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New Voting Systems, Rules May Spell Trouble

Los Angeles Times (10/24/06) Alonso-Zaldivar, Ricardo

The 2006 elections were supposed to be the payoff for six years of work on the nation's ability to vote electronically. As the November general elections approach, doubts concerning voting machine and databases have not been silenced. "The Nov. 7 election promises to bring more of what voters have come to expect since the 2000 elections: a divided body politic, an election system in flux, and the possibility--if not certainty--of problems at polls nationwide," said a report released today by the nonpartisan Election Reform Information Project, which was funded by the Pew Charitable Trust. The report says that "machine failures, database delays and foul-ups, inconsistent procedures, new rules and new equipment have some predicting chaos at the polls at worst and widespread polling place snafus at best." The Election Reform Information Group studied three key areas that governments have targeted to improve the election process: voter identification, voter databases, and electronic voting. The group's director, Doug Chapin, says, "Not all states with problems will have close elections, and not all states

with close elections will have problems. It's where the two come together that you have the potential for the kind of back and forth we saw [in 2000]." A group of 10 experts wrote to Congress in September pleading with lawmakers to adopt quality control standards for e-voting. These measures include checking the e-voting total against a statistically valid random sample of paper ballots verified by voters at the polling place. "We see the election process in the United States at grave risk," wrote the informal group of quality control consultants. Deborah L. Markowitz, president of the National Association on Secretaries of State, says the changes being suggested are "not [to] dump the technology, they are saying fine-tune the technology." To read ACM's report on "Statewide Databases of Registered Voters," visit <http://www.acm.org/usacm/VRD>
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Tech Giants Embrace Diversity **Investor's Business Daily (10/24/06) P. A5; Vallone, Julie**

Microsoft is looking to attract women and minorities to the field of technology, part of a trend that can be seen across the industry. Women in 2005 represented 15 percent of the bachelor's degrees in computer science and engineering, down 17 percent from 2004, according to the Computer Research Association. The Bureau of Labor and Statistics reports that in 2005 seven percent of African-Americans and 5.3 percent of Latinos had occupations in computers and math, and five percent of African-Americans and 4.5 percent of Latinos had occupations in science. Males outnumber females at Microsoft three to one, a statistic that is average for the industry. Programs such as DigiGirlz, a yearly week-long summer technology day camp for middle and high school girls, are working to close the gender gap. Microsoft also holds a program based at its Redmond headquarters, with outposts in other states. Beginning in 2000, the program has helped at least 600 girls learn about career choices in technology from female and minority employees at Microsoft. "It's a chance for them to learn about the kinds of things they can do in an environment like this and connect with the women doing the work," says Mylena Padolina, senior diversity consultant for Microsoft. A group known as Women in Computing, at Indiana University, which is sponsored by both Sun Microsystems and Cisco Systems, has invited minority computer science undergraduates from other colleges to a conference called BringIT On, which aims to show participants how to connect with K-12 students and interest them in technology. "We try to dispel the media stereotype that computer science is just a bunch of jargon-spouting video-game-playing white males," says Suzanne Menzel, a senior lecturer at Indiana University's computer science department. The Salmor Camp Research Team, coordinated by the Oregon Museum of Industry, shows Native American high school students to collect and analyze field data on an environmental project. For information on ACM's Committee on Women and Computing, visit <http://women.acm.org>
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Intelligent Sensors Watch for Impending Flood **New Scientist (10/23/06) Simonite, Tom**

A UK river is being monitored using sensors that not only gather data, but are capable of making decisions based on this data. Previous systems would drown scientists in data, leaving them only a few frantic hours before needing to make a decision concerning an impending flood or air pollution incident. The "grid" of 13 intelligent sensors in the River Ribbles, in Yorkshire Dales, consists of 11 nodes measuring pressure from below the waterline to determine depth, and the other two nodes to monitor the speed of the river flow--one using ultrasound underwater, and the other using Web cams to track objects and ripples moving along the surface. Each node is smaller than a fist and powered by batteries and solar panels. A chewing-gum sized processor executes the necessary calculations. The sensors communicate with each other using Wi-Fi or Bluetooth antennas, allowing them to collaborate for data collection and processing, creating a larger community computer. This "grid" computing technique is used to connect computers in different locations for distributed research projects. When the river's

behavior starts to change, the network runs models and predicts what will happen next. If an impending flood is detected, a detailed signal is issued. Danny Hughes, a computer and environmental scientist at Lancaster University, UK, who is working on the project, says the hope is that the grid will be able to send emergency information directly to those in harm's way, using interactive billboards or text messaging. Another "end goal would be that people living in areas that flood can install these grids themselves. They are simply robust enough to make that possible," says Hughes.

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SC06 Conference Volunteers Building Huge Network Into Tampa Convention Center Business Wire (10/24/06)

The SCinet team will be installing 10 10-Gbps network connections for the SC2006 conference, creating a network in the Tampa Convention Center that will be about 20,000 times more capable than the fastest residential Internet service provided by cable and telephone companies. The project is a huge team effort, explains Dennis Duke, a physics professor at Florida State University and SCinet chair for the SC06 conference, which takes place Nov. 11-17, 2006. Duke says the network is the result of the effort of 140 volunteers and loaner equipment from "dozens" of companies. He says, "We started...in October 2005 and have been working at it steadily since then." Over 12 miles of fiber optics and cable wires were installed in the convention center, including two network outlets in each meeting room, a high bandwidth infrastructure serving all parts of the exhibit areas, and wireless throughout. Attendees and exhibitors will be connected to half a dozen key network sites throughout the country. As at every Supercomputing conference, scientists and engineers will compete in the Bandwidth Challenge, in attempt to make the most of the bandwidth provided by SCinet. No group yet has been able to flood the network to its breaking point, but ingenious applications have allowed record amounts of data to move across the network. This year's contest will be called "Bridging the Hero Gap"--bridging the gap between what networking "heroes" can achieve and what the average researcher with access to high speed networks can achieve. Although 10 Gbps links are more common than ever, achieving rates close to 10 Gbps, or even 1 Gbps, across these networks is still out of reach for most. Also a fixture of the conference, SCinet's Xnet (eXtreme networks) division will introduce groundbreaking pre-commercial or pre-competitive developmental networking technologies, protocols, and experimental networking applications. For more information about SC06, or to register, visit <http://www.sc-conference.org/>

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Dr. Peslak and Marcy Stanton Pursue Success Model Penn State Worthington Scranton (10/24/06)

A study conducted at Penn State set out to shed some light into the reasons that some team members are more successful in a modern IT team, and what components of such a team can ensure success. Dr. Alan Peslak, assistant professor of IST at Penn State, has more than 25 years of practical experience in manufacturing and service industries, and understands that "the ability to function as an IST professional today virtually mandates an understanding of how teams function, and, perhaps most importantly, the ability to place oneself within a working IST team and contribute in a positive way." Working with recent IST graduate Marcy Stanton, the pair came up with a general research question: "Can an overall team success model (TSM) be developed that includes the relationship between demographic variables, team and personal process factors, emotions, and overall team success?" "We were looking for factors that both enhanced and served as obstacles to optimal IST team functions," says Peslak. The pair set out to answer their question by examining performance, group process analysis, emotional reactions of workers, individual psychology, and even trust between members. The sample consisted of 55 students in 18 teams whose progress was measured at several stages of the semester-long project. Factors leading to team success were found to be "emotion, personal processes, and team processes. Within these parameters we were able to quantify significance of individual factors and relationships between

many of them." The pair concluded that implications for their model for success are clear: "the challenges for managing IST teams begins with an understanding of group dynamics [and] extends to owning the responsibility for self management."

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Some Va. Voting Machines Cut Off Names Washington Post (10/24/06) P. B4; Smith, Leef

Hart InterCivic voting machines, used by three districts in Virginia, chop off the end of candidate's names, as well as their entire party affiliation, on the screen that shows a voter their selection for verification. Election officials blame the mistake on an increase in font size. Signs will be posted all over poll locations in these districts, alerting voters to the flaw in the computer system, and assuring them that their vote will be counted. The problem has existed since 2002 when the machines were purchased, but Jean Jensen, secretary of Virginia State Board of Election, has only been aware of the problem for a few days. She now pledges to fix the problem before the 2007 elections. "You better believe it," she says. "Even if I have to get on a plane to Houston and bring Hart InterCivic people here myself, it'll be corrected." Hart InterCivic has developed an upgrade for the firmware, but receiving state certification will be time consuming, says Jensen. The glitch affects some candidates more than others, based on name length, but James T. Hirsch, an independent running for the house, says, "that situation is unacceptable. There's enough voter confusion as it is." Tom Parkins, registrar for Alexandria, one of the districts affected, explains, "This is not the kind of problem that has either shaken our confidence in the system overall or that of the vote. There have been far worse problems around the country." For more information about ACM's e-voting activities, visit <http://www.acm.org/usacm>

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Electronic Jeeves to Smooth Your Social Interactions IST Results (10/24/06)

Rather than computers being simply a "black box on the desk, and we have to engage with them in a rigid way," an IST project called CHIL aims to create machines that put human needs first. The inspiration is a butler, who appears out of the background as needed, says the University of Karlsruhe's Alexander Waibel, CHIL project coordinator. CHIL is meant to be deployed in a meeting room, lecture hall, or classroom, and is still currently in the final stages of development. "Collector" is a tool that is context-aware, which could, for example, detect whether or not an employee wishes to receive calls or not, or if they would only like to receive calls from family members. The system, which uses cameras and microphones, would learn the preferences of individual users and make decisions accordingly. "Memory Jog" is designed to "jog the memory" of a meeting participant who may, for example, forget the name of the person who just spoke. The device would not only recall the name, but whisper it in the user's ear using technology known as "targeted audio," which uses a narrow band audio beam. This system is able to transmit a voice to a single person's ear as they move about, remaining inaudible to everyone else around. Another application, "Attention Cockpit," is intended for use in meetings. Its modular interface allows entering and manipulation of information by different participants. The system will provide a kind of virtual table, on which items can be brought up or saved for later. Finally, "Translation Goggles" provide real-time written translation of speech imposed in a tiny heads-up display. At this point in development of the CHIL project, applications are being tweaked to appear and disappear as needed more accurately and seamlessly.

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Ear for Security**Sacramento Bee (CA) (10/23/06) Swett, Clint**

Hao Chen, assistant professor of computer science at UC Davis, has researched ways in which hackers can disrupt or tamper with cell phone service. His research has shown that an Internet connection can be used to send junk bits and bytes of data to many cell phones simultaneously, which prevents the phones from going into standby mode, and thus drains the battery about 20 times faster, and even worse, "there's no indication [to the user] that something fishy is going on," says Chen. He claims that one PC with a DSL connection could potentially attack 5,000 cell phones at once. Other hacking techniques exist that could potentially affect greater numbers. Beyond battery issues, which have been Chen's main concentration, he believes the data networks used by business travelers to send email from portable devices could be significantly slowed down or disabled. Last year, Penn State researchers found that one cable modem is all that one hacker needs to flood cell phones in a metropolitan area the size of Manhattan with enough text messages to cause service to be denied to 70 percent of a carrier's customers. The cell phone industry is not ignorant of these threats to their service. CTIA's Joe Farren says, "We have the benefit of learning from the open Internet. Our filters and firewalls are constantly being refined to address that is an evolving threat." He claims that the type of attack simulated by Chen on just a few phones would not be so easy when actually targeting tens of thousands of cell phones. Anti-virus makers are also exploring the security needs brought on by the increasing popularity of cell phone downloads using high-speed data networks. Trend Micro's Todd Theimann says that although they "haven't seen widespread damage yet...if you look at the growth of high-speed networks and the wealth of technical knowledge out there, its bound to turn virulent."

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Do Not Get Lost**Innovations Report (10/20/06)**

Computer science researchers at the University of Granada have teamed up with researchers at several other Spanish universities to develop a computer application that is able to design generic itineraries for tourists based on their preferences. SAMAP (Adaptive MultiAgent System of context dependant Planning) is designed to cull the vast amount of tourism information on the Internet and devise a visit plan after users have determined their destination, the length of stay, how much money they have to spend, how much walking they plan on doing, their favorite mode of transportation, architectural or artistic preferences, favorite foods, and more. "If somebody likes gothic art, the system will only offer him monuments or museums according to such criterion depending on the money he has at his disposal to travel and spend in the visit," says Luis Castillo, a researcher at UGR. "And if these places are too far to go walking, they can recommend him the most economical transport to arrive." SAMAP is different from other systems in that it has the ability to learn and features richer options. Users would be able to make changes to their plans on the fly from a mobile device. The project, which also involves researchers at the Institute of Artificial Intelligence of Barcelona, the University Carlos III, UNED, and Technical College of Valencia, is testing SAMAP on the city of Valencia.

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Canada Falls Short on IT Graduates**ITBusiness.ca (10/23/06) Lysecki, Sarah**

Canada's Software Human Resource Council (SHRC) has found a significant gap between the annual number of openings in the Canadian IT sector and the number of computer science and computer engineering graduates from Canada's universities each year. While total IT jobs are expected to jump from 35,000 each year to 89,000 for the next few years, only about 7,000 students are graduating each year. "We're trying to figure out where the heck the rest of the people are going to come from," says

SHRC President Paul Swinwood. However, Wilfrid Laurier University in Waterloo, Ontario, says it has the highest number of applicants to its science programs since 2003, when high school was reduced from five years to four years, meaning that number of students graduating was doubled that year. A new math curriculum, requiring a course called geometry and discrete mathematics that many avoided for fear of a bad grade, was found to be creating a bottleneck. Universities changed their admissions requirements to accept "a biology course or an earth science course," according to Dr. Stain Boctor, dean of science, engineering, and architecture at Ryerson University. There had been a 30 percent drop in qualified applicants to science and engineering programs from 2001 and 2002 to 2004 and 2005, from 10,500 to 7,000, and though this has been corrected, more changes will be made by the Ministry of Education by 2007. Unfortunately, the perception remains in Canada that the IT sector is not a reliable source of employment opportunities. "There is a psychological impact from that IT bubble bursting in 2001," says Boctor. "We are far removed from that. There are very lucrative jobs in IT and communication industry."

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Jump-Starting Quantum Error Correction With Entanglement Science (10/20/06) Vol. 314, No. 5798, P. 427; Gottesman, Daniel

Computers that use quantum bits, or qubits, to transfer information would be faster and more secure than today's computers, but a large obstacle to developing qubit computers is error-correction, as quantum information is far more susceptible to errors than is traditional information. The three properties that determine quality in error-correcting code are the rate at which the code can transmit data, the error rate that can be tolerated, and decoding time. The first two are directly related, the more noise in a communication line, the slower the transmission of information. When dealing with classical information, the Shannon capacity identifies the optimal trade-off between the two properties, and can be achieved by an error-correcting code chosen at random. The receiver needs to be able to tell what kind of error occurred during transmission in order to fix it, but this task is very difficult for a random code. Decoding time usually consists mostly of time used identifying the error. Because of the peculiarities of quantum information, no analog of Shannon's theorem exists for it. A randomly chosen quantum error-correcting code has a good data rate and error rate, but is not optimal, and takes a very long time to decode, making a quantum code that satisfies all three properties difficult to establish. Using entanglement, a quantum-mechanical phenomenon that allows strong correlations between a pair of distant quantum systems, any incompatibility in the encoding can be cancelled with an equivalent incompatibility in the decoding. The result is that classical error-correcting codes can be converted to quantum codes. Originally, the entangled state must be free of noise, but a successful transmission generates it, allowing further communication without cost to entanglement. This process makes efficient quantum transmissions possible, and would be very beneficial for a sender and receiver who communicate on a regular basis.

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How to Overcome Female Resistance What PC? (10/23/06) Bennett, Madeline

A recent Women in IT roundtable discussion focused on what can be done to attract more women to the IT industry. Dawn Pollard, a project manager at educational software and services firm RM, acknowledged that the IT industry needs an image upgrade to help young girls understand that a career in IT is about more than technical or programming skills. Meanwhile, Anne Cantelo, who helped create the Computer Clubs for Girls at E-Skills UK, noted that a study from Open University indicates that jobs advertisements that are overly technical are a turnoff for women. "Adverts shouldn't say, 'We need C++,' but 'You need to create a system that will help hospitals do this,'" said Cantelo, who added that for similar reasons, women are not pursuing computer science studies. Compuware vice president Amina

West says women need to ask for more training so that they can take advantage of career opportunities when they arise, and she added that women attempting to reenter the workforce after raising children also need the right training. More flexible work practices, such as the opportunity to work from home, would be helpful, roundtable participants suggested. "IT moves so rapidly that if you take a career break it's hard to keep up," said Amanda Zuydervelt, founder of StyleBible.com. The participants were also in support of mentoring programs in schools and the workplace.

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Tiny Electronic Chip, Interacting With the Brain, Modifies Pathways for Controlling Movement **University of Washington News and Information (10/24/06) Gray, Leila**

Researchers at the University of Washington are developing an electronic chip that may help establish new nerve connections in the section of the brain that controls motion. The most recent findings state that induced brain changes in monkeys can last over a week. Rehabilitation of patients with brain injuries, stroke, or paralysis, stand to benefit from this technology, described in the study entitled "Long-Term Motor Cortex Plasticity Induced by an Electronic Neural Implant." The inspiration for the study comes from the theory that the brain's nerve signals can be harnessed to create change in itself, just as these signals have been redirected and used to control mechanical devices outside the body. A self-contained device with a tiny computer chip, called a Neurochip, "records the activity of motor cortex cells," explains Dr. Eberhard Fetz, professor of physiology and biophysics. "It can convert this activity into a stimulus that can be sent back to the brain, spinal cord, or muscle, and thereby set up an artificial connection that operates continuously during normal behavior. This recurrent brain-computer interface created an artificial motor pathway that the brain may learn to use to compensate for impaired pathways." When neighboring sites are connected in the motor cortex, long-lasting changes occur, specifically, the motion evoked from the recording site transformed to resemble those evoked from the stimulation site. Synchronous activity generated by the brain-computer interface in these sites may be the cause of this strengthening. The effect of conditioning occurs only if the delay between recorded activity and stimulation is brief enough. After a day of continuous conditioning using the interface, conditioning will last for several days with the circuit turned off.

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The Vanishing Computer -- 2026 A Vision for the Nation's Future **The Australian (10/24/06) P. M12; Cuthbertson, Ian; Tellzen, Roland**

Many experts say that increasingly transparent technology, ubiquitous computing, will lead to all sorts of ingenious interfaces, possibly even including the air itself, which is already filled with network and radio signals. Trent Apted, PhD student at Sydney University, is developing a table intended for meetings, which is able to project images such as photos that can be passed around, enlarged, and written on. Mark Weiser, who ran the Computer Science Laboratory at Xerox PARC for seven years (ending in 1997), was regarded as the father of ubiquitous computing. "The arcane aura that surrounds personal computers is not just a 'user interface' problem...the idea of a 'personal computer' itself is misplaced, and...is only a transitional step toward achieving...[technology] that takes into account the natural human environment and allows computers themselves to vanish into the background," wrote Weiser in article for Scientific American. He even imagined "'scrap computers' like scrap paper lying about to be grabbed as needed." Futurist Michio Kaku expects ubiquitous computing to be seen "coming of age" by 2010, and "by 2020, it will dominate our lives." Looking as far ahead as 2050, Kaku sees "invisible, networked computers which have the power of artificial intelligence, reason, speech recognition, even common sense." He also predicts holograms that will store data carried by optical computers, in which "light beams...crisscross each other in an optical cube carrying information."

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Pentagon Urges 'Relevant' R&D
EE Times (10/20/06)No. 1446, P. 1; Leopold, George

The U.S. military will need contractors to concentrate more on relevant technology that troops will be able to use while battling insurgents in places such as Iraq and Afghanistan. In the immediate future, high-risk and high-payoff research will be less of a focus. For example, Defense Department planners say a sensor system that would enable war fighters to detect and destroy improvised explosive devices (IEDs) is the type of new technology that is needed, and budget forecasters say the Pentagon plans to spend more than \$200 million on IED detection and training this year. Fiscal 2006 was a record-setting year for spending on military R&D, but technology spending has reached a plateau and is likely to fall in the years to come, says Boeing's Cecil Black, who oversaw the DOD spending forecast that the Government Electronics and Information Technology Association (GEIA) released last week. The military has a budget of \$435.6 billion for fiscal 2007, and much of the spending will go toward developing missile defenses and a U.S. space force, in addition to "transformational technologies" that connect commanders to troops in the streets. Aside from IED and command and control technologies, DOD requirements include the ability to detect threats early and counter them, and the comprehensive network-centric warfare concept, in which sensors are able to turn patterns in data into useful information and relay it to ground and space networks. The Defense Advanced Research Projects Agency (DARPA) will receive around \$3 billion of the Pentagon's \$13.3 billion science and technology budget this year, and will focus on developing "robust, secure, self-forming networks" and other net-centric capabilities for the battlefield.

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IT Policy Outlook
InformationWeek (10/23/06)No. 1111, P. 53; Greenemeier, Larry; Hoover, J. Nicholas

The future of many telecommunication and IT issues is riding on the outcome of the upcoming congressional elections, and among the areas where IT policy will have a significant impact are communications, critical infrastructure, jobs and education, data privacy, and innovation. Businesses should keep a careful eye on telecom policy, as a change in congressional leadership could mean the difference between the institution or the dismissal of Internet neutrality legislation; both Congress and the FCC have also been endorsing new broadband technologies. HCR Manor Care's Tom Olzak says the government must take a lead role, in a non-autocratic manner, in protecting the nation's critical infrastructure, which is about 85 percent controlled by businesses. A decline in U.S. students' science and math literacy has prompted the introduction of legislation designed to fortify the technical workforce and reform the H-1B visa program. Legislative inaction on the issue of data privacy this year does not indicate ignorance, but there are so many bills floating around that Congress is understandably hesitant, when the volume of the proposals is weighed against the intricacy of data security and the potential cost of breach notification. One possible solution is a consistent series of federal data privacy rules for businesses. Even if Congress experiences a changing of the guard, its willingness to reform the U.S. patent system and maintain U.S. leadership in high-tech innovation will remain consistent: One of the provisions of patent system reform legislation introduced last summer is the creation of a minitrial to ascertain the quality of a patent when it is challenged.

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Interactive Storytelling
Dr. Dobb's Journal (10/06) Vol. 31, No. 10, P. 16; Swaine, Michael

Computer games and computer-based training could be shaken up by interactive storytelling, which is

Storytron creator Chris Cooper's vision. Cooper found the games industry unenthusiastic when it came to moving away from what he calls the "formulaic" product model and exploring more "unconventional" games. He says the technical elements needed to make interactive storytelling a reality began to come together about two years ago, while finding a practical business model was the last big breakthrough. Storytron system components include storyworlds, structures in which scores of stories implicitly reside and that spawn stories via interaction with players; storybuilders, artists who construct storyworlds by using the Storyworld Authoring Tool (SWAT); the Storytron Engine; the Storyteller consumer program; the Rehearsal testing feature; and the Diekto language. Cooper says the stories the system produces distinguish themselves from conventional stories by being plotless: They are rather explorations of storyworlds by players. Cooper describes designing SWAT so that nontechnical people could use it as "a murderously difficult problem," and one of SWAT's advantages is its support of point-and-click editing. Other useful features of SWAT include color-coded datatypes and tolerance of runtime errors. Cooper calls Storytron "a social interaction simulator" that lends itself to corporate and military training.

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The Internet Is Sick...But We Can Make It Better **Popular Science (10/06) Vol. 269, No. 4, P. 82; Tynan, Dan**

The Internet's vulnerability to cybercriminals requires an immune system, and Carnegie Mellon University's CyLab is working on various remedies that follow this paradigm. One solution seeks to address the widespread distribution of identical software bugs because software lacks diversity. The approach is based on biological systems' evolutionary response to disease, with the goal being to develop software that is adaptable to attack. CyLab even envisions the creation of software and operating systems that randomly alter their functions or scramble the order of their executed instructions. Another remedy being researched by CyLab seeks to shore up corporate information databases against distributed denial of service attacks through the use of survivable data storage systems. This can be seen as an interim measure until self-healing networks are developed. The ease of spoofing Internet Protocol addresses makes tracking down the source of malware often next to impossible, but Carnegie Mellon electrical and computer engineering professor Adrian Perrig says CyLab's Fast Internet Traceback (FIT) technology can follow each data packet as it travels throughout the Internet, "like leaving a trail of breadcrumbs." FIT's practicality depends on upgrading at least one-third of the Internet's approximately 100,000 routers, while proving a cybercriminal's culpability requires an unshakeable identity verification scheme, which raises serious privacy issues.

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A Conversation With David Brown **Queue (10/06) Vol. 4, No. 8, P. 14; Sproull, Bob**

In an interview conducted by Sun Microsystems Fellow and Sun Labs director Bob Sproull, Solaris expert on binary compatibility David Brown explains the reasoning and methods that facilitate the evolution of the operating system without disrupting existing applications. The most obvious motivating force for developers is the customer, who does not want new software to undermine applications already in place, according to Brown. He cites a tension between new features and the stability of existing features, which makes a cautious attitude toward the delivery of new features critical. "In practice, it's hugely important that you have some mechanical way of examining an application: To see what it's using--and to decide whether that's OK or not," Brown notes. He says the methodology for introducing change in a controlled manner has technological and sociological facets, adding that there must be a fundamental dedication to not breaking any existing applications. "Maintain strict upward compatibility from one release to the next and define the application interfaces clearly so you don't allow any applications (or layered software products) that use them to be broken in a later release of the system," Brown recommends. According to him, the need to maintain an interface's stability increases as the interface is more broadly exposed and

employed. Among the lessons about system evolution Brown cites is recognition of the fact that systems are built upon thousands of carefully evaluated engineering decisions; he also stresses the need for a mindset among developers that envisions innovation and stability as interdependent.

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