

Article from (EBSCO) Lexile:1280L

Innovation Interrupted

Title:

INNOVATION INTERRUPTED. By: Mandel, Michael, BusinessWeek, 00077135, 6/15/2009, Issue 4135

Database:

MAS Ultra - School Edition

INNOVATION INTERRUPTED

Section: IN DEPTH

During the last decade, U.S. innovation has failed to realize its promise--and that may help explain America's economic woes

"We live in an era of rapid innovation." I'm sure you've heard that phrase, or some variant, over and over again. The evidence appears to be all around us: Google, Facebook, Twitter, smartphones, flat-screen televisions, the Internet itself.

But what if the conventional wisdom is wrong? What if outside of a few high-profile areas, the past decade has seen far too few commercial innovations that can transform lives and move the economy forward? What if, rather than being an era of rapid innovation, this has been an era of innovation interrupted? And if that's true, is there any reason to expect the next decade to be any better?

These are not comfortable questions in the U.S. Pride in America's innovative spirit is one of the few things that both Democrats and Republicans--from Bill Clinton to George W. Bush to Barack Obama--share.

But there's growing evidence that the innovation shortfall of the past decade is not only real but may also have contributed to today's financial crisis. Think back to 1998, the early days of the dot-com bubble. At the time, the news was filled with reports of startling breakthroughs in science and medicine, from new cancer treatments and gene therapies that promised to cure intractable diseases to high-speed satellite Internet, cars powered by fuel cells, micromachines on chips, and even cloning. These technologies seemed to be commercializing at "Internet speed," creating companies and drawing in enormous investments from profit-seeking venture capitalists--and ordinarily cautious corporate giants. Federal Reserve Chairman Alan Greenspan summed it up in a 2000 speech: "We appear to be in the midst of a period of rapid innovation that is bringing with it substantial and lasting benefits to our economy."

WHERE ARE THE NEW PRODUCTS?

With the hindsight of a decade, one thing is abundantly clear: The commercial impact of most of those breakthroughs fell far short of expectations--not just in the U.S. but around the world. No gene therapy has yet been approved. Rural dwellers can get satellite Internet, but it's far slower, with longer lag times, than the ambitious satellite services that were being developed a decade ago. The economics of alternative energy haven't changed much. And while the biotech industry has continued to grow and produce important drugs--such as Avastin and Gleevec, which are used to fight cancer--the gains in health as a whole have been disappointing, given the enormous sums invested in research. As Gary P. Pisano, a Harvard Business School expert on the biotech business, observes: "It was a much harder road commercially than anyone believed."

If the reality of innovation was less than the perception, that helps explain why America's apparent boom was built on borrowing. The information technology revolution is worth cheering about, but it isn't sufficient by itself to sustain strong growth--especially since much of the actual production of tech gear shifted to Asia. With far fewer breakthrough products than expected, Americans had little new to sell to the rest of the world. Exports stagnated, stuck at around 11% of gross domestic product until 2006, while imports soared. That forced the U.S. to borrow trillions of dollars from overseas. The same surges of imports and borrowing also distorted economic statistics so that growth from 1998 to 2007, rather than averaging 2.7% per year, may have been closer to 2.3% per year (page 39). While Wall Street's mistakes may have triggered the financial crisis, the innovation shortfall helps explain why the collapse has been so broad.

But here's some optimism to temper the gloom: Many of the technological high hopes of 1998, it turns out, were simply delayed. Scientific progress continued, the technologies have matured, and more innovations are coming to market--everything from the first gout treatment in 40 years to cloud computing, the long-ballyhooed "information at your fingertips" (page 42). The path has been long and winding, but if the rate of commercialization picks up, the current downturn may not be as protracted as expected.

To see both the reality of the innovation shortfall and its potentially happy ending, look at Organogenesis, a small company in Canton, Mass. Back in 1998, Organogenesis received approval from the Food & Drug Administration to sell the world's first living skin substitute. The product, Apligraf, was a thin, stretchy substance that could be grown in quantity and applied to speed the healing of diabetic leg ulcers and other wounds that had stayed open for years.

From a health perspective, the approval of Apligraf seemed to open up an entire world of "tissue engineering," growing all sorts of replacement body parts from living human cells. From an economic angle, the possibilities were equally appealing: Apligraf, approved in Canada and Switzerland, was being exported, creating skilled jobs in Massachusetts. This was the sort of high-tech product needed to drive the U.S. economy into the 21st century.

But there were several big problems, recalls Geoff MacKay, the company's current CEO, who repeatedly used the word "cautious" during our interview. For one, Apligraf cost more to make than the company could sell it for--never a good way to stay in business. In addition, Organogenesis couldn't figure out how to deliver Apligraf reliably, since it was shipping a product made out of living cells. "This is something no one had done before," says MacKay, who at the time was working for Novartis, then the marketing partner for Apligraf. "The way to commercialize this type of technology was more difficult than initially anticipated."

By 2002 the early enthusiasm for Apligraf had vanished, along with the money. Novartis pulled out, Organogenesis declared bankruptcy, and jobs were slashed. The company was not alone: The entire field of tissue engineering was languishing. Shortly after, MacKay took over at Organogenesis with a clear mandate to straighten out the company's manufacturing, logistics, and sales, and turn this tarnished product into a moneymaker.

And that's what he did. By bringing down costs, "we now have margins that are pharmaceutical-like," says MacKay. Sales of Apligraf are growing at more than 20% per year, the company is taking over two more buildings on the same street in Canton, and it has FDA approval to install high-reliability robots from Japan's Denso, the same supplier Toyota uses, he says. Employment is expected to climb from 350 jobs to about 600, the company is introducing products, and MacKay is talking about "cautious globalization." In other words, Organogenesis is fulfilling the promise of 1998--a decade later.

STUMBLING BLOCKS

Now multiply that story a hundredfold and extend it to other areas. Consider, for example, micromachines--miniaturized gyroscopes, pumps, levers, or sensors on a silicon chip. Also known as

MEMS (microelectromechanical **systems**), micromachines have been around in one form or another for years, most notably as the sensors that trigger airbags in cars.

In 1998, MEMS suddenly became the "next big thing." Engineers started to see how the devices could be useful in all sorts of ways that conventional semiconductors were not. For example, MEMS, in theory, could be used to make miniature sensors to monitor a hospital patient's blood at far less cost than conventional medical equipment. Venture capitalists threw billions into optical MEMS, miniaturized arrays of tiny mirrors designed to run fiber optic networks.

"In 1998 friends of mine started a MEMS company and asked me if I wanted to live the semiconductor revolution again," says Jeff Hilbert, now president and chief operating officer at MEMS outfit WiSpry in Irvine, Calif. "I naively thought it was a lot closer to being commercialized than it was." A whole array of challenges arose when it came time to move to mass production. "We didn't know what we didn't know," says Hilbert. WiSpry, which just closed a \$20 million round of venture funding, is now about to start shipping MEMS chips that will go into cell phones, improving battery life and reducing dropped calls.

And then there is the biotech sector. The story driving the biotech boom was both scientifically sound and economically compelling: By understanding DNA and the human genome, researchers could develop effective drugs more quickly and easily. Pharmaceutical companies would no longer have to rely on serendipity to find a treatment for an illness. Instead, they could focus like lasers on the biological mechanisms that were broken or needed to be shored up. And the benefits of biotech were supposed to stretch into new sources of energy, increased agricultural production, and better ways to clean up environmental problems.

But fixing and improving the human body turned out to be far more complicated than expected. Even the sequencing of the human genome--an acclaimed scientific achievement--has not reduced the cost of developing profitable drugs. One indicator of the problem's scope: 2008 was the first year that the U.S. biotech industry collectively made a profit, according to a recent report by Ernst & Young--and that performance is not expected to be repeated in 2009.

RED FLAGS

There's no government-constructed "innovation index" that would allow us to conclude unambiguously that we've been experiencing an innovation shortfall. Still, plenty of clues point in that direction. Start with the stock market. If an innovation boom were truly happening, it would likely push up stock prices for companies in such leading-edge sectors as pharmaceuticals and information technology.

Instead, the stock index that tracks the pharmaceutical, biotech, and life sciences companies in the Standard & Poor's 500 dropped 32% from the end of 1998 to the end of 2007, after adjusting for inflation. The information technology index fell 29%. To pick out two major companies: The stock price of Merck declined 35% between the end of 1998 and the end of 2007, after adjusting for inflation, while the stock price of Cisco **Systems** was down 9%.

Consider another indicator of commercially important innovation: the trade balance in advanced technology products. The Census Bureau tracks imports and exports of goods in 10 high-tech areas, including life sciences, biotech, advanced materials, and aerospace. In 1998 the U.S. had a \$30 billion trade surplus in these advanced technology products; by 2007 that had flipped to a \$53 billion deficit. Surprisingly, the U.S. was running a trade deficit in life sciences, an area where it is supposed to be a leader.

A more indirect indication of the lack of innovation lies in the wages of college-educated workers. These are the people we would expect to prosper in growing, innovative industries that need smart, creative employees. But the numbers tell a different story. From 1998 to 2007, earnings for a U.S. worker with a bachelor's degree rose only 0.4%, adjusted for inflation. And young college graduates--

who should be able to take advantage of opportunities in hot new industries--were hit by a 2.8% real decline in wages.

The final clue: the agonizingly slow improvement in death rates by age, despite all the money thrown into health-care research. Yes, advances in health care can affect the quality of life, but one would expect any big innovation in medical care to result in a faster decline in the death rate as well.

The official death-rate stats offer a mixed but mostly disappointing picture of how medical innovation has progressed since 1998. On the plus side, Americans 65 and over saw a faster decline in their death rate compared with previous decades. The bad news: Most age groups under 65 saw a slower fall in the death rate (chart). For example, for children ages 1 to 4, the death rate fell at a 2.3% annual pace between 1998 and 2006, compared with a 4% decline in the previous decade. And surprisingly, the death rate for people in the 45-to-54 age group was slightly higher in 2006 than in 1998.

Each of these statistics has shortcomings as an innovation indicator. The relatively small decline in the death rate for many age groups could reflect an increase in obesity-related diseases among the American population rather than a shortfall in health-care innovation. The import and export numbers leave out trade in services and innovative products produced by U.S. companies overseas. And drawing conclusions about innovation from movements in stock prices is a dicey business at best. But taken together, these statistics tell a story of weaker-than-expected innovation.

The final piece of evidence is the financial crisis itself. After the 2001 tech bust, trillions of dollars flowed into the U.S.--but most of it went into government bonds and housing rather than into innovative sectors of the economy. While subprime mortgages boomed, venture capital investments have more or less stagnated since 2001, with few tech startups going public. "The U.S. was awash in capital, much of it desperately seeking a good deal," says Robert D. Atkinson, president of the Information Technology & Innovation Foundation, a nonpartisan Washington (D.C.) think tank. "If this had truly been an innovative period, then a vast array of cutting-edge innovations and their commercialization would have demanded hundreds of billions of dollars of capital."

If the description of the last decade as an innovation shortfall turns out to be accurate, that could make a big difference in how we think about the U.S. economy. For one thing, it helps explain why the trade deficit skyrocketed. A high-wage country such as the U.S. either has to develop innovative products and services to compete with low-cost countries such as China or accept a lower standard of living. "The competitive advantage of the U.S. economy has to be leveraging our science capacity for economic growth," says Pisano of Harvard. Fewer innovative products mean a weaker trade performance.

An innovation shortfall might also have weakened the country's underlying productivity growth, which in turn influenced real wages and the ability of consumers to spend without borrowing. Certainly economists on both the left and the right believe innovation is an essential ingredient for growth. A December 2006 paper by the Brookings Institution, co-authored by Peter R. Orszag, now head of the Office of Management & Budget, observed: "Because the U.S. is at the frontier of modern technological and scientific advances, sustaining economic growth depends substantially on our ability to advance that frontier."

The flip side: A shortfall in innovation could undercut growth and incomes, especially over a decade-long period. True, the economic statistics appear to show decent productivity growth across this stretch. But since there is compelling evidence that the figures are overstated by the credit bubble and statistical problems, we can construct a plausible narrative for the financial bust that gives a starring role to innovation--or rather, to the lack of it. It goes something like this: In the late 1990s, most economists and CEOs agreed that the U.S. was embarking on a once-in-a-century innovation wave--not just in info tech but also in biotech and many other technologies. Forecasters upped their long-run growth estimates for the U.S. economy. Consumers borrowed against their home equity, assuming their future incomes would rise. And foreign investors lent America money by buying up U.S.

securities, assuming the country would come up with enough new products to pay off the accumulated trade deficit.

This underlying optimism about the economy's growth potential became an enabler for Wall Street's financial shenanigans and greed. In this narrative, investors and bankers could convince themselves that rising home prices were reasonable given the bright future, which was based in part on strong innovation. In the end, the credit market collapse in September 2008 reflected a downgrading of expectations about future growth, which put trillions of dollars of debt underwater.

BEYOND INFO TECH

Many economists are skeptical about placing the blame on an innovation shortfall, preferring to focus on problems on Wall Street and in Washington. "I tend to see the direct causes in our regulatory system," says Paul Romer, an economist at Stanford University's Graduate School of Business renowned for his work on innovation. "The big task is to explain why risk was so badly mispriced, particularly the risk of a collapse of the housing bubble."

Whatever the ultimate cause of the downturn, a pickup in innovation would provide a welcome economic boost. In part, that could come from information technology, where the combination of Google, social networks, wireless technology, and the beginnings of cloud computing is substantially altering the way people live their lives.

Of course, no industrial revolution in the past has been based on a single technology. A combination of radio, television, flight, antibiotics, synthetic materials, and automobiles drove the productivity surge of the early and mid-20th century. The Industrial Revolution of the second half of the 19th century combined railroads, electricity, and the telegraph and telephone.

Similarly, for sustainable economic growth, the U.S. needs breakthrough innovations outside of core IT. Some technologies weren't ready for prime time 10 years ago but have matured. MacKay of Organogenesis says that after spending years cutting costs and increasing reliability, he is ready to "reinject innovation" back into the company. He is in the process of submitting new treatments for FDA approval, including a product made from living cells that helps stimulate the growth of gum tissue. "This is the type of manufacturing that won't be lost offshore," says MacKay.

MEMS, too, is maturing. Nintendo is about to release a new add-on for the Wii controller, containing an innovative MEMS gyroscope chip that makes it easier to sense a wider range of user movements. The chip is made by InvenSense, a Sunnyvale (Calif.) startup that was able to build on 10 years of industry false starts to produce something small enough and cheap enough to go into a mass consumer product. "If I had any idea how difficult it would be, I wouldn't have started the company," says CEO Steve Nasiri. He expects a fivefold increase in revenue this year, and he sees a competitive advantage for the U.S. "In MEMS technology, the U.S. is two to three years ahead of Europe and Japan," says Nasiri.

The imponderables are biotech and alternative energy. In biotech, the clinical-test pipelines are full of breakthrough treatments, any of which could turn out to be a blockbuster. But as we've seen far too many times, a drug can be promising up to the moment it is rejected by the FDA. Similarly, the potential for innovation in alternative energy is enormous, but it's hard to know which approach will pay off.

The professor, trader, and author Nassim Nicholas Taleb calls technological breakthroughs "positive Black Swans"--unexpected events with huge positive consequences that in retrospect look inevitable. Some, such as Google, come out of nowhere to dominate within a short time. Others take years to mature and are surprising only because people forgot they were there. We've learned over the last 10 years just how unpredictable technology can be. But right about now, the U.S. could use a few positive Black Swans.

GRAPH: A BAD NINE YEARS

GRAPH: SMALL HEALTH GAINS FOR MIDDLE-AGED AND YOUNG AMERICANS

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By Michael Mandel

TOO GOOD TO BE TRUE?

U.S. statistics may have overstated productivity--and innovation

1.7%. That's the annual reported growth in real gross domestic output per full-time worker between 1998 and 2007, according to government figures. "The amount that U.S. workers produce has grown at remarkable rates in recent years," gushed the 2007 Economic Report of the President. These productivity gains are usually held up as proof that the U.S. innovation machine has continued, despite all sorts of obstacles.

But productivity growth may be overstated, for two reasons. First, the economy was lifted by two financial bubbles in a row--stock market and credit--leading to excess growth of finance and real estate. "The financial sector contributed substantially to the surge in productivity growth," says Martin Baily, a Brookings Institution productivity expert. "Some of the financial innovation has turned out not to generate real benefits."

Second, new research by Emi Nakamura and Jon Steinsson of Columbia University suggests pervasive problems with the government's import price statistics. One example: The figures from the Bureau of Labor Statistics seem to show the reported price of imported furniture rose by a total of 9% from 1998 to 2007. But how can the import price have risen over a stretch when the price paid by consumers fell by 7%? Or take computers. The official stats indicate that the price of computers to consumers fell at an average annual rate of 22% per year from 1998 to 2007. The annual import price index for computers, however, fell by just 8%. Similar problems occur for the measured import prices of consumer durables, including motor vehicles.

These apparently arcane statistical problems mean that the real growth of imports has been significantly underestimated for goods such as computers that have rapid model changes. And that in turn distorts the productivity and growth stats and make them look a lot better than they really are. (For an explanation of how the import price problems affect the official economic statistics, see businessweek.com/go/09/growth.)

Adjusting for the finance bubble and the import price problems may mean that economywide productivity growth rose by about 1.3% per year from 1998 to 2007, rather than the reported 1.7%. Similarly, real gross domestic product growth falls to roughly 2.3% annually from 2.7%. (The exact size of the downgrade depends on what is assumed about the correct change in import prices.)

And what about manufacturing? The official stats seem to show that U.S. manufacturing output grew at a 2.6% annual pace from 1998 to 2007, a strangely positive picture considering how many factory jobs were lost and how much production was shifted overseas. After the adjustments, however, the growth rate for manufacturing output is only 0.8% per year. The conclusion: You can't depend on productivity and output growth statistics to make a case for innovation's strength.

