Bellcore Looks for a Connection

The corporate research lab for the seven Baby Bells will soon be up for sale as its owners embrace an industrywide trend toward short-term, sure-fire bets

Batteries are the bane of the communications industry. They are crucial for operating everything from car phones to entire telephone networks, but they are also big, heavy, and unfriendly to the environment. So more than 5 years ago, scientists at Bell Communications Research Co. (Bellcore), the R&D arm of the seven U.S. regional telephone companies, took on the challenge of finding an alternative to the current lead-acid batteries that would be smaller, lighter, and cleaner to produce and discard. Bellcore is now touting the result of its effort: a slim, plastic lithium-ion battery regarded as a potential breakthrough for the industry. But instead of being a symbol of the company's future, the battery may instead signal the end of an era at Bellcore.

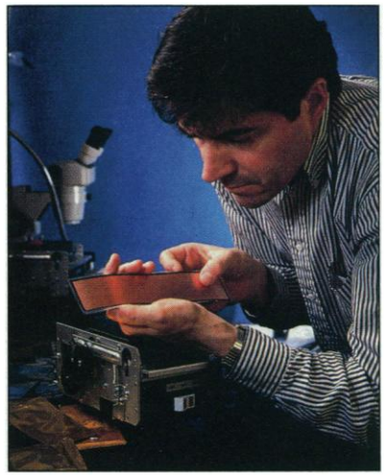
A decade after they were formed from the breakup of AT&T, the so-called Baby Bells have decided that the current Bellcore no longer meets their R&D needs. Last month, they announced that they are putting the $1 billion lab—one of the world's premier telecommunications labs—on the block. They hope to sell Bellcore to a buyer that would run it as an independent company doing research and development for many clients, including the Baby Bells.

The move is prompted by the transformation of the Baby Bells in the past decade from regional purveyors of local phone services to fiercely competitive information companies. In that environment, a joint research enterprise became increasingly awkward. But the move also reflects a trend within U.S. industry favoring research with more immediate payoff than the patient, teamlike approach used by Bellcore to produce a new battery. The companies are betting that turning to outside sources for new product ideas and technologies will be a faster, cheaper way to get what they need without the overhead of a central facility.

The trend troubles some observers. "It's very sad," says Richard Solomon, associate director for communications policy in the Center for Technology Policy and Industrial Development at the Massachusetts Institute of Technology (MIT). The Baby Bells "can afford Bellcore because they are making incredible profits, but now they don't want it." Mark Myers, senior vice president for corporate research and technology at Xerox, says that traditional ways of doing research are feeling the squeeze from the intense pressure to meet short-term bottom lines. "The circumstances of business and commerce have changed dramatically—and research will have to change, too. You've got to get a bang for the buck," he says. The impending Bellcore sale, he adds, "represents a kind of crisis, a signal of what is happening [throughout the industry]."

Recharging its image

The new battery represents the kind of work that Bellcore was set up to do: general applied research aimed at giving customers what they haven't yet asked for because they didn't know it was possible. On display last month in suburban northern Virginia at the company's first trade show, the battery is just one of a string of inventions that have come out of the lab in the past few years. Another would allow people to manipulate their view of a football game or ballet they are watching at home with a simple remote-control device that tailors the view from a wide-angle camera at the event. And research into advanced software is fueling the Baby Bells' entry onto the information highway.



BELLCORE

Charged up. Bellcore hopes products like this new lithium-ion battery will make it attractive to potential buyers.

The money to do this research has come almost exclusively from the Baby Bells, whose representatives make up a board of directors that oversees Bellcore. Bellcore was spun off from AT&T's Bell Labs to provide research and development services to the new companies. Unlike Bell Labs, however, it was not organized to do any basic research; the focus was primarily on applied research and software development. For its first several years, Bellcore researchers were given considerable leeway in exploring new technologies and services, and board members were generally able to agree on the company's direction. At the same time its applied research portfolio represents only one tenth of the company's annual $1 billion budget. The remainder goes for development of communications software, consulting services, and other information technologies.

Despite its limited investment in research, Bellcore still offered researchers a unique mixture of disciplines that made for a stimulating environment. "I had co-authors who were engineers and chemists," recalls Fan Chung, a University of Pennsylvania mathematician who until last year was head of Bellcore's mathematics, information science, and operations research. The combination, she adds, was ideal for solving complex problems.

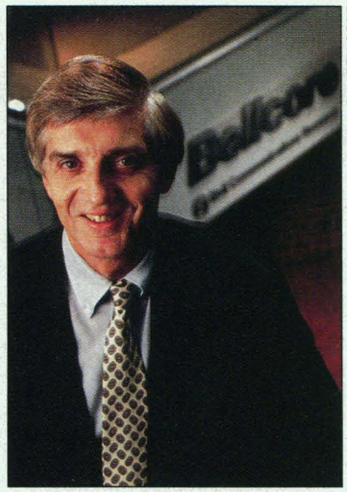
Despite this practical bent, Bellcore's seven owners began to worry that the company was increasingly removed from a fast-paced commercial world in which researchers stand alongside those who develop, manufacture, and buy products. The late 1980s was also a time of increasing rivalry among the Baby Bells. The consensus necessary to set Bellcore's direction began to break down, and agreeing on specific projects became more difficult. "The whole notion of sitting around a common table became more and more a questionable notion," says Martin Kaplan, Pacific Bell executive vice president of technology and services and the current chair of the Bellcore board. "We had different interests."

One thing the companies could agree on was the need for Bellcore to slim down and become more self-supporting. So in 1991 the board hired George Heilmeier, a former head of the Defense Advanced Research Projects Agency at the Department of Defense, to take over the company. Heilmeier brought in Robert Lucky, an engineer and Bell Labs research director, to run the applied research division.

Bellcore underwent dramatic changes under its new management. The size of the work force dropped by a quarter, research was focused on a dozen specific projects approved by the board, and the company began to market its services to non-Bell companies abroad. Bellcore also abandoned its independent approach to research by setting up a

"Collaboratory" with the Baby Bells to create and test software for navigating computer networks. Joint work also led to the development of an electronic receptionist to track down a traveling business manager and an advanced research network, called Aurora, to link major laboratories and universities.

The transformation sent tremors through the applied research division, where the focus shifted from research to applications. "Things changed quite rapidly," says Chung. But not rapidly or dramatically enough for the Baby Bells, which last year began to think seriously of selling Bellcore. Chung left because of the uncertainty surrounding the fate of research at the company; about half of the 20 scientists in her group have followed in her footsteps. Most have gone to work at universities, and a few were hired by AT&T's Bell Labs. "There really is quite a question as to the survival of research at Bellcore," she says. "It is a long-term investment, and whether it survives depends on the future ownership."



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Short horizon. Robert Lucky says his bosses want applied research to pay off within 18 months.

Lucky agrees that the future is murky, but he says the changes of the past 4 years were inevitable given the enormous financial pressures placed on Bellcore. "My whole career was based on research," he says. "But we were swept up with the times; basic research is not affordable in this environment." On the other hand, applied research is no cakewalk, either. "I have been told every day that 18 months is my horizon," he says. "If you can't help in 18 months, they don't want to see you."

The situation is likely to worsen, he says, once the Baby Bells switch from funding Bellcore directly to contract work. "It will make it harder for them to spend that money," says Lucky. Although the regional companies are free to support applied research, he adds, "the compulsion to do so will disappear."

In the meantime, Bellcore officials say they no longer try to impose their technological preferences on potential customers. "We don't do technology for technology's sake," says George Via, executive vice president of customer solutions. "It's a new Bellcore aimed at solving your problems." The planned sale also requires Bellcore to play down its reputation for applied research. "That's the perception we're trying to alter," says Via. Research expertise may impress the scientific community, but it is viewed with skepticism on Wall Street.

Giving customers what they want was certainly the theme at May's trade show in suburban northern Virginia. In addition to the lithium-ion battery, Bellcore sales representatives showed off an array of products and services, some developed by other companies and purchased by Bellcore. "We're trying to solve real-world problems," explains Lanny Smoot, executive director for information networking applications research.

Could the battery project be launched in today's business climate? "Yes, we could do it, but it would be more difficult," says Paul Warren, an organic chemist who is Bellcore's director of the energy storage research group.

Too many cooks

The proposed sale of Bellcore also highlights the different paths that the seven Baby Bells expect to take in acquiring the technology they need to grow. While some of the companies intend to beef up their internal R&D activities, others will rely on contract work. "All the companies have wildly different views," says Kaplan.

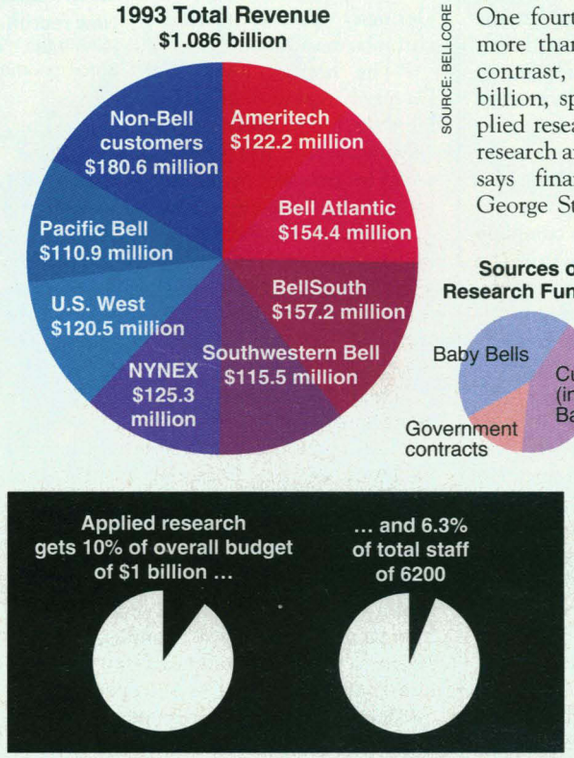
New York–based NYNEX and Colorado's U.S. West are the most research-friendly companies, while Pacific Bell in San Francisco and Chicago's Ameritech make in-house research a lower priority. "We'll probably never build a major research part of the company," says Kaplan about his company. "We're a user of technology; we're not going to be on the leading edge." Only 25 people in the company are working on applied research projects, he says, "and that is very targeted." When the company needs additional brain power, he says, it goes to one of half a dozen universities in the area.

U.S. West, by contrast, is spending between 10% and 15% of its annual revenues of $11 billion on research and development—including its contributions to Bellcore—according to Bud Wonsiewicz, the company's vice president for advanced technologies. And despite employing 365 scientists, engineers, and technicians, much of its research is done outside the company. "We will depend more on universities and other research centers," he says, with the exception of proprietary research. "Any company that tries to do everything in-house is doomed to failure."

NYNEX officials refused to discuss their research strategy, but the company, with $13.3 billion in annual revenues, says it spends $160 million a year on research and development. Of its 485 scientists and engineers, more than 40% work in computer science and 23% in electrical engineering. One fourth of them hold doctorates, and more than half have master's degrees. By contrast, Ameritech, with sales of $12.6 billion, spends only $21.6 million on applied research. "The incentive to spend on research and development really isn't there," says financial public relations director George Stenitzer, citing government restrictions that prohibit the Baby Bells and Bellcore from manufacturing hardware.

Although most Bells declined to reveal how much they spend on research, all intend to pursue a strategy that mixes in-house and out-of-house work. "We'll do some research ourselves, continue to use Bellcore for specific projects, and look to other vendors as well," says BellSouth spokesperson Joseph Chandler. He would not say how much of the Atlanta-based company's $16.9 billion in revenues is spent on research.

Kaplan expects the Baby Bells to draw on a combination of their own internal expertise



SOURCE: BELLCORE

Core support. The Baby Bells provide most of Bellcore's funds, including its research dollars. But only a small fraction of its annual budget and staff are devoted to applied research.

and the skills of Bellcore scientists. "The board is very mindful of what it wants Bellcore to be: independent and supplier-neutral," he adds. "We would not take this step if we thought it would compromise our ability to get the technology we want."

The real world

These moves by the Baby Bells to focus more on near-term research and development and to contract out much of the work mirror developments in many other U.S. companies. AT&T Bell Labs, for example, is scaling back the basic research that made it famous, and RCA's renowned David Sarnoff Research Center—the birthplace of color television—has struggled to maintain its scientific expertise since it was sold to SRI International in 1986. Replacing the old centralized megalab approach is a flexible mixture of in-house work, outside contracts with universities, and outright purchase of new technologies from more innovative companies. Some, like MIT's Solomon, view this trend with alarm, while many industry executives say it's only copying what is being done profitably in other industrialized countries.

The burning question for Bellcore's 6200 employees is whether a company no longer sponsored by the Baby Bells can continue to attract the resources it needs to be successful. Not all Bellcore managers and alumni are worried. "I don't see why the right kind of applications research won't work," says Al Aho, a former Bellcore general manager for information science and technology and now a computer science professor at Columbia University. "And the divestiture of Bellcore gives it the opportunity to do things it previously could not"—such as aggressively seek new customers outside the Bell system.

Aho and others argue that the company will also be better off once it is freed from the need to win over seven bickering masters. Under the new plan, says John Seazholtz, Bell Atlantic vice president of network technology, "if three of us want to do a project with Bellcore on a proprietary basis, we can. We don't need everyone to agree to it."

However, Lucky and others worry that a shrinking research budget will mean a shrinking pool of ideas for new products. "There will be less time for untargeted exploration," says Lucky. "You can't promise someone a lithium-ion battery—you have no idea it can exist." And Lucky is concerned about what Bellcore will put on display at upcoming trade shows, and whether scientists like Warren will continue to move between the lab and the limelight. "Now we're all standing around selling products," he says. "But I don't know in the future what we'll be selling."

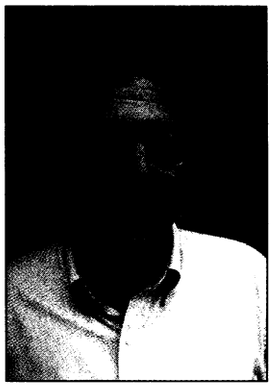
–Andrew Lawler

HUMAN GENOME PROJECT

Emphasis Turns From Mapping To Large-Scale Sequencing

No pistol shot marked the start, but the race to sequence the human genome began in earnest this spring. This was apparent to scientists attending recent meetings on human genome research—one in Santa Fe, New Mexico, on 3 May, and the other at Cold Spring Harbor, New York, from 10 to 14 May.

During these meetings, two teams—one led by John Sulston, Robert Waterston, and Bruce Roe, and the other by Michael Palazzolo and Robert Moyzis—firmed up plans to sequence chromosomes 22 and 16, respectively. By fall, they want to have data on their operations showing whether they can analyze large chunks of the human genome accurately and at low cost. In addition, a group interested in the X chromosome is meeting in mid-June and may organize a team to complete work on that chromosome. Anthony Carrano at the Lawrence Livermore National Laboratory is moving ahead on chromosome 19. Other teams in Japan and Germany are zeroing in on chromosomes X and 21.



New recruit. Bruce Roe joins a team sequencing chromosome 22.

"The bottom line," says David Kingsbury of Johns Hopkins University's genome data center, "is that the time has come to do some [large-scale] sequencing; we're not going to wait much longer" for improvements in technology. "The whole mentality of the field has undergone a substantial change in the past year ... towards a feeling that it's time to start doing it," says Francis Collins, director of the National Center for Human Genome Research (NCHGR).

This burst of sequencing activity heralds a new phase of the U.S. Human Genome Project. Until now, the project, funded jointly by NCHGR at the National Institutes of Health (NIH) and by the Department of Energy (DOE), has devoted most of its resources to producing the detailed genome maps intended to guide researchers to their ultimate goal: the complete sequence of all 3 billion base pairs in the human genome. But NIH began to shift attention last December to a new strategy proposed by two champion sequencers: Sulston, director of the Sanger Center at Cambridge University in the United Kingdom, and Waterston, director of Washington University's genome center in St. Louis (*Science*, 10 February, p. 783). The two manage automated labs that are sequencing the entire genome of the nematode *Caenorhabditis elegans*, grinding out more genomic data than anyone in the world—about 10 million DNA bases a year. This success led Sulston and Waterston to suggest a short cut.

Rather than determining the precise order of all 3 billion base pairs, they asked, why not settle for something less—say, 99% or 99.9% precision? This would mean leaving one uncertain base per 100 to 1000 bases sequenced. With this compromise and a centralized effort, they argued, it would be possible to save money and sequence the genome by 2001, 5 years ahead of target.

The initial response was muted. While disease researchers were delighted with a plan that promised to complete the genome in 5 years, others were skeptical. Some scientists didn't want to sacrifice precision, and many doubted that sequencing nematode DNA is comparable to sequencing human DNA. For example, the human genome contains longer and more frequent stretches of hard-to-assemble repeat patterns. Gene mappers were particularly dismayed, because the proposal would shift funds from mapping to sequencing sooner than expected.

Waterston's budget, projecting costs of as little as 10 cents per base, also raised some eyebrows. Many sequencers question that figure. J. Craig Venter, director of The Institute for Genomic Research in Gaithersburg, Maryland, an expert in high-speed sequencing who just reported the first complete sequences of two bacteria, *Mycoplasma genitalium* and *Haemophilus influenzae* (see p. 1273), finds it hard to believe the cost can be pushed below 30 cents per base. Waterston responds that he and his crew will be putting on "green eyeshades" this summer to refine their calculations.

Cost remains a critical issue. Even in the best of times, NIH and DOE would be hard pressed to support several large sequencing centers, as Waterston has proposed. But these are not good times. Congress is threatening to abolish DOE and cut NIH's budget next year (*Science*, 26 May, p. 1120). Nevertheless, both agencies are laying plans for new sequencing projects. NCHGR has in