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Fire of Invention

Entrepreneurs is out to reinvent invention by uniting far-flung innovators and freeing it from corporate constraints.

By Evan I. Schwartz
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Nathan P. Myhrvold has no interest in competing with Microsoft—but he does mean to challenge the very method of innovation practiced at the company he left four years ago. The 44-year-old founder of Microsoft Research and former chief technology officer of the Seattle giant argues that virtually all big corporations, even wealthy ones, lack motivation to pump money into projects outside their existing product lines. In other words, they tend to discourage *invention*, the often subversive effort to isolate new problems and generate unexpected solutions. “Invention is a side effect [at corporate labs], not the focus,” Myhrvold says. “Most large organizations have a mission, and invention often takes you in another direction. When it comes to invention at most companies, mission wins.” Even small companies such as startups, he notes, are often loath to support invention outside their core markets.

“I can’t outdevelop Microsoft and Oracle in databases. But I may be able to outinvent them,” says Nathan Myhrvold. (Photo by Fredrik Broden)

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Yet this very reluctance has opened a world of opportunity, Myhrvold believes. “I can’t outdevelop Microsoft and Oracle in databases,” he says. “But I may be able to outinvent them.”

And that’s exactly what Myhrvold and former Microsoft chief software architect Edward Jung have set out to do at Bellevue, WA-based Invention Science, a hothouse of ideas where staff have free rein to cross-pollinate insights from information technology, biotechnology, and nanotechnology—three domains that Myhrvold feels are converging to make powerful new technologies possible. In recent months, the organization has

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quietly hired some two dozen inventors, along with the patent attorneys and licensing experts needed to support them and get their ideas to market. It's the culmination of more than two years of travel, study, and planning by Myhrvold and Jung, who first set up an independent Bellevue research shop called Intellectual Ventures in 2000 (see "[The Invention Factory](#)," *TR* May 2002). The company serves as the parent for Invention Science.

The new venture, Myhrvold says, has no mission other than to invent what the inventors believe should be—or can be—invented. "Invention is the secret sauce," Myhrvold says. "It has the highest concentration of value compared with any task in a company. But because it's so risky, it also has the lowest amount of focused effort." Showing what can happen when that effort is intensified is Myhrvold's main reason for creating the laboratory, which he is funding in part from his own Microsoft-made fortune.

Myhrvold isn't the only one to see new value in cross-disciplinary collaborations where invention itself is the primary goal. In fact, more and more ventures dedicated solely to invention have been popping up in recent years—including Walker Digital, a business systems developer in Stamford, CT, and Invent Resources, a small Lexington, MA, consultancy whose slogan is "Invention on Demand" (see "[Independent Inventors Incorporated](#)," *bottom*). And the mindset is spreading to the corporate world as well: at research-driven companies like brainstorming firm Generics Group of Cambridge, England, engineers are actually paid to spend a subset of their time on personal projects, stuff that typically has little or nothing to do with what their clients are doing—yet. Even young firms like Google, in Mountain View, CA, are getting into the act: the search engine leader encourages employees to devote 20 percent of their time to developing their own far-out ideas. The belief at such companies is that creative people are fueled by freedom to find problems that interest them. "Our employees are coming up with ideas anyway," says Google cofounder Sergey Brin. "We just provide them with time to test whether those ideas work."

This freedom to pursue invention for its own sake is the main hallmark of today's climate. It's been argued that moments of invention are little different from the rest of the research and development process—they are simply a matter of applying "normal problem solving to the right problem space," says David N. Perkins, a principal investigator at Harvard University's Project Zero, a 35-year effort to understand human creativity. But a close look at the process of invention reveals that some problems are so hard that they're "unreasonable" to even consider during the normal R&D process—or worse, they're completely hidden. Dedicated inventors "can recognize latent opportunities, problems that people don't even know they have," Perkins says.

No one personifies this mindset more than Myhrvold. As the affable, bearded physicist, photographer, and paleontologist flew around the world in his Gulfstream V jet attempting to get into the heads of inventors young and old, he became convinced that a new global flowering of invention is possible. For one thing, he says, the Web and other powerful information technologies make sharing knowledge easier than ever, enabling people with great ideas to attract capital and marketing firepower more readily. Meanwhile, the very pace of technological progress is picking up. Myhrvold foresees what he calls a new age of exponential growth, in which converging technologies will bring unpredictable but important changes—at a pace comparable to that of microchip miniaturization, famously described by Moore's Law. But what inventors require to generate this kind of growth, he concluded, is focused, long-term support, like the access to patent and licensing experts he and Jung are providing to their staff.

Ultimately, Myhrvold and others funding pure invention are out to debunk the perception that research labs make sense only when they are part of an existing corporate structure—one that includes development, manufacturing, distribution, and marketing. Until the 1980s, Myhrvold points out, businesses had a similar attitude toward software, believing that it was only valuable when bundled along with hardware. Bill Gates and others thoroughly disproved that theory. In the same way, “We think invention can be valuable in and of itself,” says Myhrvold.

“Invention is the new software.”

Independent Inventors Incorporated			
A sampling of companies and organizations that exist chiefly to incubate new inventions—often for hire			
Invention Science Bellevue, WA	Started by former Microsoft executives Nathan Myhrvold and Edward Jung	In-house inventors explore convergence of information technology, nanotechnology, biotechnology; 25 employees	New types of lasers
Walker Digital Stamford, CT	Launched in 1999 by Jay Walker, creator of priceline.com	Develops and licenses business-related technologies; 40 employees	USHomeGuard, a system of surveillance webcams and civilian spotters
Invent Resources Lexington, MA	Formed in 1992 by former MIT physicist Richard Pavelle and electronics engineer Sol Aisenberg	Consults with clients to test ideas and develop prototypes; four employees	Electronic time stamp; advanced microwave ovens
Generics Group Cambridge, England	Established in 1986 by electrical engineer Gordon Edge	Brainstorms new products and consults with clients on development; more than 200 employees	Advanced fuel cells; strong cardboard can for carbonated drinks
Sarcos Research Salt Lake City, UT	Created in 1983 by roboticist Stephen Jacobsen	Develops products for government and commercial clients; 50 employees	Robotic arms and hands for industrial and prosthetic uses
Deka Research and Development Manchester, NH	Launched in 1982 by independent inventor Dean Kamen	Develops products to improve patient quality of life and increase mobility; 200 employees	Home dialysis machine; stair-climbing wheelchair; Segway human transporter

Milestones

1940

The U.S. Census Bureau eliminates “inventor” as a separate job category.

More Power to the Little Guys

The new climate for invention, say Myhrvold and others, is the result of four major trends. The first is the reemergence of invention outside big corporations. For nearly a century, the innovations of large corporate research centers such as Bell Labs or General Electric overshadowed those of inventors working alone or in small groups. But now a constellation of forces is bringing the individual inventor and small technology companies—and sometimes small teams within large firms—back to the fore.

The change marks a comeback for those iconoclastic souls who still call themselves inventors—the people considered the driving force of the economy in the days of Thomas Edison, Alexander Graham Bell, and the Wright brothers. From the 1920s and '30s onward, with the rise of giant technology-based companies like GE, AT&T, and DuPont, invention became co-opted by corporate labs that had to answer

to management hierarchies. Within corporate labs, inventors were reclassified as “researchers.” In 1932, the year after Edison died, more U.S. patents were granted to corporations than to individuals for the first time, and in 1940, the U.S. Census Bureau eliminated “inventor” as a job category.

At big companies, the emphasis gradually moved from invention to what legendary economist Joseph A. Schumpeter called the second and third stages of technological change: *innovation*, in which ideas are transformed into marketable products and services, and *diffusion*, which sees those products and services distributed across markets. Companies adopted the view that invention by itself was only a tiny part of business success; for every \$1 spent on basic research, the conventional wisdom went, \$100 would be spent on development and \$1,000 on commercialization. Since great ideas often fail, and the best or most original product doesn’t necessarily win in the marketplace, the inventor came to be perceived as a relatively minor player in the equation. The dot-com boom of the late 1990s skewed this model to new extremes, as billions of dollars were staked on the conviction that the Web was changing everything about commerce, without much in the way of marketable inventions.

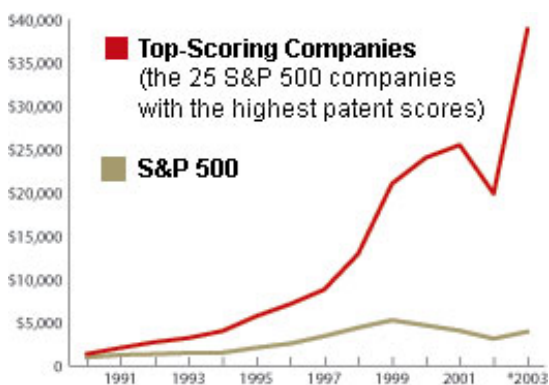
Now, with big corporate research laboratories focusing more and more on shorter-term product cycles, many see a growing opportunity for small companies, academic researchers, and individual inventors to generate breakthroughs that have longer-term impact. Anthony Breitzman, vice president of CHI Research, a Haddon Heights, NJ, patent analysis firm, reports that big corporations still have a wide lead in patent filings, especially in areas such as aerospace, motor vehicles, oil and gas, computing, and plastics, where research is expensive and small companies don’t have the resources to compete. But Breitzman notes that “there are areas where small companies are really competing.” In biotechnology, pharmaceuticals, and medical electronics—fields where every company is drawing on the same base of knowledge about the human body and the genome—about 25 percent of patents are being issued to small companies and individuals (see “*Reinventing Biology, Virtually*,” page 3). A disproportionate number of those are “high-impact patents,” Breitzman says, inventions that actually do become significant products in the marketplace.

The second trend: burned by the often vague schemes that passed for breakthrough thinking in the late 1990s, venture capitalists, in particular, have become far more selective, often insisting that the companies they back have significant, patented inventions that will shield their investments from competition. Attention to invention is becoming more rigorous across all areas of technology, says MIT engineering professor David Staelin. Staelin cofounded an MIT venture mentoring program that currently advises about 70 student- and faculty-led startups; he says 85 percent of the companies were formed around patentable inventions, from a smart golf club that tells users how to improve their swings to exoskeletons that help people in rehab.

The new emphasis on invention pays off. CHI Research combs patent databases for “highly cited” patents, ones that are frequently referenced in papers and later patents. According to CHI, the stocks of companies with a high proportion of these highly cited patents have greatly outperformed both the S&P 500 index and the stocks of companies with low numbers of highly cited patents (see “*Investing in Invention Pays Off*,” below). “Highly cited patents correlate to [stock market] success,” says Breitzman.

Investing in Invention Pays Off

Companies holding patents that are cited most frequently by papers and other patents and that yield marketable products the fastest have far outperformed the S&P 500. This chart depicts the successive year-end values of \$1,000 initially invested in January 1990.



Source: CHI Research (Investing)

Milestones

1981

In *Diamond v. Diehr*, the U.S. Supreme Court rules that software can be patented.

Inventing Locally, Marketing Globally

Thirdly, the Internet and other ubiquitous communications tools are enabling new global connections. Inventors everywhere are able to not only access patent databases, troves of online technical specifications, and genomic repositories but also take advantage of e-mail and collaborative software tools to brainstorm across borders and tap international markets. A record 49.9 percent of U.S. patents awarded in 2003 listed at least one non-U.S. citizen as a coinventor. Foreign entities will likely account for the majority of U.S. patent filings from 2004 onward, predicts CHI's Breitzman. Some two dozen

countries now produce significant levels of U.S. patents per capita, a figure that is highly correlated with higher GDP and standards of living (see the [Global Invention Map](#)).

For high-cost nations like the U.S. and Britain, this worldwide competition—which is intensifying as other countries beef up their educational systems and intellectual-property protections, and firms outsource high-tech jobs to lower-wage regions—means that professionals must prove their worth by moving up the intellectual-property value ladder. Instead of just completing assignments that are handed to them, employees need to be more inventive and more original in their thinking—often by finding new problems to tackle in the first place. Former U.S. labor secretary Robert Reich, now a professor at Brandeis University, identifies two growing categories of work in today's economy. The first he calls "symbolic analysis"; it involves the application of in-depth knowledge and includes jobs in R&D, design, and engineering. The second is "personal services" such as those provided by retail clerks, security guards, and hospital attendants. "Only the first [category] is commanding better pay and benefits," Reich notes. "This category includes identifying and solving new problems." In a nutshell, that's exactly what inventors do.

The leveling of the international playing field enhances the long-standing premium on original thinking, and smart companies are becoming more and more open to licensing inventions from smaller competitors, wherever they may be. "We're scanning the horizon for new ideas outside the company," says Simon Beesley, professional-audio marketing manager for Sony Professional Services Europe, a 1,200-employee division of Sony. "We're not as closed as we were ten years ago." He cites as an example the company's rollout of Hypersonic Sound, a directional-audio system developed by U.S. inventor Elwood "Woody" Norris (see "[The Sound War](#)"). Sony is bundling the invention as part of plasma screen audiovisual systems. But Beesley says it is also selling the technology to dozens of retailers, banks, and museums across Europe that are "clamoring" to build products, machines, and exhibits that can beam audio narration or marketing pitches to one customer at a time. "Every time I show this to someone," Beesley says, "they come up with a new idea for using it."

Milestones

2004

U.S. patent filings from foreign entities are expected to surpass those from U.S. entities for the first time.

Peering inside Invention

That fits with the final trend—toward a new appreciation of how the cognitive process of invention actually works. Invention is so steeped in the myth of accidental discovery that one might conclude it's like playing the lottery. For example, there is the tale of Percy Spencer, the researcher at Waltham, MA-based Raytheon who reportedly noticed that a radar tube in his lab melted the candy bar in his pocket—resulting in the microwave oven. Chance can indeed be a key element of invention. But from their studies, Myhrvold and others have come to realize that truly “accidental” inventions are rare and

are usually exaggerated in hindsight—sometimes to justify why researchers deviated from what they were supposed to be doing. Most of these stories leave out the fact that these researchers were keenly observant and were deliberately trying to invent new things all the time.

In fact, invention is now being recognized as a more focused, deliberate process, enacted by people who are especially good at finding new problems and who often work and think differently from typical researchers and technicians. Sarcos Research of Salt Lake City is a case in point. The 50-employee invention shop, which CEO Stephen Jacobsen calls a “skunk works for hire,” develops prototypes and licenses them to firms such as Merck, Pfizer, Disney, Sony, Lucent, and the Palo Alto Research Center.

By mixing ideas from biology and engineering, Sarcos's researchers have built everything from high-precision catheters for maneuvering inside the bloodstream to robot dinosaurs for Hollywood. But Jacobsen himself—the inventor of the Utah Arm, the world's most advanced robotic arm replacement for humans—may be the company's most unconventional thinker. Visual representations preoccupy Jacobsen to such an extent that he says he has virtually no recollection of nonvisual data, such as dates. He visualizes the progression of the hundreds of inventions he has worked on in terms of how their intricate shapes were formed and assembled over time. After enlarging a device such as a microchip or a nanosensor in his mind and setting it spinning and twisting, he can go about constructing it and writing the software for it. “What I remember is the geometry,” he says.

Few people may think as visually as Jacobsen, but everyone can be more inventive, the experts say. “We've got a prefrontal cortex that works as an experience simulator,” says Harvard psychologist Daniel Gilbert. “We can have experiences in our heads before we try them out.” With practice, just about anyone can learn visualization and other high-level thinking skills that help to create new concepts and translate them into practical technologies, Gilbert says. Inventor Jay Walker—the founder of Walker Digital, the creator of priceline.com, and the holder of more than 200 business process patents in industries ranging from retail to gaming to health care—agrees. “Can anyone learn to do improv, or to become a pianist or a chef or a wine taster?” he asks. “Sure. Anyone with above-average intelligence can do those things. But it takes years and years to train your brain to do it well. Invention is the same way.”

Myhrvold and the Invention Factory

By Evan I. Schwartz

Technology Review: What kinds of inventors have you hired?

Nathan Myhrvold: We have a staff of 20 to 25 people, plus 10 or 15 outside affiliated inventors. Lots of fantastic people. One reason they're successful is that they have a giant experience base. A large fraction of our inventors are women. At one brainstorming session, we looked around and noticed that men were in the minority, and that white men were in the minority among the men.

TR: How many inventions are you currently working on?

Myhrvold: We have many hundreds of ideas under investigation. We invent in solid-state physics, in electronics, in software, nanotech, biotech, biomedical. We're about following our inspirations, as opposed to working on any preordained problems.

TR: Are there any good models for Invention Science?

Myhrvold: The model for what we are doing now was set in the 19th century. Edison and Bell and Tesla and lots and lots of others had invention-oriented businesses back then. Invention was a big thing. The world is due for this to come back.

TR: Do you foresee competition?

Myhrvold: We'd welcome competition. We hope our inventions spawn other inventions. I hope there are people who get fantastically wealthy building on our ideas. There is a real opportunity for small groups of people to make incredible contributions. Silicon Valley and Wall Street will rise to the challenge if great new ideas are created.

TR: What didn't you know when you started your invention lab?

Myhrvold: What has surprised me most is how well

So in addition to leaping across disciplines and challenging assumptions, inventors visualize results and embrace uncertainty—which is another reason a bigger proportion of invention may be taking place outside the traditional corporation. “All the conventional wisdom works against invention,” says Walker. “The field of management is about reducing the risk of bad outcomes involving people; the field of engineering is about reducing the risk of bad outcomes involving technology. But invention is about taking risks that will almost certainly fail in order to find the unlikely breakthrough.”

we have been able to get inventors to play off one another and collaborate in brainstorming. We have a couple very exciting inventions involving new kinds of lasers. If you asked me if we could have done that, I would have said no two years ago. I would have even said no before going into the sessions where we invented these things. I had the key idea on both. But one person can provide only 25 percent of the bridge across the Grand Canyon. That’s only enough to get you to fall to the bottom. You need lots of help. If you can get a rapport going among inventors with different backgrounds, you can accomplish amazing things.

By that logic, brainstorming laboratories like Myhrvold’s Invention Science are almost certain to produce lots of failures—but also, perhaps, the occasional big idea that changes the world...and later gets called an accident.

Evan I. Schwartz is a *Technology Review* contributing writer and the author of *Juice: The Creative Fuel Driving Today’s World-Class Inventors*, forthcoming in September.

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