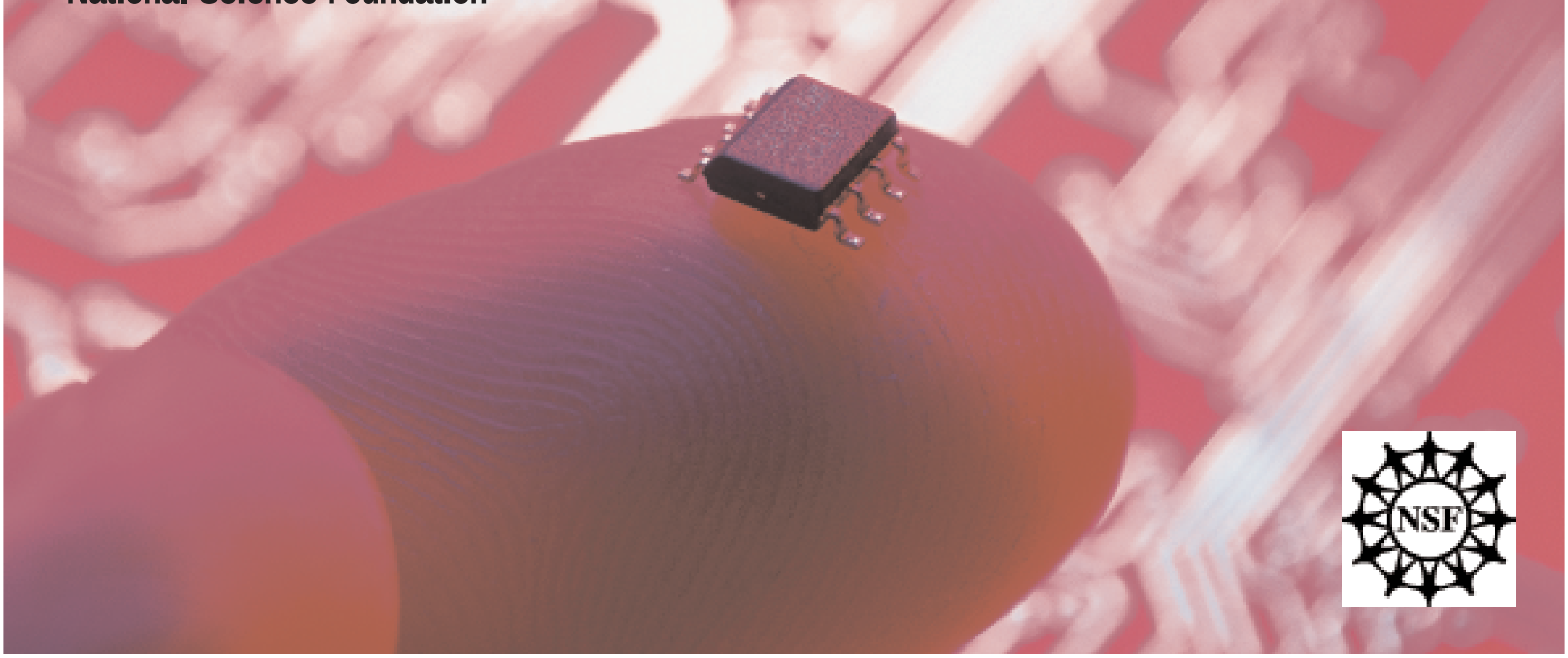
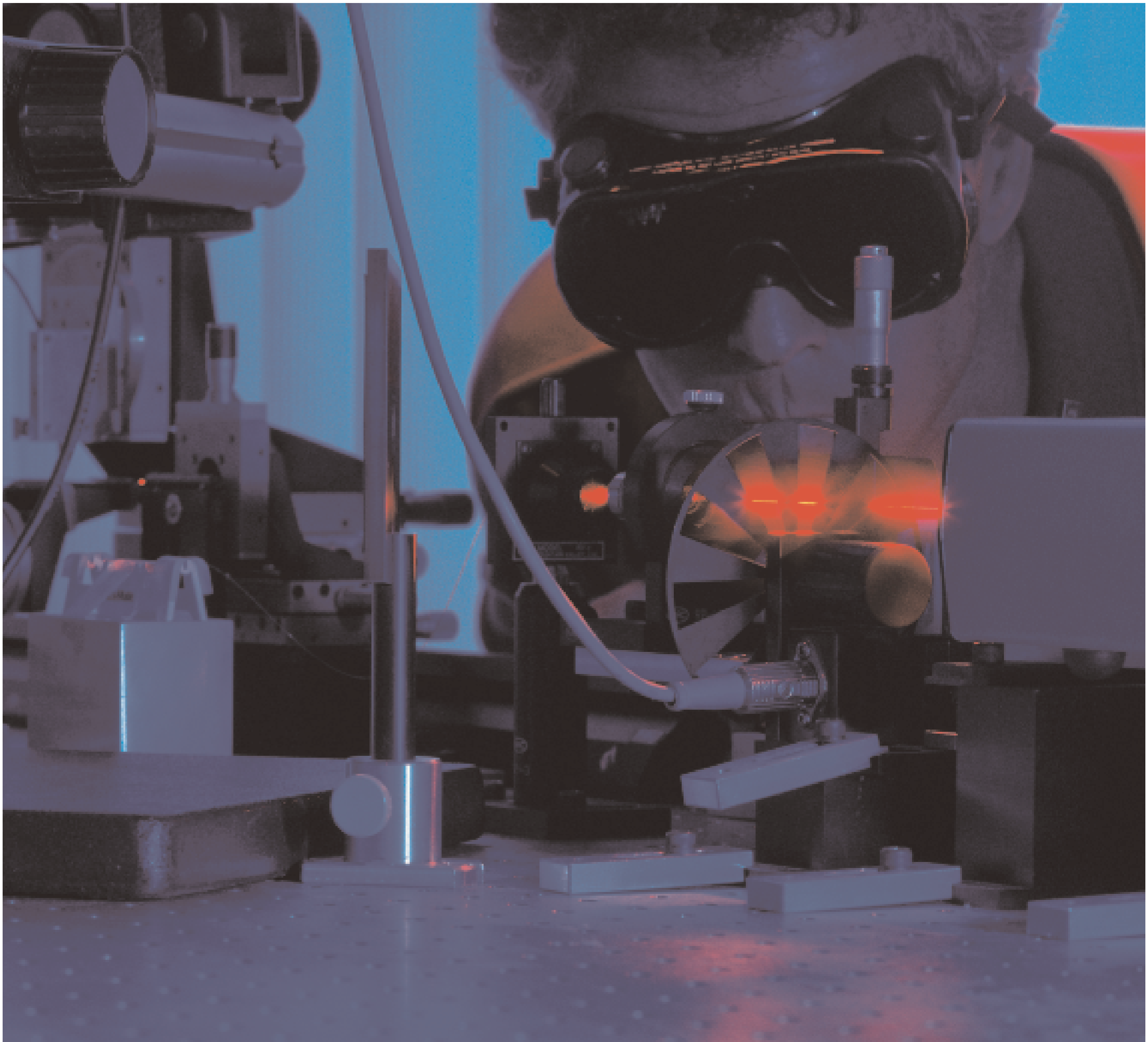


Making Imagination Real

Advisory Committee, Directorate for Engineering
National Science Foundation





One part dreamer and one part pragmatist, engineers use the raw material of imagination to design and build wondrous new devices and systems. The National Science Foundation's Directorate for Engineering supports individuals who are **Making Imagination Real** by creating knowledge that forms the basis for brand-new high-tech industries as well as the transformation of existing industries. NSF-funded engineering research encompasses a broad spectrum of activities carried out by a diverse group of investigators throughout the United States and internationally. On the cover (front and back) and above are images of engineers at work, including students in various NSF-funded projects.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Awardees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities and persons with disabilities to compete fully in its programs. In accordance with Federal statutes, regulations and NSF policies, no person on grounds of race, color, age, sex, national origin or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF, although some programs may have special requirements that limit eligibility.

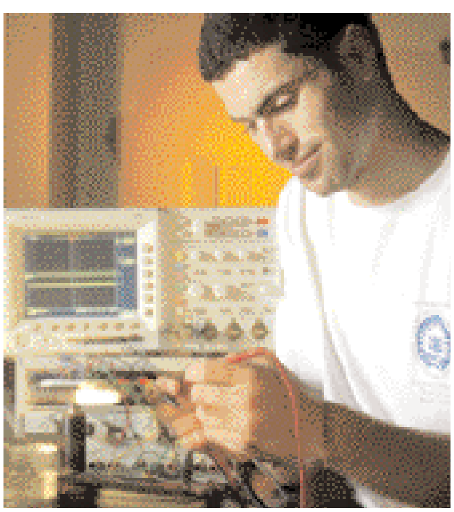
Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the GPG Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

Imagine a future...

Engineers excel at Making Imagination Real, bridging the gap between what the mind can imagine and what the laws of nature allow. While scientists seek to discover what is not yet known, engineers apply fundamental science to design and develop new devices and engineered systems to solve societal problems. Science and engineering are essential partners in paving the way for America's future through discovery, learning, and innovation.

Engineering research opens up new areas for technology and scientific discovery. The National Science Foundation and its Directorate for Engineering (NSF-ENG) play a critical role in supporting research at the frontiers of knowledge. NSF-ENG helps catalyze discoveries that form the basis for new technologies, stressing partnerships and collaborative research with universities, foundations, private industry, and other federal agencies.

With input from the community, NSF-ENG invests in the best ideas from the most capable people, using a proven and regularly audited process. The investigators we support are not just academic researchers: they are real-world innovators and entrepreneurs. A case in point is Robert Langer—professor of chemical engineering at MIT, holder of 400 patents, founder of more than 25 companies, and one of "America's Best in Science and Medicine," according to Time magazine. NSF-ENG provided Langer with early-career support to study various materials as scaffolds for growing living human tissues. The resulting technology is now used for applications such as cultivating human skin to treat skin ulcers in diabetics.

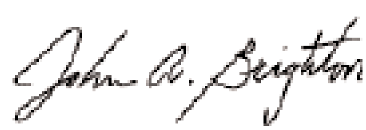


Researchers supported by NSF-ENG also are among the nation's leading educators. Strengthening engineering education and developing the future workforce is a priority area for NSF-ENG investment. We cooperate with universities and professional engineering societies on initiatives to encourage more students, especially women and underrepresented minorities, to consider engineering as a career as well as to ensure that engineering curricula and teaching successfully equip the next generation of American engineers to become technology leaders and innovators.

Composed of the nation's top experts, the NSF Advisory Committee for Engineering created this booklet to raise public awareness of NSF-ENG's role in enabling research that promotes three important objectives: improving the nation's health, strengthening security, and advancing economic vitality. Investments in health-related research are leading to novel medical treatments, such as new antibiotics and cancer-fighting drugs, and powerful new imaging technologies for medical diagnostics. Support for research on sensors and sensor networks is yielding knowledge for technologies to enhance

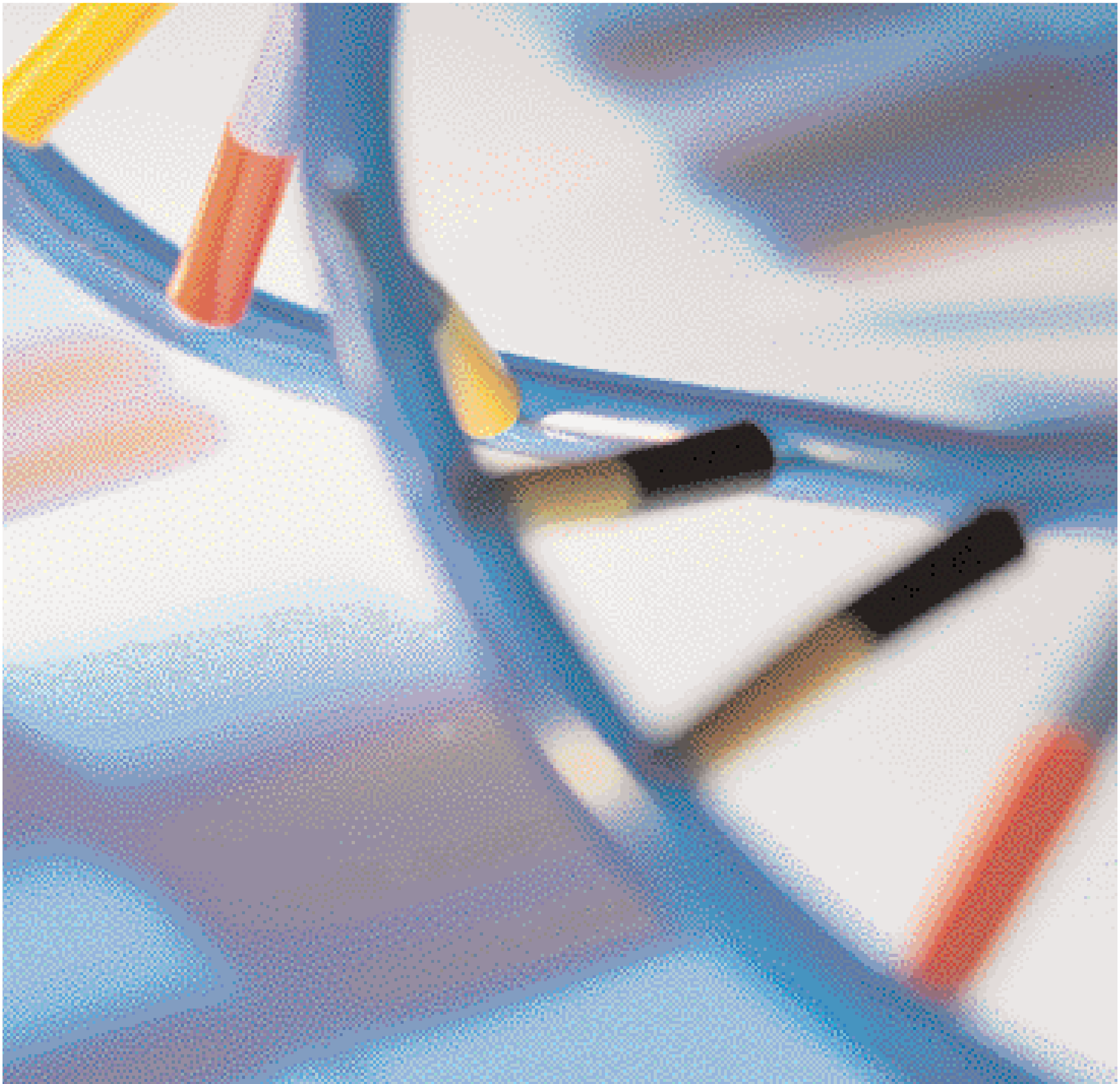
homeland security. And funding for research on advanced computing and manufacturing technologies is creating a solid foundation for America's economic future.

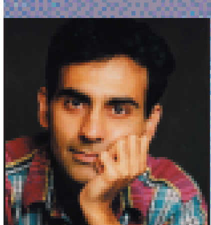
This booklet offers you a flavor of NSF-ENG's investments in generating new knowledge for technological progress. We believe the projects presented here amply illustrate a basic truth: advances in fundamental engineering research and engineering education are essential to America's future.



John A. Brighton
Assistant Director for Engineering
National Science Foundation

Kristina Johnson
Chair
NSF Advisory Committee for Engineering





"For virtually every new technology that has emerged from my lab, the pivotal discovery or technical capacity that made it possible can be traced back to an exploratory project funded by NSF. The opportunities provided by NSF funding have been of paramount importance to my work."

Chaitan Khosla, Professor of Chemical Engineering, Chemistry, and Biochemistry, Stanford University, and co-founder of Kosan Biosciences, Inc.

Engineering Better Health

NSF support for Engineering Better Health includes

- Developing new technologies and processes to improve health care quality and reduce costs, such as technologies for less invasive diagnostics and for more precise delivery of drugs to target tissues
- Designing novel structures and materials, such as ceramic joints and artificial skin
- Developing models and tools to understand and control biological systems, such as bioengineering approaches to creating new antibiotics and anticancer drugs

Imagine a future . . .

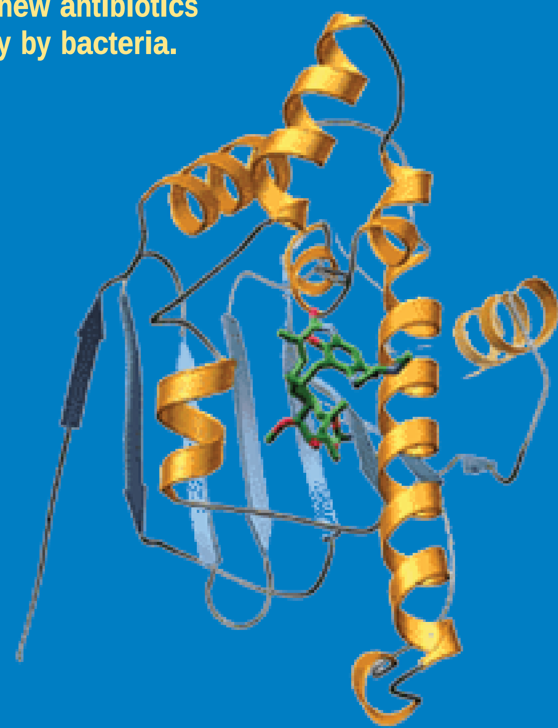
in which the endless bounty of nature is transformed into powerful new antibiotics and cancer-fighting drugs manufactured quickly and cost-effectively by bacteria.

NSF-supported researcher Chaitan Khosla of Stanford University is pioneering an exciting new approach to the production of novel antimicrobial and anticancer drugs from bioengineered organisms. Working at the crossroads of chemistry, biology, and chemical engineering, he is developing products that could not have been conceived of a few years ago.

Khosla is redesigning bacteria to produce more effective compounds for fighting human diseases. His techniques provide a faster, lower-cost method of creating new and improved variants of already-known natural drugs.

Kosan Biosciences, Inc., a start-up firm co-founded by Khosla, is working with pharmaceutical companies to advance the most promising drug candidates. Two anticancer compounds, KOS-862 and 17-AAG, are now in clinical trials.

Among the first to spot Khosla's promise, NSF-ENG provided this gifted researcher with his first federal grant in 1992. Khosla received continued NSF support throughout the 1990s under programs designed to afford outstanding young science and engineering faculty greater freedom to pursue cutting-edge research.



Created with support from NSF, a bioengineered version of the natural tumor-fighter geldanamycin (green) attacks a cancer-promoting protein called Hsp-90 (gold and blue).

Engineering Better Health

Imagine a future . . .

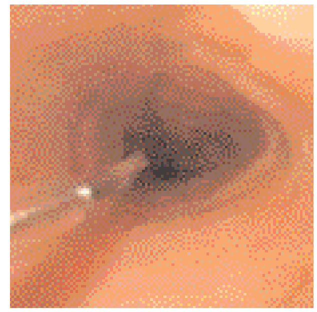
where patients with suspected tumors are diagnosed in real time using much less invasive “optical biopsies.”

The interaction of light and biological molecules can yield important information about the health and functioning of living tissues. To lay the foundation for new medical diagnostic tools and therapies, NSF-ENG has teamed up with the National Institutes of Health (NIH) and the Defense Advanced Research Projects Agency (DARPA) to lead the Biophotonics Partnership Initiative, which supports development of technologies needed to make optical biopsies and other biomedical innovations a reality.

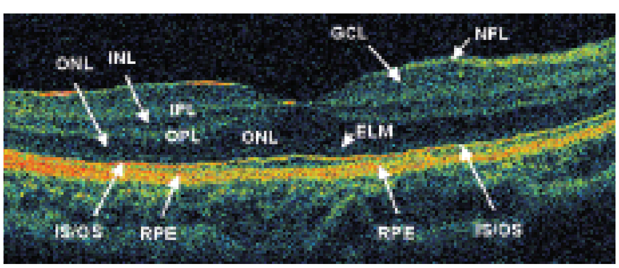
For instance, Professor Rebecca Richards-Kortum and her team at the University of Texas are developing optical technologies for detecting early-stage cancer and other diseases. Clinical trials of her techniques for diagnosing early-stage cervical cancer inside the body (rather than in a smear on a microscope slide) have shown that these techniques can be more effective and cost-effective than existing diagnostics.

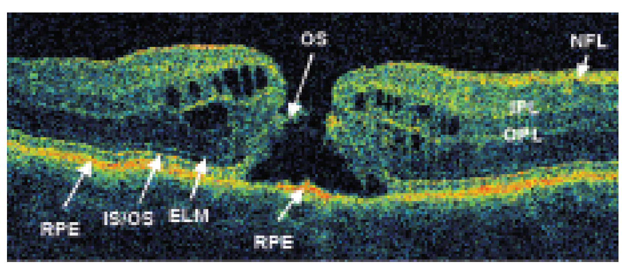
NSF-ENG is also supporting the collaboration of Professor Ming Wu of the University of California at Los Angeles and Professor James Fujimoto of the Massachusetts Institute of Technology to create new methods for ultrahigh-resolution internal body imaging. The team is working to develop novel microscanning devices that would enable cellular-level imaging via instruments used with standard hospital endoscopes. The system they envision would make it possible to perform real-time guidance of biopsies and improve accuracy and sensitivity in diagnosing early-stage cancers of the gastrointestinal tract.

Fujimoto also receives NSF-ENG funding to address one of the key obstacles limiting widespread clinical and research applications of some advanced photonic imaging technologies: the lack of compact, low-cost ultrashort pulse lasers. He has developed a laser with record-low pump-power requirements, which will allow ultrashort pulse lasers to be built at 1/3 to 1/5 of their previous cost. Fujimoto’s technology is currently in clinical use at the New England Eye Center.



Supported by NSF-ENG, researchers at UCLA and MIT are developing a microscanning device that promises to enable ultrahigh-resolution, real-time internal body imaging (above, top) for improved cancer diagnosis (an “optical biopsy”) using a standard hospital endoscope (above).





Unprecedented, ultrahigh-resolution biophotonic images from the New England Eye Center show a normal human retina (left) and a diseased retina with a macular hole (right). New laser technologies developed by James Fujimoto of MIT will enable improved diagnosis and treatment of retinal disease. This high-resolution optical imaging technology could potentially be used for detection of early-stage skin cancers, oral cancers, and cancers in the lining of the digestive track.

"The systems approach promoted by NSF has become our modus operandi and has enabled us to push the field forward in a coordinated way that differs completely from the spot-by-spot approach of much research funding."

Bill Costerton, Director, Center for Biofilm Engineering, Montana State University–Bozeman

Imagine a future . . .

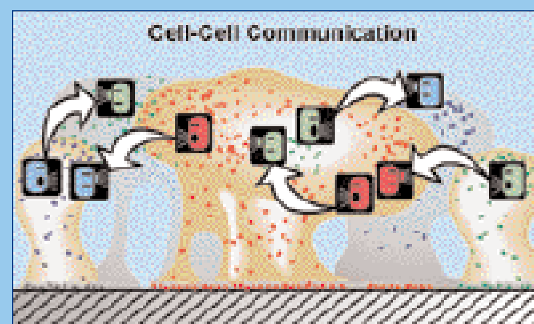
in which a brand-new class of antibiotics precisely targets and disrupts the ability of bacteria to form persistent, debilitating, treatment-resistant infections—from the ear infections that plague toddlers to chronic prostatitis and infections that complicate replacement of hips and heart valves in their grandparents.

Most bacterial infections that make us sick enough to visit the doctor are caused by organisms growing in biofilms—slimy layers of bacteria and glue-like substances. Yet, today's arsenal of antibiotics is less effective against bacteria in biofilms than the free-floating bacterial infections (such as typhoid) they were designed to attack.

The Center for Biofilm Engineering (CBE) at Montana State University–Bozeman is investigating the basic structure and function of biofilms to engineer solutions to biofilm-related problems. For instance, CBE researchers deciphered the hormone-like signals that bacteria exchange to coordinate their roles in biofilm formation—knowledge that is now guiding the search for hormone blockers to stop the formation of biofilms before they take hold. Two such drugs are expected to reach the marketplace within the next two years.

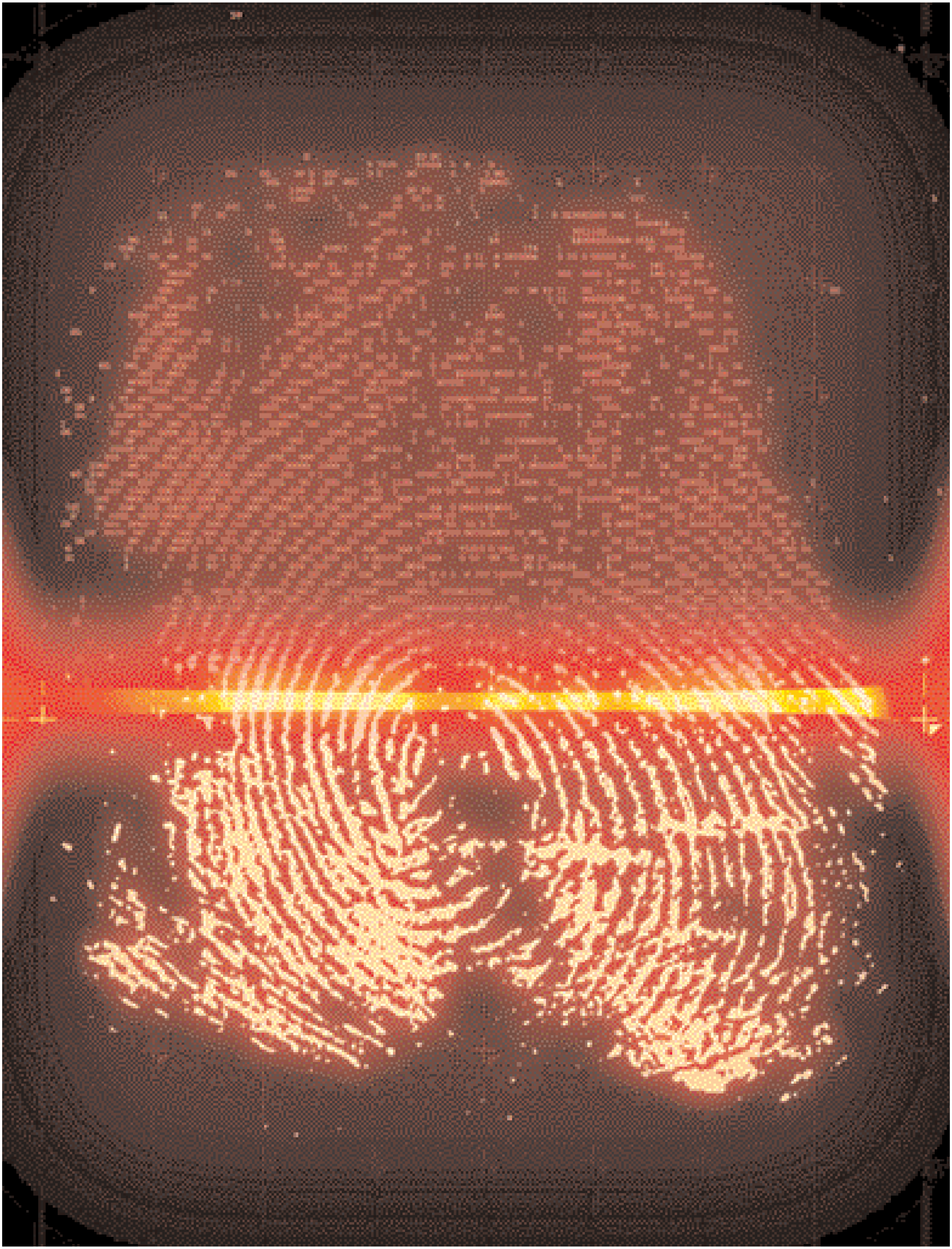
More recently, CBE scientists have found major differences in gene expression between bacteria in biofilms and free-floating bacteria. This fundamental breakthrough provides additional clues in the search for brand-new antibiotics that will be more effective in preventing and treating biofilm-based bacterial infections.

NSF-ENG provided major funding to launch CBE and support its first 11 years of revolutionary research. The Center is now financially independent of NSF and is supported through partnerships with 26 industrial companies, including several major biomedical companies.



This highly simplified drawing illustrates breakthrough findings from research supported by NSF-ENG on how bacteria in biofilms are organized for survival and resistance to current-generation antibiotics. Talking and listening heads and arrows represent mechanisms by which microbes from different colonies and even different species (shown in red, blue, and green) are able to coordinate their activity, including resistance to drugs, in a densely packed environment of slimy biofilm (shown as mushroom-like blobs).

Scanning electron micrograph of slime-enclosed bacteria in a biofilm on the surface of an infected tissue.



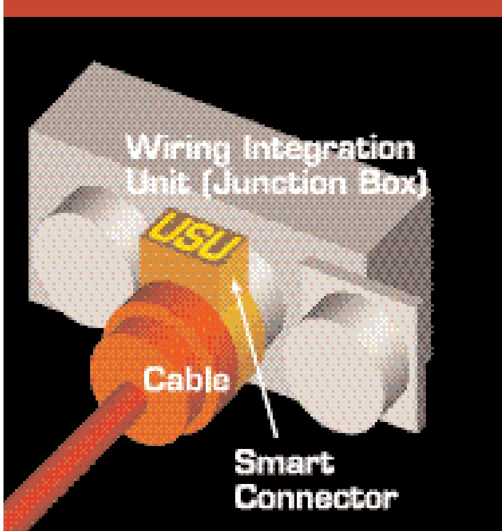
Engineering Better Security & Safety

NSF support for Engineering Better Security & Safety includes

- Developing tools and methods to enhance the structural integrity of buildings, infrastructure, and lifeline systems in case of earthquakes, bombings, and other natural and manmade disasters
- Designing devices and approaches to facilitate rapid response to emergencies, such as robots that explore and shore up collapsed buildings and new technologies to limit cascading failures in electric power networks
- Developing devices and systems to detect biological and chemical threats, such as "labs on a computer chip," or threats to critical equipment and infrastructure, such as sensors to detect faulty wiring in airplanes

Imagine the airplane of the future . . .

with "smart wiring" systems that tell pilots and mechanics when old, brittle, fraying wires need to be replaced and the precise location of the trouble spot, before fires occur—making flying safer and saving hundreds of millions of dollars in aircraft maintenance costs.



This "smart connector," created with support from NSF-ENG, will enable pilots to run a safety check of airplane wiring just before takeoff and to monitor wiring continuously during flight.

Cynthia Furse of the University of Utah is solving one of the airline industry's most serious safety problems: faulty wiring.

Airplanes are now flying twice as long as the anticipated life span when they were originally designed and built. While most aircraft components are replaced over time, wiring is not, because it's generally inaccessible and thus too difficult and expensive to replace.

Existing technologies for detecting wiring faults provide only a partial solution, since they can't specify a precise location for the fault and can't function while the plane is flying, creating costly delays in which aircraft sit idle while technicians work for hours or days to locate and repair problems.

With support from NSF-ENG, Furse and her team have created a "smart connector"—a computer sensor and electrodes that combine to form an automated testing system that eventually will be embedded inside aircraft wiring systems. To be commercially viable, smart connectors will have to be inexpensive and light, since a commercial jet will contain 800 to 1,500 of them.

Furse predicts that handheld testers for the system will be ready for the commercial market by 2005, and a fully embedded version could be ready within one or two years after that.

Engineering Better Security & Safety

Imagine a future . . .

in which advanced digital technologies and high-mobility platforms provide a virtual reconnaissance team with unprecedented real-time information for directing recovery efforts following earthquakes, hurricanes, tornadoes, and other natural and manmade disasters.

Supported by NSF-ENG, Georgia Tech's David Frost has created PQuake, a Palm Pilot–based system for collecting infrastructure and subsurface information following earthquakes. The system uses a digital camera, handheld global positioning system (GPS) receiver, digital voice recorder, and custom software written for the Palm Pilot to directly input damage information to an electronic database.

Field-tested during a post-earthquake mission to Gujarat, India, PQuake was also used to gather information on structural and nonstructural damage to buildings in the vicinity of the World Trade Center in September 2001.

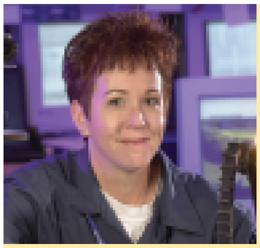
With advancing technology, Frost envisions future applications using several high-mobility vehicles such as Humvees to access the affected disaster zone. Each vehicle would collect data from teams of PQuake-equipped field workers and transmit the data back to a home base/telecommunications studio, where a virtual reconnaissance team would make decisions based on real-time data and simulations of structural response.

The system might also incorporate data from other technologies now in development with support from NSF-ENG, including aerial laser mapping (which provides a 3-D representation of the ground surface and structures on top of it, complementing the flat 2-D maps now used with PQuake) and rescue robots (deployed to strategically place and inflate air bags to shore up collapsed areas of buildings).

"I have always appreciated NSF's peer-reviewed funding approach and the flexibility and challenge it offers to explore the broader impacts of my research."

David Frost, Professor of Civil and Environmental Engineering, Georgia Institute of Technology

Georgia Tech engineering students use the PQuake system to assess damage to buildings surrounding the site of the September 11th terrorist attacks on the World Trade Center.



"At the World Trade Center, the rescuers would say, 'Robots for search are nice, but can they help with shoring and extrication?' With our grant from NSF-ENG, we were able to start researching the answer immediately."

Robin Murphy, Professor of Computer Science and Engineering, University of South Florida, and Director, Center for Robot-Assisted Search and Rescue

Imagine the robots of the future . . .

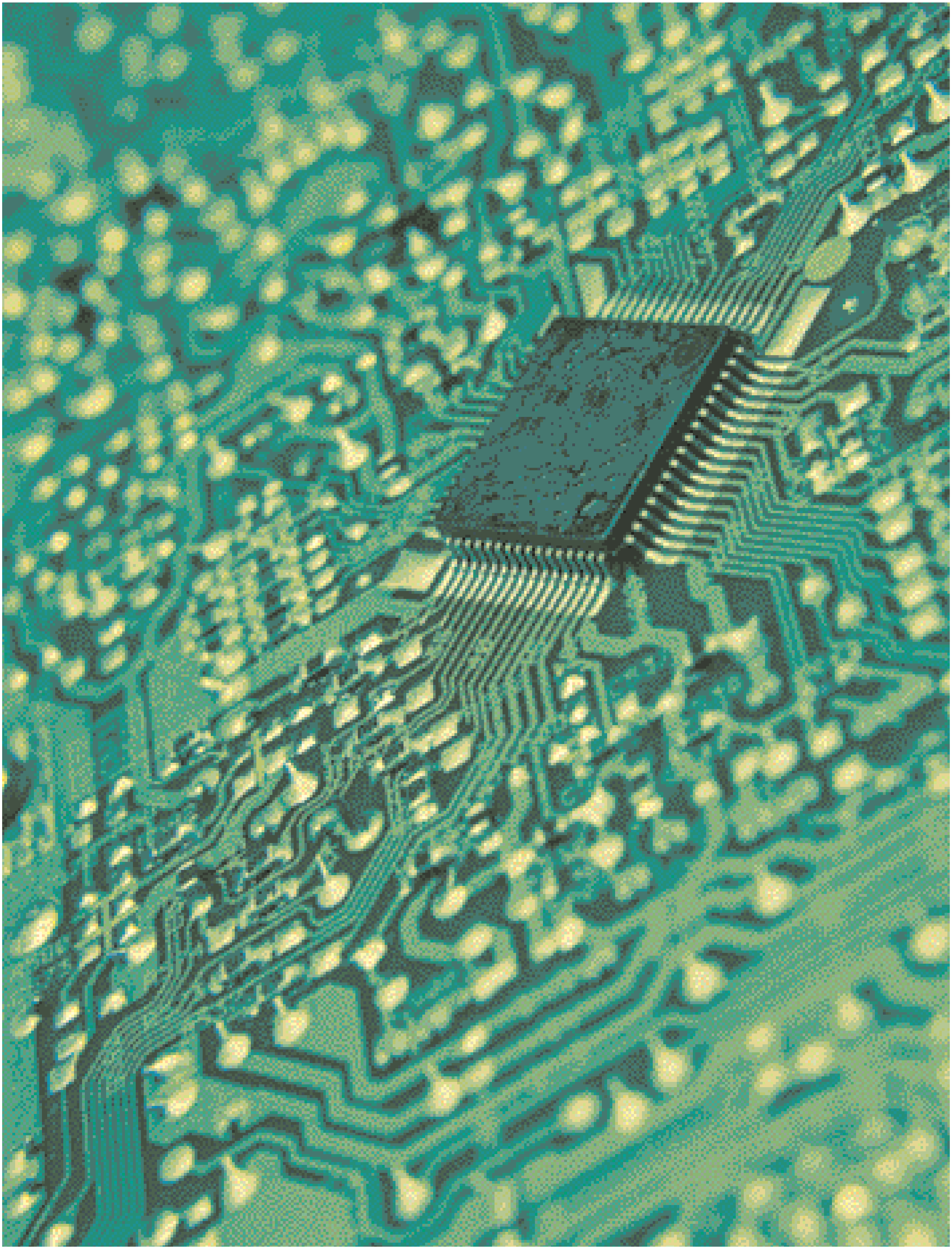
intrepid search-and-rescue specialists that crawl into small, dangerous crevices that no human or animal can penetrate—to locate victims and deploy air bags to shore up collapsed buildings.

Robin Murphy and her team at the University of South Florida's Center for Robot-Assisted Search and Rescue (CRASAR) are working to develop and deploy small, inexpensive search-and-rescue robots for release in the immediate aftermath of a disaster, when conditions are too dangerous for human and canine rescuers to begin searching for victims.

In September 2001, Murphy's shoebox-size, camera-carrying robots were used to find victim remains in the rubble of the collapsed World Trade Center buildings. With NSF-ENG support, Murphy's group is now exploring the use of robots for so-called adaptive shoring, in which teams of small robots strategically place and inflate air bags within a collapsed building and then work together to automatically adjust the shoring as rubble shifts or is removed.

Murphy believes that within a few short years, all 28 national Federal Emergency Management Agency (FEMA) teams can be equipped with and trained to use sophisticated robotic rescuers. These robots would provide their operators with important information for triage and help determine where digging and extrication efforts should be focused.

Field test of search-and-rescue robots.



Engineering a Better Economy

NSF support for Engineering a Better Economy includes

- Developing fundamental new technologies for long-term economic growth, such as technologies to enable ultrafast computers and ultrasmall, nanoscale manufacturing
- Designing practical, cost-effective, environmentally friendly manufacturing and energy technologies, such as hydrogen fuel cells and industrial processes that avoid the use of toxic solvents
- Developing advanced, flexible manufacturing techniques, such as rapid fabrication and prototyping technologies

Imagine the computer chip factory of the future . . .

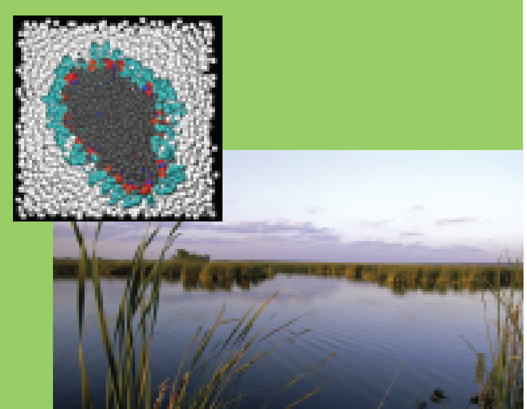
where "dry" industrial processes avoid millions of tons of wastewater, virtually eliminate the use of environment- and health-damaging chemical solvents, reduce chip defects, and substantially lower construction costs.

Joseph M. DeSimone of the University of North Carolina–Chapel Hill and North Carolina State University and his colleagues at the NSF Science and Technology Center for Environmentally Responsible Solvents and Processes are developing innovative manufacturing methods that save money as well as reduce pollution.

Based on the use of liquid and supercritical carbon dioxide (CO_2) as a cleaning agent and reaction medium, the technology eliminates the large streams of wastewater and airborne emissions created by conventional processes.

The new technology is already being used in a new chain of dry-cleaning stores called "Hangers," where liquid CO_2 replaces the volatile organic solvent perchloroethylene, a known contaminant of groundwater. In addition, DuPont has adopted the technology in a new $40 million Teflon manufacturing facility, which unlike plants using the conventional water-based process, does not use a pollutant known as C8.

Micell Technologies, a private company co-founded by DeSimone, is now targeting the cleaning process for wafers and chips in the microelectronics sector as the next important industrial application of the new technology. Processes involving CO_2 could be especially important in cleaning components with fragile nanostructures, which would collapse under the high surface tension of water (liquid CO_2 has virtually no surface tension and the surface tension of supercritical CO_2 is zero by definition). Because of the enclosed nature of CO_2–based processes, new computer chip manufacturing plants using this technology may have less need for "clean rooms" and thus be less costly to build than those featuring conventional cleaning technologies.



Developed with NSF support, an innovative system of carbon dioxide–based dry-cleaning agents avoids the use of toxic solvents that can pollute water resources. The inset photo shows a computer-simulated variation on the cleaning agent's molecular structure, with carbon dioxide molecules appearing in white and modified forms of the surface-active molecules shown in red and teal.

Engineering a Better Economy

Imagine a future . . .

in which "3-D fax machines" lead a revolution in faster, flexible, low-cost manufacturing, "printing out" complex objects ranging from aircraft parts to biomedical devices.

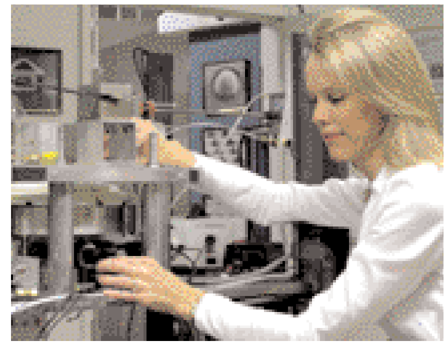
Long-term support from NSF-ENG for improved manufacturing processes is now paying dividends, as several flexible manufacturing technologies are emerging from the research-and-development pipeline into real-world industrial applications. These processes form the core of new manufacturing strategies that can produce dramatic time and cost savings for businesses.

Two such technologies are 3-D printing, developed by Emanuel Sachs and colleagues at the Massachusetts Institute of Technology, and high-speed, droplet-based manufacturing, developed by Melissa Orme of the University of California–Irvine. Both processes rest on the realization that an object of any shape can be created by stacking very thin layers, usually about the thickness of a human hair.

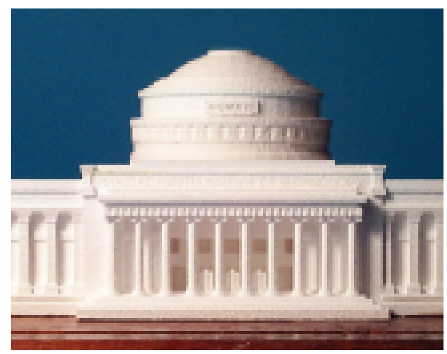
With these technologies and computer-design software, a designer can push a button and "print out" a 3-D version of a functional part or tool. The "printed" object can be different every time, much as ink jet printers can be used with desktop publishing software to quickly and cheaply create various kinds of documents. These rapid fabrication techniques can cut the interval from designer's concept to testing of a finished component from six months to as little as one hour and eliminate the costliest steps involved in developing new products.

Professor Sachs's 3-D printing process is already revolutionizing the world of industrial design and prototyping. It involves spreading thin layers of powder, which are selectively joined by a binder material. The process can be used to make objects (for prototyping or actual use) of virtually any powdered substance and has been licensed for use in diverse fields, including metal parts and tooling, industrial filters, biomedical devices, and computer-assisted design.

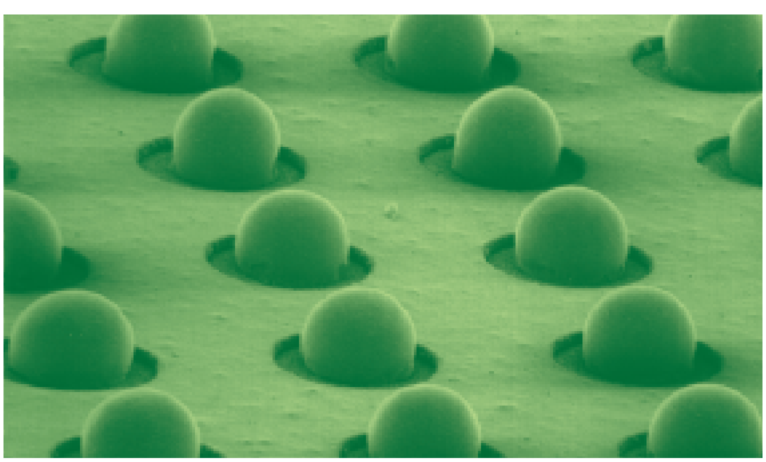
Professor Orme's process uses streams of molten metal generated at rates of up to 40,000 droplets per second. These droplets are steered by electric fields to precise locations in the finished part. The technology has attracted industry partners interested in applications ranging from aircraft parts to computer processors.



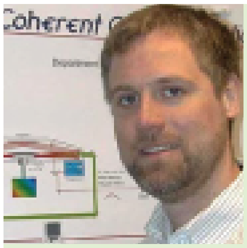
Melissa Orme of the University of California–Irvine with her "3-D fax machine."



Model of MIT made by 3-D printing, a fabrication technique that builds parts layer by layer. An ink jet printer delivers a binder that selectively joins a powdered material that makes up each layer. About six inches long, the model was made from alumina powder with a binder of colloidal silica.



High-speed, droplet-based techniques were used to fabricate arrays of miniature metallic bumps, which use minimal space to make electrical connections between electronic components, an important aspect of continued miniaturization in the microelectronics industry.



"The people at NSF saw the potential of this work early on and helped us get the program going. They've provided long-term support for ideas that had no guarantee of paying off. And our laser work is now used in hundreds of labs worldwide."

Henry Kapteyn, Department of Physics, University of Colorado, and Fellow of JILA, a research center operated jointly by the University of Colorado and the National Institute of Standards and Technology

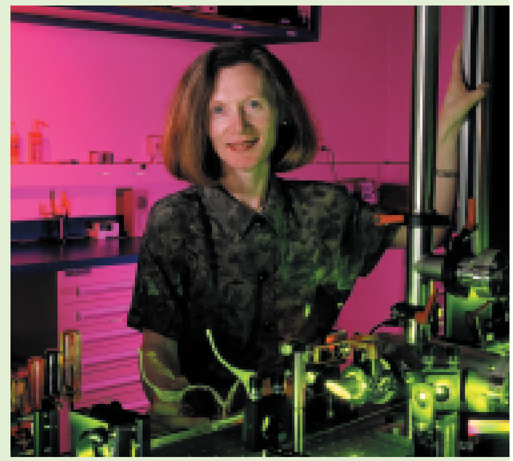
Imagine a future . . .

in which computers run 20 times faster and the most precise microscopes ever created allow researchers to view real-time movies of the complex dance of atoms in chemical reactions, catalysts, or living cells.

Researchers Henry Kapteyn and Margaret Murnane of the University of Colorado are pioneers in the quest for speed. They build lasers that flash for ten quadrillionths of a second, the fastest things that humans have ever created.

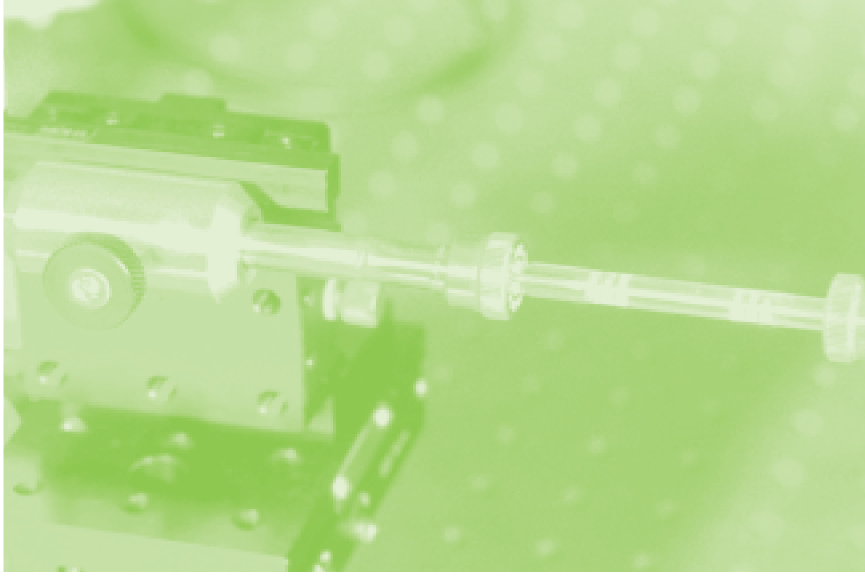
Using a device that could fit on a dining room table, Murnane and Kapteyn have developed a laser-like beam of light at extreme ultraviolet (EUV) wavelengths (10–100 times shorter than visible light) that pulses in ultrashort bursts, enabling researchers to "see" tiny features and to measure the fastest reactions in the microscopic world. This capability will help bring down a major hurdle to developing components for ultrafast next-generation computers and ultrasmall nanoscale machines.

The system devised by Kapteyn and Murnane for converting visible laser light into EUV wavelengths is the first small-scale laser-like source to cover this entire wavelength region. It also produces a tightly focused EUV beam that is difficult to achieve using pre-existing laser technology. The new technology could have a profound impact on science and technology for years to come, with applications ranging widely from basic research on the behavior of molecules to engineering of manufacturing and biotechnology systems.



Margaret Murnane and the EUV light source she developed with Henry Kapteyn.

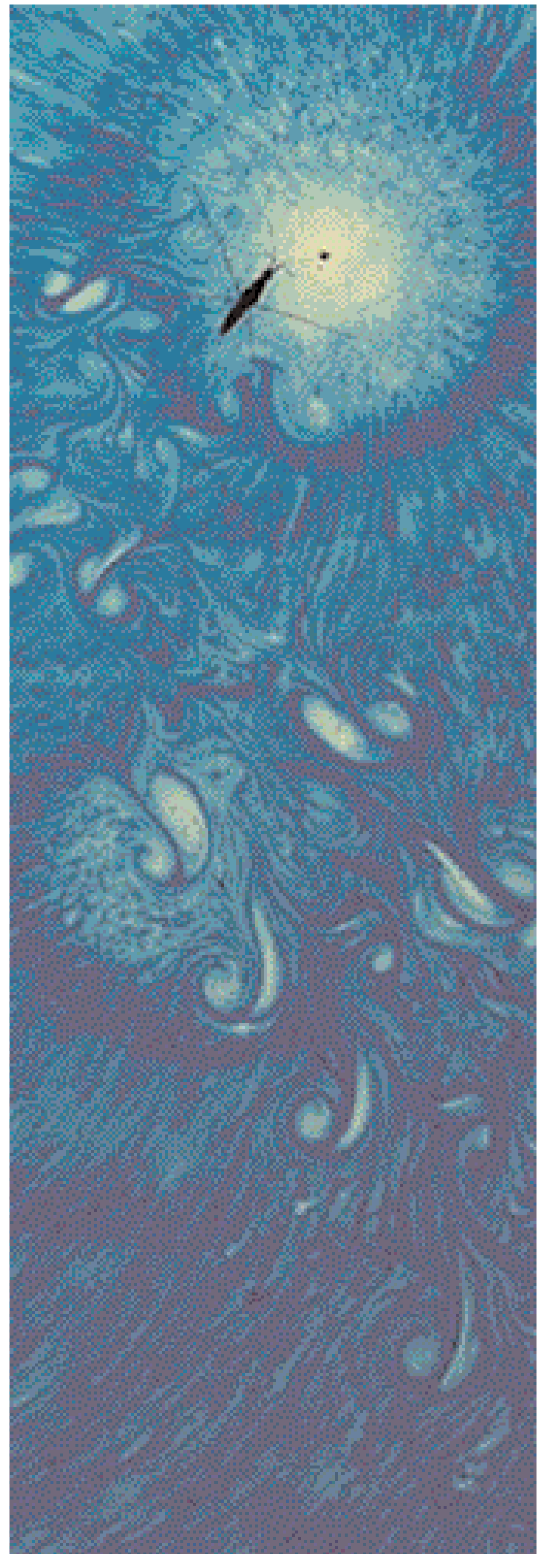
Sharply focused, laser-like beams of EUV light can be used to "see" tiny objects, with many applications in such fields as microscopy, lithography, and nanotechnology.

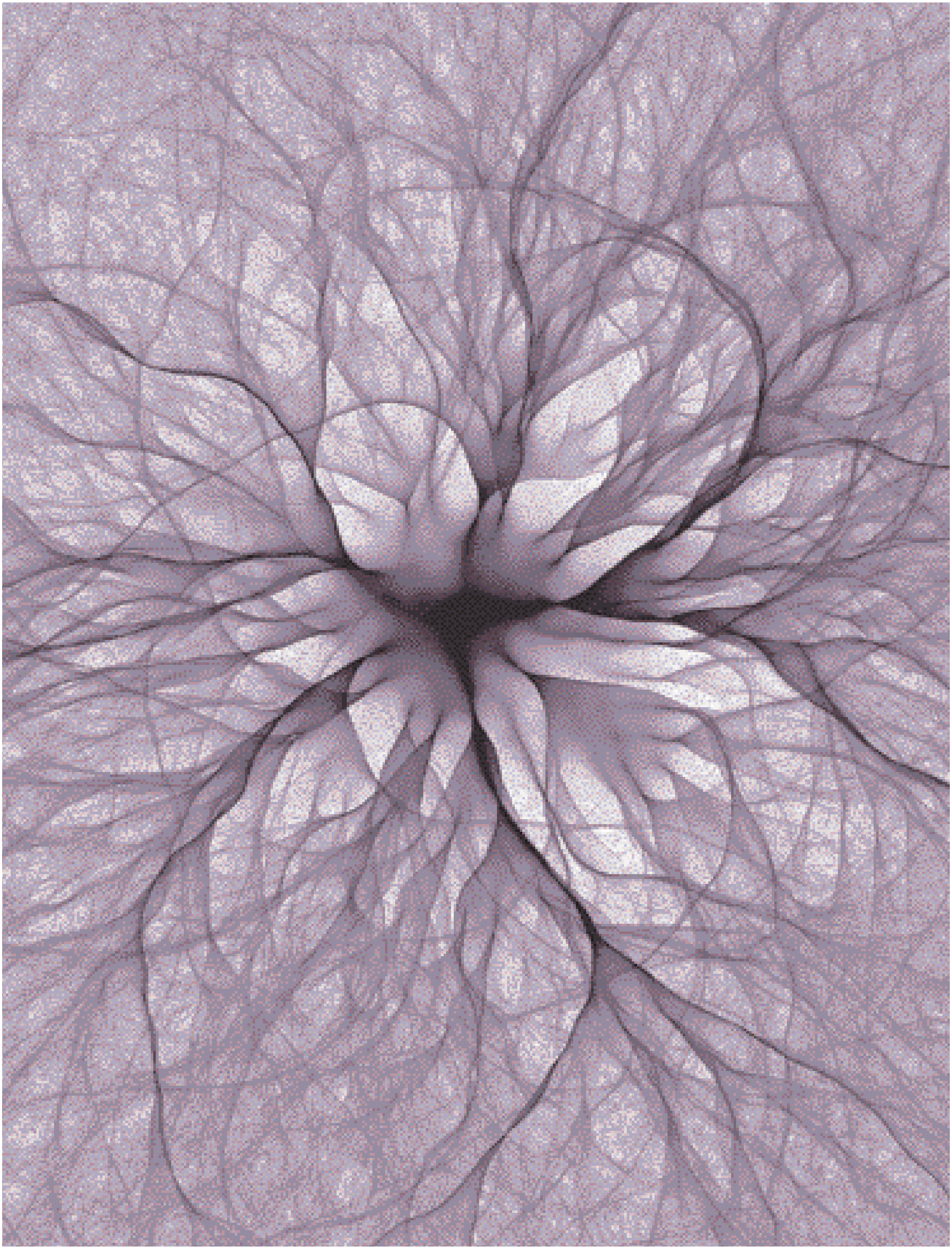


The Scales of Engineering Research

Engineers work at many different scales—from the infinitesimally small world of the nanometer (one billionth of a meter) and the femtosecond (one quadrillionth of a second) to the familiar world of inches, feet, and miles, to the vast expanses of extragalactic space. Some engineering research focuses on the built environment we see around us, using new, high-tech approaches to study age-old problems, such as how bridges and buildings respond to earthquakes, high winds, and other strong forces. Increasingly, however, engineering research ventures into brave new worlds of the very large and the very small.

These images depict the spectrum of modern engineering research—from studies of branched electron flow in almost two-dimensional space (far right) to fluid dynamic studies of how insects generate thrust to propel themselves across water (immediate right) to the design of advanced telescope systems that bring into view the far reaches of the universe (below).





Nanotechnology: At the Frontiers of Engineering Research

Imagine a future . . .
in which new materials and devices are custom-designed at the molecular scale ("nanoengineered") to create high-performance products, eradicate illnesses through subcellular control, and extend the limits of sustainable development through new approaches for water filtration, energy transformation and storage, and novel agricultural systems.

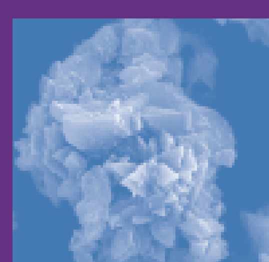
One of the most exciting topics in modern engineering research, nanotechnology gives us the ability to measure, control, and manipulate matter at the molecular level to create materials and devices with fundamentally new properties and functions. The systematic control of matter at the nanoscale has the potential to yield revolutionary technologies for electronics, medicine, aeronautics, the environment, manufacturing, and homeland security. Because nanotechnology is expected to bring profound economic and social impacts over the coming decade, leadership in nanotechnology development will be crucial to future U.S. competitiveness in the global economy.

NSF plays a critical role in U.S. efforts to advance nanoscale science and engineering. The agency launched the National Nanotechnology Initiative and provides the largest contribution to this interagency effort, with primary responsibility for investments in fundamental research, education, and provision of research infrastructure. Within NSF, the Directorate for Engineering has lead responsibility for nanotechnology.

NSF-ENG supports a wide range of nanotechnology research, including efforts to develop near-term commercial applications through the Small Business Innovation Research Program (SBIR). For example, NanoScale Materials, Inc. has received SBIR support to devise commercial-scale methods for manufacturing NanoActive™ materials, a technology emerging from the Kansas State University lab of Kenneth Klabunde.

These advanced nanocrystalline materials have enhanced surface area and chemical reactivity, which gives them unparalleled ability to capture and neutralize a wide range of toxic chemicals as well as the capacity to destroy chemical warfare agents. The company recently introduced FAST-ACT™ (First Applied Sorbent Treatment Against Chemical Threats), a family of products designed to expand the capabilities of first responders, hazmat teams, and other emergency personnel in their efforts to counteract and clean up chemical hazards.

NSF-supported researchers Arun Majumdar and Peidong Yang of the University of California at Berkeley are using nanoscale engineering techniques to revive the decades-long, once elusive search for a material that is both superinsulating for heat and a strong conductor of electricity. They have developed a composite material featuring silicon-germanium nanowires embedded in plastic tape, which is attracting global interest for its potential role in enabling flexible, off-grid electric power generation using any available fuel.



Scanning electron micrograph of NanoActive™ Magnesium Oxide Plus. The large surface area of NanoActive™ materials gives them the ability to capture and destroy toxic chemicals. Just 25 grams of the material (a little less than 1 ounce) has the surface area of nearly three NFL football fields.

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