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Missed Calls

AT&T Inventions
Fueled Tech Boom,
And Its Own Fall

**Bell Labs Invented Transistor,
But Couldn't Exploit It;
Passing Up a Cell License**

A Secret On Sale for \$25,000

By CHRISTOPHER RHOADS

Staff Reporter of THE WALL STREET JOURNAL
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In December 1947, William Shockley and his team of scientists came up with a solution to a problem vexing their employers at **AT&T Corp.**

At the time, voice was amplified over long distances using vacuum tubes. The bulky tubes often overheated and broke down, making long-distance calling expensive.

Working at AT&T's Bell Labs in Murray Hill, N.J., two members of the team, Walter Brattain and John Bardeen, came up with a device made from a paper clip, two slivers of gold foil, and a slab of germanium on a crystal plate. The contraption made it easier to transmit sounds with clarity over a long distance. It was later dubbed the transistor.

More than any other technology, the invention unleashed the information revolution of the late 20th century. Over time, it also carried the seeds of AT&T's demise.

The transistor, and its subsequent improvement and miniaturization on silicon chips, made it possible to store and distribute ever-greater amounts of information. That drove the development of computers, satellites, space exploration and much of modern communications and electronics. Dr. Shockley moved

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to California and founded a company that played a role in spawning Silicon Valley. The transistor invention won the Bell Labs team the Nobel Prize in 1956.

[William Shockley]

The resulting upheaval created new industrial fortunes -- and destroyed others. AT&T was on the casualty list. After its forced breakup in 1984, it was slowly crushed by technologies that drove down the price of a long-distance call, and more recently by wireless calling and Internet phoning. In the past few years its revenue has shrunk steadily, leaving it with valuable long-distance business customers but little else.

Once the largest phone company in the world, with a million employees when it was broken up by the federal government 21 years ago, a humbled AT&T agreed Monday to be acquired by one of its offspring, **SBC Communications Inc.**, for \$16 billion.

The transistor "shows how AT&T invented something that worked to sink it," says David Isenberg, who worked at the company's labs for 12 years until 1998 and is now an independent telecom analyst.

Along with the transistor, many of the inventions critical to the telecom upheaval today came at least partly from Bell Labs. They include the Unix computer operating system used in many corporate computer systems; cellular technology, which sparked the rise of wireless calling; and voice-compression technology, which helped make Internet calling possible.

But AT&T's monopoly status meant that it rarely exploited its inventions. Constantly threatened with breakup, the company agreed to put its transistor patents in the public domain and submitted to regulations barring it from businesses that didn't involve the telephone. Besides, executives felt little need to seize on the lab achievements since AT&T already enjoyed steady profits from its lock on the phone business.

"When I run into old Bell Labs people the first thing they say is, 'Can you believe what has happened?' " says Robert Lucky, a scientist and executive who worked at Bell Labs for 31 years until 1992. Even at the time of the breakup in 1984, he says, "the feeling was that we had a network that was the envy of the world. No one could duplicate it."

Instead, says Dr. Lucky, "what you had was big, new industries taking Bell Labs technology and turning it into lots of revenue."

The growth of Internet phoning was the "final nail in AT&T's coffin," says Mr. Isenberg. The technology allows users to make calls through their high-speed Internet connections independent of the phone company. Some companies offer software to do this free. The inventor behind one of them, a Swede named Bastiaan Kleijn, is a former scientist at Bell Labs. Other companies charge a monthly fee for unlimited calls.

In the year before its sale to SBC, AT&T embraced Internet calling. But as the technology takes hold, it

is unlikely companies will be able to charge much for it. "AT&T started the electronics revolution that in the end devoured it," says Eli Noam, the director of the Institute for Tele-Information at Columbia University.

The revolution began with Dr. Shockley and some silicon. During World War II British and American scientists had discovered signs that silicon could detect high-frequency radar signals, according to a PBS program and Web site on the history of the transistor, called "Transistorized." Silicon is a type of semiconductor -- a substance that conducts only small amounts of electricity.

Dr. Shockley made some headway designing a semiconducting device to improve long-distance voice transmission, but ran into problems and handed his work to two members of his team, Dr. Brattain, a physicist with a knack for building things in a lab, and Dr. Bardeen, an accomplished theoretical thinker. Shortly before Christmas 1947, the two made the breakthroughs that led to the creation of the transistor.

Immediately aware of the significance of their discovery, Dr. Shockley was happy, but also outraged that he had not been included in their important work. He subsequently built his own, sturdier version of the transistor within a month and insisted that only his name should go on the patent.

The other two scientists were shocked. "He called both Bardeen and I in, shortly after the demonstration, and told us that sometimes the people who do the work don't get the credit for it," recalled Dr. Brattain in an interview recorded in 1974 and preserved on the Web site. Drs. Brattain and Bardeen ultimately kept Dr. Shockley's name off the first transistor patent although his name was on later patents.

Drs. Brattain and Bardeen later became university professors. In 1956, Dr. Shockley moved to California where he started his own company, called Shockley Semiconductor, located near Stanford University.

Just a year later, exasperated with Dr. Shockley's difficult personality, eight of the original scientists at the company left to start their own company called Fairchild Semiconductor Corp. Veterans of Fairchild went on to form other powerhouse chip makers including Intel Corp., bringing to prominence the industry that gave Silicon Valley its name. (Dr. Shockley's reputation was later tarnished by his theories on intelligence and race. He died in 1989.)

Normally a company would seek to squeeze maximum licensing fees from a breakthrough patent. But AT&T was motivated to share its transistor technology. The U.S. government had filed an antitrust lawsuit in 1949, seeking to break up the company. "If AT&T sat on the patents it would give the Justice Department one more reason to break it up," says Michael Riordan, co-author of a book on the history of the transistor, called "Crystal Fire." The company had repeatedly argued that its monopoly -- and the innovation its labs nourished -- was for the public good.

Bell Labs agreed to share its knowledge on how to build a transistor with any interested party for just \$25,000. Dozens of companies, including International Business Machines Corp., General Electric Co. and Texas Instruments Inc. paid the fee, according to Mr. Riordan. Another buyer was a Japanese tape-recorder maker called Tokyo Tsushin Kogyo. It developed a transistor radio along with other consumer electronics and soon found a name Americans could pronounce: Sony.

In 1956, AT&T signed a consent decree with the federal government that allowed it to keep its structure under which it sold both phone service and telephones themselves. In exchange, AT&T promised to stay out of other businesses and license its patents freely. AT&T's equipment arm, Western Electric, had to withdraw from selling sound equipment for film producers and movie theaters -- giving up experience in a competitive market that would have proved useful later.

[Long Distance]

The decree also put the transistor patents in the public domain. As a result, while AT&T used transistors to improve the reliability and quality of the phone calls it relayed, it played little role in developing the integrated circuit. That fame and fortune went largely to Texas Instruments and Fairchild, which

independently figured out a way in the late 1950s to fabricate and embed multiple, miniaturized transistors on a tiny silicon chip. Those advances led to the birth of the microprocessor, the engine of personal computers.

Keeping AT&T from selling to customers other than itself made it wholly unprepared for the day, in 1984, when it was no longer a monopoly and became free to compete like any other company.

"There was never any sense of urgency in the company because competition was absent," says Greg Blonder, an engineer and executive at the labs for 17 years until 1999 and now a venture capitalist. "Whereas everyone else in the world saw the new technologies as an opportunity to upend the market, AT&T saw no reason to do this."

Cellphones were a major area where AT&T squandered a technology lead, and it wasn't because of government restrictions. Bell Labs scientists conceived of the cellular concept -- the idea that a phone call could be moved from one tower to another as the caller moved -- as early as 1947. Along with Motorola Inc., Bell Labs scientists helped make mobile telephones a commercially viable proposition in the 1970s.

In 1983 the Federal Communications Commission set guidelines for the rollout of cellphone service. An incumbent carrier would get one license in each market while the second would be up for grabs. At the time, AT&T was about to be split up, and it could have demanded that the new AT&T long-distance company be given the incumbent licenses. But Charles Brown, then chief executive, decided that the cellphone was largely a local business.

"He felt that it was logical that the cellular business should go to the Baby Bells," says Sheldon Hochheiser, AT&T's former historian, referring to the local phone companies spun off in the 1984 breakup. A study at the time by McKinsey & Co. predicted that by the year 2000 there would be 900,000 cellphone users in the U.S. Many thought the prediction was way too high. The actual number was more than 100-fold greater than the prediction. The licenses that Mr. Brown had decided not to seek turned out to be worth many billions of dollars.

Eventually AT&T realized it had missed the boat on cellphones. It bought a cellphone provider in 1993 but later spun it off as an independent company called AT&T Wireless. That company was acquired last year by Cingular Wireless, which is 60%-owned by SBC, and the AT&T Wireless name was retired.

AT&T was also well-positioned to become a powerhouse in computers at the time of its breakup. Some envisioned it as a competitor to IBM. "It turns out that knowing a lot about computers was different than selling them," says Mr. Hochheiser. AT&T was used to designing computers for itself, not outside customers. To jump-start the business, in 1991 AT&T bought computer maker NCR Corp. in a hostile deal worth \$7.4 billion. The deal flopped and NCR was spun off five years later.

Inside AT&T, some played down the failure to seize new markets, believing that new technology was driving growth in the company's core business. The fax machine, for example, was another innovation Bell Labs helped develop that ended up being manufactured and sold elsewhere. "AT&T as an equipment maker missed the fax machine," says John Zeglis, the former chief executive of AT&T

Wireless who also served earlier as AT&T's president and general counsel. "But wow, did long-distance minutes boom. The theory was, give away the technology so it creates more usage for the communications path."

Now as AT&T finally prepares to vanish as an independent company, it leaves a vacuum in innovation and research that will be hard to fill. AT&T could afford to embark on long-run research because, as a telephone monopoly, it was the only phone company that would benefit. But in today's world of cutthroat competition, few companies can afford such an approach. (**Lucent Technologies** Inc. owns the bulk of the old Bell Labs, which focuses on developments with more immediate uses for Lucent.)

"Yes, phone calls were very expensive and we got rid of a monopoly," says Mr. Riordan, the co-author of the transistor history. "But this was a company that literally dumped technology on our country. I don't think we'll see an organization with that kind of record ever again."

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