



## IBM's Almaden Research Center marks 15 years of innovation and impact

For better or worse, Silicon Valley is a fast-twitch culture. Our collective gaze is locked on a point 15 minutes into the future -- the next product, the next quarter's numbers, the Next Degree in Really Cool. Given this focus -- this myopia, if you prefer -- it comes as no small comfort that there are a few very bright people in our midst who spend all day scanning the farthest points on the scientific horizon.

On any given day at IBM's Almaden Research Center, a visitor might find one scientist working on a theorem that could eventually lead to a more efficient data-compression algorithm that could in turn someday lead to putting a server's worth of data in a wristwatch.

Down the hall, someone in quantum computing is testing a few atoms' worth of material, working on research that might someday free the digital world from its rigid strings of zeroes and ones, perhaps leading to computers thousands or millions of times faster than what we have today.

But there's more to the lab than the territory *out there*. Researchers are also working on disk-drive technology that will be in IBM laptops next year -- and on data displays that might be in eyeglasses a few years after that.

Almaden, which will celebrate its 15th anniversary Thursday with an open house for invited guests, is one of eight research labs within Big Blue. While the facility, nestled into the south San Jose foothills adjacent to Santa Teresa County Park, is the company's prime lab for storage technologies and information management, it also does work in a broad swath of computer science, physical science and materials science.

Why should consumers care what goes on up there on the hill? I ask lab director Robert Morris, who seems momentarily taken aback by my offhanded assertion that hard science is, well, *hard* for a lot of us to grasp. "These things are at the heart of everything people do, directly or indirectly. If you look at the whole range, they touch people in so many ways. Look at data management -- it touches people any time they cash a check or go to an ATM. . . . And the whole concept of exploiting data, searching data. People didn't think of that in the old days. Now data search is something any kid understands."

While the Almaden lab is 15 years old, the organization can be traced back to the seminal days of Silicon Valley. Almaden is the direct descendant of IBM's original San Jose research facility, founded in a former print shop at 99 Notre Dame Drive in 1952. It was there, in 1956, that IBM gave birth to the disk-drive industry with the development of RAMAC, the world's first disk drive. The research operation eventually moved to IBM's Cottle Road facility.

## Center is unique

Almaden is not the only elite research facility in the region, but it's different from academic enclaves and other corporate labs. How different? Ted Selker, a renowned user-interface researcher who came to Almaden from IBM's Watson Research Center in New York, recalls one incident in 1998:

"I was going to go to Mount Everest to work on a scientific expedition. So I called up my friends in the disk-drive business down the hall and I said, 'I'd like a disk drive that will work at 20,000 feet.' And they said, 'It'd be great to make the head fly different by changing the wing shape -- but that'll take nine months.' I told them I had two. And they said, 'Well, why don't we go into the hyperbaric chamber tomorrow and take a look some disk drives?' Three months later, I was on the mountain with these disks."

Selker, who left Almaden in 1999 to become an associate professor of media arts and sciences at MIT, says that kind of across-the-disciplines, across-the-hall collaboration is part of Almaden culture. "There is a goal of having cross-fertilization," he says. "Find me another organization that would have had the skills to redesign the disk drive in a few weeks."

IBM's research division used to assign a numeric rank to each of its researchers worldwide. It doesn't do that anymore. But the question remains: In an atmosphere saturated with super-achievers, how does one measure success? By scholarly papers (Almaden's researchers are strongly encouraged to publish, but it's not a hard requirement). By patents. And by products -- or work that contributes to products. But the thing researchers point to most often is an amorphous measure they call "impact."

"Impact," says Morris, "is changing people's lives, that's really what it comes down to. If you dig down and ask so many researchers, 'Well what do you *really* want to do?' that's what you'll come to. They want to see people using their work."

The first Almaden technology to have monumental impact on daily life -- the relational database -- was actually born down the hill at the old Cottle Road facility in 1970 and nurtured at Almaden. A relational database is one that can link items within different tables of data and define relationships between the tables in a variety of ways. Today, relational databases are at the heart of many financial networks and virtually all the e-commerce systems in use on the Web.

Along the way, Almaden has also developed little things that made a big quality-of-life impact on average consumers, such as Selker's TrackPoint -- a cursor-pointing device nestled within the keyboard -- which came with him from the Watson lab to Almaden. Although it's already in millions of laptops, Almaden researchers continue to refine and extend the technology. Almaden's user-interface researchers are at work on everything from more functional mice to more efficient keyboard layouts for handhelds.

## Smaller, lighter

Since the commoditization of the disk drive, magnetic storage is hardly the sexiest field in Silicon Valley. But advances in storage technology developed at Almaden are moving at a velocity greater than that of many other tech disciplines. Consider that at the dawn of the disk-drive industry, RAMAC housed five megabytes of data -- roughly the complete works of Shakespeare -- on two-foot-wide platters, with a data density of 2,000 bits a square inch. Today, Almaden's Microdrive -- the world's smallest, lightest drive -- can contain a gigabyte of data -- roughly 10 meters of shelved books -- in a matchbook-sized device with a data density of 15.2 billion bits a square inch.

In terms of capacity, one card-sized Microdrive could hold the data contained on 200 refrigerator-sized RAMACs. And in terms of data density, IBM's most advanced Travelstar drive, at 25.7 gigabits a square inch, packs data nearly 13 million times as efficiently as RAMAC.

And it's not rocket science -- it might be in the memory slot of the digital camera your kid took to camp.

### **Pushing limits**

As IBM's flagship lab for storage, Almaden's stock in trade is pushing the extreme physical limits of disk drives: How tightly can we pack the individual bits on the disk? How close can we get the head to the disk? How small can we make the entire package? Over the last two years, Almaden researchers have been able to push back one of the storage industry's most formidable barriers, the "superparamagnetic effect," which means data is lost when the magnetic areas of the disk get too small. Almaden researchers got over the hurdle with a new magnetic coating, "antiferromagnetically coupled media," a sandwich of materials just a few atoms thick.

This "Pixie Dust," already appearing in IBM's new laptop drives, could potentially allow disks to be built with a data density as much as four times the current industry standard.

From the 1950s until fairly recently, IBM's research division was physically and philosophically a world apart from its product-development staff. "Go back 15 or 20 years and you'd see we were operating more like a pure research lab or a university," says Morris. "That changed over time. The first stage in the transition was we got much closer to our product people. And the second stage, in the last seven or eight years, is we got much closer to our customers."

### **'Challenges coming'**

Morris will allow that Almaden has an ample buffer to shield it from the harsher realities of the marketplace -- but it isn't entirely immune to pressure from its corporate parent. "When it's doing well, we tend to grow more. When it's not, we tend not to grow," he says. "We've been accorded a lot of buffering, but when certain products are in danger of being late, we feel that pain and jump in and help."

Is it inevitable that before the lab can celebrate another big anniversary, the researchers at Almaden will hit some hard, physical limit on the number of bytes they can cram into a square inch? "We thought we'd be stopped a long time ago," says Morris. "We see challenges coming up. It's going to be very difficult to continue. And we're going to have to make significant changes in the technology. But we don't see anything stopping us outright in the next 20 years."

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