

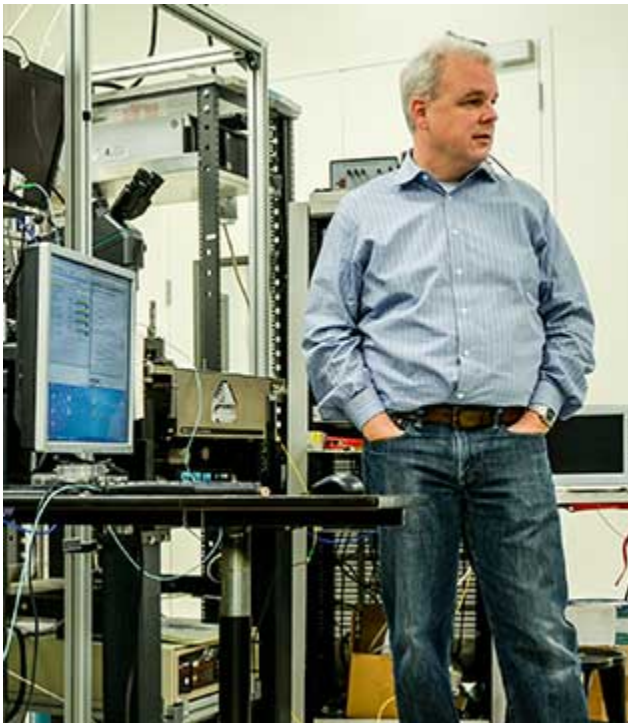
Bloomberg Businessweek**Technology**

<http://www.businessweek.com/articles/2014-06-11/with-the-machine-hp-may-have-invented-a-new-kind-of-computer>

With 'The Machine,' HP May Have Invented a New Kind of Computer

By [Ashlee Vance](#) June 11, 2014

If Hewlett-Packard ([HPQ](#)) founders Bill Hewlett and Dave Packard are spinning in their graves, they may be due for a break. Their namesake company is cooking up some awfully ambitious industrial-strength computing technology that, if and when it's released, could replace a data center's worth of equipment with a single refrigerator-size machine.



Photograph by Richard Lewington/Hewlett-Packard
HP CTO Martin Fink in the Photonics laboratory at HP Labs. That's what they're calling it at HP Labs: "the Machine." It's basically a brand-new type of computer architecture that HP's engineers say will serve as a replacement for today's designs, with a new operating system, a different type of memory, and superfast data transfer. The company says it will bring the Machine to market within the next few years or fall on its face trying. "We think we have no choice," says Martin Fink, the chief technology officer and head of HP Labs, who is expected to unveil HP's plans at a conference Wednesday.

A decade ago, it wouldn't seem as outlandish as it now does for a company such as HP, IBM ([IBM](#)), or Sun Microsystems to build a new computer architecture from the ground up. The hardware powerhouses, known as systems companies, all made their own chips, networking technology, and custom OS. Then commodity components became more powerful, and better data center software began to make up for deficiencies in the cheaper hardware. Consumer Web companies such as Google, Amazon.com ([AMZN](#)), and Yahoo! ([YHOO](#)) advanced new data center designs that were quickly adopted by the mainstream, shrinking the market share of the systems companies.

HP Labs, the company's R&D arm, was once revered throughout Silicon Valley as a steady

source of new products that could open up new markets. It's been far less inspiring in recent years, ginning up a mishmash of mobile software, printing services, and teleconferencing systems that haven't made it to customers in a meaningful way. Amid budget cuts, a costly, complex new computer system would seem like a stretch.

The Machine started to take shape two years ago, after Fink was named director of HP Labs. Assessing the company's projects, he says, made it clear that HP was developing the needed components to create a better computing system. Among its research projects: a new form of memory known as memristors; and silicon photonics, the transfer of data inside a computer using light instead of copper wires. And its researchers have worked on operating systems including Windows, Linux, HP-UX, Tru64, and NonStop.



Photograph by Richard Lewington/Hewlett-PackardA memristor characterization experiment at HP Labs

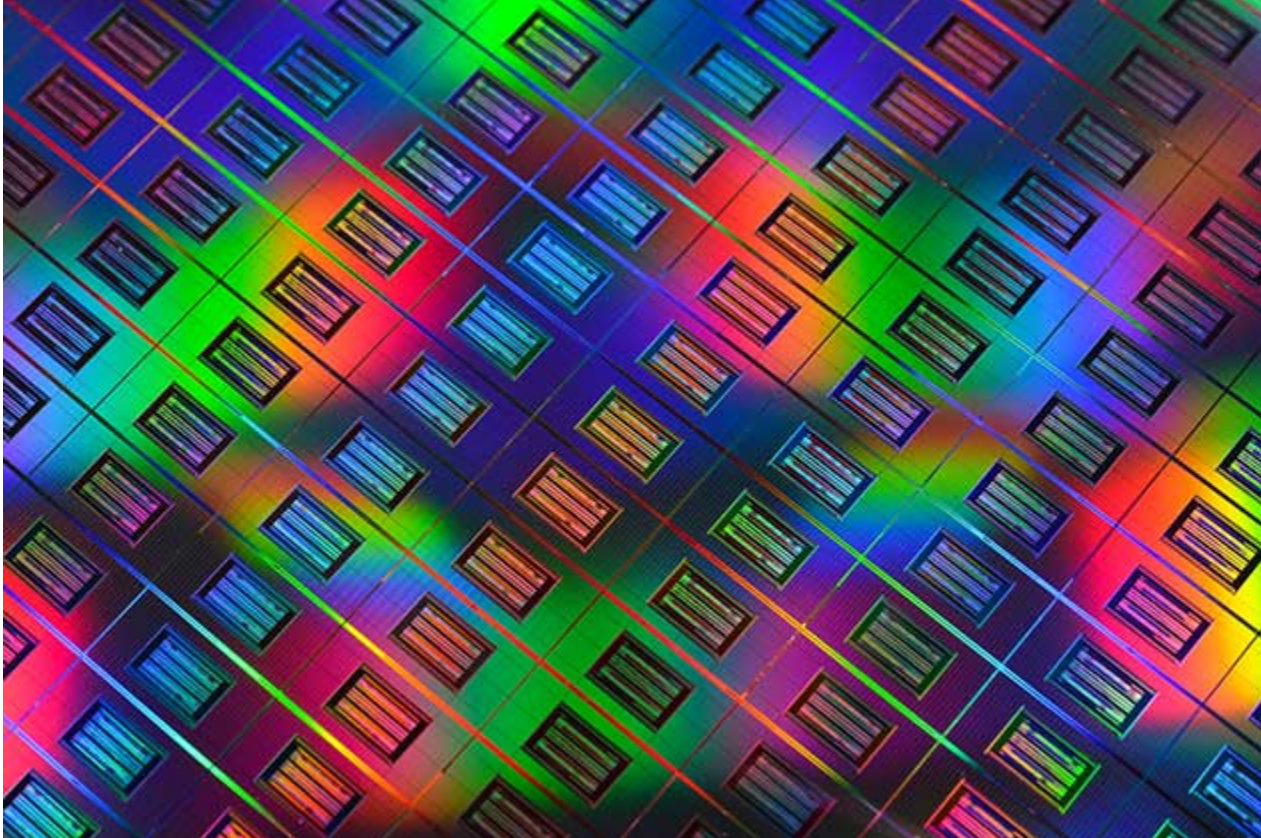
Fink and his colleagues decided to pitch HP Chief Executive Officer Meg Whitman on the idea of assembling all this technology to form the Machine. During a two-hour presentation held a year and a half ago, they laid out how the computer might work, its benefits, and the expectation that about 75 percent of HP Labs personnel would be dedicated to this one project. "At the end, Meg turned to [Chief Financial Officer] Cathie Lesjak and said, 'Find them more money,'" says John Sontag, the vice president of systems research at HP, who attended the meeting and is in charge of bringing the Machine to life. "People in Labs see this as a once-in-a-lifetime opportunity."

Memory represents perhaps the biggest opportunity for change. Computers have worked in a similar way for many years now. When a person wants to do something such as run Microsoft Word, the computer's central processor will issue a command to copy the program and a document from the slow disk it had been sitting on and bring it temporarily into the high-speed memory known as DRAM that sits near the computer's core, helping ensure that Word and the file you're working on will run fast.

A problem with this architecture, according to computing experts, is that DRAM and the Flash memory used in computers seem unable to keep pace with the increase in data use. As the current memory technology hits its physical limits, dozens of companies continue to work on possible replacements. "Everyone on the planet who is paying any attention to this type of thing wants to see this new kind of fast, cheap, persistent memory," says Greg Papadopoulos, a partner at the venture capital firm New Enterprise Associates. "If one of these things works, and one of them will, it will change computing architecture fundamentally."

HP's bet is the memristor, a nanoscale chip that Labs researchers must build and handle in

full anticontamination clean-room suits. At the simplest level, the memristor consists of a grid of wires with a stack of thin layers of materials such as tantalum oxide at each intersection. When a current is applied to the wires, the materials' resistance is altered, and this state can hold after the current is removed. At that point, the device is essentially remembering 1s or 0s depending on which state it is in, multiplying its storage capacity. HP can build these chips with traditional semiconductor equipment and expects to be able to pack unprecedented amounts of memory—enough to store huge databases of pictures, files, and data—into a computer.



Photograph by Richard Lewington/Hewlett-Packard
Closeup of memristor devices on a 300mm wafer

In theory, that would remove the need for a conventional slow disk/fast memory system. With the Machine's main chips sitting on motherboards right next to the memristors, they can access any needed information almost instantly. "It's the Platonic form of computing and is the natural way to do things," says Papadopoulos, a former computer architect for HP and Sun. "You want lots of, lots of memory, and you want it to always be there and to use it as storage."

HP's proposed silicon photonics would also be a big deal. HP, Intel ([INTC](#)), and others have been struggling to shrink speedy fiber-optic equipment enough to replace cheap, proven copper wiring inside a computer. In theory, fiber could also replace Ethernet cables and link entire racks of servers together.

New memory and networking technology requires a new operating system. Most applications written in the past 50 years have been taught to wait for data, assuming that the memory systems feeding the main computers chips are slow. Fink has assigned one team to develop the open-source Machine OS, which will assume the availability of a high-speed, constant memory store. Another team is working on a stripped-down version of Linux with similar aims; another team is working on an Android version, looking to a point at which the technology could trickle down to PCs and smartphones.



Photograph by Richard Lewington/Hewlett-Packard
Writer Ashlee Vance tours the clean room at HP Labs

Fink says these projects have burnished HP's reputation among engineers and helped its recruiting. "If you want to really rethink computing architecture, we're the only game in town now," he said. "We have found some people that are battle-tested and bloodied and know how to do this sort of thing. At the same time, we want people that have never done this before and are not constrained by the traditional architectures."

The Machine isn't on HP's official roadmap. Fink says it could arrive as early as 2017 or take until the end of the decade. Any delivery date has to be taken with some skepticism given that HP has been hyping the memristor technology for years and failed to meet earlier self-imposed deadlines. "Memristors have been vaporware for a long time," says David Kanter, a chip analyst and editor of the semiconductor publication *Real World Tech*. "There is a huge difference between research and production." Papadopoulos says he applauds HP's plan and hopes it succeeds, but he warns that the OS development alone will be a massive effort. "Operating systems have not been taught what to do with all of this memory, and HP will have to get very creative," he says. "Things like the chips from Intel just never anticipated this."



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