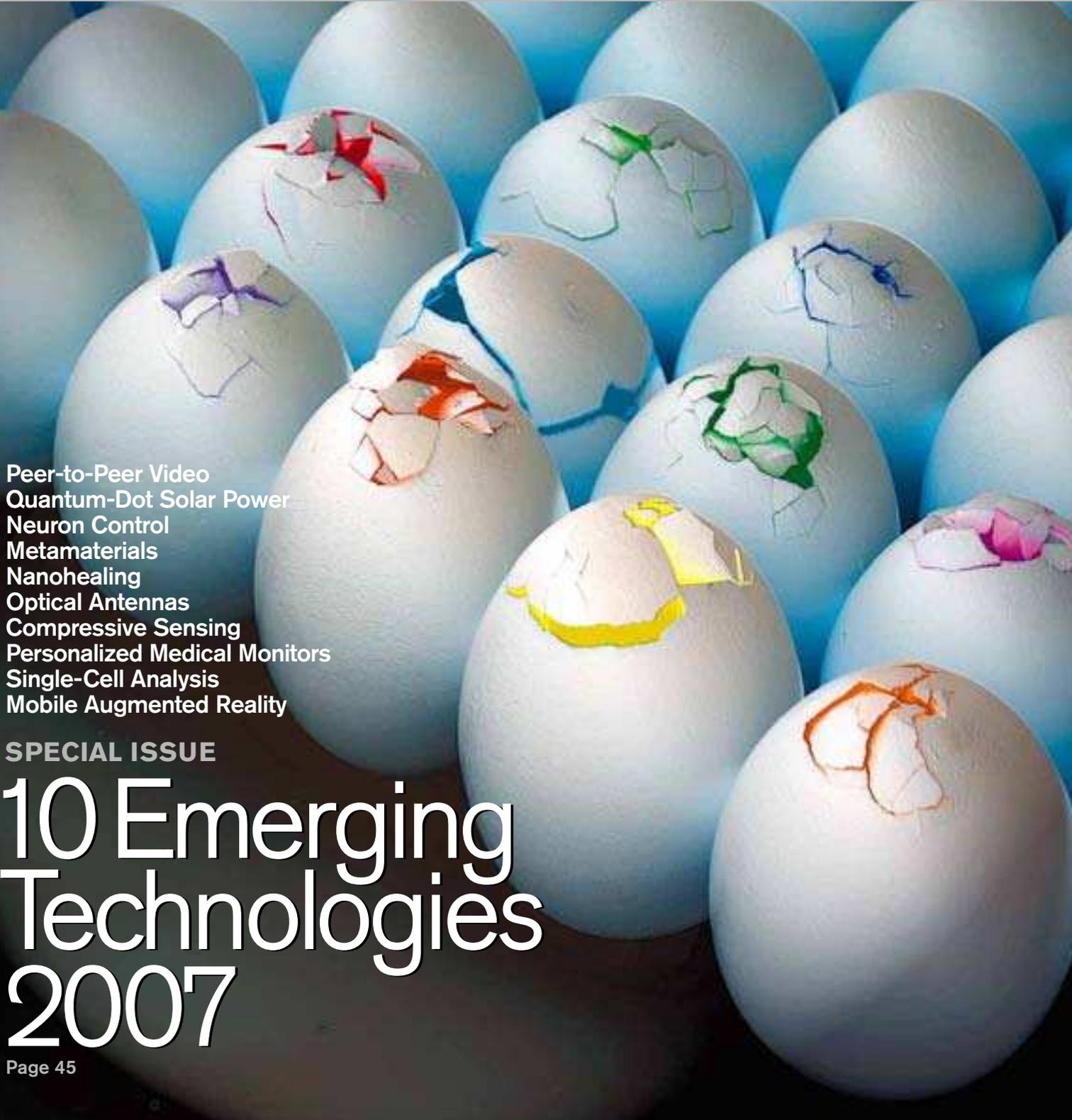


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Peer-to-Peer Video
Quantum-Dot Solar Power
Neuron Control
Metamaterials
Nanohealing
Optical Antennas
Compressive Sensing
Personalized Medical Monitors
Single-Cell Analysis
Mobile Augmented Reality

SPECIAL ISSUE

10 Emerging Technologies 2007

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De Technologia non multum scimus. Scimus autem, quid nobis placeat.

What's New on Our Website

New Bloggers

In February, we introduced blogs by Simson Garfinkel and David Ewing Duncan. Here's a brief description of who these writers are and what they'll be up to on our site.



Simson Garfinkel is a fellow at Harvard University's Center for Research on Computation and Society and a researcher in the field of computer forensics. Despite having a PhD in computer science, Simson tends to be interested in the more mundane aspects of Internet life: balancing his checkbook with Quicken, reading his e-mail with IMAP, and keeping all of his data properly backed up. Simson will be writing about what makes computers fun.



David Ewing Duncan is a best-selling author, journalist, and NPR commentator. His blog will explore discoveries in the life sciences but will also offer thoughts on and analysis of how the field influences business, politics, and society. David is currently chief correspondent on NPR's "BioTech Nation" and is a regular contributor to *Technology Review*, *National Geographic*, *Wired*, *Discover*, and *Fortune*. His six books have been published in 19 languages; the latest is *Masterminds: Genius, DNA, and the Quest to Rewrite Life*.

More Videos

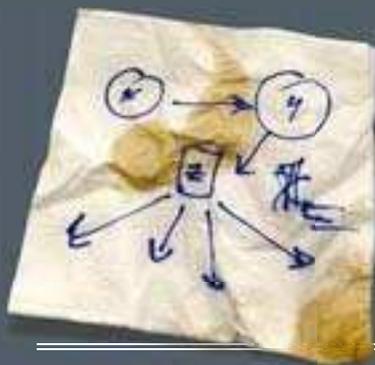
Be sure to watch our latest video, which offers an inside look at Alinea, a restaurant in Chicago that doesn't



so much cook food as engineer it. The restaurant and its chef, Grant Achatz, were featured in an essay by *Atlantic Monthly* food writer Corby Kummer in the January/February issue of the magazine ("The Alchemist"). Interviews with both writer and chef reveal a neat irony: sometimes technology is best used in the service of great artistic passion.

Aggregation

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Contributors



When **John Borland** took on the tough assignment of writing about Web 3.0, a catchall term for an elusive phenomenon, he did it fully aware of its pitfalls (“*A Smarter Web*,” p. 64). “I’ve always been skeptical of giving any progress on the Web at large a version number,” he says, “even the now well-established ‘Web 2.0.’ It’s a catchy meme, but the analogy to software quickly raises problems. That said, there is a developing group of technologies here that does deserve a family name, even if it doesn’t end up being Web 3.0. These tools are immature but hold enormous potential and may ultimately help deliver on some of the most ambitious promises we’ve been hearing from Web optimists for years.” Borland has written about technology, science, and digital entertainment for 10 years, most recently for CNET News.com.



David Marusek obliged our interest in putting something different into this issue: fiction (“*Osama Phone Home*,” p. 72). And he did so by using our content as a point of departure: “In the March/April 2006 issue of this magazine,” he says, “Mark Williams wrote an article on bioterrorism that contained a line that set my science fiction imagination on fire: ‘We live

in a world where gene-sequencing equipment bought secondhand on eBay and unregulated biological material delivered in a FedEx package provide the means to create biological weapons.’ I wondered what a home-grown, highly technological group of Western ideologues might look like. And what kind of trouble they might cook up.” Marusek, the author of the novel *Counting Heads*, has published stories in *Playboy*, *Nature*, and *Asimov’s*, and his work has been excerpted in *Scientific American*. His collection of stories, *Getting to Know You*, will be published in April 2007 by Subterranean Press. He is currently working on his second novel, *Mind over Oship*.



Apoorva Mandavilli wrote a review of a product she was afraid to try: a night cream whose manufacturer claims it contains “150 nano complexes” (“*Nanocosmetics: Buyer Beware*,” p. 84). As Mandavilli explains, “I had no idea companies were using nanotechnology for cosmetics. There are all kinds of products out there throwing out terms like nanosomes, nano-emulsions, nano filters. The thing that I found really scary, though, is that the companies themselves seem to have no idea what these things are and how they might affect people’s health. And there’s no regulation. They can use anything they want in cosmetics and nobody can do anything about it. At least until something goes horribly wrong.” Mandavilli is senior news editor of *Nature Medicine*. For the past few years, she has been traveling

the world chasing down stories about medicine and public health, with a particular concentration on neglected communities. She maintains a blog and writes for publications such as *Nature*, *Discover*, *Women’s Health*, and *O, the Oprah Magazine*.



In our roundup of 10 technologies we think likely to prove important, **Jon Cohen** reports on the ability to view, in previously unattainable detail, the contents and behavior of individual cells (“*Scrutinizing Single Cells*,” p. 62). Cohen looked at the research being done by Norman Dovichi, an analytical chemist at the University of Washington, Seattle, and says that getting a peek at the instruments being built to probe cells was an amazing experience. “The lab attempts to analyze the contents of single cells, and you can see the fiber-optic ‘capillaries’ that hold the samples, the high-voltage electrode that zaps them, the blue and green laser lights that then shine through the ‘analytes,’ and the Erector Set-like platform everything sits on. Not exactly erotica, but it is sexy stuff.” Cohen, a longtime contributor to this magazine, is a correspondent for *Science* and has written for the *Atlantic Monthly*, the *New Yorker*, the *New York Times Magazine*, *Slate*, and many other publications. He is the author of *Shots in the Dark: The Wayward Search for an AIDS Vaccine* and *Coming to Term: Uncovering the Truth about Miscarriage*.

Letters

Charles Simonyi and Programming

In your otherwise excellent coverage of Charles Simonyi and his pioneering concept of intentional programming (“Anything You Can Do, I Can Do Meta,” January/February 2007), you unfortunately included a throwaway remark about the Unified Modeling Language (UML): “But UML diagrams can’t be transformed into finished software, which is Simonyi’s dream for intentional programming.”

This would come as quite a surprise to a large and growing community of software architects and developers. While it is true that UML, now a staple of every major software-development tool worldwide, is often

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used only for “sketching” an architecture or design, people have for years been successfully employing the full capabilities of UML “all the way down” to executing systems.

*Richard Mark Soley
Needham, MA*

Intentional programming might be a great help to those who must maintain software, as original “intent” is often lost. However, I suspect there may be too many potential dimensions to the task. One can only hope the effort won’t run off the rails. As I wrote in the March 1990 issue of *C Users Journal*, “Complexity is neither created or destroyed—it only changes its appearance or location and distribution.”

*Scott Maley
Condon, OR*

I found the criticism of the intentional-software idea referred to in the article amusing to ludicrous. The notion that Simonyi’s idea is “implausible”

is astounding. It reminds me of the prediction of scientists that the four-minute mile was a human physiological barrier. Every single scientific breakthrough has received that sort of dismissal before it was achieved.

Also, the complaint from programmers that it distances them from the “raw code” is ludicrous. Being stuck with the raw code is exactly the problem that intentional software is aiming to solve. The complaint sounds like a concern over job security.

*Richard Odessey
Lawrenceville, GA*

Charles Simonyi’s intentional programming is a great idea, but Simonyi’s huge programming background unfortunately ties him so much to conventional programming techniques that, no matter how hard he tries, he will never be able to conceive of the truly radical approach to programming that’s needed to solve the software crisis. We need someone not steeped in

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Riverside Walk on the Thames.

current programming methods to devise a totally new, unfettered approach. I wish Simonyi the best of luck in his endeavor, but I fear we're only going to get a marginal reduction in program obfuscation and a still further slowdown in run-time speed. Let's hope it's not a C+++.

*Bill Earle
Scituate, MA*

I liked editor in chief Jason Pontin's most recent column about programming languages ("On Rules"), but I am a little bit disappointed that he did not mention Prolog, a rule-based software language model that is really elegant in terms of expressing solutions to problems. Once upon a time, I used a mixture of Prolog and C, and I can tell you it was a real delight. On the other hand, I remember an article in *Technology Review* by the late Michael Dertouzos about making all computing matters simpler ["Creating the People's Computer," April 1997]. I do

not see that spirit in Simonyi's proposal. What I think is more in line with Mr. Dertouzos's agenda is what is known as Business Process Management (BPM) systems. Most BPM solutions offer a Lego-like graphical programming paradigm that allows the user to define his organization's processes and computations. I think this is the paradigm we should follow.

*Luis Fernando Flores Oviedo
Aguascalientes, Aguascalientes,
Mexico*

Uninspiring Vista

It's a shame that writer Erika Jonietz has only now discovered that "Macs are simple" ("Uninspiring Vista," January/February 2007). I discovered this in 1984, when they first came out.

Many people in the academic and business communities still wonder why this discovery has been, and continues to be, so elusive and rare. I turned on my first Mac, opened Macword, and was working productively in five min-

utes. That has been my standard ever since. Around 1991, one could put together a LAN with Macs and printers just by plugging wires together. On a PC system, it took full-time administrative personnel to set up and keep such a system running. In 1991 and 1992 I worked in two different offices with networked PC systems, and no one at either place could tell me how to print in landscape format from Lotus 1-2-3. I had to print in portrait format, cut out and tape the pieces together, and put them on a copy machine to get the format I needed. No such antics were ever needed on a Mac.

*Daniel Whitney
Cambridge, MA*

Correction: In the January/February 2007 essay "The Alchemist," we inaccurately described the Institute of Food Technologists, which is a scientific society made up of 22,000 members working in academia, government, and the food industry.



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On Science Fiction

How it influences the imaginations of technologists



Once wrote on this page, “Science fiction is to technology as romance novels are to marriage: a form of propaganda” (see *Against Transcendence*, February 2005).

This represents my sincere view, but stated so baldly, without elaboration, the remark implies a contempt I do not feel. For I *adore* science fiction. If it is propaganda, I am its happy dupe; and if I am a technology editor and journalist today, it is because between the ages of seven and fourteen, I read little *but* science fiction.

I grew up on a farm on the North Coast of California that had at one time been a kind of hippie commune. Around the various cabins on the property were dozens of yellowed paperbacks of the sort that the counterculture loved; and when I recall my childhood all at once, it is perpetually summer, and I am alone in a field or a tree house, reading Alfred Bester, Algis Budrys, Samuel R. Delany, Philip K. Dick, or Robert Heinlein.

I grew out of science fiction—which is to say that I learned to enjoy other, more literary writing and to disguise my passionate fandom. But science fiction continues to influence me. To this day, my tastes and choices as an editor and journalist are bluntly science fictional: I look for technologies that are in themselves ingenious and that have the potential to change our established ways of doing things. Best of all, I like technologies that expand our sense of what it might mean to be human.

In this, I believe, I am an entirely conventional technologist. Most of us came to technology through science fiction; our imaginations remain secretly moved by science-fictional ideas. Only the very exalted are honest about their debt. In his collection of lectures on the future of technology, *Imagined Worlds*, the great theoretical physicist Freeman Dyson writes, “Science is my territory, but science fiction is the landscape of my dreams.”

Science fiction’s influence on technologists’ imaginations can be observed in its successful and unsuccessful predictions. Discerning a causal relationship between what science fiction has predicted and what technologists have created might be an instance of the logical fallacy *post hoc ergo propter hoc* (“after this, therefore because of this”), except for a curious fact: SF writers not only describe current research and extrapolate its likely development but also prescribe cool things that enthralled technologists later make or try to make. In short, life imitates art.

Fans decry any emphasis on their favored genre’s predictive power (science fiction, they say, is really about the

present day); but nonetheless, the accurate predictions of many science fiction writers are justly famous. Geostationary telecommunications satellites were first proposed by Arthur C. Clarke in a paper titled “Extra-Terrestrial Relays: Can Rocket Stations Give World-Wide Radio Coverage?” published in *Wireless World* in October 1945. Space travel has been a staple of science fiction since Jules Verne published *De la Terre à la Lune* in 1865. Robots first appeared in Karel Čapek’s play *R.U.R.* in 1921. Indeed, it is more useful to ask, What *hasn’t* SF predicted?

But the prescriptive power of science fiction has functioned both positively and negatively. Older computer scientists and electrical engineers such as Marvin Minsky and Seymour Cray, born in the mid-1920s, pursued a vision of humanlike artificial intelligence and mainframe computing popularized by science fiction after World War II (see Isaac Asimov’s “Multivac” stories). These scientists remained committed to the glamour of big computing long after research suggested that it would not soon produce the thinking machine for which they pined. Here, science fiction’s predictions were wrong, but still influential.

By contrast, consider the influence of science fiction on the development of the personal computer and the Internet. It is often said that SF missed both, but that isn’t really true. The “cyberpunks” and their precursors began dreaming of the Net in the late 1970s. Algis Budrys’s highly literate 1977 novel, *Michaelmas*, describes a worldwide web of telecommunications and computer data. Vernor Vinge, in 1981’s *True Names*, anticipated a cyberspace that is recognizably our own. Most notably, William Gibson invented the “consensual hallucination” of the Matrix in *Neuromancer*, published in 1984. These fictions were greatly influential on younger technologists, such as Tim Berners-Lee and Jaron Lanier. The Web would not be the demotic, freewheeling society it is without the cyberpunks.

One can go further. In his survey of science fiction, *The Dreams Our Stuff Is Made Of: How Science Fiction Conquered the World*, Thomas M. Disch writes, “It is my contention that some of the most remarkable features of the present historical moment have their roots in a way of thinking that we have learned from science fiction.” I think he’s right, and so we’re publishing some science fiction of our own: a story by David Marusek, author of the acclaimed 2005 novel *Counting Heads* (see “Osama Phone Home,” p. 72). Write and tell me what you think at jason.pontin@technologyreview.com. **Jason Pontin**

Forward

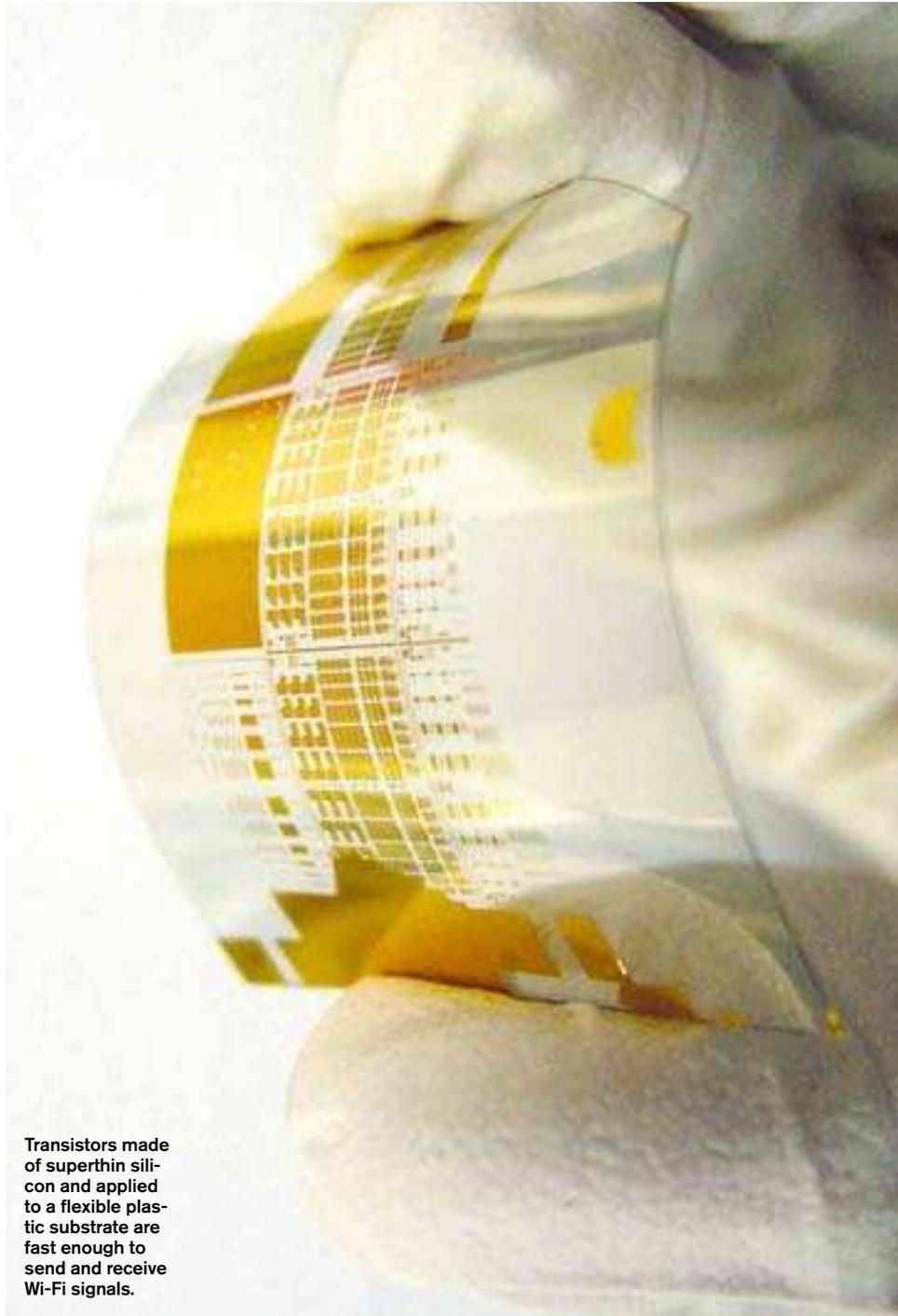
TECHNOLOGY REVIEW MARCH/APRIL 2007

HARDWARE

Fast, Bendable Computers

Already, flexible-but-slow polymer electronics have made their way into technologies like roll-up digital displays. If superfast silicon electronics could also be made flexible, we might be able to do things like weave computing devices into clothing, or mold antennas around an airplane's fuselage, making for more precise radar. Now researchers at the University of Wisconsin-Madison have made ultrathin silicon transistors that are 50 times as fast as their predecessors.

Previously, researchers at the University of Illinois at Urbana-Champaign showed that nanometer-thin films of single-crystal silicon transistors could be made flexible. But Wisconsin researchers Zhenqiang Ma, professor of electrical and computer engineering, and Max Lagally, professor of materials science and physics, improved the transistors' performance by putting strain on the silicon's crystalline structure, increasing electron mobility. And by altering fabrication methods to reduce electrical resistance, Ma achieved a transistor speed of 7.8 gigahertz—fast enough for, say, a flexible sensor that could send and receive Wi-Fi signals. Ma says he expects to reach speeds of 20 gigahertz; military antennas are a likely first application. **Kate Greene**

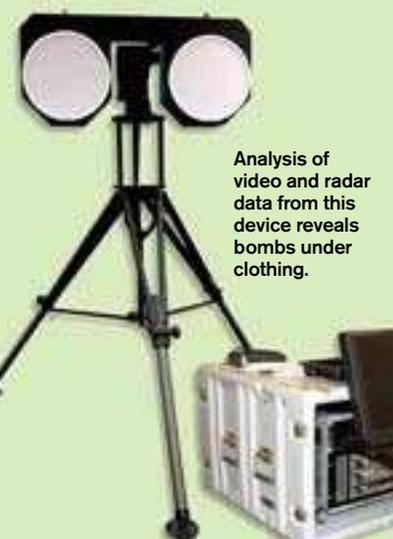


Transistors made of superthin silicon and applied to a flexible plastic substrate are fast enough to send and receive Wi-Fi signals.

SECURITY

Detecting Suicide Bombers

Screening people for bombs doesn't do much good if a suicide bomber simply pulls the trigger at the checkpoint. A new technology could detect bombs by directing a low-power radar beam at people from a safe distance—as far as 100 meters away. Signal-processing software reveals concealed objects without producing an under-the-clothes image that could violate privacy. The technology, developed by SET of Arlington, VA, is assisted by video analysis software designed by Rama Chellappa, a professor of electrical and computer engineering at the University of Maryland. Chellappa's software tracks the movements of the person being screened, which helps keep the radar on target. The software could one day augment the technology even further by discerning subtle differences in the way people walk when they're concealing heavy objects. Thomas Burns, CEO of SET, says the device, dubbed CounterBomber, could be ready for sale by this fall. —Karen Nitkin

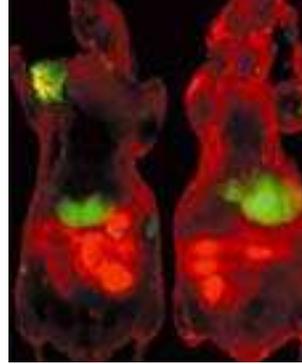


Analysis of video and radar data from this device reveals bombs under clothing.

NANOTECH

Tumor-Killing Nanoparticles

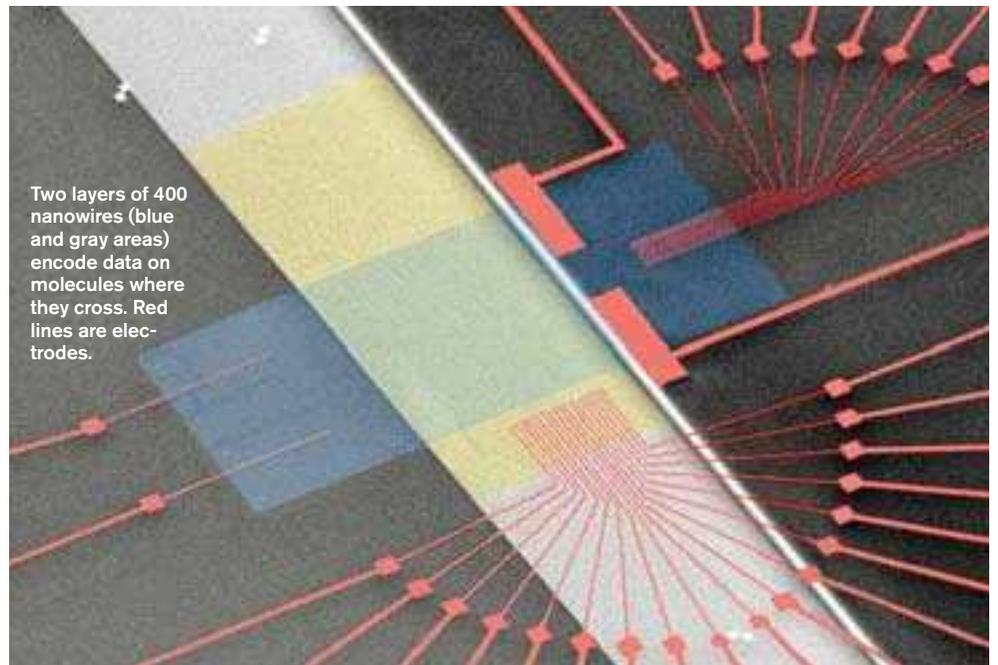
A new class of nanoparticles that accumulate inside tumors could one day improve imaging quality and cancer treatment by delivering image-enhancing agents or cancer drugs directly to tumor sites. A team led by Erkki Ruoslahti, a professor at the Burnham Institute



Fluorescent peptides attached to iron oxide particles glow bright green in a tumor (top left) and in the liver in these images of mice.

for Medical Research in La Jolla, CA, coated iron oxide nanoparticles with a peptide that is attracted to protein clots in tumor blood vessels. When injected into mice with

breast cancer, the nanoparticles sought out the tumors and bound to their blood-vessel walls. For reasons the researchers do not yet understand, the particles also induced more clotting, which attracted more particles, enhancing their effectiveness and potentially choking off a tumor's lifeblood. The team is working to ensure that the particles won't build up in normal tissues. —Prachi Patel-Predd



Two layers of 400 nanowires (blue and gray areas) encode data on molecules where they cross. Red lines are electrodes.

NANOTECH

Nano Memory

Researchers at Caltech and the University of California, Los Angeles, have reached a new milestone in the effort to use individual molecules to store data, an approach that could dramatically shrink electronic circuitry. One hundred times as dense as today's memory chips, the Caltech device is the largest-ever array of memory bits made of molecular switches, with 160,000 bits in all. In the device, information is stored in molecules called rotaxanes, each

of which has two components. One is barbell shaped; the other is a ring of atoms that moves between two stations on the bar when a voltage is applied. Two perpendicular layers of 400 nanowires deliver the voltage, reading or writing information. It's a big step forward from earlier prototype arrays of just a few thousand bits. "We thought that if we weren't able to make something at this scale, people would say that this is just an academic exercise," says James Heath, professor of chemistry at Caltech and one of the project's researchers. He cautions, however, that "there are problems still. We're not talking about technology that you would expect to come out tomorrow." **Kevin Bullis**

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