Special issue:

The education of the professional physicist

What kind of education do colleges and universities in the United States now give students who want to become physicists? Are we educating enough of them, and are we educating them well enough to meet national needs in the next decade? Do institutions of higher education have the resources they need for this task? Are employers satisfied with the results? These are some of the questions addressed in this special issue of PHYSICS TODAY.

Special issues of PHYSICS TODAY on physics education in 1968 and 1969, peering into a cloudy crystal ball, did not foresee a statistical precipice that lay ahead. Shortly thereafter, the surge of enrollments and graduations in physics that had begun a decade earlier began to slacken. The numbers of physics degrees granted at all levels—bachelor's, master's and doctoral—dropped from historic highs. Driven by an economic recession, by cutbacks in several national programs employing physicists, by saturation in the academic job market and by a perception of growing underemployment and some unemployment among young PhDs, the decline continued for over a decade. The numbers did not stabilize until the early 1980s, at levels far below their earlier peaks: bachelor's degrees down 20%, master's degrees 35% and doctorates 40%.

Now, almost two decades after the previous special issues, the editors find it timely again to examine professional education in physics for their readers. Conditions are changing. For example, it now appears uncertain whether there will be enough physicists around to replace those academic physicists retiring in the next decade. Enrollments and annual graduations have begun to grow again, but only slowly. Questions about the quality of professional education in physics are vexing and cannot be answered with the assurance of earlier years. Financial stringencies make it difficult for undergraduate and graduate institutions to provide up-to-date laboratory equipment. These institutions must at the same time compete with industry and government in an increasingly active market for the services of physicists. Recent years have also brought marked changes to graduate education: The number of foreign students enrolled has increased steadily and that of US citizens has declined; the differences between small physics and big physics are becoming more prominent—and more divisive (see page 7). Demographic changes—in particular the decline in the numbers of college-age students that will last until well into the 1990s—will cause difficulties for disciplines such as physics that already have relatively small populations. This numerical decline must be weighed against the prospect of increasing numbers of academic retirements in physics during those years.

It is not surprising that the physics community is increasingly concerned about educating the next generation of physicists. Conferences of departmental chairs in physics convened by the American Association of Physics Teachers and The American Physical Society in 1983 and 1985 discussed the state of physics education and the response to growing problems. The National Research Council's physics survey committee devoted a great deal of attention to physics education in its recent report and warned of serious problems looming ahead (PHYSICS TODAY, April, page 22). Yet these and other groups have reported that demand for physicists is strong, opportunities in physics still abound and the possibilities for exciting advances are still great. It appears unlikely that future physicists will regret that they chose physics.

The articles in this special issue discuss physics education from several vantage points. Jerry Gollub and Neal Abraham take up physics in primarily undergraduate colleges on page 28. These institutions make vital and increasingly important contributions to physics education; although they differ widely in capability and affluence, as a group they are holding their own, and there are among them colleges that are providing outstanding undergraduate educations in physics. On page 36 Malcolm Beasley and Lawrence Jones report for the universities on the graduate-level education of physicists for research. Long and rightfully regarded as the crown jewel of the physics-education enterprise, graduate education is alive and well, but changing. Foreign students in US physics departments are the subject of the article by Mark McDermott and Edward Thomas on page 48. The growing number of graduate students from abroad is working a major change in graduate and undergraduate classrooms and laboratories. On page 58 Bruce Schechter reports on what people in industry think of the preparation and motivation of young physicists now joining industrial research laboratories; these have become the major employers of new PhDs in physics. On page 70, Beverly Porter and Roman Czujko describe the flow pattern in the education of professional physicists, drawing on data obtained in a long series of surveys by the American Institute of Physics and others. The sidebar by Mildred Dresselhaus on page 74 reveals an encouraging upward trend in the number of women undertaking graduate work and receiving advanced degrees in physics.

What is missing from this issue? A

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ANDREW GREENBERG

Studying tritium decay at NYU. Graduate student Zuyun Fang and faculty member Burton Budick discuss the operation of the detector.

lot, the authors would remind you. Utilizing the underutilized—ethnic and racial minorities—in physics is touched on, but not discussed in depth. Providing the kind of education needed by teachers of physics in high schools, who are a critically important subset of professional physicists, is far in the background. Both of these problems have been discussed before in the pages of PHYSICS TODAY and need to be taken up again in the future. It should also be noted that the articles here were written from personal perspectives. The authors consulted their colleagues as much as possible and used available data, but generally were not able to conduct new surveys. These are personal assessments, not committee reports.

Because the education of a professional physicist is an intensely personal and individual experience, it is difficult to treat except in personal reminiscences or, as here, phenomenologically. With the exception of Lloyd Whitman's interesting sidebar on page 41 concerning the situation of the graduate student, this personal aspect of education could not be treated here. The reader must look elsewhere for an account, for example, of Richard Feynman's delight, as a student, in the bright and various world; of Hendrik Casimir's emergence as a physicist; or of how Niels Bohr transmuted his undergraduate research on surface tension into the liquid-drop model of the nucleus. But behind the trends, statistics and problems presented here are the hum of voices at departmental coffee hours before colloquia, the midnights in the lab or at the computer, the chalkboards and problem sets, the friends and competitors, the frustration and exhilaration that are the education and the life of a professional physicist.

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American Association of Physics Teachers