First Minority Graduate Education at Mountain States Alliance (MGE @ MSA)

Doctoral Mentoring Institute

Increasing Ph.D. Production and Shaping Tomorrow’s Leaders

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Special thanks are extended to:

Brian L. Foster, Antonio A. Garcia, Roosevelt Y. Johnson
Gary Keller, Albert L. McHenry, Michael J. Sullivan

MGE@MSA Website: http://www.asu.edu/MGE
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1 Welcoming Remarks and Introduction

Welcome
On behalf of the workshop organizers, Arizona State University, the executive committee of the Minority Graduate Education at Mountain States Alliance (MGE@MSA), and the many participating institutions, I would like to thank each of you for taking time out of your very busy schedules to attend the

First MGE@MSA Doctoral Mentoring Institute.

Introduction
We believe that the problem of Ph.D. “underproduction” in science, mathematics, engineering, and technology (SMET) has reached a state which seriously jeopardizes the long-term economic security of the Nation. This is particularly evident when one examines SMET degree production around the world (e.g. China, India) [27], [35], [36]. Ph.D. “underproduction” in underrepresented groups (i.e. women, minorities, and people with disabilities) has received heightened attention because of

- the need for highly trained technical individuals to meet anticipated SMET research, development, and manufacturing challenges and demands,
- the increasing importance of diversity in the global marketplace, and
- because these groups are disproportionately represented in the SMET workforce.

To address the long-term implications that the above has on our Nation, both economically and socially, the Office of Science and Technology Policy (OSTP) in cooperation with the National Science Foundation (NSF) have taken action to address the problem of Ph.D. “underproduction” in underrepresented groups. This workshop - and its mentoring/networking themes - represents an important (albeit small) step that is being taken to address this national problem.

We hope that you have arrived with an open mind, that this workshop will stimulate discussion on how to best achieve our objectives, and that you will leave with a desire to take advantage of the nominal resources that our MGE@MSA-NSF program offers so that collectively we can significantly impact the problem of Ph.D. SMET “underproduction” in underrepresented groups within our region.

Thank you very much.
Armando A. Rodriguez
Workshop Organizer and Program Chair
Arizona State University
Electrical Engineering
2 Workshop Organizers, Sponsors, and Special Acknowledgements

Workshop Organizers
Putting together this workshop involved many individuals. Thanks are extended to

- Brian L. Foster,
- Antonio A. Garcia,
- Roosevelt Y. Johnson,
- Gary D. Keller,
- Albert L. McHenry,
- Michael J. Sullivan,

and to the many individuals - students, staff, faculty, guest speakers, National Science Foundation (NSF) officials, White House Office of Science and Technology Policy (OSTP) officials - that have contributed.

Workshop Sponsors
Workshop sponsors include

- National Science Foundation Alliance for Graduate Education and Professoriate Program - see page 93,
- White House Office of Science and Technology Policy (OSTP),
- Hispanic Research Center (HRC),
- Minority Graduate Education at Mountain States Alliance (MGE@MSA) - see page 51,
  - Arizona State University, Brigham Young University, Colorado School of Mines, Colorado State University, University of Arizona, University of Colorado at Boulder, University of Nevada at Las Vegas, University of Nevada at Reno, University of New Mexico, University of Utah, and Utah State University
- Western Alliance to Expand Student Opportunities (WAESO),
- Coalition to Increase Minority Degrees (CIMD),
- System Science and Engineering Research Center (SSERC),
- Center for Innovations In Engineering Education (CIIEEE),
- Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET).
Special Acknowledgements

Special acknowledgements are given to the many individuals across our Nation that have served as mentors and to those that, because of circumstances, have not had access to a mentor.
3 Pre- and Post-Workshop Participation Incentives

The following are pre-workshop and post-workshop incentives extended to all participants.

Pre-Workshop Incentives

All workshop participants will receive the following incentives:

- travel and hotel paid (reimbursed according to university guidelines),
- per diem for meals (reimbursed according to university guidelines),
- $200 participant stipend.

Post-Workshop Incentives

After completion of the workshop, all participants will receive a certificate of participation. Individuals completing the workshop will be eligible and are encouraged to take advantage of the following:

- *Doctoral Mentoring Initiation and Research Documentation.* Up to $500 supplies/travel budget per Ph.D. student per semester initiate mentoring and/or to document mentoring of underrepresented Ph.D. students,
- *Faculty Communications Network.* Up to $500 supplies/travel budget per semester to participate via listserv in a new Faculty Communications Network,
- *Faculty-Student Mentoring Network.* Up to $2,500 consultant stipend and/or supplies/travel budget per semester to facilitate discussion via listserv within new Faculty-Student Mentoring Network,
- *Peer Mentoring Network.* Similar stipends ($500—$2,500 per semester) are available for your Ph.D. mentees to participate in or facilitate in a new parallel Peer Mentoring Network.

We will share your burden!
Conference and Reimbursement Logistics.

All conference and reimbursement logistics are being handled by:

Michael J. Sullivan  
Hispanic Research Center  
PO Box 872702  
Arizona State University  
Tempe, AZ 85287-2702  
Internet: michael.sullivan@asu.edu  
Voice: (480) 965-5388  
Toll-free: 1-800-327-4893  
Fax: (480) 965-8309
4 Workshop Agenda: An Overview

12:45 Registration
AED 68 - Architecture and Environmental Design (North) Building, Room 68

1:30 Welcome and Opening Remarks
Dr. Albert L. McHenry
Director, MGE@MSA Project
Dean, College of Technology and Applied Sciences
Arizona State University, East Campus

Dr. Roosevelt Y. Johnson
Director, AGEP Program
National Science Foundation

Dr. Brian L. Foster
Chair, Governing Board, MGE@MSA/WAESO
Provost, University of New Mexico

Dr. Milton D. Glick
Senior Vice President and Provost
Arizona State University

Dr. Linell E. Cady
Interim Dean, College of Liberal Arts and Sciences
Arizona State University

Dr. Peter E. Crouch
Dean, College of Engineering and Applied Sciences
Arizona State University

2:00-3:00 Mentoring 101: Making the Case and Making A Difference
Invited Speaker: Professor Armando A. Rodriguez
Arizona State University
Department of Electrical Engineering
1998 Presidential Award for Excellence in SME Mentoring
3:00-4:00 A Perspective on Mentoring: Strategies and Tactics I
Invited Speaker: Professor Charles Thompson
University of Massachusetts at Lowell
Department of Electrical Engineering
1997 Presidential Award for Excellence in SME Mentoring

4:00-4:15 Break

4:15-5:15 A Perspective on Mentoring: Strategies and Tactics II
Invited Speaker: Professor William Y. Velez
University of Arizona
Department of Mathematics
1997 Presidential Award for Excellence in SME Mentoring

5:15-6:00 How to Get Started Tomorrow: Some Incentives, About the MGE@MSA Program
Invited Speaker: Professor Armando A. Rodriguez
Arizona State University
Department of Electrical Engineering
1998 Presidential Award for Excellence in SME Mentoring

6:00-6:15 Discussion and Transition To University Club

6:15-8:00 Dinner with speakers and workshop participants.
Arizona State University
University Club

7:00-8:00 Mentoring: The Possibilities Are Endless.
Arizona State University
University Club
Invited Speaker: Dr. Julian M. Earls
Deputy Director of Operations
National Aeronautics and Space Administration
John Glenn Research Center
The ASU Main Campus

- Executive Lunch (12:00-12:45 PM) will be held at Memorial Union (MU) Building, Yavapai Room
- Mentoring Workshop (12:45-6:00 PM) will be held in AED Building, Room 68 - Located below X1
- Dinner (6:15-8:00 PM) will be held at University Club (UC) - Located to right of X2
5 Background Data: Making The Case

The New Economy.
The past ten (10) years has seen historical socio-eco-political changes that have resulted in a so-called global economy. The economic security of the Nation is rooted in the creation of new knowledge/intellectual capital that can be leveraged to significantly impact the human condition. The new economy that has emerged requires a highly trained technical workforce.

Statistical Data.
Statistical data [27], [28] is now presented to support the following fundamental hypothesis

*Ph.D. underproduction in SMET fields is a critical problem that requires the immediate and collective attention of SMET professionals across the Nation.*

*The problem is particularly critical for underrepresented groups.*

The data to be presented examines:

U.S. Workforce Data
Figure 1: Workforce Issues: Unemployment By Education (page 14)

World Degree Data
Figure 2: Worldwide Undergraduate Degree Production (page 15)
Figure 3: Worldwide B.S./B.A. Engineering Degree Production: Ordered By Percentage (page 16)
Figure 4: Worldwide B.S. Engineering Degree Production (page 17)
Figure 5: Additional Worldwide B.S. Engineering Production Data (page 18)

U.S. Degree Data
Figure 6: U.S. Bachelor’s Degree Distribution Across Disciplines (page 19)
Figure 7: U.S. Advanced Degree Distribution Across Disciplines (page 20)
Figure 8: Additional Degree Distribution Data (page 21)
Figure 9: 1997 U.S. Census Population Estimates (page 24)
Figure 10: 1997 Graduate Student Enrollment (page 25)
Figure 11: 1997 SMET Graduate Enrollment (page 26)
Figure 12: 1997 Graduate Enrollment In Engineering (page 27)
MGE@MSA Regional Data
Figure 13: 1998 Population Data For Our Region (page 28)
Figure 14: 2000 M.S. and Ph.D. Degrees in Our Region (page 29)

Acknowledgements
Figures 1-8 were obtained from Dr. Duncan T. Moore, Associate Director of Technology, White House OSTP.
Figures 9-14 were obtained from Professor Antonio A. Garcia, WAESO Project Director, Arizona State University.

For a comprehensive treatment, also examine [35], [36], [37], [38].
U.S. Workforce Issues: Unemployment By Education.

Figure 1 examines education level and unemployment [27].

<table>
<thead>
<tr>
<th>Over 25 years of age</th>
<th>Aug-98 Number</th>
<th>Aug-00 Number</th>
<th>Max %</th>
<th>Min %</th>
<th>% Jan 93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than HS</td>
<td>869 1000's</td>
<td>764 1000's</td>
<td>7.4%</td>
<td>6.0%</td>
<td>11.1%</td>
</tr>
<tr>
<td>HS-No college</td>
<td>1467 1350</td>
<td>1350 1350</td>
<td>4.0%</td>
<td>3.3%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Some College</td>
<td>873 946</td>
<td>946 946</td>
<td>3.1%</td>
<td>2.5%</td>
<td>5.6%</td>
</tr>
<tr>
<td>College Graduates</td>
<td>615 653</td>
<td>653 653</td>
<td>2.0%</td>
<td>1.5%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Sum</td>
<td>3821 3700</td>
<td>3700 3700</td>
<td>3.4%</td>
<td>2.9%</td>
<td>5.8%</td>
</tr>
</tbody>
</table>

Overall Unemployment (16 and over)

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>%</th>
<th>Max %</th>
<th>Min %</th>
<th>% Jan 93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 98</td>
<td>5650</td>
<td>4.1%</td>
<td>4.5%</td>
<td>3.9%</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

All numbers are seasonally adjusted
Prepared by D.T. Moore-Office of Science and Technology Policy, EOP

Key points:
Unemployment in all education groups is almost half what it was at the beginning of this administration.
As the economy continues to be more technological, it will be harder to find the required workers to continue the boom.

"One of the clearest messages our economy has sent in the last decade is that one sure route to higher wages is higher education [52, page 45, Clinton, 1996]."

Worldwide Undergraduate Degree Production.
Figure 2 addresses the question [27]:

*How does the U.S. compare worldwide with respect to B.S./B.A. degree production?*

<table>
<thead>
<tr>
<th>Undergraduate Degrees- 1997 or most recent year</th>
<th>% of 24 yr olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>1,174,000</td>
</tr>
<tr>
<td>India</td>
<td>750,000</td>
</tr>
<tr>
<td>Japan</td>
<td>525,000</td>
</tr>
<tr>
<td>Russia</td>
<td>407,000</td>
</tr>
<tr>
<td>China</td>
<td>325,000</td>
</tr>
<tr>
<td>UK</td>
<td>251,000</td>
</tr>
<tr>
<td>Brazil</td>
<td>245,000</td>
</tr>
<tr>
<td>Germany (long + short)</td>
<td>213,000</td>
</tr>
<tr>
<td>South Korea</td>
<td>197,000</td>
</tr>
<tr>
<td>Mexico</td>
<td>191,000</td>
</tr>
<tr>
<td>Total</td>
<td>4,278,000</td>
</tr>
<tr>
<td>Worldwide Total</td>
<td>6,266,000</td>
</tr>
</tbody>
</table>

Figure 2: Worldwide Undergraduate Degree Production

In 1997, 33.4% of U.S. 24 year olds possessed an undergraduate degree. In India, the figure was 4.8%. In China, 1.4%. One can be very misled by this data.

Bachelor-level SE degrees leveling off; shift in emphasis to doctoral training [35, page 4-17]

- What about B.S./B.A. production?
Worldwide Undergraduate Degree Production (continued).

Figure 3 addresses the question [27]:

*How does the U.S. compare worldwide with respect to B.S./B.A. production?*

<table>
<thead>
<tr>
<th>BS/BA degrees as a fraction of 24 year olds</th>
<th>(Ordered by percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>147,000</td>
</tr>
<tr>
<td>Australia</td>
<td>98,000</td>
</tr>
<tr>
<td>United States</td>
<td>1,174,000</td>
</tr>
<tr>
<td>UK</td>
<td>251,000</td>
</tr>
<tr>
<td>New Zealand</td>
<td>17,000</td>
</tr>
<tr>
<td>Denmark</td>
<td>21,000</td>
</tr>
<tr>
<td>Norway</td>
<td>49,000</td>
</tr>
<tr>
<td>Japan</td>
<td>525,000</td>
</tr>
<tr>
<td>Spain</td>
<td>174,000</td>
</tr>
<tr>
<td>Ireland</td>
<td>15,500</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>50,000</td>
</tr>
<tr>
<td>Finland</td>
<td>15,000</td>
</tr>
<tr>
<td>Total</td>
<td>2,536,500</td>
</tr>
</tbody>
</table>

Figure 3: Worldwide B.S./B.A. Production: Ordered By Percentage

The figure shows B.S./B.A. production ordered by percentage. U.S. B.S./B.A. percentage (33.4%) looks “acceptable.” One can be very misled by this data.

- How does the U.S. compare worldwide with respect to B.S. Engineering degree production?
Worldwide Undergraduate Degree Production (continued).
Figure 4 addresses the question [27]:

*How does the U.S. compare worldwide with respect to B.S. Engineering degree production?*

<table>
<thead>
<tr>
<th>Undergraduate BS Engineering degrees</th>
<th>% of BS/BA degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Worldwide Total</strong></td>
<td>866,771</td>
</tr>
<tr>
<td>China</td>
<td>148,600</td>
</tr>
<tr>
<td>Russia</td>
<td>131,800</td>
</tr>
<tr>
<td>Japan</td>
<td>102,951</td>
</tr>
<tr>
<td>United States</td>
<td>63,400</td>
</tr>
<tr>
<td>South Korea</td>
<td>41,300</td>
</tr>
<tr>
<td>Germany</td>
<td>39,800</td>
</tr>
<tr>
<td>Mexico</td>
<td>34,200</td>
</tr>
<tr>
<td>India</td>
<td>29,000</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>23,300</td>
</tr>
<tr>
<td>France</td>
<td>20,600</td>
</tr>
<tr>
<td><strong>Total of top ten</strong></td>
<td>634,951</td>
</tr>
</tbody>
</table>

*Figure 4: Worldwide B.S. Engineering Degree Production*

It shows B.S. Engineering production worldwide - expressed as a percentage of B.S./B.A. degrees received. In terms of raw numbers, the U.S. ranks fourth behind China, Russia, and Japan. The U.S. percentage (5.4%), however, is very poor when compared to nations around the world. Percentage wise it ranks 9th! Also see [35, page 4-18, 4-19]

- How does the U.S. compare with respect to other nations?
Worldwide Undergraduate Degree Production (continued).

Figure 5 shows that the U.S. percentage of 5.4% (see Figure 4), when compared to other nations around the world, is very poor [27].

<table>
<thead>
<tr>
<th>Undergraduate BS Engineering degrees</th>
<th>(In order of % of total BS/BA degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>148,600</td>
</tr>
<tr>
<td>Russia</td>
<td>131,800</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>3,624</td>
</tr>
<tr>
<td>Singapore</td>
<td>1,676</td>
</tr>
<tr>
<td>Finland</td>
<td>3,804</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>4,338</td>
</tr>
<tr>
<td>South Korea</td>
<td>41,300</td>
</tr>
<tr>
<td>Columbia</td>
<td>11,036</td>
</tr>
<tr>
<td>Croatia</td>
<td>1,549</td>
</tr>
<tr>
<td>Japan</td>
<td>102,951</td>
</tr>
<tr>
<td>Belgium</td>
<td>2513</td>
</tr>
<tr>
<td>Worldwide</td>
<td>866,711</td>
</tr>
</tbody>
</table>

21.0%  20.4%  20.2%  19.6%  19.5%  13.8%

Figure 5: Additional Worldwide B.S. Engineering Production Data
U.S. Higher Education Data.
The following question is now addressed:

What fields are U.S. students getting degrees in?

U.S. Bachelor’s Degrees.
Figure 6 shows how Bachelor’s degrees are distributed across disciplines [27]. Engineering (5.2%), Physical Sciences (1.7%), and Mathematics (1.1%) are not as popular as we would like them to be. Each experienced a decrease (two consecutive years). Numbers for Health Professions, Biological Sciences, and Computer/Information Sciences have increased (two consecutive years).

![US Higher Education Data (1996-97)](image)

Figure 6: U.S. Bachelor’s Degree Distribution Across Disciplines

- SE B.S. degrees increased at an average annual rate of 2.6% from 1990-1996 [36, Table 4-17, pp. 228-229].
- 1996, Degrees Earned, Women: 46% mathematics, 28% computer sciences, 18% engineering [35, page 4-28].
- For two decades, foreign students have earned 3% – 4% of SE bachelor’s degrees; 7% for engineering, mathematics, and computer science [35, page 4-29].
- What about advanced degrees?
U.S. Advanced Degrees.

Figure 7 suggests that Ph.D. production in engineering and the sciences needs to be increased [27].

![Table: PhD's and other Professional Degrees]

- In 1997, the U.S. awarded 27,000 doctoral SE degrees - more than twice that of any of the other major industrial country (Germany, France, U.K., Japan) [35, page 4-22].

- Scale of graduate education in Japan has been small by international standards [35, page 4-23].

- In 1997, Asia (China, India, Japan, South Korea, Taiwan) awarded 18,000 doctoral SE degrees - 12% annual growth during 1993-1997 [35, page 4-23]. Chinese students earned more than twice the number of doctorates within Chinseese universities as opposed to within U.S. universities [35, page 4-24]. Universities within 5 Asian countries now produce more engineering doctorates than universities within the U.S.. Gap is even larger, since half of U.S. degrees are earned by foreign students, the majority of whom are Asian [35, page 4-24].
U.S. Higher Education Data (continued).

Figure 8 provides additional data on how degrees are distributed [27].

Master’s Level. At the Master’s level, the percentage of women receiving Engineering (18%) degrees does not compare well with Education (77%), Business (39%), and Health related disciplines (79%). In 1996, underrepresented minorities earned 7.4% of SE master’s level degrees [35, page 4-32]. Fewer foreign graduate engineering students since 1994 account for fall-off in engineering master’s degrees [35, page 4-32].

Ph.D. Level. A very large percentage of engineering Ph.D. degrees went to nonresidents: Engineering (48%), Computer Science (43%), Mathematics (47%), and the Physical Sciences (35%). The Ph.D.’s earned by women represented 12% in engineering, 34% in SE, and almost 35% in natural sciences [35, page 4-32]. Underrepresented minorities earned 7% of all doctoral SE degrees. [35, page 4-38].

By 1997, underrepresented minorities were 9% of graduate enrollment in SE fields. Women represented 38%

<table>
<thead>
<tr>
<th>Other interesting Education Facts for 1997</th>
<th>Total</th>
<th>Women</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associates Degrees</td>
<td>571,226</td>
<td>347,278</td>
<td>61%</td>
</tr>
<tr>
<td>Bachelor’s Degrees</td>
<td>1,172,879</td>
<td>652,364</td>
<td>56%</td>
</tr>
<tr>
<td>Master’s Degrees</td>
<td>419,401</td>
<td>238,454</td>
<td>57%</td>
</tr>
<tr>
<td>PhD’s, ED’s</td>
<td>45,876</td>
<td>18,730</td>
<td>41%</td>
</tr>
<tr>
<td>First Professional degrees</td>
<td>78,730</td>
<td>33,166</td>
<td>42%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,288,112</strong></td>
<td><strong>1,289,992</strong></td>
<td><strong>56%</strong></td>
</tr>
</tbody>
</table>

| Of the Master’s degrees                 |           |           |         |
| Education                               | 110,087   | 84,281    | 77%     |
| Business                                | 96,923    | 37,688    | 39%     |
| Health                                  | 35,958    | 28,256    | 79%     |
| Engineering                             | 25,787    | 4,667     | 18%     |

| Of the PhD’s                           |           |           |         |
| 48% of PhD’s in Engineering went to Nonresidents |   |   | |
| 43% of PhD’s in Computer science went to Nonresidents |   |   | |
| 47% of PhD’s in Mathematics went to Nonresidents |   |   | |
| 35% of PhD’s in Physical Sciences went to Nonresidents |   |   | |
| 12% of PhD’s in Engineering went to Women   |   |   | |

Source of data: National Center for Education Statistics (nces.ed.gov)
Prepared by Duncan T. Moore, OSTP, Nov 1999

Figure 8: Additional Degree Distribution Data

- Need to reach more women!
National Science Board U.S. Land of Plenty Report


<table>
<thead>
<tr>
<th>Gender</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, Male</td>
<td>41.7%</td>
</tr>
<tr>
<td>White, Female</td>
<td>34.7%</td>
</tr>
<tr>
<td>Black</td>
<td>10.3%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>9.2%</td>
</tr>
<tr>
<td>Asian and Other</td>
<td>4%</td>
</tr>
</tbody>
</table>

1997 SET Workforce

<table>
<thead>
<tr>
<th>Gender</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, Male</td>
<td>67.9%</td>
</tr>
<tr>
<td>White, Female</td>
<td>15.4%</td>
</tr>
<tr>
<td>Black</td>
<td>3.2%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3%</td>
</tr>
<tr>
<td>Asian</td>
<td>10.2%</td>
</tr>
<tr>
<td>American Indian</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

Underrepresented Groups

- Women
- Blacks
- Hispanics
- Pacific Islanders
- American Indians

Persons with Disabilities:

- 20% of U.S. population
- 14% of U.S. workforce
- 6% in SET fields

To Remain Competitive, Something Must Be Done!
Who Is In Academia? [35, pp. 6-3, 6-22-6-24]

- **Faculty Numbers.** Employment of doctoral scientists and engineers in academia reached a record 232,500 in 1997. Those with full-time faculty appointments were also at an all-time high of 178,400.

- **Age.** The average age of the doctoral academic science and engineering faculty continues to rise.

- **Full-Time.** Fewer than one-third of new science and engineering Ph.D.’s hired by the research universities obtained full-time faculty appointments - less than half the percentage of the early 1970’s.

- **Tenure-Track.** The tenure-track fraction among young Ph.D.’s with faculty positions - about 75 percent - has remained roughly stable since the early 1970’s.

- **Primary Activity.** The balance among SE Ph.D.’s reporting teaching or research as their primary activity has shifted toward research, for faculty and nonfaculty alike. But among recent Ph.D.’s ion faculty positions, trends in primary activity have reversed direction since the late 1980’s: Teaching rose from 56 percent to 68 percent; research declined from 38 percent to 23 percent.

- **Women.** In 1997, an estimated 59,200 women with a doctorate in science or engineering were employed in academic positions. This represented 22% of all doctoral SE academic faculty. By rank, 12% were full professors (9,500), 25% were associate professors (13,000), and 37% were junior faculty - i.e. assistant professors and instructors - (17,000) [35, page 6-22]. Only 3% of women had doctorates in engineering, versus 14% of men [35, page 6-22].

  Men. In 1997, an estimated 209,891 (= \( \frac{59,000}{0.22} - 59,000 \)) men with a doctorate in science or engineering were employed in academic positions. For men, by rank, 34% were full professors (71,400), 18% were associate professors (38,000), and 14% were junior faculty (29,500).

- **Underrepresented Minorities.** American Indians, Alaskan Natives, Blacks, and Hispanics remain a small minority in academia - about 6% or 13,700 in 1997 with SE doctorates. Represented about 5 – 6% of all physical and life science, mathematics, and engineering SE doctorate faculty; 3% of all computer and environmental science SE doctorate faculty [35, page 6-23].

- **Asians and Pacific Islanders.** In 1997, Asians and Pacific Islanders represented 27% of academically employed computer science Ph.D.’s, 20% of engineers, and 14% of physical scientists and mathematicians. 51% held positions in physical, environmental, and computer sciences - a much higher percentage than for whites (34%) or underrepresented minorities (28%) [35, page 6-24].

Need to Increase Underrepresented Groups In Academia!
U.S. Population Data.

Figure 9 addresses the question [28]:

*What is the Composition of the U.S. Population?*

![Pie chart showing population composition](image)

Figure 9: 1997 U.S. Census Population Estimates

In tabular form, we have:

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, non-Hispanic</td>
<td>72.0%</td>
</tr>
<tr>
<td>Black</td>
<td>12.6%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>10.8%</td>
</tr>
<tr>
<td>Asian, Pacific Islander</td>
<td>3.7%</td>
</tr>
<tr>
<td>American Indian</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

We would like to see this composition reflected across SMET disciplines - at all levels.

- How are these groups represented in graduate school?
U.S. Graduate School Enrollment.

Figure 10 shows the composition of U.S. graduate student enrollment [28].

![Graduate Student Enrollment 1997](image)

Figure 10: 1997 Graduate Student Enrollment

The figure shows that White, non-Hispanics and Non-US citizens have the highest enrollment percentage - followed by Asian-Pacific Islanders, Blacks, Other, Hispanics, and then American Indians.

- Lets examine SMET disciplines closer.
U.S. SMET Graduate School Enrollment.

Figure 11 shows the composition of U.S. graduate student SMET enrollment [28].

![1997 SMET Graduate Enrollment](image)

Figure 11: 1997 SMET Graduate Enrollment

In tabular form, we have:

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, non-Hispanic</td>
<td>55.9%</td>
</tr>
<tr>
<td>Non-US Citizens</td>
<td>24.2%</td>
</tr>
<tr>
<td>Asian-Pacific Islander</td>
<td>6.4%</td>
</tr>
<tr>
<td>Black</td>
<td>4.7%</td>
</tr>
<tr>
<td>Other</td>
<td>4.6%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3.7%</td>
</tr>
<tr>
<td>American Indian</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

This shows that the percentages for Asian-Pacific Islanders, Blacks, Hispanics, and American Indians are disproportionately low when compared to population percentages.

- What composition exists for graduate enrollment in Engineering?
U.S. Graduate Enrollment In Engineering.

Figure 11 shows the composition of U.S. graduate student SMET enrollment [28].

![Pie chart showing enrollment percentages by ethnicity and citizenship]

1997 Graduate Enrollment in Engineering

Figure 12: 1997 Graduate Enrollment In Engineering

In tabular form, we have:

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, non-Hispanic</td>
<td>45.6%</td>
</tr>
<tr>
<td>Non-US Citizens</td>
<td>36.1%</td>
</tr>
<tr>
<td>Asian-Pacific Islander</td>
<td>8.1%</td>
</tr>
<tr>
<td>Other</td>
<td>4.4%</td>
</tr>
<tr>
<td>Black</td>
<td>2.8%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2.8%</td>
</tr>
<tr>
<td>American Indian</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

Non-US citizen and Asian-Pacific Islander percentages have improved with respect to those given in Figure 11. The percentages for Blacks, Hispanics, and American Indians, however, have gotten worse - exacerbating the already disproportionately low percentages in Figure 11. This suggests that we have a national problem - particularly when one considers the demand for highly trained SMET degrees. We must reach more underrepresented groups.

- Now lets examine our region.
  - Arizona (AZ), Colorado (CO), New Mexico (NM), Nevada (NV), Utah (UT).
Population Data For Our Region.

Our region consists of

- Arizona (AZ), Colorado (CO), New Mexico (NM), Nevada (NV), Utah (UT)

The population composition for our region is shown in Figure 13 [28].

![1998 Population Data for Our Region](image)

Figure 13: 1998 Population Data For Our Region

In tabular form, we have:

<table>
<thead>
<tr>
<th>Population</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, non-Hispanic</td>
<td>71.9%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>18.4%</td>
</tr>
<tr>
<td>Black</td>
<td>3.7%</td>
</tr>
<tr>
<td>American Indian</td>
<td>3.7%</td>
</tr>
<tr>
<td>Asian-Pacific Islander</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

- What is the composition for M.S. and Ph.D. Degrees in our region?
M.S. and Ph.D. Composition For Our Region.
The composition of M.S. and Ph.D. degrees for our region is shown in Figure 14 [28].

![Graph showing composition of M.S. and Ph.D. degrees]

**Figure 14: 2000 M.S. and Ph.D. Degrees in Our Region**

In tabular form, we have:

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, non-Hispanic</td>
<td>77.7%</td>
</tr>
<tr>
<td>Other</td>
<td>16.1%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3.5%</td>
</tr>
<tr>
<td>Asian-Pacific Islander</td>
<td>1.3%</td>
</tr>
<tr>
<td>Black</td>
<td>0.7%</td>
</tr>
<tr>
<td>American Indian</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

We have a problem, it needs to be addressed, and we are determined to make a significant contribution!
Making the Case for Mentoring of Underrepresented Ph.D. Students

Why should we increase the number of SMET Ph.D. graduates?

The case for mentoring of underrepresented Ph.D. students can be made as follows.

Basic Premises

- The Nation needs highly trained individuals with advanced technical degrees to meet the technical SMET research and development challenges of the 21st century.

- Diversity is essential for the Nation to properly compete in the very diverse - increasingly technological - global marketplace.

Problem

- The Nation is losing potential SMET students disproportionately more in underrepresented groups. Given global competition trends, this loss can not be permitted to continue - as it threatens the long-term security of the Nation.

Strategic Goals

- To increase underrepresented SMET students to acceptable levels, it is necessary for underrepresented groups to be proportionately represented in the professoriate, in national labs, and in industry.
  - The Nation must significantly increase the number of underrepresented students receiving Ph.D. degrees in SMET fields.

- Every group must be afforded the opportunity to participate (proportionately) at the highest level in SMET fields. The Nation cannot afford to play a passive role in the development and nurturing of human capital.
  - The Nation must increase the number of SMET mentors.

Consequences

- The economic and national security of the Nation depends on our success. If we succeed, many will benefit (Multiplier Effect). If we fail, the Nation will pay a large economic and social price.

This workshop, fundamentally, is about tactics and empowering a new wave of mentors!
6  Mentoring: Additional Perspective and Motivation

Why should anyone mentor a student? We have provided some answers to this question. The following impassioned quotations provide us with additional perspective, motivation, and inspiration [25], [26].

“When I was an undergraduate, considering graduate school, a faculty member, without any shame, announced that he didn’t see any value in investing in women. In his words, ‘we don’t waste fellowships on women.’ Fortunately, I had strong mentors along the way . . . . They were my role models and they offered me a chance to learn and grow as a young scholar.”

Dr. Rita R. Colwell  
Director  
National Science Foundation

“There is virtually nothing that we can do in Washington, D.C. that can match the pleasure and the joy of helping a young person to use his or her talents to the fullest.”

Dr. Arthur Bienenstock  
Assistant Director for Science, Office of Science and Technology Policy  
Executive Office of the President

“Your work as mentors in science, mathematics, and engineering puts you right in the center of things that matter. It matters to the individuals you guide and to the society that benefits from your guidance.”

Dr. Joseph Bordogna  
Deputy Director  
National Science Foundation

“You have, through your institutions, through your individual efforts, made a difference in someone’s life. It is significant that you are being honored today, because it says that the country values those people who give their lives to others.”

Dr. Freeman A. Hrabowski, III  
President  
University of Maryland

“Homogeneity makes us stale. Our national science and technology enterprise needs practitioners from diverse backgrounds and perspectives, if we want to keep our lead in an age of innovation.”

Dr. Neal Lane  
Assistant to the President and Director, Office of Science and Technology Policy  
Executive Office of the President

“Teaching is the facilitation of learning. Mentoring is the facilitation of growth.”
Professor Raymond Landis  
University of California, Los Angeles  
Presidential Excellence Awardee (1999)

“A successful mentor will never falter in their commitment to the student, but project onto them a sense of self-worth and confidence, of enthusiasm and intellectual passion.”

Professor Ram S. Lamba  
University of Puerto Rico, Cayey  
Presidential Excellence Awardee (1999)

“If you tell your students, ‘you are going to do an organic reaction,’ it doesn’t mean anything. But if you say, ’you are going to use a microwave oven to make aspirin in ninety seconds,’ they feel excited.”

Professor Ajay K. Bose  
Stevens Institute of Technology  
Presidential Excellence Awardee (1999)

“When we mentor young people, we share the load, we help them find their path; and by doing so, we embrace our humanity at its most fundamental level.”

Dr. Jane Stutsman  
Deputy Assistant Director for Education and Human Resources  
National Science Foundation

“Our scientific and technological strengths as a nation can only be increased by a diversity of perspectives.”

Dr. Joseph Bordogna  
Deputy Director  
National Science Foundation

“Part of the problem in having minorities and women get through the Ph.D. level in (science, mathematics, and engineering) disciplines is the lack of resources that may be at their disposal and the discouragement that they receive in obtaining those resources ... It is important for the National Science Foundation to encourage industrial cooperation and involvement in mentoring programs and in the provision of funds in support of students ... Mentoring is not recognized broadly as an issue in industry, but needs to be addressed by this sector.”

Dr. Patricia Wirth  
AT&T Laboratories  
Institutional Presidential Excellence Award (1998)

“The most valuable mentor is one who is honest and provides direct yet supportive reality checks on perfor-
mance, expectations, and requirementds for success.”

Professor Caroline Kane
University of California, Berkeley
Presidential Excellence Awardee (1998)

“The cornerstone of my mentoring philosophy is the basic principle that every student is sacred, that we as a Nation must view all of our children as essential resources, resources to be nurtured, developed, disseminated, integrated into the society, fully utilized, and too valuable to lose.”

Professor Armando A. Rodriguez
Arizona State University
Presidential Excellence Awardee (1998)
7 Mentoring 101: Making a Difference

Why don’t we get more Ph.D. Students?

- Eagerness to work, good economy, make money, apply what they have learned, school fatigue.
- Fear of unknown.
- Horror stories.
- Lack of perspective, guidance, . . . , role models.
- First in family to attend graduate school and/or pursue Ph.D.
- Feel it is not needed; not cost-effective (opportunity costs).
- Unaware of possibilities.
- Failure to capture imaginations of students.
- Belief that Ph.D.’s are for professors and/or will limit opportunities.
- Economic/social/gender/racial barriers.

What can we do?

- Explain importance of an advanced degree in our increasingly technological world.
- Explain many possibilities that an advanced degree offers.
- Capture imaginations of students.
- Make sure students are aware of the many resources that are available.
- Break down those social/gender barriers.
- Provide perspective and guidance, reduce uncertainty.

We Need More Mentors!
What distinguishes M.S. from Ph.D. experience?

- Technical Differences
  “Traditional” problem solving (assuming no M.S. thesis) versus research.
  - M.S.
    - focus is on learning and “traditional” problem solving
    - requires little independence
    - need not make a contribution
    - solve a priori carefully/precisely formulated solvable problems with one unique solution.
  - Ph.D.
    - focus on knowledge creation and problem formulation
    - can require a significant amount of independence...working towards becoming an independent researcher
    - need to make a “significant” contribution
    - learn to precisely formulate (important) approximately solvable problems with tractable solutions.

- Required background.

- Rigor and commitment.

- Uncertainty (e.g. thesis topic, time-to-graduation, job prospects, etc.).

- Other: economic, social, emotional, etc.

What can we do to reach more students?

We Need More Mentors!
What Is A Mentor?

The concept of a mentor goes back a long way. We recall from Classical Greek Mythology that [29]:

*Mentor was a loyal adviser of Odysseus entrusted with the care and education of Telemachus (son of Odysseus and Penelope); Telemachus would help kill the suitors of Penelope while his father was away fighting in the Trojan War.*

Most dictionaries would provide a definition like [30, pg. 1201]:

*mentor - a wise and trusted counselor or teacher.*

We all know that

**A mentor is much much much more!**

We need a much broader definition.

**References on Mentoring**

An excellent reference on mentoring is the following:

References on Mentoring
Another excellent reference is the following:


We will draw considerably from the above works. Other excellent references are provided within the bibliography (page 97).
What Is A Mentor?

A mentor is a “very wise”

- adviser (personal, academic, research, career/professional)
  - counselor (get inside student’s mind), consultant
  - coach, guide, trainer, validator, motivator (inspires, pushes protégé forward [42])
  - critic, trouble shooter, disciplinarian, admonisher (promotes productivity, timely progress [42])
  - strategist, planner (assists in setting realistic goals, milestones [42])
  - observer, illuminator, elucidator
  - sounding board, communicator

- teacher
  - tactician, instructor, educator, monitor (supervises progress, assists in accomplishing tasks)
  - logician
  - problem solver, conflict resolver
  - mirror (so that student becomes self-aware, reflective, introspective, etc.)

- role model (pulls protégé through, one can be a great role model without being a mentor [42])
  - colleague
  - professional (do as she/he does...)
  - citizen of the world

- friend
  - listener, sponsor, advocate, protector, politician, confidant
  - empathetic (e.g. underrepresented students may take more time to feel they fit in)

- facilitator
  - resource outlet, enabler (assists in achieving realistic goals [42])
  - head hunter
  - partner, collaborator

...the precise stoichiometry (combination) must be optimized for each student.
The Ideal Mentor: Desirable Qualities and Attributes

- wise, visionary
- good leader (strategic - to address change, [55, pp. 39-40]), role model
- good manager (tactical - to address complexity, [55, pp. 39-40])
- patient, unassuming objectivity, open minded, observant
- professional, sensitive and empathetic (e.g. toward cultural, gender, racial, disability, and other issues, etc.), thoughtful, caring, perceptive
- fair (judicious), introspective, reflective, ethical
- approachable, available, good communicator
- enthusiastic about many opportunities that exist for students to develop professionally and otherwise
- passion for learning, analytic, inquisitive
- belief that no student is expendable; that students represent our future

Why Mentor?

- share and pass on knowledge and experiences - hopefully wisdom
  - classical Homeric point of view
- personal satisfaction
  - achieve warm fuzzy and, to some extant, immortality - living through your student
  - become a more effective advisor (develop better sense of student needs, goals, expectations, strengths, weaknesses, etc.)
- critical recruitment tool
  - build talent-diverse research group (to permit movement in new directions, learn, cross areas)
  - attract good students
- help our Nation
  - multiplier effect - your students will help others
Responsibilities of a Mentor: What Do Mentees Need?

- create an environment in which the protégé’s talents, skills, creativity, and interests are assessed, nurtured, permitted to flourish, and given the support needed to reach their full potential

- provide perspective - a sense of the Big Picture, how the pieces of the puzzle fit together
  - protégé must learn to distinguish main points (the “forest”) from details (the “trees”)
  - vital for evolving into a mature independent researcher (can’t read everything!)

- provide objective advice, guidance (technical, personal, career, etc. ... know your limits)
  - provide insightful examples, alternative approaches/solutions to technical/personal problems, personal experience, other sources of advice

- help plan, set, and achieve realistic tasks, goals, and milestones
  - provide a roadmap, help student deal with and reduce uncertainty
  - plan and anticipate hurdles and forks, provide contingency plans (challenges/safety nets)
  - literature survey, proposal, qualifier, paper, publish, conference, comprehensive, defense, cv, job search ... students must understand what their contributions are! (understand Big Picture)
  - become a resource outlet that steers students to the appropriate resources (e.g. financial, scholastic, other mentors, etc.)
  - play active role in seeking out, finding, and creating opportunities

- help formulate a worthwhile original research problem, develop a realistic solution, leaving room for student to evolve into an independent researcher
  - properly assess a student’s background and interests (we should not be cloning ourselves)
  - so that student can make a “significant” contribution to the field
  - help define scope; keep abreast of technical aspects and opportunities associated with field

- develop mentor-protégé relationship into a true partnership (student should not read everything)
  - treat student with respect - as a colleague
  - meet periodically to guage progress (quality time), provide feedback (constructive criticism, continuous assessment)
  - provide friendship when needed (monitor degree of independence)
  - explain what a professor does! (teaching, research, service - provide perspective/understanding)
Ph.D. Student Mentoring Checklist

Assessment

• Skill Assessment
• Interest Assessment
• Topic Selection, Problem Definition
• Personal Assessment

Getting Started

• applied, experimental, abstract, theoretical
• industry, small company, laboratory, post-doc, professoriate

Master Plan (Big Picture)

• scope
• objectives/goals
• strategies/tactics
• literature survey plan
• problems/subproblems/experiments

Planning

• Personal Plan
• Academic/Intellectual/Scholastic Plan (Learning)
• Research Plan (Knowledge Creation)
• Career/Professional Plan
Ph.D. Student Mentoring Checklist

Resources: A Comprehensive Support Infrastructure

• Funding
  – research assistantship
  – teaching assistantship
  – fellowship
  – scholarship
  – employment

• Technical Resources
  – internet resources (useful url’s and search engines)
  – conference/journal papers, books, theses (library access)
  – notes, examples, problems, exams, solutions
  – projects

• Academic
  – catalog
  – program of study forms
  – independent study forms
Ph.D. Student Mentoring Checklist

Resources: A Comprehensive Support Infrastructure (continued)

• Career/Professional
  – internet resources (useful url’s and search engines)
  – presentations
  – qualifying exam questions and presentations
  – comprehensive exam questions and presentations
  – proposals
  – professional organizations, society memberships, journal subscriptions
  – peer networking
  – mentoring network
  – bulletin board
  – events
  – seminars
  – scholarships, fellowships, grants, etc.
    * statements of purpose, applications, letters
  – industry/faculty position opportunities
    * résumé, cv, cover letters

• Personal
  – organizations and support groups
  – gender
  – racial/ethnic
  – economical
  – social
  – cultural
  – health
Ph.D. Student Mentoring Checklist

Resources: A Comprehensive Support Infrastructure (continued)

- Physical Resources
  - copying
  - computing
  - laboratory
  - hardware
  - software
  - equipment
  - other facilities
  - supplies

Time Management (prioritizing)

- time line, critical deadlines, milestones, forks (options, contingency plans)
  - preliminary work
  - literature survey
  - qualifying exam
  - courses
  - independent study classes
  - meeting times
  - seminars
  - presentations
  - conference deadlines
  - paper reviewing
  - publishing
  - proposal writing
  - comprehensive exam
  - thesis committee composition
  - writing of thesis
  - thesis defense
  - internships
  - job hunting
Ph.D. Student Mentoring Checklist

Student-Mentor Relationship

- respect
- honesty
- trust
- open communication
- understanding/clarity
- empathy
- pact (plan which defines rules)
Ph.D. Student Mentoring Checklist


**Intellectual Growth and Development**

- Encourages my imagination and creativity
- Encourages my inventiveness including the identification of new research topics, discovery of new techniques, development of new apparatus and patentable inventions
- Helps me develop my capacity for logical reasoning including abstract and theoretical reasoning as well as my ability to draw logical inferences from observational and experimental data
- Helps me to be critical and objective concerning my own results and ideas

**Research**

- Shows me how to do original research
- Takes steps to improve my ability to conceive explanatory hypotheses and design critical tests of such hypotheses
- Takes steps to improve my observation of natural, technical, or social phenomena
- Provides constructive feedback on my experimental designs
- Provides thoughtful advice on my research

**Professional Career Development**

- Provides counsel for important professional decisions
- Is instrumental in building my professional networks
- Provides guidance on professional ethics
- Promotes collegial relationships with professional community
- Helps me to envision a career plan
- Provides guidance on finding a job or postdoctoral appointment
- Provides guidance on a full range of career options or a referral
Ph.D. Student Mentoring Checklist


Academic Guidance

- Provides sound advice in planning my courses and curriculum relative to my career goals
- Provides sound advice on my academic goals relative to my career plans
- Discusses pitfalls in my academic growth

Skill Development

- Takes steps to develop my planning and organization, communication, teaching, and team-leadership skills
- Provides constructive feedback on presentation skills
- Provides constructive feedback on writing skills

Personal Communication

- Listens carefully to my concerns
- Keeps in touch on my progress
- Takes into account gender, ethnic, and cultural issues
- Takes a respectful attitude toward my interests and work
- Does not abuse power—does not take advantage of my time and abilities
- Provides feedback in timely fashion
Ph.D. Student Mentoring Checklist

- Detailed Plan
  - Mentor-Protégé Agreement with Detailed Time Line, Tasks, Milestones, and Deliverables
  - Agreement Must Be Understood and Accepted By Student

- Feedback for Mentor
  - Session Mentor Checklist: Do’s and Don’ts
  - Aligned with Plan
  - Grade Yourself, Get Feedback from Student

- Feedback for Protégé
  - Session Protégé Checklist: Do’s and Don’ts
  - Aligned with Plan
  - Protégé Must Properly Utilize Mentor

- Consult Department/College/University Mentoring Guide
  - Does One Exist?

Spend Consistent Quality Time With Your Students!
Establish An Agreed Upon Routine!
Adapt!
8 About MGE@MSA Program

Most of this section is available at MGE@MSA Web Site:

http://www.asu.edu/MGE

Arizona State University  
PO Box 871003  
Tempe, Arizona 85287-1003  
Voice: (800) 327-4893 (students)  
(480) 965-3958 (others)  
Fax: (480) 965-8309  
E-mail: MGE@asu.edu

Albert L. McHenry, Ph.D.  
Project Director  
Dean, College of Technology and Applied Sciences  
Arizona State University, East Campus

8.1 A Brief Introduction

Major new features of the MGE@MSA program (among many others) include the following:

Faculty Mentoring Institutes

The objective of this activity is to provide training/orientation for faculty mentors to help them acquire their resources and skills in their specific disciplines to function as truly effective mentors of minority graduate students.

Faculty Graduate Mentoring Network

The objective of this activity is to continue the strong effort that began with the Faculty Mentoring Institutes by providing a forum to serve as both a reference resource and dynamic tool full of useful information on mentoring and peer networking that faculty can incorporate easily into their daily routine. The network will provide a world wide web site, bulletin board, and active listserv.

Graduate Student Peer Network

To facilitate and encourage peer networking and peer advising between and among beginning, intermediate, and advanced graduate students in order to help the students, especially beginning students, progress effectively and expeditiously towards degree completion.

Faculty-Directed Documentation Of Student Research Achievements

To provide students with guidance on how they should be progressing in order to meet their graduate degree requirements, not in a nominal sense, but genuinely calibrated to the research expectations of the sponsoring department.
8.2 What is MGE@MSA?

The National Picture: Current Status of Minority Graduate Education in the United States

It is well-documented that very small numbers of underrepresented minority students receive Master’s or doctoral degrees in science, mathematics, and engineering (SME). Moreover, the problem of inadequate underrepresented minority participation in SME graduate education has scarcely improved during the past decade. Both the small numbers of underrepresented minorities studying at the undergraduate level, and, especially, the even smaller number who actually apply to graduate school are serious problems. The following chart demonstrates the severity of the problem in a striking manner:

<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>% of Total Undergraduate Degrees</th>
<th>% of Total Doctoral Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>7</td>
<td>2.9</td>
</tr>
<tr>
<td>Hispanic American</td>
<td>6</td>
<td>3.0</td>
</tr>
<tr>
<td>Native American</td>
<td>0.6</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Source: National Science Foundation, NSF 99-320

The percentage declines are even more worrisome when we find how small the pools are in the first place. According to the U.S. Department of Education, in 1995 only 52 Native Americans received bachelors in all the physical sciences combined, only 98 B.S. degrees were awarded to Hispanics in mathematics, and only 169 African Americans received M.S. degrees in the Biological/Life Sciences.

At the doctoral level, the numbers are appallingly small. The National Research Council documents that in 1996 only 41 American Indians, 232 African Americans, and 295 Hispanics (compared to 10,316 Anglos and others), earned doctorates in the physical sciences, engineering, and biological sciences combined. In certain fields the minority presence is nearly non-existent. In computer science, only one Mexican American received a doctorate in 1996. A single Native American in the entire United States received a doctorate in mathematics that year. Similar vacuums exist in such fields as astronomy, physics, earth, atmospheric and ocean sciences, various subfields of chemistry or engineering, and others.

Leadership By The National Science Foundation

In order to help address this national shortage of underrepresented minorities receiving SEM doctoral degrees, in 1998 the National Science Foundation established the Minority Graduate Education (MGE) program within its Education and Human Resources (EHR) Directorate. The goal of the MGE is quite simply to increase significantly the number of students receiving doctoral degrees in the science (physical and life science disciplines), mathematics, and engineering, with special emphasis on population groups underrepresented in these fields. Because there exists a critical shortage of role models, the NSF is especially interested in increasing the number of minority professors in these fields. In order to achieve its ambitious overall goal, the MGE program seeks (1) to develop and implement innovative models for recruiting, mentoring, and retaining minority students in science and engineering doctoral programs; and (2) develop effective strategies
for identifying and supporting underrepresented minorities who want to pursue academic careers.

In the first year of MGE (FY 1998) eight projects were established across the country. The institutions involved included Georgia Institute of Technology, Howard University, University of Michigan, University of Alabama at Birmingham, University of Florida, University of Missouri-Columbia, University of Puerto Rico, and Rice University. In FY 99, an additional eight projects were established. Besides the MGE@MSA alliance, other institutions funded in 1999 include the University of Mississippi, University of California at Berkeley, State University of New York (SUNY) Stony Brook, the University of Massachusetts at Amherst, University of North Carolina at Chapel Hill, Howard University, and City University of New York (CUNY). In 1999, the federal government approved appropriations to NSF’s Education and Human Resources for $642.5 million with $7.5 million for continuation of a minority graduate education activity.

Minority Graduate Education at Mountain States Alliance (MGE@MSA)
The MGE@MSA builds upon our Western Alliance to Expand Student Opportunities (WAESO) which is an eight year alliance within NSF’s Louis Stokes Alliance for Minority Participation (LSAMP) aimed at increasing the number of underrepresented minority students obtaining baccalaureate degrees in the sciences, mathematics, and engineering. MGE@MSA establishes a number of new components and activities which, while drawing upon the extensive experience and manifest successes of the WAESO alliance at the undergraduate and transition to graduate school levels, are carefully designed to meet the challenge of retaining graduate students through the timely receipt of the doctoral degree and helping them engage in postdoctoral career paths, particularly as faculty members. The problems of faculty inexperience and the need for faculty information and training; the lack of mentors, role models or family/community experience with graduate school by underrepresented students; and the challenge of establishing a research program as expeditiously as possible are areas tackled by MGE@MSA through carefully designed activities.

Doctoral granting institutions participating in MGE@MSA are

- Arizona State University, Brigham Young University, Colorado School of Mines, Colorado State University, University of Arizona, University of Colorado at Boulder, University of Nevada at Las Vegas, University of Nevada at Reno, University of New Mexico, University of Utah, and Utah State University.

As we have done with unparalleled success for over seven years in WAESO, each specific activity will be developed and refined through a unique peer review process modeled after the best aspects of the peer review system at NSF but customized to a smaller, regionally-focused scale. Scientists, specifically faculty members working with students, will be involved in every aspect of the project and will have primary control over the project and the allocation of funds, through their participation in the operational committees. Committees made up of faculty throughout our alliance will review, approve, request modifications, or disapprove each request for a specific activity at member institutions submitted by a faculty mentor. This mechanism has made our alliance successful at encouraging innovation and in replicating effective activity models at the undergraduate level throughout our region in part because committee members are rotated through our 3 cycle
(Fall, Spring, Summer) per year activity process and participating faculty (including 223 experienced SEM research faculty from our alliance’s participating comprehensive universities) obtain examples of successful activity models conducted throughout our alliance.

**Numerical Goals of the MGE@MSA**

The goals and objectives (anticipated outcomes) of the MGE@MSA project are as follows:

- **Graduate Enrollment**
  
  To increase by 100% over the five years of the project, total underrepresented SME graduate student enrollment. Our current baseline graduate student enrollment is 696. By the end of the fifth year we will double the graduate enrollment to 1,392.

- **M.S. Production Goal**
  
  To increase by 75% over the five years of the project, the total number of M.S. degrees earned by underrepresented SME minority students. Our current baseline annual minority graduate student M.S. production is 119. By the end of the fifth year we will increase that number by 75% to 208.

- **Ph.D. Production Goal**
  
  To increase by 300% over the five years of the project, the total number of underrepresented minority SME doctoral students who earn the Ph.D. Our current annual minority student SME Ph.D. production is 20. We will increase this to 60 by the end of the 5th year of this project.

- **Ph.D. Placement Goal**
  
  To place 90% or more of our students who graduate with the Ph.D. with a job consistent with their research preparation, preferably as faculty members or researchers in labs or institutes.
8.3 What MGE@MSA Can Do For You

The Problem
University research programs in science and engineering are incubators for new ideas and technology that shape our modern life. However, while innovations are creating new information and industries, the growing economy and a diminished interest in graduate studies is making it increasingly difficult to recruit and retain graduate students in science and engineering [32]. Within our own region (Arizona, Colorado, New Mexico, Nevada, and Utah) of the U.S., several research programs at public universities are severely limited in their growth and fulfillment of research contracts due to a scarcity of doctoral students in engineering and science disciplines. Public universities are also under increasing pressure at the state and federal level to limit the use of tax payer dollars to educate international students [33].

The Opportunity
The growing population of underrepresented students obtaining baccalaureate degrees in science, mathematics, and engineering especially within our region offers a unique opportunity to recruit motivated and talented doctoral students. The MGE@MSA has designed specific programs to retain, graduate, and provide career options for students who are traditionally underrepresented in science, mathematics, and engineering. These programs will also strengthen the overall capabilities of science, math, and engineering university research programs to benefit all students by recruiting the following key players and offering incentives for their participation.

The Key Players

Graduate Students:

Prospective Students
Why go to graduate school? What can I expect from a doctoral program? Aside from important general reasons such as the fact that a doctoral degree opens the door to research and faculty opportunities, prospective students need to hear from the community in their respective fields consisting of current graduate students, recent graduates, faculty, and professional organization members. The MGE@MSA provides a web site and materials for Graduate Record Examination (GRE) preparation, a consolidated student application and information packet for applying to graduate programs, and networking opportunities with this community. Continuing Students Graduate students face the challenge of creating a body of work that is recognized as advancing their chosen field of study. To accomplish this task, they need to draw from an ever expanding knowledge base in an effective and time efficient way. It is also important that graduate students develop a peer network in which they can draw expertise from during their graduate research or later in their professional lives. Coursework at the undergraduate and graduate levels is an intensive approach to obtaining a specialized knowledge base, but a vast body of expertise resides within journal articles, faculty, industrial researchers, databases, and web sites. Moreover, qualifying exams which determine candidacy for doctoral programs expect students to synthesize the body of undergraduate work taken and understand how to apply this specialized knowledge to tackle their respective research topic.
The first line resource to help graduate students accomplish their mission is their research advisor(s). The MGE@MSA has several programs to help research faculty develop skills to more effectively mentor students so that they can achieve high productivity and realize their creative potential. Also, the Graduate Student Peer Network and Student Professional Development programs of the MGE@MSA bring additional resources and expert guidance that can be of near and long term utility. As an added incentive, a small $250 stipend for each semester of active involvement in the Graduate Student Peer Network will be provided through the MGE@MSA.

In order to ensure that students are on a genuine, productive research course, the MGE@MSA Faculty-Directed Documentation of Student Research Achievements will provide student guidance on how they should be progressing in order to meet the graduate degree requirements. Students will receive a $500 per semester research budget that they can accumulate for professional travel to conferences, materials and supplies, software or other expenses through this MGE@MSA program.

Research Faculty
University research faculty are involved in several key roles at their institutions, but central to their interests is the creation of new knowledge. Collaborations with graduate students often prove fruitful in this endeavor, however faculty have received little or no training or orientation on mentoring minority students.

The MGE@MSA has designed the Faculty Mentoring Institutes to give faculty mentors the resources and skills in their specific disciplines to function as truly effective mentors of minority graduate students. These institutes will span 1-3 days in length and be led by nationally recognized science and engineering faculty who have a track record of successfully mentoring and graduating minority doctoral students. Attending faculty who sign up as a MGE@MSA graduate mentor will be provided with a small incentive budget of about $500 for materials and supplies and/or travel to help continue interactions with mentor faculty of national prominence and to help provide an enhanced research environment for minority graduate students. Also, the MGE@MSA is providing a forum through the Faculty Graduate Mentoring Network program that will serve as both a reference resource and dynamic tool full of useful information on mentoring and peer networking that faculty can incorporate easily into their daily routine.

Department and Center Chairs
Productive research groups are presented with new opportunities for training and development funds to grow their graduate programs and departments. As federal agencies continue to increase funds for research training grants, competitive institutions are the ones which show a track record for mentoring American students, and especially underrepresented students in science, mathematics, and engineering. The MGE@MSA will track the underrepresented minority students and their mentors and provide a summary report to the governing board and representatives from each of our participating universities. Data on other MGE programs nationwide will also be made available.
Efficiency of university resources is also an increasingly important concern. At the department and center level, times to completion and retention rates are becoming increasingly important since the Carnegie Classification of Universities is currently focused on doctoral degree production more than ever. The MGE@MSA programs focus on faculty mentoring and bring a new level of monitoring progress to degree through the Faculty-Directed Documentation of Student Research Achievements and the Faculty Mentoring Institutes. These programs can serve as a model that chairs and directors can disseminate to their faculty as a whole.

Deans

Due to retirements and a healthy economy a very competitive marketplace for science, mathematics, and engineering faculty has emerged over the last few years. There is also a need for motivated faculty to recruit students into science and engineering fields during an era which is seeing interest dwindling in these fields among pre-college and college students [34]. A new source of applicants for faculty positions should come from groups which have traditionally been underrepresented in these fields of study. Moreover, in order to reflect a responsiveness to changing demographics and satisfying state legislators, public universities have been struggling to change the historic data that while African Americans, Hispanics/Latinos, and American Indians comprise 23% of the U.S. population, only 4.5% of doctoral degree recipients are from this segment of the population.

The MGE@MSA has a stated goal of increasing the number of underrepresented minorities enrolled in graduate programs and the annual rate obtaining M.S. and Ph.D. degrees. Towards this goal, programs are designed to create institutional change that will benefit all students paradigmatically.
9  How to Get Started Tomorrow: Incentives and Resources

MGE@MSA Programs

1. Faculty Mentoring Institute
2. Faculty Mentoring/Documentation of Student Research
3. Faculty Mentors’ Communication Network (Participants and/or Facilitators)
4. Faculty Mentor/Protégé Pairing Service
5. Protégé Peer Network
9.1 Faculty Mentoring Institute

Goal
Provides orientation/training to help faculty to maximize their effectiveness as mentors of underrepresented minority students (African American, Hispanic, Native American, and Native Pacific Islander) who are in science, engineering and mathematics (SEM) doctoral programs.

Incentive Honorarium
Faculty (whether currently mentoring or not mentoring a minority doctoral student) will receive a $500 budget for mentoring materials, supplies or travel. Faculty currently not mentoring may use funds to recruit underrepresented minority students.

Grant Requirements

- Faculty must be currently mentoring or have an interest in mentoring an underrepresented minority SEM doctoral student.

- Faculty must attend a workshop led by nationally recognized science and engineering faculty who have a track record of successfully mentoring and graduating minority doctoral students.

Seminars for Faculty and Mentoring Initiation, $500
9.2 Faculty Mentoring and Documentation of Student Research

Goal
Provide an interactive environment to assist underrepresented minority protégé in the successful and timely completion of the doctoral degree.

Incentive Honorarium
Faculty may request funds up to $500 per semester for each protégé mentored for materials, supplies, software, duplicating, and travel.

Grant Requirements

- **Meetings**
  Faculty will meet with protégé at regular scheduled intervals (minimally bi-weekly, preferably weekly) to advise student and review students documentation of academic progress.

- **Student Bio**
  Faculty must collect from protégé and submit to MGE@MSA an MGE@MSA student biographical form for each doctoral protégé mentored.

- **Meeting Schedule**
  Faculty must submit a one page description of the proposed schedule of meetings with protégé (submitted in electronic format (e.g. HTML or MS Word.)

- **Research Progress**
  At the end of each semester/term of participation, each protégé mentored must submit a one to two page synopsis of their faculty mentor/protégé meetings documenting progress toward degree.

**Mentoring Initiation and Research Documentation, ≤ $500**
9.3 Faculty Mentoring Communication Network

Goal

The objective of this activity is to continue the strong effort that began with the Faculty Mentoring Institutes by providing a forum to serve as both a reference resource and dynamic tool full of useful information on mentoring and peer networking that faculty can incorporate easily into their daily routine. The network will provide a world wide web site, bulletin board, and active listserv.

Incentive Honorarium

Faculty can request a budget which should reflect the intended level of participation (e.g., participants maximum $500 per semester to listen in and comment weekly; facilitators - maximum $2,500 per semester to facilitate listserv).

Grant Requirements

- Weekly monitoring of listserv messages, active sharing of information (publications, workshops, etc.) on mentoring, and active participation in discussion (without using the names or ids of specific students) with other participating faculty regarding issues confronted and their resolution as they effect the progress of participating underrepresented minority SEM graduate students.

- **Participants** agree to receive email messages via a listserv and comment at least once every two weeks. Messages will be from other faculty regarding mentor/protégé issues, suggested resolutions, and sharing information regarding conferences, etc.

- **Facilitators** agree to read, and, as necessary, initiate and/or facilitate discussions among participating faculty mentors via the listserv.

**Faculty Communications Network, \( \leq $500 - $2,500 \)**
9.4 Faculty-Protégé Pairing Service

Goal
Facilitate communication between MGE@MSA participating faculty mentors and prospective applicants from the pool of competitive underrepresented minority students seeking admission to doctoral SEM programs in the United States via MGE@MSA.

Incentive Honorarium
Service is available year round to MGE@MSA faculty mentors and is free of charge.

Grant Requirements

- Participating faculty will provide information regarding their major field and area(s) of specialization to MGE@MSA staff.
- MGE@MSA staff will arrange for potential doctoral applicants to communicate (via email) with participating faculty mentor(s).

For important guidelines that apply to all MGE@MSA applications, consult General Guidelines for Applicants.

Faculty-Protégé Pairing Service
9.5 Graduate Student Peer Network

Goal
To facilitate and encourage peer networking and peer advising between and among MGE@MSA minority protégés in doctoral science, mathematics, or engineering (SEM) programs in order to help the students progress effectively and expeditiously towards degree completion.

Incentive Honorarium
Participants will be provided with a maximum of $500 for each semester for active involvement with the network. Trained student facilitators may apply for a maximum of $2,500 per semester depending on their expected level of monitoring and facilitation participation.

Grant Requirements

- Underrepresented minority graduate students must be enrolled in a doctoral SEM program or, if they are in a masters program in these fields, must be genuinely interested in pursuing a doctorate in these fields.

- Participating underrepresented minority graduate students must provide a completed student biographical form to MGE@MSA.

- Participants must discuss their issues, network and seek professional and career advice from their peers using the provided electronic forums on a regular basis (minimally bi-weekly, preferably weekly).

- Facilitators agree to read, initiate as necessary, and facilitate discussion among student peers via the listserv and disseminate information regarding conferences and other opportunities pertaining to success in obtaining the doctoral degree.

- MGE@MSA will provide the world wide web site, bulletin board, and active listserv for SEM underrepresented minority graduate students to discuss issues, peer networking and peer advisement.

Peer Communications Network, ≤ $500 — $2,500

STUDENTS WHO MEET THE ABOVE CRITERIA SHOULD CONTACT MGE@MSA FOR APPLICATION MATERIALS.

Selection Committee, MGE@MSA, c/o Hispanic Research Center, Box 872702, Arizona State University, Tempe, AZ 85287-2702, (800)327-4893, (480) 965-3958.
9.6 Mailing Applications

MAIL completed applications to:

   Selection Committee, MGE@MSA
   c/o Hispanic Research Center
   Box 872702
   Arizona State University
   Tempe, AZ 85287-2702

OR

FAX completed applications to (480) 965-8309

If you have questions, call

   (800)327-4893
   (480) 965-3958

The street address for private courier is listed below.
Do not use this street address for regular or express U.S. Mail (it may result in significant delays.)

   215 E. 7th St., Suite 107
   Tempe, AZ 85281
9.7 Student Biographical Form

Student Biographical Form
(Available at http://www.asu.edu/MGE)
9.8 Faculty Application Form

Faculty Application Form
(Available at http://www.asu.edu/MGE)
10 Activities and Unique Aspects of the MGE@MSA Project

10.1 Recruiting Minority Graduate Students

The Problem

There is an urgent need to facilitate applications to graduate programs for admission with financial aid by the additional baccalaureate degree recipients being produced annually by the LSAMP program nationally. There is no guarantee that simply because the LSAMP/NSF increases the number of students with bachelor’s degrees in the relevant fields, that these students will go on to graduate school. There are very strong competitors for this same talent in the corporate world. In addition, the climate for graduate study as perceived by underrepresented students has deteriorated markedly in recent years, including in such key states as California and Texas due to problematic political and legal developments.

Our current NSF grant on behalf of WAESO (Western Alliance to Expand Student Opportunities) includes an extensive graduate preparation and admissions component, almost exclusively funded by Non-NSF (cost-share) funds also called Project 1000, that specializes in recruiting underrepresented minority undergraduates into SME graduate programs. The research component of Project 1000 dates from 1985 and it has been helping thousands of minority students (originally almost exclusively U.S. Hispanic but now available to all underrepresented minority SME students) enter graduate programs since 1987, including functioning as an integrated component of the WAESO LSAMP since 1991. Through WAESO’s graduate preparation and admissions component (Project 1000), we have accumulated a wealth of research and we have established initiatives for graduate recruitment that have had outstanding success. It has received national recognition (for example, winning the $50,000 Charles P. Dana Foundation Award for “Pioneering Achievement in Education” in 1992) and has been supported by many foundations including the Carnegie Corporation of New York, Alfred P. Sloan Foundation, Ford, Rockefeller, Rockefeller Brothers, Hewlett, General Electric Fund, Pew Charitable Trusts, U.S. Department of Energy, U.S. Department of Education and others. Through extensive experience therefore, WAESO’s graduate preparation and admissions component has thus been able to document the following issues related to the recruitment of minority graduate students:

- (a) Unlike most majority students who typically apply to 3-5 universities, a large-scale survey of student application behavior (Baird, 1982) suggests that fully 79% of all underrepresented minority graduate school applicants apply to only a single university. This application behavior reflects less information about the graduate admissions process on the part of minority applicants who have fewer role models in their family, community, among peers and professors, and elsewhere to establish a highly informed strategy for graduate admissions. Many minority graduate school applicants are the first in their family to have ever gone to college as an undergraduate. The graduate program and graduate admissions are a step even more unfamiliar for the minority applicant.

- (b) Minority students typically apply much later in the graduate admissions cycle than their majority counterparts. This behavior, which also reflects the tendency to treat graduate admissions like the undergraduate counterpart, commonly leads to applications that are late or are not as competitive
as they might be, even from minority students with otherwise strong aptitudes for and predictors of success.

- (c) When compared with majority students, prospective minority graduate students lack precise information not only about the graduate admissions process but requirements, obtaining financial aid and the various types of graduate majors and subfields.

WAESO has had over 10 years of operational success in addressing these problems.

The Solution

Thanks to substantial new cost-share commitments by Arizona State University specifically to MGE@MSA, we are confident that MGE@MSA, drawing on its vast experience and an extraordinary pool of WAESO students to recruit, can seize the moment and dramatically increase graduate recruitment in our region at no additional direct cost to NSF. In order to positively address the problems involved in the recruitment of minority graduate students that were described above, MGE@MSA, through WAESO’s already existing graduate preparation and admissions component, almost exclusively funded by non-NSF (cost-share) funds, has already developed a number of proven, successful project components for providing an optimal level of programmatic information and financial aid opportunities to the students; facilitating the graduate admissions process; and matching graduate students with programs. These project components include the following:

A consolidated graduate student application form which the participating graduate schools accept for the purpose of full admission or pre-admission. Students applying to several graduate schools save enormous amounts of time and effort through this service. Application fee waivers for students applying to most participating Graduate Schools. A centralized credentials service that permits students to apply to several graduate schools simultaneously without having to submit more than one application, one transcript for each undergraduate institution attended, and one set of recommendation letters. A concerted effort to obtain the necessary financial aid from the participating graduate schools or third parties such as government agencies (In our most recent year, over 85A toll-free 1-800 telephone line through which we provide intensive, in-depth support and consultation for the student with our professional advisors at every step of the admissions process and as often as the student requires. We are able to accommodate during peak periods as many as 8 students simultaneously with professional advice over the toll-free telephone. The average number of contacts for undergraduate seniors to Project 1000 is seven to ten; for sophomore or junior participants in Project 1000, working their way toward graduation and graduate school, it is three to five. Help for minority students to prepare for the Graduate Record Exam (GRE) in three ways. The first and most general is through overall counseling of applicants on the GRE, its function, its relative importance in the admission process, as well as recommendations for better preparation for this test personally over the telephone, on the world wide web, and via CD-ROM. Second, we bring the actual people at ETS who are responsible for the GRE general and subject tests to conduct one-day workshops at specific sites to orient minority students to the GRE. Finally, we provide GRE test fee waivers to financial aid eligible minority students.
Over 10% of the Puerto Rican and Mexican American students who annually take the Graduate Record Examination and apply to graduate school for full-time study are now served by WAESO’s graduate preparation and admissions component.

WAESO’s graduate preparation and admissions component’s team of carefully-trained advisors aid project students in fulfilling each component of the admissions process (application, test scores, letters of recommendation, essay or statement of purpose), through the actual admission and award of financial aid. Project staff think of themselves as the ”student’s co-pilot” as they monitor each student’s applications to the various graduate schools and follow up through the admission offer of the graduate school and the initiation of the student’s graduate studies. No students are ever charged for any project services.

One of the most useful components of the WAESO’s graduate preparation and admissions component project is a free user friendly CD-ROM (and world wide web site) microcomputer program centered on the needs of the student applicant. The program (for both Windows as well as Macintosh operating systems) makes liberal use of pulldown menus, controls for common mistakes, and has other facilitating features. In addition, the CD-ROM contains a wealth of information about the graduate school admissions process, a comprehensive database of majors, degrees, and specializations at participating institutions, an overview of graduate programs at each institution, and allied information that will help inform the student applicant and facilitate the admissions process. Thus, targeting on the ultimate consumers, the graduate students themselves, MGE@MSA’S students will be much better informed and much more able to easily submit carefully targeted multiple applications to graduate school resulting in a much higher percentage of students receiving offers admissions with substantial financial aid.

In sum, thanks to substantial cost-share commitments to be undertaken by Arizona State University, MGE@MSA will benefit from being able to provide the following features in recruiting graduate students at no additional direct cost to NSF:

- waiving of application fees for student applications at most participating graduate schools,
- waiving of GRE test and additional score report fees for financially needy students,
- free on site workshops by ETS staff to help students preparation on the GRE,
- free extensive personalized academic counseling over an 800 telephone number, and
- a plethora of valuable free information in both text and database format as appropriate
- free highly successful staff efforts to have all students admitted with the necessary financial aid.
10.2 Retaining, Expeditiously Graduating, and Providing Career Options for the Students

The Problem

Among the serious challenges that face projects that wish to graduate underrepresented SME students with doctoral degrees the following need to be addressed: Faculty are relatively inexperienced with minority graduate students because there are relatively few such students in the academy. Faculty need to be provided information and training on how to perform as mentors to minority graduate students. These are not roles that can be performed without orientation. Minority graduate students themselves face an environment where they are relatively inexperienced. Often they are the first in their family to go to college much less graduate school, and at the graduate level there is a dearth of role models and mentors. Minority graduate students tend to overemphasize coursework and pay insufficient attention to the development of research topics and dissertation research. Beginning and intermediate-level graduate students obtain relatively little experience in managing their own research budgets.

Building upon our current WAESO alliance model of success at the undergraduate level and the pool of some 500 faculty and other resource people (approximately 85% are scientists) who have participated in WAESO, most of whom teach at the graduate level as well as the undergraduate level, we have devised a number of project components and activities to retain and graduate minority students through the Ph.D. These include: Faculty Mentoring Institutes to develop the necessary faculty skills and expertise for the role of mentors; a Faculty Graduate Mentoring Network, where, making use of the Internet, faculty can consult and discuss with each other their student’s progress and receive valuable resource and expertise information; an analogous Graduate Student Peer Network where beginning and advanced graduate students can communicate, discuss issues, and engage in peer advising; Faculty-Directed Documentation of Student Research Achievements, a tool to increasing graduate student research productivity and to provide students experience in managing research budgets; and Student Professional Development, which provides through the MGE@MSA listserv, web site, and periodic newsletters, a wealth of information about MGE@MSA departments, professional organizations, corporations, and other resources.

The Solution

MGE@MSA proposes to use NSF MGE funds to establish a number of new components and activities which, while drawing upon the extensive experience and manifest successes of our WAESO alliance at the undergraduate and transition to graduate school levels, are carefully designed to meet the challenge of retaining graduate students through the timely receipt of the doctoral degree and helping them engage in postdoctoral career paths, particularly as faculty members. We address the above issues that describe problems of faculty inexperience and the need for faculty information and training; the lack of mentors, role models or family/community experience with graduate school by underrepresented students; and the challenge of establishing a research program as expeditiously as possible. It should be noted carefully, however, that these activities do not supplant any of the normal institutionally or grant-funded activities of participating departments, centers, schools, and universities. Indeed, they count on these ongoing traditional and special
non-MGE@MSA-funded activities and propose to transcend them additively to entirely new thresholds of qualitative and quantitative success.

In MGE@MSA, as we have done with unparalleled success for over seven years in WAESO, each specific activity will be developed and refined through a unique peer review process modeled after the best aspects of the peer review system at NSF but customized to a smaller, regionally-focused scale. Scientists, specifically faculty members working with students, will be involved in every aspect of the project and will have primary control over the project and the allocation of funds, through their participation in the operational committees. Committees made up of faculty throughout our alliance will review, approve, request modifications, or disapprove each request for a specific activity at member institutions submitted by a faculty mentor. This mechanism has made our alliance successful at encouraging innovation and in replicating effective activity models at the undergraduate level throughout our region in part because committee members are rotated through our 3 cycle (Fall, Spring, Summer) per year activity process and participating faculty (including 223 research faculty from our alliance’s participating comprehensive universities) obtain examples of successful activity models conducted throughout our alliance.

While more than 20% of NSF MGE funds will go directly to participating graduate students in the form of carefully targeted incentives and the remainder will be targeted to cause direct benefits to these students, we will not be using NSF MGE funds to provide major financial support to MGE@MSA students. We believe strongly that it is the sole responsibility of our participating institutions to provide substantial assistantship and fellowship financial support for our participating underrepresented minority SME students. NSF MGE funds will therefore be used exclusively to permit us to add significant new cost-effective interventions to ensure the successful recruitment, retention, timely completion of doctoral studies, and faculty placement of MGE@MSA students. The major new features of the MGE@MSA program that will address these issues include the following:

**Faculty Mentoring Institutes.** Most faculty have received little or no training or orientation on mentoring minority graduate students. Consequently, few have developed the necessary expertise to be more than moderately effective as mentors. Many will not set aside time to do this unless a respected peer who could also help their research careers are conducting the seminars. The objective of this activity is to give faculty mentors the resources and the skills in their specific disciplines to function as truly effective mentors of minority graduate students. One 1-3 day institute per year will be conducted at a minimum of five (one per state) of the following participating MGE@MSA universities: Arizona State University, the University of Arizona, Colorado State University, the New Mexico Institute of Mining and Technology, the University of Colorado, the University of New Mexico, the University of Nevada, Reno, the University of Nevada, Las Vegas, the University of Utah, Utah State University.

Each institute will be led by nationally recognized science and engineering faculty who have a track record of successfully mentoring and graduating minority doctoral students. These resource faculty include individuals such as Howard Adams (Georgia Institute of Technology), William Jackson (University of California, Davis),
James Mayer (Arizona State University), José Mestre (University of Massachusetts), Richard Tapia (Rice University), and other outstanding mentors. Local Deans, Chairs, and Directors will be strongly encouraged to request and provide incentives to all relevant active research faculty in their respective colleges, schools, departments, and centers to attend these institutes.

Attending faculty who sign up as a MGE@MSA graduate mentor will be provided with a small incentive budget (approximately $500) for materials and supplies and/or travel to help continue interactions with mentor faculty of national prominence and to help provide enhanced research environment for minority graduate students. This amount and form of incentive has proven most successful as a catalyst for faculty initiating several hundreds of faculty-directed undergraduate research projects as mentors to underrepresented minority SME undergraduates over the last seven-plus years. Indeed, several citations in a very recent (December 1998) NSF report (NSF, Division of Science Resources Studies, Summary of Workshop on Graduate Student Attrition, NSF 99-314) noted the following:

“... The study also assessed characteristics of faculty who are high producers of Ph.D. degrees compared with low producers. The high-producing faculty, for example, were more likely to: scaffold their students’ learning and model professional behavior by initially providing more intellectual support and withdrawing slowly as the student becomes more self-directing; co-author work with students and/or allow students to be the first author ... The greater Ph.D.-productivity of faculty who engage in these ways with their students suggests that attrition is, in part, shaped by the type of faculty with whom a student becomes affiliated.” (p. 6) And, “... The academic interactions by the high-productive faculty include attending colloquia, spending more hours per week interacting with students on their studies and work, seeing students in informal as well as formal settings, collaborating on academic tasks such as research papers and presentations, and co-authoring papers ... One observer struck a cautionary note, however, about requiring faculty to work with their students more often and to monitor their progress more closely. With their already busy schedules, they must be given incentives to devote more time to mentoring and monitoring.” (p. 11)

**Faculty Graduate Mentoring Network.** Faculty are not trained to be mentors during their pre- or post-doctoral study, nor do they normally spend professional development time dealing with graduate advising and mentoring issues. The objective of MGE@MSA’S Faculty Graduate Mentoring Network is to continue the strong effort that begins with WAESO’s Faculty Mentoring Institutes by providing a forum that will serve as both a reference resource and dynamic tool full of useful information on mentoring and peer networking that faculty can incorporate easily into their daily routine. The Network will provide a world wide web site, bulletin board, and active listserv for MGE@MSA faculty to report in general terms (without using the names or ids of specific students) and discuss with other participating faculty the issues confronted and their resolution regarding the progress of participating underrepresented minority SME graduate students.

MGE@MSA staff will research, solicit, purchase or otherwise acquire, and provide through the website and in hard copy information form and a bibliography of publications dealing with mentoring, SME, and minority grad students, and collaborating with other faculty on these issues. WAESO already has considerable expe-
rience in setting up an effective listserv and web site through its Alliance for Minority Participation Virtual Institute (AMPVI) project (an NSF supplementary award to WAESO’s approximately one million dollar per year LSAMP cooperative agreement). One of the defining features of WAESO has been that our LSAMP funds are awarded competitively on the basis of individual faculty responses to thrice yearly “requests for proposals” (RFPs). This model has maximized our flexibility in allocating resources and ensured that good ideas are encouraged and the best ideas actually invested in (funded). Using the RFP model, faculty will be invited to submit plans and a small budget (such as materials and supplies or graduate student travel or stipend supplements) to contribute to the site, serve as department/campus facilitators for active research faculty, and share information (publications, workshops, etc.) on mentoring.

**Graduate Student Peer Network.** Graduate students are often very late in focusing on their research progress and thesis development. Most students spend too much time worrying about coursework rather than prioritizing and planning their research agenda including their thesis topic. Some students may also be left to drift if their advisor is not closely monitoring their progress. Moreover, research by Professor Uri Treisman at UC Berkeley has documented what WAESO’s own considerable experience has shown: that underrepresented minority students typically do not establish good mentor relationships with faculty and do not usually have the benefit of peer networking.

This proposed activity will facilitate and encourage peer networking and peer advising between and among beginning, intermediate, and advanced graduate students in order to help the students, especially beginning students, progress effectively and expeditiously towards degree completion. In conjunction with our Faculty Graduate Mentoring Network, MGE@MSA will set up a world wide web site, bulletin board, and active listserv for SME underrepresented minority graduate students to discuss issues, peer networking and peer advisement. Participating students will be provided small $250 incentive stipends each semester for active involvement in the network. We have extensive successful experience in WAESO over the past seven-plus years with enticing students to beneficial activities they traditionally overlook or underutilize by offering small financial incentives. These financial incentives are not meant to substitute for the substantial financial support necessary for graduate study which must be supplied by the department or institution. They do however succeed in encouraging students to first notice then take advantage of highly beneficial opportunities. Trained MGE@MSA graduate assistants with substantially higher stipends will monitor the site and, as appropriate, refer questions to the faculty graduate mentoring network in order to enhance graduate experience for students.

**Faculty-Directed Documentation of Student Research Achievements.** The graduate student environment is quite different from the undergraduate one. On the one hand graduate academic life is relatively unstructured when compared to the undergraduate domain. At the same time, apprenticeship is emphasized over the mere accumulation of completed coursework. Beginning graduate students, given their prior undergraduate experience which places emphasis on coursework often engage in misplaced practices and goals that are insufficiently conducive to increasing graduate student productivity (i.e. students may not focus sufficiently on their professional development as researchers and scholars). This MGE@MSA component will
ensure that students are on a genuine, productive research course; a course that is documented and certified, 
as it were, in a manner seldom institutionalized elsewhere by means of an ongoing weekly faculty review of 
a student’s progress to degree completion within the particular research culture of the sponsoring academic 
department.

The MGE@MSA faculty-directed documentation procedure will also provide students with guidance on how 
they should be progressing in order to meet the graduate degree requirements, not in a nominal sense, but 
genuinely calibrated to the research expectations of the sponsoring department. Students will report on 
their progress in all graduate components and faculty will review these reports before they submit them. 
Students will compile weekly reports that will provide the basis for faculty review and documentation and 
will submit copies to WAESO at the end of each semester. As an added incentive (similar to those of the 
Graduate Student Peer Network), each participating underrepresented minority SME student will receive a 
$500 per semester research budget that they can accumulate for professional travel to conferences, materials 
and supplies, software, or other expenses. In this fashion, from the beginning, students will gain invaluable 
firsthand experience in managing research budgets.

Student Professional Development. Many programs are available to students through our participating 
MGE@MSA departments, professional organizations, corporations, and institutions but students are un-
aware of the benefits of utilizing these existing programs. This activity will inform graduate students and 
encourage them to take advantage of the opportunities that are available. In order to increase our access to 
minority graduate students, MGE@MSA graduate assistants will collect the information and provide it to 
students through the MGE@MSA listserv, web site, and periodic newsletters. In addition, we will inform 
participating doctoral recipients of all faculty, academic professional, and post-doctoral research positions 
at participating institutions in our region. Similarly, we will inform all faculty, academic professional, and 
post-doctoral research committees in our region of all graduating underrepresented minority SME doctoral 
students.
11 Speaker Biographies

Armando A. Rodriguez

Arizona State University
Department of Electrical Engineering
1998 Presidential Excellence Award Recipient

Professor Armando Antonio Rodriguez joined the Electrical Engineering Department at Arizona State University (ASU) after receiving a Ph.D. from the Massachusetts Institute of Technology in 1990. His main areas of research include: control of sampled data distributed parameter systems; approximation theory; modeling, simulation, animation, and real-time control (MoSART) of dynamical systems; robust control of flexible autonomous machines operating in uncertain environments (FAME); and the development of interactive multivariable control system design tools. Application areas include: robotics, aerospace systems, IVHS, and semiconductor manufacturing. He has over 100 technical publications that span the above areas. He has organized many technical sessions and has given over 50 invited seminars. Professor Rodriguez has worked and/or consulted for various companies: AT&T Bell Laboratories, Boeing, Eglin Airforce Base, Honeywell, and IBM. He is an AT&T Bell Laboratories Fellow, a Boeing A.D. Welliver Fellow, and an ASU Faculty Fellow. He is the recipient of various teaching excellence, mentoring, and IEEE advising awards. These include two Engineering Teaching Excellence Awards (1993, 1999), the IEEE Phoenix Section Outstanding Counselor Award (1999), and IEEE’s Outstanding Counselor (International) Award (1999). Since 1994, he has managed a comprehensive undergraduate research and mentoring program in the area of MoSART-FAME. Over 100 students have participated in the program - many going on to obtain prestigious awards, fellowships, advanced degrees, and challenging positions in industry. In 1998, Professor Rodriguez received a White House Presidential Excellence Award for Mentoring of SME Students. The award was presented in a White House ceremony with President Bill Clinton. Participating in the ceremony were the President’s science advisor and Director of the Office of Science and Technology Policy (OSTP), Dr. Neal Lane, National Science Foundation Director, Dr. Rita R. Colwell, U.S. Secretary of Education Richard Riley, U.S. Secretary of Transportation Rodney E. Slater, the Late Honorable George E. Brown (Representative, 42nd Congressional District, California), and other dignitaries. “You have made an enormous contribution to this Nation’s future,” said Dr. Neal Lane. The award received significant local and national publicity. Ten individual awards are given yearly across all science, mathematics, and engineering disciplines. In 1996, ASU mathematics professor Joaquin Bustoz (and former mathematics department chair) received one of the first White House Presidential Excellence Awards. From 1998-2000, Professor Rodriguez served as an eminent engineering authority on Honeywell’s Sweett Award Committee - a committee responsible for administering the company’s highest technical award for scientists and engineers. Since 1998, he has served as an associate editor on the IEEE Control System Society Editorial Board. Having served on various National Science Foundation (NSF) review panels, he continues to serve as a reviewer of technical proposals, papers, books, and other materials. Since 1997, he has managed the ASU Electromechanical Design Systems Laboratory and has served as the ASU IEEE Student Branch Counselor. He led in the development of
ASU’s new MoSART-FAME facility. Recently, he obtained funding to establish an *IEEE Center of Excellence for FAME Research*. In 2000, he was an ASU Professor of the Year finalist. Sponsors have included the White House, National Science Foundation, Intel, Microsoft, Boeing, Accenture, AG Communications, Agilent, Altera, Honeywell, IBM, Integrated Information Systems, International Rectifier, Lockheed Martin, MathWorks, Medtronic, Motorola, National Instruments, OnSemiconductor, Sundstrand Aerospace, TDK, Minority Graduate Education Mountain States Alliance (MGEMSA), Western Alliance to Expand Student Opportunities (WAESO), Coalition to Increase Minority Degrees (CIMD), System Science and Engineering Research Center (SSERC), Center for Innovations In Engineering Education (CIEE), Center for Research on Education in Science, Math, Engineering and Technology (CRESMET), the Institute for Electrical and Electronics Engineers (IEEE), other agencies, and companies.
Charles Thompson

University of Massachusetts at Lowell
Department of Electrical and Computer Engineering
1997 Presidential Excellence Award Recipient

Charles Thompson is Professor of Electrical and Computer Engineering, Director of the Center for Advanced Computation and Telecommunications and formerly Associate to the Dean for Research and Graduate Study at the University of Massachusetts at Lowell. He received a B.S. in E.E. from New York University, a M.S. at the Polytechnic University, and a Ph.D. in Acoustics at MIT. He was Assistant Professor of Engineering Science and Mechanics at the Virginia Polytechnic Institute and State University from 1982 to 1986. Dr. Thompson served on the executive board of the Cooperative Research Fellowship program of AT&T Bell Laboratories (1991-1996), on the executive board of the Cooperative Research Fellowship Program of Lucent Technologies (1996-1999) and on the executive board of the AT&T Labs Fellowship Program (1996-present).

At Lucent Technologies Dr. Thompson created with the Vice President of Research, Arno Penizas, the W. Lincoln Hawkins Mentoring Excellence Award (1994). This award is given to a member of the research staff for fostering the career growth of Bell Labs students and associates. This award is Research’s highest honor for affirmative action contributions. In 1998, AT&T Labs instituted a similar award named for Dr. Thompson.

His awards include the Presidential Award for Excellence in Mentoring (1997); Tau Beta Pi Eminent Engineer; Analog Devices Career Development Professor; James E. Blackwell Scholar; Outstanding Young Men in America Award; AT&T Bell Laboratories Cooperative Research Fellow. He is cited in Who’s Who in the World, among African Americans, Education, and Technology Today; American Men and Women of Science; He is a Fellow of the Acoustical Society of America and Senior Member of IEEE and SME. He has published on acoustics, control theory, fluid mechanics, heat transfer, linear and nonlinear systems, telecommunications.
William Y. Velez

University of Arizona
Department of Mathematics
1997 Presidential Excellence Award Recipient

I was born in Tucson, Arizona on January 15, 1947 and grew up in the embrace of the Spanish-speaking community. My parents, Julia Yslas de Velez and Emilio Garcia Velez were both born in the state of Sonora in Mexico. I graduated from the University of Arizona in May of 1968 with a major in mathematics and a minor in physics. I began graduate school at the University of Arizona in September of 1970. I earned a Master’s Degree (1972) and a Doctorate (1975), all in mathematics, at this institution. In July, 1975, I accepted a position as a member of Technical staff at Sandia Laboratories in Albuquerque, New Mexico. During my stay there I worked on problems dealing with the command and control of atomic weapons systems. In July 1977, I accepted a position as Asst. Professor of Mathematics at the University of Arizona, promoted to Assoc. Professor with tenure in 1981 and Full Professor in 1989. In 1998, I was selected to be a University of Arizona Distinguished Professor. My main research interest has been in algebraic number theory. I have published about 35 mathematical papers and directed three doctoral dissertations. I worked as a consultant to the Naval Ocean Systems Center in San Diego for four summers and received three patent applications dealing with signal processing for military communication systems. During my tenure at the University of Arizona, I have served on many committees. I have been awarded outstanding teaching awards and advising awards. From August 1992-August 1993, I was a program director for the Algebra and Number Theory Program at the National Science Foundation. In July, 1993 I was awarded the National Science Foundation Director’s Equal Opportunity Achievement Award. In 1997, I was awarded a President’s Award for Excellence in Science, Mathematics and Engineering Mentoring. I currently serve on eight National Advisory Committees. I am a Founding Member of the Society for the Advancement of Chicanos and Native Americans in Science and served as President of this organization from 1994-96. My most recent efforts have been directed to increasing the opportunities for Hispanic students in mathematics based careers. I served as the Director of the NSF funded Southwest Regional Institute in Mathematical Sciences from 1994-99.
Julian M. Earls

Deputy Director of Operations
National Aeronautics and Space Administration
John Glenn Research Center

Dr. Julian M. Earls, Deputy Director for Operations, NASA Glenn Research Center, is a native of Portsmouth, Virginia and has been referred to as a “Renaissance Man.” He is a scholar who earned the Bachelor’s Degree, with honors, in Physics from Norfolk State University; the Master’s Degree in Radiation Biology from the University of Rochester School of Medicine; and the Doctorate Degree in Radiation Physics from the University of Michigan. In addition, he earned a Master’s Degree in Environmental Health from the University of Michigan and is a graduate of the Harvard Business School’s prestigious Program for Management Development. Also, he has been awarded the Honorary Doctor of Science Degree by the College of Aeronautics in New York and the Honorary Doctor of Pedagogy Degree by Nova Southeastern University in Florida. He is an author who has 27 publications, both technical and educational. He is an educator who has been Distinguished Honors Visiting Professor at numerous universities. He is an executive who has been awarded NASA medals for exceptional achievement and outstanding leadership. In 1999, President Clinton conferred upon Dr. Earls, the rank of Meritorious Executive in the Senior Executive Service.

Dr. Earls is a humanitarian. He is co-founder of an organization whose members make personal contributions for scholarships to black students who attend Historically Black Colleges and Universities. He was inducted into the inaugural class of the National Black College Alumni Hall of Fame and has been designated Black College Graduate of Distinction by the National Urban League. As part of the President’s Initiative on Race, Dr. Earls was appointed by The White House to serve on the panel to engage the scientific community in a dialogue on race. He is a life member of the NAACP and Kappa Alpha Psi Fraternity. Also he is a member of Alpha Kappa Mu Honor Society, and Beta Kappa Chi Science Honor Society. Dr. Earls is an athlete who has run over 10,000 miles in the past 5 years. He has successfully completed 24 marathons including the Boston Marathon. He is a much sought after orator and is a Jennings Foundation Distinguished Scholar Lecturer.

He is a husband and father and is married to the former Zenobia Gregory of Norfolk, Virginia. They have two sons. Julian, Jr., is a neurologist who graduated from Howard University and Case Western Reserve Medical School. Gregory is a filmmaker who graduated from Norfolk State University and the American Film Institute in Hollywood, California.
12 List of Workshop Attendees

Arizona State University

1. Dr. Phillip Huebner, American Indian Programs
2. Dr. Gregory Raupp, Assistant Dean, College of Engineering and Applied Sciences
3. Dr. Mary Anderson-Rowland, Associate Dean, College of Engineering and Applied Sciences
4. Dr. Jiping He, Bioengineering
5. Dr. David Capco, Biology
6. Dr. James Collins, Biology
7. Dr. Elizabeth Davidson, Biology
8. Dr. Elliot Goldstein, Biology
9. Dr. Susanne Neuer, Biology
10. Dr. Jeanne Wilson-Rawls, Biology
11. Dr. Terry Alford, Chemical and Materials Engineering
12. Dr. Nikhilesh Chawla, Chemical and Materials Engineering
13. Dr. Wilson A. Francisco, Chemistry and Biochemistry
14. Dr. Timothy Steimle, Chemistry and Biochemistry
15. Dr. Neal Woodbury, Chemistry and Biochemistry
16. Dr. Apostolos Fafitis, Civil and Environmental Engineering
17. Dr. Emmanuel B. Owusu-Antwi, Civil and Environmental Engineering
18. Dr. Han Zhu, Civil and Environmental Engineering
19. Dr. Sumit Ghosh, Computer Science and Engineering
20. Dr. Peter Crouch, Dean, College of Engineering and Applied Sciences
21. Dr. Keith Holbert, Electrical Engineering
22. Dr. Narciso F. Macia, Electronics and Computer Engineering Technology
23. Dr. Thomas Sharp, Geological Sciences
24. Dr. Yang Kuang, Mathematics
25. Dr. Alvin Swimmer, Mathematics
26. Dr. Wesley Harris, Mechanical and Aerospace Engineering
27. Dr. Patrick Phelan, Mechanical and Aerospace Engineering
28. Dr. William S. Saric, Mechanical and Aerospace Engineering
29. Dr. Ampere A. Tseng, Mechanical and Aerospace Engineering
30. Dr. Yung Chang, Microbiology
31. Dr. Ferran Garca-Pichel, Microbiology
32. Dr. Otto Sankey, Physics and Astronomy
33. Dr. Kong-Thon Tseng, Physics and Astronomy

**Arizona State University, West Campus**

1. Dr. Joseph Graves, Life Sciences

**Brigham Young University**

1. Dr. Jasbir S. Chahal, Mathematics
2. Dr. David D. Allred, Physics and Astronomy
3. Dr. Joseph Ward Moody, Physics and Astronomy

**Colorado State University**

1. Dr. Peter K. Dorhout, Chemistry

**New Mexico Institute of Mining and Technology**

1. Dr. Carlon Ami, Engineering Annex

**University of Arizona**

1. Dr. George H. Atkinson, Chemistry
2. Dr. Emmanuel T. Akpordiaye, Microbiology and Immunology
3. Dr. John A. Szivc, Orthopedic Surgery and Biomedical Engineering Interdisciplinary Program
University of Colorado, Boulder

1. Dr. George W. Morgenthaler, Aerospace Engineering Sciences

University of Nevada, Las Vegas

1. Dr. Deborah K. Hoshizaki, Biological Sciences
2. Dr. J. Abiodun Elegbede, Chemistry
3. Dr. Jacinaria R. Batista, Civil and Environmental Engineering
4. Dr. Moses Karakouzian, Civil and Environmental Engineering
5. Dr. Gerald R. Frederick, Civil Engineering
6. Dr. Samaan G. Ladhany, Civil Engineering
7. Dr. Y.S. Cooper, Computer Science
8. Dr. Robert Boehm, Director of Research, College of Engineering
9. Dr. Brendan O’Toole, Mechanical Engineering

University of Nevada, Reno

1. Dr. M. “Salid” Saïdi, Civil Engineering
2. Dr. David Sanders, Civil Engineering

University of New Mexico

1. Dr. Diane L. Marshall, Biology
2. Dr. Rebecca Reiss, Biology
3. Dr. Tim E. Gutierrez, Special Programs

University of Utah

1. Dr. Joseph C. Klewicki, Mechanical Engineering
13 National Science Foundation (NSF)

13.1 About the National Science Foundation (NSF)

We are all grateful to the National Science Foundation and its contributions throughout its 50 year history. This section is intended to provide perspective - historical and otherwise - about the National Science Foundation. This section is taken from [26, pp. 28-29].

NSF is an independent federal agency created by the National Science Foundation Act of 1950 (P.L. 81-507). Its aim is to promote and advance progress in science and engineering in the United States. The idea of such a foundation was an outgrowth of the important contributions made by science and technology during World War II. From those first days, NSF has had a unique place in the Federal government: it is responsible for the overall health of science and engineering across all disciplines. In contrast, other federal agencies support research focussed on specific missions, such as health or defense. The Foundation is also committed to ensuring the nation’s supply of scientists, engineers, and science and engineering educators.

NSF funds research and education in science and engineering. It does this through grants and cooperative agreements to almost 2,000 colleges, universities, K-12 schools, businesses and other research institutions in all parts of the United States. The Foundation accounts for about one-quarter of federal support to academic institutions for basic research.

NSF receives approximately 30,000 proposals each year for research and education and training projects, of which approximately 10,000 are funded, and several thousand applications for graduate and postdoctoral fellowships. These typically go to universities, colleges, academic consortia, nonprofit institutions, and small businesses. The agency operates no laboratories itself but does support national research centers, user facilities, certain oceanographic vessels, and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, U.S. participation in international scientific efforts, and educational activities at the K-12 level as well as universities and colleges.

The Foundation is led by a presidentially appointed Director and governed by the National Science Board (NSB). The Board is composed of 24 members, representing a cross section of American leadership in science and engineering research and education; appointed by the President to 6-year terms, with one-third appointed every 2 years; and selected solely on the basis of established records of distinguished service. The NSF Director is a member ex officio of the Board. In addition to governance of the Foundation, the Board serves the President and the Congress as an independent advisory body on policies affecting the health of U.S. science and engineering and education in science and engineering.

NSF is structured much like a university, with grants-making divisions for the various disciplines and fields of science and engineering, and for science, math, engineering and technology education. NSF also uses a variety of management mechanisms to coordinate research in areas that cross traditional disciplinary bound-
aries. The Foundation is helped by advisors from the scientific community and from industry who serve on formal committees or as ad hoc reviewers of proposals. This advisory system, which focuses on both program direction and specific proposals, involves approximately 50,000 scientists and engineers a year. NSF staff members who are experts in a certain field or area make award recommendations; applicants get anonymous verbatim copies of peer reviews.

Awardees are wholly responsible for doing their research and preparing the results for publications; the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals on behalf of all qualified scientists and engineers and strongly encourages women, minorities, and people with disabilities to compete fully in its programs. In accordance with federal statutes and regulations and NSF priorities, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving financial assistance from NSF.

For more information on NSF programs and plans, see NSF’s website at http://www.nsf.gov/.

**NSF Directorates**

- Biological Sciences (BIO)
- Computer and Information Science and Engineering (CISE)
- Education and Human Resources (EHR)
- Engineering (ENG)
- Geosciences (GEO)
- Mathematical and Physical Sciences (MPS)
- Social, Behavioral and Economic Sciences (SBE)
13.2 NSF Directorate for Educational and Human Resources

This section, taken from [26, pg. 30], describes the NSF Directorate for Educational and Human Resources.

The National Science Foundation’s Directorate for Educational and Human Resources (EHR) is responsible for health and continued vitality of the Nation’s science, mathematics, engineering, and technology education and for providing leadership in the effort to improve education in these areas. EHR has five major long-term goals.

- To help ensure that a high quality school education in science is available to every child in the United States and that it is sufficient to enable those who are interested, to pursue technical careers at all levels, as well as to provide a base for understanding by all citizens.

- To help ensure that the educational pipelines that carry all students to careers in science, mathematics, and engineering yield numbers of adequately educated individuals who can meet the needs of the U.S. technical workplace.

- To help ensure that those who select a career in a science or engineering discipline have available the best professional undergraduate and graduate education and that opportunities are available at the college level for interested non-specialists to broaden their scientific backgrounds.

- To encourage the development of a cadre of professionally educated and trained teachers to ensure excellence in school education for every student and learner.

- To support informal science education programs and to maintain public interest in and awareness of scientific and technological developments.

The goals provide the focus for the various activities of the Directorate’s seven divisions and offices.

EHR Divisions

- Division of Undergraduate Education (DUE)
- Division of Graduate Education (DGE)
- Division of Elementary, Secondary, and Informal Education (ESIE)
- Division of Educational Systemic Reform (ESR)
- Division of Human Resource Development (HRD)
- Division of Research, Evaluation and Communication (REC)
- Experimental Program To Stimulate Competitive Research (EPSCoR)
13.3 NSF EHR Division of Human Resource Development

This section, taken from http://www.ehr.nsf.gov/hrd/ and [26, pg. 31], describes the NSF EHR Division for Human Resource Development (HRD).

The Division of Human Resource Development within the Directorate for Education and Human Resources, serves as a focal point for NSF’s agency-wide commitment to enhancing the quality and excellence of science, mathematics, engineering, and technology (SMET) education and research through broadening participation by underrepresented groups and institutions. The Division’s programs aim to increase the participation and advancement of underrepresented minorities and minority serving institutions, woman and girls, and persons with disabilities at every level of the science and engineering enterprise. In so doing, these programs contribute to attainment of the PEOPLE outcome goal of the NSF Strategic Plan FY 2000-2005: A diverse, internationally competitive and globally-engaged workforce of scientists, engineers and well-prepared citizens. Programs within HRD have a strong focus on partnerships and collaborations in order to maximize the preparation of a well-trained scientific and instructional workforce for the new millennium.

The programs of the HRD Division are organized to align with our target populations: Minorities and Minority Serving Institutions, Women and Girls, Persons with Disabilities, Crosscutting.

Five themes are evident across the program targets: Education Research and Demonstration Projects on Access and Equity, Institutional Educational Capacity Enhancement, Large-scale Implementation, Institutional Research Capacity Enhancement, and Recognition and Dissemination.

The Presidential Awards for Excellence in Science, Mathematics, and Engineering, Mentoring Program is managed on behalf of the Executive Office of the President in order to identify and recognize outstanding mentoring efforts that enhance the participation and success of groups that are underrepresented in science, mathematics, and engineering.

The Program for Persons with Disabilities and the Program for Gender Equity support innovative projects designed to extend our knowledge about effective approaches to increase skills and career participation as well as to encourage interest in, knowledge of, and involvement in SMET fields from kindergarten through college for, respectively, persons with disabilities as well as women and girls.

The programs of the ethnic diversity continuum (Historically Black Colleges and Universities Undergraduate Program, Louis Stokes Alliances for Minority Participation, Alliances for Graduate Education and the Professorate, and Centers for Research Excellence in Science and Technology) provide coordinated and integrated approaches to developing and leveraging individual talents and institutional infrastructures in order to increase substantially the number of underrepresented ethnic minorities well prepared for participation and leadership in the SMET workforce. Managed synergistically, these programs enable seamless student transitions from undergraduate study at the associate and baccalaureate levels to attainment of doctoral
degrees as well as strengthen the research vigor and competitiveness of graduate students and faculty at minority serving institutions.

HRD Programs

**Minorities and Minority Serving Institutions:**
- Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)
- The Louis Stokes Alliances for Minority Participation Program (LSAMP)
- Alliances for Graduate Education and the Professioriate Program (AGEP)
- Centers of Research Excellence in Science and Technology (CREST)

**Women and Girls:**
- Program for Gender Equity in Science, Mathematics, Engineering, and Technology (PGE)

**Persons with Disabilities:**
- Program for Persons With Disabilities (PPD)

**Crosscutting:**
- Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM)
13.4 Alliances for Graduate Education and the Professoriate (AGEP) Program

This section, taken from http://www.egr.nsf.gov/hrd/agep.asp, describes the Alliances for Graduate Education and the Professoriate (AGEP) Program within the Division of Human Resource Development.

The Alliances for Graduate Education and the Professoriate (AGEP) Program seeks to increase significantly the number of Black (African-American), Hispanic and American Indian/Alaskan Native (Native American) students receiving doctoral degrees in the sciences (physical and life science disciplines), mathematics, and engineering(SME). The lack of the role models and mentors in the professoriate constitutes a significant barrier to producing minority SME graduates, and NSF is particularly interested in increasing the number of minorities who will enter the professoriate in these disciplines.

Specific objectives of the AGEP Program are (1) to develop and implement innovative models for recruiting, mentoring, and retaining minority students in SME doctoral programs and (2) to develop effective strategies for identifying and supporting underrepresented minorities who want to pursue academic careers.

The AGEP Program also supports a research effort to identify major factors that promote successful transition of minority students from (1) undergraduate through graduate study, (2) course-taking in the early years of the graduate experience to independent research required for completion of a dissertation, and (3) the academic environment to the SME workplace. To accomplish this objective, the research component will be informed by a portfolio of Federal and private efforts in this arena in order to identify factors underlying exemplary as well as unsuccessful efforts.

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14 Mentoring Institute Questionnaire

In an effort to significantly increase faculty participation in our MGE@MSA program, we intend to organize additional Mentoring Institutes throughout our region. We would like to do so soon. Given this, we would greatly appreciate it if you would take time to answer the following questions. Please submit your responses via email (text or MS Word) to aar@asu.edu as soon as possible.

Please keep in mind that our goal is to get as much faculty participation as possible.

- **This Mentoring Institute**

  1. Why did you choose to participate in the Mentoring Institute?
  2. Were your expectations met? If not, why? Did you learn anything new? If so, what stands out?
  3. What did you like about the Mentoring Institute? What did you dislike about the Mentoring Institute? Was the length appropriate?

- **Future Mentoring Institutes**

  1. What modifications would you like to see us make for future Mentoring Institutes?
  2. Who would you like to see speak at future Mentoring Institutes? A department chair, dean, provost?
  3. Is there a specific format that you would like to see adopted?
  4. During future Mentoring Institutes, should attendees be divided into subgroups for 15-20 minute breakout sessions that address specific issues?
  5. Should attending every faculty member be asked to give a very short (1 minute) presentation?
  6. Would it be helpful (or of interest) to hear from a doctoral student?
  7. Would you like to see additional data presented? If so, what data?
  8. Should every faculty member be asked to submit a one page “What would I like to see addressed” writeup prior to attending the workshop?
  9. Should future workshops last an afternoon? a day? two days?
  10. What suggestions do you have for getting other faculty members to attend?
  11. Where would you like the next Mentoring Institute to be held? UNLV? UNM?

- **MGE@MSA Programs**

  1. Do you have any comments or suggestions regarding the *mentoring initiation/documentation of student research* component of our MGE@MSA program?
  2. Do you have any comments or suggestions regarding the *Faculty Communications Network* component of our MGE@MSA program?
3. Do you have any comments or suggestions regarding the Faculty-Protégé Pairing Service component of our MGE@MSA program?

4. Do you have any comments or suggestions regarding the Graduate Student Peer Network component of our MGE@MSA program?

- Additional Questions

1. Any general comments or suggestions? Any general faculty recruitment ideas? Any general student recruitment ideas?

2. Have you mentored an underrepresented student (at any level)? If so how many?

3. Why are you doing this?

4. Do we have your permission to make your email/institute information available to other faculty participants?

I would be very happy to provide the above questionnaire to you in an MS Word file. Just send me an email.

Thank you very much.
Armando A. Rodriguez
aar@asu.edu
15 Concluding Remarks

Thank you for taking time to participate in our Mentoring Institute. We hope that the workshop has been fun, informative, and helpful to you.

The problem that we are attempting to tackle is not easy to solve. It is very complex and, like anything worthwhile, it will require considerable effort.

We hope that you and other faculty from institutions across our region will take advantage of the various doctoral mentoring programs and resources offered by our MGE@MSA. I am very confident that, collectively, we can significantly impact SMET Ph.D. production within our region.

I hope that each of us will play a definitive role in “opening the door of advanced SMET research” for individuals that have been “statistically locked out” - a door that we all know leads to a very rewarding, fulfilling, and worthwhile career. Being able to help a young person fulfill their potential is a wonderful thing. It is something that lives on for all generations to see.

Thank you for your time and for your efforts.

Respectfully,
Armando A. Rodriguez
Electrical Engineering
Arizona State University
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“When I was an undergraduate, considering graduate school, a faculty member, without any shame, announced that he didn’t see any value in investing in women. In his words, ‘we don’t waste fellowships on women.’ Fortunately, I had strong mentors along the way .... They were my role models and they offered me a chance to learn and grow as a young scholar.”

Dr. Rita R. Colwell
Director, National Science Foundation

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References


References


[28] Statistical Data Obtained from Professor Antonio Garcia, Arizona State University, Project Director, WAESO Program, November, 2000. Data Sources: National Center for Education Statistics (nces.ed.gov), National Science Foundation.

References


[35] National Science Board, Science and Engineering Indicators - 2000, 50th Anniversary of the NSF, Volume 1, National Science Foundation, NSB-00-1. Chapter 3 - Science and Engineering Workforce. Chapter 4 - Higher Education in Science and Engineering. To obtain copies of Volume 1 or Volume 2 of Science and Engineering Indicators - 2000, contact paperpubs@nsf.gov or call (301) 947-2722. Each volume can also be found at http://www.nsf.gov/sbe/srs/stats.htm. Science and Engineering Indicators is a biennial report prepared by the National Science Board.

[36] National Science Board, Science and Engineering Indicators - 2000, Appendix Tables, Volume 2, National Science Foundation, NSB-00-1 Appendix Tables. To obtain copies of Volume 1 or Volume 2 of Science and Engineering Indicators - 2000, contact paperpubs@nsf.gov or call (301) 947-2722. Each volume can also be found at http://www.nsf.gov/sbe/srs/stats.htm.


[38] Kathy Kowalenko, “Increasing Diversity In America’s Science, Engineering and Technology Fields,” The Institute, December 2000, Volume 24, Number 12, Pages 1, 8.


