

# MAKING STRIDES

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## Retention of the Best Underrepresented Minority Graduates in Science and Engineering

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Developing and maintaining *students' skills* in science and engineering disciplines and providing a steady supply of *skilled science and engineering graduates into the U.S. workforce* has been an important priority of U.S. science and education policy. This goal clearly cannot be accomplished without the participation of all racial/ethnic groups including underrepresented minorities. This goal cannot be evaluated unless the employment and education patterns of recent science and engineering graduates are examined to determine which graduates are staying in science and engineering fields and which graduates are shifting to other fields. When entering the labor force it is also important to determine how many graduates are entering science and engineering jobs. An important part of retention extends not only to an S&E graduate's decision to remain in an S&E curriculum and obtain an S&E degree but whether one moves into an S&E job after graduating and entering the workforce.

This paper focuses on those students with the best academic records to determine whether or not they are being retained in science and engineering. The report examines the relative performance of three separate groups: Whites, Asians, and underrepresented minorities. Underrepresented minorities include blacks, Hispanics, and American Indians or Alaskan natives.<sup>1</sup> In this report the best S&E graduates are identified in terms of their self-reported undergraduate grade point averages with the top students having GPAs of between 3.75 and 4.0.<sup>2</sup> Graduates' GPAs are not a perfect indicator of their overall strengths in S&E, but they do measure past success at least within an academic environment.

### Graduates' Perception of the Relationship between their Work and their Education

One of the simplest ways of determining whether graduates' work is related to their education is to obtain their own evaluation. An examination of job titles cannot provide us with information on whether the job requires knowledge of science and engineering (knowledge of S&E may be required but it is not the principal characteristic of the job). Other positions might require an S&E background when in fact that training is not required by the job. In both instances the graduate may have more accurate responses than otherwise could be obtained.

Table 1 shows that about two-fifths (43 percent) of bachelor's degree recipients who were working said that their work was closely related to their degree, and about one-third of bachelor's degree recipients (30

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<sup>1</sup>The groups included as Underrepresented Minorities: Blacks, Hispanics, and American Indians or Alaskan Natives, were combined together in this analysis because sample sizes for each individual group were not large enough to support separate presentations. It is important to note that each of these groups may behave differently than the combined group if sample sizes were large enough to warrant a separate category for each group.

<sup>2</sup> The question wording was: "using a 4-point scale, what was your overall UNDERGRADUATE grade point average?" The response categories were 3.75-4.00 (Mostly A's), 3.25-3.74 (About half A's/half B's), (2.75-3.24) (Mostly B's), 2.25-2.74 (half B's/half C's), 1.75-2.24 (Mostly C's), 1.25-1.74 (About half C's/half D's), less than 1.25 (Mostly D's or below). When schools did not use a 4-point scale, graduates were expected to convert their GPAs so that all responses were comparable.

percent) said that their work was somewhat related. Bachelor's graduates with high GPAs were more likely to say that their work is related to their degree than those with lower GPAs. Underrepresented minorities with bachelor's degrees were slightly more likely to report that their work was closely related to their degree (45 percent) than Asians (44 percent) and Whites (42 percent).

Among the best science and engineering bachelor's graduates (those with GPAs of 3.75 and above) underrepresented minorities were again slightly more likely to say that their work was closely related to their degree (55 percent), followed by Whites (54 percent) and Asians (51 percent). Among the best master's graduates Asians and underrepresented minorities were equally likely to say that their work was closely

related to their degree (78 percent), followed by Whites (73 percent). A very large number of the best Asian bachelor's graduates also reported that the relationship between their work and their degree was somewhat related (40 percent).

### **A Broader Definition of the Relationship between Work and Education**

While graduates' own evaluations of the relationship between their work and their education is useful, self evaluation is not without weakness. There may be some bias if graduates try to give more socially acceptable answers, or if their own desire is to believe that their education was more important in their job. They may also give answers that are inconsistent with other graduates who

have similar jobs but give different evaluations. For this reason the relationship between work and training is examined here using a classification system developed by NSF. Graduates were asked to provide a general description of their work and to classify their work using a job code list. This second approach also broadens the analysis by accounting for graduates who were still in school at the time they were surveyed. Such students, if they were not employed, were not asked about the relationship between their work and education, yet the area of their continued studies provides valuable information about the students' long-term plans to stay or leave science and engineering than does the area of employment. (Such graduates may not yet have had the credentials required to obtain their desired

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**Please reference Table 1.pdf to view this table**

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employment, and their employment may reflect their need to finance their education and other expenses rather than reflecting long-term career goals.)

Using this more comprehensive measure, about two-thirds of bachelor's degree recipients were no longer in S&E or not yet established in S&E (table 2). Nevertheless there is a strong relationship between retention in science and engineering fields and students' undergraduate GPAs. Using this measure among the best-performing bachelor's graduates, underrepresented minorities were

the most likely to be continuing their education in science and engineering (25 percent). Asians were the least likely among the best-performing bachelor's graduates to be neither in school nor employed in a science-related or engineering related job (21 percent). Best-performing underrepresented minorities and Whites were almost equally likely to be neither in school nor employed in a science-related or engineering related job (35 and 34 percent respectively).

About two-thirds of the top master's degree recipients were in a science and engineering education or a sci-

ence and engineering job when they were surveyed. The best-performing underrepresented minorities were the most likely to be in school studying science and engineering fields (31 percent, versus 29 percent for Whites and 19 percent for Asians.

#### Retention in Specific Disciplines

The definition of retention in S&E includes graduates who have remained in the same discipline or job. Table 3 shows that retention varies by degree level and degree

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field. Graduates with master's degrees have higher retention rates (53 percent) than those with only bachelor's degrees (26 percent). Graduates with engineering degrees regardless of degree level have higher retention rates (68 percent) in science and engineering than those with science degrees (18 percent). The patterns are similar for the top graduates but their retention rates are higher.

**Science bachelor's graduates.** Among bachelor's degree holders in science, retention rates in the same field were very similar (ranging from 18 percent for Whites and 22 percent for Asians). Underrepresented minority retention rates were 21 percent. Among the top graduates, retention rates were higher than those for all bachelor's graduates with science degrees (29 percent versus 26 percent). Among racial/ethnic groups, underrepresented minorities who

were among the top graduates were the most likely to be retained in their field of study (31 percent versus 22 percent for Whites and 26 percent for Asians).

**Engineering bachelor's graduates.** Among bachelor's degree holders in engineering, retention rates varied from a low of 59 percent for underrepresented minorities to a

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high of 70 percent for Whites. When the top graduates are looked at separately, underrepresented minority performance is better than that for all other racial/ethnic groups—with 76 percent of those graduates retained in their field of study. Retention rates for Whites were 69 percent and for Asians 73 percent.

**Science master's graduates.** Among master's degree holders in a scientific discipline, retention rates vary from a low of 44 percent for underrepresented minorities to a high of 60 percent for Asians. The retention rate for Whites with master's degrees in a scientific discipline was 45 percent. The pattern for the top graduates with science master's degrees is somewhat different with underrepresented minorities and Whites retained in science and engineering at the same rate—55 percent. Asians have a significantly higher rate of retention—68 percent.

**Engineering master's graduates.** Among Master's degree holders in an engineering field retention rates vary from a low of 54 percent for Asians to a high of 73 percent for Whites. The retention rates for underrepresented minorities were between that for Whites and Asians (60 percent).

A similar pattern was true for the top graduates with the Asian retention rate at 54 percent, significantly lower than the White retention rate of 78 percent. Data on underrepresented minorities was unavailable for this item.

### Reasons for Leaving Science and Engineering

Master's degree recipients were more likely than bachelor's degree recipients to say the most important reason for working outside their S&E degree field was that a job in that field was not available (25 percent versus 21 percent) (table 4). Approximately 26 percent of underrepresented minorities with S&E bachelor's degrees and 26 percent with S&E master's degrees reported that they were working outside of their degree field because a job in their field was unavailable. However, the most important reason for underrepresented minorities working outside of their degree field was that pay and/or promotion opportunities led them there. Approximately 36 percent of S&E bachelor's degree recipients and S&E master's degree recipients responded that pay and/or promotion is the reason they are work-

ing in a field outside of their own degree field.

### Summary

Most bachelor's degree recipients in science and engineering were not in S&E jobs or education when they were surveyed (one-two years after receiving their degree). The students with the best undergraduate records were more likely to have remained in S&E than other students. Underrepresented minorities with bachelor's degrees were equally as likely as other students to remain in an S&E job or field. The top underrepresented minorities were more likely to be retained in S&E education and employment for both engineering graduates and science graduates.

Most master's recipients were continuing in S&E-related employment or education, even among those with the lowest GPAs. Master's degree recipients with high undergraduate GPAs were much more likely than other master's recipients to stay in S&E fields. The master's students with the best academic records were

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also more likely to be retained in an S&E field or an S&E job. Underrepresented minorities with master's degrees were less likely than other students to be retained in S&E education or employment. This was also true for the top underrepresented minority graduates.

Based on the facts presented in this report one can conclude that underrepresented minorities as a group appear to have some problems with retention in engineering at the undergraduate level, and both the sciences and engineering at the graduate level. Among the best and brightest underrepresented minorities no problems are evident at the undergraduate level, but some prob-

lems are evident with retention in the sciences at the graduate level.

### Survey Methodology

Data in this report were obtained from the 1997 National Survey of Recent College Graduates (NSRCG) which is sponsored by the National Science Foundation, Division of Science Resources Studies (SRS). The NSRCG is one of three data collections covering personnel in science and engineering, which constitutes the NSF's Scientists and Engineers Statistical Data System (SESTAT). Further information about the 1997 NSRCG can be found at the SRS web site [www.nsf.gov](http://www.nsf.gov). The 1997 NSRCG

used a two-stage sample design. In the first stage a stratified nationally representative sample of 275 institutions was selected with probability proportional to size. Each institution was asked to provide lists of graduates for sampling. The second stage of the sample involved selecting graduates within the sampled institutions by cohort. Eligible graduates were those that received bachelor's or master's degrees in science and engineering from July 1994 through June 1996. The overall sample size of graduates was 14,057. The institution-level (first-stage) response rate was 100 percent and the graduate response rate (second stage) was 81.7 percent.

# Results of the 1999 PhDs.org Graduate School Survey

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## Overview

The PhDs.org Graduate School Survey is an online assessment of educational practices in science and engineering graduate departments in the United States. We conducted the survey with the goal of determining the extent to which departments have implemented the educational best practices recommendations of the National Academies of Science, the Association of American Universities, and others. We gathered responses over a period of ten weeks, from April 25, 1999, to July 8, 1999. Altogether, 6529 graduate students and recent Ph.D.s completed a survey.

The survey was publicized in the *Chronicle of Higher Education*, *Science*, *Science's Next Wave* (an online AAAS publication for young scientists), *HMS Beagle* (an online publication for life scientists), through the National Association of Graduate-Professional Students (NAGPS) network of graduate student associations, and on the PhDs.org web site. Survey participants were encouraged to tell others

about the survey, and we enabled participants to send an invitation to their colleagues by completing an online form.

The survey is an observational study, not a controlled experiment. Although the participants were self-selected, we have important evidence that our results represent widely held student opinions rather than a small outspoken set of negative voices.

1. Our survey reached a broad cross-section of the graduate student population. The demographics of the survey participants, after controlling for discipline, bear a close resemblance to the demographics of recent cohorts of Ph.D.s. (NSF 1995, 1996)
2. Far from being disgruntled, the vast majority of students expressed satisfaction with their overall educational experiences and with their advisors. Most would recommend their programs to others.
3. A number of our questions are based on a recent national study

conducted at the University of Wisconsin-Madison and funded by the Pew Charitable Trusts (Golde and Dore 2001). The Golde study obtained responses from 42.3 percent of all students surveyed: doctoral students in their third year or beyond in 11 disciplines at 27 leading research universities. Preliminary analysis of the data showed that student assessments of their educational experiences as measured in the Madison study were nearly uniformly more negative than those we found, which suggests that our results, if anything, may be positively biased. See <http://www.phds.org/survey/results/validate.phtml> for a detailed comparison of results.

Our survey offers, for the first time, a way for graduate students to engage as a group in the process of improving their own educational experiences. The survey represents a fundamentally new resource that will help prospective students make more informed decisions about choosing graduate programs, increase trans-

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parency in the graduate educational process, and help departments, funding agencies, and policy makers obtain a better understanding of the current state of science and engineering education.

Detailed survey findings may be obtained from <http://www.phds.org/survey/results>.

## Summary of Findings

An overwhelming majority of the students reported positive overall educational experiences.

- 85% of respondents say they are satisfied with their overall educational experiences.
- 78% of respondents say they are satisfied with their advisors.
- 76% would recommend their programs to others.

Nevertheless, the participants raise a number of important concerns, concerns that echo those raised in recent reports from the National Science Board (NSB 1998), the National Academies of Science (NAS 1995) (NRC 1998), the Association of American Universities (AAU 1998), and others.

## Student Perspectives on Existing Policy Recommendations

In this section we highlight specific recommendations from recent reports on graduate education and show relevant survey findings.

### Career Information and Guidance

"[W]e have an obligation to inform graduate students accurately and explicitly about career options so that they will be able to make better educational choices, formulate more realistic career expectations, and achieve greater satisfaction in their careers, while contributing more effectively to fulfilling national goals." (NAS 1995)

- 50% of respondents say their program did not provide enough information during the application process for them to make an informed decision about choosing to pursue a Ph.D.

"[U]niversities have a responsibility to collect and evaluate information about the placement of their doctoral students... In addition to placement data, universities should maintain comprehensive data on time-to-degree and completion rates... [I]nformation on program performance and student placement should be available to all students who are considering applying to graduate programs." (AAU 1998)

- 63% of respondents report that their program did not inform them of where recent program graduates were employed after graduation.

"It is worth noting that even the National Collegiate Athletic Association (NCAA) now publishes graduation rates for athletes; an equivalent requirement for these heavily recruited prospective scholars does not seem so unreasonable!" (Kennedy 1997)

- 71% of respondents report that their programs did not inform them of the percentage of students who complete the program with a Ph.D.

"The Federal government and universities are responsible for developing relevant experience and training to meet expanding workforce needs and to prepare the student for his or her chosen career. More should be done to inform graduate students of the full range of employment opportunities and to offer a choice of options for expanding career-related training." (NSB 1998)

- 37% of respondents report that effective career guidance is not available from their department or university career services center for *academic* careers.
- 49% of respondents report that effective career guidance is not available from their department or university career services center for *non-academic* careers.

### Curricular Breadth and Flexibility

"Institutions should evaluate the graduate curriculum to assure that it equips students with the knowledge and skills needed for a broad array of postdoctoral careers that they might wish to pursue." (AAU 1998)

- 11% of students believe that their programs are not doing a good job of preparing them for an *academic* career.

- 36% believe their programs are not doing a good job of preparing them for a *non-academic* career.

"More students should...have off-campus experiences to acquire the skills desired by an increasing number of employers, especially the ability to communicate complex ideas to nonspecialists and the ability to work in teams of interdependent workers." (NAS 1995)

- 51% of students report that their program does not encourage them to broaden their education through such activities as coursework outside the department, industrial internships, and external workshops.

### Mentoring

"The overriding purpose of graduate education is and must always be the education of graduate students." (AAU 1998)

- 21% of respondents feel that their advisor sees them as a source of cheap labor to advance his/her research.
- 28% of respondents say that graduate students in their program are there primarily to help faculty fulfill their research and teaching obligations.

"A student's progress should be the responsibility of the department rather than of a single faculty member; a small supervisory group (including the student's advisor) should determine when enough work has been accomplished for the Ph.D. degree." (NAS 1995)

- 48% of respondents report that there is no faculty member other than their advisor who keeps track of their research.

### Teaching and Professionalism

"Asking graduate students to teach courses without adequate prepara-

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tion is inappropriate for both teacher and students.” (AAU 1998)

- 50% of respondents report that teaching assistants do not receive effective preparation and training before they enter the classroom.

“Graduate students learn to teach...by performing these activities under faculty mentorship. Apprenticeship teaching experiences at progressively more advanced levels, augmented by workshops and other pedagogical training programs, are extremely effective ways to teach prospective teachers how to teach.” (AAU 1998)

- 63% of respondents report that their program or institution does not carefully supervise teaching assistants to help them improve their teaching skills.

### Diversity

“Universities should seek to build diverse student bodies in their graduate programs... [U]niversities need to continue their efforts to increase the participation of students underrepresented in their graduate programs.” (AAU 1998)

- 37% of respondents say their department does not actively seek to recruit talented students from underrepresented groups.

“If it appears that the numbers of women and minority-group members are low in particular fields, an effort must be made to determine whether there are barriers to entry, including issues perceived as barriers by members of the group in question. If so, steps to encourage increased participation should be devised and implemented.” (NAS 1995)

- 34% of respondents say their department does not provide a supportive environment for members of underrepresented groups who are enrolled in the program.
- 38% of women (versus 28% of men) and 49% of underrepresented

minority students (versus 31% of Caucasian and Asian students) report that their department does not provide a supportive environment for members of underrepresented groups.

### The 2000 National Doctoral Program Survey

The Alfred P. Sloan Foundation is funding a follow-up survey conducted by the National Association of Graduate-Professional Students (NAGPS) in cooperation with the first author. The follow-up survey gathered data from March 30, 2000 through August 15, 2000. This second-generation survey contained a number of important improvements:

- The new survey was expanded to cover the humanities and social sciences in addition to the sciences and engineering. Canadian doctoral programs were included as well.
- The survey questions were clarified, expanded and reviewed by both students and higher education researchers.
- Department chairs and university administrators were more directly involved in the data gathering process.
- Expanded publicity efforts substantially increased student participation in and faculty awareness of the survey.
- Students had more control over the dissemination of their data, and a more detailed privacy policy clearly explained how student data will be used.
- Improved security mechanisms.

The final report for the 2000 survey, is tentatively scheduled for release in September 2001. The report will provide results at the level of individual departments from which there is sufficient student participation. Department-level data will be provided to students, faculty, and administrators for the departments in question and will also be made publicly available on the web. For further information on the 2000 NAGPS survey, visit <http://survey.nagps.org>.

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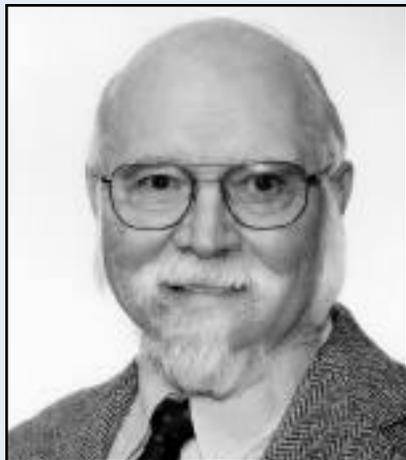
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# An Interview with Dr. William E. Spicer

Interviewed by Jolene Jesse, Senior Program Associate



Dr. William E. Spicer

Each issue of Making Strides features a short interview with an SME professor who has been instrumental in mentoring and encouraging students through the pipeline, as well as demonstrating leadership and outstanding accomplishments in the world of SME.

This issue profiles Dr. William E. Spicer, Professor Emeritus at Stanford University. Dr. Spicer received his first B.S. from the College of William and Mary, Phi Beta Kappa at the age of 19. Further degrees were earned at MIT and the University of Missouri at Columbia (Ph.D.'55). He has won the senior prizes of the American Physical Society and the American Vacuum Society, the Buckley Prize and the Welch Medal; he was the R&D Magazine (Dunn and Bradstreet) Scientist of the year in 1981; and received an honorary degree from Linköping University in Sweden (1975) as well as other awards. Dr. Spicer is also the co-recipient of the AAAS 2000 Mentor Award for Lifetime Achievement for his remarkable work with women and under-represented minority graduate students in physics and engineering.

**MS:** Tell me about your background and the reasons you chose physics.

**Spicer:** I was born and raised in Louisiana. I had very bad learning and speech difficulties. Louisiana also had a primitive education system. There were 50 students in my first grade class. I had a lot of trouble from the first grade on. At the end of first grade the teachers wanted to hold me back. My mother had to go to the state board of education to get me transferred to a school in another part of town with smaller classes. To this day, I can't spell and am completely tone deaf. Earlier I couldn't pronounce L's but through speech therapy I can now do that. I also had a thick southern accent and people couldn't understand me at all. Now, because of all the speech therapy, I tend to talk in monotone without knowing it. All these things made me different and lesser than the other students.

During the years before college I developed an intellectual life independent of school. I didn't make good grades in high school, but I read a lot and created my own advanced intellectual world. Once I had to write an essay on Burns for an English class. I got a hold of Carlisle's biography of Burns and that turned me on and I wrote a very powerful essay. When the teacher handed out the papers with the grades, she waited until the end to hand mine back. She announced to the whole class that she had given me a B- because she knew I was not capable of writing that paper. This is an extreme example of how I was treated, but it was not unusual.

In Louisiana, high school ended with the eleventh grade, so I was 16 when I started at the College of William and Mary. My father had gone there and so used his contacts to get me in. When I got to college I found I no longer needed two separate lives. I would have gone into History or English, but the fact that I couldn't spell was an impossible hurdle in

those fields. I had entered college as a pre-engineering student, but was more attracted to physics. Engineering is learning about how things do the things they do but not why. Physics was about understanding why things work the way they do. This learning about the "why" of things was something I was first attracted to in History. Physics was the only area of major interest where I really had the odds stacked in my favor, though. So I went into Physics and there were good and bad times. I always ended up doing much better than anyone expected me to.

**MS:** I understand you have helped produce more African American Ph.D. physicists than anyone else in the country and that you have successfully mentored 10 underrepresented students through the Ph.D. program at Stanford. How do you account for your incredible success rate?

**Spicer:** My background gave me an unusual affinity for working with students. Most professors are elitists. If you are an elitist it is very hard to work successfully with a minority student that doesn't fall into an elitist class. For minorities and women doors are closed in very subtle ways, and it is hard for most professors to understand what is going on with the student, because professors have for the most part excelled and haven't faced the barriers that minorities and women have had to face. My background gave me that understanding, and, like me, most of my minority students came from the South, although the women came from all different backgrounds. In all cases, however, they had, to some extent, suffered from feeling different. What I try to do is to build a platform of knowledge and methodology so that students can learn and attack new problems during their whole life.

I didn't just do well with minorities. I also did well with other students. I am a physicist but teach in an electrical engineering department. Electrical

engineering attracts among whites a lot of first generation college students. These students often had a lot of difficulties with their families not understanding why they needed to go farther than a bachelor's degree. The students often responded to family criticism by trying to be overachievers. I was experienced with that as well. I have had success with doing the same with non-minority men as I did with minorities and women. One of my Ph.D. graduates is one of the top people at Intel. Two others are executive vice presidents at Motorola and Texas Instruments. Four have been on Stanford's faculty. Ten all together are in tenured faculty positions across the country.

It's not that I have a special strategy for minorities and women. I may change the strategy a bit, but I am not an elitist, and my objective is to put the development of the student first and have faith that the quality of research will follow. A more typical way of advising a Ph.D. thesis is to have the students be the hands and the professor direct them rather than to build them as people. The greatest thing is to build a person's abilities and confidence so that they can attack any problem. Rather than focusing on one particular problem set, I focus on instilling in my students a method of problem-solving that allows them to change direction every so often.

**MS: Tell me about the "Spicer Group."**

**Spicer:** Another difficulty in graduate schools is that there isn't an established social organization supporting the students. My experience is that this is very important. So the "Spicer Group" is several things. First, I design research projects so that students have to share equipment and ideas, and in that way they have to interact. Second, I have license to direct Ph.D. candidates in four different departments, so I try to have students from different disciplines working closely together. Students spend most of their time with other students and they have the most potential to learn from each other. When they come from different disciplines and backgrounds, they are exposed to different approaches to problem-solving. Third, I try to

make sure that there is no competition between the members of the group so that they feel that it is to their advantage to work together.

But in addition to all that, the "Spicer Group" is a networking and support organization. I try to get to know each student as personally as possible. I like to know their family background and their reasons for going into physics, so that we can find ways to get around any hang-ups they might have. This sense of community extends beyond the completion of the degree and becomes an effective networking tool for students. I, or other graduates from the group, actively work to get a student a job in which they will be happy. But socially, too, students are brought together. For example, an early member of the group got married, and in one way or another everyone who had graduated from the group was involved in his wedding. If students find that their lease is up on their apartment they have come and lived with me for extended periods of time. There is also a lot of visiting back and forth between group members.

One of the things that I didn't realize at first, and the reason I have been able to be so successful with women and minorities, is that it is particularly important for them to walk into a lab and see others like themselves. It is a positive influence for them even if they don't work directly with those other students. Black faculty members are especially important because often students don't know how to react to various problems, and if they have someone who has gone through it before and can direct them, that helps an awful lot.

**MS: What do you look for in potential graduate students?**

**Spicer:** My first emphasis is really on desire. It really helps to have a high powered intellect, but that is not enough. Someone good enough to get into the Ph.D. program at Stanford obviously has the ability. But, a student also needs a strong desire. I'm an experimentalist, so I look for interests in that direction. I have taken on 60 students as Ph.D. candidates and every one of them has finished the Ph.D.—sometimes against their will! All of them have also been

productive afterwards. The stereotype of a physicist is a guy who doesn't see people. There is a lot to that, but it is also an exaggerated stereotype. Much of my success is in understanding my students as people first.

**MS: What skills are most important for the success of students in physics?**

**Spicer:** I'm unusual among physicists in that I think about physics pictorially not mathematically. To be successful you have to get to the right place by thinking pictorially. Then when you are at the right place you have to transform all you've learned into mathematics. The biggest single mistake I see among many physicists is that they try and use only mathematics. But with mathematics, one wrong approximation makes the whole thing nonsense physically. Thinking pictorially you see multiple possibilities and you see things others may have missed. I encourage students to look at the "garbage." I tell them to try things even if they don't work and then step back and look at why they didn't work. By building on failures you can get to the right answers. People who want to be good physicists need a methodology that is not necessarily based solely on logic, but that looks at the experimental process as trying to find truth out of chaos. The typical Ph.D. tries to force his data to agree with accepted theory. I try to teach my students to look at each problem not from a purely theoretical stance but from an experimental position.

**MS: What is the best way to recruit more women and minorities into SME disciplines?**

**Spicer:** At Stanford, we had department chairs who were a driving force behind getting grants from various foundations to fund a remarkable recruitment program for African American students. A key member of the departmental staff was also a very active African American woman. The program gave us extra leeway in admitting more black students. Then, in the spring, some of these students would go and visit the historically black universities in the south and talk to students about careers in physics and the program at Stanford. In total 19 African

Americans got their Ph.D.s in physics, and five others received them in electrical engineering through the program. A faculty member would call up professors personally to get them to take on these students. I was the only professor that really had an affinity with the black students. I would see potential where other professors did not and then nurture and train students.

Although Stanford has been less successful in recruiting black students in recent years, there is renewed interest on the part of the Physics Department to increase African American participation in the program. One of the most important ways to attract and keep minority and women graduate students is to offer them support networks. The departments of Electrical Engineering, Physics, and Applied Physics, and the Stanford Linear Acceleration Center (SLAC) will explore the creation of a combined

support organization for African American graduate students in their programs.

This year Stanford will also host the annual meeting of the National Conference of Black Physics Students in conjunction with the meeting of the National Society of Black Physicists from March 29 through April 1, 2001. The Departments of Physics, Applied Physics and Electrical Engineering, as well as SLAC, are officially co-hosting the conference, and there are considerable funds available to cover the transportation costs of students from all over the country who are interested in attending the conference. Agilent Technologies will also give out monetary awards for the best student papers. A reunion of black Stanford physics Ph.D.s is scheduled for the Sunday following the meeting.

Another way that Stanford was able to recruit top minority graduate stu-

dents in the past was to make use of a summer internship program that Bell Labs instituted in the 1970s. Bell Labs invited top minority students from historically black colleges and universities (HBCUs) into their internship program, and a majority of my students had been in the program. Now, unfortunately, the program is defunct. But it was a very effective way to make the jump between HBCUs and research institutions like Stanford.

*Thank you so much for your insights, Dr. Spicer!*

More information about the National Conference of Black Physics Students is available at <http://www.stanford.edu/dept/physics/events/ncbp/> or at <http://www.nsbp.org/>.

More information about the AAAS Mentor Award for Lifetime Achievement is available at <http://www.aaas.org/aaas/award.html>.

## A Profile of an AGEP Institution: Alabama Alliance for Graduate Education and the Professoriate Program

*By Louis Dale, Ph.D., Associate Provost, Minority Affairs and Special Programs  
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### SETTING THE PACE

The Alabama Alliance for Graduate Education and the Professoriate (AGEP) Program is a statewide project designed to significantly increase the number of underrepresented minority students receiving doctoral degrees in the science, mathematics, engineering, and technology (SMET) fields and entering the professoriate. The project includes The University of Alabama at Birmingham, Auburn University, The University of Alabama, The University of Alabama in Huntsville, and seven Historically Black Colleges and Universities (HBCU), Alabama A&M University, Alabama State University, Miles College, Oakwood College, Stillman College, Talladega College, and Tougaloo College. The HBCU partners serve as feeder

schools for the AGEP graduate institutions that offer high-quality education and research facilities, and outstanding faculty ready to prepare students for successful careers.

The Alabama AGEP Program developed the following activities to support student success in graduate school entrance and degree attainment:

#### For Undergraduate Students

- Graduate School Awareness Activities
- GRE Preparation
- Graduate School Preparation
- Recruitment and Admissions Activities
- Graduate School Fair

#### For Graduate Students

- Mentoring and Advising
- Retention and Support Network
- Creating a Supportive Institutional Environment
- Graduate Bridge Program
- Degree Completion and Job Placement

- The AGEP Graduate School Fair is an annual event held in the fall on the campus of the University of Alabama at Birmingham. It is designed to promote interactions between graduate institutions and undergraduate students.
- GRE tutorials are offered to assist with graduate school preparation. Each AGEP institution has dedi-

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cated personnel, facilities and software to aid students with their preparation for the GRE.

- Each AGEP institution has both a faculty mentor/advisor and a student mentor, as well as opportunities to interact with minority faculty and other minority graduate students. Such interactions help to create and nurture a supportive environment in which students thrive.
- The Alabama AGEP Graduate Bridge Program is designed to provide a smooth transition for students graduating from AGEP undergraduate institutions and planning to attend graduate school.
- Financial assistance is available in the form of fellowships or assistantships. Stipends range from \$10,000 to \$17,000 plus tuition payments. Funds are also available for students to attend scientific meetings, workshops and conferences related to their areas of study.
- The progress of all AGEP students is monitored to ensure completion of degree requirements.

#### Bridge to Success

The Graduate Bridge Program is available for students during the summer following the attainment of a baccalaureate degree. This program is designed to introduce graduate education to those selected participants. In addition to taking a transitional graduate course, students are assigned a research mentor to gain valuable research experience. Participants also attend weekly seminars. The program provides a stipend, payment of tuition and fees, and room and board for participants. The Bridge Program is held on the

campus of each AGEP graduate institution.

#### Mentoring is the Key

A key to success in graduate school is proper mentoring and advising. The minority graduate retention rate at the University of Alabama at Birmingham is near 85%. The mentoring program is based on the premise that it is often difficult for minority students entering a large majority institution to find the resources and services needed during the first critical months of graduate study. Each graduate student is provided both a student mentor and a faculty mentor.

#### The Comprehensive Minority Faculty and Student Development Program

The Comprehensive Minority Faculty and Student Development Program (CMFSDP), an award winning companion program to the AGEP Program, serves to increase interaction between faculty and minority graduate students. Jointly, these programs help to create an environment in which students succeed. ***The CMFSDP alone has produced 40 African American Ph.D.'s since its inception in 1989.***

#### AGEP Impact

The mentoring program is only one component of the efforts necessary for the positive impact of the Alabama AGEP Program. By subscribing to the elements of a successful AGEP effort, collaborating with the HBCU partner institutions and the Alabama LSAMP consortium, the Alabama AGEP graduate institutions have increased minority SME enrollments from 87 in 1997 to 118 in 1999.

#### Key Features of an AGEP Effort

- A large pool of minority SME undergraduate students.
- Efforts in undergraduate institutions to increase awareness of graduate school opportunities.
- Institutional programs designed to prepare students for graduate school.
- A supportive environment that encourages students to succeed and assists students with problems, both academic and non-academic.
- Academic and financial support.

*Making Strides* is a quarterly (January, April, July, and October) research newsletter published by the American Association for the Advancement of Science, Directorate for Education and Human Resources Programs. Its purpose is to share information about minority graduate education in the fields of science, mathematics, and engineering. It is available in print and electronic format. Inquiries, information related to AGEP, and all correspondence should be sent to the editor.

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