

Postwar Employment Bubble Bursts

Jeff Hecht

Optics prospered along with other areas of physics and engineering as American research universities grew after World War II. Military programs encouraged universities to expand basic research, both in hope of developing new defense technology and to train specialists for defense research at government agencies or defense contractors. Over the years from 1938 to 1953, military support of university physics research soared by a factor of 20 to 25, after adjusting for inflation.

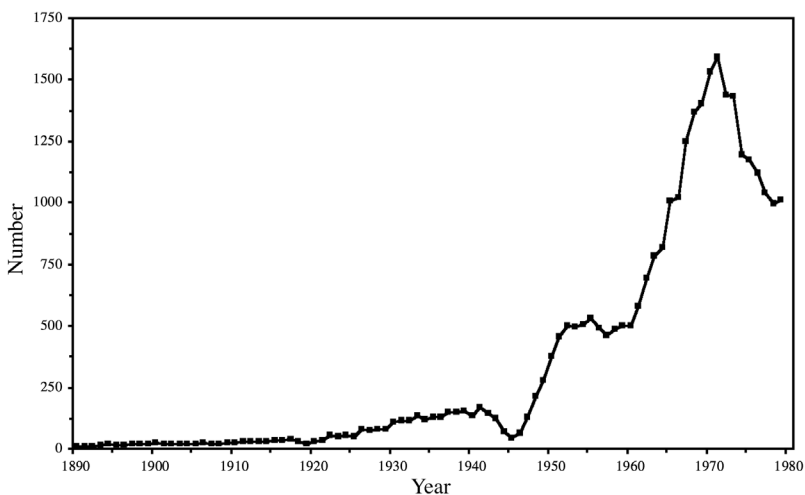
These programs provided both bright new ideas and bright people to help launch the laser era in optics. The Columbia Radiation Laboratory, founded in 1942 at Columbia University to develop new microwave tubes for 30-GHz radar, received \$250,000 a year after the war from the Army Signal Corps to continue microwave research in Columbia's physics department. At the time, that was enough to support a staff of 20 and nearly as many graduate students, as well as to pay several faculty members over the summer. Charles Townes headed the radiation lab from 1950 to 1952, during the time he conceived of the microwave maser.

Military research dollars also produced new physicists. American universities had graduated about 150 new physics Ph.D.s annually just before the war, and the number dropped steeply during the conflict. But from 1945 to 1951 the number of physics Ph.D. graduates doubled every 1.7 years, reaching about 500 per year, as shown in Fig. 1. Seeing where the jobs were, postwar students concentrated on experimental physics. Engineering likewise boomed in the postwar years, with 159,600 bachelor's degrees awarded from 1946 to 1950, more than from 1926 through 1940.

Dwight Eisenhower had seen part of that growth as president of Columbia University from 1948 to 1951, but as President of the United States he cut military research spending in 1953, and the number of physics Ph.D.s remained in the 500–600 range through the 1950s. The cuts led universities to scale down their programs. Boston University went further, shutting the optics lab it had inherited from Harvard; veterans of that group became the nucleus of the Itek Corporation, founded in 1957 by Richard Leghorn with funding from the Rockefeller family.

Eisenhower changed course after the Soviet launch of Sputnik 1 on 4 October 1957 stunned the American physics community, the Pentagon, and politicians. Fearing the U.S. was falling behind in an arms race in space, his administration boosted funding for physics and engineering research and education. The money brought quick results. The number of Ph.D.s graduating from American universities rose exponentially from about 500 in 1960 to some 1600 in 1970, faster than the growth of Ph.D.s in any other field. The number of American universities offering Ph.D.s in physics climbed from 52 in 1950 to 78 in 1960 and reached 148 in 1970. The number of undergraduate degrees in physics also climbed, from 1000 in 1945 to a peak above 6000 in 1968. Engineering degrees also increased. The numbers reflected both growth in overall college enrollment and an increase in the fraction of students studying physics and engineering. It did not include the Postwar baby boom, who started to graduate from college in 1968.

The arms race, the space race, fast-growing industrial labs, and a booming technology industry created unprecedented demand, particularly for physicists. A 1964 report from the American Institute of Physics found that in 1960 only 17,300 trained physicists were available to fill some 29,000 physics-related jobs in the U.S. It's not clear how many of the excess jobs went unfilled or were filled by people lacking physics degrees, but the deficit seemed formidable—and the gap was projected to reach 20,000 by 1970.



◀ **Fig. 1.** Number of Ph.D. physicists graduating from American universities annually, showing the dramatic postwar boom and post-1970 decline. (© 2002 by The Regents of the University of California. All rights reserved [1].)

A tripling of government research and development funding from 1955 to 1965 helped propel the boom, with defense and space programs leading the way. The birth of the laser and increasing military use of electro-optics pumped up spending on optical research and development, and in 1962 OSA’s Needs in Optics Committee concluded that existing training programs could fill only a quarter of the need for 3500 new optics specialists in the coming five years [2].

Yet by the mid-1960s, the well-oiled machinery of growth had begun hitting serious bumps in the road. Doubts were growing about America’s escalating involvement in Vietnam, and opponents were raising questions about the presence of military research on university campuses. Budget watchers worried that the country could not afford to continue pumping more money into basic research while fighting a war. Pentagon auditors found that military spending on basic research yielded a disappointing return on investment and urged focusing narrowly on mission-oriented research and development.

Congress began pressing to cut military spending on basic research, and spending on new research buildings was stopped in early 1967, forcing some creative financing to build the new Optical Sciences Center at the University of Arizona [2]. Congress complained that too much research money was going to a few elite universities, and too little to other Congressional districts. Topping off the trend, the Mansfield amendment in 1969 barred Pentagon spending on research lacking direct military applications, although those restrictions were later eased.

Universities also began re-examining their military research policies, pushed by faculty and student protests. In 1967 Columbia, an early hotbed of protests, divested its Electronics Research Laboratory, which became the Riverside Research Institute. More would follow. Stanford in 1970 split off the Stanford Research Institute, later SRI International, and in 1972 MIT divested its Instrumentation Laboratory, which became the Charles Stark Draper Laboratory. The most important split for the optics world probably was the University of Michigan’s 1972 divestiture of its off-campus Willow Run Laboratories, the birthplace of laser holography and optical signal processing.

In retrospect, it should have been obvious that the rapid growth powered by the space and arms races could not continue, but students recruited with promises of well-paying jobs were caught by surprise. Recruitment advertisements, which had fattened campus newspapers at elite schools like Caltech, began evaporating after 1967. Job fairs at physics conferences shrank. Only 253 jobs were advertised at the American Physical Society’s 1968 annual meeting, but nearly 1000 applicants showed up, and over 1500 people received Ph.D.s that year. Two years later, 1010 job-hunters chased 63 jobs at the APS April meeting. “American physics had indeed reached a crisis by 1970, exactly when the 1964 report had predicted,” wrote MIT historian David Kaiser [1]. But the crisis was a shortage of jobs rather than of physics graduates.

Inevitably, graduate enrollment shrank, and the number of new physics Ph.D.s dropped from a peak of 1600 at the start of the 1970s to about 1000 per year at the end. Physics research continued growing, but at a much slower pace. One measure of research, the number of abstracts published each year in *Physics Abstracts*, increased about 3% a year from 1971 to 1999—only a quarter of the 12%

annual growth from 1945 to 1971. Optics in general fared better than many other specialties, leading some physicists in hard-hit fields to move into optics.

Engineers were caught in a similar crunch. Ph.D.s in electrical engineering, the major most related to optics, peaked at 858 in 1971, then slid steadily to 451 in 1978, a 47% drop—larger than the 37% drop in physics Ph.D.s. The decline in bachelor's degrees, which in the 1970s were typically the terminal degree in engineering, was much less. Electrical engineering undergraduate degrees peaked at 12,288 in 1970–1971, then bottomed out at 9874 in 1976, only a 20% drop [3]. Many of those engineers, and some physicists, wound up in the fast-growing computer industry. Others ended up in optics.

Optics also felt the slowdown of the late 1960s and early 1970s, but with only a handful of schools training optical engineers and physicists, optics still offered opportunities for young physicists and engineers. Many of the newcomers adapted their skills to work on lasers and fiber optics, the fastest-growing fields in optics in the 1970s and 1980s. The newcomers brought new skills, and helped optics grow into new areas as they developed their careers.

References

1. D. Kaiser, “Cold war requisitions, scientific manpower, and the production of American physicists after World War II,” in *Historical Studies in the Physical and Biological Sciences*, Vol. 33 (University of California Press, 2002), Part 1, pp. 131–159.
2. S. Wilks, from the History of OSA (to be published).
3. M. K. Fiegenger, “Science and Engineering Degrees: 1966–2010: detailed statistical tables” (National Science Foundation, June 2013).