Building the Multiplier Effect: Summary of a National Symposium, September 14-16, 1978 (1979)

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Summary of a
National Symposium
September 14-16, 1978

Committee on Minorities in Engineering
Assembly of Engineering
National Research Council

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Foreword

Historically, minority groups have been grossly underrepresented in management positions of the nation's technological industries. As a consequence, the nation is deprived of the rich diversity of experience and heritage among those minorities—specifically black, Mexican-American, Puerto Rican, and American Indian. For several years, major industrial corporations, foundations, and minority organizations have sought to correct this inequity and to end the wasteful underutilization of a large and important pool of human resources in the engineering profession.

Engineering is a major route to careers in corporate management and leadership positions, particularly in industries with a technological or scientific base. Therefore, as one element in the effort, a national symposium was held September 14-16, 1978, in Washington, D.C., to evaluate the progress made to increase the number of minority graduates from college and university engineering programs, to determine how best to expand minority participation in engineering, and to chart a course for the next phase.

The minorities in engineering program began in the early 1970's out of the concern of business leaders that their minority employees were stuck in jobs that lacked the potential for advancement into mid-level and top management. They brought their concern to the attention of the National Academy of Engineering, which held a symposium in 1973 to explore the problem and develop plans for action. Following the symposium, the Academy organized the National Advisory Council on Minorities in Engineering (NACME) to enlist nationwide support for the proposed program. NACME is composed of leaders of corporations, universities, engineering societies, minority organizations, and government bodies. At the same time, the Academy formed the Committee on Minorities in Engineering (CME) to provide administrative support for the program. CME develops models of successful programs, counsels local and regional groups, and conducts seminars, workshops, and studies on general and specific issues.

The minorities in engineering effort is now half way to the proposed ten-year goal of increasing the representation of blacks, Mexican-Americans,

Puerto Ricans, and American Indians in the engineering professions to a level roughly in proportion to their population in the United States.

Much has been achieved since the program began. More minority high school students are graduating with the academic prerequisites and personal motivation needed to pursue further studies and careers in engineering. The number of minority students enrolled in university engineering programs has increased. Employment opportunities for minority engineers have expanded significantly. But although great strides have been made, the goal for minorities in engineering jobs is still elusive.

The purpose of the 1978 symposium was to bring together leaders in the various fields that are involved in the effort to increase minority participation in engineering. The theme of the symposium was the next five years, or Phase 2: how to create a "multiplier effect" that builds on the knowledge and experience gained so far in order that many more minority youth will enter and succeed in the engineering profession. To this end, the participants explored the obstacles—and there are many—that still exist and the productive pathways that are open or opening.

As a result of the symposium, NACME and CME have launched a major effort to expand and strengthen the minorities in engineering program. This effort has three major components: to broaden the membership base of the organizations that are involved in the program and to expand the base of financial support; to shift program emphasis toward the pre-college years in order to enlarge the talent pool of qualified minority applicants; and to strengthen and expand the individual programs that are now under way.

The purpose of this ambitious action is to at least double the number of minorities embarking on college engineering during the next five years. Efforts will continue to motivate minority students in engineering careers, to foster their retention in engineering schools so they don't leave for financial or academic reasons, and to support minority engineers during the early years of their employment.

There are no easy answers to the problem. It may be one or two decades before our country achieves the full goal of the program—to increase minority participation in industrial management. The next five years will largely determine what is possible in the future. Accordingly, a great national commitment to the minorities in engineering program must be made now.

THOMAS L. MARTIN, JR.
Chairman
Committee on Minorities in Engineering

1 Phase Two: Building the Multiplier Effect

Less than 1 percent of the 1971 engineering graduates of colleges and universities in the United States were blacks, Mexican-Americans, Puerto Ricans, and American Indians. Despite the minimal representation of these disadvantaged racial and ethnic minorities among graduating engineers, people in these groups made up a significant proportion of the nation's population. In the 1970 census, 14 percent of the population consisted of the four minority groups.

Since then, increasing numbers of minorities have entered college and university engineering programs. By 1978, minorities represented 8.8 percent of the undergraduates in engineering. Their graduation rates had increased from 3.5 percent in 1973 to 4.3 percent in 1978. However, one measure of this progress must be against the demographic status of the four minority groups in the nation's population. Census studies show that in 1978, nearly 16 percent of the population was made up of blacks, Mexican-Americans, Puerto Ricans, and American Indians. The disparity between the percentage of minority engineers and the percentage of these four minorities in the total population is still perverse.

To evaluate the progress that has been made and to determine what measures can be taken to greatly increase minority enrollment in engineering programs, the 1978 Symposium on Minorities in Engineering explored the entire pre-college, college, and employment phases of engineering in terms of minority needs. The title of the symposium, "Phase 2: Building the Multiplier Effect," suggested both a recognition of the notable achievements that have been made and the need to undertake a major expansion of the program.

In all, more than 500 representatives from business, universities, the engineering profession, the minority community, and government gathered at the National Academy of Sciences in Washington, D.C., for the symposium.

In the opening remarks, Melvin Thompson, Executive Director of CME, summarized the status of the minorities in engineering program, saying: "The first five years have been easiest. We have identified priorities, established goals, and many organizations have been set in motion . . . But the next five

years will be most difficult. They will require more substance, more planning expertise and resources, both human and fiscal." Thompson said that the increased resources must come primarily from the corporate community and the federal government. He also spoke of ways in which CME can assist groups to expand their resources, such as workshops on how to develop and follow through on proposals for government funding.

Minorities who enter college engineering programs are likely to find good employment opportunities when they graduate. Frank Press, Director of the Office of Science and Technology Policy, said that there is now a strong demand for able engineers and that the need is likely to persist for some years. Propelling this demand, Press observed, is the country's requirement to upgrade its industrial capacity and productivity and to become more efficient in the use of energy and natural resources. He said that engineers also are needed to assist the less developed nations of the world to advance technically, socially, and financially. "We will need every bright mind and willing pair of hands we can get in our engineering professions," Press told the symposium. "This is not only a matter of providing opportunity for minorities, but of making the best use of our human resources."

Four symposium speakers voiced the perspectives of the groups that are central to the minorities in engineering program. These speakers were: Jerry Apodaca, Governor of New Mexico; Robert Garcia, Congressman, 21st District, New York: Kenneth Gibson, Mayor of Newark, New Jersey; and LaDonna Harris, President, Americans for Indian Opportunity.

One of the troubling ideas about engineering in the minds of young Mexican-Americans, said Governor Apodaca, is that "maybe it has been a profession that has been elite . . . a profession that somehow our young people . . . erase out of their goals in life and somewhere in early childhood determine that it is not something that they can do. Perhaps the first thing that must be done is to erase that false barrier."

Puerto Rican perspectives were expressed by Garcia, who recalled that his father and mother together had only 12 years of education and that one of the basic problems for "most of us who came out of communities such as mine is that we feel that we cannot achieve and cannot be part of a group such as this." The destruction in his Congressional precinct has been described like that at Fort Apache, Garcia said, but as one who was born and raised in New York City's South Bronx, he had this to say: "The fact is that there is a lot of talent in South Bronx. Nobody has gone after that talent, to pull it out . . . It is a question of changing the thought and the image so that these young people know that they can achieve . . ."

Newark's Mayor Gibson observed that his graduation as a civil engineer was an important event in his family. Even so, he noted, the entrance of blacks into the professions is not simply a matter of personal gains. "It is good business to get people who can relate to the community with which you

intend to do business," Gibson said. As an example he cited the expansion of business activities in Africa. "It is certainly important for those of you who intend to do business in those countries," he said, "to consider that it will be important to have blacks who are competent professionals and can deal with (black people) on a businesslike and an equal basis."

Engineering opportunities for Indians have been severely limited by the kind of education Indians receive, Harris told the symposium. "We, like all people of color, have been discriminated against in that the educational systems that we have had to attend had poor or no science departments." Harris said it is essential that Indians are involved in solving such problems because American Indian tribal nations are diverse and complex. "There are more than 250 tribes–all uniquely different," she said. "We are different peoples. We speak different languages . . . (and are) governmental entities . . . with unique treaties and laws." Because of these differences, she said, attempts to overcome the problems will not work unless Indians are involved.

2
Obstacles and Goals

"It is convenient to think about an engineering career trajectory as having three distinct phases—the pre-college phase, the college phase, and the career-development phase," CME Chairman Thomas L. Martin, Jr., informed the symposium. "For minorities to have truly equal opportunities for leadership positions, they must achieve parity in all three phases of the engineering career path."

The symposium participants reviewed the obstacles to minorities in each of these phases and identified specific strategies for overcoming the obstacles as tangible goals for the CME effort during the next few years. The next section describes the obstacles and goals and provides specific examples from CME experience of how the goals can be achieved for each phase of engineering careers.

Pre-College Phase

During the first five years of the minorities in engineering effort, the emphasis was on the college and career development phases. The symposium participants recognized that, while it is essential to strengthen current support in these two vital areas, there must be a broadened commitment to the first phase in the career trajectory. Proper motivation and adequate academic and personal preparation at the junior high and high school levels are the keys to success in the second and third phases. As Raymond R. Wingard, President of the Board of Minority Engineering Education Effort, Inc. noted: "The pipeline cannot 'come-a-gusher' if only a trickle enters at its source."

Obstacle: Lack of sufficient *motivation* among minority youth to choose engineering as a career.
Goal: To create a greater *awareness* among minority high school and junior high school students and their parents of career opportunities in the engineering field by disseminating *information* at the local level.

Engineering has never been a traditional career choice for minorities. In general, minority individuals have tended to enter those professions in which they work alone, such as medicine or law, or in which they work with other minorities, as in teaching and social service. Gerda Steele of the National Association for the Advancement of Colored People (NAACP) explained some of the reasons for this. "Years back we trickled into medicine and into law, but engineering was a field that was not within our vision," she said. "It was a field where we felt there was no place for us to go. There were not any opportunities for us. We were left out and locked out." Now that the engineering employment picture has changed, Steele said, "We have to dispel this perception at the community level. We have to gain credibility in these communities in reference to the field of engineering as a viable career for minority students."

Henry J. Casso, President of the National Institute for Professional Development, Inc., elaborated on this theme: "We are faced with the challenge of animating young people into careers in science and engineering, where they see very few who look like them. We must convince the parents of these young people as to the marketability, the personal, human, social, and economic attractiveness, and the significance of their sons and daughters participating in science and engineering careers, to be meaningfully part of this new technological era in which our country finds itself."

In his remarks, John G. Truxal of the National Coordinating Center for Curriculum Development (NC^3D) added: "As the engineering profession attempts to develop strategies for affecting secondary school education, we should recognize that if we can convey to young people the true picture of today's engineering in the service of the public, we will provide the student that academic motivation and learning experience essential to augmenting the pool of secondary school graduates having the freedom of career choice that includes engineering."

A number of successful means of bridging this information gap have been pioneered at local, regional, and national levels. Several programs have been developed by industry. From 1974 to 1978 General Electric's Expo-Tech, an engineering exhibit carried in a large trailer, crisscrossed the country to junior high schools with predominantly minority enrollments and introduced students to engineering as a career. Expo-Tech is currently housed at the Illinois Institute of Technology. For another, RCA's Minorities in Engineering Program provides science and engineering projects that expose students to engineering skills in some of the communities where RCA facilities are located. Plant visits, employee visits to classrooms, and dissemination of print and audiovisual materials are all part of the ongoing effort by U.S. companies.

Raymond R. Wingard, Board President of the Minority Engineering Education Effort, Inc. (ME^3), said that the purpose of his organization is to "become explorers for the raw material of the engineering professions—to

focus their efforts at the pre-college level, in the high schools and even the junior highs—to identify black, Mexican American, Puerto Rican, and American Indian students with the apparent aptitude to succeed in undergraduate engineering programs." When potential engineers are identified, Wingard said, the ME^3 "closes the loop" by providing the names of these students to colleges and universities throughout the country, and giving the students information on schools they might consider. More than 100,000 students with engineering aptitudes have been given this assistance, Wingard said, and substantial numbers of those students are now enrolled in college engineering programs.

The National Society of Black Engineers also links the pre-college and college phases of the minority engineer's career, according to Virginia L. Booth, an engineering student who chairs the National Society of Black Engineers. Booth said that one of the Society's activities has been to invite high school students to a spring event in which discussions among students and their parents cover the different fields of engineering, the co-op and summer job opportunities, and the educational demands of college.

Regional and local organizations have been created to increase minority student awareness of engineering as a career. Several programs have been developed in which industry, universities, professional societies, and community groups participate and work closely with local school systems to expose students to engineering careers. Among the consortiums are: The Texas Alliance for Minorities in Engineering (TAME); Philadelphia Regional Introduction for Minorities in Engineering (PRIME); Mathematics, Engineering, Science Achievement (MESA); Southeastern Consortium for Minorities in Engineering (SECME); and Committee on Institutional Cooperation + Midwest Program for Minorities in Engineering (CIC + MPME).

The consortiums use a wide variety of communication methods, ranging from classroom demonstrations, career days, and science fairs to field trips to engineering schools and industrial sites. Pre-college efforts by consortiums help to increase the pool of motivated and prepared minority students who are equipped to undertake rigorous undergraduate study in engineering and other scientific and technical disciplines. As Thomas E. Ford, Program Officer of the Alfred P. Sloan Foundation, put it: "Whenever possible, minority engineers and minority engineering students work with secondary school students. They act as role models and help to introduce the students to the field of engineering and the methods and products of technology."

The consensus at the symposium was that programs that bring the engineering message to high school and junior high school students should be expanded to take in more locales. A number of speakers also stressed the need to extend programs to include younger students, even those of elementary school age. Howard C. Kauffmann, President of the Exxon Corporation and NACME Chairman, said that pre-high school programs "reach students when their interests are in the most formative stages." However,

Kauffmann emphasized that this, as well as other increased efforts in the minorities in engineering program, will require an expansion of the base for financial support and enlistment of more members from business, government, educational institutions, professional organizations, and minority and community resource groups.

Obstacle: Lack of academic *preparation* for entrance into a college engineering program, particularly in the areas of mathematics, science, and communications skills.
Goal: To *identify* promising students early in their academic careers, give them appropriate *guidance* in choosing a program of study, and ensure the availability of quality *curriculum* and *instruction*.

A recent study by the National Science Foundation showed that in 1975 only 10 to 15 percent of all minority students had the necessary prerequisites to pursue further study in the sciences. This was compared to 50 percent of the general population. In the engineering career trajectory, an individual's subsequent progress is directly related to the quality of instruction in mathematics and science at the preparatory level, a number of symposium participants pointed out. Without a solid grounding in these subject areas, the minority student is likely to have trouble completing engineering courses in college.

Theodore Lobman, Program Office of the William and Flora Hewlett Foundation, noted that although inadequate preparation in mathematics is a national problem and not peculiar to minorities or even to the inner city, "research is showing that primary school teachers, uncomfortable with math and its many uses, help pass on math anxiety to their students. "Evidence shows that fewer students take a math sequence in high school. When they do, the easier, more applied courses are selected. When students take precollege courses, they take fewer of them and if they use the same textbooks as suburban schools, fewer chapters are covered. All of this is compounded for the inner city student by the familiar problems of inadequately informed teachers and guidance counselors, absence of role models, unengaging curriculum, and an atmosphere not particularly supportive of academic achievement."

To correct this situation, Lobman said that students "need to perceive their preparation and motivation experiences as coherent, interrelating, and mutually supporting. Experiences have to be continuous over many years to affect aspirations and behavior. And they must be comprehensive, covering all the aspects of guidance, academic preparation, and familiarity with engineering education and careers that are available to relatively advantaged students."

In response to an observation that most of today's minority engineering students have a middle class background, Lobman used the pipeline analogy

and concluded that "without secondary recovery mechanisms, the flow out of the pipeline will not increase despite improvements in drilling or refining techniques." It is from the reserve of academically disadvantaged students that a flow will be large enough to meet the next five years' objectives of the minorities in engineering program, said Lobman.

A variety of programs for enriching the pre-college academic experience of minority students has grown out of the minorities in engineering effort. Industry, universities, and community, regional, and national organizations have contributed to this pursuit. In addition to raising an awareness among minority students of the opportunities available to them in engineering, the consortiums are working closely with local high schools to improve mathematics and science curricula and the quality of instruction and counseling.

The Alfred P. Sloan Foundation has been a major source of funds for many of these regional consortiums. Thomas Ford of the Sloan Foundation told the symposium that the emphasis of such programs is on student mastery of important quantitative and expository skills. Special supplementary curricular materials in high school math, science, and communications skills have been designed and are being distributed to the programs by another Sloan Foundation grantee, the National Coordinating Center for Curriculum Development (NC^3D). Ford said that many of the instructional materials are drawn from specific engineering interests and examples, and that teachers are encouraged to call on university and industrial engineers for assistance in interpreting and adapting the materials. Such interaction between teachers and engineers in the use of the instructional materials is an important ingredient in a successful program, he said.

To this John Truxal, Director of NC^3D, added: "Engineering and modern technology provide extremely powerful vehicles for motivating the minority young people toward further study in mathematics, science, and communications. These students live, study, and play in a technological environment. Entertainment, recreation and transportation, for example, demand understanding of this technology—and the underlying science and mathematics."

In summing up the future direction of the pre-college effort, Thomas L. Martin, Jr., observed that more pre-college programs are needed in more locales, existing programs need to be expanded, and a broader base of continuing financial support of local programs will be needed if the effort to at least double the number of minority students who enter engineering is to be realized within the next five years.

College Phase

The symposium identified the key ingredients to successful completion of a college engineering program as adequate motivation and preparation in high

school. But for minorities who enter college, many difficulties remain. These include an adjustment to the college environment, particularly in non-minority schools; a need for tutoring and other academic support; and a lack of funds.

Obstacle: Lack of *information* on the part of minority students about college engineering programs.
Goal: To improve college *recruitment* and *admissions* practices as they relate to minority students.

Before the minority student can enter the second phase of the engineering career trajectory, he or she must first learn about college level programs available and be admitted to one of these programs. This is the job of college recruitment and admissions departments. Although there have been dramatic increases in the college enrollments of minority students in engineering programs in recent years, more minority students must be attracted to engineering programs, particularly to those in non-minority universities. (Six predominantly black colleges, Tuskeegee, Howard, North Carolina A&T, Prairie View, Southern, and Tennessee State, account for nearly one-fifth of all black engineering graduates.) It is not possible for these colleges to absorb the additional students that are needed to attain a level of minority engineering students in proportion to their numbers in the total U.S. population.

Thomas L. Martin, Jr. warned non-minority institutions that lowering entrance standards, developing less demanding curriculum, or providing remedial work after college entrance are *not* solutions to the problem of getting minority students into engineering schools.

Richard M. Cyert, President of Carnegie-Mellon University, agreed with Martin and observed that "effective retention is heavily dependent on recruiting students with the potential to graduate." To achieve this, said Cyert, it is necessary for those who are recruiting minorities for engineering to move into more areas of the country than would be the case for normal admissions activities. He noted that a different approach also is necessary to recruit students from minority groups. The recruiter must be able to explain more about engineering and to interest students in engineering because it is unlikely that many minority students have decided to go into the profession. "Thus, engineering must be sold to the student before the school itself," said Cyert.

Obstacle: Problems in *adjusting* to the college environment.
Goal: To ease the minority student's *transition* from high school to college.

Many non-minority institutions of higher education have found that adjustment to life on their campuses can be particularly difficult for minority students. Paul E. Gray, Chancellor of the Massachusetts Institute of Tech-

nology, stressed that "this transition has important personal, social, and academic components. For most of the minority students with whom we are concerned, our institutional settings represent both a more demanding, faster-paced academic environment and a less-structured, more permissive social environment than they have experienced previously. At the very time their studies require that they develop a new singlemindedness and intensity of purpose about their academic tasks, the new social environment in which they function offers more freedom and fewer guidelines. The adjustment is, for many students, a wrenching one."

To help make this transition less disruptive, a number of colleges have initiated summer programs for minority students who plan to enter these colleges in the fall. At MIT, Project Interphase offers such students seven weeks of calculus, physics, chemistry, and humanities. "At the same time," Gray said, "they have a chance to adjust to cultural and academic communities in which they will spend four or more years."

Obstacle: High minority ***attrition*** in college engineering programs.
Goal: To ***retain*** minority students in college engineering programs by providing ***support systems*** to those who need them.

"How do we keep the students? How do we keep them motivated? How do we keep them so that they will study and make a grade average that allows them to stay in school?" These questions, raised by Joseph Martin, President of the American Society for Engineering Education, highlighted sessions of the symposium that were concerned with ways to retain minority students in college and university engineering programs.

It is not enough for a college to accept minority students into its engineering programs, symposium participants pointed out. The emphasis has to be on graduating minorities from the colleges rather than simply on admissioon levels. "The data suggest that while enrollments are up," Cyert said, "we're still having a tremendous problem with keeping minorities in school and ultimately getting them through the institution. These events are occurring because the tendency is to place an emphasis exclusively on admissions and to ignore the institutional environment and the educational process."

At the same time, Cyert said, "our experience at Carnegie-Mellon suggests that an effective retention program is heavily dependent on recruiting students with the potential to graduate. Identifying these students and enrolling them is difficult. Both can and must be done."

According to many participants at the symposium, a good minority student retention rate usually requires some of the following elements:

- *Effective counseling* by faculty, particularly by minority faculty members. "Informed and effective advising influences far more than a student's

academic experience," said Gray. "It can be an important support for continuing motivation and can help students develop insight about professional opportunities and career alternatives."

- *Timely academic support* for minority students who are having trouble with course work. The support can take many forms—tutoring by faculty or students, short courses in specific techniques, study groups, videotaped instruction, and modules for self-paced study have all been successful. "What matters most for success," Gray advised, "is that the supportive resources be available *when* the need arises . . . the responsibility is ours to be sure students who need help are aware, in a timely way, of resources on which they may call. We must be certain that no student is about to go under for the third time before we throw a life preserver!"
- *Flexibility* in personal and productive progress. Many minority students could benefit from curriculum stretch-out programs, reduced course loads, and leaves of absence, with a course of study designed to suit their personal and academic needs.

Retention of minority college students also was a major concern of Raul Alvarado, Jr., President of the Society of Hispanic Professional Engineers. "Like the grim statistics of war," he said, "there will be many casualties. Less than 50 percent of those that entered as engineering students will make it through all the classroom battles toward an engineering career."

Alvarado said that it is ironic—with so much time, money, and energy expended on getting a minority student into engineering school—that "very little assistance remains once accepted to the university. This task has been assigned to minority professional engineering societies, such as the Society of Hispanic Professional Engineers. Participation is, of course, the key, and all students are continuously encouraged to become involved in chapter and school activities."

Perhaps the most important service a support group can offer college students, Alvarado said, "is to assist them in locating summer employment." This enables Hispanic students to develop professional contacts in their field, he said, and "students need not suffer the frightful sensations of being alone in a highly technical field."

Obstacle: Lack of *funds*.
Goal: To provide needy students with sufficient *financial aid* in an appropriate form.

One of the biggest obstacles to minority student admission and retention in college has always been financial. Lacking sufficient funds, a high school graduate is unable to enroll in college, and constant money worries can adversely affect the college student's academic performance.

In 1974 the Committee on Minorities in Engineering assisted in the creation of the National Fund for Minority Engineering Students (NFMES) to work for increasing the national financial commitment to the education of minority engineers. NFMES provides financial assistance to minority engineering students through the award of incentive grants to engineering schools that have demonstrated a commitment to the goal of expanding the number of minority engineers. According to Garvey E. Clarke, NFMES President, "the Fund does more than simply award scholarship money to minority engineering students. It encourages engineering schools to become full partners in the effort by awarding them financial incentives to expand their minority enrollments and by improving their recruitment and support services programs."

To date, more than 1,000 NFMES scholars have been assisted by grants, ranging from $250 to $2,000 a year, provided by 75 engineering schools participating in the program. In the summer of 1977, NFMES launched the Summer Engineering Employment Project (SEEP), which was designed to expose NFMES scholars to career opportunities in engineering while they earn money to help pay for their education. Clarke informed the symposium audience that NFMES currently is sponsoring a study to determine the financial resources needed to expand minority engineering enrollments to the parity goal. The results of this study will provide the Fund with essential guidelines for formulating its fund-raising goals and for determining how many scholars it should assist each year until parity for minority engineering students is achieved.

As a result of the efforts of NFMES and the increased availability of student financial aid from industry, government, and foundations in the form of scholarships, loans, and work-study programs, the problems of obtaining funds for education of minority students have been greatly alleviated. Gray of MIT noted, however, that many minority youngsters are apprehensive about educational loans of the size associated with present college costs. "This apprehension requires that we make special efforts to avoid placing excessive loan burdens on students and try, as well, to communicate with prospective students about financial aid matters in ways that encourage a reasonable and balanced perspective."

Career-Development Phase

Obstacle: The difficulties minorities face in "making it" in the working world.
Goal: To ease the transition from college to employment and to smooth the minority engineer's professional progress.

A lack of employment opportunities does not appear to be a major obstacle confronting minority engineering graduates. "In most cases," said Jesse

M. Smith, Executive Director of the College Placement Council, "minority candidates capable of competing in the major organizations are being courted continuously as early as their freshman year." He predicted that the demand for minority engineers will continue to exceed supply well beyond the 1980's as a result of the pent-up demand that now exists.

Alfred L. Richardson of the Los Angeles Council of Black Professional Engineers spoke of "the difficult transition . . . from college to the 'real world' of engineering." Richardson called for a concerted effort to advance the sound professional development of the minority engineer, "because 25 to 30 years from now, in the upper management levels, we think the world is going to be different . . . We think [minority engineers are] going to be the most important resource that we have in terms of international relationships and third-world development. The kids that you're talking about now in high schools . . . may very well be [this nation's] technical representatives somewhere on the international scene."

Because the emphasis of the minorities in engineering effort has been on increasing the number of minorities in college-level engineering programs, the career-development factors have received less attention. As more minorities are employed as engineers, it is likely that increased emphasis will be placed on this for minorities in engineering.

Lindon E. Saline, Manager of the Professional Development Operation of General Electric Company, said that the resilience of minority engineers will unfortunately be tested in isolated and fragmented instances and institutions throughout our society for many years. Efforts on the part of college placement officers, alumni associations, industry, and engineering professional societies, particularly those organized by and for minorities to help minority engineers in these areas, need to be encouraged.

Saline also stressed the importance of these aspects of the employment of minority engineers:

1. That minority engineering graduates be hired for real work because they are qualified and not for "showcase" jobs or for "tokenism";
2. That minority engineers, in accepting the opportunity to compete, "be measured and be rewarded fairly" and understand what is to be accomplished by their employers in terms of time, resources, and other limits and responsibilities;
3. That minority engineers should recognize that it is important to continue acquiring "new technical, economic and political knowledge—a continuing and evolving development of new interpersonal and process skills, and a continuing enrichment of design, production, and application experiences";
4. That engineers must have the flexibility and resilience that are needed to cope with uncertainty and change in engineering employment; and
5. That there must be patience and persistence to see the minority engineering effort through to a successful conclusion.

3
Program Components

Overcoming these obstacles and realizing the goals that are necessary to overcome them are the aims of the principal components of the minorities in engineering effort. These components are community groups, universities, the engineering profession, private industry, foundations, the government, and such regional and national organizations as NACME and CME. No single component can solve the entire problem alone. Each needs to work in concert with the others if the final objective is to be achieved. Thomas L. Martin, Jr., described the ideal relationship of all the components as a wholesome partnership:

> There is first the partnership that exists among the schools, where the students are and where the academic work is done, and industry, which has the resources of time, talent, funds, jobs, and the like, and community groups, which can assist in early identification of capable students and in publicizing the program within minority communities, and engineering colleges, which can provide guidance, coordination, and program supervision. Additionally, there is a partnership among local organizations, which are carrying out programs of action, and national organizations, which support local actions in many different ways. And finally, there is need for a partnership, which needs to be defined with great care, among the successful local minority engineering programs and government agencies at all levels.

Community Groups

The participation of community groups is important to the success of the minorities in engineering effort, particularly if pre-college goals are to be met. Community groups can provide a vital communications link for many components in the minorities in engineering components and the families they are trying to reach with their message. "When I think of the community," Gerda Steele of the National Association for the Advancement of Colored People said, "I think of a coalition, and this community coalition, of course, will

work with the other partners in business, government, and so forth." Steele stressed the importance of constructing a secure foundation in community organizations by providing the organizations with information on a systematic basis in order to support a greater minority participation in engineering.

John S. Robottom, Director of the Equal Opportunity Training Program at the University of Texas at Austin also emphasized that the success of minority programs is tied to local involvement, particularly involvement with the schools.

Regional Consortiums

Regional programs have been important primary links among minority parents, students, and local communities. Such programs have provided such valuable academic and motivational activities as summer academic programs to strengthen the mathematics and science backgrounds of students, tours to engineering work sites, talks by minority engineers, and experiences in developing engineering project models. Regional consortiums also have provided orientation programs for parents and workshops for teachers and guidance counselors, and have been instrumental in establishing engineering clubs. In addition the regional programs have close working relationships with colleges, universities, and private industry in structuring and developing their operations.

The consortium relationships with colleges and universities offer a unique opportunity for minority students to learn first-hand about the academic and social environments they may encounter when they enter engineering school. At the same time those contacts provide an important opportunity for work experience in an engineering setting. Some of the regional consortiums also provide summer jobs in engineering-related environments as part of their pre-college program experience.

Regional consortiums, such as PRIME and TAME, have proved to be an effective way to reach the minority community. It was suggested at the symposium that the objective of the minorities in engineering effort should be to increase the use of existing community-based organizational resources. Steele spoke of the NAACP commitment to increase minority participation in the engineering and science professions. "We have 1,700 branches all over the country," Steele said. "I see the NAACP as an organization that already has a mechanism set up where programs can be developed for this effort, and I see the same with the Urban League. I see the same with some of the other professional organizations—Mexican-Americans and Puerto Ricans and American Indians through their tribal councils and other avenues . . . As minorities and as entities within minorities, we need to figure out the best way to deal

with our populations . . . I think in the community the key to what to do with minority children is the parents."

The distribution of resources within regions to support minorities in engineering activities is an important concern, according to Russell O'Neill, Dean of Engineering of the University of California at Los Angeles. "The problems and their solutions [are] not the same for the different minorities, for the different regions, and for the different institutions," O'Neill observed.

Universities

Concerning university participation in the minorities in engineering effort, Cyert said: "Universities have an important opportunity to make a significant contribution to society by solving an educational problem—something they know how to do. The time is late, the problem is important, and university presidents must see that success is attained in each of their institutions."

Several recommendations for ways to broaden the scope of university involvement emerged from the symposium. These included: increasing awareness among state departments of higher education about minorities in engineering; reassessing the needs of minority colleges; developing college retention demonstration projects; devising methods for assisting engineering colleges to design and implement minority programs; establishing a link between minority students at junior colleges and community colleges and university engineering programs; and gathering more data on the high rates of attrition among minority students in college engineering programs.

James E. Cheek, President of Howard University, discussed the significant role of predominantly black colleges and universities in attempts to resolve what he called the persistent problem of obtaining a larger number of minority engineers. "Despite the increasing number of black students entering predominantly white colleges and universities," Cheek said, "predominantly black institutions continue to be the principal resource for black graduates. As evidence of this, more than 70 percent of the blacks earning degrees [come] from these institutions. . . With specific reference to engineering, we estimate that at the inception of the national effort to increase minorities in engineering, black colleges and universities easily accounted for approximately one-half of the engineering bachelors degrees held by blacks in the United States."

The black institutions, Cheek said, "must serve the entire spectrum of aspiring students, from those who have impeccable secondary education credentials to those for whom academic deprivation threatens foreclosure of engineering opportunity."

In recent years, engineering societies have recognized that their responsibilities extend to the vast pool of potential minority engineers. Bryce MacDonald, President of the Engineers Joint Council, told the symposium that several years ago the profession took positive steps to remedy this deficiency through the Engineers' Council for Professional Development (ECPD). ECPD operates its Minority Introduction to Engineering (MITE) Program at 35 colleges in 21 states. In 1972, ECPD also organized a task force, the Minority Engineering Education Effort, which has since developed into an independent national organization. The American Society for Engineering Education, through its Black Engineering College Development Committee, and the Institute of Electrical and Electronic Engineers also have been important partners in this effort.

Many professional societies have been organized by minority engineers. Among those that provide support for the minorities in engineering effort are the National Society for Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE), the Mexican American Engineering Society (MAES), the Puerto Rican Engineers and Scientists Society (PRESS)*, and the American Indian Science and Engineering Society (AISES). Among the many activities and programs they have organized in support of the minorities in engineering effort are the promotion of cooperation among minority community leaders, members of the engineering profession, and representatives of industry, local government, and education institutions; the creation of awareness among parents and students of career opportunities in engineering; the operation of pre-college and college assistance programs involving tutoring, counseling, and motivating of students; the representation of the interests of minority engineers on the local, regional, and national levels; and the provision of career-counseling services to engineering graduates.

"However well we may have done," said Manuel Castro, President of MAES, "we have done so with limited funding and limited man-hours on a grass roots level." Raul Alvarado, Jr., SHPE President, added that most minority professional societies are small local organizations that "seldom have funded national offices and must donate their own time and generate their own finances in order to accomplish the task."

Alfred Qöyawayma Colton, AISES Chairman, echoed these sentiments, and said that his organization is an active society which operates totally with voluntary help and with no administrative funds. A society like this, he said, can quickly exhaust its resources. AISES is in great need of fulltime staff, personnel, and further leadership development, Colton said. "I'm sure that other minority societies are in the same situation to one degree or another.

*Since the symposium met, this group has merged with the Society of Hispanic Architects and Planners, and is now known as the Society of Hispanic Architects, Engineers, and Planners.

We request aid in meeting these challenges. Active minority societies represent a prime mechanism to let minorities help themselves, but first we need help."

Private Industry

Industry has assumed a key position in the minorities in engineering program from the start. The major effort has always been aimed at placing more minorities in positions that are considered starting points for careers in top-level corporate management. The first symposium on minorities in engineering was organized by the National Academy of Engineering at the suggestion of corporate leaders, and today thirty-four corporate chairmen and executives sit on the National Advisory Council on Minorities in Engineering (NACME).

"Large corporations bring three important resources to the minorities in engineering effort–money, people, and the processes of the workplace," Walter A. Hamilton, Vice President of the Public Affairs Research Division of The Conference Board, noted. "Corporate money has helped to establish and sustain vital programs," Hamilton said. "Corporate people have been instrumental in bringing many programs into being. They continue to participate actively; they have used their professional skills and their familiarity with the conditions and requirements of engineering work to teach and advise; they have served as role models; and they have decided how best to put corporate money to work. The ongoing processes of the workplace, observed and more actively experienced, have contributed an important dimension of depth to the understanding and motivation of students and teachers."

Industry has been one of the major sources of financial support for the minorities in engineering effort. Howard Kauffmann, NACME Chairman, pointed out that 38 companies and five foundations provide 98 percent of the funds that support national programs to increase minority participation in engineering. "Perhaps another 50 companies contribute financial aid through the NFMES," he said, "and of course others make direct contributions to colleges for this support." It was Kauffmann's conclusion, shared by many at the symposium, that this is too narrow a base of industry support.

Hamilton observed that the most successful corporate programs were those that had "the strong active commitment of top management" who in turn "assigned responsibility to an individual, a committee, or a staff unit at the corporate level for stimulating, coordinating and/or motivating minorities in engineering activities."

Kauffmann urged the expansion of this type of corporate commitment. "More company affiliates can be encouraged to help develop programs at local levels," he said. "This sort of thing is important in achieving the 'Multiplier Effect' we're striving for . . . The important thing is to be active, inter-

ested participants in the minorities in engineering movement, not just passive sources of funds. Participation means *personal* participation."

Foundations

At present, only two foundations make substantial contributions to the minorities in engineering effort on a national scale. These are the Alfred P. Sloan Foundation and the William and Flora Hewlett Foundation. Nils Y. Wessell, President of the Sloan Foundation, pointed out that foundation resources are finite, and "with respect to the needs and opportunities represented by minority engineering education, they are limited modes as well." He speculated that one reason why so few foundations are interested in engineering education is that they expect government to fill the role, and with programs vast in dollars, leaving no significant role for the private foundation. Another explanation, he said, is that "programs in the sciences, and particularly those involving social action with immediate consequences, might seem more glamorous or more important or achieve greater visibility." Wessell said he believes that in the instance of minority engineering education, the private foundation can make a contribution of real value and with an almost unique role to fill.

Wessel outlined the different aspects of the foundation's potential role in the minorities in engineering effort:

- *explorer*, identifying problems, undertaking objective analysis of these problems, examining various approaches to the problems, and giving them visibility in those quarters that can do something about them;
- *catalyst*, bringing together interested parties who can work more effectively together than independently;
- *initiator*, leading the way to larger programs and efforts by funding small experimental model programs; and
- *critic*, monitoring efforts undertaken by others, particularly those of government agencies, or the failure of government agencies to act.

Government

Much of the symposium discussion was directed to government participation in the minorities in engineering effort. To date, government agencies have assumed only a limited role in this effort. Mention was made of a number of agency programs that indirectly affect, or have the potential for affecting the minorities in engineering program. F. James Rutherford, Assistant Director for Science Education of the National Science Foundation

(NSF), spoke of several NSF programs: the Minority Institutions Science Improvement Program, Resource Centers in Science and Engineering, Minority Graduate Fellowships, Minority Institutions Graduate Traineeships, and the Minorities in Science program. Other federal programs, mentioned by Frank Press, Director of the Office of Science and Technology Policy, are sponsored by the National Institutes of Health (Minority Biomedical Support Program, Minority Access to Research Career Program), and the Department of Energy (Pre-Freshman Cooperative Education for Minorities and Women in Engineering). Mary Berry, Assistant Secretary of Education, U.S. Department of Health, Education, and Welfare (DHEW), discussed her agency's efforts to adapt some of its programs to cover the needs of minorities in engineering.

Elizabeth Abramowitz, Assistant Director for Education and Women's Issues on the President's Domestic Policy Staff, summed up the situation at the federal government level in commenting that the federal efforts are, like most federal agencies, mission-oriented and that these efforts are fragmented.

The symposium discussion of ways to encourage greater federal interest and support for the minorities in engineering effort, centered on two issues: the need to develop methods of tapping existing federal resources, and the need for federal legislation that specifically earmarks appropriations and programs for minorities in engineering.

Congresswoman Shirley Chisholm addressed the second issue in her closing remarks at the symposium. "The federal role is defined by Congress," she said, "and I believe that if you are serious about garnering government support, much needs to be done to bring about Congressional support." Chisholm praised industry for "being ahead of federal policy makers" in the movement to increase minority representation in the engineering field, and she called on industry to take the lead again, using its "leverage with policy makers ... to get the message across about the need for a strong federal effort to encourage minority student access to the engineering field."

Theodore Lobman of the Hewlett Foundation warned, however, that "certain precautions are warranted in the aggressive search for federal and state support." He explained further that "it is common knowledge that a number of administrative and sometimes programmatic rigidities are inevitable attachments to public cash contributions. The independence and integrity of the local programs for which contributions are sought must be maintained despite the need for substantial public money. Participation by the public sector should be defined as a partnership, not as relief!"

National Organizations

Throughout the symposium, participants returned to the need for individual components of the minorities in engineering movement to form a solid

partnership. Mary Berry of DHEW, for example, recognized that the groundwork for an effective working partnership, one that concentrates the forces of government, education, and private industry, has been laid, but a major task is still ahead. Theodore Lobman observed that the endeavors of the different components are "too often fragmented and not targeted or coordinated on the basis of systematic analysis of need and potential."

The consensus was that greater communication and cooperation among the different components of the partnership should be priorities of the minorities in engineering program, and that the national organizations, such as CME, were in the best position to coordinate efforts in this area.

4
Recommendations

Most symposium participants thought that it was time to conduct a comprehensive national review—a "mid-course evaluation"—of the broad mosaic of ongoing minorities in engineering activities. As Robert A. Finnell, Executive Director of Mathematics, Engineering and Science Achievement (MESA), said, "It's time we look at the programs and see what's producing and what isn't, see if the institutions and mechanisms that we've created are effective or doing the job, whether we need new ones, or whether we need to scale down others."

The symposium participants agreed that any evaluation should include the following elements:

- An inventory of existing programs—local, regional, and national;
- An assessment of the programs in terms of their mission, scope, objectives, and mode of operation;
- An evaluation of the effectiveness and cost effectiveness of each program in terms of its contribution to the total effort; and
- An analysis of total resource requirements and the development of a plan for the efficient allocation of available funds.

This information would be used in the formulation of a national plan to guide the development of the objectives and strategies of the minorities in engineering effort. The primary aims of this plan would be to:

- Establish long-range goals and objectives;
- Accelerate the expansion of the pool of prepared and motivated minority high school students;
- Identify localities where programs are needed, develop strategies for serving those needs, and assign responsibility for accomplishing the goals of the minorities in engineering effort;
- Estimate the total cost of reaching the goal of parity representation and obtain adequate funding; and

• Develop methods for continuous monitoring of program progress and effectiveness.

A number of symposium participants expressed the hope that closer attention will be paid to the essential differences in needs of the various minority groups and locales covered by the minorities in engineering effort. As Jerry Apodaca, Governor of New Mexico, said, "I do not believe that you can try to implement a program that works in New York City and apply it to the reservation in Arizona and New Mexico. You cannot take a program that works in the City of Los Angeles, and apply it to the City of Santa Fe, New Mexico." In the same vein, Abramowitz added, "If you are talking about American Indians, it is a different problem than if you are talking about blacks. If you are talking about Spanish-speaking groups, you are talking about four different sets of people—Chicanos, Puerto Ricans, Latin Americans, Central Americans—all of whom are having tremendously different problems that we are trying to address as if they are all one."

Although greater participation by various minority groups is important to ensure an understanding of each minority group's needs at the national level, and to coordinate and implement programs at regional and local levels, Gerda Steele of the National Association for the Advancement of Colored People warned, "We also need to keep in mind that we need to get together. We need to form coalitions. . . We need to join forces (to avoid a) divide and conquer attitude, which in the end will not work to our benefit, but will work only to our detriment."

The overall recommendations for the next phase of the minorities in engineering effort cover four areas:

• The need to broaden and deepen the base of support for the minorities in engineering effort from government, industry, universities, the engineering profession, community and national organizations, and foundations;
• The need to focus future efforts primarily in pre-college years;
• The need to evaluate the past five years of the minorities in engineering effort and develop a comprehensive plan for the future; and
• The need to pay more attention to the specific needs of various minority groups and of persons in various stages of the engineering trajectory.

Angel A. Rivera, President of the Puerto Rican Engineer's and Scientist's Society (PRESS), summed up the views of symposium participants in these words: "Have we succeeded in meeting the directives of the first symposium? Partially. To satisfy the national need to develop the future leadership of America, the momentum of the past must not be allowed to wane. It must be continued and increased."

In closing remarks to the symposium, Theodore Lobman said, the "new initiatives called for in this conference in no way second guess the remarkable accomplishments of the pioneers. We need only to expand their work on the basis of a new knowledge and a plan of action. The conference has cast the spotlight on a broad and inspiring base of dedicated and effective leaders in this field. So, although the law of diminishing marginal returns may make the second five years more arduous, we are better armed. If this operation were selling 1982 stock options, I'd buy 'em."

5
Recent Program Activities

Since the conclusion of the symposium, a number of activities have addressed concerns that were raised at that gathering. At the February 1979 meeting of NACME, Howard Kauffmann, NACME Chairman, charged that body with the task of developing a national plan for the minorities in engineering effort. The Conference Board has agreed to serve as the convenor of a study group to begin collecting and evaluating information to develop a set of recommendations and strategies that would carry the effort through the 1990's.

The study group has begun its work, identifying the subjects of primary concern. Next, information will be gathered about effective programs and methods for increasing minority participation in the engineering profession.

Following the symposium, CME translated the symposium recommendations into activities to be developed by its subcommittees on pre-college preparation, engineering education, finance, and career development. Key among those activities for the 1979-1980 program year is a summer study to be conducted by a group of experts from engineering education, minority engineering programs, secondary education, and education research organizations to develop a plan for assessing the effectiveness of pre-college minority engineering programs. This group will develop guidelines for the assessment and a set of action steps for its implementation. The purpose is to document significant information about existing pre-college programs in order to make some determination regarding their effectiveness. The purpose is to develop more effective programs and to move toward the institutionalization of programs and/or program elements within existing institutions such as schools.

CME also has begun plans to survey effective retention programs. The results will be made available to engineering schools to stimulate the development of effective retention methods and to improve existing retention programs.

As the result of concerns expressed at the symposium, the CME finance subcommittee has developed a demographic information model to provide data useful to organizations interested in inaugurating or expanding minority

engineering programs or activities. The first of these models was developed for Denver, Colorado.

CME's continuing interest in how minority engineers perceive their professional development once they enter the workplace is being addressed by a personnel utilization study developed by a task force of CME's career development subcommittee.

Directors of pre-college minority engineering programs also have taken steps to see that concerns they raised at the symposium will be addressed. They have formed the Association of Pre-College Directors for Minorities in Engineering. This association had its beginnings as an informal group of pre-college program directors and has been expanded to include the program directors and the chairmen of their respective boards. The group will hold biannual meetings to discuss issues of mutual concern, such as program evaluation and fund raising.

Appendix

List of Speakers to the Symposium with Titles and Addresses

Abramowitz, Elizabeth, Assistant Director for Education and Women's Issues, Domestic Policy Staff. Untitled remarks.

Alvarado, Raul, Jr., President, Society of Hispanic Professional Engineers. "Today! Tomorrow! Together?"

Apodaca, Jerry, Governor of New Mexico. Untitled remarks.

Berry, Mary, Assistant Secretary of Education, Department of Health, Education, and Welfare. Untitled remarks.

Booth, Virginia L., National Chairperson, National Society of Black Engineers. "The Missing Link."

Casso, Henry J., President, National Institute for Professional Development, Inc. "New Programs and Relationships–An Overview."

Castro, Manuel, President, Mexican-American Engineering Society. "MAES–A Key Factor in the Multiplier Effect."

Cheek, James E., President, Howard University. "The Role of Black Colleges and Universities in Increasing Minorities in Engineering."

Chisholm, Shirley, Congresswoman, 12th District, New York. Untitled remarks.

Clarke, Garvey E., President, The National Fund for Minority Engineering Students. "Innovations at the College Level to Better Serve Minority Clientele: Student Financial Assistance."

Colton, Alfred Qoyawayma, Chairman, American Indian Science and Engineering Society. "Our Challenge: The American Indian Engineer."

Crim, Alonzo, Superintendent, Atlanta Public Schools. "Building the Multiplier Effect into the Normal Operation of the Secondary Schools."

Cyert, Richard M., President, Carnegie Mellon University. "Role of White Universities in Attracting Minority Students to Engineering."

Ford, Thomas E., Program Officer, Alfred P. Sloan Foundation. "Minority Engineering Education: Consortia Approach at the Pre-College Level."

Garcia, Robert, Congressman, 21st District, New York. Untitled remarks.

Gibson, Kenneth, Mayor, Newark, New Jersey. Untitled remarks.

Gray, Paul E., Chancellor, Massachusetts Institute of Technology. "Retention of Students: Changing Perspectives on the Utilization of Engineering Education Resources."

Hamilton, Walter A., Vice President, Public Affairs Research Division, The Conference Board. "Major Corporations as Key Contributors to the Partnership."

Harris, LaDonna, President, Americans for Indian Opportunity. Untitled remarks.

Hill, Robert B., Director, Research Department, National Urban League. Untitled remarks.

Kauffmann, Howard C., President, Exxon Corporation and Chairman, National Advisory Council on Minorities in Engineering. Untitled remarks.

Lobman, Theodore, Program Officer, William and Flora Hewlett Foundation. "A Mid-Course Correction for the Minorities in Engineering Effort–New Initiatives, New Finance."

MacDonald, Bryce, President, Engineers Joint Council. Untitled remarks.

Martin, Joseph J., President, American Society for Engineering Education. Untitled remarks.

Martin, Thomas L., Jr., President, Illinois Institute of Technology, and Chairman, Committee on Minorities in Engineering. "The Minorities in Engineering Program."

O'Neill, Russell, Dean of Engineering, University of California, Los Angeles. Untitled remarks.

Press, Frank, Director, Office of Science and Technology Policy, and science and technology adviser to the President. "Developing the Future Engineers America Needs–Together."

Rivera, Angel A., President, The Puerto Rican Engineer's and Scientist's Society. "Representation Thru Cooperation."

Robottom, John S., Director, Equal Opportunity Engineering Program, University of Texas at Austin. Untitled remarks.

Rutherford, F. James, Assistant Director for Science Education, National Science Foundation. "Available Science Education Funding from the National Science Foundation."

Saline, Lindon E., Manager, Professional Development Operation, General Electric Company. "The Utilization of Minority Engineers by Major Employers–What Lies Ahead?"

Smith, Jesse M., Executive Director, College Placement Council. "The Outlook for Minority Engineering Enrollment and Employment over the Next Ten Years."

Steele, Gerda, Director of Education Programs, National Association for the Advancement of Colored People. Untitled remarks.

Thompson, Melvin, Executive Director, Committee on Minorities in Engineering. Untitled remarks.

Truxal, John G., Director, National Coordinating Center for Curriculum Development, State University of New York. "Improving Instruction and Curriculum."

Wessell, Nils Y., President, Alfred P. Sloan Foundation. "Foundations and Minority Engineering Education."

Wingard, Raymond R., Vice President and Manager, Human Resources Department, Koppers Company, Inc., and President of the Board, Minority Engineering Education Effort, Inc. "Improving Information Systems."

(These addresses to the symposium are available on request to the Committee on Minorities in Engineering. There is a nominal charge for handling and postage.)

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