Higher Education for Science and Engineering

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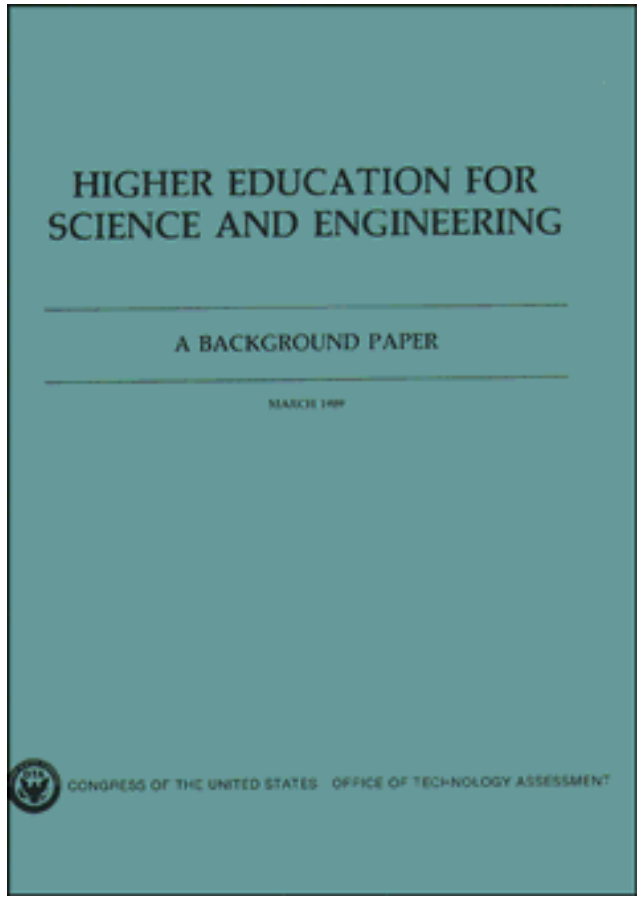

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PREFACE

This background paper focuses on the end point of educational preparation for science and engineering careers — undergraduate and graduate study. It places the issue of future supply in the broad cultural context of changing demographics, labor market adjustments, and intervention policies. In a dynamic economy and an increasingly technological society, planning is essential. But because of that very dynamism, the flexibility of workers is critical, as is the recognition that some short-term remedies may create longer-term problems.

The demographic trend of greatest significance is that the school-age population, beginning in the 1990s, will look unlike any we have ever seen in this Nation. That makes the future less certain and less predictable. It also warns us to be particularly careful with the extrapolations of the past that show, for example, a poor representation of minorities in these fields. The trend further suggest the need to identify and replicate programs and actions that seem to work, both inside school and out, to bring students into science and engineering and keep them there through completion of degrees.

History has shown that some students have not been well served by formal public education. If we are to bring more of these students into the ranks of scientists and engineers, promising programs are worth trying, even if they are unproven. We need to revise our methods and models of recruitment, clarify the image of "scientist" and "engineer," and rethink the notion of "professional calling" as it relates to the accessibility of the scientific career.

This paper also represents the last leg of an OTA journey begun in 1984 at the request of the Science Policy Task Force of the House Committee on Science and Technology. The first leg, *Demographic trends and the Scientific and Engineering Work* Force (December 1985), warned of the perils of trying to project demand for scientists and engineers.

A followup Staff Paper in January 1987, "Preparing for Science and Engineering Careers: Field-Level Profiles, "disaggregated 20 years of enrollment and degree data, by field, sex, and race and ethnicity. This statistical characterization of student flows into science and engineering underscored the need to analyze the process by which students bridge educational aspirations to achievements. In a report published in June 1988, OTA presented such an analysis. *Educating Scientists and Engineers: Grade School to Grad*

School recast the science and engineering pipeline as a kind of permeable membrane that accommodates the recruitment and retention of some students who, for the most part, are undecided about their careers and sensitive to opportunities they perceive in an everchanging job market. Students are buffeted about an education system that succeeds for some yet fails so many others.

These "others" are the very segments of the school-age population from which elementary and secondary education must draw students to interest in, and prepare for, careers in science and engineering. OTA's Technical Memorandum, Elementary and *Secondary Education for Science and Engineering* (December 1988), elaborates the "all one system" theme while examining both formal and informal education in science and mathematics. Clearly, curriculum, teaching, textbooks, and testing are components of schooling. But schools are subject to State and local jurisdictions. Since no one thing works for all children, research on how students learn and how to affect classroom practice now complements the development of out-of-school programs anchored in the community and fortified by a coalition of local business, industry, university, and government support.

The Federal role is catalytic — some say more symbolic and experimental than exemplary — but leadership, most agree, must be exercised at the national level. The purpose of this paper is to analyze, with various data collected in the course of the assessment reflected in *Educating Scientists and Engineers* the distinctive and common characteristics of undergraduate, graduate, and engineering education in the United States. These three topics are addressed in separate chapters, preceded by an introduction that offers a perspective on Federal policies for higher education, and specifically on the processes that transform talented students into productive researchers, innovators, faculty, and administrators.

It may be an axiom of social change, growth, and progress, but people are our most precious commodity. Renewing and developing human resources is a vital underpinning of American society and its competitive position in the world. Whether the goal is an increasingly science and technology literate public, excellence in research and development, a robust economy, or an improved quality of life for all citizens of the Nation, education is arguably the most protracted and therefore powerful experience in our lives. It demands attention.

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OTA PROJECT STAFF

John Andelin, Assistant Director, *OTA*
Science, Information, and Natural Resources Division

Nancy Carson, Program Manager
Science, Education, and Transportation Program

Daryl E. Chubin, Project Director

Lisa Heinz, *Analyst*

Richard Davies, Analyst

Robert Garfinkle, Research *Analyst*

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National Science Foundation

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Monsanto Chemical Company
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Center for Science and
International Affairs
Harvard University
Cambridge, MA

[1]currently President, Reed College.

[2]Currently Professor of Bioscience and Biotechnology.