

BELL LABS REORGANIZES RESEARCH FOR MORE COMPETITIVE ENVIRONMENT

Seven years ago, just after the US telephone company was broken up in a surprisingly uncontroversial court-approved consent agreement and just as Bell Labs was about to be split into two organizations—one serving AT&T and one serving the seven newly created regional phone companies—physicist and science writer Jeremy Bernstein came out with a book about the lab as it had existed up until then called *Three Degrees Above Zero: Bell Labs in the Information Age* (Scribner's, 1984).

Among physicists it was of course well understood that Bell Labs was the world's premier institution doing condensed matter physics and a leader in some other fields too. It seemed to be Bernstein's principal objective to make sure that this was known and appreciated among a broader educated public. A second objective, perhaps, was to identify and communicate some of the lab's unique qualities

so that these would not inadvertently get lost as what was once the national phone company went through the difficult process of transforming itself into a private corporation.

Bernstein's book consisted in the main of profiles of researchers at the lab, some of them rather obscure, and some rather famous (at least among physicists). Thus there were sections about William Shockley, John Bardeen and Walter Brattain, who invented the transistor at the lab's Murray Hill facility in 1948; about Charles Townes and Arthur Schawlow, concerning their original work on lasers; and about some of the lab's other famous Nobelists, including Princeton University condensed matter theorist Philip Anderson (who characterizes himself in the book as a "relatively obscure" Nobelist) and Robert Wilson and Arno Penzias, whose discovery of the 3-kelvin blackbody radiation inspired

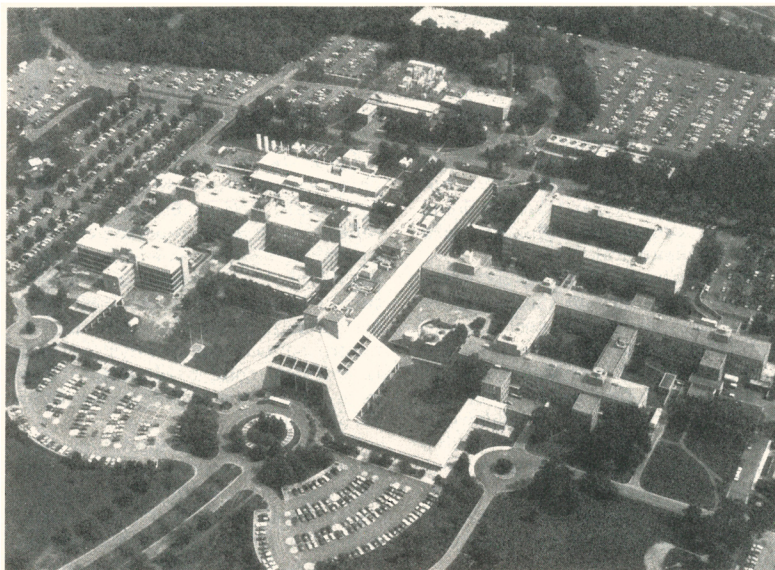
Bernstein's title.

One of the leitmotifs of Bernstein's book, admittedly an idealized portrait of the lab, is that Bell historically was an even better place to work than the very best university. The former chief administrator of an engineering school told Bernstein, for example, that Bell Labs was the real "ivory tower," while universities are merely "the real world." At Bell Labs, he explained, "scientists do not by and large have to compete in the continual rat race for money that university scientists do, usually by writing innumerable contract proposals to government agencies that fund research. At Bell Labs scientists and engineers do not have their productive lives dissipated by endless hours of teaching or by the kind of committee work so characteristic of academic life at all but the very best universities. At Bell Labs, unlike the universities, salaries have kept pace with inflation. . . [A]lthough no one really has tenure at Bell Labs, almost no one is fired."

An ivory tower no more?

This kind of idyll ended rather abruptly in July last year when Penzias, who has been head of research at the lab for about a decade, informed the assembled research staff that the era of university-style research at the lab was over. While Penzias said it would still be the lab's objective to keep its research "what it always has been—the best in its class," he said Area 11—the lab's term for its research operations—would be rather substantially reorganized to make divisions, laboratories and departments more directly responsive to the needs of the company's business units. The new focus "reverses the trend toward university-like research which began in the 1960s," Penzias said, and seeks to restore "the kind of organizational climate that created the transistor."

Penzias assured his audience that the unity of the lab would be preserved: The new structure would not be designed "to give each business



AT&T Bell Labs facility at Murray Hill, New Jersey, where most of the laboratory's basic research is conducted. About 3000 staff members currently work at Murray Hill.

unit its own research organization." Rather, the aim would be to ensure competence in needed areas without unnecessary internal competition or redundant effort.

Nevertheless, a lot of the researchers listening to Penzias were rather alarmed, and especially those, of course, who felt that they personally would be the first to go in the new regime. In the months following his speech many staff members began to talk about leaving, and leading institutions in condensed matter physics, such as the University of Illinois, Urbana-Champaign, found themselves flooded with applications from Bell Labs staff. What's been bothering people, to judge from several dozen interviews conducted by PHYSICS TODAY on and off the record, is not merely material insecurity but, just as importantly, a sense that the spirit of the place is changing and that the lab may no longer be such a supremely attractive spot to engage in basic physics research.

In the new managerial language, which is a far cry from the kind of words people typically used when they were talking to Bernstein seven or eight years ago, the buzzwords are "customer" and "one-stop shopping." The idea is that the company's business and development units are customers, that they come first and that they ought to be able to find what they're looking for in just one stop when their representatives come over to visit the research labs. Naturally this kind of talk drives some scientists right up the wall and leaves them wondering what they're doing working for a corporation.

Yet it's also still the case, now that the dust is settling from a year of internal reorganization, that many of the lab's special qualities remain intact. David J. Bishop, the head of the microstructure physics department in Paul Fleury's physical research laboratory, says Bell Labs still is "one of the few places that offers somebody out of grad school the resources to do serious work without distraction." One of the things that Bishop particularly likes about the lab is that decisions are made quickly—"it's a place where you never have to wait for very long for an answer to anything."

It's also a place where "you can make very radical switches in direction," says Peter B. Littlewood, who works in Michael A. Schluter's theoretical physics department. British born and Cambridge educated, Littlewood describes the reorganization as a "damp squib" (Webster's: a small or fizzling firecracker). Apparently he means that from his perspec-

tive the reorganization has had only a small impact.

A 'damp squib'?

Looking at the research area as a whole, the situation would indeed appear to be remarkably unchanged. Area 11 contains four major divisions: physics, under William Brinkman; materials science and engineering, under C. Kumar N. Patel; information sciences, under Sandy Fraser; and communication sciences, under Robert Lucky. Area 11 still employs about 1200 scientists, just as it did seven years ago, and it still accounts for about 10% of the lab's total budget, which currently comes to about \$2.9 billion. In 1981, the last full year before the divestiture, the total budget came to \$1.6 billion.

"The money entrusted to Bell Labs for basic research in Area 11 is larger than it's ever been," says Solomon Buchsbaum, senior vice president for technology systems at the lab. "Research now is being reshaped to meet the company's needs, but research always has been in the process of being reshaped to meet business needs."

Within basic research, funds are being reallocated away from the physical sciences and hardware and in the direction of software and computer systems. It is generally understood that over a period of about five years the balance is to shift from 60% physical sciences and 40% software to the inverse, 60% software and 40% physical sciences, and that this will lead to a decrease in the physics budget and staff of about 15-20%.

Fraser, the head of information sciences, says that as far as his division is concerned, the reallocation of resources has not had a very big impact as yet. He says the reorganization mostly continues a trend that has been long under way. Twenty years ago, he says, there were not more than 30 people in research doing work on computing, whereas now there are about 150.

Fraser's division includes five laboratories, devoted to mathematics, speech, computing sciences, computing systems, and software and systems engineering. The last was created during the past year under the directorship of Peter Weinberger. Lucky's communications science division concerns itself mainly with physical systems, including radio, optical transmission, specialized integrated circuits, computers and communication devices.

Fleury's lab

Within Brinkman's physics division, the locus of the most basic physics

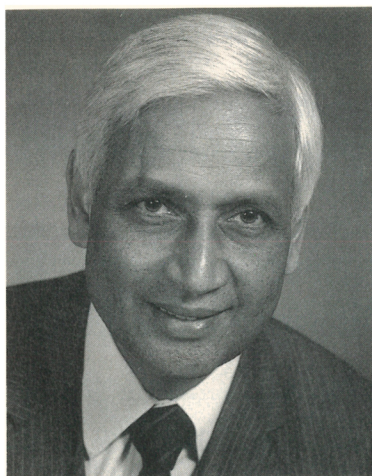
research is Fleury's physical research lab, dubbed 1111. Despite a general sense among lab staff that the number of people doing basic physics research has been somewhat reduced and is destined to be reduced still more, Fleury's lab came out of the reorganization about 50% bigger because of the incorporation of groups doing basic research from other labs and divisions. It now has seven departments and about 120 researchers, some of whom still do work that is very remote from corporate applications.

Astrophysicist Tony Tyson, for example, has been getting a lot of attention at international conferences with his spectacular real-color photographs of what he believes are the most distant galaxies in the universe. Using advanced charge-coupled devices and a special wide-field camera that he attaches to the best available optical telescopes (on Mauna Kea and at Cerro Tololo), Tyson has developed a technique for imaging dark matter in closer regions of the universe, based on gravitational distortion of images from the most distant galaxies.

Why does it still make sense for the lab to support such work? Fleury points out that it "pushes the limits of technology": In addition to requiring excellent CCDs, it involves probably the largest database anybody has developed in research, which in turn gives the computer people something real—and something really exciting at that—to crunch. In addition, Tyson notes, he recently has been asked by the chip development people at Bell's Allentown lab to bring his wide-field camera over to photograph certain microprocessing phenomena for purposes of analysis.

Tyson is attached to the optical physics department, which is headed by Richard E. Slusher, who, with his colleagues at Bell, reported the first squeezing of light. The other departments in 1111, besides microstructures (Bishop) and theory (Schluter), are surface physics (Donald R. Hamann), semiconductor physics (Horst L. Stormer), condensed matter (Cherry A. Murray) and biophysics (Lynn W. Jelinski).

The relatively small biophysics group mainly studies memory and information processing in simple biological systems such as slug brains, and it is developing techniques for real-time noninvasive observations of living neurons. Fleury says its activities were greatly stimulated by ideas about neural networks that John Hopfield of Caltech brought to



C. Kumar N. Patel

the lab eight to ten years ago, when he was still on the staff one-quarter time.

Silicon lab

Probably the most important and certainly the most noticeable effect of the reorganization was the creation of a new laboratory, in Brinkman's division, that is devoted specifically to silicon technologies. It replaced the chemical physics lab, which was headed by Robert C. Dynes, one of Bell's superconductivity stars, who recently left for the University of California, San Diego. In addition it incorporated large pieces of the former electronics research laboratory at Holmdel, which also was abolished, as well as smaller pieces from Patel's materials division.

The net effect of this reorganization, according to Penzias and Brinkman, is that two labs devoted to fundamental research and three labs devoted largely to compound semiconductors have been replaced by one fundamental research lab, one compound semiconductor lab and the silicon lab. Before, Dynes's lab was classified as basic physics, and there were labs working mainly on gallium arsenide and related matters in both Patel's and Brinkman's divisions, and in the electronics research lab.

The old electronics research lab originally was headed by Charles Shank, who left Bell a year and a half ago to become director of Lawrence Berkeley Laboratory. Daniel Chemla, a leading member of the electronics research lab staff, joined Shank at LBL as director of the materials science division, and Shank was succeeded as head of the electronics research lab by Richard

E. Howard. The lab traditionally was tightly coupled to light-wave systems research, and characteristic inventions coming out of it included optical switching and so-called seed devices used in optical computing. When the electronics research lab was abolished, Howard was made head of the newly created silicon electronics research lab.

A 43-year-old man who got his doctorate in applied physics at Stanford, Howard has spent his entire career at Bell Labs, where his interests have taken him from superconductors for power transmission to superconductors in microelectronics, then to microfabrication and VLSI, and further to electronic neural networks and learning theory. Echoing Littlewood, Howard points out that Bell Labs still is a place where researchers can make big changes of direction.

"But this is no longer a national laboratory funded by a regulated monopoly," he says, and since that's not exactly a big secret, he adds that the lab now "aggressively protects its intellectual property." That is to say, the lab is not planning to do something like giving away the transistor again (the kind of thing it once did partly to avoid antitrust actions).

Bell Labs used to be criticized for concentrating too much on exotic materials and ignoring silicon, the bedrock of the electronics industry. *PHYSICS TODAY* asked Howard, however, whether silicon isn't now old hat—whether AT&T has already missed the boat. He said that silicon is still the entire electronics market, for all practical purposes, and that it will remain so at least well into the next decade. That is not to say that Bell Labs is oblivious to gallium arsenide and other exotic materials. The third laboratory in Brinkman's division is devoted mainly to III-V devices and was largely unaffected by the reorganization. Now (as before) it is headed by David V. Lang.

Materials and engineering

Patel used to be head of the physics division, but several years ago, when Brinkman succeeded him there, he became executive director of the materials science and engineering division. That division really has gone through two reorganizations. First, a year ago, silicon activities were spun off, involving the abolition of the semiconductor processing research lab, which had been headed by A. Y. Cho, a well-known pioneer in molecular-beam epitaxy techniques. (Cho now directs a free-standing semiconductor research group under Brink-



William F. Brinkman

man.) Then, about two months ago, a new laboratory called Materials and Technology Integration Research was formed to study semiconductor packaging and interconnects. The other two laboratories under Patel are devoted to materials processing research and passive components research.

Seven years ago, when *PHYSICS TODAY* profiled Bell Labs in the immediate aftermath of the divestiture (*PHYSICS TODAY*, May 1984, page 77), Patel told the magazine that those who said the lab was becoming more applied were "better at measuring second and third derivatives than I am." Interviewed for this story, Patel told us that now "my answer would be slightly more qualified if I were asked the same question" (which he was). "I can measure a derivative now. And if you were an academic-type scientist, you might complain that we've become more applied."

"The pre-divestiture days when any good science was acceptable—I think those days are gone," Patel said. "We still want good science, but good science which may have some reasonable probability of being connected with the technology of the future." This implies a narrowing of the number of topics the lab is going to address, he said, but once those topics are selected, the lab still tries to recruit the very best people, and once people are hired, it still lets them follow their noses.

PHYSICS TODAY asked Patel whether he feels he has a clear idea of what the corporate imperatives are these days. He said, "One of the things that often can get frustrating is trying to gauge the business needs of the corporation because if you ask a business unit what their needs are, they'll tell you what their wants are rather than

their needs, and their wants really reflect yesterday's needs.

"Rarely will you find a business unit that is capable of identifying or enunciating the needs of the future," Patel continued. "And so it's the responsibility of the research area to extrapolate what needs will be if the corporation continues to develop as expected."

Patel pointed out that the materials and engineering laboratory traditionally has had a very close connection with production, so that, for example, optical fiber technology was transferred very rapidly directly from the lab to factories, without the normal intermediary of development work. Still, he said, the lab now was trying to organize itself so that its "customer set" will be significantly larger than it used to be.

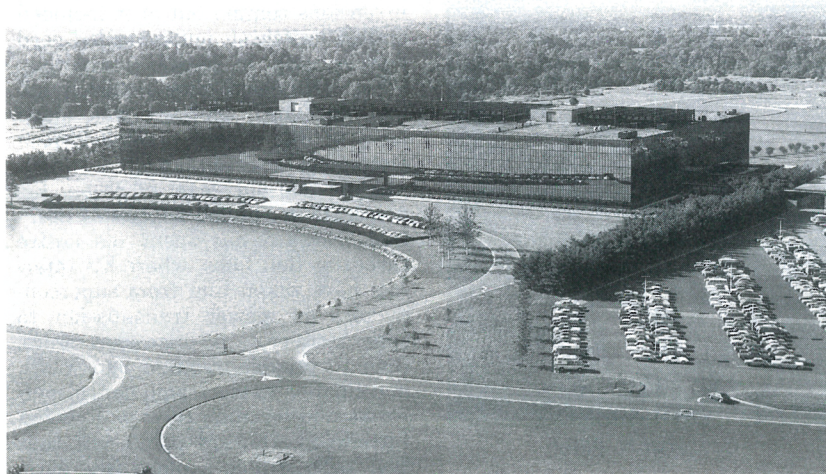
Pipeline and morale

According to Bishop, about one year ago a research inventory was done, in which it emerged that quite a large proportion of the Bell Labs staff already are doing applied work. This finding focused attention on "the pipeline," Bishop told us.

Locally, Area 52—the development people considered to be about midway between basic research and production—had a reputation for being notoriously high nosed about anything they didn't come up with themselves. Their "not invented here" attitude was said to apply especially to the people from basic research who would come over from time to time with bright new ideas. At the same time, the people in basic had a local reputation for being a hermetically sealed unit, sometimes referred to as "the airlock."

Among some staff who have left in recent months, there is a feeling—indeed a conviction—that the reorganization is making things worse rather than better. As they see it, the attempt to eliminate duplication and to put everything into readily identifiable boxes is bound to lead to greater isolation, less communication and less flexibility. But as Brinkman sees it, the reorganization cannot help but make people "reassociate." The main point of the reorganization, he says, was to give lab directors well-defined areas of responsibility, so that they could be held accountable for progress made toward meeting corporate goals. Each of the 15 directors has been designated to act as a contact person between the research area and one of the company's business units.

It is too soon to tell whether the reorganization has made internal technology transfer more efficient,



Holmdel, New Jersey, facility has a more applied bent than Murray Hill. About 4000 Bell Labs staff work at the facility, plus another 2000 who are visitors, temporary staff or members of the corporation's business units.

but it certainly is clear that morale has suffered in the process. Just about everybody agrees that the reorganization and refocusing of the lab has been very unsettling, and almost everybody says the lab is a different place from what it was 20 years ago. Dynes points out that when he came to the lab two decades ago people just said to do very good science, and that nobody would say that to a new staff member now.

Theodore Geballe of Stanford, another of the lab's former superconductivity superstars, says he expects that the lab will now consist of "islands of excellence rather than uniform excellence." It's not hiring as many outstanding young students as it once did, Geballe observes, and it's losing people it's not replacing. "This is a blow to US condensed matter physics."

Daniel Murnick, who left the lab for Rutgers in 1988, has the impression that morale probably is worst among people in their fifties and sixties but not all that bad among most younger staff, though they are being more tightly managed. Anderson, who left for Princeton earlier in the 1980s, is reminded of the period in the early 1950s when there was a freeze on senior-level hiring, a policy he says "worked well."

An incentive-retirement program has prompted many senior-level staff to leave AT&T in the last few years, but it has had less impact in research than in corporate management. Because of the tight university and industry markets *nobody* expects to

see basic researchers leaving Bell Labs in droves. The general expectation inside and outside the lab is that there will be a steady trickle of departures, as in the past, though attrition from basic research may be somewhat above normal.

It's not the case, everybody agrees, that Bell Labs was ever a place where people were not fired, or where people were necessarily so comfortable they would never leave voluntarily. Competition and peer pressure can be acute in an elite institution like Bell, and even freedom from guidance can take its toll when inspiration fails.

For the people in development, the greater emphasis on applied research can hardly be unwelcome—even if it also means greater accountability. One such person, who happens to work on chip design at Allentown, observes that even the basic research people who are still core funded—that is, whose work is paid for out of general corporate funds provided to the lab as opposed to coming from specific business units or other sources—now are being urged to secure additional funding, from both outside and inside the lab. As a result "they're much more anxious to work with us now than they were before the breakup. They used to be much snootier. They had pretty much unlimited funds, lifetime employment. They had *carte blanche*. There was a real country club atmosphere at Bell Labs, with no pressure or deadlines. Now they're being asked to justify their existence."

According to Brinkman, 90% or more of the research in Area 11 still is core funded. How precarious is that funding? Nobody knows for sure, but probably more precarious than it used to be. "Bell Labs, predivestiture, was a national laboratory," observes John Rowell, a former member of the research staff who joined Bellcore after the divestiture and now is president of Conductus Inc, a California company specializing in applications of the new high-temperature superconductors. The lab "was simply paid for by a tax on telephone bills, rather than by an income tax.... The funds from the telephone bills went to AT&T via the local telephone companies, then to Bell Labs. The funding source was stable, predictable and long term, and the scientists were protected from short-term micromanagement from the source itself by the buffer of AT&T." (For an article by Rowell in this issue, see page 22.)

A creeping gradualism?

Jeffrey Bokor, one of the people transferred from the former electronics research lab to the newly created silicon lab, observes correctly that when you ask people how things are at Bell Labs, you hear a wide range of opinion, from "the sky is falling" to "everything is just fine." People talking casually are quick to say that the lab is "collapsing," and the words "national tragedy" come up again and again. But when people are talking for attribution, knowing that their words may appear in print, they tend to become a lot more cautious, circumspect or judicious.

Nevertheless, even after exercising every reasonable and responsible precaution, a lot of people at and near Bell Labs express serious concern about its future. The head of one of Fleury's departments worries out loud that all of Bell Labs might be abolished in five or ten years' time if, say, AT&T decides it really is a service company and is not in the hardware business anymore. One of the most famous resident physicists thinks there is a real chance that basic research will not survive.

Chemla feels the lab is to be commended for maintaining its firm commitment to basic research throughout the seven years since divestiture. "But once a company is asked to compete in a very fast market, it has to use all its resources," Chemla observes. To him this suggests that Bell may go the way a lot of other eminent industrial labs have gone in recent years.

Probably the most pervasive ra-

tional fear was expressed by a young researcher in Federico Capasso's group, which works on the fractional quantum Hall effect, tunneling in double layers and superconductivity, among other things. This researcher worries there will be "a kind of gradualism that will be hard to detect, in which the things you work on are more and more directed toward things that you might not historically have chosen but which in fact are dictated by the needs of the company. People are afraid they won't have this freewheeling physics environment that they used to have."

Example of solitons

Several people at the lab suggested considering the case of Linn Mollenauer as an example of what might be lost in a less freewheeling environment. For about a decade Mollenauer and his colleagues have been working on solitons and optical fibers, most of the time in fairly splendid isolation. The subject was considered quite remote from applications, and Mollenauer's group was doing "some really basic physics," as he puts it. A few years ago, with the invention in Britain of erbium-doped amplifiers, the transmission of solitons in optical fiber over transoceanic distances suddenly became a practical possibility, and AT&T's development people got very interested in Mollenauer's work. Since then, he says, his job has been "a lot of fun—the kind of thing every researcher dreams of."

The starting point for his work, Mollenauer says, was an insight about two decades ago by the Bell Labs plasma physicist Akira Hasegawa, who reasoned that the nonlinear Schrödinger equations might apply to propagation of signals in optical fibers. Knowing about the soliton solution to those equations, Hasegawa conjectured that waves might be propagated in optical fiber as solitons.

At the time nobody paid much attention to Hasegawa's speculations because fibers having low loss in regions where you can have solitons did not exist. Around 1980 such fiber appeared, prompting Mollenauer's group to make their first observations of solitons in fibers. In 1988 Mollenauer demonstrated the first long-distance transmission of solitons in optical fiber, first over 4000 kilometers and then over 6000 km.

Meanwhile, optical fiber cables were being laid under the oceans that require signal regeneration every 80–100 km or so. Regeneration involves conversion of the optical

signal into an electronic signal, amplification and reconversion back into an optical signal.

"Until we got into erbium-doped amplifiers," Brinkman told us, "you didn't need solitons, but once the amplifiers came along, we begin to have to use solitons and probably will use them." The difference between the current replenishment system and future amplification systems, he explained, is that once "you no longer are converting your pulses of light back into electricity and reshaping and retiming them, the dispersion and nonlinear effects are acting over the whole distance of the line. So now, the idea of compensating dispersion with nonlinear effects and of using solitons is *really* an important issue. That's a dramatic change in the way you think about things."

"The real neat thing about this story," Brinkman concludes, "is that all these years Mollenauer was doing experiments here in research that developed a good understanding of how solitons work in fibers, and he showed that they can be propagated for long distances, so that his results were pregnant for use."

Business prospects

Looking back on his two decades at the lab, Mollenauer agrees with others that the atmosphere is different than it was 20 years ago. "At that time the lab was in clover, and the idea was just to do good research that would generate good PR for Bell.... Support for the lab was lavish, and we were a great, internationally recognized scientific treasure and a terrific national institution. The danger now, with great financial pressures, is that this no longer can continue."

What about those financial pressures? When you probe people at Bell Labs for their thoughts and feelings about the future of AT&T, you get pretty much the same spectrum of responses you get when you try to needle them about the lab itself. At one extreme people will say the company's reputation is that it wouldn't know how to market eternal life itself. At another extreme are those who fear that the company is so rapidly transforming itself into a service company, following the general trend in the US economy and indeed the highly industrialized world as a whole, that it soon will have no more use for people who build things that you can touch.

There appears to be a certain contradiction or contradictoriness here. On the one hand the fear is that AT&T isn't able to sell anything; on the other, that AT&T is doing such a

magnificent job of selling things like its new "universal" credit card—7 million accounts so far—that it soon won't have any interest in marketing the kinds of things it used to make.

The fact is that the company is still very much in the business of making chips, cable and gigantic switches, which in turn require hugely complex software systems. AT&T has retained a very respectable chunk of the US market for equipment and has built, starting from scratch, a \$1 billion annual business in the international equipment market. In its core business, the provision of long-distance service in the US, it has put its major competitors on the defensive.

Since the divestiture, which implicitly invited AT&T to go head to head with IBM in the computer business, the company admittedly has had a difficult time, as everybody knows. An alliance with Olivetti to produce things like personal computers was unsuccessful and finally was terminated. Yet the company also won a contract worth more than \$1 billion from the Department of Defense for workstations. Its Unix operating system looks to be gradually reducing all competition, and its strategic alliance with Sun Microsystems has yielded a close collaboration with one of the computer industry's fastest-moving and most successful companies.

While AT&T has not had very good luck with its PCs and mainframes, these have been unexpectedly troubled parts of the computer market in recent years, and IBM also has experienced grave difficulties. During the last economic quarter, a period in which AT&T was waging a determined battle to take over NCR, IBM's stock fell, while AT&T's climbed 25%, easily enabling the company's leadership to match NCR's demands for a more rewarding payout.

Whatever else one may say of the NCR merger—and a lot of industry analysts have been quick to point out

that there is no record in the computer industry of successful mergers—it certainly signals AT&T's determination to remain a player in the computer hardware business. The marriage surely looks complementary, as every business analysis also has pointed out: NCR has been specializing in things like grocery store cash registers and automated bank teller machines—things that need to be connected up—and AT&T has been specializing in connecting.

National mission

Speaking as an advocate for the changes that have been taking place at Bell Labs, Brinkman emphasizes that the US is in a highly competitive situation with respect to technology and that the total health of the country depends on the US performance in this competition. "So if you are in a leadership position at a high-tech company like AT&T, you would like to do what you can to help assure that the company is technically strong and competent and that it contributes to the national well-being."

PHYSICS TODAY reminded Brinkman that many experts on basic research in industry worry about a kind of downward ratchet effect such that basic research always tends to get trimmed when business is poor, and never gets restored. Brinkman said that one purpose of the reorganization was to secure the long-term future of basic research in Fleury's laboratory.

Perhaps the only way to absolutely guarantee the future of basic research at Bell Labs would be to reconsider the breakup of the national telephone system and to restore Bell Labs as an institution that draws on a guaranteed income and performs a well-recognized national mission. But as Brinkman says, "Nobody is talking about that now." As far as he and most of his colleagues at the lab can tell, the divestiture decision is for keeps.

—WILLIAM SWEET



Sidney Wolff

Washington.

Wolff earned her bachelor's degree in astronomy at Carleton College in 1962 and her PhD at the University of California, Berkeley, in 1966. She worked at Lick Observatory for one year and then joined the Institute for Astronomy at the University of Hawaii, where she remained for 17 years. She was named associate director of the institute in 1976 and acting director in 1983. In 1984 she became director of the Kitt Peak National Observatory, and in 1987 director of NOAO (an organization that embraces Kitt Peak, Cerro Tololo Inter-American Observatory in Chile and the National Solar Observatory).

Wolff's research interests have included stellar spectroscopy, photoelectric photometry and magnetic stars. Her recent work has concentrated on the study of the stellar analogy of solar activity and abundance determinations—specifically, the chemical composition of hot stars. Wolff is the first woman to head a major US observatory and the second woman (after Margaret Burbidge) to be elected president of AAS.

In other AAS election results, Mary K. Hemenway of the University of Texas, Austin, is the new education officer; Alexander Dalgarno of the Harvard-Smithsonian Center for Astrophysics was chosen to serve as one of three AAS members of the US National Committee for the International Astronomical Union; Helene R. Dickel of the University of Illinois, Urbana-Champaign, and Robert C. Bless of the University of Wisconsin's Washburn Observatory are newly elected to the nominating committee; and Suzan Edwards of Smith College, Richard G. Kron of the Yerkes Observatory and Mark M. Philips of the Cerro Tololo Inter-American Observatory are newly elected councilors. ■

WOLFF IS ELECTED PRESIDENT OF AMERICAN ASTRONOMICAL SOCIETY

Sidney C. Wolff, director of the National Optical Astronomy Observatories, is the new president-elect of the American Astronomical Society. She will take office as president in June 1992, succeeding John N. Bahcall of the Institute for Advanced Study in Princeton.

James E. Hesser of the Dominion Astrophysics Observatory in Victoria,

British Columbia, is AAS's newly elected vice president. He will serve as one of three vice presidents, replacing Frank H. Shu of the University of California, Berkeley, who has completed his three-year term. The other two vice presidents are Harvey D. Tananbaum of the Harvard-Smithsonian Center for Astrophysics and Paul W. Hodge of the University of