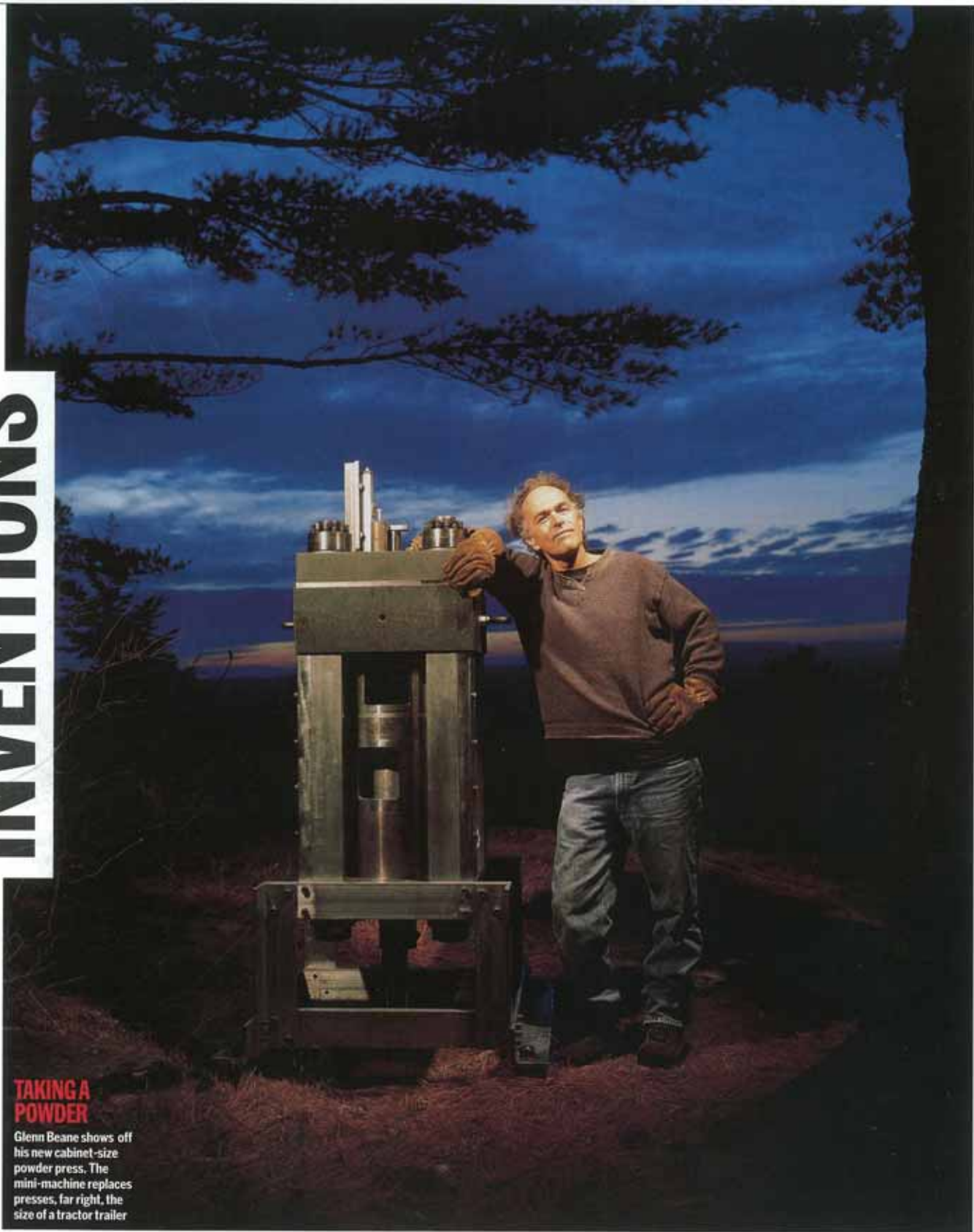


# TIME

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INVENTORS & INVENTIONS

INVENTIONS



## TAKING A POWDER

Glenn Beane shows off his new cabinet-size powder press. The mini-machine replaces presses, far right, the size of a tractor trailer

Photographs for TIME by Richard Schultz

# a new factory for a new age

*For 70 years,  
making machine  
parts has been a  
crude business.  
Now three New  
England inventors  
have built a factory  
the size of a cabinet  
—and industry may  
never be the same*

**BY JEFFREY KLUGER**



ERIN PATRICE O'BRIEN FOR FORTUNE

**I**F YOU OWN A MANUFACTURING BUSINESS, you might want to pay a visit to West Lebanon, N.H. Odds are you've never been to West Lebanon. You may not even have heard of it. But you will. What's going on there may forever change the way you do business—or perhaps put you out of it altogether.

Tucked away in an unremarkable industrial building on the outskirts of town is a little machine about the size of a three-drawer filing cabinet. There's a curious Willy Wonka look to it. Feed a bit of metal powder into its maw, and after a moment of whirring and digesting, it spits out, say, a valve for a diesel engine or a gear for a car transmission or a pump component for a hot tub. It's an odd bit of

industrial alchemy to watch—mere dust transforming itself into highly refined hardware.

The little machine in West Lebanon is known as a powder metallurgy press, and to most manufacturers, there ought to be nothing especially new about it. Powder presses have been around for 70 years, stamping out everything from truck-motor parts to medical equipment. Remarkably common though they are, these machines are remarkably crude. Most powder presses are great, loud, chugging things, about the size and shape of a tractor trailer and demanding the ministrations of at least 200 people to keep them running through a workweek. Retooling the presses to switch from making one component to another can take days. And

any parts the machines do produce are coarse things at best, requiring up to a dozen refinements and improvements before they're ready for use.

The West Lebanon machine, developed by Mii Technologies LLC, is a whole different industrial beast. It's part of a new manufacturing system that is fast, portable and computerized. It can be shipped wherever it's needed and easily reconfigured to make just about any part for just about any manufacturer.

A machine this elegant ought to have come from the R.-and-D. wing of a Honeywell or a John Deere or an IBM. Instead, it sprang from the imagination of a team of local inventors who might be among the most important industrial visionaries since Steve Jobs and Steve Woz-

# The mini-press has twice the power of the gigantic machines it replaces

niak first took to their workbenches. While the machine the West Lebanon inventors are giving the world is not quite the personal computer, it could become to 21st century manufacturers what the cotton gin was to the farmer or the loom to the miller. "If these guys have the materials and can automate the manufacturing process," says Kevin Prouty, an industry analyst with AMR Research in Boston, "that's moving toward a new level—toward a manufacturing renaissance."

By any measure, a renaissance in manufacturing is long overdue. Traditional powder presses are not the only low-tech way parts have been built over the years; stamping machines, casting machines and forging machines are used to melt or muscle metal into shape. Not only are these machines imprecise, they are also fantastically expensive and hard to come by. A start-up company that wants to manufacture parts for a new product may have to wait two years for a press to be built and delivered. Not exactly the quick turnaround time we've come to expect in

the age of silicon.

Mii's powder press may change all that, turning American industry on its head. That, as it happens, is exactly what company CEO Alan Beane, 52, has wanted to do for most of his professional career. Born in Laconia, N.H., Beane, like so many New England natives, developed an admiration for the rugged factory culture that defines this corner of the country. He had manufacturing in his blood; in his youth he spent Sunday mornings poking about his grandfather's Dartmouth Woolen Mills, which produced green blankets for the U.S. military. "My image of factories came from those mornings in the mill with Grandfather," he says. "He was fearsome, but he knew the name of every worker and respected them deeply."

Beane was ambitious—or at least ambitious enough to leave Laconia when he turned 18 and go study economics and industrial R. and D. at the University of Pennsylvania. He returned in 1970—a Wharton graduate in a land of lunch buckets—and became a partner in his fa-

ther's C.P.A. firm, servicing the high-tech companies that were slowly replacing the smokestack factories he had grown up with. After a few years of totting up the profits of other people's businesses, he decided he'd rather be doing some of that manufacturing on his own.

Beane bought a technology company that made components for motherboards and other PC hardware for the burgeoning computer industry. By the mid-1980s, his company was flourishing, and he had begun making the kind of silicon-driven millions so many other high-tech entrepreneurs were piling up. All the while, though, what really fascinated Beane was reinventing not just products and components but the factory itself—creating a digital manufacturing system for the New Economy. One thing that caught his attention was the problem of the powder press. He wondered if

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## HOW IT WORKS

Traditional presses take up huge amounts of floor space and require constant maintenance. Mii Technologies' powder press is the size of a filing cabinet and produces finished parts 50% faster.



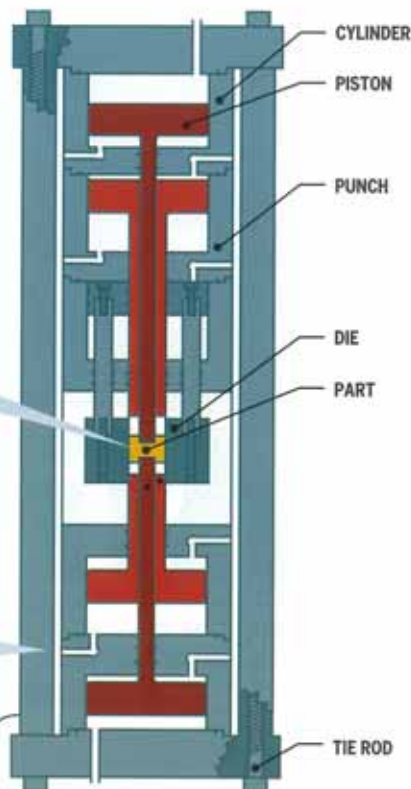
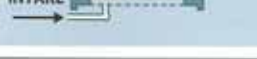
The heart of the press is two critical parts—die and punch. The die defines the shape of a part, the punch applies the force that compresses the powder. Hydraulic power drives the press the way a compressor drives a jackhammer. A single hydraulic system has the power to drive a dozen or more presses.

Every load of micron-size grains fed into the press is measured by weight, not volume. This ensures that all the parts the machine stamps out are identical. Once the powder is in the die, it is fluidized—suspended in a gas to guarantee a smooth and uniform distribution of grains.

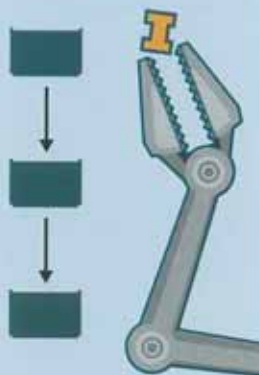


Computers control the hydraulic power that drives each piston, which in turn drives each punch. Built-in sensors track the punches, allowing the computers to step in and adjust the system if something goes awry.

FLUID INTAKE



The press can be quickly customized by changing die and punch. For an even faster turnaround, another press can be rolled in and switched on.



The essentially self-operating Mii system can run pretty much round the clock. What's more, its finished parts are ready to ship immediately, as they require little or no refinement after pressing.

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it was possible to update the Industrial Age brute. Before he could venture onto this alien turf, however, he knew he needed help—and realized he could get it from his younger brother Glenn.

At first blush, Glenn Beane didn't appear to be the stuff of which industrialists are made. A painter, sculptor and filmmaker, he had studied art at Syracuse University, then returned to Laconia, where he converted an old farm building into a sculpture studio and bronze foundry. There, during the years Alan spent as an entrepreneur, Glenn created his art and took in the odd commercial job, like casting bronze propellers for boats. "That's how I made money and put wine on the table," he says.

Behind the loosey-goosey exterior, Glenn was something of a perfectionist, and found himself growing fascinated not just with learning the art of casting but also with refining it, creating molds that grew more and more intricate and had fewer and fewer flaws—precisely the kind of near-zero-tolerance quality needed in industrial manufacturing. When Alan approached Glenn in 1985 and asked for his help, both brothers figured the collaboration would be a good one. "We started doing together what we'd been doing separately," Glenn says, "me the processes, Alan the materials."

### START THE PRESSES

THE BEANES ESTABLISHED MII AS A small materials-research firm, spending the bet-

ter part of 15 years developing and patenting computer systems and other infrastructure for digitally run presses. In 1993 they recruited materials chemist David Lashmore to help them puzzle out the complex chemistry of the powdered metal that would feed the machine they hoped to build. Finally, last spring, they developed a working prototype of a New Age powder press and guessed it just might be the device they were after. They guessed right.

The cabinet-size press the Beaness and Lashmore invented is an astonishingly economical piece of engineering—and an astonishingly powerful one. A traditional 936-cu.-ft. press generates about 440,000 lbs. of force to compress its metal dust. The new 16-cu.-ft. press generates a whopping 920,000 lbs. Four built-in computerized control systems run the press's robotics, monitoring quality and minimizing work-stopping breakdowns. This helps reduce the small SWAT team of 200 workers normally required to run such a machine to just three. What's more, by keeping quality high and eliminating the extra finishing steps needed by parts produced by cruder presses, the new press can complete a job up to 50% faster. "This means we can lower costs by 30% to 50% too," says Alan.

It's Mii's powder as much as its machine that makes this kind of radical improvement possible. Typical powder presses use alloys made of two or more metals that are sifted together in a process little different from—and little more precise than—mixing flour and sugar for baking. In any single mix, there's always the chance of a clot of just one metal remaining unsifted, ruining the entire batch. Mii's powders don't have that problem. Each tiny particle is made of one metal

with a fine rind of the other one coating it—ensuring a denser and stronger alloy. "David helped us understand our work at an atomic level," says Glenn.

Though the Beaness and Lashmore started commercial production only nine months ago, their press is already drawing attention. Mii is manufacturing parts for six industrial customers and is looking for more. While the Beaness and Lashmore will happily run their presses 24 hours a day, seven days a week to serve the clients they do attract, they hope to lease their system and sell their powders so manufacturers can do the work on their own. Mii's robotic presses can not only be shipped around the world, they can also be remotely operated. Thus a supervisor at a computer console in, say, Singapore can monitor a press in, say, Seattle, troubleshooting any problems that come up.

At the moment, Mii is generating revenues of about \$10 million for its three owners—real money by almost any measure but mere bus fare in the high-tech world. The Beaness and Lashmore, however, see far bigger things in the company's near future, and many industry types are beginning to agree.

"This is like the airplane or copying machine in previous eras," says Jay Agarwal, an analyst with Charles River Associates, who has advised the Beaness. "How long it takes the market to form will depend on how long it takes manufacturers to change the way they think about their businesses and the laws of physics."

If the new press can really deliver on its promise, the laws of economics will probably have something to say about it too. —Reported by Susan Disenhouse/  
West Lebanon

ILLUSTRATION FOR TIME BY CHRISTOPHER NIEMANN