High Tech's Bright Horizon

Area Development Site and Facility Planning
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The current knowledge-based economy will be markedly smarter tomorrow, as the seeds of future innovation are being planted in many sectors today.

WANT A PEEK INTO THE FUTURE of high tech? From advanced biodegradable products and integrated supercomputers to nanoscale fuel cells and personal planes, developments in the technology world will dramatically impact the world at large. Here's a glimpse of how four key sectors are shaping and accelerating how we live and work in the world.

Biotechnology's Third Wave

Coverage of biotechnology advances typically focuses solely on the areas of medicine and agriculture. No more. Enter the fledgling and equally world-changing area of industrial biotechnology, poised to make its mark as the "third wave" of biotech.

Powerful scientific tools developed in Healthcare biotech and now applied in the manufacturing sector are creating "a new industrial infrastructure based on biology and renewable resources instead of older rust-belt technologies and fossil fuels," says Brent Erickson, vice president of the industrial and environmental section of the Washington, D.C.-based Biotechnology Industry Organization (BIO).

"The recent dramatic advances in biotech techniques, such as genomics and bioinformatics, are creating a paradigm shift more robust and inherently cleaner than the existing manufacturing paradigm," Erickson says. "And it holds a huge potential for economic development in all regions of the country."

The big news is the anticipated production boom of the cleaner fuel ethanol, which reduces carbon dioxide emissions from vehicles and doesn't pollute the groundwater. "It's a transitional fuel we need to use now until the hydrogen economy comes 20 years in the future," Erickson says. New technology now allows firms to take leftover

biomass waste (e.g., from com, rice, or sugarcane) and turn it into this promising fuel. For example, earlier this year Canadian biotech firm logen produced and delivered the first commercial quantity of cthanol from wheat straw to a petrochemical refinery in Ottawa.

"Every region, every state has the biomass resources ready to be converted into ethanol," Erickson notes. Since the fuel can't be pipelined - only hauled by truck or rail - it's a bit expensive now to transport it long distances to end users. However, when communities start making the fuel locally, costs should come down significantly - and employment figures should go up. Erickson points out that analysts in Iowa, a state with abundant biomass waste, estimate that 10 new bio refineries alone will create 22,000 new jobs.

And it's not just energy being created. It's also a diverse catalog of biodegradable products. In Blair, Neb., for example, Cargill Dow is making biodegradable plastic from corn. Other firms are making industrial chemicals, pharmaceutical drugs, better degreasing agents, metal cleaners, and much more. Together all these new biotech enzyme technology products are creating a "strong ripple effect" in the national and global economies worth "hundreds of billions of dollars," Erickson states.

IT'S New Networks

These days the hardware and software marvels bringing life to information technology (IT) are developing at rates that were hard to imagine possible just a few years ago. So to predict where the industry will make breakthroughs it may be best to consult recently published science fiction books describing "impossible" technology now poised to become reality.

Certainly life-sciences research continues to benefit from IT advances that make it quicker and easier to collect, archive, and analyze complex data from experiments. For example, the Interoperable Informatics Infrastructure Consortium is working on creating a standardized global language for the biotechnology and pharmaceutical industries which will help search, manipulate, and link biological databases.

Enter "Blue Gene," IBM's super-computer project for life science now under development. This new family of optimized supercomputers will handle gigantic amounts of data while consuming just a fraction of the power and floor space required by today's fastest systems. The Blue Gene machine, now being created at the Lawrence Livermore National Laboratory in California, will be 500 times more powerful than today's fastest computers when it is completed next year.

Predicting what will dominate the IT world 10 years from now is almost impossible,

says Patrick Juola, assistant professor of computer science at Pittsburgh's Duquesne University. "We may even have warp drive by then," he adds with a laugh. "Data mining and interlocking databases will be big, however. For example, all your purchases will be analyzed so businesses can predict by what you purchase from Amazon.com what kind of car or other products you may buy."

When library and Wal-Mart databases combine, he notes, we'll lose the idea of what "average America" wants. Computers will have the power to find us and meet our consumer needs individually. Concurrently, inventory and/or product tracking chips will become more sophisticated.

"Businesses may be able to tell how oftun you wear a shirt back into a store, or where it goes," says Professor Juola, adding that "invasion of privacy may become a very serious issue" with such advances. Cheryl Currid, president of Currid & Company, a Houston-based technology research firm, agrees. "There are no secrets in the digital world. Privacy as we know it today will be gone."

In the near future a computer on your desk will be quaint, predicts Juola. Instead it will be "everywhere you go, as will the entire Internet, and be on your wrist or waist." Currid adds that such personal devices may incorporate technology that uses a "remembrance agent" that watches what you do (perhaps from inside your eyeglasses), then helps you look up forgotten or new info. "It would perform almost like an extra brain." She also predicts that grid computing, the same sharedresources concept used to crack the human genome, is coming to your home and office.

"It will change how individuals and companies buy or rent computer power," Currid says. You'll simply plug your device into the wall and use whatever amount of power you need. While security is a primary obstacle right now, she predicts "this is one of those technologies just too good not to happen."

Advanced Materials: 1 + 1 = 5

Advanced materials have been with us for years and are used in nearly every industry, but only recently have been recognized by the public for their advantageous properties.

Simply stated, they are high-tech plastics, resins, fibers, composites, and ceramics that are woven, glued, shaped, or baked together. When combined in this special way, they're stronger, more durable, or lighter than the individual materials in the mix. Such advanced materials are readily found in airplanes, packaging, boats, home construction, swimming pools, furniture, medical devices - even toys.

Already, hundreds of millions of dollars have been invested in nanotechnology research, which is conducted on the atomic level. But not all R&D funds are headed in that direction. Scientists in this multidisciplinary industry are generally influenced by the areas of biomedical science, information technology, physics, and chemistry, to name just a few.

New developments are forthcoming in fields such as high-temperature materials, metallic foams (and other cellular materials), corrosion of materials, intermetallics, multicomponent alloys, biomedical materials, surface science and coating technology, laser methods in materials processing, structural material composites, and modem casting and powder metallurgical techniques.

Dr. Alex Ignatiev is a professor at the University of Houston and director of its Texas Center for Superconductivity and Advanced Materials. The center's work is representative of numerous industry R&D projects worldwide. For example, a thin-film fuel cell as slim as one one-hundredth of a human hair in diameter is being developed that produces 10 watts per cubic centimeter. Highly efficient, the device will be used for small operations; e.g., to power laptops and even NASA spacesuits. About twice as energy efficient as electric generating plants, the fuel cells can also be used as a distributed electro-energy source to power your house. "If they make too much energy," Dr. Ignatiev says, "you can just sell it back to the grid."

Another project at the center is a light-sensitive ceramic material, very stable in all kinds of chemical environments, to be used as an artificial retina that replaces damaged rods and cones in the eyes. Human trials conducted with blind people this winter will aim to restore their sight using this advanced material. Additionally, the center is creating a new type of high-temperature, superconducting ceramic material integrated with metal foil. Dr. Ignatiev predicts it could save 15 percent of America's energy costs if it replaced the copper wire now used in motors and transformers.

Over at the Center for Advanced Materials Research at Brown University in Providence, R.I., some projects focus on developing smooth, hard, and tough nanoscale materials designed as tooling and protective coatings, says director Bill Curtin. "We're also working on making flat-panel displays using transparent and electrically conducting materials," he adds. One future application will he a flexible computer display which can be unrolled from a tube.

Aerospace Goes Sci-Fi

After the Cold War the "more and bigger" mantra of the aerospace/defense industry was replaced by one pushing "a desire to be smart, fast, and mobile," according to

research firm Hoover's Online.

A June 2002 AP story reported that the Pentagon planned to spend more than $1 trillion in the next decade on futuristic planes as well as on ships and weapons. Part of the story is the 2001 "mother of all defense deals" whereby Lockheed won the $200 billion Joint Strike Fighter contract, the largest defense contract ever negotiated. "Spread out over almost 30 years, it may be the last major deal for a major manned fighter program," notes a Hoover's report, "as the success and sophistication of unmanned is expected to continue, supplanting the need for the more expensive manned jets and making it unnecessary to risk pilots' lives in combat."

The still-ailing U.S. commercial sector continues to explore new aircraft designs using the latest materials and technologies. In related news, within 10 years NASA and program partners want to make personal air travel safe, affordable, and "as easy as driving a car" with micro planes capable of safely flying to any of the nation's 5,400 public-use airports. These efforts fuel the tantalizing idea that the age of highway gridlock may come to an end.

Hoovers asserts that expectations for the space market "continue to outstrip the short-term realities. But companies continue to invest in this area. Even before the terrorist attacks, Boeing, for example, was placing more emphasis on this market in its strategic thinking, and proposed a sweeping overhaul of the world's air-traffic control system."

Advances in biotech, nanotech, and IT are producing designs that will be "radically different from today's aircraft," according to NASA's description of the twenty-first-century aerospace vehicle. "Aircraft of the future will not be built of traditional, multiple, mechanically connected parts and systems. Instead, aircraft wing construction will employ fully integrated, embedded 'smart' materials and actuators that will enable aircraft wings with unprecedented levels of aerodynamic efficiencies and aircraft control."

While the United States is now the dominant force in the industry, some readers may be surprised to learn that Europe's goal is to become the world leader in aeronautics by 2020. The EU's vision is to win at least half the shares of world markets for aircraft, engines, and equipment, according to the 2001 report European Aeronautics: A Vision for 2020, produced by the European Commission for Research.

The report also describes the aircraft of tomorrow, noting the development of "new shapes and sizes by 2020 to improve the technical efficiency of the air transport system, and to raise their safety and environmental performance. Flying wings could

offer more efficient and quieter solutions, airships may finally establish themselves as a cheap alternative for carrying freight, and convenience flying could be a reality with tilting wings that allow vertical take-off and landings."

The report continues, "The superliners able to carry 1,200 or more passengers may need new airport systems to handle them, folding wings to avoid occupying too much airport space, and entrances and exits of a size once found only on passenger ships."

Technology advance's will use second-generation composite materials, while "the use of hybrid laminar flow ewer the entire aircraft could make vast contributions to reducing aircraft weight and air drag, thereby reducing fuel consumption. Major stride's in safety will be possible, the report says, through "human factors, research and intelligent monitoring and control systems" that will anticipate problems and take preventive actions even before the pilot is aware that anything is going wrong.

[Author Affiliation]

By Lisa A. Bastian, CBC