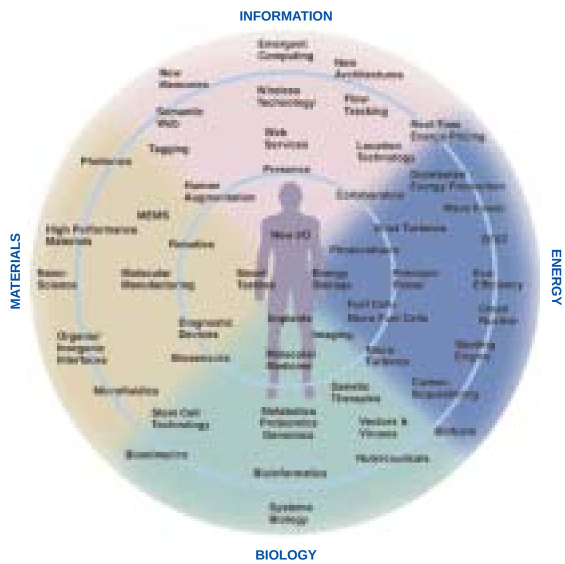
The New World Map:

A Quick Tour of the Ten-Year Technology Horizon



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About the Institute for the Future

Located at the northern edge of Silicon Valley in Menlo Park, California, the Institute for the Future is an independent, nonprofit research firm that specializes in long-term forecasting. We help businesses identify and evaluate specific opportunities presented by market trends and new technologies. Founded in 1968, the Institute for the Future has become a leader in action-oriented research for business, government, and private foundations. Our members include Fortune 500 companies as well as midsized and emerging companies. We analyze policy, forecast alternative future scenarios, and identify markets for new products and next-generation technologies.

Acknowledgments

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Introduction

Every two years, the Institute for the Future (IFTF) surveys the broad technology horizon to reconsider and recalibrate the future. Our goal in this process is not so much to list interesting new technologies as to see how the many innovations from different sectors will intersect. We're trying to *imagine* the kind of the world they will create, taken together.

We represent this scenario graphically. Two years ago, we followed key trend lines from each of four sectors: information technology, biotechnology, material science, and energy. We identified hot spots at the intersections of these trend lines.

This year, we see that these intersections have already begun to weave a much more cohesive picture, an increasingly integrated whole. We've chosen to represent this world as an interdependent system, with the human body at the center.

This memo is a quick tour of our map. The map itself is an electronic hypertext tool with three different views, nearly 100 text "briefs," and a handful of short digital films that illustrate some of the most intriguing ideas to come out of this broad scan. What follows are the highlights.

From Center to Periphery:
Slouching Toward an Ecosystem

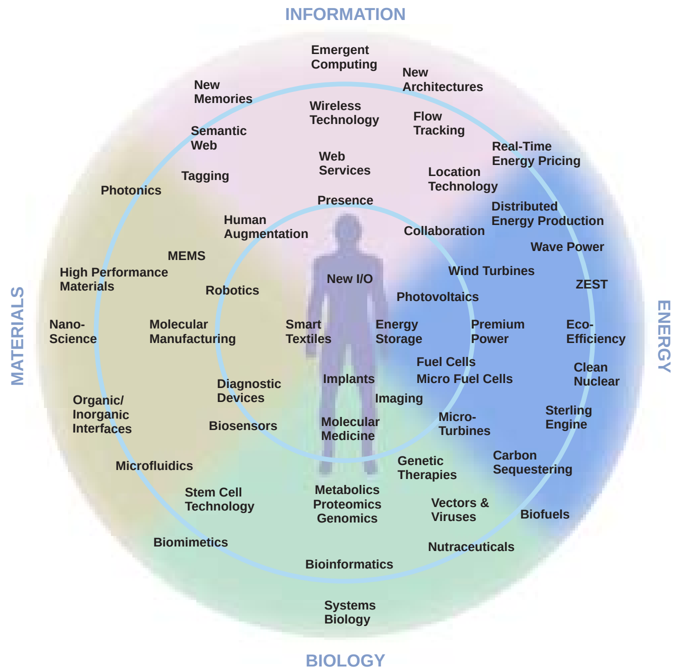


Figure 1
One of the ways to read this map is to see it as a series of concentric rings. Close to the center are the technologies that will be our personal interface to the new world. Spiraling out from the center are the technologies that will shape our businesses and communities, our society and economy. At the outer edges are the science and conceptual innovations that will shape the way we think about the world, our work, and our humanity.

Let's start at the center of the map—with the human body. We placed this human body at the center of the map because, in the next decade, it will become one of the primary application areas for new technology. New biotechnologies and innovations in life sciences will target, first and foremost, human health. Information technologies will develop increasingly personal and intimate interfaces. Energy sources will be portable, wearable, even implantable. Materials will change our clothing into information systems, medical systems, security systems.

So the first ring of technologies around the body are those that will be the most intimate with our bodies. New input and output devices will build on the intersection of information technology with biology and materials. Biometrics and direct neural stimulation will give us custom access and custom experiences in a physical world increasingly embedded with information. New materials will respond to touch, movement, or body heat and chemistry to provide richly embroidered information about the physical world or even to heal our bodies. Meanwhile, small-as-a-pin batteries will intersect with molecular-scale drug delivery devices, using new materials to mimic cellular processes. These and other implantable devices will bring the world of technology right into our bodies—whether it's biotechnology such as genetic vaccines or electro-chemical devices to stimulate an ailing nervous system.

As we move away from the center of the map, we enter the realms of society and economy. Here are the technologies that will shape our work and home lives, our business opportunities and our communities. A theme circles through this ring: *small components, big systems*. RFID tags, XML tags, plus Web services—all very small—add up to a global computing environment. Fuel cells, photovoltaic solar cells, and small turbines have the potential to restructure the energy grid as a large but distributed infrastructure, blurring the distinction between big producer and small consumer. Throughout the realm of biology, discovery will be increasingly focused on the complex interactions of the smallest molecules with whole systems—from the proteome to the genome to the physiome. In the matter of materials, manufacturing will be re-envisioned from the molecule up, layering yet another human era on top of our existing heritage of agricultural, industrial, and digital production.

Reaching the periphery of the map, we come to the more abstract science, the new concepts that will give rise to future technologies, even beyond our ten-year time frame.

At the four cardinal points of the map are the tenets of a new worldview—one which is distinctly ecological. It's no surprise that biology is the template for this future. Literally, much of what will be truly transformative in materials and computing and perhaps even energy will copy the structures and rules of biological systems. Inorganic materials will self-assemble from organic templates. Organic computing will make strides toward using the intelligence embedded in proteins to solve complex problems, while genetic algorithms and neural programming will link bioinformatics and computing in a virtuous cycle of innovation that ends in self-organizing programs. In energy, new technologies and market strategies will become increasingly subject to ecological benchmarks while at the smallest scale, bio-like membranes will solve problems with water management in micro fuel cells. (Water is the waste product of hydrogen fuel systems.)

Taken as a whole, then, this map of the world tells a story of technology that is transitioning from independent engineered systems to interdependent emergent systems. If we ever harbored the illusion that we were controlling our tools, this is the time to give it up. Our tools are becoming our co-authors in what India has long called *leela*—the play of form.

The Four Sectors:
Vanishing Boundaries

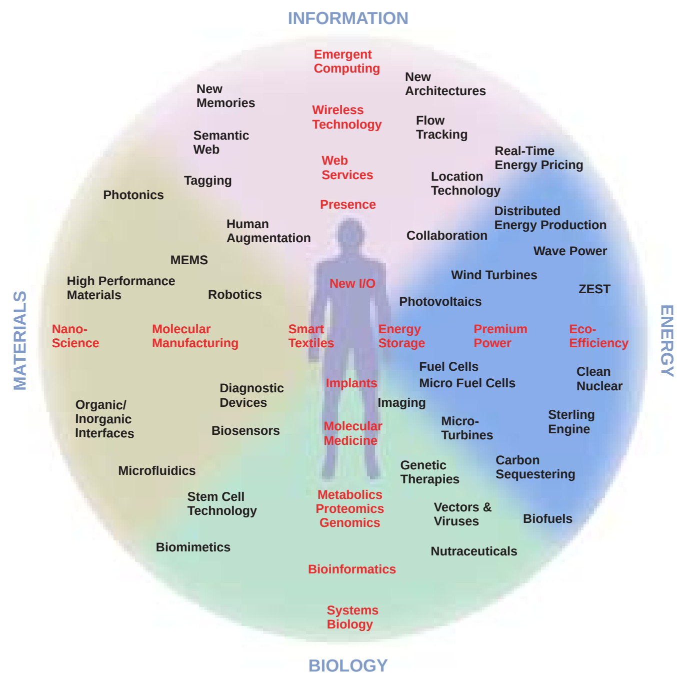


Figure 2
The cardinal points at the top, bottom, and sides of the map form two axes that show the main trajectory of each of the four sectors. The boundaries begin to define the emerging culture at the intersections.

Notice that the cardinal points of our new map of the world form two intersecting axes. Along these axes are the defining technologies in each of the four sectors. At the boundaries of the four sectors are the technologies that will emerge as these four main vectors color the culture of each territory.

Start with energy. Here, the marketplace will buzz with the technology of premium power—power that people will pay more for, per watt. This is a way to frame, and perhaps justify, three decades of investment in energy technologies that provide a measure of self-sufficiency and independence from the traditional grid (although, as we'll see below, they will definitely not cut us loose). The fact that these are high-cost add-ons when they were originally conceived as low-cost alternatives reflects our increasing sophistication about eco-efficiency. When we take into account the start-to-finish efficiency of technologies like fuel cells and photovoltaic cells, they do in fact cost more. They also come with some built-in problems, namely storage. So watch for innovations in energy storage to parallel the growth of these mini-production technologies.

Now, biology. We arrive here—at biology as a technology—having traveled the path of information technology. So it is no surprise that we should see biology through the lens of information systems. At the most conceptual level, we are finally able to engage biology as an entire system, empowered by information technologies that allow us to track the parts and the whole at the same time. In the marketplace, this new capability plays out in the "*ome*-ification" of biology—the creation of comprehensive information platforms about the gen*ome*, the prote*ome*, the metabol*ome*. These are descriptions of key systems within the biome, but they are also platforms for buying and selling information about human health—and ultimately they are platforms for products that use this information. These platforms will be the springboard for molecular medicine—much of which will be delivered to the body through implants.

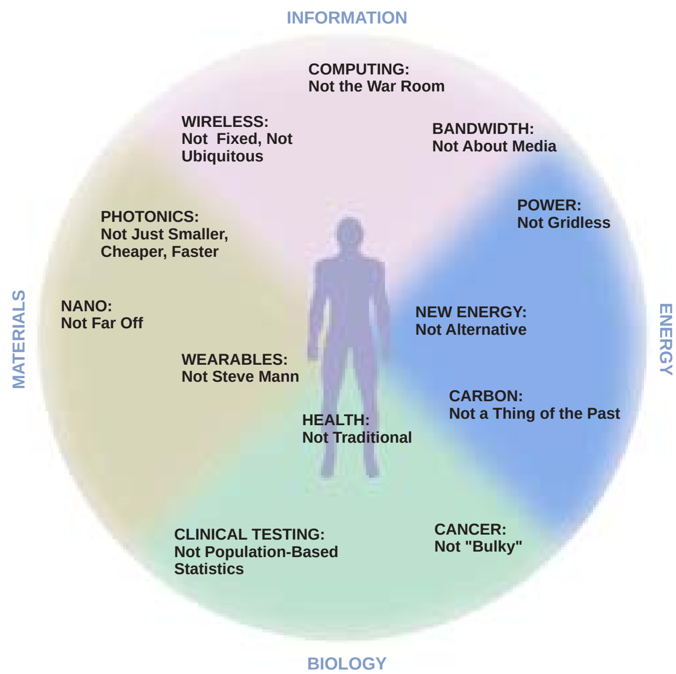
The transition from biology to materials is almost invisible. Here, too, molecular-scale technologies are the leading edge, and many of them will initially focus on health. But the big story in this sector is the reconceptualization of manufacturing from an industrial model (that focuses on converting large resources into mass products) or a digital model (that applies that same paradigm in miniature) to a model of molecular self-assembly. In this model, the qualities and behaviors of molecules are manipulated to create more or less complex products. Close in to the body, we can expect these new molecularly conceived and manufactured materials to interact with our interest in embedded intelligence and ultimately transform our clothing.

Finally, circling up to the top of the map, we plot the future course of intelligence. With the obvious current focus on wireless communication, small web services that interact more or less autonomously, and presence (in the guise of instant messaging), we begin to see a new form of computing that transcends the underlying technologies—whether they are electronic, photonic, atomic, or organic. We've called this "emergent computing" and define it in more detail later. Suffice it to say for now that we mean computing that emerges from a complex network of data, sensors, tags, and semantic metatags, all interacting with lots of independent small programs according to a minimum set of high-level standards. We can expect this kind of computing to behave like any complex, self-organizing system, producing emergent behavior that can't be predicted in advance.

That's the sector-by-sector tour. But what of the intersections, the regions where the sectors overlap? In our two-dimensional map, we're constrained to consider four of these regions. Here's how we see them: The region between information and materials is characterized by embedded intelligence. Between information and energy is a culture of ruggedly individualistic collaboration. At the boundary between biology and energy, issues of life and death are being redefined as issues of quality of life. And a quarter turn around the map, at the boundary between biology and materials, templates are the dominant theme as organic forms provide both conceptual and physical scaffolds for inorganic materials—and vice versa.

The Top 12 Trends:
Not Exactly What We Thought

Figure 3
Technologies often have their own trajectory, but they don't become world-changing trends until they interact with the marketplace. We've tried to identify a dozen key trends that are likely to emerge as the technologies on our map interact with consumers and companies, with business models and policy choices. If you're looking for what's important, these are our top candidates.



The second layer of our map focuses in on the 12 trends that we think are most important to track. Trends, by definition, have a history. Most of ours have relatively short histories, and it's always dangerous to forecast the future from a short history. Nevertheless, for most of our top picks, we're able to look back at least a few years, see what people were thinking then, and compare that to where we are now. In all of our cases, we find a departure—or at least a clarification—from the earliest expectations. So here is our pick of 12 technology trends that are not exactly what we thought they would be. (Supporting data is included in the hypertext version of the map.)

Wireless:
Not Fixed, Not Ubiquitous

The broadband wireless grid will not be built out the way the cellular phone grid and the first digital wireless grid were. It will not be the much touted 3G or any product of telecom companies aiming to provide ubiquitous coverage in large-scale markets. Rather, it will be a network ecology, built out using a mix of technologies and business models.

In one model, the buildout happens through a loose collaboration of established carriers, network device manufacturers, and companies that would ordinarily spend a lot of money on large marketing campaigns—that is, consumer goods and services companies. The consumer companies will pay for installation of network connectivity in hot spots, such as their own premises or places where their goods are consumed. The carriers will provide the long-line connections in exchange for a portion of consumer company revenues.The consumers will pay for connect time and get goods or services for free. Or they'll pay for goods and services and get connect time for free. This is the "hot spot" model of wireless service—it doesn't aim for ubiquity.

Another scenario combines mesh networks with ad hoc device-based networks. The mesh networks use a NAP—a high-power neighborhood access point—and then a lot of low-power "piggyback" antennas to extend the network inexpensively through an evolving network of homes or offices. Portable Bluetooth, Wi-Fi, and other network devices could use these mesh networks, but also act as relays, untethering the network and extending it in a constantly changing configuration.

In either case, the network is dynamic, in a state of constant flux, with changing concentrations of nodes and traffic depending on the behaviors of consumers and businesses trying to reach those consumers. The end result is that broadand wireless looks less like a ubiquitous, closed utility and more like an open, changing ecology.

Bandwidth:
Not About Media

When we look at the future of bandwidth, we need to ask three questions: How much bandwidth will be available? Will it be wired or wireless? How will it be used?

A debate rages over the whether or not there's a glut of fiber optic bandwidth. The debate centers on how much of the current fiber infrastructure is actually lit, and the estimates range from 2-5 percent to 25 percent. What everyone agrees about is that the cost of lighting fiber is a lot more than the cost of laying it (about 20 times more).

Furthermore, while carriers may be suffering under the debt of installation, they haven't really over-installed. Big utility grids are typically installed to meet demand 20 years into the future. A use rate of 25 percent at this point is just about on target. Also, 63 percent of the data routes between large cities are currently running at or near capacity.

Metropolitan areas are much more congested, creating choke points. Carriers are actually going to need to upgrade their fiber lines in the not too distant future.

Meanwhile, the participants in the wireless network ecology are racing to bring broadband wireless to users who increasingly have multiple devices often operating simultaneously. If these technologies can rapidly pick up customers, they could add both capacity and demand, especially in metropolitan areas.

So what will we use the bandwidth for? Some software and hardware manufacturers continue to bank on personal digital media that look a lot like traditional broadcast media—family photos, music exchanges, workplace IP broadcasts. These players may be looking in the wrong direction, however. Visions of Internet video and audio are perhaps only copycat dreams. They simply mimic broadcast media and telephony.

The authentic use of the new broadband digital network is likely to be something quite different—a material medium in which things take on communication functions. In the coming decade, the combination of sensors with data and object tagging will begin to define a new medium that is more authentically suited to the broadband digital infrastructure. In this new medium, things will not only talk to things, but also make decisions, and ultimately even act on the basis of the information they exchange. Humans are perhaps only minority players in this new medium.

Emergent Computing:
Not the War Room

A little over a decade ago, industry leaders began to define a new direction for computing—not a desktop box, not even a portable or handheld device, but rather a world in which computing becomes embedded in the environment. Descriptions of this ubiquitous or environmental computing sounded a lot like Hollywood visions of the war room: walls paneled with large displays; cameras focused on every corporate "battlefield" from the conference room to the water cooler; continuous audio feeds from multiple sources; modulated to reach individuals at just the right time and in the right context. Augmented reality was cast as a kind of constant visual overlay on the material world.

Today, five years later, a more likely shape of "out-of-the-box" computing is coming into focus. We've called it emergent computing—by which we mean that a combination of network architectures, web services, tags, and sensors create—and recreate over and over—a dynamic computing environment which is not programmed but which is self-organizing. Sensors automatically capture information. Tags declare the information to Web services that process it and deliver it to specific virtual or real-world locations, based on requests from other web services. This is, in fact, much more in keeping with the original vision of ubiquitous computing, also called "calm computing," developed by the late Mark Weiser, former chief technology officer at Xerox PARC.

Power:
Not Gridless

When fuel cells first became the big buzz, we immediately thought about off-the-grid power—real options for upscale urbanites who wanted to get away from it all and finally build that home in the Grand Tetons. Or we speculated that such a technology might power remote villages in undeveloped regions to bring impoverished people into the global economy.

A few years later, though, it looks like the new power technologies will actually find their home in the areas where the grid is already built out to the max. It will be supplementary power—power to rely on when the grid can't handle the load or can't provide the reliability and peak loads that a consumer requires. Or it will be a new source of revenue for business and household consumers alike.

Self-sufficiency (the counterculture romance of the 1970s) is redefined here with an upscale overtone. And none of these new power consumers are romantic enough to disconnect from the grid. No, these are the MBAs and engineers of the 1980s, the entrepreneurs of the 1990s. Not only are they not going to disconnect from the grid, they're going to run their meters backward, sell their excess power back to the power companies, and get their electricity for free. And even those who don't invest in their own corporate or household power plant will be monitoring the grid to save money—using technology that calculates the cost of power in real-time and makes decisions about deploying power based on those calculations. Smart appliances will use power when its most cost-effective. The result is a more consumer- and business-friendly grid.

New Energy:
Not Alternative

The new energy has its roots in the alternative lifestyles of the 1970s. Solar, wind, and geothermal power were all conceived as replacements for carbon-based fuels (and their high environmental impacts). In the 2000s, however, these and other non-carbon technologies are emerging not as alternative technologies but as premium technologies. As indicated above, they are supplemental. They will initially cost a lot more per watt and people will pay more because they can't stand to be without them.

People will want a long charge for their laptops and cell phones. If they're in manufacturing or if they run a hospital, for example, they need extra reliability. If they're putting up wireless towers, they don't necessarily want to follow the power lines. The highest premiums will go to portable power; the lowest, to the automobile. This cost curve means that houses will be commercially fitted with fuel cells before cars are (which our experts forecast will happen by the end of the decade). But even when cars go hydrogen, they will almost always be second (or third) cars.

The end result is that these technologies will actually increase overall demand for power.

Carbon:
Not a Thing of the Past

While new energy technologies will come online to meet excess demand for power and provide reliability on an increasingly congested grid, they will not be competitive solutions for the carbon problem. (This problem can be defined simply as the damage to the atmosphere from burning carbon-based fuels like coal, oil, and natural gas). Instead, carbon abatement will most likely come from two sources: increased efficiency of existing carbon-based power technologies and carbon sequestration.

Over the past 30 years, as non-carbon technologies have been evolving, conventional power plants have been steadily increasing in efficiency—doubling in the last ten years. Today's modern plants define the efficiency factor to beat: 50%. None of the non-carbon technologies beat this number. PEM fuel cells come in at 55%. A new zero-emission steam turbine technology is somewhere in between, but it has an advantage when it comes to carbon emissions: it burns natural gas and delivers pure carbon as waste that can be immediately sequestered.

Carbon sequestration is the second half of the equation for near-term carbon abatement. Carbon sequestering removes carbon from the atmosphere. It can happen two ways. One is to plant forests which remove carbon dioxide from the atmosphere. The other is to bury it in the ground or in pockets on the ocean floor. Carbon sequestration technology may be the world's best hope for combating global warming in the first half of this century.

Health:
Not Traditional

The single most striking—and perhaps most important—trend to emerge from the new technology horizons map is the focus of investment on health applications. Many of these new technologies and applications will be in clinical medicine—that is, they will require the knowledge and acceptance of trained medical specialists to bring to market and to administer in an ongoing health care delivery system.

However, many other technologies will develop at the edges of traditional health care, in applications that intersect other markets: alternative health, food, cosmetics, fashion, security, and the building trades. These will attract new money to health, rapidly expanding a health market that is already the third largest sector of the economy—to the extent that we are forecasting a health economy as the basis of overall market growth within a decade.

The big growth in this expanding health market will occur precisely at the intersections with these six related markets. The result will be twofold. First, each of these markets will be redefined, to a greater or lesser extent—in terms of health. This means that people will think of products in these markets increasingly in terms of their health benefits and make purchases based on those benefits. The simplest examples are clothes that protect against the sun's UV rays or snack bars that are proven to reduce the risk of heart disease.

Second, traditional health care may not be the sole beneficiary of the projected increase in health spending over the next decade. New health consumers—the 50% of consumers who have discretionary income, who are well-educated, and who rely on information to make health choices—could spend an increasing proportion of their health money (and their household budget overall) on non-traditional health products and services in these related markets.

The distribution of benefits from emerging technologies and health spending remains a challenging problem. This scenario, in which the edges of traditional health care grow more rapidly than the core, may ultimately undermine the ability to provide basic health services to poorer populations.

Clinical Testing:
Not Population-Based Statistics

One of the promises of the project to map the human genome has been to lower the overall cost of drug development. The scenario goes something like this: using information technology, we can do a lot of the preliminary testing in silico (dry labs) to greatly reduce the number of drugs going into costly clinical trials. And when a drug does go to clinical trials, it will be more likely to succeed and the clinical trials themselves will become simpler and less costly.

However, with the mapping of the genome, attention has shifted to the proteins that enact the genetic code in a particular cellular environment. At the same time, the development of microfluidics technologies has raised hopes of being able to observe the impacts of protein-based drugs on a single cell or a single cell site. Together, these two technological developments have signaled a possible change in the future of clinical testing: rather than focusing on population-based tests (with a statistical range of acceptability for the entire population), future testing might actually rely on diagnostic kits that first identify the presence of target cells in an individual and then measure the direct impacts of a drug on those cells. This strategy of identifying the right person for the right drug would change not only the ultimate delivery of drugs, but also the way that clincial trials themselves are conducted.

Some people see such diagnostic testing as technologically viable within five years. FDA policy, of course, would have to catch up.

Cancer:
Not "Bulky"

Everyone seems to agree that immune diseases such as AIDS and cancers will be the first targets of genetic therapies. A few years ago, such therapies promised to eliminate fatal cancers—turning cancer into a chronic disease. This promise stands today, although with the clarification that like many chronic diseases, chronic cancer will be challenging (and expensive) to live with and will ultimately be a cause of death.

The gene therapy scenario for treating cancer begins with conventional chemotherapies to "de-bulk" the cancer. (The bulk of cancer cells is what makes the disease fatal.) However, the side effects of these chemotherapies will be reduced significantly by targeting the right cancers in the right people with the right drugs. Once the cancer is de-bulked, the patient will begin a life-long regimen of cancer vaccines, approximately six times per year.

This transformation of cancer is significant for a number of reasons. First, any life extending technology has a demographic impact: it tends to increase the overall population and the aging population in general. Second, it will be expensive. This expense will ultimately come back to rest on consumers' shoulders, whether it is distributed across the population or seen as an individual choice. In either case, it inflates the portion of the household budget spent on health care and probably excludes the poorer members of the population from such treatments.

Nano:
Not So Far Off

Two years ago, when we did our last broad scan of the technology horizon, we placed nanotechnology at far reaches of our map. We said it would probably show up around 2015 at the earliest, most likely in the world of electronics.

A lot has happened in the intervening two years, and some forms of nanotechnology now loom as a commercial frontier within this decade. Nanotechnology is about creating materials and devices at a very small scale—smaller than the micron that has defined microelectronics for the past half century. More practically, nano can be defined as the scale at which a material is fully defined, which usually involves hundreds to thousands of molecules.

Just as photolithographic manufacturing techniques have defined the era of microelectronics, molecular manufacturing will define the era of nanotechnology. Molecular manufacturing depends on the ability to control molecular interactions—the triggers that start a chemical or bio-chemical reaction in a molecule. It also depends on the ability to analyze these reactions. We already have the technologies to control these reactions. The breakthroughs that will eventually push molecular manufacturing into the marketplace will be the development, in the next 5 to 10 years, of tools for probing, measuring, and analyzing events at the molecular level. These tools will allow molecular manufacturing processes to be standardized for repeatable quality and efficiency.

How close are we? Some nano-scale applications already exist, but a robust industry based on self-assembly will depend on how quickly the analytical tools are developed. As IFTF technology forecaster, Paul Saffo, likes to say, the current state of nanotechnology is akin to the transistor; we still await the equivalent of the integrated chip. That said, it is worth noting that a start-up firm called Neophotonics is currently offering as its primary technology a molecular manufacturing process—which brings us to our next trend.

Photonics:
Not Just Smaller, Cheaper, Faster

Photonics has been cast as the successor to electronics—a smaller, cheaper, faster version that will allow us to keep a Moore's Law trajectory for computing and communications.

But just changing scale won't necessarily pay off with exponential rewards. Photonics is not the same as electronics. The principles of electronic engineering don't really apply here. Instead, we need to think of photonics as a new paradigm, which is where molecular self-assembly comes into play. Photonics, not electronics, will most likely be the commercial testing ground for molecular manufacturing.

It should be noted that photonics is just one of many options for the future of computing technology. Quantum computing, organic computing, and photonics are all candidates for new non-von Neumann computing architectures. We focus on photonics here because it bridges the gap between digital intelligence and light—that is, it potentially integrates the display with the computing and communications intelligence. Already we're starting to see light-emitting technology being applied to textiles. Just as electronics integrated lots of different computing functions on a single chip, photonics could take that integration further, to seamlessly integrate display with intelligence. This development leads us, once again, to another trend—which is smart wearables.

Smart Wearables:
Not Steve Mann

Steve Mann is the former MIT Media Lab poster boy of wearable computing, now at the University of Toronto. For nearly two decades, his garb has included fanny pack-style computers, and a visor that sports both a digital camera for sending images to his Web site and a miniature display for viewing the virtual world while plodding through the real world. He also had embedded sensors to monitor bodily functions. Mann gained notoriety when he was stopped by airport security and forced to unplug in order to board the plane—and subsequently suffered psycho-neurological disorders.

This is not the future of smart wearables. Smart wearables are more about materials than they are about computing. Consider the recent announcement by France Telecom that they have created an optical fiber that can be woven into fabric using conventional weaving technologies. Or perhaps even more interesting is some of the work being done by the MIT Institute of Soldier Nanotechnology, where fabrics can change colors, patterns, textures, and porosity to camouflage, protect, and even heal the wearer.

This doesn't mean that computing and connectivity are absent from the future of wearables. But they're much more integrated into the fabric of life, so to speak. Combine the new materials with very small RFID tags and we have the ability to connect clothing to the global Internet or a private intranet. Clothes, like other objects, then become part of the world of emergent computing. They become the body's ongoing interface to this new distributed computing environment. They perhaps monitor our vital signs and alert us or others when a critical threshold is reached. Maybe they monitor the environment for pathogens or toxins and even respond by altering our "close-in" environment.

Steve Mann wore technology because it was big and visible. He once confessed that he rode his cyber-bike as a way to pick up women. The rest of us will do the opposite: we'll wear it because it is invisible and unobtrusive. But like Mann, we may come to depend on this exoskeleton.

Such a forecast brings us back to where we began our tour of the map…with the new intimacy of technology and the body. Put on your clothes and you're putting on the world.

Glossary

- **Biome.** A comprehensive set of information about the structural and functional characteristics of an entire biological system.
- **Genome.** A comprehensive set of information about the entire genetic composition of an organism.
- **PEM fuel cells.** An energy technology that uses a proton exchange membrane (PEM) to create electrical power by stripping hydrogen atoms of their electrons, leaving them with the positive electric charge.
- **Physiome.** A comprehensive set of information about the structural and functional characteristics of an organism.
- **Proteome.** A comprehensive set of information about the proteins of an specific individual's organ or organism under a variety of conditions. A proteome differs fundamentally from a genome in that it is dynamic rather than static.
- **RFID.** Radio frequency identification. This technology is used in very small chips that can be embedded in products and packaging, and read at a distance.
- **Web services.** Based on XML and its extensions, these are programs that allow different kinds of web applications to talk to each other and share data from diverse sources.
- **XML.** Extensible markup language. XML is a broad and flexible standard, like HTML, for marking data with relevant contextual information.

In Conclusion:
The Technology Horizon as Cultural Horizon

The Institute for the Future has a persistent interest in culture. From early on when developing and evaluating new group media, we have focused on how these technologies are adopted in different contexts, redefined to fit those contexts, and appropriated as symbols for what is important in work and life.

We suggest that the most profitable way to use this interactive map is as a starting place for exploring the cultural horizon. Use it, as we have in our short digital stories, to imagine how new technologies might change business processes or household choices. Use it to identify new product or service opportunities; to anticipate turns in the road that could take your organization by surprise; or to interpret other technologies that we didn't include. Finally, don't shrink from asking the large and difficult questions about whether this horizon is where we want to go, not only as individuals and companies, but as a species. After all, the new world map is, as we have said, a distinctly ecological map. It won't do to look at any single opportunity in isolation from the whole.

For more information on this Technology Memo Series or on the Institute for the Future's Technology Horizons work please contact, Patty Zablock at 650-854-6322 or pzablock@iftf.org.

Who and What to Watch:
Some Good Guides to the Future

As we were looking for human guides to the future, we had one overriding criteria—they had to be working "in the trenches" at the edge of challenging technologies, markets, or policy issues. Our new world map is really the result of their work. They certainly aren't the only players worth looking at, but if you want to watch the evolution of the map we've drawn here, these are some very important people to track:

- **Tom Armour,** DARPA—Augmented Human Intelligence
- **Jon Bosak,** Sun Microsystems—Universal Business Language
- **Steve Burrill,** Burrill & Co.—Bio-Sciences Investment
- **Gerald Ceasar,** National Institute of Standards & Technology—Premium Power
- **Joel Darmstadter,** Resources for the Future—Modeling of Energy & Environment
- **John R. Delaney,** Neptune Project—Ocean Floor Research
- **William Dolan,** Microsoft Research—Natural Language Recognition
- **Skip Ellis,** University of Colorado—Collaborative Workflows
- **Albert Folch,** University of Washington—Microfluidics
- **Martin Giedlin,** Cerus—Genetic Therapies and Cancer Vaccines
- **Jonathan Grudin,** Microsoft Research—Collaborative Information Retrieval
- **Gus Hunt,** CIA—Metalanguages
- **Tim Jenks,** Neophotonics—Molecular Manufacturing
- **Chuck Klabunde,** Boeing—GRID Computing
- **Robert Morse,** IBM Almaden—Autonomic Computing
- **Nagesh Pabbisetty,** RealNetworks—Collaborative Media
- **Kris Pister,** University of California, Berkeley—Smart Dust
- **John Platt,** Microsoft Research—Statistical Media Analysis
- **Nuria Oliver,** Microsoft Research—Attentional User Interfaces
- **Robert Schneble,** Boeing—Data Fusion
- **Ray Smith,** Lawrence Livermore National Laboratory—Zero-Emission Energy Technologies
- **Vivek Subramanian,** University of California, Berkeley—Organic, Very Low-Cost Tags
- **Amitabh Srivastava,** Microsoft Research—Collaborative Programming
- **Turner Whitted,** Microsoft Research—MEMS Display
- **Steve Wood,** Wireless Services— B2B "Hot Spot" Software

Please note that the labels for each person above are ours and are not necessarily endorsed by the individuals. Also, the map and corresponding descriptions are only our interpretation of what these experts told us, not necessarily their viewpoints. Any errors are ours.