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Bernard W. Harleston
University of Massachusetts Boston

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Cover Page Footnote

The author wishes to thank Professor Jerome Brooks, Deputy to the President of City College, and Daniel Akins, Professor of Chemistry, Director of the Center for Analysis of Structures and Interfaces, and chair of the college-wide committee of pipeline programs, for their encouragement and support in the preparation of this paper. Detailed information about each of these programs can be obtained by writing to Professor Daniel Akins, Department of Chemistry, the City College of New York.

Expanding the Pool of Women and Minority Students Pursuing Graduate Study: The Development of a National Model

by Bernard W. Harleston



The underrepresentation of women and minority students in certain disciplines in the graduate schools of American colleges and universities is a matter of great national concern. This concern has been intensified by the decline during the last fifteen years, especially from 1978 to 1988, in graduate school enrollments of *all* categories of American students. But, even before this most recent period of decline and during a time when the enrollment of women and minority students was at its highest (between 1968 and 1974, as a consequence, primarily, of the civil rights movement), the representation of women and minorities in the sciences, engineering, and mathematics, and, in the case of minorities, in the humanities, was negatively disproportionate to their numbers in undergraduate colleges and, indeed, in postbaccalaureate education. (Betz 1990; Carter and Wilson 1988, 1989, 1990, and 1992; National Science Foundation 1988)

The need to correct this imbalance, to expand the numbers and increase the pool of women and minority students pursuing graduate study, are matters of great urgency. The reasons are familiar and compelling (Betz 1990; Kahle 1982; Malcolm 1990; Oakes 1990; New York State Science and Technology Foundation 1990): the unnecessary and costly loss of talent; the loss of role models; the loss of diversity; and, the weakening of the nation's ability to educate, to motivate, and to compete.

A number of institutions in the United States have initiated programs designed to address and, to varying degrees, redress aspects of the problem of underrepresentation of women and minorities. In addition, federal agencies, most notably, the National Science Foundation and the National Institutes of Health, private philanthropies such as the Ford and Mellon Foundations, and many corporations, have committed significant resources to address this problem.

It is essential that all of the funding sources not only continue, but increase such support. One way to insure their continuing support is to develop strategies that will dramatically, and quickly, increase the numbers in the pool of students from underrepresented groups. As a matter of national policy, specific goals with fixed deadlines for expanding the pool of underrepresented groups in specific

disciplines must be set (Bowen and Rudenstine 1992; Malcolm 1990; McBay 1990; New York State Science and Technology Foundation 1990).

The City College Initiative

A focused effort was begun eight years ago by the City College of the City University of New York to address the problem of underrepresentation of women and minority students in undergraduate programs leading to graduate study and careers in research and scholarship. These efforts have produced consistent and highly significant results and have been institutionalized as a continuing priority within the college's mission. These efforts have also led to the development of certain working principles that are generalizable and transferable, thereby permitting the project to serve as a national model.

The building blocks of City College project consist of a number of discrete programs with specific goals that are responsive to the criteria proposed by the particular funding agency supporting the program. While the activities and the structure of the programs vary, they have in common the goal of expanding the pool of students who are oriented towards graduate school and academic, scholarly, and research careers. Most of the programs are focused at the undergraduate level and concentrate on undergraduate education: One program includes high school juniors and seniors; three programs involve both undergraduate and graduate students; another program focuses exclusively on graduate education and training. These pipeline programs currently serve over two-hundred students (not including the enrollments in the feeder programs CCAPP and PRES discussed later in this article) and involve over one-hundred faculty members as student mentors. Only two of the programs do not require students to be either science or engineering majors. Thus, the overwhelming thrust of these programs is to recruit minority science and engineering majors.

• *The City College Academy for Professional Preparation Program, or CCAPP.* Funded by the New York State Department of Education, this program provides science students with a supportive community of fellow students, faculty, and staff that offers intellectual

enrichment, promotes their academic success, and prepares them for entry into professional careers and/or graduate programs. CCAPP serves students throughout their undergraduate careers and is one of two feeder programs for other component projects. In the summer, entering freshmen and transfer students are offered an intensive four-week program that teaches problem solving skills for the sciences using content in physics and chemistry. During the academic year, students receive a full range of academic support and enrichment activities, including workshops that are required for all students and elective science and math courses, individual and group counseling, career preparation classes, internships on- and off-campus, and referrals to the college's science research programs. There are also workshops on such topics as time management, test-taking procedures, and career and graduate school admissions. CCAPP also provides social activities and a place to study. To be eligible, students must be science majors or pursuing premedical studies. They must be in good academic standing.

- *The Program for the Retention of Engineering Students (PRES)*. A related program established to provide academic and support services to assist minority engineering students in meeting their academic and career goals, PRES is a feeder program. The major objective of PRES is to ensure that students succeed in introductory math, chemistry, and physics courses required in the engineering program. The PRES program activities include: a prefreshman summer transition program; small-group and individual tutoring in mathematics and the sciences; personal counseling; academic advising; group study sessions; and workshops to develop students' written, oral, and visual communication skills. PRES is funded by City College and contributions from corporations, foundations (most notably, the Alfred P. Sloan Foundation), and federal agencies.

- *The Transfer Retention at City College program (TRACC)*. Established with a grant from the General Electric Foundation, this program was recently awarded a grant from the Department of Energy in support of its activities. TRACC is a companion program to PRES, providing services to minority students transferring from CUNY community colleges to City College's School of Engineering. The goals, objectives, and support services are identical to PRES, except in the area of tutorial services. Tutoring is offered to TRACC students in upper-level courses in engineering. Otherwise, students in TRACC experience the same nurturing and supportive environment as PRES students.

- *Project Preserve (PP)*. Funded by the National Aeronautical and Space Administration (NASA), this project is a three-institution, national program designed to give minority engineering students a "second chance" to complete engineering degree requirements. City College, Xavier University, and California State-Northridge recruit students who have been dismissed from previous engineering schools because of poor academic performance and provide support services to improve their academic status. Students have the option to return to their previous schools or remain at the PP institution. The main goal of

this project is not to lose minority engineering students already in a national pipeline. Students receive the same type of support services as those in PRES and TRACC, but there is a strong emphasis on closer monitoring of academic progress, regular counseling sessions, and more parental involvement. Currently, there are twenty Project Preserve students at City College from M.I.T., Howard University, the University of Pennsylvania, Rensselaer Polytechnic Institute, Stevens Institute of Technology, SUNY-Buffalo, Drexel Institute, and Cornell University. Many of the students have improved their academic status and six have been readmitted to their original institutions.

- *The City College Undergraduate Fellowship Program*. Funded by the Ford Foundation and supported by other private funding sources, this program supports students who are considering careers in college or university teaching in any of the traditional disciplines. The program aims at developing the next generation of faculty, starting with the undergraduate training of City College fellows and culminating in their placement in appropriate doctoral programs. Fellows become involved members of a close-knit community of scholars from a variety of disciplines. They participate in activities that draw them together as a group, teaching and learning from each other as well as from faculty, and are guided and supported in a wide range of experiences that prepares them for graduate school and possible futures as faculty members. Upon admission to the program, each student is paired with a faculty mentor, a professor engaged in research, publication, and other professional activities. Fellows work with their mentors as research assistants and, with the help of their mentors, gain firsthand experience of the rewards and responsibilities of academic life. All fellows must be U.S. citizens. Students majoring in any discipline who have completed no more than sixty credits are eligible to apply to the program.

- *The Mellon Minority Undergraduate Fellowship Program*. Funded by the Andrew Mellon Foundation, this program also supports students who are considering careers in college or university teaching. Upon admission to the program, each student is paired with a faculty mentor who guides his or her academic progress and provides an introduction to the culture and routine of academic life. Eligibility is limited to black, Hispanic, and Native American students who are U.S. citizens or permanent residents and are majoring in the humanities, geology, ecology, or mathematics and have completed no more than sixty credits.

- *The Center for Analysis of Structures and Interfaces (CASI) program*. Funded by the National Science Foundation through its Minority Research Centers of Excellence (MRCE) program, CASI is committed to conducting exemplary research and increasing the number of minority scientists trained to conduct high-level scientific research. Undergraduate and graduate CASI students become members of research teams in one of four ongoing research projects in chemistry, physics, and engineering, contributing to the progress of the research while working with and learning from the project director and faculty. A summer enrichment program is also

available for incoming freshmen. Students who are U.S. citizens and are black, Hispanic, Native American, or Pacific Islanders are eligible for the CASI program. Preference is given to students who are active members of CCAPP or PRES and have expressed an interest in graduate study in chemistry, physics, or electrical or chemical engineering. The Center of Excellence at City College is one of eight established throughout the U.S. and Puerto Rico.

- *The Center for Minorities in Information Processing Systems (CMIPS)*. Funded by the National Science Foundation, CMIPS offers a combination of academic support services and enrichment activities for minority students interested in research and teaching careers in computer science and computer engineering. The CMIPS program stresses a collaborative learning environment that provides opportunities for undergraduates to study together in groups, learning from and teaching one another. In the junior and senior years, students conduct research either independently or as a member of a research team under the direction of a mentor. Students who are U.S. citizens or permanent residents and are black, Hispanic, or Native American are eligible. Students must have expressed an interest in graduate study in computer science or computer engineering.

- *The College Research Scholars (CRS) program*. Funded by City College, the CRS program is designed to increase the number of students who will enter graduate or professional schools and who intend to pursue research careers in biomedical science. This program provides high-quality training in biomedical research through faculty-guided research and a wide range of courses. CRS students participate in a weekly symposium which provides a forum for the presentation and discussion of their research projects. In addition, outside speakers are invited to present lectures on scientific research as well as information about graduate programs. Students who are U.S. citizens or permanent residents majoring in biochemistry, biology, chemistry, mathematics, or physics are eligible to apply.

- *Focused Opportunities for Research Careers in Engineering, or Project FORCE*. Funded by the National Science Foundation, Project FORCE supports engineering doctoral study and research traineeships for women, minorities, and persons with disabilities. Each FORCE student is assigned a specially selected faculty mentor to assist her or him in meeting the challenges of doctoral level study. In addition, support services such as counseling and advising are available. Students are provided with internship opportunities in corporations associated with the FORCE program and devote increasing amounts of time to research as they progress through the doctoral study program in order to link realistic work opportunities with sophisticated technical, theoretical, and research experiences. Women, underrepresented minorities, and persons with disabilities who have been accepted into one of the City University of New York's civil, chemical, electrical, or mechanical engineering, or computer science Ph.D. programs are eligible.

- *The Howard Hughes Undergraduate Biological Sciences Program*. Funded by the Howard Hughes Medical Institute, this program provides enriched undergraduate educational opportunities in the biological, biomedical, and biochemical sciences through a variety of initiatives. For high school juniors and seniors, the Hughes program sponsors the High School Summer Research Program. Students spend seven weeks at the City College campus exploring college-level biological research and studies. The Summer Transfer Program offers a three-week summer course for transfer students in biology and chemistry to help them prepare for key intermediate-level science courses at City College. Undergraduate juniors and seniors can participate in the Upper Division Research Program in which students are paired with faculty mentors and conduct biological research under the mentors' supervision. For students who have already completed their undergraduate education in any discipline, but who would like to prepare themselves for careers in the biological and biomedical sciences, the post-baccalaureate program provides opportunities to conduct mentor-sponsored research while strengthening and augmenting the student's science background. All students are eligible to apply to each of the initiatives.

- *The Minority Access to Research Careers (MARC) program*. Funded by the National Institute of General Medical Sciences, the MARC program provides training for undergraduate minority students interested in careers in biomedical research through faculty-guided research and a wide range of courses. MARC students participate in a weekly symposium which provides a forum for the presentation and discussion of their research projects. Students interact with outside speakers and receive guidance about graduate programs and preparation for graduate study. Black, Hispanic, Native American, and Pacific Islanders who are U.S. citizens or permanent residents and intend to major in biochemistry, biology, chemistry, mathematics, or physics are eligible to apply.

- *The Minority Biomedical Research Support (MBRS) program*. Funded by the National Institute of General Medical Sciences, the MBRS program is designed to increase the number of minority students who will enter graduate and professional schools and who intend to pursue research careers in biomedical science. This program is similar in design to the MARC program. However, both undergraduate and graduate students are eligible to participate.

- *Research Careers for Minority Scholars (RCMS) program*. There are two RCMS programs at City College. Both are funded by the National Science Foundation. One supports minority engineering students who are considering careers in college or university teaching. The other supports undergraduates majoring in the sciences and mathematics and is tied in to the CASI program. In each case, students are paired with mentors and are provided with research opportunities and academic and intellectual enrichment, including roundtable discussions and workshops in problem solving, advising, and counseling. Applicants must be U.S. citizens or permanent residents and must be black,

Hispanic, Native American, or Pacific Islander. To be eligible, students must be majoring in civil, chemical, electrical, or mechanical engineering, computer science, chemistry, physics, or mathematics and have completed no more than sixty credits.

• *The Research Opportunities in the Marine and Atmospheric Sciences (ROMAS) program.* Funded by the Office of Naval Research of the Department of Defense, the ROMAS program is designed to attract students into research careers in ocean sciences, meteorology, and related areas of the physical and natural sciences, engineering, and computer science. Students perform laboratory and field research under the mentorship of faculty members engaged in a marine or atmospheric research project. As an integral part of the program, students will complete a two-week summer training course that provides them with firsthand experience in oceanographic research. To be eligible, students must be U.S. citizens or permanent residents and plan to attend graduate school in the marine or atmospheric sciences or related areas in engineering. In addition, students must be full-time with at least sixty-four completed credits.

• *The Undergraduate Student Researchers Program (USRP).* Funded by the National Aeronautics and Space Administration, the USRP program is designed to increase the number of minority scientists trained to conduct scientific research in aerospace and related engineering disciplines. Undergraduate students participate in mentor-directed research projects. To be eligible, students must be U.S. citizens or permanent residents and have completed four years of mathematics and three years of science in high school and/or have a combined verbal and mathematics score of 1100 on the Scholastic Aptitude Test.

The Need for Coordinating Programs

As programs began to mature and new programs were developed, it became clear that an oversight committee was needed in order to maximize the impact of the various programs. This led to the establishment of a college-wide coordinating committee of pipeline programs, known as PORT (Professional Opportunities in Research and Training). The needs and concerns of this group include: competition for students; duplication of administrative services; the need to develop and maintain a common database; the need to develop effective recruiting strategies; reducing overhead costs; and, strengthening fundraising efforts. In particular, it was felt that there should be synergy between and among programs to increase the number of students who could be served and to use federal funds as leverage in soliciting private support.

Over the course of two years, the philosophy, goals, and structure of a coordinating mechanism began to evolve. The Committee on Professional Opportunities in Research and Training was established as an oversight and steering committee to maximize the information flow to, and the effective functioning of, each of the component programs, and to facilitate and strengthen productive interaction between and among the programs.

One of the first activities undertaken by PORT was the

planning and mounting of the first annual President's Assembly and Reception in honor of the students participating in the various programs. This event was remarkably successful in showcasing students and programs, in strengthening the relationships among the various programs, in strengthening and reinforcing the motivation to go to graduate school, and in disseminating information about the programs to funding agencies, the academic and City College communities.

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The next activity undertaken by PORT was sponsorship of the Student Scholars Day at City College. A significant recent activity of PORT has been the development of a brochure describing the component programs and the criteria for participation which will be a major recruitment tool. PORT is expected to play an important role in increasing funding for programs to expand the pool of underrepresented individuals and in facilitating peer review for quality control and heightened effectiveness of the programs.

Key Elements of Success

The major common elements of the City College initiative can be summarized as follows:

A Strong Institutional Commitment

- Active support of the president;
- An articulated statement to the college community that the activity is a major and significant priority within the mission of the college;
- Involvement of faculty and administration; and,
- College-wide recognition of the programs and the participating faculty and students.

Recruiting a Diverse Student Body

- Recruiting at the high school level;
- Recruiting on campus;
- Recruiting from the community colleges;
- Recruiting both well-prepared and under-prepared students; and,
- Recruiting across a variety of disciplines.

Individualizing the Education

- Strong mentor-student relationships;
- Opportunities and support for individualized scholarship; and,
- Individualized academic support services, advising, and counseling.

Incentives for Students

- Financial support;
- Peer review in both teaching and research settings;
- Group learning and problem solving;
- Integration of students to insure certain common core experiences so that students from various programs share certain intellectual, academic, and professional experiences; and,

- Participation in professional activities such as attendance at professional meetings, presentation of poster or research reports, and coauthoring publications.

Incentives for Faculty

- Availability of funding from federal, state, and private sources to qualified institutions and projects;
- An appealing blend of teaching and research;
- Working with students in the programs advances the faculty member's scholarship;
- Recognition and rewards from the college.

Opportunities for Off-Campus and Interinstitutional Experiences

Certain programs provide only limited opportunities for the students to pursue academic, scholarly, and research activities off-campus, especially during the summer. Most notable among these are the Ford City College Fellows Program and the Mellon Minority Fellows Program. The development of interinstitutional consortial arrangements could greatly enhance such opportunities for students to the benefit of all participating institutions. The elements of the City College initiative—a strong institutional commitment, recruitment of a diverse student body, individualized education, and incentives for students and faculty—are essential to the success of any integrated effort.

A significant, promising next step in this effort is for City College to establish one or more consortial arrangements with colleges and universities throughout the nation. The purpose of the consortium would be to bring into active cooperative relationship a set of institutions, all of which are committed to expanding the pool of underrepresented groups in a variety of fields and disciplines, most notably science, mathematics, and engineering, in order to enhance the effectiveness of the participating institutions, expanding the pool of students and enriching the pipeline beyond the level that the institutions would reach by acting independently.

Conclusion

The programmatic initiatives undertaken at City College to enrich the pipeline and expand the pool of women and minorities pursuing careers in science, mathematics, engineering, and other disciplines, represent an ambitious, intensive, highly focused effort involving large numbers of students, faculty, and staff. But, the immediate and long-term results indicate that there are viable programs that are effective in expanding the pool of minorities and women pursuing the study of science, mathematics, and engineering, and that these programs can be mounted in a variety of institutional settings. In the undergraduate pipeline and in the Ph.D. programs sponsored at City College, there are more targeted women and minority students pursuing academic programs in science and

engineering than at any other institution in the United States. As these students progress through the curriculum and new students are added to the entry-level programs, City College will have had a significant effect in expanding the pool of women and members of underrepresented minority groups. With the establishment of consortial arrangements, this effect may be greatly enhanced in a relatively short period of time.

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Bernard W. Harleston was president of the City College of New York from August 1, 1981, to September 1, 1992. He is currently director of the Doctoral Study in Higher Education Administration program in the Graduate College of Education at UMass Boston.

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