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What ten high-tech innovations will change the way you do business over the next five years? Here's what the experts think.

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Sitting on a sofa in his office in San Francisco, Dr. James Canton is pondering the future. Specifically, he's mulling the technologies he believes will drastically alter the business landscape over the next half-decade. Suddenly, midthought, Canton comes out with a startling statement. "The CFO of the 21st century," he says, "needs to understand technology better than the CIO of the 20th century."

That's a sobering prediction, particularly coming from Canton. This is not some idle daydreamer, mind you, not some pie-in-the-sky crackpot. Canton is president of the highly regarded think tank, **the Institute for Global Futures**. Moreover, he is White House advisor on science and technology, as well as a consultant to a raft of Fortune 1000 companies. In short, when it comes to business technology, Canton has a pretty good idea of what's what.

And frankly, what Canton foresees is a little unsettling. Innovative technologies, he says, will be cropping up at an almost overwhelming pace. "There has been more technology innovation in the past 50 years than in the previous 5,000." That's a lot for any finance manager to contend with–and you ain't seen nothin' yet.

In the world according to Canton, computers, networks, biotechnology,

and nanotechnology will be the power tools of the new millennium. Each development feeds another. “Technology is causing a rapid design of new products, business models, and markets,” he says, “with all eyes on the needs of the emerging customer.”

Ironically, while whiz-bang products will arrive at a regular clip, few of the underlying technologies will be overnight successes. At Xerox’s Palo Alto Research Center (www.parc.xerox.com), Nick Sheridon is working on electronic paper. Although he spent the 1980s focused on other projects, he began the paper chase back in the 1970s.

But for CFOs, the quest–and the question–is more immediate. Which leading-edge technologies should a company adopt; which can be ignored?

Unfortunately, emerging technology comes with no guarantee. The good news is that common standards and vendor collaboration are becoming more widespread, so it will be harder to misstep than back in the days of proprietary solutions. The bad news: Innovation does not come cheap. According to the London-based Computer Business Review, companies will have to spend 40 percent of their operating budgets on IT just to keep up with competitors. To stay ahead of the pack, the figure rises to about 60 percent.

That puts the CFO squarely in the hot seat. CEOs may be dazzled, but few projects will get off the ground without the CFO’s imprimatur. Innovation, it seems, still needs a little tire-kicking. “Companies shouldn’t be overwhelmed by the hype of emerging technology,” says Les Hales, director of Gartner Group in Hong Kong. “This is still 80 percent a business issue.”

Which brings us back to Canton’s prediction about the 21st century CFO. If he’s right, finance managers have some catching up to do. It’s tough to assess where your company should place its technology bets if you don’t know UCAID from UNCLE.

To help with the vision thing, eCFO interviewed scientists, gurus, and industry prognosticators. We asked: What technologies will change the way companies do business over the next five years? We purposely limited the time frame. We weren’t looking for science fiction here, but rather, real innovations that will have a real impact on real corporations–and soon.

The answers were fascinating. From holographic storage to human-computer interaction to digital ink, sweeping changes are headed our way. While our gurus disagreed on which innovations possess commercial potential, all agreed that the next five years will see widespread corporate adoption of technologies that not long ago seemed the stuff of Star Trek.

Here then are 10 technologies the experts say every CFO should know about. We've listed the choices according to the estimated time of wholesale business deployment–from sooner to latest.

Body Heat Biometric security ETA: 2.5 years

Bandied about for some time, biometric technology is becoming a reality. Biometrics enables a computer to confirm an individual's identity based on a stable physical trait, such as face, fingerprint, or iris. Once a device like a Webcam or a fingerprint pad captures an image for measurement of the appropriate body part, a software algorithm converts it to a digital code.

At its simplest, biometrics should make computer networks more secure–and will reduce the theft of information and capital assets. Beyond that, scientists believe the technology–which combines security with convenience–will ease consumer fears about purchasing over the Net. Says Dr. Joseph Atick, CEO of Jersey City, New Jersey-based **Visionics Corp**, a specialist in face recognition technology: "There is nothing to remember and nothing to leave home without."

Fingerprint verification may be less sexy, but it has plenty of support. Santa Clara, California-based **Veridicom Inc.** , for instance, was set up to create commercial applications for the biometric advances made at Lucent/Bell Labs in Murray Hill, New Jersey. And last November, Japan's NEC started fitting desktop PCs with fingerprint readers. A user can't log onto the computers without fingerprint verification.

Some companies have already embraced biometrics. San Francisco-based InnoVentry Corp., a subsidiary of US bank Wells Fargo, uses

Visionics' FaceIT technology. The system enables InnoVentry to offer ATM-based financial services to customers who normally would be considered bad credit risks.

Smart Money Cashless consumerism, smartcards ETA: 2.5 years

We know–financial institutions have been pushing smartcards for years. A smartcard looks like any other plastic card, with one major difference: Embedded in the plastic is a microprocessor capable of carrying out a range of security processes and holding information relevant to the card holder. Unlike conventional magnetic-stripe cards, a smartcard can verify PINs entered by the card holder and securely authenticate itself to payment terminals, without reference to a computer network.

Using technology originally developed at the UK's NatWest Bank, member institutions of Mondex International, the MasterCard-led consortium, started to launch Mondex cards with mondo hype in the mid-1990s. As of yet, the cards have not lived up to expectations. Even Banksys, a Belgian banking network operator that has issued some 25 million smartcards, has had a slow go changing customers' minds about electronic money. The difficulty, says Alan Laird, marketing manager for e-solutions at French electronics conglomerate Groupe Bull, is altering established habits. "When you describe it to consumers, they think it's a great idea," Laird says. "The problem is getting them to use it."

It seems, for most people, there's nothing like cash. That doesn't mean smartcards are dead and buried. Currently, there are 1.1 billion smartcards in circulation. And the smartcard concept–putting processing power onto a plastic, all-in-one-card–remains intriguing. No less a force than Microsoft has gotten behind the idea, releasing its **Windows Smart Card Toolkit**.

But smartcards need some refining. Much of that reshaping will come from Europe, where smartcards are generally more accepted. Laird believes smartcards will catch on because they speed up online

transactions and offer private and public key encryption. That verification of a user's identify, Laird says, makes smartcards much safer than conventional credit cards. Some banks already use smartcards, in tandem with biometrics, to beef up security for online customers.

Many prognosticators believe the real promise of smartcards lies in user identification. Soon, consumers will be able to use the cards to encrypt mail and identify themselves to online businesses. Moreover, smartcards enable users to sign digital documents. Using company-issued or third-party smartcards, employees will be able to fill out and sign online expense reports and group insurance forms.

Ray of Hope Fiberless optical networks ETA: 2.5 years

The performance of today's high-speed local area networks (LANs) and wide area networks (WANs) is like quicksilver–fast but erratic. The link between the two–the "last mile"–is a notorious bottleneck. Copper wires are jammed with increasing traffic, and the cost of the alternative–laying optical fibers from the WAN to the door of the LAN–has so far proven exorbitant.

Ultimately, optical switching and microphotonics–tiny optical transmission devices–will render the problem moot. Until then, technology developed by **TeraBeam Networks** could go a long way toward speeding up data flow between WAN and LAN. TeraBeam has a fiberless optical system that delivers broadband capacity across the last mile–on a beam of light. "It's a revelation," says no less a light than George Gilder, noted futurist and fellow at Seattle's Discovery Institute, a public-policy think tank.

TeraBeam's system uses photonics, an optical technology around since the 1980s, coupled with holographic and telescopic technologies. The combination sends a "fuzzy" (expanded) laser beam to transmitter/receivers in the windows of subscribers. The system can transmit up to one gigabit of data per second–640 times faster than some alternatives.

TeraBeam's technology employs standard Internet security protocols,

encoding data using methods much like those used by current mobile telephony. And it's inexpensive. Transmitter/receivers, the size of a small satellite dish, cost around $150 and take just a few days to install. The system has been tested in Seattle's business district. Service rollout to other US cities is in the works.

Up on the Net Without a Wire Wireless Application Protocol ETA: 3 years

You can't swing a dead cat these days without hitting a vendor pushing a wireless Internet product. The hype exists for one reason: the massive potential of the wireless Net.

First, a little background. Most mobile Internet products are based on the wireless application protocol. WAP is a data-delivery specification developed as a global open industry standard. The protocol enables Internet content to be displayed on the small screens of handheld devices (mobile phones, personal digital assistants, and so forth). Before WAP, surfing the Net wirelessly was like swimming in Jell-O because of the relatively low data-transmission levels. Early WAP-enabled products haven't been much better, with consumer complaints about slow log-on times and lack of wireless content.

Nevertheless, the future of WAP–and wireless data–looks rosy. In general, Japan leads the way in mobile data, with Europe fast closing in. Tapio Hedman, vice president of communications at Finland-based phone maker **Nokia** , predicts that in three years, there will be more mobile devices than PCs connected to the Net. "We don't only think WAP is changing the way companies do business," Hedman says, "it will ultimately affect the way Net users use different services."

The key to WAP's future will be convenience, says Rickard Gustafson, managing director of the European ebusiness group at GE Capital Corp. If a shopper exhausts a line of credit while shopping, says Gustafson, "with his mobile, he can go online and get a credit extension." Much will also depend on the ability of GPRS (general packet radio service), which vastly increases the data capacity of networks and phones. In Japan, which boasts a similar concept

called I-Mode, sales of handsets have soared since its launch.

We're moving toward what Hedman calls "a mobile Net society." It may take another three years to get over the teething pains, however.

The Searchers Software agents ETA: 3 years

The scarcest corporate resource isn't computing power or network bandwidth. It's time. Enter software agents, or softbots. Softbots are miniprograms that free humans from routine tasks by automating certain computing functions. In time, experts predict softbots will exercise judgment on the user's behalf.

Some softbots serve as personal assistants, finding and filtering information. Others improve process and workflow across an organization and assist with network management and diagnostics. An agent might watch for an event in a computer system, for instance, and issue an alarm when it occurs. It's believed corporate use of agent-based monitoring programs will dramatically pare IT support costs and ratchet up worker productivity.

Softbots will likely be used in data mining, as well, performing tedious searches in background mode. Mobile agents could even propagate across a network, camping where needed.

Examples of agent technology already abound. Provo, Utah-based networking giant Novell's **DigitalMe** initiative enables information to flow from a user's client device to an ecommerce server, automatically filling in forms on a retail Web site–a customer time saver. And Hewlett-Packard Labs in Palo Alto, California, has developed **e-speak** , a platform that enables Web-based networks of services to communicate with each other.

Scientists believe software agents will grow more sophisticated as artificial-intelligence techniques mature. A neural network can learn the interests of an Internet shopper by correlating the locations the surfer visits, as well as associated input. That way, the softbot can consistently deliver content of real interest to the consumer. The result should be what Marcus Zillman, CEO of **BotTechnology.com** , a community site for developers, calls "the ultimate search bot."

Casting a Wider Net Internet2, advanced networking ETA: 3 years

Folks at the University Corporation for Advanced Internet Development (UCAID), the Washington, DC-based secretariat for **Internet2** , keep tab on the most-asked questions about their much-trumpeted project. Topping the list: “When can I connect?” Not far behind: “When is the IPO?”

The answers are “you can’t” and “never.” Not a specific technology, Internet2 is more a scientific playground that tries to re-create the R&D environment that spawned the Information Superhighway and World Wide Web. Since its start in the mid-1990s, UCAID has attracted 178 US academic institutions and 70 companies as members. In addition to a who’s who of high tech, the roster comprises companies like J.P. Morgan & Co.–businesses that want a front seat on the future.

The universities and colleges bring research skills and demanding network users; the companies supply equipment, services, and cash. Computer networking giant Cisco Systems Inc. has given tens of millions of dollars’ worth of network routers, while Qwest Communications Inc. has thrown in complimentary bandwidth. Says Heather Boyles, UCAID’s director of government and international relations: “The projects provide a valuable space for companies to work in ways not possible in normal commercial environments.”

With time, it’s believed Internet2 will give rise to dramatic network technologies, such as IPv6 (next-gen Internet protocol), multicasting, and quality of service (24/7 delivery of mission-critical data and programs over the Internet). Those innovations should lead to lucrative commercial applications–things like digital libraries and virtual laboratories.

Pulp Fiction? Electronic paper, digital ink ETA: 3 years

The paperless office is a lost cause, says Nick Sheridon, senior research fellow at **Xerox Corp.’s Palo Alto Research Center**. But

the pulp-paperless office–that's a different story.

Sheridon and his team are working on electronic reusable paper. The technology, which Xerox calls Gyricon, comprises minuscule balls, white on one side, colored on the other, that rotate in response to an electric charge–digital ink, in effect. To the naked eye, the material resembles superfine sandpaper between two sheets of clear film. Sheridon anticipates resolution close to that of a typical laser print job.

3M has signed up to focus on production of the paper, leaving Xerox to concentrate on devices. Xerox's main rival in the pursuit of electronic paper is Cambridge, Massachusetts-based **E Ink Corp**. , which is commercializing technology developed at MIT's Media Lab. Backed by the Hearst Corp. and others, E Ink already has a signage product on the market. The application is obvious: billboard ads that change with the push of a button.

Xerox, while interested in that application, believes the real promise of digital ink is in newspapers and books–or any disposable document, such as draft copies–that can be updated without being reprinted. Contracts would also seem to be ideally suited for electronic paper.

Wireless transmission of data will play a key role in the rise of digital ink. One possibility is a wandlike instrument a user waves over a sheet, realigning the balls into new text and images. Or data could be stored in memory chips implanted in the devices themselves. Either would likely be a boon to mobile workers.

Sheridon, who expects the first Xerox offering to emerge next year, reckons that an 8 1/2 x 11-inch sheet might cost less than three dollars and be reusable up to four million times.

His Master's Voice Speech recognition ETA: 4 years

Star Trek seems positively quaint when Mr. Spock loads data onto a floppy disk and hands it to a crewman. But more than 30 years after the Vulcan issued his first voice commands to the ship's computer, most of us are still tapping away at keyboards.

Nevertheless, speech recognition is slowly catching up with its

promise. “We’re at the point now where we have real applications, real communication products,” says Nelson Morgan, director of the **International Computer Science Institute** , a research center affiliated with the University of California at Berkeley. But, Morgan adds, “They’re the low-hanging fruit,” such as dictation products.

Audio mining, the ability to search and retrieve chunks of spoken data, is a bit further up the tree, according to Morgan. Currently, the technology works best in a controlled environment, with careful use of microphones, and with expensive equipment. But in a few years, it’s possible that two finance managers could chat in an airport lounge, record the text on their PDAs, and search it back at the office.

Voice Signal Technologies Inc., based in Cambridge, Massachusetts, is working toward embedding speech-recognition technology in a variety of appliances, from cell phones to automobiles. And researchers at **MIT’s Laboratory for Computer Science** have developed a half-dozen voice-driven applications that provide everything from weather information to airline schedules.

Of course, the Holy Grail of speech recognition is speech-to-speech translation–the target of researchers at **Carnegie Mellon University’s Language Technologies Institute** in Pittsburgh. The institute’s Janus system translates from English or German into English, German, or Japanese. Commercially available systems that allow users to move beyond narrowly defined subject matters are still several years away. But speaking into a telephone in English, and communicating, at least in a rudimentary way, with someone who speaks Mandarin, now seems possible. In time, such technology could be a boon for companies that sell globally over the Net.

Parallel Parking Holographic data storage ETA: 5 years

Information is now the customer’s No. 1 asset,” says Bill Monahan, CEO of Oakdale, Minnesota-based storage technology provider Imation (www.imation.com <Javascript:Start(‘http://www.imation.com/’)>). “They will need more storage, better management capability, and new services.”

Certainly, graphics, images, video, and sound are maxing out traditional storage devices. Even though densities of two-dimensional media (magnetic disks, optical disks, and magnetic tape) have increased more than 60 percent annually in recent years, those gains have come by packing and stacking individual bits of data closer together. That approach may fast be reaching its limit.

Storing information in three dimensions, using holography, can increase capacity dramatically. Essentially, a hologram is produced when a laser reference beam interferes with another beam reflected from the object to be recorded. The pattern of interference is captured by photographic film, a light-sensitive crystal, or some other optical material. Illuminating the pattern with the reference beam reproduces a 3D image of the object.

A block of photo-refractive material a few millimeters thick can record and store hundreds of images at different angles, without cross-interference–individual angles provide a different view of the same object. Holographic data storage works the same way, with each angle storing a different page of information.

Imation is collaborating with **Lucent Technologies** to develop holographic drives. Imation management reckons the company will produce a 125-gigabyte disk by 2003. Future disks should hold about 1 terabyte, or eight times as much data.

One caveat: Holographic technology is analog. Therefore, corporate users will need some serious processing power to read the massive amounts of data stored on the drives. It's likely, therefore, that first-generation holographic storage devices will serve to complement magnetic storage methods. But for companies looking for high-speed access to massive data warehouses, 3D storage could prove to be an immediate solution.

Wired and Emotional Human-computer interaction ETA: 5 years

Dan Russell is a man with a plan. Russell, head of user sciences and experience research at **IBM's Almaden Research Lab** in California's Silicon Valley, wants to make the relationship between humans and

computers, well… more personal. After all, the basic computing experience hasn't changed much since PCs first showed up on workers' desks. "The best analogy I can give is that the design of amusement parks took a major shift when Disneyland opened [in the 1950s]," Russell says. "Until that point, amusement parks had been assemblages of rides, but Disney designed an experience." Computing is like that, Russell says. "Right now, we've got a motley assembly of applications on the desktop, laptop, wherever. There's no reason they can't be more coherent."

While voice plays a central role in human-computer interaction, IBM wants to shift more of the burden to the machines by exploiting nonverbal cues. **Big Blue's BlueEyes project** uses a camera to read a computer user's gaze. One prototype fills a scrolling ticker on a monitor with information related to the user's current task. The goal: to know where the user is looking, the applications that are running, and the Web pages displayed, and then suggest paths of action. Under a second prototype, the user's eyes actually affect the movement of the cursor. IBM believes eye-tracking technology will be fairly common in five years.

Experts are also measuring the heart rate, temperature, galvanic skin response–yes, galvanic skin response–and minute body movements of human test subjects, then matching them with six emotional states: happiness, surprise, anger, fear, sadness, and disgust. The next step would be infrared or temperature-sensitive devices embedded in a chair, keyboard, or mouse that take readings from the user. The computer would gauge the emotional state of the user, then adjust the presentation of information accordingly. Backers believe such customizing will increase worker productivity dramatically.

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