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Broadening the Search for Minority Science and Engineering Doctoral Starts

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This analysis looked at doctorate completion in science and engineering (S&E) by underrepresented minorities: blacks, Hispanics and Indian Americans. These are the groups we must increasingly depend upon to make up for shortfalls in science and engineering doctorate production among American citizens. These shortfalls derive from truncated birth rates among white people, for the most part. The analysis answered several questions officials will need to know the answers to if we are to plan effectively to develop the talents of these individuals. Specifically, the National Science Foundation asked us to look at the feasibility of involving nontraditional minority science and engineering graduates (baccalaureates at 25+) as doctoral starts, along with minority S&E graduates who had taken jobs with corporations to pay off student loans and military personnel involved in S&E study and S&E work (see NSF report of research under grant SED-9107756). We found that nontraditional minority S&E doctorate recipients matched their traditional counterparts in elapsed time to degree and similar indicators. They had less in the way of support for doctoral study, however. We found that minority S&E graduates who took jobs in corporations were keenly interested in returning to campus to complete degrees. We also found that many bright minority youngsters are studying S&E subjects in the Community College of the Air Force and in U.S. Army SOC colleges. Some have enrolled in baccalaureate programs on university campuses and plan to continue on to the PhD. We concluded that money is important in tapping these talent pools to make up for the demographically driven shortfalls discussed above.

KEY WORDS: Minority students; doctoral starts.

INTRODUCTION

More and more leaders now recognize that America has a problem where the continued flow of well-educated scientific and technical workers is concerned and that demographic shifts require better development of talents of minorities to make up for the shortfalls in Science and Technology (S&T) and Science and Engineering (S&E) workers. Charles Vest told a conference of the National Science Foundation's (NSF's) Young Presidential Investigators recently that we will enter the 21st century with a deficit of 700,000 science and technology workers, and "that if somebody doesn't do something, things will get worse" (Vest, 1992). Dr. Vest is president of the Massachusetts Institute of Technology. He went on to note that a combination of demography and lessened interest in studying for PhD degrees in S&E places manpower for this sector at serious risk. He noted that American citizens now receive less than 44% of the engineering doctorates each year and less than 60% of doctorates in the physical sciences.

Dr. Vest called for renewed and increased interest in NSF's Minority Initiative, noting that

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women and minorities comprise the last reservoirs of untapped talent for S&E doctorate production. He noted that women now seem to have hit a plateau in doctoral study, with minimal changes in the ratios of doctorates received over the past few years (about 30% of the total). He concluded that serious attention now must be placed on talent development among minorities.

"Some college and university officials are in for a rude awakening," Patrick Crecine told a *Change* magazine interviewer (Marchese, 1992) recently. "This is especially true for those involved with science and engineering," Crecine went on. "White males, age 18–34 comprised 40% of these cohorts in 1990 but this figure will drop to less than 30% in the year 2000," he said. "Minority kids and their development thus becomes hugely important to the success of this country to compete in global markets," Crecine continued. Dr. Crecine is president of Georgia Technological University.

The obvious solution to this problem is to train more nonwhite people to be scientists and engineers. Blacks, Hispanics and Indians comprise 20% of the population. They receive 10% of the S&E baccalaureates (N = 30,000) and less than 5% (N = 831) of the S&E doctorates awarded American citizens each year. Greater participation is needed. The National Science Foundation is deeply involved in efforts to do just this.

The task is complicated by the fact that many minority college students complete their degrees as nontraditional students, e.g., they commute to school instead of living on campus, and they often have to work for a while to save money to begin school. Many begin their college careers in community colleges and some of the more capable take S&E jobs in corporations upon graduation to pay off student loans.

Graduate S&E faculties, on the other hand, prefer doctoral starts with different credentials, e.g., four uninterrupted years in a "good" four-year residential college, mentoring by S&E faculty, lots of lab time on personal or faculty projects, attendance at S&E conferences, flawless applications, and letters of professorial support for admissions and assistantships.

A major task in higher education and in the general community is to increase the number of "traditional" minority S&E students. Progress is being made and some remarkable initiatives are being mounted by NSF and others. It is going to take time to do this, however. Meanwhile. NSF is trying to convince more faculty that nontraditional baccalaureate recipients comprise a talent pool that should be tapped.

We were asked to complete a study that compared minority traditional and nontraditional science and engineering doctorate recipients and to examine the extent to which recent minority S&E corporate hires were interested in returning to the campus and completing a PhD degree (Brazziel and Brazziel, 1992).

We looked at all black, Hispanic, and Indian science and engineering doctorate recipients (N = 7235) over a ten-year period (1981–1990) by analyzing data sets from the National Doctorate Database of the National Research Council (1992).

We began our work by requesting data sets of all minority science and engineering doctoral recipients for the last ten years (1981–1990) from the National Research Council's National Doctorate Database. All of our subjects were American citizens or holders of permanent visas. We limited our sample to the so-called underrepresented minorities: black, Indian, and Hispanic Americans. The latter comprises three sub-groups: Mexican–Americans, Puerto Ricans and Other Hispanics (e.g., Cubans, Brazilians, *et al.*).

To corroborate our statistical conclusions, we identified ten traditional and ten nontraditional minority S&E doctoral recipients who agreed to be interviewed on their experiences in doctoral study and to offer opinions on how best to expand the numbers of underrepresented minorities receiving S&E doctorates.

To explore possibilities for attracting new corporate hires to doctoral study, we identified ten members of minority groups who recently completed science and engineering baccalaureates, who joined major corporations upon graduation, and who agreed to be interviewed regarding their interest in returning to campuses to study for a PhD degree.

To explore possibilities for recruiting military technical personnel to S&E doctoral study upon their completion of tours of duty, we identified ten members or former members of the U.S. Armed Forces, all of whom were involved in the study of science or engineering and who agreed to be interviewed regarding their interest in continuing on to the PhD degree.

Using a select-if technique, we created two groups from the minority sample we received from

NRC: The traditionals, which consisted of minorities who had completed baccalaureates at age 24 or earlier and who had gone on to complete S&E PhD degrees, and the nontraditionals, minorities who had completed baccalaureates at age 25 or older and who had gone on to complete S&E PhD degrees. There were 6015 traditionals and 1220 nontraditionals (Table I).

In our statistical analyses, we compared the traditional and nontraditional groups on a number of variables: fields of study, elapsed time to the PhD degree, age at doctoral completion, chief sources of support for doctoral study. We juxtaposed findings from both groups on occasion with those from the NRC data base for all recipients.

For our interview work, we developed interview schedules and spent about an hour each with ten traditional and ten nontraditional S&E doctorate recipients.

For our interview work, we also developed interview schedules and spent an hour or so with young people from minority groups who had recently joined corporations and who were engaged in S&E work. We also developed schedules and spent time with young people who were enrolled in science and engineering credit-bearing courses and degree programs in the Community College of the Air Force and Servicemen's Opportunity Colleges (SOC). Others had recently left the Armed Forces and were completing baccalaureates at various colleges or universities. All of the latter had brought credits to their universities from the Army's SOC program or the Community College of the Air Force.

FINDINGS

Completion Rates by Race and Ethnic Group

When examining the data for completion rates, we found, predictably, that black Americans had completed more S&E doctorates over the decade in question. Blacks comprise America's largest minority. Black recipients comprised the largest single group among both the traditionals and the nontraditionals. Blacks at 47.0% and 58.4%, respectively, of the totals of the two groups, were followed by Other Hispanics at 24.2% and 21.6% respectively. Hispanics taken as a whole were the most numerous, however. Hispanic will soon be America's largest minority group (Table II).

Table I. Number and Percent of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990

	Recipients	
Baccalaureate origin	*N*	%
Traditional	6015	83.1
Nontraditional	1220	16.9
Total	7235	100.0

Gender of Recipients

Women were well represented among the completers, comprising 40.9% of the traditionals and 29.3% of the nontraditionals. Their share of recipients (30%) compares favorably with women's share of S&E doctorate recipients nationally (National Research Council, 1992) (Table III).

Age at Doctorate Completion

The traditionals completed their doctorates at age 32.5 on average, while the nontraditionals took two years longer (age 34.0). Significantly, the latter

Table II. Race and Ethnic Group of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

	Traditional		Nontraditional	
Group	*N*	%	*N*	%
Black	2826	47.0	712	58.4
Mexican-American	693	11.5	123	10.1
Puerto Rican	696	11.6	47	3.8
Indian/Alaskan Native	347	5.8	74	6.1
Other Hispanic	1453	24.2	264	21.6
Total	6015	100.0	1220	100.0

[a]Chi-square significant at 0.05 level.

Table III. Gender of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

	Traditional		Nontraditional	
Gender	*N*	%	*N*	%
Male	3557	59.1	862	70.7
Female	2458	40.9	358	29.3
Total	6015	100.0	1220	100.0

[a]Chi-square significant at 0.05 level.

group completed in plenty of time to make a contribution. Further analysis revealed that well over two thirds completed their degrees before age 38. Science and engineering advisers often penalize applicants who would not be able to complete their programs before age 30. They cite "diminished ability to make a contribution after 35" for assessing this penalty, although no one has been able to show anyone this "diminished ability." Regardless, the recipients in this study were right on time (Table IV).

Table IV. Mean Age at Degree Completion of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

Baccalauteate origin	Age at degree completion		
	Mean	Range	SD
Traditional	32.5	23–63	3.5
Nontraditional	34.5	29–75	4.5

[a]Chi-square significant at 0.05 level.

Table V. Field of Study of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

Field of study	Traditional		Nontraditional	
	N	%	*N*	%
Physical sciences	961	16.0	117	9.6
Life sciences	1610	26.8	291	23.9
Engineering	574	9.5	97	8.0
Social sciences	2870	47.7	715	58.6
Total	6015	100.0	1220	100.0

[a]Chi-square significant at 0.05 level.

Field of Study of Recipients

Sixteen percent of the traditionals in the groups and 9.6% of the nontraditionals majored in the physical sciences. The traditionals compare favorably with national norms (16%) for this field (National Research Council, 1992). The nontraditionals had lower recipient rates in the field (9.6%). Their record looks better, however, when we consider that 65% of the physical science degrees in recent years have been awarded to citizens of other countries. All of the nontraditionals in our study were American citizens. Both the traditionals and the nontraditionals exceeded national averages (18.4%) in percentages majoring in life sciences. Percents for the former: 26.6%, for the latter: 23.9%. Thus, the question of whether these individuals would tackle the hard sciences has been answered in the affirmative (Table V).

Junior and Community College Attendance

Table VI indicates that 9.4% of the traditionals and 26.8% of the nontraditionals began their college careers in junior or community colleges. Thus, the question of whether individuals from these groups could begin college in junior colleges and still go on to doctorates in science and engineering has been answered in the affirmative. It must be pointed out, however, that there is room for improvement in this area. While over a quarter of the nontraditionals attended junior colleges, well over 50% of minorities begin their college careers in junior colleges. Junior and community colleges must reach out to talented minority students more vigorously and try to mentor more onto doctoral tracks in science and engineering. The fine honors program at Rockland Commu-

Table VI. Junior and Community College Attendance of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

	Traditonal			Nontraditional		
	N	%	V%[b]	*N*	%	V%[b]
Attended junior college	342	5.7	9.4	188	15.4	26.8
Did not attend junior college	3288	54.7	90.6	514	42.1	73.2
No response	2385	39.7		518	42.5	
Total	6015	100.0	100.0	1220	100.0	100.0

[a]Chi-square significant at 0.05 level.
[b]Valid percent = percent of subjects responding to item. Note: NRC data base does not include data for four years for this item.

nity College in Suffern, New York, is a good example of this sort of thing.

Source of Support for Doctoral Study

Table VII shows that support from the federal government was the most common source of support for most (38.6%) of the traditionals. It was the second most common source for the nontraditionals (25.8%). This category of support includes all grants, loans, and fellowships provided by the federal government for doctoral study. Another prominent category for both groups was "other." This category includes foundation grants and subsidized study by corporations.

More university aid could be afforded both groups of these students. In 1991 (see National Research Council, 1992), university support ranged from 30.7% for social science doctorate recipients to 74.0% for recipients of physical science degrees. This category includes research assistantships funded by the federal government, most often through research grants. Underrepresented minorities are not selected very often for these assistantships. They should be, however. Indeed, they must be if their talents are to be developed and if we all are to benefit from this talent development.

Education of Fathers

As noted in Table VII, very few subjects in the sample listed personal as their primary source of support. This category includes personal funds, spouse support, and support from parents. Underrepresented minorities have little of this sort of support. This contention is borne out by data in Table VIII, which includes the principal indicator of wherewithal for family support: education of father. Over 43% of the fathers of the nontraditionals and over 27% of the fathers of the traditionals had less than a higher school education. On the up side, this comprises a ringing rejection of those who contend that it is no longer possible for "disadvantaged" children to complete doctoral degrees in science and engineering. These individuals did it, and they did it with minimal support. What will happen when we truly dig in and provide this support and develop this talent?

Elapsed Time to Degree

Table IX shows elapsed time to degree of the subjects by field. Note that mean elapsed time to degree is 10.58 years for traditionals and 10.61 for nontraditionals. Time to degree for all 1991 doctorate recipients was 10.4 years, for U.S. citizens, 11.1. The latter figure includes education and humanities doctorates, both categories of which require 12–14 years for doctoral completion (National Research Council, 1992). As shown in Table IX, science and engineering doctorates complete their degrees in less time, ranging from 8.8 years from the baccalaureate for physical science recipients to 11.4 years for social scientists. In 1991, physical scientists completed their degrees 7.8 years after the baccalaureate and social scientists completed their degrees 10.8 years after the baccalaureate (National Research Council, 1992). According to National Research Council officials, the length of time for completion is becoming longer for all recipients and is a cause of concern.

Table VII. Primary Source of Support for Graduate Study of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

	Traditional		Nontraditional	
Source of support	*N*	%	*N*	%
Personal	453	7.5	82	6.7
University	863	14.3	112	9.2
Federal	2320	38.6	315	25.8
Other	1583	26.3	494	40.5
No response	796	13.2	217	17.8
Total	6015	100.0	1220	100.0

[a]Chi-square significant at 0.05 level.

Table VIII. Education of Fathers of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

	Traditional		Nontraditional	
Level of education	*N*	%	*N*	%
Less than high school	1244	20.7	471	38.6
High school 9, 10, 11	401	6.7	84	6.9
High school 12	1305	21.7	257	21.1
College 1, 2, 3	693	11.5	94	7.7
College 4	835	13.9	99	8.1
Master's and professional	850	14.1	71	5.8
PhD and postdoctoral	323	5.4	29	2.4
No response	364	6.1	115	9.4
Total	6015	100.0	1220	100.0

[a]Chi-square significant at 0.05 level.

Correlates of Elapsed Time to Degree

Table X shows results from a Scheffe *a posteriori* test for an ANOVA exercise designed to test for significant differences in elapsed time to degree and field of study. The Scheffe asterisks indicate that completion time for every field of study was significantly different from every other field of study. Thus, field of study comprises a key correlate to elapsed time to degree. Field of study can be regarded as a surrogate for support for doctoral study. Physical science recipients almost universally have assistantships and fellowships. They also lead the list in elapsed time to degree.

CORROBORATING INTERVIEWS

As noted above, we conducted interviews with ten individuals each for the traditional and the nontraditional categories of doctorate recipients. These interviews were very revealing. Indeed, they gave new meaning to the concept of educating minority individuals to help our country remain competitive in a global economy. We interviewed some brilliant people engaged in some very important and difficult work.

We interviewed a president and a chief operating officer of an electrical engineering consulting firm in the Washington, D.C., metropolitan area. This was a husband and wife team. Both were truly brilliant people: baccalaureates from MIT and PhDs from Stanford in electrical engineering. Elapsed time from baccalaureate to doctorate was seven years.

We interviewed a technical staff person from the Washington office of the Rand Corporation, another very brilliant person with an MIT baccalaureate and Stanford PhD. Elapsed time to degree was six years, field of study was physics.

We interviewed a young woman who began her college career at a black college in a small town in Georgia. She completed her PhD in pharmacology at a black university in Florida. She is now serving as a research analyst at the 3M Corporation of Minneapolis, Minnesota.

We interviewed a research fellow at the University of Kansas Medical Center. He took all of his degrees in pharmacology at a black university in Florida.

We interviewed the director of the Puerto Rican Cultural Center at the University of Connecticut. This young man took master's and PhD degrees in anthropology from Stanford after graduating with an anthropology degree at the University of Connecticut.

We interviewed a high school principal who came to Connecticut after high school in Puerto Rico and who completed all of her degrees in psychology at the University of Connecticut.

We interviewed a husband–wife team of research engineers from the Bell Communications Corporation of Red bank, New Jersey. These young people completed their PhDs at the University of Florida, only five years after completing their baccalaureates at the nation's second largest black university. Their field was electrical engineering.

We interviewed a young woman who is a research physicist at the City of Hope National Medical Center in Duarte, California. She completed a nuclear engineering degree at the University of Virginia at age 21. She completed her nuclear engineering PhD degree at the University of Florida five years later.

Table IX. Elapsed Time to Degree of Minority Science and Engineering Doctorate Recipients with Traditional and Nontraditional Baccalaureate Origins: 1981–1990[a]

Range (years)	Traditional		Nontraditional	
	N	%	*N*	%
<3			2	0.2
3–5	671	11.2	120	9.8
6–8	1970	32.7	360	29.5
9–11	1380	22.9	327	26.8
12–14	878	14.6	188	15.4
15 and over	1116	18.6	223	18.3
Mean years:				
Traditional	10.6	SD = 5.4		
Nontraditional	10.6	SD = 5.1		

[a]Chi-square significant at 0.05 level.

Table X. Scheffe *A Posteriori* Test of ANOVA Exercise for Elapsed Time to Degree by Field of Study of Minority Science and Engineering Doctorate Recipients with Traditional Baccalaureate Origins: 1981–1990

Field	Social sciences	Life sciences	Engineering	Physical sciences
Social sciences		*	*	*
Life sciences			*	*
Engineering				*
Physical sciences				

We interviewed an assistant professor of psychology at Miami University of Ohio who began her college career at a regional state university in Alabama. She completed a developmental psychology degree at the University of Florida seven years later.

Major Interview Themes

Money could be regarded as the major theme in the interviews. The most striking difference between the traditionals and nontraditionals was the paucity of money on the part of the latter. This corroborates the finding of significant differences between the education of fathers of the two groups. We noted that father's education comprised a key indicator of the amount of money for education of individuals. One nontraditional student, for example, worked for two years to enter his baccalaureate program. He worked for another five years to gather enough money to become an S&E doctoral start. He completed his degree $25,000 in debt. The Stanford husband and wife electrical engineers, on the other hand, received support from their families as well as university fellowships. There was no struggle at all, and they completed their degrees with no outstanding debt whatsoever.

The views of the interviewees regarding support for doctoral study support the selection of money as the dominant theme. About half of each group had benefitted from fellowships of $12,000–$15,000 to support their doctoral study. Another $5000 or so went to the universities for tuition and fees. Every fellowship recipient reported that the fellowship was supremely important in their decisions to study for a doctorate. Every nonrecipient reported that lack of a fellowship made their entry to doctoral study an "iffy" proposition. Furthermore, all nonrecipients of support reported that on several occasions they seriously considered quitting their programs. The reason was lack of money. Both groups named highly capable friends and relatives who decided to forego study for the doctorate for lack of money. Also in this vein, the director of the Florida Endowment Fund, the nation's top fellowship provider for minority S&E doctoral students, reported that each year they are oversubscribed and that more money for such fellowships should be forthcoming from somewhere.

Both groups discussed their programs and the beginnings of their interest in science. The recurring theme here was "get them early." Subject after subject stated emphatically that junior high school was "too late" to try to build interest and skills in S&E, that interest and basic skills in S&E is something that happens in elementary school, even in preschool. Indeed, one interviewee suggested science and engineering Head Start programs. The wisdom of the early-years strategy of NSF's Minority Initiative, e.g., science camps, was borne out in these interviews.

Interviews: Corporate and Military Personnel

As noted above, interviews were conducted with ten young minority corporate S&E professionals and ten members of the U.S. military to explore the possibility of recruiting doctoral starts from these sectors.

The net results of these interviews were positive. New corporate hires seem to comprise a fine source of doctoral starts. Nine of the ten interviewees expressed a keen interest in returning to college and working toward a doctorate. The one demurrer was engaged in quality control work and felt that a doctorate would not help her advance in the corporation at all, indeed, that a doctorate might be a deterrent to her advancement.

Generally, the more recent the hire, the more interest shown in returning to school for a doctorate. Most of the young people with less than five years of experience on the job said they would return to campus the next semester if they had fellowships or assistantships to do so. Significant to those who would recruit from this group, the interviewees noted—to a person—that they were "out of the loop" where knowledge of scholarships and fellowships were concerned. Most had lost contact with their departments and had no idea of how to reconnect or how to find money to go back to school. To a person, they noted that the best time to get people like themselves into doctoral programs was in the senior year of college—"before kids get out here and get used to making $50,000 a year," as one interviewee put it.

Most of the military interviewees came from the Community College of the Air Force or the Army Service Opportunity Colleges (SOCs). All were enlisted men. All were (or had been) engaged in S&E work in the military. All had extended coursework in S&E and some had associate in science degrees. A few had AS degrees along with 30–40 extra credits.

Individuals from this sector comprise excellent prospects for doctoral starts, but they will require more time and more resources to get them onto campuses and through baccalaureate programs. A shortcoming of the study was the lack of funds to interview minority members of the officer corps in the armed services. Many of these individuals will be facing military down-sizing in the years to come and will be mustered out. A sizable windfall of minority talent will be available for a short period of time for those who wish to recruit from this talent pool. The U.S. Department of Defense (DOD) recently signed on as a supporter of ACCESS, the large Atlanta-based consortium that matches minorities interested in pursuing S&E doctorates with schools interested in producing minority S&E doctorates. The DOD target: minority officers affected by downsizing.

We must keep in mind that while corporate recruits will almost always need to have some sort of fellowship or assistantship, military veterans will bring their own support in terms of veterans benefits. A huge success story in this respect is the former Army SOC veteran who entered the chemistry program at the University of Connecticut last year. He transferred in 38 credits in chemistry and general eduction received from SOC colleges from around the world. This young man was an artillery sergeant last stationed at Fort Sill, Oklahoma. He came to UConn with $25,000 in GI benefits. He will be a chemistry doctoral start in two or three years.

We concluded that innovative methods must be developed for relating to minority technical personnel while they are still serving in the military. Many are lost to other pursuits otherwise. Furthermore, mentoring for eventual doctoral study is a long and drawn-out process.

SUMMARY AND OBSERVATIONS

What do we now know that we did not know when we began our study? A lot. First, we now know that underrepresented minorities already complete doctoral degrees in science and mathematics, so we do not have to start from scratch.

Second, we now know that these individuals will tackle the most difficult fields in science and engineering and that they will succeed in their quest for degrees. Furthermore, they will do so with a certain amount of dispatch.

Third, we now know that minorities with nontraditional backgrounds already complete doctorates in science and engineering and that their numbers can and must be increased.

Fourth, we now know that talk of the passing of the era of S&E doctorate completion by "disadvantaged" students is premature and greatly exaggerated. It surely helps to have money when you are trying to get an education, but many still manage to get one without a lot of it.

Fifth, we now know that new minority corporate hires in S&E comprise a promising talent pool from which to recruit doctoral starts. We also know that military personnel, many of whom will be mustered out because of military down-sizing, could become a talent pool from which to recruit minority S&E doctoral starts.

Sixth, and in the same vein, we now know that we must experiment with ways to relate to talented minority military personnel while they are still in services and mentor them into pursuit of S&E doctorates.

Seventh, it is very clear that more money is needed from all quarters—government, universities, foundations, corporations and individual benefactors—if this job is to get done.

Finally, we now realize that to recruit more minority talent in S&E, we must go to where minority S&E talent is. We now realize that some of this talent is in places quite different from those of white people. We also realize that we must work on two fronts simultaneously. As mentioned above, we must work to develop more traditional minority doctoral starts. As noted, too, this will take time. Meanwhile, we must somehow tap talent in the nontraditional sector more fully.

IMPLICATIONS

Where do we go from here? What are the implications of what we have found? For starters, we can and should become proactive on the idea of broadening the search for minority S&E doctoral starts by including capable people who have been overlooked simply because they attended college part-time, started later than most freshmen, or started their college careers in junior or community colleges. Although these categories include huge numbers of minority students, proactivivity will be very necessary to convince graduate schools, depart-

ments, and programs to change their entrenched ways. If there are entities more conservative than graduate education, we have yet to become aware of them. So, to the barricades. Exhort. Push.

Second, we need to become proactive on the idea of broadening the search for minority S&E doctoral starts by reaching out to corporate personnel who would like to return to campus and complete an S&E PhD. As noted in this study, money is key in the decisions of many highly capable minority students to forego graduate school in favor of corporate employment. Recently, too, the American Council on Education released a study that showed 50% of black PhD recipients in 1992 left school owing more than $10,000 in degree-related debts. Less than a third of white recipients owed this kind of money (American Council on Education, 1994). It will take a lot of persuasion for many program directors to write a letter or send a flyer to good minority students making $50,000, a year and invite them to return to campus and spend three or four years on a $16,000 assistantship, but persuade we must.

Third, we must come up with creative means of implanting the idea of graduate education in the minds of very capable young servicemen in the Community College of the Air Force and the Servicemen's Opportunity Colleges. We must recall and have program directors recall that some of the very best researchers and teachers now retiring on campuses came from the ranks of veterans of World War II and the Korean Conflict. Tapping the present crop of servicemen now mustering out because of military down-sizing is a natural extension of the huge successes of the past. We mentioned ACCESS of Atlanta early on in this paper. Recall that this is the matching agency that works closely with the Pentagon to find graduate education slots for departing servicemen. We must also mention ACCESS to program officers in as many ways as possible.

Finally, we must urge deans, department heads, and program officers to become involved in the new consortia and networks now evolving from government and education efforts to spur production of more minority doctorates. The new Compact for Faculty Diversity now up and running is a case in point. It is sponsored by the New England Board of Higher Education, the Southern Region Education Board, and the Western Interstate Commission on Higher Education. Funds are available for fellowships for large numbers of minority PhD aspirants. Few deans, department heads, or program officers are aware of the compact. We must alter these states of consciousness forthwith.

In this vein, the new Teach America legislation has spawned a fine new faculty development program that is being administered by the Higher Education Office of the U.S. Department of Education. Part B of the program provides for fellowships to all but dissertations and to rising young stars now teaching with master's degree, at minority serving institutions (MSI). These schools include the historically black colleges and universities and a growing number of western colleges and universities with heavy minority enrollment. New Mexico State University is a case in point, as is Flaming Arrow University of Oklahoma, an MSI school with almost all Indian enrollment.

We could sum things up by saying that the train seems to be leaving the station on minority PhD production. Our job, in light of this study and recent developments, is to make sure all are on board the train.

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