

Resuscitating industrial research without monopoly money

The award of the 2009 Nobel Prize in Physics to Charles Kao, Willard Boyle, and George E. Smith underscores again the importance of industrial research, the subject of Joe Anderson and Orv Butler's article, "Industrial R&D in Transition" (PHYSICS TODAY, July 2009, page 36). I have a few comments to add about companies involved in semiconductor research, with which I am most familiar.

At Bell Labs from the postwar period through the mid-1960s, an "enlightened management philosophy" espoused by President Mervin Kelly attracted some of the best scientists and engineers, allowing them substantial latitude to follow their instincts in pursuit of basic research. But their research had to be on topics that might help its parent company AT&T improve its communications products and services. That mission-oriented approach helped Bell Labs attract such first-rate physicists as William Shockley, John Bardeen, Charles Townes, and Philip Anderson, who would otherwise have gone right into academia (which they all did eventually). Kelly realized that scientists of such high caliber could not be told exactly what research avenues to pursue but instead needed the freedom to find their own paths. By setting an overarching mission of improving communications, however, Kelly got what he had bargained for.

Thus when Bardeen came on board in early 1946, Shockley asked him to examine why the group's attempts to make a field-effect semiconductor amplifier had failed so miserably. Bardeen soon suggested his hypothesis of "surface

states"—that electrons trapped on the semiconductor surface were blocking electric fields from penetrating it. He and Walter Brattain were then encouraged to pursue basic research on the nature of those states. More than a year later, in November 1947, they made a serendipitous discovery that enabled them to invent the point-contact transistor. The mission-oriented focus of industrial research at Bell Labs meant that the fruits of basic research could be applied almost immediately to fabricating a useful electronic device. Today, more than 60 years later, the transistor is among the most useful devices ever created.

Bell Labs could afford to grant its best scientists that freedom because AT&T enjoyed a regulated monopoly on US telephone service. A few pennies of every dollar that we paid for toll calls in those days went to support the R&D efforts of Bell Labs and Western Electric. Given such a stable, assured funding stream, managers like Kelly could take a long-range view and support risky research projects that might not contribute to the company's bottom line for decades, if ever. Other industrial labs that did basic research—for example, General Electric and IBM—also enjoyed lucrative monopolies or near-monopolies on important goods and services. They, too, could and did take the long view.

After its 1984 breakup, however, AT&T had to compete head-to-head with its regional offspring and other companies such as MCI. Bell Labs no longer enjoyed the stable funding guaranteed by government regulation. Although its managers strove to maintain a commitment to basic research, the financial odds were stacked against them. Research that might not contribute to the bottom line within several years became increasingly difficult to justify.

Similar influences contributed to the decline of the central research labs that Anderson and Butler discuss, many of which had been established during the 1950s and 1960s in emulation of Bell Labs. Another problem was getting the fruits of research out of the labs and into product development in their manufacturing arms. Here Kelly tried another management innovation, setting up satellite units of Bell Labs engineers in

certain Western Electric plants—for example, the plant in Allentown, Pennsylvania, that fabricated high-tech semiconductor devices. Similar difficulties occurred at Fairchild Semiconductor Corp, which marketed the first commercial silicon microchips in 1961. Thus when Robert Noyce and Gordon Moore quit Fairchild and founded Intel seven years later, they intentionally avoided setting up a separate research lab; instead they incorporated R&D (predominantly D) functions directly in Intel's production units.

The 1950s and 1960s truly marked the industrial research labs' golden age, driven in part by the Cold War and ample military funding, and Bell Labs was its great exemplar. Doing basic research in a practical, industrial context and focusing it on improving goods and services has clearly had an enormous impact on modern life. We need to find ways to resuscitate that kind of activity in our laboratories today.

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Many of the points made in the article "Industrial R&D in Transition" are excellent, informative, and timely. In the section headed "Decentralizing research," the authors expressed some skepticism about the effectiveness of joint research involving industry, academia, and the government. We believe such collaboration can be extremely effective. The Semiconductor Research Corp, of which the Micro Electronics Advanced Research Corp and the Nanoelectronics Research Corp are subsidiaries, is an industrial consortium that sponsors precompetitive and targeted university research on behalf of the semiconductor industry. Since its founding in 1982, the SRC has helped to enable the continuation of an exponential rate of growth in performance per unit cost (Moore's law) for semiconductors and has provided support for more than 7500 graduates with advanced degrees in semiconductor technologies and related areas.

The SRC was gratified to receive the 2005 US National Medal of Technology for its contributions to the advancement of semiconductor technologies. Our

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