Appendix B

Responses to an OTA Survey on Information Needs Related to Minorities in Science and Engineering

The literature on the factors that affect minority participation in science and engineering is not nearly so well developed as that for women. To supplement the few comprehensive studies on this subject to date, OTA sent a questionnaire on "information needs related to minorities in science and engineering" to 40 recognized experts in the field. Respondents were asked to present their views as to the causes of and remedies for problems in minority participation in science and engineering; the effectiveness of existing intervention programs to promote such participation; and the need for further research, additional information, and policy actions. Responses received from 18 individuals are summarized below, by question.

1. What do you believe to be the principal factors that influence minorities' decisions to participate and continue in science and engineering careers? Are there special factors that discourage minorities from participating?

The negative factors most commonly mentioned by respondents were:

- lack of academic preparedness in elementary and secondary school (literacy and necessary science and mathematics courses);
- lack of role models, mentors and teacher encouragement;
- lack of parental support and encouragement;
- lack of peer support;
- inadequate career and academic counseling;
- lack of confidence and perception of self;
- financial strains; and
- lack of awareness of career opportunities.

Other negative factors included:

- societal emphasis on sports, rock stars, and "quickie" models of success rather than a slow and sequential model;
- loss of interest or motivation;
- poor study habits;
- lower educational and financial background (socioeconomic class standing);
- dry unimaginative teaching;
- lack of institutional commitment to minority students:
- declining number of qualified teachers and lack of in-service training opportunities for teachers;
- increasing remedial classes;
- identity problems (one respondent believes this is especially so for American Indians);
- lack of summer jobs in science/engineering;
- lack of cultural and society support for science;
- type and environment of undergraduate institution;
- lack of effective instructional programs to promote cultural awareness and development of bilingual skills (especially Chicano, Puerto Rican, and American Indian); and
- lack of transitional instructional programs for students with limited English language skills.

Positive factors for all minorities are:

- competence in the English language;
- early enrollment in math and science courses;
- continuation of math and science sequence in secondary school;
- basic interest in science and math;
- intervention programs;
- encouragement and support from mentors, family, and teachers;
- role models;
- positive input from peer group with high expectations;
- availability of financial resources;
- self-discipline;
- good study habits;
- continued success;
- challenge;
- good environment;
- intellectual gratification;
- opportunity to obtain research experience;
- second-generation college student (for blacks);
- awareness of careers and opportunities in science and engineering;
- starting salaries and possibilities for promotion; and
- one respondent said the perception of a science or math career as an avenue for "escape" from an undesirable environment.

2. Are there major gaps in information and understanding relative to the factors which influence minority participation in science and engineering? If so, please identify.

A majority of the respondents felt that more information is needed on the experiences of minority students who are successfully participating in science and engineering. No major study exists on how graduates succeed in completing science and engineering programs. Why not study those who made it, let them explain why, how, and where they came from before they completed a science or engineering degree? Study every member of several black, Hispanic, and American Indian science and engineering societies to determine what they have in common, and what their differences are,

We do not understand the *relative influence* of the various factors that affect the participation of different minority groups in science and engineering. Little attention has been given to differences in cognitive styles that might exist for different minority groups. Many pieces of data, otherwise "available," are not broken down by race and by sex, so that it is difficult to make full use of collected information.

Successful programs have not been evaluated to determine how they work, why they work, and what they have produced. Further research is required to develop new strategies and programs that will encourage minority students to pursue careers in science and engineering,

3. **What new research initiatives would you recommend to help provide the needed information or understanding relative to the factors influencing minority participation in science and engineering?**

One of the most frequentl, cited recommendations was the need to improve the quality of mathematics and science programs at the pre-college level, including improving basic skills. Improving the quality of teaching was also highly recommended, and a need was expressed for approaches that would motivate, update, and retrain inner-city school teachers. Guidance counselors should be retrained and attuned to current opportunities in science and math.

Research is needed on the outcomes of programs specifically designed to recruit and maintain minorities in science and engineering. We know relatively little about which programs have succeeded and why. Previously supported programs that have had a strong positive educational impact should be examined for possible reinstitution.

Financial aid is still crucial to enable minorities to attend and remain in college.

There is a need to track students through the educational pipeline; students who show an aptitude for science and mathematics as early as junior high school. Participants in pre-college special programs should be tracked for **10** years **after high** school graduation to determine the relationship between program participation and academic performance, retention in college and career choice. The relationship between career aspirations of minorities between grades K and 12 and their decision to participate in science and mathematics education should be examined.

Research on the effect of role models and early exposure to science on career choice is needed.

Current information should be made available, broken down by race and sex. More efforts are needed to sort out the relative weight of the different barriers to minorities' participation in science and engineering.

The whole web of cultural and social values should be examined in order to understand why Asians and Asian Americans as a group have successfully entered quantitatively based fields in disproportionately large numbers relative to their representation in the population, in spite of numerous barriers. We need to identify factors at work in the case of individual non-Asian minorities, who successfully enter science and engineering fields.

One respondent suggested the following additional studies: The family and educational backgrounds, and career pattern and experiences of minority scientists and engineers. Quantitative studies of high school students experiences in mathematics and science courses. The attitudes of teachers and parents regarding appropriate candidates for science/engineering. A study of guidance counselors' familiarity with opportunities for blacks in science and engineering, More systematic evaluation of intervention programs. A study of the impact of the availability of financial aid on career decisionmaking. A study of high school students' career awareness with respect to opportunities in science/engineering.

As a final note, three respondents believed no new research was necessary. What is needed is action.

4. **In the recent past, a variety of programs and policies have been initiated, on the Federal, State, local, and institutional level, to promote minority participation in science and engineering. How effective have the programs and policies with which you are most familiar been in achieving their goals? Can you cite specific examples of success or failure?**

Three programs were cited most often as successes: The Mathematics, Engineering, Science Achievement (MESA) program of the Lawrence Hall of Sciences in Berkeley, CA; the Philadelphia Regional Introduction for Minorities in Engineering (PRIME) program; and the Resource Centers for Science and Engineering. The Atlanta University Resource Center's Summer Science Enrichment Program was also mentioned. Only a few

of the respondents had actual knowledge of the programs; most relied on hearsay.

In terms of actual experiences one respondent stated,

> I created the first successful program to bring blacks into engineering in circa 1965-1968 at Oakland University, Rochester, Michigan. In 197'3 I began a program to bring women into Engineering at the University of Virginia. We went from ***zero*** to the highest percentage of women in the Nation in five years.

Another respondent reported first-hand knowlege of the following minority programs sponsored by Federal agencies: Minority Research Initiation (MRI), Research Initiation in Minority Institutions (RIMI), Minority Biomedical Research Support (MBRS), Minority Access to Research Career (MARC), Research Center for Science and Engineering (RCSE), and the Minority Institutions Science Improvement Program (MISIP). Of the preceding programs, only the Resource Centers were conceived and planned to be comprehensive in approach. Through the respondent's experience with the Puerto Rico Resource Center, the respondent concluded that the only effective way to upgrade science education for minorities was to follow a holistic approach in which resources are optimized to address different stages of the educational process. Most other programs tend to be targeted, rather narrow, and limited in scope.

The same respondent stated that the MBRS and MARC programs have a strong overlap in goals, but nonetheless have been extremely successful in encouraging and orienting students toward biomedical research careers. The National Science Foundation (NSF) should be encouraged to consider the possibility of creating equivalent programs in the physical sciences, mathematics, and engineering. The MRI at NSF has been particularly successful in starting young minority scientists in their research careers. Competition for research funds is so keen that without the MRI programs, many minority scientists might not be able to establish themselves as regular faculty members in research institutions. Lastly, the RIMI program has been crucial in providing infrastructure for research in minority institutions although the funds available are not sufficient to remedy the seriousness of the problem.

Other exemplary programs cited were: Project Act 101 (Drexel University), Project Yes (University of the District of Columbia), Southeastern Consortium for Minorities in Engineering (SECME), A Better Chance, Inc. of Boston, National Action Council for Minorities in Engineering (NACME), Phillips Academy, and the Andover-Dartmouth Urban Institute intensive 4-week summer mathematics program for secondary school teachers.

The most successful programs have been those with clearly defined goals; stable financial support and stable staffing; a range of support services; and strong ties to parents, professional societies, the local schools, and other community groups.

One respondent stated it this way: Most of the long-established programs are quite successful, but most suffer from inadequate long-term funding, inadequate long-term assessment, little funding for transfer of successful models, and the need to prove themselves over and over again. The Resource Centers were a successful program at NSF, but they are not being supported in 1985 because of the lack of long-term Federal commitment. The decision to discontinue the program was made independent of the fact that it works.

Another expressed disapproval:

> Most of the Federal, State, or local programs have not been the most effective use of resources. Programs have disappeared at the end of funding. Resources duplicated existing programs. California's investment in MESA and Washington's in the minority engineering effort, are examples of how to build results-oriented, long-term programs that have multi-sector support and work with educational institutions for the benefit of parents. Many of the old NSF programs were effective in training teachers, but they are ended.

5. **What have we learned from these programs and policies; what specific factors appear to account for differ**ences in relative effectiveness?

Evidence obtained to date from the many intervention programs indicates that women and minority students will do as well as white males when provided with quality education and support for their goals. The early identification of minority students with an aptitude for mathematics and science, followed by a long-term enrichment and motivation program, has been shown to be an effective approach.

Specific factors cited by one respondent as contributing to the success of such programs were:

- an effective liaison between primary and secondary educational systems and higher education;
- parental awareness and participation;
- length of enrollment in the pre-college program;
- adequate resources; and
- a career development component.

Activities with a large motivational content, where students are exposed to role models and to nontraditional ways of teaching science, were said to have a profound and permanent effect in encouraging students to continue careers in science. Special programs to train kindergarten to sixth grade teachers in the presentation and teaching of mathematical and scientific concepts, and the development of quantitative skills and scientific methods were cited as crucial if minor-

ity students are to be oriented toward science and mathematics programs in large numbers. Respondents stressed the importance of continuity in minority programs. They must be comprehensive and maintained over a sustained period of time.

One respondent stated that the principal lesson learned from the Resource Centers was that a systems' approach is crucial to establish a comprehensive and coherent plan to develop minority institutions into research centers and increase the number of students who go on to become research scientists and engineers.

Other factors cited were:

- hands on experience;
- strong directors and able, interested staff;
- opportunities for in-school and out-of-school learning experiences;
- community support;
- development of a peer support sytems;
- evaluation;
- long-term follow up; and
- careful data collection, and mainstreaming.

6. What additional information is needed to better understand the causes of success and failure in programs and policies that promote minority participation in science and engineering?

Most of the respondents felt that program evaluation is the most needed supplement to existing information. This includes evaluation of intervention programs and policies for promoting minority participation in science and engineering; all pre-college engineering, mathematics, and science programs; and curricula of primary and secondary systems attended by minorities compared to those attended by majority students.

Further study and support of the following was also suggested: The current and future role of predominantly minority institutions in the preparation of students for quantitative fields, the presence and role of minorities in arenas where major science policy issues and decisions are being made, successful efforts at the undergraduate level to recruit and retain minority students in quantitative fields, specific ways to effectively communicate with the minority community about the importance of science and its applications in their lives, and the availability of computers to minority students and the ways in which they are being instructed to use them.

Three of the respondents felt that no more information is needed, only action; the implementation of recognized successful programs in education.

7. What actions, if any, would you recommend Congress take to promote minority participation in science and engineering, or to develop a better understanding of the factors that influence minority participation?

Most of the actions recommended for congressional consideration fell into three main categories: The establishment and support of special programs for minorities in science and mathematics, strengthening the quality of mathematics and science education in general, and financial support for minority students.

Some of the types of programs cited as deserving of support were: programs to promote curriculum development in mathematics and science for minority students at the primary and secondary school level; programs that provide elementary and high school students with hands on exposure to science and engineering; programs that encourage minority scientists and upper level minority **science students to participate** in minority science education; community-based programs that utilize outside expertise, but maintain control within local schools; programs aimed at increasing the number of students completing Algebra 1 and Biology 1 by the 9th grade, and the number of students taking and completing 3 or 4 years of mathematics, science, and English by the time they receive their high school diploma; and the development of magnet schools for the education of students with a special interest in science. It was recommended that the Government provide summer enrichment programs for minority students with talent and interest in science and mathematics, and reestablish the Resource Centers program.

Associated with program support was the need to improve instruction in science and engineering in general. Pre-college science and mathematics instruction in urban schools needs to be improved with an emphasis on involving both sexes. There should be increased funding for research on effective teaching and learning of mathematical and scientific concepts and skills, with a reasonable proportion set aside to study populations at risk for low achievement on the fundamental cognitive and conceptual level. We should continue informing the very young of opportunities in science and engineering, and educating the educators. Finally mathematics and science education in general should be strengthened through special funding for equipment and teacher training.

Financial support for minority students was suggested via various means: Establishment of "congressional scholars in science and technology" (a comprehensive 3- or 4-year program of undergraduate

support, research, and work experience to ensure that talented minority students will not be lost to science and engineering because they are unable to pay the cost of first-rate college training in these fields), Two-year scholarships could be awarded to a group of minority high school juniors, and to a comparable number of minority college juniors, who have demonstrated significant interest in and potential for successfully pursuing science or mathematics study at the next educational level. (Consideration might be given to targeting some of the proposed awards to students interested in pursuing science/mathematics teaching careers.) Financial support to students could be increased, especially support not involving loans. No-interest or low-interest college loans could be provided to students with strong mathematics and science backgrounds who agree to teach mathematics and science courses in economically disadvantaged communities. A federally guaranteed, low interest loan program could be established and specifically designated for minorities who indicate an interest in becoming scientists or engineers.

Some respondents recommended an examination of the Department of Education and NSF programs for minorities to determine their effectiveness, and the need for additional financial support. Continuity of successful minority programs should be the guiding factor in the determination of funding by Congress for minority programs, in their view. Such programs should be "mainstreamed" into the regular educational process, where possible.

A number of respondents called for a centralized organization to deal with the problems of minorities in science and mathematics. A national conference or hearing could be convened on minority participation in science and engineering. A commission could be established, composed of scientists and educators from the underrepresented groups as well as representatives from employers affected by the underrepresentation (e.g., universities, industry, national labs). A national office is needed, according to some respondents, to facilitate and conduct activities designed to increase minority participation in science and mathematics.

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