SCIENTIFIC AMERICAN 50

A MICROSCOPE THAT CAN SEE objects smaller than an atom.

The first field test of a fleet of electric vehicles powered by fuel cells. A tariff to limit vehicular traffic in central London. These are but a few of the path-breaking developments that have taken place in recent months in laboratories, corporate suites and the halls of government. For the second year, the SCIENTIFIC AMERICAN 50 recognizes the singular accomplishments of those who have contributed to the advancement of technology in the realms of science, engineering, commerce and public policy. This year's selections by the Board of Editors pay tribute to individuals, teams and companies that have stood out in a wide variety of technological disciplines. It also honors Leaders of the Year for achievements in research, business and policy. Their work again demonstrates the ingenuity and resourcefulness that generate the ever more sophisticated tools and solutions for meeting society's needs.

AEROSPACE

AGRICULTURE

AUTOMOTIVE

CHEMICALS & MATERIALS

COMMUNICATIONS

COMPUTING

DEFENSE

ECONOMIC DEVELOPMENT

ENERGY

ENVIRONMENT

IMAGING

MANUFACTURING

MEDICAL PHYSIOLOGY

MEDICAL TREATMENT

NANOTECHNOLOGY & MOLECULAR ELECTRONICS

PRIVACY & SECURITY

PUBLIC HEALTH & EPIDEMIOLOGY

ROBOTICS

TOM DRAPER DESIGN

SCIENTIFIC AMERICAN

50

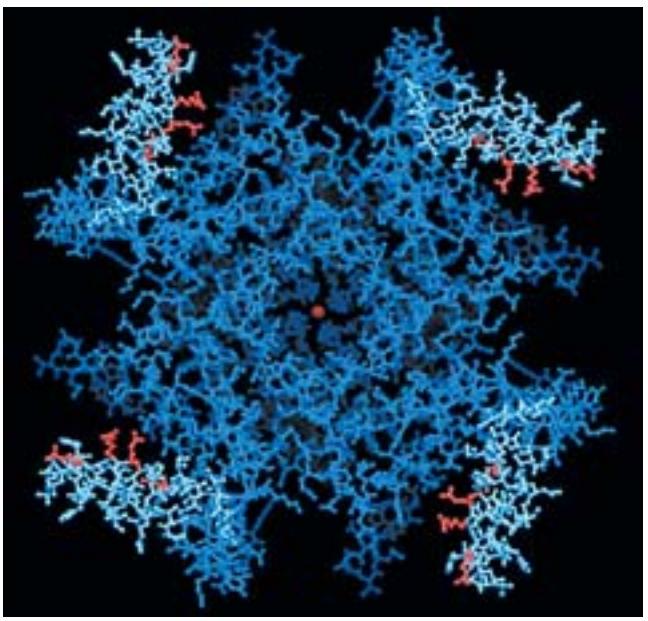
RESEARCH LEADER of the year

RODERICK MACKINNON

Professor of molecular neurobiology and biophysics, Rockefeller University; investigator, Howard Hughes Medical Institute

Elucidated the structure and function of ion channels, particularly the potassium ion channel.

THAT ELECTRICITY MIGHT ANIMATE mere flesh goes all the way back to *Frankenstein,* yet the mechanisms remained vague until Roderick MacKinnon, a physician, worked out the structure of the potassium channel. Then, this past spring, he deduced the mechanism by which a potassium channel senses electricity—its voltmeter, as it were. These achievements won him the 2003 Nobel chemistry prize.



Molecular snapshot reveals the working parts of the voltage-regulated potassium ion channel.

When a channel for any one of three inorganic ions—calcium, sodium or potassium—senses a voltage, it opens to allow ions in or out, changing the concentration and thus effecting a behavior, such as neural discharge, muscular contraction or hormone secretion. We could neither think nor move nor survive for many minutes without these channels, and MacKinnon's explanation of them should guide the development of drugs for neuromuscular and other disorders, such as cystic fibrosis and cardiac arrhythmias. Drug companies should show particular interest in the implications for arrhythmia, a common pharmaceutical side effect in numerous patients that has cost them billions in failed clinical trials.

The challenge here, as in the earlier research, lay in forming a crystal of the pore proteins that was good enough to diffract x-rays into patterns a computer could render into images. The task is hard because the proteins are very large and mixed in oils that must be removed with detergent, which is itself a problem. Furthermore, the volt-sensing element has moving parts that are buried deep inside the protein. Interestingly, MacKinnon studied the voltmeter in an Archaebacterium taken from a superhot ocean vent. That an organism so far removed in evolutionary history from us should have such similar channels indicates that the structures were highly resistant to mutation over eons and thus critical to survival.

PHOTOGRAPHS COURTESY OF THE ROCKEFELLER UNIVERSITY

Other Research Leaders

Aerospace

LARRY CORNMAN and ROBERT SHARMAN

Cornman, project scientist, and Sharman, project scientist, research applications program, National Center for Atmospheric Research, Boulder, Colo.

Discovered an algorithm that allows aircraft radar to better detect turbulence.

THE DOPPLER RADAR carried by commercial airplanes can pick up the strong winds close to the center of thunderstorms, where swirling water droplets are abundant and easy to detect. Building a clear picture of turbulence is a much more difficult problem, especially toward the edges of a storm. But with funding from NASA, physicist Larry Cornman and meteorologist Robert Sharman devised an algorithm to give radar the ability to detect turbulence accurately, even at a storm's fringes. After the first successful flight test of the algorithm in November 2002, Cornman began to work with the Federal Aviation Administration to figure out how to test and certify the improved radar in commercial systems.

Agriculture

JOANNE CHORY

Professor of plant molecular and cellular biology, Salk Institute for Biological Studies, San Diego; investigator, Howard Hughes Medical Institute

Pinpointed a gene that may allow shaded plants to grow more productively.

WHEN PLANTS GROW in the shade, they engage in the shade-avoidance response. First they grow longer stems (and therefore fewer leaves) in an effort to get out of the shade. If that fails, they produce flowers and seeds prematurely—a last-ditch effort to ensure survival of some offspring. In late 2002 Joanne Chory and a colleague identified a gene, *pft1*, that regulates this response. The results potentially have great significance. In agriculture, high density of plantings probably triggers shade avoidance to some degree in all the plants in a field, affecting how they grow and what proportions of stem, leaves and seed are produced. With an understanding of *pft1*'s role, it may be possible to develop plants that, even under shady conditions, still flower and seed late—increasing crop yield.

Shade-avoiding plant (*right*) grows a longer stem and fewer leaves than its ordinary neighbor (*above*).

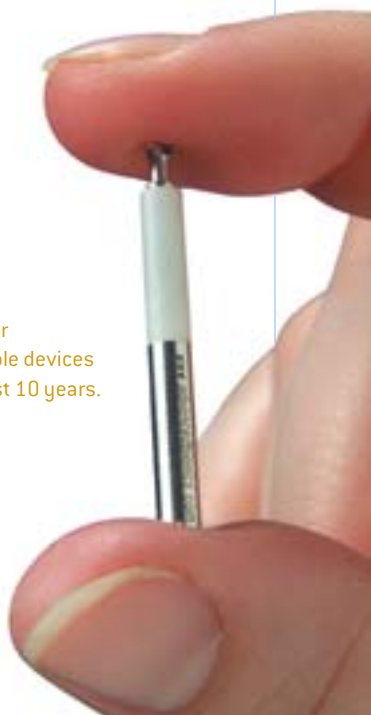
Automotive

KHALIL AMINE

Group leader, Battery Technology Development, Argonne National Laboratory, Argonne, Ill.

Made superior lithium-based batteries for hybrid vehicles and medical devices.

BORN IN MOROCCO and trained in France, Khalil Amine last year led a team of Argonne materials scientists that made notable achievements in the design of lithium batteries. To make batteries suitable for hybrid gasoline-electric vehicles, which require high peak power, they refined a lithium-manganese chemistry that is inherently safer than the alternative process, based on lithium and cobalt. The manganese crystal is also expected to last longer, avoiding the need for an expensive battery change during the life of the car. The researchers also improved a design based on lithium, iron and phosphate for implantable medical devices, where the sticking point is energy storage rather than peak power. Today's implantable batteries last only about three years, but Argonne's version is expected to last 10 years—long enough to make it practical for so-called microstimulators, which are being investigated as a treatment for Parkinson's disease and other disabilities of the central and peripheral nervous systems.



Battery for implantable devices should last 10 years.

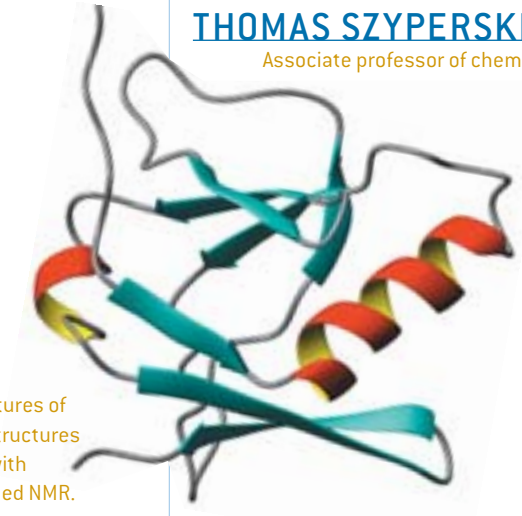
JORGE CASAL *University of Buenos Aires (top)*; ARGONNE NATIONAL LABORATORY (*bottom*)

Other Research Leaders

Chemicals and Materials

THOMAS SZYPERSKI

Associate professor of chemistry and biochemistry, State University of New York, Buffalo



Quick pictures of protein structures emerge with streamlined NMR.

Adapted nuclear magnetic resonance techniques to map a protein's atomic structure in hours, not days.

NUCLEAR MAGNETIC RESONANCE (NMR) is a laboratory technique that uses magnetic fields and radio-frequency pulses to identify and locate the atoms in molecules. As a way to analyze proteins, NMR has always taken a backseat to x-ray crystallography and other methods because it is slow: picking out the connections between individual atoms in a large protein involves going through the results from thousands of radio-frequency spectra, which can take up to a week. But in January, Thomas Szyperski published a paper in the *Journal of the American Chemical Society* describing G-matrix Fourier Transform NMR, a new method to collect data gleaned from radio-frequency pulses. The process reduced the time for protein mapping from days to just hours. Szyperski is the inventor of this technique, which improves the way NMR data are analyzed.

Communications

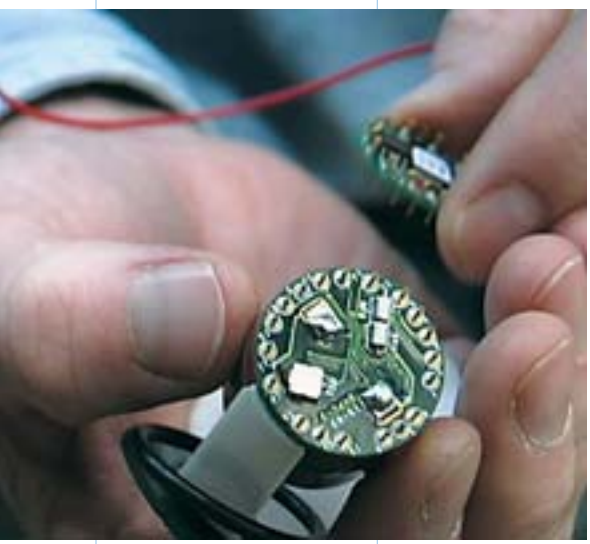
DAVID E. CULLER

Professor of computer science, University of California, Berkeley; former director of the Berkeley laboratory of Intel Research

Field-tested networks of sensors for military and environmental applications.

LAST YEAR David Culler and his colleagues began field-testing sensors that interconnect wirelessly in ad hoc networks that can describe their environment to a base station. Though dubbed "motes" by the Defense Advanced Research Projects Agency (DARPA), the sensors today are each still closer in size to a quarter than to a mote, and they cost several hundred dollars rather than small change. While reducing their size and cost, Culler and his group are trying out sample networks for tracking local stresses on the Golden Gate Bridge, the microenvironment in a redwood grove, the nesting areas of shorebirds and the rescue operations of firefighters. Because the information comes from many points, it can convey the dynamics of situations to firefighters who want, say, to determine whether a burning building is near collapse. And because the network is (or will be) cheap, it can be distributed through potential earthquake zones and battlefields, where the sensors can be consulted from a distance should the need arise.

Mini sensors can track light, temperature and humidity in a redwood grove.



Computing

ARMANDO FOX

Assistant professor of computer science, Stanford University

Showed how software could protect networks from disastrous crashes in individual servers.

COMPUTERS WILL always crash. For the average user, rebooting is a mere nuisance, but a network server crash can cost large businesses thousands of dollars. Armando Fox is a leader of a growing trend in the design of computer networks: the creation of systems designed to cope with inevitable failure. Fox and his team have developed a technique called micro-rebooting that allows the diverse software modules running on a computer at any given time to be restarted independently when a glitch is encountered. Thus, the entire suite of programs does not have to be shut down and restarted from scratch. Last year micro-rebooting was demonstrated successfully in a satellite ground station, the type of facility that often encounters failures [see "Self-Repairing Computers," by Armando Fox and David Patterson; Scientific American, June].

THOMAS SZYPERSKI (*top*); COURTESY OF UNIVERSITY OF CALIFORNIA, BERKELEY (*bottom*)

Defense

FRANK X. HURSEY

President, Z-Medica, Newington, Conn.

Developed a mineral sponge that stops blood loss on the battlefield and on the playground.

BADLY WOUNDED soldiers (like accident victims everywhere) are often at risk of bleeding to death before they can be treated, which is why blood loss is the primary cause of mortality from severe bleeding injuries. Frank Hursey's invention might change that. QuikClot is an inert granular substance that, when poured on a wound, concentrates the clotting factors in the outflowing blood and thereby speeds coagulation. Last year's approval of QuikClot by the U.S. Food and Drug Administration means a home version of the technology should be released in 2004. Hursey, a scientist who works on advanced oxygen-generating systems, discovered the properties of the QuikClot material by serendipity. Many years ago he cut himself while shaving. On a whim, he turned to an adsorptive agent that he had been developing for one of his research projects and applied it to his face. The bleeding stopped immediately.

Granules stem bleeding when poured on a wound.

Economic Development

RICHARD JEFFERSON

Chair, Center for the Application of Molecular Biology to International Agriculture, Canberra, Australia

Helps innovators in the Third World develop biotechnologies.

THE GREEN REVOLUTION—the steady increase in crop yields that started in the 1960s—is starting to bump up against limitations of land use, water supply, pest control and existing plant genetic variety. Biotechnology may be able to help, but so far it has pretty much passed the developing world by. Few have done more to change that than Richard Jefferson. Having made his name in the 1980s by creating a technique for probing protein synthesis, he has dedicated himself to ensuring that scientists and farmers in developing countries share the benefits. In 1991 he established CAMBIA, a nonprofit research institute whose mission is to make often proprietary technology more widely available. For example, CAMBIA is now putting together a do-it-yourself kit that lets start-up companies tinker with genes without having to confront battalions of intellectual-property lawyers.

Energy

JAMES A. DUMESIC

Professor of chemistry, University of Wisconsin–Madison

Pioneered economical catalysts for turning biomass into hydrogen fuel.

IF THE MUCH HERALDED hydrogen economy is ever to arrive, a cheap way to make hydrogen must be discovered. James Dumesic has developed catalytic methods that turn carbohydrates in biomass directly into hydrogen. The processes can operate at low temperature, in the liquid phase, saving a lot of energy compared with other approaches being researched. Last year Dumesic and his colleagues showed how the reaction could be mediated with a platinum catalyst; this year they did it with a far cheaper combination of nickel and tin. The main by-products are water and carbon dioxide. Although carbon dioxide is a greenhouse gas, the biomass grown for the next cycle of energy harvesting would absorb it all, so no net greenhouse gas would be produced.

Environment

DANIEL PAULY

Fisheries scientist, University of British Columbia

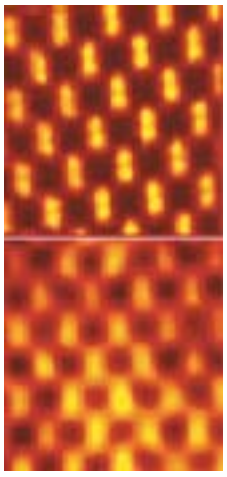
Advances the case for setting up marine reserves so that fisheries can make a comeback.

Marine reserves might combat overfishing.

FOR YEARS, Daniel Pauly has been carefully documenting the devastating effects of overfishing, particularly on large predator species such as cod, snapper and tuna [see "Counting the Last Fish," by Daniel Pauly and Reg Watson; Scientific American, July]. This year Pauly attempted to spread the alarm to the general public with his book *In a Perfect Ocean* (Island Press). An iconoclastic and erudite researcher, he argues that governments must abolish subsidies to fishing fleets and establish marine reserves to allow fisheries to recover. (Present marine reserves cover less than half of 1 percent of the total sea area.) Pauly spent much of his early career developing new methods for estimating fish populations. One of his latest projects is FishBase, an online database with information on more than 28,000 fish species.

COURTESY OF Z-MEDICA (*top*); SANDY HILL *AP Photo* (*bottom*)

Other Research Leaders



Correcting distortions (*top*) improves atomic-level imaging.

Imaging

PHILIP E. BATSON

Researcher, department of physical sciences, IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.

Demonstrated an electron microscope that can see objects smaller than an atom.

ASTRONOMERS MEASURE instabilities in the atmosphere and in the telescope itself, then use computers to manipulate the lenses, correcting for the distortions. Such "adaptive optics" have now been applied to a complex set of 40-odd magnetic corrective lenses in an electron microscope, allowing researchers to resolve features smaller than an angstrom, about the diameter of a hydrogen atom. Philip Batson, along with non-IBM scientists Ondrej Krivanek and Niklas Dellby, reported in the August 8, 2002, *Nature,* that the instrument leads to a qualitatively new understanding of the atomic-level behavior of nanometer-scale objects. These improvements in electron microscopy will allow routine observation of single-atom behavior within a bulk material.

Manufacturing

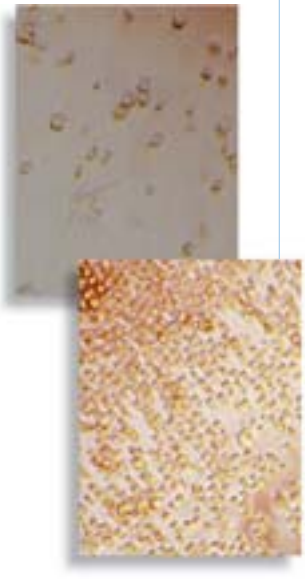
DAVID GRIER

Professor of physics, New York University

Built arrays of optical tweezers that may eventually power micromachines.

OPTICAL TWEEZERS, which use light to move semitransparent objects, date back to the mid-1980s. But arrays of tweezers, created by using holograms to separate light from a single laser into multiple beams, have recently shown promise as powerful tools for use in microscopic and nanoscopic machines. David Grier, a professor at the University of Chicago before moving this month, reported this past spring that holographic optical tweezers could twist light to spin vortices in a fluid. Such vortices can function as microscopic pumps: beads spun by the vortices can propel fluids around the microscopic channels of devices that may eventually be used in pharmaceutical manufacturing. One day they might even spin the gears on micromachines. Grier's work was the inspiration for Arryx, a company that has begun to commercialize holographic optical tweezer technology.

Addition of Wnt to blood-forming stem cells prompts proliferation (*bottom*).



Medical Physiology

ROEL NUSSE

Professor of developmental biology, Stanford University School of Medicine; investigator, Howard Hughes Medical Institute

Purified a molecule that may restore blood cells destroyed through chemotherapy.

IN AN ADVANCE that could benefit cancer patients, Roel Nusse and his colleagues announced last April that they had purified a powerful factor that prompts blood-forming stem cells to proliferate. The molecule, named Wnt, had eluded purification for years because it has a fatty "tag" that makes it stick to test tubes. Scientists are now evaluating Wnt's ability to restore blood cells that are destroyed during chemotherapy for cancer. Physicians might one day remove a sample of a patient's bone marrow, where stem cells for the blood system reside, expose them to Wnt in the laboratory to cause them to divide, and return the expanded population of cells to the patient as a treatment.

Medical Treatment

BAHIGE M. BAROUDY and CHRIS HITCHCOCK

Baroudy, director, department of antiviral therapy, Schering-Plough Research Institute, Kenilworth, N.J., and Hitchcock, senior director of exploratory development, Pfizer Global Research and Development, Sandwich, England

Created drugs that blocked a receptor to prevent HIV from entering cells.

HIV, THE VIRUS that causes AIDS, must bind to several receptor molecules to infect cells. One such receptor is called CCR5. People who have naturally occurring mutations in the receptor show some degree of resistance to HIV infection. Bahige Baroudy and Chris Hitchcock led teams at their respective pharmaceutical companies to formulate small-molecule drugs that can block CCR5, preventing HIV from entering cells and thereby halting its ability to reproduce and spread. Both companies' compounds entered clinical trials in human patients in the past year. Preliminary results suggest that the potential drugs have few side effects and are well tolerated by patients.

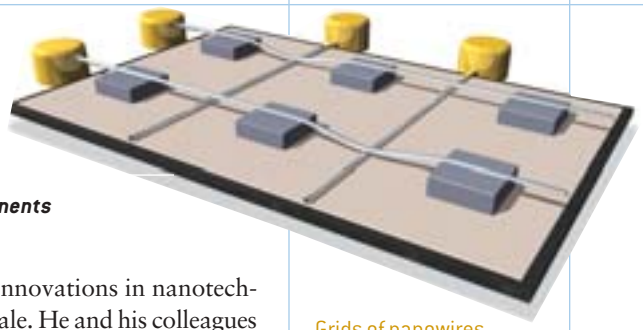
IBM RESEARCH (*top*); COURTESY OF REYA AND DUNCAN *Duke University* (*bottom*)

Nanotechnology and Molecular Electronics

CHARLES LIEBER

Professor of chemistry, Harvard University

Made nanowires, switches, sensors and lasers; fabricated electronic components and devices with features only billionths of a meter across.



Grids of nanowires may form circuits in future computers.

CHARLES LIEBER'S laboratory is responsible this year for several key innovations in nanotechnology, the controlled manipulation of matter at the atomic or molecular scale. He and his colleagues have achieved better control over nanowire growth, gaining the ability to build wires of differing lengths and thicknesses. In addition, the laboratory has made nano "on/off" switches that might be useful for digital memory storage. With such electronic controls, nanowire lasers could potentially be used to transmit information across a silicon chip, to etch microchips or to give laser surgery greater precision. In January, Lieber published a paper that described how a cadmium-sulfide nanowire could produce laser light from the ends. Last year saw the creation of a nanoscale biosensor, in which certain molecules (antigens) present in the bloodstream activate a nanowire transistor.

Privacy and Security

RAKESH AGRAWAL

Fellow, IBM Almaden Research Center, San Jose, Calif.

Devised methods to preserve the privacy of information in large databases.

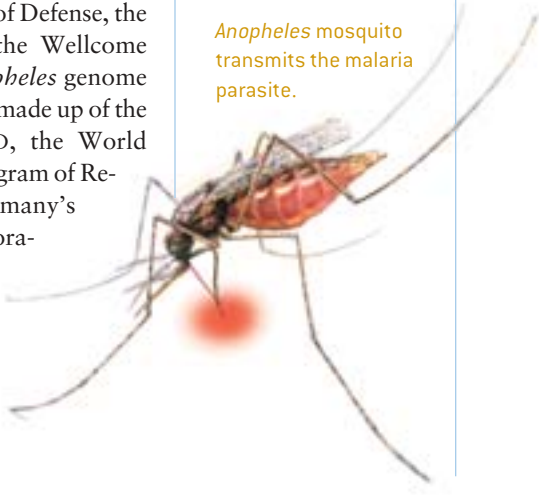
WE FORGET THINGS we do not need or want; perhaps databases must cull their memories in the same way to keep sensitive data from falling into the wrong hands. As a pioneer of data mining—the art of extracting useful patterns from masses of data—Rakesh Agrawal knew that this technology could take off only if privacy could be assured. Because the most important data are indeed sensitive—involving purchasing decisions, online searches, health records and the like—he sought ways to make misuse impossible once the information had been analyzed into a general trend. Recently he developed software that enables a computer to decide what to delete or, in less onerous cases, to quarantine data from all but the most privileged users. Another method he has investigated would safeguard one data point among many like it—say, an individual's age, as entered on a Web site form—by adding or subtracting a random number to it. The system would then aggregate all the data points and statistically reconstruct the overall distribution of ages with reasonable accuracy, while keeping each individual's age a secret.

Public Health and Epidemiology

THE MALARIA PARASITE/MOSQUITO GENOME PROJECTS

Unraveled the genetic information of the parasite that causes malaria and of the mosquito that spreads it.

MALARIA CONTINUES to be the most deadly disease in human history, slaying millions every year. Late in 2002 two international research consortia announced that they had sequenced the DNA for the malaria parasite *Plasmodium* and for the *Anopheles* mosquito, which transmits the parasite from person to person. The extraordinary potential of this achievement should accelerate the design of a vaccine and of drugs targeted to these organisms' genetic vulnerabilities. It will also encourge the development of environmentally sound methods to control mosquitoes. The sequencing of the *Plasmodium* genome was done by a partnership composed of the Institute for Genomic Research (TIGR), the U.S. National Institute of Allergy and Infectious Diseases (NIAID), the Wellcome Trust, the Burroughs Wellcome Fund, the U.S. Department of Defense, the Stanford Genome Center and the Wellcome Trust Sanger Institute. The *Anopheles* genome was sequenced by a collaboration made up of the Celera Genomics Group, NIAID, the World Health Organization's Special Program of Research on Tropical Diseases, Germany's European Molecular Biology Laboratory, the Institute of Molecular Biology and Biotechnology in Crete, the Pasteur Institute in Paris, TIGR, Genoscope (the French National Sequencing Center), and the universities of Iowa, Rome, Notre Dame and Texas A&M.



Anopheles mosquito transmits the malaria parasite.

SLIM FILMS (*top*); ROBERTO OSTI (*bottom*)

BUSINESS LEADER of the year

TOYOTA MOTOR CORPORATION

Toyota City, Japan

Commercialized affordable hybrid cars.

WHEREAS MOST OTHER automakers have merely talked of combining internal-combustion engines with electric motors, Toyota has actually been selling such a hybrid car for years. Called the Prius, it came out first in Japan in the late 1990s and soon after in the U.S. Toyota's 2004 Prius, due out in October, appears to get around the dismal engineering trade-offs associated with hybrids by improving performance and fuel economy over last year's model while keeping the price the same, around $20,000.

Prius, a hybrid vehicle from Toyota, saves fuel and cuts down on pollution by pairing a small engine with an electric motor.

Hybrid power plants do away with big engines and their extravagance with both fuel and pollution by substituting a small engine, to provide steady power, and an electric motor to assist it during acceleration. The strategy pays off best in stop-and-go city driving (which the Environmental Protection Agency test emphasizes strongly), when a big engine goes almost entirely to waste. Indeed, the Prius actually gets better mileage in the city than on the highway. Unlike the so-called mild hybrids, the Prius does not use the motor solely as an assist but is capable of cruising around on electricity alone.

The new model has been lengthened just enough to move it into the midsize category, giving it more legroom. It also has better acceleration. Yet according to preliminary estimates by the EPA, it now gets 59 miles per gallon in the city and 51 miles per gallon on the highway, up from 52 and 45 mpg, respectively, for the 2003 model. The Prius now goes about twice as far on a gallon of gasoline as the average car in the U.S. fleet; if all vehicles did that well, it would save the U.S. some 1.5 billion barrels of imported oil a year.

TOYOTA PRODUCT COMMUNICATIONS

Aerospace

BURT RUTAN

President, Scaled Composites, Mojave, Calif.

Designed a reusable suborbital passenger spacecraft.

SpaceShipOne, a passenger spacecraft, comes in for a landing.

BURT RUTAN first gained wide recognition when his twin-engine, polymer-composite Voyager airplane became, in 1986, the first aircraft to travel around the world nonstop. Rutan and his collaborators have completed more than 35 truly innovative manned and unmanned aircraft. In April his company, Scaled Composites, unveiled its entry to the X Prize, a privately funded contest established in 1996 that will award $10 million to the first firm that builds and flies a reusable suborbital passenger spacecraft. Scaled Composites's design, called SpaceShipOne, is similar to the U.S. Air Force's late-1950s X-15, which was launched from an airborne B-52. One of the most innovative qualities of the design forwarded by Rutan is a tail that flips up to brake through the air during reentry. (The company has not released any information regarding how much it would cost for someone to take a ride on the completed spacecraft.) Scaled Composites is one of the few companies that are taking an active role in privately funded space research.

Agriculture

FERNANDO DE CASTRO REINACH

General partner, Votorantim Ventures, São Paulo, Brazil

Started biotechnology companies that are trying to improve Brazilian crops.

AS A UNIVERSITY professor, Fernando de Castro Reinach has made a name for himself by initiating a project that in 2000 sequenced the genome of *Xylella fastidiosa,* a bacterium that destroys millions of dollars' worth of Brazilian citrus every year. That effort put Brazil on the international biotech map and produced a national cadre of highly trained scientists. In 2002 Reinach also took on the role of general partner at Votorantim Ventures, one of Brazil's largest venture capital funds. The fund has started up (among others) the companies Alellyx and Canavialis, both with Reinach as temporary CEO. This past spring Alellyx determined that a mutant of the tristeza virus was the cause of $20-million damage to Brazil's 2002 orange crop. Alellyx is now working on a laboratory test for detecting the disease and developing a genetically modified orange tree with resistance to the mutant strain. Canavialis, meanwhile, is laboring on disease-resistant sugar cane.

Automotive

DAIMLERCHRYSLER

Stuttgart, Germany

Pushed fuel-cell cars toward the commercial marketplace.

Oxygen goes in and mere water comes out of DaimlerChrysler's fuel bus.

SINCE THE MID-1990s, DaimlerChrysler has spearheaded a fuel-cell project. Recently the company began the first field test of a fleet of electric vehicles powered by the technology, which is essentially hydrolysis in reverse. About 30 such buses were distributed to a number of European cities this year; cars, based on the Mercedes-Benz A-Class, are to be tested in the U.S. by the end of this year. In fuel cells, ambient oxygen reacts with hydrogen (stored as compressed gas), producing mere water. They thus achieve the California-mandated goal of zero smog and zero greenhouse emissions. The first cars will serve as package delivery vehicles for UPS and will tank up at the EPA's office in Ann Arbor, Mich.

COURTESY OF SCALED COMPOSITES (*top*); MERCEDES-BENZ USA (*bottom*)

Other Business Leaders

Enzymes that break down the leaves and stalks of corn and other biomass products to create ethanol fuel may now be made more inexpensively.

Chemicals and Materials

NOVOZYMES

Bagsvaerd, Denmark

Launched a program to reduce by an order of magnitude the cost of enzymes for making ethanol.

"WHITE BIOTECHNOLOGY" involves finding natural organisms and compounds that can perform the work done today by petroleum-based chemicals. A major player in this arena is Novozymes, the world's largest producer of industrial enzymes. The company is just completing a successful three-year effort funded by the U.S. Department of Energy's biomass program to seek a 10-fold reduction in the cost of producing a critical enzyme blend for the making of ethanol from the leaves and stalks of corn. The blend is used to create sugar mixtures required in the production of clean, renewable biomaterials for industries such as chemicals and transportation fuels. Another company—Genencor—is independently pursuing the same research. An enzymatic process to produce these sugars offers the best prospects for making this approach competitive with petroleum-based fuels and chemicals. Before this breakthrough, enzymes were considered too expensive to be utilized for the conversion of cellulose to sugars. The teams used a variety of advanced biochemical, genetic and engineering technologies to enhance enzyme activities. Novozymes has also recently released other innovative enzymes for various industrial applications using a process it licenses called directed evolution, which introduces new combinations of genes and then screens for the best enzymes.

Communications

STEVEN JOBS

CEO, Apple Computer, Cupertino, Calif.

Started an online music service that serves as a model for the rest of the record industry.

TWO TECHNOLOGIES, the MPEG audio file format and decentralized file-sharing software, have made life difficult for the recording industry. Although a few companies launched pay-for-play online music stores this year, Apple's iTunes stood out from the pack for its simplicity and low cost (only 99 cents per song). It also received attention for its popularity: by September, more than 10 million songs had been purchased. Unlike some other services, it allowed downloading by the track and did not require a subscription fee. Originally, iTunes was open exclusively to Macintosh users; the company recently unveiled a Windows version of the service. Its chances for long-term success are still unknown, but Apple has at least made a stab at a workable approach to online music distribution.

iTunes stands out among music services for its simplicity and low cost.

COURTESY OF APPLE (*bottom*)

Computing

INTEL CORPORATION

Santa Clara, Calif.

Crafted possible solutions for Internet bottlenecks and constructed chip sets that make wireless networking easier.

THERE ARE MANY promising ideas that the Internet cannot try out by itself, either because it would bog down in a flood of data or lay itself open to malicious attacks. In June, to provide an independent test bed for those ideas, Intel formally launched PlanetLab, contributing the first 100 of a planned 1,000 computer nodes maintained by heavy Net users around the world, mostly universities. The project is already helping to monitor system usage, locate bottlenecks, and set traps for the propagators of viruses and worms. Meanwhile, to encourage consumer use of network services, Intel has launched its Centrino line of wireless products, which take advantage of the increasing number of Wi-Fi "hot spots," in places such as food courts and city squares. Centrino laptops contain a wireless communications card, a communications chip and a microprocessor all optimized to work together. To make portable Internet access more practical, the computers squeeze more processing power out of each watt, extending battery life—perhaps the single greatest impediment to mobility.

Defense

CEPHEID

Sunnyvale, Calif.

Enabled some post offices to track anthrax through use of biodetectors.

THE ANTHRAX ATTACKS in the fall of 2001 set off a scramble to find readily deployable technology for detecting biological weapons. Cepheid has become a leader in this emerging marketplace by making biodetectors that distinguish pathogens from benign microbes by analyzing their DNA. The company supplies its GeneXpert technology to Northrop Grumman, which received a $175-million contract from the U.S. Postal Service earlier this year to install technology in its facilities to detect anthrax. GeneXpert speeds the process of carrying out the polymerase chain reaction, which amplifies samples of DNA. The process, which usually takes several hours, can be completed within 30 minutes with the Cepheid device. After the anthrax attacks, the company bolstered revenues substantially by selling its products to the U.S. military and federal and state public health laboratories.

Identification of the anthrax bacterium (*above*) now takes place in minutes, not hours.

Energy

CHANGING WORLD TECHNOLOGIES

West Hempstead, N.Y.

Devised a method for turning solid waste into oil.

MOTHER EARTH learned long ago how to turn biomass into oil, but for those of us who cannot wait for eons while subterranean plates grind, heat and decompose dead plants, Changing World Technologies has evolved a plan. It runs a slurry of biomass through a pressure cooker to break down the longer polymers, then releases the material into a much lower pressure to boil off half the water. The oil in the remaining sludge can then be separated by centrifuge and cracked, just as with natural oil. The company has already demonstrated the process in a small plant in Philadelphia, and this past summer it opened a larger plant in Missouri that plans to convert 200 metric tons of offal from a nearby turkey processing plant into 10 tons of gas and 600 barrels of oil. Even if the idea contributes only a smidgen to our energy needs, it will certainly help get rid of burgeoning waste.

Fuel cell developed at Los Alamos could become a key component of zero-emission coal plants.

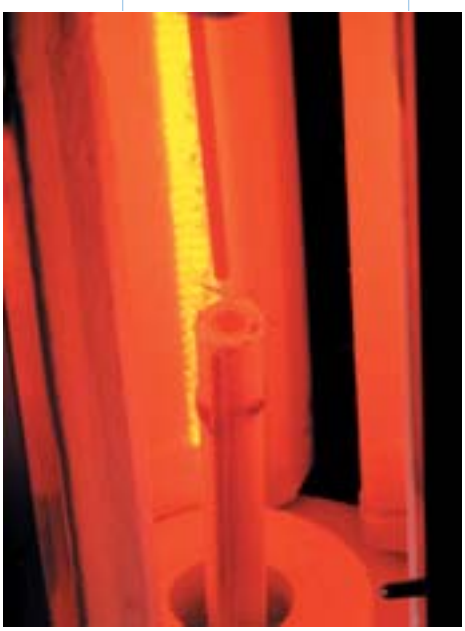
Environment

ZECA CORPORATION and LOS ALAMOS NATIONAL LABORATORY

Calgary, Canada, and Los Alamos, N.M.

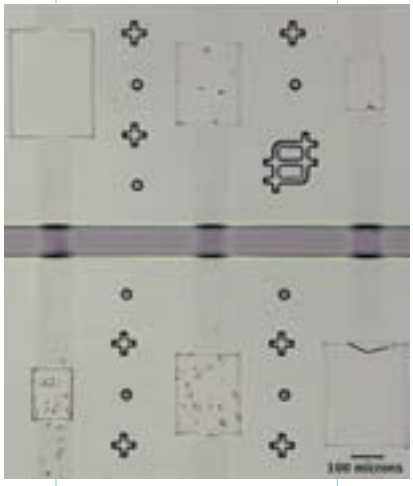
Commercialized a process to convert coal into hydrogen fuel.

NORTH AMERICA is blessed with vast seams of coal, but conventional coal-fired power plants release large amounts of the greenhouse gas carbon dioxide and other emissions into the atmosphere. In recent years, researchers at Los Alamos National Laboratory have been developing a zero-emission concept for power generation. The process would convert coal into methane, which would in turn be reformed into hydrogen and calcium carbonate. The hydrogen would go to a fuel cell to generate electricity while the calcium carbonate would be broken down to calcium oxide and carbon dioxide. The latter gas could be incorporated into a mineral (magnesium carbonate), then disposed underground. In essence, the carbon would return to the earth from which it was mined. The process is about 70 percent efficient, roughly twice that of current coal-fired plants. A consortium of energy companies and research institutes formed the Zero Emission Coal Alliance in 1999. The for-profit ZECA Corporation replaced the alliance in 2001 and is now working to design and construct a pilot plant.



JEFF JOHNSON (*top*); COURTESY OF LOS ALAMOS NATIONAL LABORATORY (*bottom*)

Protein crystals grow in wells of the Topaz Crystallizer chip.



Manufacturing

FLUIDIGM

South San Francisco, Calif.

Built microscopic channels, pumps and valves that will create the fluidic equivalent of microchips.

A START-UP co-founded by Stephen R. Quake, a young professor of biophysics from the California Institute of Technology, continues to distinguish itself as a leader in the emerging field of microfluidics. Fluidigm moved ahead during the past year with the release of the Topaz Crystallizer, a system that can very rapidly crystallize large numbers of proteins for the purpose of learning their structures. Moreover, the system can work with extremely small volumes of protein solutions, enabling many tests to be run in parallel. To build the microfluidic system, Quake used a novel lithography technique that constructs three-dimensional networks of microscopic channels, valves and reaction chambers. It creates these structures using a silicone-based rubber stamp. In September 2002 the company announced that it had employed a microfluidic valve technology, built using this so-called soft lithography method, to partition a sample into 20,000 polymerase chain reactions (gene amplifications), with the solution in each reaction holding less than a billionth of a liter.

Medical Treatment

GENENTECH

South San Francisco, Calif.

Developed the first commercial drug that stops blood vessel growth in tumors.

GENENTECH is poised to become the first company to make a commercial success of drugs to block angiogenesis, the formation of new blood vessels. To survive and spread, cancers must make yards of new vessels, called capillaries. Compounds that stifle the growth of new vessels were shown years ago to shrink tumors in animals, but supportive data in humans have been slow to appear. Genentech's angiogenesis inhibitor is bevacizumab, trademarked as Avastin. It is a monoclonal antibody—a specific molecule produced by the immune system—that targets a growth factor crucial to vessel formation. Last May the company announced that Avastin improved the survival of patients with metastatic colorectal cancer when administered along with traditional chemotherapy. Several large-scale clinical trials involving people with breast cancer and nonsmall-cell lung cancer are also in progress, and the drug has been granted fast-track status by the U.S. Food and Drug Administration.

Nanotechnology and Molecular Electronics

NANOSYS

Palo Alto, Calif.

Funded the development of nanotechnology.

Vials hold semiconductor nanocrystals for which Nanosys controls the intellectual-property rights.

NANOSYS spent 2003 snapping up proprietary rights to some of the year's key nanotechnology innovations, including nanowire lasers and nanocomposite solar-cell technology. By May the firm had secured an additional $38 million in funding, giving it a total of nearly $70 million to continue its buying spree. In June, Nanosys forged an exclusive licensing agreement with Yissum, the technology-transfer subsidiary of the Hebrew University of Jerusalem. Thanks to that arrangement, Nanosys now controls the patents for more than 120 basic nanocrystal materials and applications. These deals give the company the ability to commercialize a vast array of nanotechnology products. Improved solar cells, for example, could be on the market as early as 2006. Nanosys intends to bring these products to market through corporate partnerships in various industries.

COURTESY OF FLUIDIGM (*top*); COURTESY OF NANOSYS (*bottom*)

Privacy and Security

ANONYMIZER

San Diego, Calif.

Protected the anonymity of those offering tips about corporate malfeasance.

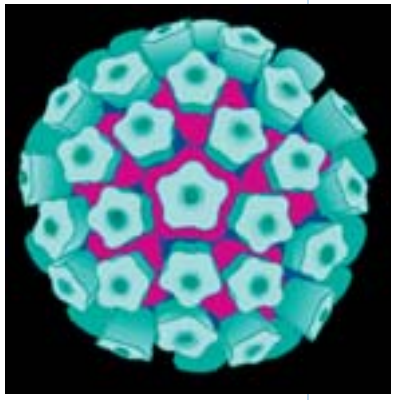
WITH THE PASSAGE of the Sarbanes-Oxley Act of 2002, companies are now required to refrain from an act of retribution against employees who blow the whistle on accounting practices they deem dubious. How to be seen to be in compliance with the law remains an open question, one to which an answer has been offered by the Internet security firm Anonymizer. In April the company launched SECtips.com, a Web-based service that any company can join. Member companies must provide their employees with a password that would enable them to submit tips from any computer without fear of identification. Despite the name of the site, the tips do not go directly to the Securities and Exchange Commission but rather to the company's own compliance officer. The compliance officers do not themselves enjoy anonymity; if they receive a tip and sit on it, they can assume that prosecutors will eventually find out.

Public Health and Epidemiology

MERCK RESEARCH LABORATORIES

West Point, Pa.

Created a vaccine that may help eliminate cervical cancer.



Human papillomavirus vaccine has the potential to combat the virus that accounts for almost all cervical tumors.

CERVICAL CANCER kills 250,000 women every year, more than any other type in developing countries. In November 2002 scientists at Merck Research Laboratories announced that they had developed a vaccine that protects women from viral infections caused by a strain of human papillomavirus (HPV-16) found in roughly half of all cervical tumors. The researchers made the vaccine by mass-producing one of two proteins that form a shell around the HPV-16 virus. The protein then elicits an immune reaction. To test the vaccine's effectiveness, a study at multiple research centers tracked 2,392 women, half of whom received the vaccine and half a placebo. In regular samples taken during the course of the study, none of the women receiving the vaccine tested positive for the virus, but 41 in the placebo group did.

Robotics

iROBOT

Burlington, Mass.

Introduced the first truly mass-market household robot.

Roomba robot vacuums the floor unaided.

FOR DECADES, technopundits have been predicting that robots would soon whiz into our daily lives: fetching the paper, cleaning the house and fixing dinner. If that vision is now starting to become a reality, it is in large measure thanks to iRobot. The company was founded in 1990 by three leading roboticists at the M.I.T. Artificial Intelligence Lab—among them the lab director, robotics pioneer Rodney Brooks. In the fall of 2002 the company introduced Roomba, the first mass-market household robot. Roomba will automatically vacuum and sweep a floor while avoiding obstacles. The breakthrough was not the technology per se—most of the components were available back in the 1980s—but the packaging into a useful, durable and affordable unit. Another iRobot product, a remote-controlled tanklike robot called PackBot, was deployed by U.S. forces in Afghanistan during 2002. There, and later in Iraq, PackBots inspected potential booby traps and ambush positions.

LINDA STANNARD *University of Cape Town (top)*; COURTESY OF iROBOT *(bottom)*

SCIENTIFIC AMERICAN 50

POLICY LEADER of the year

GRO HARLEM BRUNDTLAND

Former secretary general, World Health Organization

Coordinated a rapid global response to stem the SARS outbreaks.

WITH TYPICAL SCANDINAVIAN understatement, Gro Harlem Brundtland, then the secretary general of the World Health Organization, worked mainly undercover to meet the challenge of SARS. But she recognized the need to concentrate minds with decisive strokes and did so on three occasions last year. She issued the first global health alert ever, warned about travel to Toronto and other cities, and frankly criticized the Chinese government, which had suppressed news of the outbreak in Guangdong Province.

Children in Hong Kong have surgical masks put on in early April in the hopes of fending off SARS.

Quarantines, perhaps helped along by the simple changing of the seasons, contained the outbreak, and that is why the unprecedented toughness is now seen as fully justified. In any case, the old-fashioned containment measures have bought time for the molecular biologists to develop better diagnostic tests and the first vaccines. Furthermore, by setting the precedent of exerting pressure on influential member states (of which there are 192), Brundtland has made life easier for her successors if they should face similar situations. In all these actions, she worked together closely with David Heymann, director of the WHO's office of communicable diseases, and with the Centers for Disease Control and Prevention, whose director, Julie Gerberding, lent critical support. The CDC's Thomas Ksiazek led a team that quickly identified the coronavirus responsible for SARS.

Brundtland, a medical doctor, honed her political talents in a variety of senior governmental jobs in her native Norway before becoming its prime minister, a position she held for three terms. At WHO, she used those skills to raise the organization's profile and to cultivate support in the United Nations. By vigorous fund-raising, particularly among private foundations, she increased the WHO budget by about two thirds, to about $1 billion a year. The money goes to finish old projects, such as the eradication of polio, and the new ones she started, including bringing low-cost drugs to poor countries and improving the surveillance system for emerging diseases, such as SARS. Although Brundtland would very likely have sailed into a second term, she decided to retire, citing her age, which is 64.

PAUL HILTON *EPA Photo (top)*; ANAT GIVON *AP Photo (bottom)*

Aerospace

HAROLD W. GEHMAN, JR.

Chair, Columbia Accident Investigation Board

Distinguished himself for a hard-nosed approach to investigating the* Columbia *accident.

EARLY CRITICS of the board that NASA appointed to investigate the destruction of the space shuttle *Columbia* said the all-government panel would not be independent enough to uncover the underlying factors that led to the orbiter's breakup during reentry on February 1. The board's August 26 report may have forever silenced those doubters. The panel blamed the mishap not only on the damage to the left wing by a chunk of foam shortly after the launch but also on the institutional culture that allowed a preventable accident to occur. But even before the report was released, the chief investigator, Harold Gehman, had already stood out as someone who would not be constrained by the space agency. His leadership of the accident board may serve as a model for how to bring needed scrutiny to bear on an organization in crisis.

Agriculture

PAUL R. POLAK

President, International Development Enterprises, Lakewood, Colo.

Encouraged local markets to improve access to water for Third World farmers.

PAUL POLAK has pioneered an approach to poverty alleviation that has already markedly improved the lives of millions of people. By providing small land holders with access to affordable microirrigation technologies—such as low-cost drip irrigation—Polak aims to help more than 30 million rural farm families in the developing world rise out of poverty by 2015. He has been pursuing this goal by spearheading the Smallholder Irrigation Market Initiative (SIMI) of International Development Enterprises. SIMI, active in both Africa and Asia, operates not by providing handouts, which often do not produce sustainable change, but by encouraging participation of local markets in developing improvements in irrigation—a $100-an-acre drip-irrigation package in India, for instance. In the summer of 2002 SIMI Net was launched to compile and disseminate useful knowledge related to smallholder irrigation.

Low-cost drip irrigation delivers water to plant roots.

Automotive

KEN LIVINGSTONE

Mayor, London, England

Implemented tariffs to regulate city traffic.

ECONOMISTS HAVE LONG fretted about externalities—the exploitation of common resources by some people at the expense of others. Driving a car in a city and thereby clogging traffic offers a classic example of such an externality, one that can be balanced only by imposing a tax so unpopular that politicians never dared to try it on a large scale, until early this year, when London's mayor, Ken Livingstone, showed the necessary courage. The foray into such social-cost pricing has worked: now that drivers must pay a £5—nearly $8—fee, traffic jams are a third less common and the drivers themselves are happy with the trade-off. Livingstone's show of guts and leadership was widely questioned at first, and many commentators thought that he might forfeit his office because of it. Now it looks like he'll be getting another term—and mayors of other big cities, including those on this side of the Atlantic, are taking notice.

Charging fees for road use has unclogged the streets in central London, making traffic jams much less common.

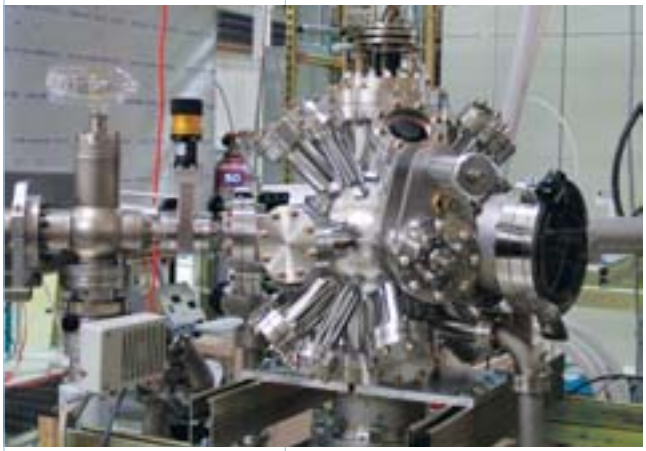
RICHARD T. NOWITZ *Corbis (top)*; RICHARD OLIVIER *Corbis (bottom)*

Other Policy Leaders

Chemicals and Materials

ANTHONY J. MUSCAT

Associate professor of chemical and environmental engineering, University of Arizona



Reactor vessel uses an environmentally friendly process to clean and build microelectronic devices.

Introduced environmentally friendly chipmaking technologies.

THE BEST INCENTIVE for the semiconductor industry to adopt environmentally friendly chipmaking technologies is if those same manufacturing methods also save piles of money. Last year Anthony Muscat and his team of researchers demonstrated techniques using supercritical carbon dioxide (in a pressurized state poised between liquid and gas) to clean the porous insulating material used in today's most advanced microchips. Supercritical carbon dioxide cleans better than the chemicals currently used. In addition, supercritical CO_2 can be acquired from the copious emissions from most heavy industries and is easily recycled. Muscat's group is also researching chemicals that can block out areas of a chip surface like masking tape around a painted wall, eliminating costly and polluting steps in the chip-etching process.

Communications

EDWARD FELTEN

Professor of computer science, Princeton University

Persistently criticized proposed digital TV standards.

CORPORATIONS INTENT on monopolizing the digital economy have come to fear Edward Felten, who has fought their claims with technical analysis sharpened by a sense of the ridiculous. When Microsoft, in its antitrust case, claimed that its browser could not be separated from its operating system, Felten separated them. When the Recording Industry Association of America unveiled a music-encryption technology, he found holes in it (and was almost sued for publishing the holes). Now he is fighting Hollywood's efforts to introduce legislation mandating privacy devices for all digital products, particularly digital television. In testimony before Congress, he pointed out that a would-be pirate could already videotape a movie for a few dollars rather than go the digital route, which would cost hundreds of dollars. His Web site posts comical examples of devices, such as toys, that a proposed law would digitally bind and gag.

Computing

HENRY CHESBROUGH

Visiting assistant professor, Institute of Management, Innovation and Organization, University of California, Berkeley

Advocated the abolition of the not-invented-here syndrome that afflicts many companies.

WHILE WORKING for disk-drive maker Quantum in the 1980s, Henry Chesbrough began to wonder why large corporations such as IBM and AT&T couldn't seem to reap the market benefits of the advanced technologies they created. The problem, he decided, was that these megacorporations were too insular: the companies used only concepts conceived in-house. Recently technological upheavals in computing and communications, often fostered in start-ups or university research centers, have made some of these companies realize that they no longer have a monopoly on ideas. In his influential book *Open Innovation: The New Imperative for Creating and Profiting from Technology,* published this year, Chesbrough suggests that the solution is to eliminate the boundaries that traditionally exist among businesses and universities. Although companies may share their research, what they gain in return may outweigh the cost of this sacrifice.

IBM Research has opened its doors to new ideas.

COURTESY OF ANTHONY J. MUSCAT (*top*); COURTESY OF IBM (*bottom*)

Defense

ARTHUR K. CEBROWSKI

Director, Office of Force Transformation, U.S. Department of Defense

Articulated the "network-centric" approach to warfare implemented during the Iraq conflict.

THE OUTSTANDING performance of U.S. military forces in this year's war in Iraq can be ascribed in large part to the remarkable coordination of action among all the participants. This radical approach to war fighting, which links units from multiple services electronically to permit rapid decision making on the battlefield, is known as network-centric warfare. Since 1995 Arthur Cebrowski has led the effort to develop and implement this information-based strategy within the Pentagon, where he is known informally as its transformation czar. Cebrowski is credited not only with best articulating and advancing the cause of network-centric warfare but also with laying much of the groundwork for this vision in his prior roles as director of command, control, communications and computers on the Joint Chiefs of Staff and as head of the Naval War College.

Linking units from multiple military services permits rapid decision making on the battlefield.

Economic Development

FRANCES J. STEWART

Professor of development economics, University of Oxford

Promoted antipoverty campaigns to help quell armed conflicts in developing nations.

WHEN TRYING to make sense of the wars and other struggles that wrack the world today, journalists and policymakers tend to trace the political roots, especially ethnic tensions. But Frances Stewart is beginning to convince people that the economic roots are just as important. Stewart started the Center for Research on Inequality, Human Security and Ethnicity this past April. Since the 1960s she has studied and promoted poverty alleviation, particularly in the form of long-term aid that assists people in helping themselves, political institutions that defend the interests of the poor, and the removal of trade barriers against developing nations' exports. Her recent work on conflict has influenced institutions such as the United Nations, which traditionally paid little attention to the economics of civil conflicts. Stewart argues that long-standing antipoverty programs should carry on even while war rages; by reducing inequalities, they can hasten the end of conflict.

Energy

KURT YEAGER

Chief executive officer, Electric Power Research Institute (EPRI), Palo Alto, Calif.

Lobbied for a major overhaul of the power industry long before the 2003 blackouts.

AFTER AUGUST'S great blackout in the U.S., no one needs to be reminded that the electric grid has not kept pace with rising demand and sweeping market deregulation. Yet Kurt Yeager began reminding the country in 1996, when he took the top job at EPRI. One of his first actions as chief executive was to assemble experts from industry and government to chart the future and lay out the needed technologies and the money they would cost. Their conclusions were summarized in the EPRI Electricity Technology Roadmap and continually updated. They included a call for reductions in greenhouse emissions, improvements in power quality and—notably—a 250 percent increase in spending on transmission infrastructure. The spending would have covered not only new power lines but also grid-level electric storage and other features that would have come in handy on August 14, 2003. Since that dark day, Yeager has argued that after years of borrowing against the future, the infrastructure bill has finally come due.

August 14, 2003, was a dark day for New York City and a big swath of the rest of North America.

EVAN VUCCI *EPA Photo (top)*; JASON SZENES *EPA Photo (bottom)*

Other Policy Leaders

Environment

ANDREW BALMFORD

Conservation scientist, University of Cambridge; co-founder, Cambridge Conservation Forum

Described how economic motives can justify preserving natural habitats.

Forest clearance can decrease the economic benefits reaped from a habitat.

CAN YOU PUT a price tag on nature? In an influential article last year in *Science*, Andrew Balmford attempted to do just that. He and his co-authors reviewed studies of five habitats in Malaysia, Cameroon, Thailand, Canada and the Philippines that had been converted to private use. The researchers found that the economic benefits from the habitats consistently decreased after they were razed, drained or dynamited for logging, farming or fishing. For example, the profits earned from turning a Thai mangrove into a shrimp farm were far outweighed by the costs of damage to offshore fisheries and the loss of storm protection. But Balmford has gone beyond simply publishing these results; he works with conservation groups to determine the best ways to reverse the shrinkage of natural habitats. In 2000 he co-founded the Cambridge Conservation Forum to strengthen the links between researchers and conservation practitioners.

Medical Treatment

ANTHONY S. FAUCI

Director, National Institute of Allergy and Infectious Diseases

Convinced the Bush administration to commit $15 billion to combat AIDS in Africa and the Caribbean.

IN HIS FEBRUARY State of the Union address, President George W. Bush asked the U.S. to commit $15 billion over the next five years to combat AIDS in Africa and the Caribbean. Much of the credit for bringing about this development, according to AIDS activists, goes to Anthony Fauci, who worked to convince administration officials to dedicate resources on a large scale. Congress is expected to pledge between $2 billion and $3 billion to the initiative in fiscal year 2004. Among the project's goals are to prevent 60 percent of the 12 million new infections anticipated in 14 targeted countries, to offer antiretroviral drugs to two million HIV-positive people, and to provide care for 10 million AIDS patients and orphans. An estimated 42 million people worldwide are living with HIV, and 20 million more have died of AIDS, according to the Joint United Nations AIDS Program.

Preventing newborns from contracting AIDS is a priority.

Manufacturing

HEATHER WHITE

Founder and executive director, Verité, Amherst, Mass.

Campaigned to extricate migrant workers from virtual slavery.

FOR 15 YEARS, Heather White tracked down outside contractors who could serve as suppliers to apparel companies. Today she is a watchdog of the contractors she once hired. Verité, an organization that she started in 1995, has become one of the foremost groups involved in monitoring factory conditions worldwide to identify worker exploitation and health and safety infractions. Last summer Verité started a campaign to combat debt bondage in Asia. Workers from Vietnam, Thailand and the Philippines migrate to Taiwan and other countries that want to stay competitive with mainland China. They pay high placement fees and deposits to find jobs and are often relegated to a form of indentured servitude. Since it opened its doors, Verité has performed 1,000 "social audits" in factories to assess compliance with workplace standards. Since 2002 the State of California Public Employees' Retirement System has based some of its investment decisions on Verité's ratings of labor practices in developing countries.

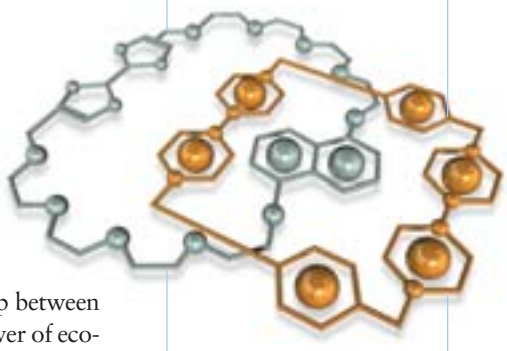
COURTESY OF ANDREW BALMFORD (*top*); GIDEON MENDEL *Corbis* (*bottom*)

Nanotechnology and Molecular Electronics

PHILLIP J. BOND

U.S. undersecretary of commerce for technology

Promoted nanotechnology effectively within the executive branch.



Molecular transistors may become a linchpin of the nanotechnology era.

FROM THE TIME he was sworn into office in October 2001, Phillip Bond has been an outspoken public supporter of nanotechnology. Bond is particularly keen on making sure that the U.S. is prepared to blaze a trail in this new frontier that bridges the gap between basic science and applied technology. In his view, nanotechnology will become a key driver of economic growth and will promote the nation's leadership in technology, but the country will need to invest substantially in nanotech to realize that benefit. The Commerce Department supports research on nanotechnologies, mostly through the National Institute of Standards and Technology. The Bush administration has requested $46.2 million for NIST for the 2004 federal fiscal year, more than 5 percent of the proposed $847 million in federal spending on nanotechnology.

Privacy and Security

JOE SIMITIAN and STEVE PEACE

Simitian, state assemblyman (Palo Alto),
and Peace, former state senator (San Diego County), California State Legislature

Sponsored law that requires issuing warnings when possible identity theft occurs.

THE THEFT of data, like other forms of white-collar crime, is so embarrassing that companies are loath to report it. As a result, many people never learn that hackers or criminals working on the inside have invaded their privacy. Thanks to the sponsorship of Assemblyman Joe Simitian and former state senator Steve Peace, a law remedying that problem took effect in California in July. From now on, companies must notify by letter or e-mail anyone whose name, Social Security number, driver's license number or bank account data may have fallen into the wrong hands. Companies that do not work hard enough to make their employees aware of the need for such disclosures are subject to class-action lawsuits. The two legislators' leadership has already had wider repercussions: U.S. Senator Dianne Feinstein has said that she will introduce a federal bill modeled on the California law.

Public Health and Epidemiology

BILL & MELINDA GATES FOUNDATION

Seattle, Wash.

Gave hundreds of millions of dollars to meet the challenges of global health.

Bill and Melinda Gates visit Mozambique.

OVER THE PAST YEAR the Gates Foundation, which was established in 2000, evinced the power of its carefully honed vision and its huge endowment. Its strong philosophical base holds that millions of people in the developing world die every year from treatable diseases and that we in the developed world possess the means to prevent much of this suffering and death. Toward this end, the foundation's Global Health Program has committed more than $3 billion in grants to expand access to existing interventions for malaria, tuberculosis, trachoma and AIDS and to fund research into new tools. Two important milestones occurred in 2003. One was the establishment of Grand Challenges in Global Health, a $200-million program in partnership with the National Institutes of Health that will identify critical health problems and increase research on diseases of the developing world. The other is a $168-million grant to accelerate malaria research, the largest ever single donation toward fighting the mosquito-borne disease. The number of lives that will be touched by the foundation's vision and by its intelligent and generous implementation is probably without precedent.

SLIM FILMS (*top*); BILL & MELINDA GATES FOUNDATION (*bottom*)

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