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## Tinkering Makes Comeback Amid Crisis

By [JUSTIN LAHART](#)

The American tradition of tinkering -- the spark for inventions from the telephone to the Apple computer -- is making a comeback, boosted by renewed interest in hands-on work amid the economic crisis and falling prices of high-tech tools and materials.

The modern milling machine, able to shape metal with hairbreadth precision, revolutionized industry. Blake Sessions has one in his dorm room, tucked under the shelf with the peanut butter on it.

The Massachusetts Institute of Technology junior has been using the mill to make prototypes for a bicycle-sprocket business he's planning. He bolts down a piece of aluminum plate, steps to his desk and, from his computer, sets the machine in motion.

### Tinkering With Technology

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*Alex Welsh for The Wall Street Journal*

Jason Euren, an anthropology student at the New School University in Manhattan, worked with a soldering kit at the Brooklyn hackerspace Resistor recently.

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"It's kind of a ridiculous thing to have," says Mr. Sessions, 20 years old. But "in today's marketplace you can't only offer a technical aptitude. You have to be able to provide something more."

Occupying a space somewhere between shop class and the computer lab, the new tinkerers are making everything from devices that Twitter how much beer is left in a keg to robots that assist doctors. The experimentation is even creating companies. With innovation a prime factor in driving economic growth, and corporate research and development spending tepid, the marriage of brains and brawn offers one hopeful glimmer.

Engineering schools across the country report students are showing an enthusiasm for hands-on work that hasn't been seen in years. Workshops for people to share tools and ideas -- called "hackerspaces" -- are popping up all over the country; there are 124 hackerspaces in the U.S., according to a member-run group that keeps track, up from a handful at the start of last year. SparkFun Electronics Inc., which sells electronic parts to tinkerers, expects sales of about \$10 million this year, up from \$6 million in 2008. "Make" magazine, with articles on building items such as solar hot tubs and autopilots for robots, has grown from 22,000 subscribers in 2005 to more than 100,000 now. Its annual "Maker Faire" in San Mateo, Calif., attracted 75,000 people this year.

"We've had this merging of DIY [do it yourself] with technology," says Bre Pettis, co-founder of NYC Resistor, one of the first hackerspaces, in Brooklyn. "I'm calling it Industrial Revolution 2."

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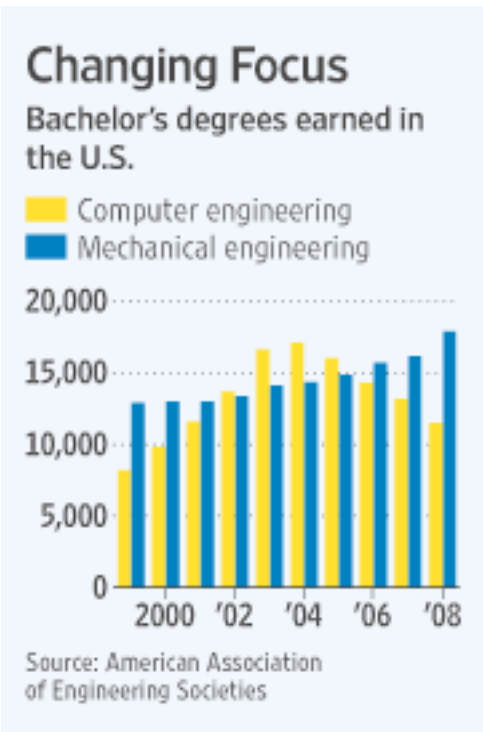
“[Maybe it's time to bring my old white board out of retirement, and rethink some of those old projects.](#)”

— *Richard Tomalewicz*

The financial crisis played a role in taking a nascent trend and giving it increased urgency, says Michael Cima, an MIT engineering professor. "I've been here 23 years and I definitely see this trend back to hands-on," he says. "A lot of people are pretty disappointed with an image of a career in finance and they're looking for a career that's real."

Access to the tools to tinker is getting easier. "Computer numerical controlled," or CNC, tools -- which cut metal and other materials into whatever design is plugged into the computer attached to them -- now cost as little as a tenth of what they did a decade ago. Mr. Sessions, the MIT student, says he first looked at such mills on a lark, assuming the price would be well out of his reach. But his mill cost about \$7,000 to buy and set up.

He sees the bike-sprocket business as a springboard for developing more complex products, such as a device to increase mobility for arthritis sufferers or an energy-efficient car transmission. He thinks his interest in tinkering will give him an advantage in a global marketplace.



"If it doesn't have that creative aspect to it, it may not be worth doing, because your job can be outsourced," he says.

Innovation in the U.S. is peppered with examples of tinkerers who started out small, but came up with big ideas, says Naomi Lamoreaux, an economic historian at the University of California, Los Angeles. "The really dynamic times in our history are times when you have lots of ordinary people who think they have a chance to make a difference."

Through much of the past century, however, developing new products required increasingly complex and expensive tools that were out of reach of most individuals -- the Wright brothers built an airplane in their bicycle shop, but the first jet-powered aircraft were built at well-funded corporate and government labs. As a result, large firms came to dominate innovation.

That trend was disrupted in the 1990s when low-cost computers allowed Internet and software start-ups to compete with giants. But when it came to developing innovative physical products, high prices kept high-tech machine tools and materials out of most tinkerers' reach.

"There have always been hobbyists, but it was really hard to go from being a hobbyist who built hot rods to becoming a car company," says Erik Kauppi, a member of at A2 Mech Shop, an Ann Arbor, Mich., workshop where tinkerers pool tools they own. "But now, all of a sudden a guy or a couple of guys have a lot more leverage."

The electric scooter that Mr. Kauppi, who is 49, developed at the workshop is now in production. His business, Current Motor Co. in Scio Township, Mich., plans to begin shipping its scooter, with a starting price of \$5,500, this month.

At engineering schools, the drop in costs is putting tools once accessible only to senior

researchers into the hands of undergraduates. The Hobby Shop at MIT, once mainly a wood shop, has been accumulating advanced equipment, some castoffs from MIT laboratories, some bought.

"Now you can build sophisticated robots and things like that with all these new pieces of equipment they have," says Greg Schroll, 23, a 2008 MIT engineering graduate.

He hopes to eventually start a company around a spherical robot he built at the MIT shop, which he sees being used to gather information in places too hazardous for humans. Projects made by MIT students in the Hobby Shop now in commercial production include a LED system to create lighting effects for film and a machine to salt the rim of a margarita glass.

Hands-on is catching on at other schools. There were 27% more undergraduates who earned mechanical-engineering degrees in 2008 than in 2003, according to the American Association of Engineering Societies. Over the same period, the number of computer-engineering graduates slipped by 31%.

Students at Carnegie Mellon University asked to stay at school for a week after exams last spring so they could hang out and build things. Ed Schlesinger, a professor there, says that after a long period where theoretical work dominated at engineering schools, "when students talk to each other now, it's 'So, what cool project are you working on?' It's not enough to say I took these classes and got an A." Stanford University's Product Realization Laboratory, where students learn machining, welding and other hands-on skills, has seen membership jump to 750 from 450 over the past five years.

As a junior at Stanford in 2004, Carly Geehr thought she was headed for medical school. Then she took a course on manufacturing and design at the Stanford workshop.

"I'd never held a drill in my life, but working with the milling machine -- I was just blown away," says Ms. Geehr, who is 24. She changed her major to engineering and, as a doctoral candidate in engineering, is now a teaching assistant for the course that gave her the bug to build. On a recent day, she cheered students on as they prepared molds for sand-casting bronze, occasionally donning a protective fire suit to skim red-hot dross from the crucible before pouring molten metal into the molds.

Giulio Gratta, a senior in Stanford's engineering school, has been using the workshop to build a panoramic camera. Even though Stanford is in the heart of Silicon Valley, he says software and Internet development don't hold as much interest as before. "It's no longer the thing to do," says Mr. Gratta, who is 21. "People have to figure out something else. Maybe...physical things."

## **More Video**

- [See Andy Jordan's report from May of 2008 on the "Maker Faire" gathering of tinkers. 05/12/08](#)
- [See Andy Jordan's report from two years ago to see how far 3D printing has come in just two years. 11/29/07](#)

From hacker spaces to profitable businesses, tinkering is experiencing a renaissance. WSJ's Andy Jordan explores some of the "stuff" people are making with new devices that encourage hacking and creativity.

Until the 1950s, economists thought how fast the economy grew was mostly a matter of how much money was spent and how much work was getting done. But in a 1957 paper that helped him later earn a Nobel Prize, MIT economist Robert Solow showed capital and labor only accounted for about half of growth. The remaining half he attributed to innovation -- an area where the U.S. has long had an advantage.

In recent years, however, U.S. spending on research and development has led some economists to worry that innovation will no longer provide the boost it once did. Corporate R&D spending grew an average of 2.6% annually from 2000 to 2007, down from an average of 6% in the 1980s and 1990s, according to the most recent figures from the National Science Foundation. Chief financial officers surveyed in September by Duke University's Fuqua School of Business and CFO Magazine said they expected their companies' R&D spending to grow by just 0.4% over the next year.

Tinkering represents innovation outside such figures. TechShop in Menlo Park, Calif., for example, is a for-profit workshop and operates like a gym, except that the members who pay \$100 a month are milling iron rather than pumping it.

Founder Jim Newton tallied a list of all the tools he could imagine needing. Now TechShop, opened in 2006, has \$500,000 worth of lathes, laser cutters and other equipment.

There are 600 members at TechShop's original location, up from 300 a year ago, and it has opened workshops in Durham, N.C., and Beaverton, Ore. Projects under way include a liquid-cooling device for computer servers and an electric two-wheeled car.

NYC Resistor, the hackerspace in Brooklyn, is funded by members and fees from classes it offers. It opens to visitors every Thursday. Recently, a group gathered around Ben Combee, who demonstrated the laser cutter. He put a piece of Plexiglas into place, started the air compressor, pushed a button and shouted, "Fire the laser!"

At a table strewn with laptops, wires and circuit boards, Eric Skiff showed off a robotic arm that twitches when a hand is passed near it. In a corner is the Barbot, a robot that, when it works, pours and stirs an absinthe cocktail called a Sazerac.

Such projects -- not to mention a giant Lite-Brite and a toy piano that plays Philip Glass's "Modern Love Waltz" -- may seem frivolous. But Zach Hoeken Smith, a NYC Resistor cofounder, thinks something important is going on. The computer kits sold by companies such as Apple in the 1970s were demeaned as toys, he says, but ended up launching the personal computer revolution.

Mr. Smith, 25, studied computer science at the University of Iowa, and worked as a Web developer. But a few years ago, he started playing with an "Arduino" -- an open-source microcontroller. These are used as the "electric brains" for everything from wall-avoiding

robots to a hat that pokes the wearer's heads if the person stops smiling. "I was hooked," he recalls.

Intrigued by the idea of making a machine than can build its own parts, Mr. Smith got interested in "rapid prototyping machines" -- 3D printers that lay down layers of materials like plastic to form objects. The technology is used by manufacturers to make prototypes, with industrial machines typically costing tens of thousands of dollars.

Mr. Smith's NYC Resistor friends Mr. Pettis and Adam Mayer joined the project. Using off-the-shelf electronics and parts, along with a laser cutter, they came up with a machine. Now they're selling kits to make 3D printers.

Their company, MakerBot Industries, has shipped 350 of the \$750 kits so far. They hired two employees, started paying themselves, and are building another 150 kits for their next shipment.

Adam Elkins and members of a hackerspace in Philadelphia, called Hive 76, bought one kit and built the machine. Mr. Elkins, a 28-year-old system administrator for a software company, says he doesn't have access to a lot of space, so he goes to the hackerspace to build. "There's no man-cave I can go to and do things."

The first thing he made on the 3D printer was a black plastic ring topped off with white plastic jewel. Last month, he presented it to his girlfriend, along with a marriage proposal. She said yes.

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