

The background of the cover is white, decorated with an abstract pattern of small squares in purple, orange, yellow, and black. These squares are arranged in various configurations: some are isolated, some form small clusters, and others form larger, more complex shapes that resemble stylized letters or symbols. The pattern is distributed across the entire cover, with a slightly higher density of squares along the left and right edges.

The Color of Science

BY SUSAN M. REISS

Creating a Multicultural Mosaic

The country is getting more and more colorful," says Shirley Malcom, director of the American Association for the Advancement of Science's Directorate for Education and Human Resources Programs. "But the science community does not look like the rest of the country."

Although the number of science and engineering (S&E) degrees earned by underrepresented minorities—African Americans, Native Americans, and Hispanic Americans—continues to slowly increase, their numbers are still small. According to the National Science Foundation, the number of S&E doctorates awarded to these minorities in 1990 was 831—just 6% of all S&E doctorates. In 1980, 559, or 4% of all S&E doctorates were earned by minorities. Of 63,087 engineering degrees granted in 1991-92, 7.4% went to African Americans, Hispanics, and American Indians. The National Action Council for Minorities in Engineering (NACME) contends that two-thirds of freshmen enrolling in engineering programs never complete their programs and half of those students drop out of college altogether.

As microcosms of society, the U.S. educational system and business community struggle with the same problems facing the nation: providing equal opportunity for all and improving U.S. competitiveness in world markets. As the nation rapidly becomes a multicultural mosaic, the numbers of minorities in science and engineering will rise—some say by default, others say by design. To support human rights in the fullest sense, every individual, regardless of ethnic background, should be given the opportunity to reach his or her potential. Pundits suggest that diverse student populations, university faculties, and R&D staffs will enhance U.S. competitiveness at home and abroad because of the wealth of new ideas and multicultural connections that minorities offer.

To increase the number of minority S&E graduates, universities and businesses across the country have implemented a variety of programs, but the changes required to create a multicultural mosaic in science and engineering go beyond what individual



Janice Wallace, GEM Fellow, at work at FERMI National Accelerator Laboratory. CREDIT: Fermi Laboratory Visual Media Services.

institutions or companies can accomplish. "Race still makes a difference in this country whether we want it to or not," says Malcom. "We need special programs because the world is not yet fair to these groups, but we also must work to change the system."

ROLE MODELS: FIRST IMPRESSIONS

Educators and industrialists agree that a lack of role models and mentor relationships are responsible for high attrition among minorities in science and engineering programs. Dennis Hall, director of the University of Rochester's Institute of Optics, blames society and the science and engineering communities for the lack of role models. "As a whole, society doesn't raise scientists up as heroes," he contends. "As scientists, we do a poor job of conveying how creative science and engineering professions are."

In 1993, 13 individuals completed the Ph.D. program at the Institute of Optics—one was African American. According to Hall, the number of minority students applying to the Ph.D. program in optics is one or two a year.

At the University of Arizona, the number of minorities completing optics programs is similarly small. "This is a very difficult situation," notes Jack Gaskill, former associate director of academic affairs for Arizona's Optical Sciences Program. "We want to increase the numbers, but we don't want to recruit people

A GEM of a Program

Since it began in 1976, the National Consortium for Graduate Degrees for Minorities in Engineering and Science Inc. (GEM) has awarded \$7 million in fellowships and grown from 18 university members and 9 corporate sponsors to 75 universities and 73 research laboratories and industry supporters.

Ted Habarth, a researcher at Johns Hopkins Applied Physics Laboratory, started GEM with office space and administrative staff provided by the University of Notre Dame. Although GEM began as a way to increase the number of minority scientists and engineers available to work on government contracts, its mission now is to develop the multi-ethnic, multi-racial talent pool needed to compete in the next century, says Habarth.

"We make a critical difference in funding minority students at the graduate level in science and engineering," explains GEM Executive Director Howard Adams. "People say it's good foreign policy to fund foreign students, but I think

it's good policy to fund students born in the U.S." GEM currently supports one out of every eight full-time, minority graduate students in U.S. engineering programs.

Providing funding to minority students puts them on the playing field and, when allowed to compete, they win, says Adams. "Excellence does not come by ethnicity," he maintains.

In addition to easing the financial burden of graduate school, GEM acts as an advocate for graduate education in the U.S. and develops materials promoting graduate school. GEM has also produced a series of videotapes to motivate students toward careers in science and engineering. In October, GEM will sponsor a teleconference on the role of the graduate school advisor.

A unique aspect of the GEM program is the personal attention given to each student. Fellowship recipients are followed closely through the completion of the Ph.D. and beyond. "We're not concerned with numbers as much as with names," says Habarth. "If someone cares that you succeed, you may stick it out."

Applications for 1994 GEM fellowships will be accepted until Dec. 1, 1993. For more information, write GEM, P.O. Box 537, Notre Dame, Ind. 46556.



D'Anthony Woods, GEM Fellow at work at Fermi National Accelerator Laboratory. CREDIT: Fermi Laboratory Visual Media Services.

just because they are minorities."

Recruiting minority faculty is just as difficult. John Caulfield, on the faculty at Alabama A&M University, is trying to attract top African American optics researchers to the school. He's finding that many view historically black colleges and universities as "backwaters." Another challenge is trying to convince state and university officials to provide top salaries to attract leading researchers, since these salaries are higher than those typically found at historically black colleges and universities (see sidebar, page 20).

Minorities must also deal with historical misconceptions. They continue to battle the perception that they are incapable of achieving in science and engineer-

ing. "People have become accustomed to saying there are no qualified candidates among minorities," declares Howard Adams, executive director of the National Consortium for Graduate Degrees for Minorities in Engineering and Science Inc. (GEM) (see sidebar, this page).

To counter arguments that minorities are inadequately prepared in mathematics and science before they enter college, NACME President George Campbell points out that the very best minority students—those with strong academic profiles—gravitate toward science and engineering. When these students fail to complete S&E degree programs, it's because of institutional barriers and a lack of financial resources, he maintains.

"Institutions are shifting their scholarship resources toward affluent students who will increase the institution's net revenues," explains Campbell. Low income students also lose out because many institutions now offer loans, rather than grants, as part of the financial aid package.

On top of the financial burdens of a college education, minority students, like others, must contend with the impersonal nature of science and engineering curricula. For minorities, large classes, lowered faculty expectations, and a minimal peer support system combine to make science and engineering degree programs less attractive.

Learning how to help minorities overcome society's assumptions and how to retain these students in science and engineering programs is a central issue

on college campuses. "We need to get a better handle on retention," says the University of Rochester's Sharon Flucker, director of the Office of Minority Student Affairs. "A lot of attention has been focused on recruitment, but now we have to ask the hard questions like, 'Who will graduate and how long will it take?'"

MINORITY PROGRAM MONTAGE

Rather than placing the burden on students, science and engineering educators are beginning to look at the education system and cultural bias brought to the teaching process. "For the first time, the community is willing to openly discuss that in some areas, higher education is dysfunctional," notes Malcom. "We always put the onus on the kids, but we should look at the culture they encounter. The education system needs to nurture students, not weed them out."

To retain minorities in science and engineering at the undergraduate level, schools and minority aid groups are experimenting with mentoring opportunities, providing research experiences for undergraduates, and involving students in scientific activities such as conferences and seminars.

"If we're going to make a dent in this problem at the undergraduate level, then the [larger] Neiman-Marcus institutions like Georgia Tech, Penn State, Michigan, and Illinois must step up," contends Norman Johnson, special assistant to Georgia Tech's President John Crecine. "If we wait for the boutiques like MIT, Carnegie-Mellon, and Duke, we'll be waiting until the year 3000 because they don't have the size or capacity to do it."

Georgia Tech, for example, is on a crusade to produce more minority graduates than any other institution in science and engineering. Johnson points to the school's location on the west side of Atlanta and its reputation as a top-notch Southern institution as key reasons for such a campaign. Tech's attrition rate for minority students is less than 4%. In 1992, the engineering powerhouse graduated 182 minority students at all degree levels—a record second only to the University of Puerto Rico.

"We expect our students to succeed," says Johnson. "If you set the standard, most people want to meet it." Using total quality management (TQM) concepts such as defining the student as a customer, working in teams, and monitoring student performance, Tech officials have significantly improved minority freshmen GPAs. This spring, 112 of 194 underrepresented minority freshman earned a 3.0 GPA or higher. Before TQM was adopted, minority GPAs averaged less than 2.5.

This year, the University of Rochester began the Ronald E. McNair Post-Baccalaureate Achievement

Program to recruit low income, first-generation college students and minority students into doctoral programs in the sciences and economics. The program includes the McNair Colloquia—aimed at explaining the value of graduate school, the admissions process, and forging mentor relationships with faculty; the McNair Academic Scholars—25 outstanding minority students honored for their academic excellence; and the McNair Summer Research Program—rising seniors from Rochester and eight other institutions spend eight weeks conducting research under the guidance of a faculty mentor in biology, chemistry, computer science, economics, engineering, optics, or physics.

To promote cross-cultural communication and sensitivity to different cultural perspectives, NACME is sponsoring diversity workshops at Rensselaer Polytechnic Institute (RPI) and the University of Cincinnati. "We can derive clear advantages, such as high quality solutions that can enrich the environment, if we can manage the diverse workforce or diverse student population," explains NACME's Campbell.

Rensselaer's Jorge Haddock, professor of decision sciences and engineering systems, co-coordinates RPI's workshop program, which brings first-year students and faculty together to discuss their perceptions and beliefs. "Minorities face the same issues that other students face during their freshman year in college, such as being homesick and scared," says Haddock. "But on top of that, race often becomes an issue for the first time." Workshop leaders include senior white

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Portrait of an Optiker: Cardinal Warde

Massachusetts Institute of Technology is a long way from Barbados. For researcher and businessman Cardinal Warde, the journey proved challenging yet fruitful. Warde, a professor of electrical engineering at MIT, first became interested in science because of support from his high school physics and chemistry teachers—both women.

Encouragement and support were important ingredients in Warde's scientific journey. While in Barbados, Warde met Harvard Professor John Herzog, his wife Dorothy Herzog, and then-graduate student Bowman Cutter (now with the Clinton Administration). These mentors urged him to apply to colleges overseas. Warde graduated from Stevens Institute of Technology with a B.S. in physics and continued his studies at Yale University, graduating in 1974 with a doctorate in solid state physics. His doctoral research involved using a new optical technique to investigate the properties of thin solid oxygen films.

Although Warde applied for and received a faculty position at MIT, no office or laboratory space was allocated before his arrival. "They weren't ready for me," he says. "I was given an appointment, but wasn't taken seriously." By voicing his concern over the lack of lab space, Warde was able to acquire a student machine shop. Using \$2,800 of his \$3,000 equipment allowance, he also bought an optics table. "I decided lab space would be a fight for me," Warde recalls. The 4 ft. × 8

ft. optics table was enough to garner more space in a storage area.

When he approached university officials regarding the lack of lab space, Warde didn't assume race was a factor. "I never felt inferior to anyone. In the Caribbean, race is not the first thing you

look to as an excuse," he explains.

Warde's early research focused on developing a microchannel spatial light modulator (SLM) with Jeffrey Shapiro. After the SLM, for which Shapiro and Warde hold a joint patent, Warde focused his research on the broader field of devices for optical information processing. In 1982, he founded Optron Systems and worked out of his basement building device prototypes for the Department of Defense. Today, the company specializes in large screen high definition projection displays.

Warde has this advice for minority students seeking a career in science or engineering:

- Be good in your field—publish research results or get good grades if you're just starting out; and

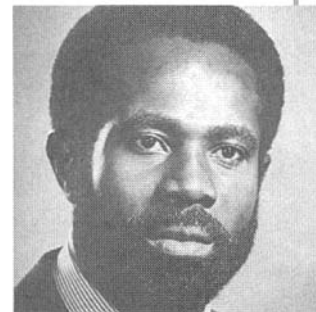
- Follow the accepted norms—tailor elements such as appearance and language to those of the community you want to enter.

"You'll always be under a microscope," he warns. "To get around the stereotypes, be good in your field. . . people have their biases and sometimes personal things get in the way."

Since receiving tenure seven years

ago, Warde spends more time working on projects to help minorities enter science and engineering careers. In addition to leading a freshman seminar at MIT that focuses on black inventors, Warde participates in science and engineering networks set up by the New England Board of Higher Education. Optron also supports a summer internship program for college juniors and seniors who are minorities. Warde and gastroenterologist Edward Layne, a childhood friend, are also working with an elementary school in Barbados donating equipment and scholarships through the Helena Layne and Rosetta Warde Foundation.

During a recent sabbatical, Warde helped John Caulfield and Calvin Lowe



Cardinal Warde

at Alabama A&M University lay the foundation for a photonics research center at the school. Although a lack of space and researchers has slowed progress on the center, Warde is hopeful that a combination of government funds, a joint venture between MIT and Alabama A&M, plus surplus government equipment through the National Association for Equal Opportunity in Higher Education, will make the center a reality.

"The first 10 years I was in a dormant stage," says Warde. "I figured I wouldn't be a good role model if I failed myself. Now, it's a good feeling to give back."

male faculty members, a minority faculty member, and a female faculty member.

Despite the varied success of programs across the country, no nationwide, comprehensive program to address minority education is in the works. "America is searching for a way to do minority education but it looks distressingly plateaued," contends Caulfield. "The issue of education has gotten involved with unpleasant politics. This is not a liberal or conservative thing, but the future of our country."

WORKFORCE DIVERSITY BY DESIGN

Although legislation in the 1960s forced employers to implement affirmative action and equal opportunity plans, in the last decade companies have pushed diversity because it makes good business sense. "Diversity has a bottom line impact," says Richard Wesolowski, Kodak's director of Employee and Labor Relations for the Imaging Division. "If our engineers don't reflect who the marketplace is and what it wants, we will miss a significant opportunity in terms of product development and product features."

At Kodak, diversity is more than focusing on minorities, says Wesolowski. "We need to create management systems and processes that are open to all."

Kodak targets its recruiting by establishing strong relationships with historically black colleges and universities such as Florida A&M and North Carolina A&T. A high-level manager develops a relationship with the school and Kodak provides support in terms of capital and research.

Once employed by Kodak, employees can participate in networks for their particular minority group. The company also sponsors a two-day workshop for supervisors and managers on how to lead a diverse workforce. Each Kodak division can offer additional sensitivity training for its staff. "It's a continual journey," says Wesolowski. "All employees will be touched by diversity."

Many other large companies field their own teams to oversee diversity in the workplace. Hughes Aircraft, IBM, Hewlett-Packard, and Polaroid, to name a few, all support programs to increase minorities in their workforces. Other companies choose to work

with consultants to provide diversity strategies.

Industry's current interest in workforce diversity was preceded by years of resistance. "It took a while for American industry to view [the lack of] diversity as a serious problem," says Dave Barclay, vice president for workforce diversity at Hughes Aircraft. He points to *Workforce 2000*, a 1987 Hudson Institute report, as a major factor in pushing CEOs to promote diversity in the workplace. *Workforce 2000* described the future facing U.S. companies:

- White males, thought of only a generation ago as the mainstays of the economy, will comprise only 15% of the net additions to the labor force between 1985 and 2000.

- An essential ingredient required to maintain a high-productivity, high wage economy is highly-skilled workers.

- For companies that have previously hired mostly young white men, the years ahead will require major changes. Organizations will be forced to look beyond their traditional sources of personnel.

Although U.S. corporations acknowledge the importance of workforce diversity, complete acceptance by management and staff remains elusive. But, acknowledges Wesolowski, "Management and employees are anxious to improve the bottom line. When we couch diversity as a business issue and explain that we're trying to be inclusive and not exclusive, then people get excited."

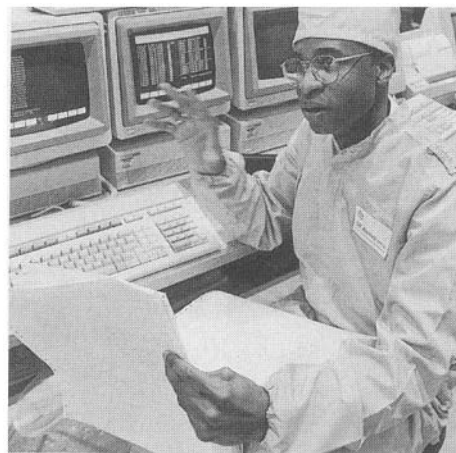
Is corporate America doing all it can to attract and retain minority scientists and engineers? Frank McCarthy, founder of Xavier Associates, a minority search firm in Massachusetts, doesn't think so. "There's a big myth in America that there are no people of color in various disciplines. I think corporate America doesn't want to go through the process of finding people," says McCarthy. From corporate boards to technicians, representation by minorities is nominal, he maintains.

Corporate hierarchies that fail to reflect the multicultural nature of America run the risk of losing well-qualified minority applicants. "Fast-track people of color have some options and they will leave, if they sense the playing field is not level," says McCarthy. Hewlett-Packard (HP), for example, has strong ties to minority communities through its education programs in grades K-12, as well as connections with university campuses and minority professional societies. But as Emily Duncan of HP's Corporate Workforce Diversity Department points out, "Clearly, our senior management is not as diverse as we'd like it to be." Companies that promote diversity in the workplace will see payoffs in higher profits and retention of highly-skilled, productive workers, she claims. "Successful companies will incorporate the concepts of diversity into the fabric of their businesses."

The U.S. may also gain a competitive edge over foreign competitors because of its cultural diversity. "We can leverage ideas and capabilities from our culturally rich workforce," says Kodak's Wesolowski. "Our competitors don't have cultural diversity. We might compare the heterogeneity of America to the homogeneity of Japan."

Garfield Malcolm, a NACME Incentive Grant Program scholar, earned a bachelor's degree in electrical engineering from the University of Pennsylvania in 1991. He works in quality assurance engineering at GE Astro Space.

CREDIT: NACME



MANY COLORS, ONE CANVAS

In the best of all possible worlds, the language of science would know no gender or race. It would transcend these differences. For minorities interested in pursuing science and engineering careers, just getting a chance to hear the language of science requires courage and perseverance.

Those interviewed for this article acknowledge that the U.S. is moving toward a day when special programs for minorities are unnecessary, but they feel that more needs to be done. For many, the movement comes much too slowly. They agree that it's time for businesses and schools to take the initiative and show minority communities the many opportunities available in science and engineering.

Between 1984 and 2000, the number of jobs for natural, computer, and mathematical scientists will increase 68%, according to *Workforce 2000*. The National Science Foundation predicts engineering jobs to increase between 14 and 27% over the next decade. By investing in education, training, and other assistance for minorities, employers will have a globally competitive workforce in the years after 2000. More importantly, as *Workforce 2000* suggests, these investments will finally deliver the equality that has been America's great unfulfilled promise.

"To get people involved is not a matter of moral obligation, if you care about the country," suggests John Caulfield. "America is a great experiment and I want it to succeed."

SUSAN M. REISS is the news editor of *Optics & Photonics News*.

RESOURCES

- *Workforce 2000*, Hudson Institute Inc., Herman Kahn Center, 5395 Emerson Way, P.O. Box 26919, Indianapolis, Ind. 46226; 317/545-1000.
- *Managing a Diverse Workforce: Regaining the Competitive Edge*, John P. Fernandez, Lexington Books, 1991.
- *Investing in Human Potential: Science and Engineering at the Crossroads*, Marsha Lakes Matyas and Shirley Malcom, eds. AAAS, 1333 H St., NW, Washington, D.C. 20005, 1991.
- *The New Leaders*, Ann Morrison, Center for Creative Leadership, Jossey-Bass Inc., 350 Sansome St., San Francisco, Calif. 94104.
- Conference on the Recruitment and Retention of Minorities in Physics, Nov. 5-7, 1993, National 4-H Center, Chevy Chase, Md. For more information contact, AAPT, 5112 Berwyn Rd., College Park, Md. 20740-4100.
- For information on women in optics, see *Optics & Photonics News*, September 1991.