

May 23, 2003 4:57 a.m. EDT

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At Bell Labs, Hard Times Take Toll on Pure Research

Under Weakened Lucent, Famed Haven For Theorists Gets a More Practical Bent

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For seven years, Bell Labs linguist Chilin Shih struggled to develop the world's best program for making a computer speak. It would have the subtle intonations that go into real speech, and not just sound like a robot. Roaming through the labs' hallways in Murray Hill, N.J., she brainstormed with mathematicians and statisticians, with little success.

One day in 1999, she started talking to a physicist, Greg Kochanski, who leapt at her problem, mapping out a possible solution on a cafeteria napkin. That sparked a collaboration: Dr. Kochanski's equations helped Dr. Shih model the muscles of the mouth, and eventually get a better idea of how to convey emotion in computerized speech.

The two are still perfecting their software, but they're not doing it at Bell Labs. In November, **Lucent Technologies Inc.**, parent of the renowned facility, scuttled the speech-research department. The move comes as part of a \$2.1 billion cost-saving and reorganization program at Lucent. These cuts, combined with five large business divestitures, have shrunk the labs' pure-research staff to just over a third of its 1996 level, and narrowed the labs' focus to projects directly related to telecommunications products.

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Chilin Shih

For many researchers, these moves represent the erosion of a scientific icon. For nearly eight decades, Bell Labs stood at the summit of American technological prowess, garnering six Nobel Prizes and fostering a climate of unhampered scientific inquiry. The labs' deep pockets funded research that either invented or laid the groundwork for the transistor, communications satellite, fax machine, VCR and numerous other landmark devices. When the Apollo space program needed to calculate rocket trajectories and landing spots for its first mission to the moon, it called on Bell Labs for help.

Now, in the wake of the telecom collapse and Lucent's flagging fortunes, Bell Labs' research budget has sunk to about \$115 million from its mid-1990s level of \$350 million. To many scientists, the labs are now a symbol of declining corporate support for "pure" research -- scientific inquiry that seeks not to develop specific products, but to make basic discoveries from which future innovations are drawn.

Bell Labs is a "national tragedy," says Charles Vest, president of the Massachusetts Institute of Technology. "Bell Labs for decades was not only an icon of farsighted research, but it employed the very best scientists. [Now it] is an icon for changes that have happened to basic research."

During the 1960s and 1970s, spurred by Cold War rivalries, the federal government paid for about two-thirds of all basic research in the U.S. That figure has since dropped to about a third, according to the National Academy of Sciences. The rollback was bearable as long as private industry took up the slack, which it did during the 1980s and early 1990s. But because of stiff global competition and shareholder demands, companies have little room to fund blue-sky research. Xerox Corp. spun off its famed Palo Alto Research Center last year, making it responsible for its own profit and losses. Lucent spin-off Agere Systems Inc., an integrated-circuit maker, no longer maintains a central research laboratory.

To be sure, Lucent's \$2.3 billion R&D budget is still one of the biggest in telecommunications, and the 21st largest among U.S. companies during 2002, according to researchers Schonfeld & Associates. Having just received its 30,000th patent, the company continues to push hard into the core research that can make telecom and wireless networks cheaper and more flexible. Some inside the Labs say that its new focus on applied research is a necessary change, given that scientists used to joke that they didn't know why the company was paying for their work in the first place. Lucent, meanwhile, says it will return to profitability in the quarter ending Sept. 30 after 13 straight losing quarters.

Lucent executives acknowledge that scientists need room to dream. However, they say, the purpose of Bell Labs is no longer to serve some vague public interest but the specific demands of its five million shareholders. "The reality is that progress can only be there to the extent that we can afford it," says Bell Labs President William O'Shea.

Originally created in 1925, and funded by the monopoly profits of AT&T Corp. and its equipment-making arm, Bell Labs was designed to bring together some 4,000 engineers and scientists working on improving phone systems. The labs were also a way for AT&T to show its commitment to the national interest, heading off criticism of its market power. With callers paying artificially high phone rates, the company spent lavishly. Researchers could get approval within two days to buy elaborate lab equipment. A swarm of librarians was on hand to order any book staff scientists requested.

The freedom to spend created a freedom to explore. Researchers were attracted by the opportunity to pursue their work unfettered by market demands. One of their biggest discoveries came in 1965. When tinkering with a radio antenna -- originally used to detect radio signals across a network of orbiting balloons -- Bell Labs astronomers Arno Penzias and Robert Wilson noted a disturbance affecting the transmission. Further exploration led them to conclude that the disturbance was the lingering effect of the Big Bang: the explosion that scientists believe created the universe. For this work, the two were awarded the Nobel Prize in physics in 1978.

By the mid-1990s, Bell Labs' pure-research staff had swelled to about 1,100. To turn their breakthroughs into actual products, the labs employed another 23,000 developers spread among 21 sites in eight states. Perhaps the most famous site of all was the main labs' cafeteria in Murray Hill -- where top scientists from different disciplines mingled freely, without the strict divisions in place at universities. They were an eclectic group: At one point, various researchers were designing computerized ballets with digital stick-figures and creating psychological profiles of successful managers. Working at Bell Labs, say veterans, was like being at a university with no classes to teach and no papers to grade.

The cafeteria is still a meeting ground for scientists. But the corporate world around it has changed drastically. The transition began in 1984, when a court broke up AT&T, carving out the local phone operations into seven separate carriers. What was left of AT&T was splintered into three more units in 1996, one of which combined Bell Labs and Western Electric, the venerable operation that designed and built telecom equipment.

The new company, Lucent, rose through the telecom boom. But when the crash came, Lucent was too bloated with employees and facilities to keep pace. It lost more than \$28 billion over the past two years alone, at one point dimming lights in the Murray Hill hallways to save money. The market currently values Lucent at about \$10.5 billion, down from \$287 billion in late 1999.

Today, Lucent's core-research staff at the labs numbers about 400. Many departments have lost about a quarter to a third of their researchers. Gone entirely are research centers for ecology, psychology and economics, which were founded when Lucent was part of the flush AT&T.

Some scientists who remain at Bell Labs say they want to keep their scientific autonomy but feel pressured and personally motivated to help the company through its hard times. That has led to complaints that scientists have been turned from long-range thinkers into short-term tinkerers, called in as "SWAT teams" to consult customers on Lucent product snafus. The fear among many current and former workers is that these short-term demands are turning Bell Labs into just another industrial-development group, without the carte blanche that led to so many breakthroughs.

"The message is clear that 'capital-S' science does not matter," says Jon Bentley, a former Bell Labs expert on computer programming who has since moved to Lucent spinoff Avaya Labs. Now what matters is "what things can you do to help the company this quarter."

To some scientists, the new, practical Bell Labs is an improvement over the old operation, in which they could toil for decades and never see their work turn up in AT&T products. "We get joy out of doing research, and double joy out of seeing it in real use," says Rod Alferness, a top researcher in optical networking, systems that use waves of light to transmit data.

Labs scientists now continuously meet with their counterparts running Lucent businesses to get a better sense of the technical demands they're facing. In marketing, the company's services unit touts customers' "access to the experts," a direct linkage that would have been considered almost heresy years earlier. The new cooperation "shows we care," says Jeff Jaffe, Bell Labs' president of research.

Mr. O'Shea, the labs' overall president, says: "Though smaller than in the past, we continue to do great work across a range of fundamental research disciplines." One such project would make transistors out of plastic, instead of silicon, greatly reducing costs.

The travails of Bell Labs' speech-research group provide a window onto the clash between business needs and scientific curiosity. The group can trace its beginnings to Alexander Graham Bell, who improved on a symbol system used for the deaf. Its innovations over the years included the Voder, exhibited at the 1939 World's Fair. It was the first machine to artificially generate the sound of the human voice, using a series of keys and foot pedals.

By the 1980s, in a warren of offices in Murray Hill's Building 2, the speech team worked on the building blocks of speech emulators and voice-recognition tools. The offices echoed with the sounds of sentences repeated over and over again, like Henry Higgins training Eliza Doolittle in "My Fair Lady." For English alone, the group collected recordings of about 60,000 sentences over 20 years, building multiple systems to tackle the problem.

Dr. Shih, who was hired in 1986 to create a Chinese-language speech simulator, recorded the distinct parts of speech sounds, such as the sound "pa" in the word "pan." Another colleague spent years studying facial expressions and lip movements to develop an animated "talking head" that would appear to speak written text.

"This is why I loved Bell Labs the most," says the 48-year-old Dr. Shih, who met her husband in the same fourth-floor corridor where she would later be laid off. "Everyone has an intrinsic interest in other people's problems, and they plug their own pieces in, and we plug our pieces in, and we solve problems very, very quickly."

Dr. Shih's collaboration with the physicist, Dr. Kochanski, was only beginning when Lucent embarked on an ambitious effort to sell its speech expertise. In January 1999, it launched 60-employee Lucent Speech Solutions using personnel from New Jersey and Naperville, Ill. The new unit sold speech-recognition software and hardware to the likes of Moviefone Inc.

Then the Internet and telecom bubble burst. By 2001, amid Lucent's widening financial woes, Dr. Shih began to listen for the roar of the company helicopter, reasoning that the more flights it made, the more likely that bankers and lawyers were descending on Murray Hill to either sell Lucent or bring it into bankruptcy.

The speech lab began to scramble to show its relevance to Lucent. Dr. Shih was one of four scientists assigned to build a new speech synthesizer from scratch, with hopes that it would compete with a similar AT&T system. As layoff rumors floated through the labs, Dr. Shih says she and a few colleagues "sensed we needed to do something drastic" to prove their worth to the company. Within about a month they had constructed a proposal: Using some of their speech-analysis software, they worked up a project that would

automatically analyze incoming customer e-mail and phone calls and provide automated responses.

The proposal was turned down by the labs' research director, Dr. Jaffe. In an interview, Dr. Jaffe says he admired the plan, but it wasn't a research project so he couldn't fund it.

In the spring of 2002, for the first time in the history of the labs, managers met to conduct full reviews of each of the labs' 50 research projects.

Bell Labs ranked each of the units, based on quality of research and relevance to the company. The speech group did not fare well, according to Dr. Jaffe, because the field was relatively mature. "You reach a point where you think a certain level of breakthrough has already been achieved," he says. "The next breakthrough is sufficiently far off."

After a series of smaller cuts earlier in the year, the speech group received its final layoff notices in November. While their children were at school, Dr. Shih and some of her former Bell Labs colleagues gathered for grant-writing "salons" in her home just feet from the Bell Labs entrance.

Then, earlier this month, members of the group began hearing welcome news. Dr. Shih says she is expected to get a teaching post at the University of Illinois at Urbana-Champaign starting this fall. Her husband has already confirmed a faculty position there. Her main collaborator, Dr. Kochanski, will take up a professorship at Oxford University in England, and other colleagues have secured jobs at **International Business Machines** Corp. The two plan to continue working by e-mail on their project to put more emotion into computerized speech.

"There will be a little bit of Bell Labs growing in a hundred different places," Dr. Shih says. "So maybe it's not so bad."

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Updated May 23, 2003 4:57 a.m.

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