Section IV:

**Findings from the Focus Groups Conducted During the
Review of Undergraduate SME&T Education**

The following section presents excerpted portions from the SRI (Stanford Research Institute) report on the Focus Groups conducted by the EHR Advisory Committee on Undergraduate Education (published 24 February 1997). Details on the full text, including the methods and presentation of the analysis, may be obtained by contacting the Division of Undergraduate Education of the National Science Foundation.

Introduction

Overview of the Focus Groups

As part of the year-long review of the condition and needs of undergraduate education in the United States in the areas of science, mathematics, engineering, and technology (SME&T), SRI International, under contract to NSF, conducted a series of 32 focus groups over an eight month period (beginning in November 1995). Six types of stakeholder groups were included, which together represented approximately 200 individuals:

- General employers (SME&T and non-SME&T)
- Teacher employers
- Teacher graduates (SME&T and non-SME&T)
- Current students (SME&T and non-SME&T)
- Recent graduates (SME&T and non-SME&T)
- Parents of current SME&T students.

The focus group methodology was well suited for eliciting the opinions and recommendations of individuals regarding SME&T preparation. The groups were set up so that individuals within constituent groups interacted with others from the same constituent group, and the opinions of all participants in a group related to one particular institution.[1] Groups were replicated to improve the validity of findings. The focus groups were audiotaped, allowing analysts to work directly from transcripts of the sessions.

NSF identified four types of institutions of higher education from which to select participants: two-year community colleges, liberal arts colleges (including one historically Black college or university [HBCU]), comprehensive universities, and research universities. In consultation with NSF staff, two institutions were chosen in each of four regions (the West, Midwest, South, and East).

Highlights of the Meetings

Summarized below are focus group findings that cut across the six constituent groups. The findings are grouped into two categories: (1) aspects of SME&T preparation that participants generally viewed as strong, and (2) aspects of SME&T preparation that most participants thought should be changed or improved.

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[1] The Boston employer group was organized differently than the other groups in the study. Employers in that group recruited from a broad range of colleges and universities in the Boston area, rather than one specific college or university (as was the case in the other employer groups). Quotes taken from Boston group participants are identified as "northeastern college/university," since multiple types of institutions were represented.

Strong Aspects of SME&T Preparation

- *General Quality of SME&T Preparation* – Undergraduate programs generally do a good job of preparing SME&T majors. Employers are satisfied with the depth of SME&T programs but generally favor more breadth. In general, most SME&T students feel confident that they will do well when they transfer to the next level, whether to a four-year institution, graduate school, or the workplace. Recent SME&T graduates were very pleased with the quality of the SME&T education they had received. One of the most valuable aspects of a SME&T education is that it teaches students problem-solving skills that are highly valued by employers.

- *Quality of SME&T Instruction* – Students and recent graduates from two-year, comprehensive, and liberal arts institutions were more positive than those from research universities regarding the quality of undergraduate instruction. Students enrolled in these non-research institutions saw their instructors as more caring and motivated to teach, and as more accessible and willing to provide help outside of class. Students from Historically Black Institutions were the most positive with respect to the quality of instruction they received.

- *Introductory versus Advanced SME&T Courses* – Students found the pedagogy and content of advanced SME&T courses (including laboratory work) to be stimulating and to reinforce prior learning in the area. These courses had a strong conceptual emphasis and smaller class sizes, and they promoted more interactions between students and between students and the instructor. In general, students recommended this approach to be used whenever possible in introductory courses. Students felt that the best introductory courses struck a good balance between facts and concepts, and provided a meaningful context for learning the material.

- *Access to SME&T Preparation* – Women and underrepresented minority students reported good access to SME&T programs. On the other hand, women and minorities continue to face barriers in pursuing SME&T careers.

- *Work Experience* – Students and employers were very supportive of work experience. Recent graduates felt that work experience facilitated transition to the world of work because it helped them to better understand their SME&T course work and better define their interests, and it provided a reality check on their expectations. Employers valued work experience because it gave them a chance to "try out" employees before formally hiring them. However, students acquire this experience infrequently.

Aspects of SME&T Preparation That Should Be Improved

- *SME&T Introductory Courses* – More than any other aspect of SME&T, students targeted SME&T introductory courses as being in need of improvement. They found that such courses often were not geared to their individual ability level, were boring and difficult to follow because of the large lecture format, and were taught by instructors who seemed to care little about the subject matter or student learning. They recommended that introductory courses be taught more like advanced SME&T courses, which they generally valued highly.

- *SME&T Laboratory Sections* – The relationship between the lecture portion of courses and supporting laboratory work is weak. Additionally, some students found laboratory experiences to be mechanical, with little connection between tasks and scientific concepts, and they found little support from faculty or teaching assistants while in the lab setting.

- *Experience of Non-majors* – Many non-science majors with an initial interest in SME&T drop out (or are "screened out") of undergraduate SME&T courses because of the large lecture format

typical of introductory SME&T courses. Early negative experience with SME&T courses is a major barrier to pursuing further studies.

- *Teacher Preparation* – Because of the current design of undergraduate SME&T courses, many new K-12 teachers enter school systems under-prepared to teach science and mathematics, and therefore lack the confidence and ability to engage their students in understanding scientific and mathematical concepts. Faculty often actively discourages SME&T majors from becoming K-12 teachers, seriously interfering with the recruiting efforts of teacher preparation programs.

- *Workplace Readiness* – SME&T graduates enter the workforce ill prepared to solve real problems and to apply the interpersonal skills most desired by employers. Employers put a premium on students with technical competence who also have social skills, a broad knowledge of different subjects, skills in synthesizing and communicating information, and the ability to work as part of a team. Many SME&T graduates lack these critical characteristics.

- *Partnerships* – Linkages among institutions and with industry are poor. For example, many teacher preparation programs do not work with K-12 systems, and there are too few examples of strong university-industry partnerships. Further, interdisciplinary collaboration within institutions is limited.

- *Technology* – Access to technology varies greatly across campuses. The fact that, in general, non-research institutions have much more limited access to current technology was a major concern for students. There was also general agreement that many instructors are "behind the times" when it comes to their knowledge and application of technology.

Summary of Employer Focus Groups

Together, the employer focus groups included 35 employers: 23 participants represented SME&T employers, and 12 participants represented non-SME&T employers. The majority of participants was in the human resources departments of their companies and had responsibility for recruiting from college campuses. Participants from small or start-up firms were often the owners or CEOs of their firms.

Summarized below are their opinions about the skills and attributes desired in recent graduates, diversity issues considered by employers, quality of SME&T preparation, and the need for industry/higher education collaboration.

Skills and Attributes Needed by Employers

The focus groups generated especially rich data with respect to what employers look for in new employees. We organized their input into five clusters:

- Interpersonal skills and teaming
- Proactive approach to work
- Technical competence
- Experience in the workplace
- Basic skills.

Employers participating in focus groups repeatedly mentioned these five clusters of skills and attributes. The initial focus group findings were summarized and presented to the *final* group (the Boston group). Participants in that group were asked to rate individual skills/attributes on a five-point scale, from 1, "factor not considered at all in recruitment/hiring," to 5, "upper-most factor considered." All of the individual skills/attributes were rated 3 ("moderate consideration") or higher. The ratings from the Boston group were used to order the discussion of the clusters, beginning with those rated as most important.

Participants were especially eager to share their views, opinions, and experiences with respect to characteristics of "successful" and "unsuccessful" employees. Much of what they had to say focused on particular skills or attributes within the clusters. However, the following two quotes, the first provided by a SME&T employer who recruited SME&T graduates primarily from a research university and the second offered by a non-SME&T employer who focused her recruitment on a two-year college in the same region, provide a flavor of the desired "mix" of employee characteristics:

> *Sherry, regarding a research university*: "We go in looking for students that are above average, with some basic qualifications, but then what we're really searching for is someone who has those basic qualifications and then has the communication skills, some kind of relevant technical experience, and has leadership skills and can really communicate ... They're screened out initially based on their technical experience, their grade point average, and technical ability... the two things that draw the line would be their communication skills or the fact that they don't have experience. They don't have internships."

> *Wendy, regarding a two-year college*: "The ideal candidate for us, at least for the training position, would have at least an associate's degree ... What I look for most of all is the personality and the oral and interpersonal skills. Do they express themselves well? Do they have energy; do I see a spark upon that person's eyes? Are they vibrant? Are they well spoken? Are they dressed

appropriately ... Major doesn't really matter. We'll have majors in history, psychology, sociology, engineering, technical, and computer, because if they are interested in going to college, we see some interest in higher education, which we prefer. There's some ethic there in studies and some belief in getting some kind of course work completed, and the effort of going to school is a plus for us, regardless of the degree."

Interpersonal Skills and Teaming

The attributes included in this cluster were interpersonal skills, or "people skills," and the ability to work as a productive member of a team.

Interpersonal skills, or "people skills." Participants could not say enough about the importance of interpersonal skills (e.g., "human relations skills," "knowing how to deal with people," "getting along with others") in the workplace. Given a choice of technical skills or interpersonal skills, employers invariably said they would opt for interpersonal skills. Employees who lacked interpersonal skills either did not last long in an organization or presented problems to their managers, who had to spend an inordinate amount of time working with them to develop such skills. Many employers voiced the concern that interpersonal skills cannot be "taught," as other skills can, and doubted whether colleges or universities could do anything to promote their development.

Ability to work as part of a team. Being a successful team member depends on strong interpersonal skills. In the workplace of today, teamwork is the norm. As one employer pointed out, "The R&D function has traditionally always been teamwork." Recruiters are so sensitive to this issue that they probe for it in screening interviewees.

Although the above quote was taken from an employer of an international high-tech firm, the concept of teaming applies to non-SME&T employers as well:

> *Johnnie, regarding an historically black liberal arts college*: "… what is important in this instance is how well you can interact in a team environment, because I don't care what your scenario is, you have got to be a team player – and you are not going to find that out until you actually get somebody in the job and see how they react in an adverse situation."

Several employers had ideas of what colleges/universities could do to promote this skill:
- Emulate the MBA model of team assignments.
- Designate that project work be done in teams.
- Use cooperative learning techniques in instruction.
- Do group performance assessment.

Such activities teach students about sharing the workload and depending on others for results.

Proactive Approach to Work

Prospective employees or new employees who demonstrated a proactive approach to work were highly attractive to employers because, according to participants, this type of individual tends to have good problem-solving skills, takes initiative, is capable of independent and self-motivated learning, and has leadership skills – all characteristics that relate to success in the workplace.

Ability to solve problems. Unfortunately, employers noted that they encounter many graduates, even from top-notch schools, who do not demonstrate good problem-solving skills. One employer said, "I think a lot of people don't know how to attack a problem." They related this deficit to the concomitant lack of critical-thinking skills they see in SME&T graduates.

One employer noted a particular school in the area that required seniors to do outside projects. Students were required "to go out and ask for help – talk to people, get answers – and that is a skill in itself. And when you interview: 'Tell me what your senior project is.'" He said that in interviewing candidates about their senior projects, it was interesting what valuable information he could pick up about their problem-solving skills.

Initiative. Taking initiative seems to go hand in hand with problem-solving capabilities. Employers put a high value on employees who can analyze situations and take steps to address a problem on their own.

Another employer, one who recruited from two-year colleges, said that she can tell from the interview process whether candidates have initiative and hence will be successful in her firm: "It really starts in the interview process. You can see it. They have the ability to inject themselves into the company, and they can articulate. 'Okay, here is how I see myself contributing to the company.' 'Here is what I can do.'"

Independent and self-motivated learning. Employers stressed the importance of employees' taking responsibility to learn what they need to know on their own because their academic preparation often does not prepare them for what they eventually do for a living. Technology and the needs of the workplace change so rapidly that no one, no matter how up-to-date he or she may be at graduation, can afford not to continue to learn and adapt as situations demand.

Leadership skills. Leaders must be able to solve problems, take initiative in their workplace, and seek out information that will help them make sound business decisions. Technically prepared graduates are particularly vulnerable, probably because their training is narrowly focused on specific SME&T skills. Some firms have addressed this issue with internal management training.

Technical Competence

When discussing "technical competence," employers talked about specific technical skills related to programming, hardware or software applications, academic course work (major concentration or field of study), and (to a lesser extent) GPA. Although employers valued technical competence, many took it for granted that by the time candidates were undergoing the interview process, their technical competence had been established. Several employers said that technical competence was relatively not as important as the capacity to learn, because in-house training would supplement whatever technical skills were lacking.

Specific technical skills. Technical skills desired by employers varied according to their industry segment. The SME&T skills discussed by our employers ranged from the highly technical to general. As indicated by these two excerpts, one from a high-tech employer who recruits from the best technical research universities and one from a scientific staffing firm that seeks two-year graduates for entry-level positions in technology firms.

Academic Course Work. Many employers, especially large, high-tech firms, look at the number of graduates in particular technical fields (e.g., computer science, electrical engineering, mechanical engineering) as a guide to focusing their recruitment resources. Although academic course work is clearly

a factor that is considered seriously by employers, one informed participant suggested that it may not be as important today as it was just a short while ago:

> *Dennis, regarding a research university*: "You know what is going on right now in Silicon Valley is that it doesn't matter what they graduate in. The companies are dying for people to do certain types of software, and they will just take anything technical and say, 'Come on in and we will figure out how to get you to be productive.' So, that is a big message that schools need to hear right now, and I do not know how long this is going to last."

Importance of GPA. Several employers said that they still relied on GPA as the first screen in weeding out candidates. But many others, SME&T and non-SME&T alike said that their firms are trying to get away from depending so heavily on GPA and cited shortcomings of that approach.

Experience in the Workplace

Judging from the sheer volume of discussion around particular topics, job experience would appear to be the most salient factor to employers. However, the quantitative ratings from the Boston group showed that it was perceived by employers as somewhat less important than interpersonal skills, having a proactive approach, and technical competence. Employers discussed three related characteristics with respect to work experience: specific job-related experience, understanding the work environment, and the ability to apply academic preparation to the workplace.

Specific job-related experience. Students often picked up job-related experience via internships, coops, work-study, and prior employment. The fact that there did not appear to be standardized definitions of "internships" or "coops," even within schools, was confusing to employers as they discussed the various work experiences they were familiar with. But, no matter what the specific structure of job-related experience, all employers agreed that it enhanced a candidate's chances of being hired and being successful on the job. Job experience helps the candidate really find out what his/her interests are; it provides "cultural exposure"; it helps students understand the work environment; it helps them have realistic expectations about work; it helps students "grow up"; and "it gives them confidence."

Understanding the work environment. Job experience is particularly useful in exposing students to the culture and norms of the workplace environment. Norms and expectations vary from company to company, but there are certain basic "rules" that most employers expect, such as taking direction from supervisors, acting in a professional manner, showing up for work at the correct time, dressing appropriately for work, etc. Employers noted that unsuccessful new employees often did not "pick up on" the informal (often unspoken) rules of the workplace. Coops and internships give students firsthand experience in the work environment, which helps them transition more smoothly from college life to the working world.

Ability to apply training to workplace. There is no substitute for actual job experience in helping students to apply what they have learned to the workplace. A good coop or internship will show them the applied side of the theory they learned in their course work. One employer said that she gets consistent feedback from managers that undergraduates "lack the ability to look at the problem and create the appropriate application from all their theoretical knowledge."

Basic Skills

When employers referred to "basic skills," they included oral and written communication skills, reading, simple mathematics skills, and rudimentary computer skills. Many employers that recruit from

comprehensive and research universities assume that, with the exception of communication skills, candidates possess such basic skills. Basic skills seemed to be more of an issue for employers who recruit from two-year colleges. Communication skills include oral and written communication, public speaking, and listening skills.

Other employers mentioned the necessity of basic math skills and basic computer skills, as the following quotes illustrate:

> *Cathy, regarding a comprehensive college*: "I think math [is important] – I mean being able to do the metric math, especially in the medical fields, if you can't do the metric math you are going to kill somebody – bottom line!"

> *Dennis, regarding a research university*: "Oh, I think math is essential! I think – I mean, employers today are looking for people who can do the basics, and...you would like to assume that people coming out of college could do that. So, math and speaking ability and listening ability are very important."

> *Cecil, regarding a historically black liberal arts college*: "Everyone is going to need to know something about computers. ... learn a software program. Learn [a leading word processing system] or *anything*."

Diversity Issues Considered by Employers

Many of the employers in the focus groups noted that they considered diversity when recruiting graduates. Some employers focused their recruitment on colleges and universities with relatively high proportions of minority students and females, especially in the technical fields. Other employers were more proactive in looking for underrepresented graduates and had put in place collaborative programs with particular colleges/universities to ensure diversity in their hiring. Other employers were not as concerned about bringing in underrepresented candidates, but they had programs in place to support them once they were hired.

Several employers discussed issues that they ran up against in their efforts to recruit a diverse workforce. One problem was obtaining the appropriate legal clearance to use foreign-born graduates at the bachelor's level because, compared with those who had advanced degrees, it was harder to make an argument that there were no available U.S. citizens with the required skill set. Another problem employers ran into related to poor English-speaking ability among foreign-born graduates and the lack of other essential workplace skills.

Quality of SME&T Preparation

In general, employers were satisfied with the technical preparation of graduates of liberal arts colleges, comprehensive colleges, and research universities. They were less satisfied with the job readiness of candidates and noted that they often lacked good communication skills. Employers who dealt with two-year colleges had mixed opinions about the technical skills of graduates; some thought they were adequate, while others did not. Many had serious complaints regarding these students' readiness for employment.

Depth versus breadth of SME&T preparation. Employers at all levels generally favored breadth over depth, but they were sensitive to the fact that breadth often meant limiting technical competence in a

specific area. Employers recognized the advantages of a liberal arts education that naturally included more breadth.

Current Technology. With respect to the status of technology at the undergraduate level, most employers felt that it was not up-to-date (especially at two-year colleges) but that this did not represent a critical problem for them. They expected to have to train graduates in whatever technology they used. As long as the student had some interest and understanding of technology, they were not concerned. At the rate that technology is changing, they felt that it was unrealistic to expect colleges and universities to keep pace.

Need for Collaboration between Higher Education and Industry

Employers were in agreement that higher-education/industry collaboration was needed and that an active role on the part of employers was appropriate. Two aspects of collaboration were addressed in the focus groups: work opportunities for students and higher-education/industry partnerships.

Coops, Internships, Summer Work Opportunities. As mentioned earlier, work opportunities take a variety of forms and vary from company to company and from university to university. Employers concurred that work opportunities of any type had benefits, not just for students (see work experience section above) but for employers also. A principal benefit was cost savings in the hiring process. Work experiences gave employers a chance to try out students as potential employees and lowered the risk that the new employee would leave or be asked to leave after a short time because of misperceptions about the nature of the job. As noted above, one employer said that her high-tech firm uses the coop program as a feeder program and subsequently hires half or more of coop students. Employers pointed out that there were costs associated with sponsoring work opportunities in terms of additional time and effort on the part of employers.

Higher-Education/Industry Partnerships

All employers who participated in the focus groups recognized the value of building stronger higher-education/industry partnerships and the value of more frequent communication between the sectors. Among the many advantages of partnerships, the following were brought up most frequently:

- keeping the university in touch with industry and in touch with the workforce;
- keeping universities technology focused;
- providing more opportunities for students in terms of donated state-of-the-art instruments and computers; and
- facilitating work opportunities for students.

Several of the participants in our employer groups had direct experience working with university staff and faculty. Some arranged for equipment to be donated. A recruiter who sought out underrepresented students worked with heads of departments at Historically Black Institutions and gave them continuing feedback regarding how they need to strengthen the preparation of their students. Another employer was on an academic advisory board at the local university that included both people from academia and industry. Their charge was to outline needs for new course work, lab work, and internships. This individual noted, "You know, it takes time and resources to go out and make those connections, do the networking, set up the liaisons and arrangements and working relationships." Another participant was a member of a panel of employers that talked to classes of graduating seniors about their organizations and career opportunities. Other participants took the initiative in contacting universities and volunteered to give talks to classes and various student groups. One participant invites students and faculty to come to the company and have lunch with employees who were graduates of the same school and talk about their experiences with the company. They follow the lunch with a tour of the company.

Summary of Teacher Preparation Focus Groups

Forty-four participants were included in the eight teacher preparation focus groups (three were teacher employer groups, and five were recent teacher graduate groups). Participants in the teacher employer groups included district administrators (e.g., an assistant superintendent for human resources, a curriculum director, a director of human resources) and school principals; participants in the teacher groups were mainly elementary and high school teachers, with lower representation of preschool and middle school teachers.

This section summarizes participants' input related to the supply and demand for K-12 SME&T teachers, attributes/skills sought by K-12 employers, and teacher preparation.

SME&T Teacher Supply and Demand

K-12 employers noted a critical shortage of SME&T teachers, particularly in the physical sciences at the middle and high school levels. As one Western administrator who recruits from a research university said, "There simply is a higher demand for physical science, chemistry, and physics than there is a supply." Employers of K-12 teachers were frustrated with this situation, also noting that there is a pool of potential SME&T teachers in industry that cannot be used because of credential requirements.

These administrators recognized that the shortage of SME&T teachers is in some part due to the fact that promising SME&T students, particularly minorities and females, are discouraged from pursuing teaching careers by well-intended SME&T faculty. Not surprisingly, administrators bemoaned the shortage of female and minority SME&T teachers who could serve as role models for future female and/or minority scientists, mathematicians, and engineers. One participant remarked that talented individuals from underrepresented groups "just have a lot of other options now." Participants also stressed the need for male SME&T teachers.

From the students' perspective, money is also an issue, in terms of both the additional cost of a two-year master's program (required to teach at the secondary level in some states), which keeps them out of the workforce, and teachers' relatively low salaries compared with those in industry.

In keeping with the current trend of high attrition in the first five years of teaching, some of the recent teacher graduates we spoke with said that they did not plan to remain in teaching for long. They cited the low pay and the lack of resources and supplies. Despite their frustrations, nearly all expressed an attitude of "loving teaching."

Administrators also discussed the problem of high attrition of beginning teachers. One pointed out that the common practice of giving new teachers the most difficult assignments (e.g., remedial classes, heavy course loads, extracurricular duties) is one thing the profession could change to limit attrition.

Skills and Attributes Needed by Teacher Employers

K-12 teacher employers articulated a wide range of attributes and skills they look for in hiring new teachers for SME&T teaching assignments. This summary first addresses characteristics specifically related to SME&T and then covers characteristics desired for all types of teachers, including those who teach SME&T subjects.

Attributes/Skills Specific to SME&T Teachers

School administrators sought teachers who had a strong grasp of SME&T content, both in depth and in breadth. When asked to describe attributes and skills of ideal science and mathematics teachers, they stressed the importance of a solid academic background in math and science, as indicated by grades and the number of SME&T courses on the applicant's transcript. Elementary teachers were viewed as far more deficient in SME&T areas than were high school teachers.

The issue of depth versus breadth was seen as particularly relevant at the high school level. Single-subject majors with a rich background in a particular SME&T field generally do very well teaching in their field of specialization, according to participants, but are often out of their element when required to teach out of field (which many are). The importance of breadth is illustrated in the following comment by a biology major with a master's degree in education:

> *Beth, teacher, about her student experiences in a research university*: "I think the area I wasn't prepared for was earth science. In biology, I'm perfectly fine, but when I started teaching environmental science, I hadn't had a geology course or an earth science course since high school. And, yet I had to teach this stuff; so right before I have to teach it, I have to learn it. And that's where I did not have a very strong confidence level. Because I have to learn this stuff and then I have to turn around and teach it! I definitely think I was not prepared to teach that course at all."

On the other hand, participants felt that depth is still critical for top-notch teaching in a subject area. A teacher with a physics major and master's degrees in both mathematics and education had this to offer:

> *Lawrence, teacher, about his student experiences in a research university*: "Obviously, you want as much depth as possible in the subject you're going to teach, because you start seeing new connections that way and you start saying, 'Well, oh, I see what this thing is good for.'… I know in my own teaching of the kids, seniors who are going to be college students next year, if you cover something superficially, their ideas that they come out with are mush. So trying to get that breadth really doesn't work unless you go into some detail that sort of solidifies it in their mind or links it to something. Otherwise, it's just—you might as well not teach it at all."

Despite the fact that a solid background in SME&T was viewed as extremely important by K-12 teacher employers and teacher graduates alike, other skills and attributes were seen as just as important, if not more important. This finding parallels that of the general employer group, that technical skills are important, but relatively less so than interpersonal skills.

General Teacher Attributes/Skills

K-12 employers discussed many different skills and personality characteristics as desirable in a teacher candidate. Those discussed most often were:

- Ability to relate to students
- innovative teaching
- classroom management skills
- technology skills
- willingness to learn
- ability to apply knowledge/skills in the classroom
- communication skills.

Ability to relate to students. In the educational context, being able to relate to people means relating to students – a wide diversity of students – and to their parents. This was the most frequently discussed "desired attribute" across the K-12 teacher employer groups and prompted many participants to speak up in favor of teacher preparation programs that introduce prospective teachers to the classroom as early as their freshman year, to ensure that they have adequate exposure to children and to what school settings are like today. K-12 teacher employers recognized the value of experience working with children from urban as well as suburban settings, being familiar with cultural factors that could influence teaching and learning styles, and feeling comfortable in school settings that include highly diverse student populations.

Innovative teaching. K-12 teacher employers were interested in teachers who were prepared to teach in innovative ways, such as using hands-on experiences in instruction, differentiating instruction to fit the diverse needs of learners, teaching and encouraging critical thinking, and using an interdisciplinary approach.

Classroom management skills. K-12 teacher employers pointed out that new teacher graduates are generally unprepared in classroom management.

K-12 teacher employers blamed teacher preparation programs for not addressing classroom management more directly. As a middle school principal put it, "I will say unequivocally, education courses do a miserable job in behavior management for teachers." This issue is addressed further in the section below on teacher preparation programs.

Technology skills. For the most part, K-12 teacher employers felt comfortable with new teachers' technology skills and ability to integrate technology into instruction. With very few exceptions, the teacher graduates we spoke with felt well prepared in technology and ways to integrate technology in instruction, but they noted that they were generally the exceptions in their schools. Many experienced teachers apparently either do not use technology at all, or use it for classroom management tasks, such as keeping track of students' grades.

One of the participants graduated from a master's program that specialized in educational technology. She noted that she was considered an expert in her own school, where she now teaches high school biology and math. She said: "I think not only is it being comfortable with computers, but it's having a certain attitude that you're not afraid to not know everything, because the students know more than you do. The students know more about computers than I do, than I think probably all of us." Technology changes teachers' roles in a number of ways – they have less traditional "control" of the classroom, they act in the role of facilitator more than information provider, and they must often defer to students' more advanced technological skills.

One administrator pointed out the importance of not only being "technology literate" but being familiar with a range of technology and software, including the use of multimedia technology.

Willingness to learn. Given that students, schools, theories of learning, teaching strategies, and technology are rapidly changing, administrators looked for evidence that teacher candidates would be willing to learn and have the flexibility to respond to ever-changing situations and demands.

Ability to apply knowledge/skills in the classroom. K-12 teacher employers, particularly for SME&T teachers noted this as a problem.

Communication skills. K-12 teacher employers agreed with SME&T and non-SME&T employers that communication skills were critical for the teaching profession. Administrators and principals frequently use teacher applicants' résumés to evaluate their writing skills and the job interview to gauge their communication skills. The following story is a sad testimonial on the lack of good communication skills among some teacher candidates:

> *Rick, administrator, regarding an historically black liberal arts college*: "[Here is] one of the things that bothered me this past summer when I needed a teacher: I went to the personnel file and checked the references of persons, and...then I went to the personnel file and pulled out the applications and I ... read over the applications. I was extremely disappointed because the [written responses to] questions ... – the manner in which they expressed themselves – ..., the written communication skills – were very disappointing, and I said to myself, how could that person have received a degree and not know how important the application was ... . And I was very disappointed, because I wanted to hire those persons."

Quality of Teacher Preparation

Inputs regarding the preparation of preservice teachers are organized in four sections: preservice training, student teaching, beginning teacher support, and higher-education/K-12 collaboration. This organization flowed naturally from participants' comments.

Preservice Training

K-12 teacher employers felt that preservice teachers are generally being adequately prepared in the SME&T content areas but not adequately prepared for what they face in the classroom. Recent graduates, too, generally felt well prepared, with the exception of those single-subject teachers who were required to teach out-of-field at the high school level.

The key shortcoming of teacher preparation programs from the perspective of both K-12 employers and teacher graduates was that they do not give preservice teachers practical skills to apply to classroom teaching. Participants suggested that teacher preparation programs should focus more on application in the classroom – relating subject matter content to teaching, and focusing more on teaching methods than educational theory.

With respect to general teaching methods, classroom management was singled out as an area in particular need of an applied approach. An elementary school principal recommended that preservice teachers should have "more experience with classroom management techniques and not just from a textbook ... Because it is real different, and ... new teachers have said that when they get in the classroom, things that they thought would work, often do not. They need experiences with children to know what works and how to manage a classroom."

Participants recommended that teacher preparation programs put more emphasis on dealing with diversity in the classroom and on urban school issues.

Student Teaching

Recent teacher graduates' student teaching experiences varied from very useful to horrific! The two excerpts below illustrate the range of the continuum from positive to negative.

> *Stacy, teacher, regarding teaching experiences in a comprehensive college program*: "Well, I had a really good [student teaching experience]. I had the [sixth grade] math teacher, and she had

her room set up into groups. She had great kids. It was great! She wrote me notes all of the time. We had a ... journal book where we would write notes back and forth to each other. We would sit down during planning time, and she would always check and see what I wanted to do and what I was doing and stuff like that. The kids were very well behaved. I had a great experience, and my supervisor was also real supportive and really good, and they actually hooked up, and they got along real well, so it was kind of like a threesome and everything just tied in. I wish I had them still!"

Jerry, teacher, regarding teaching experiences in the same comprehensive college program: "My cooperating teacher was, at the time, 4 or 5 years from retirement, and he gave me classes two days. The third day I was there, he gave me all of his classes and he would sit in the back of the room and start snoring.... I am the student teacher trying to explain balancing equations and I hear this snoring. He would write me up for something when he wasn't even there and I did it, or when he was asleep, so it was interesting. I wanted to get somebody who could do cooperative learning, and he says he does cooperative learning, but it is more: 'Here is the book, here is the thing; now you guys go and teach yourself how to do it,' instead of a designed kind of thing. In middle school, you can either do cooperative learning well or really bad. It is very little in the middle, and I was very interested in that. I could do what I wanted; it was a lot of work and it turned out well; it's just that I received very little feedback. I latched on to another teacher who was there who seemed interested, and she helped me a lot."

As indicated in the excerpts above, the value of the student teaching experience is related to the quality of involvement and feedback on the part of the cooperating (or master) teacher. The match between the teaching methods the student is learning (and wants to practice) and the way the cooperating teacher teaches, and the extent to which university supervision is integrated and consistent with input from the cooperating teacher. Some administrators felt that universities did not make enough effort to place their students with good cooperating teachers.

Two other factors were discussed as integral to the value of the student teaching experience: the amount of time spent student teaching and the diversity of placements. Both recent teacher graduates and K-12 teacher employers discussed the need for longer student teaching experiences. Preservice teachers need time to put into practice what they have been taught.

The participating administrators believed that not only should preservice teachers spend more time student teaching, but also they should be exposed to children and schools much earlier in their programs. They noted that this would not necessarily mean student teaching; it could be time spent observing classrooms and being around children, perhaps in the context of one-on-one projects with children. Administrators generally supported the move toward five-year programs because they give students the opportunities to student teach for a full year. From their point of view, students with more student teaching experience "tended to be stronger." Commenting on a program that put students in the classroom for two years (first observing, then teaching), an administrator noted: "The difference in their ability to go in and take over a classroom is remarkable."

The second factor that affected the value of student teaching was the diversity of placements. Students who had had two different placements valued both their experiences. As noted in the above section, exposing student teachers to students from diverse backgrounds makes them more attractive new hires. An elementary school principal stressed the value of having students placed in both an inner-city school and a suburban school.

Beginning Teacher Support

Teacher graduates' descriptions of their first day of teaching would make good material for a new sitcom. Nearly all of our participants had not only a bad first day, but also a very difficult first year of teaching. These new teachers' experiences were typical:

> *Stacy, teacher, and graduate of a historically black liberal arts college*: "And in this particular classroom the students were wild, I mean, they were *wild*, because so many substitute teachers were in and out. I started right after winter break in January. I didn't have anything prepared, of course. My room was not decorated, and I was not happy about that, and because the kids were not in a stable [environment] they were behind their work, so I was hysterical. I do agree with her [another participant's horror story]. I feel like I got a very good education here at [name of program], and I really feel they prepared us for the classroom. However, once you walk into the classroom, it's a totally different ball game."

> *Jerry, teacher, graduate of a comprehensive college*: "My favorite expression that really helped me relax in my first year of teaching was from the department head who came in – saw I was really worried about something – I don't know what it was – and said, 'Don't worry about it; your first year is a waste anyway. We don't expect you to do anything.' Just learn how to teach during your first year, and in your second year, you better know what you are doing … [another participant interjects: "Survival."] Yes. It's like she just said, 'Hang on and do the best that you can and don't worry about it.' Everyone knows your first year [can be problematic] – you will do great sometimes, and then sometimes you just go flop, and you just get used to it."

K-12 teacher employers pointed out that their districts were aware of the need for beginning teacher support. They described a range of support programs, structured mentor programs that paired beginning teachers with experienced teachers for both instructional and moral support, regular support meetings for new teachers that provided opportunities to share experiences and discuss problems, and new-teacher orientations that gave beginning teachers a "head start" on the school year and an introduction to the school's procedures. The various support programs described received mixed reviews from both teacher graduates and administrators, although the majority of both believed that such support programs were valuable.

Higher-Education/K-12 Collaboration

Throughout discussions of teacher preparation, administrators consistently pointed out the need for more dialogue and sharing between the faculty of teacher preparation programs and K-12 school staff. None of the administrators felt that the current level of interaction between their districts and local teacher preparation programs was adequate. Administrators and teacher graduates also voiced the need for teacher preparation faculty to spend more time in schools.

Summary of Student Focus Groups

Nine student focus groups were conducted at seven different institutions across the country.[2] This section summarizes the perceptions of 69 students with respect to different aspects of their SME&T courses, SME&T laboratories, the value of work experience, and diversity issues in SME&T preparation.

SME&T Courses

Introductory Versus Advanced Courses. Both SME&T and non-SME&T students often targeted introductory SME&T courses as a major barrier. They discussed problems with their difficulty level (too easy or too hard); their traditional lectures format, and disengaged instructors.

Introductory SME&T courses for nonmajors were generally perceived as "watered-down science." As one student put it, "It's frustrating because in high school, even if it was hard, at least it was interesting. Here, it's really easy, but it's really boring." Introductory SME&T courses for majors were viewed as very challenging, often serving to "weed out" less capable and/or less prepared students. Non-SME&T students at a large research institution recognized the need for intermediate-level courses targeted somewhere between these two extremes.

Students from two-year colleges and comprehensive universities brought up problems related to the way introductory SME&T courses were taught to accommodate the wide range of student abilities represented in their diverse student populations.

> *Toby, enrolled in a two-year college*: "I know there's a lot of people in the class; I mean…there's such a mixture of types…from just straight out of high school to those with two or three previous science courses. And I know the instructor is trying to teach [to] the middle or the lower middle, but sometimes it just gets so slow! … I would have the instructors go down to a high school to see what they teach, and then don't teach that again. See their labs at high school, but don't do those labs again."

Attrition rate estimates among potential SME&T students soared at one research university, mainly because of the introductory courses. Students there estimated that at least 80 percent of potential SME&T majors either change their major or decide to leave their course of SME&T study in the first couple of years of school. At one of the two-year institutions, many advanced courses were reported to have a 50 percent dropout rate. Some students believed that the system was designed that way to eliminate some of the SME&T students. They agreed that "you have to be really motivated to stay in a science major."

Both SME&T and non-SME&T students objected to the large lecture format often used in introductory courses. In worst-case scenarios, some of the introductory courses disintegrated into video presentations of material. One introductory chemistry class reportedly had an enrollment of approximately 600 students and was described as a "horrendous experience."

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[2] One of the student groups consisted of chemistry majors who had participated in the Discovery Chemistry Program, an innovative, NSF-funded chemistry program at a northeastern college.

A frequent student perception was that professors did not want to, or had been forced into, teaching introductory SME&T courses. Students imagined certain faculty members saying, "Oh God, I have to go teach this 101 course now."

Students from both comprehensive universities and two-year colleges recognized that part-time instructors taught many of the introductory courses. These instructors are often brought in at the last minute by administrators to fill a course request. Some students were critical of many of these instructors; other students preferred part-time instructors, especially if they were from local firms.

SME&T students frequently praised upper-level classes as wonderful alternatives to the stressful, less personal introductory classes. They found the pedagogy, content, and format of advanced courses to be stimulating and reinforcing. These courses had a strong conceptual emphasis, had smaller class sizes, and promoted more interactions among students and between students and the instructor. In general, students recommended that this approach be used in introductory courses whenever possible.

Older SME&T students in the focus groups often reassured younger students that there would indeed come a day when it all would make sense. In a number of different instances, students told stories in which "light bulbs" went on inside their heads and much of the SME&T material that they had been studying for years really began to make sense.

Quality of Instruction/Assessment

There was consensus among students that the quality of instruction, not the subject matter, usually determined the value of a particular course. In general, students in two-year, comprehensive, and liberal arts institutions had slightly more positive attitudes about the quality of SME&T instruction than did students in research universities.

Students discussed many different skills and attributes as desirable in a teacher, but three characteristics came up in nearly every student focus group. The abilities most sought in a professor (and some examples) were:

- Tailoring instruction to the learner
- Making connections to the real world and other disciplines
- Being accessible and caring

Common complaints about "bad instructors," especially from students in research universities, were that they knew their subject matter but did not know *how* to teach and/or that they were difficult to understand because English was not their first language. Many students, especially those from research institutions, asked for more frequent and varied types of assessment to better determine students' understanding and to help students stay on top of material.

Group work was often a popular element of both SME&T and non-SME&T courses. It tends to work best when responsibility is built in for all involved partners. Otherwise, according to students, group work can disintegrate if each person involved does not have a specific role, or if the method is used too frequently.

Technology/Technical Currency

The state of technology varied widely across campuses. Research universities and one of the liberal arts institutions had good access to the Internet and e-mail. "Chat rooms," a new resource at one research

university was very popular among SME&T students, especially as a way of sharing information about courses and instructors. Two students gave their impressions of this new technology:

> *Betty, from a research university*: "We used the computer [connections] ... you can go to a computer anywhere and you can see what the professor talked about in the lecture, and you can post notes; he can post old exams everybody can look at."

> *Sue, from a research university*: "... and you can be sitting there and it's like, oh, there's another student on the program, too. Do you want to talk to them? And you can talk to them. And you can rag on the professor and..."

Other students were excited about new technology being used in their SME&T courses, realizing that exposure to technology would help them in the job market and lack of exposure would hurt them. On the other hand, some computer science majors complained that they would probably be hurt in the job market because they had not learned current programming languages (e.g., C, C++).

Unfortunately, several of the student groups noted that their institutions lacked resources to keep technology up-to-date or to purchase enough hardware or software to serve students adequately.

Competitiveness in SME&T Preparation

Some students said that the structure of SME&T programs and SME&T courses fostered competitiveness among students, especially at the introductory level. They viewed this as a barrier to learning and a negative aspect of the SME&T experience. This competitiveness was most apparent at research universities, where admittance to higher-level SME&T courses was contingent on high grades in introductory courses. Students also felt pressure to compete for limited openings in medical schools and other types of SME&T graduate programs, and noted that SME&T programs tended to be less competitive at the advanced stages.

SME&T Labs

Most students criticized SME&T labs as being mechanical, predictable exercises that lacked meaning or connections to science concepts. They often felt frustrated because there was no instructor or informed TA to answer questions during the labs. Students felt that their creativity was being stifled when they were forced to follow a "cookbook" type of lab.

Students noted that labs improved in their more advanced courses. Aspects they valued in a lab were teamwork, real-world scenarios, freedom in design, and interesting analysis.

> *Nancy, from a comprehensive college*: "But in upper-level courses it is [much better]. … In advanced organic, in the lab, we had certain problems that we had to find solutions for, and we were in groups. Like, one group was the spectroscopy group; one group was the wet chemistry group, so we would have to go and get another group to do certain things if we didn't have the time to do it. ... That is the real world, and that was a phenomenal experience. And then the other lab that I really got a lot out of...was a 6-hour lab, and you decided what you wanted to make, how you wanted to make it. You went in there and you made sure earlier in the week that the chemicals you needed were available, and you synthesized your own reactions and it was good."

One SME&T laboratory program that addresses the problems noted above and promotes student learning in ways generally associated only with advanced SME&T courses is NSF-sponsored *Discovery Chemistry Program*, which was the topic of a special student focus group.

Work Experience

Coops, Internships, or Current Work Experience. All SME&T students recognized the value of work experience such as coops or internships during their schooling. They noted that such experience helped them to better understand their SME&T material/course work and/or helped bridge the technology gap between university and the workplace.

Future Job/Graduate School/Transfer Prospects. Most SME&T students appeared comfortable about their impending job or graduate school search. The two-year students were fairly confident that they could either find work or transfer to four-year institutions. Although they believed that work experience would help with any type of transition, students especially hoped it would facilitate an easier transition to graduate school or the work world.

Diversity Issues in SME&T Preparation

Students at institutions with diverse populations viewed diversity as a positive aspect of their experience. Some minority students reported involvement in minority alliances and targeted programs as helpful. Others were frustrated by their institution's lack of commitment to diversity. Most students acknowledged that women and minorities face more barriers than do men or non-minorities in pursuing SME&T. Students discussed three types of bias: ethnic/racial bias, gender bias, and age-related bias.

Responding to a point made by fellow students that Black students tended to drop out of SME&T programs, a Black female student responded this way:

> *Annabelle, regarding a Midwestern research university*: "It's a mentality and, like I said, a lot of it starts before college. ... I'm still dealing with it – I can't think of an appropriate word for it, but, I mean, as an African-American woman and as a female, I'm always told that, "You're going to get lower scores and you're not as capable as a white male". It's like a self-fulfilling prophecy, if you let it be. I vehemently struggled with my freshman and sophomore year. I remember this summer; I was presenting research at a conference; I was presenting my research ... And, I mean, for the first time, ever, I wasn't the only Black person in the room, and more importantly; I met another Black woman who was brought in there, but she didn't want to talk to me. [Laughter] But I saw her, and it was so shocking. I mean, I went and I called my mother from a pay phone... I mean, when people are coming up to you [at the conference and saying], 'Oh, I'm so impressed. I'm so impressed.' Okay, are you impressed because I'm first author on this? Are you impressed because of my research? Are you impressed because you don't ever see Black women in chemistry? And it's just something that you deal with each and every day."

Students who had chosen to attend an Historically Black Institution generally felt that they had made the right decision, but almost all were ready to move out of the all-Black environment by the end of their schooling.

One woman was angry about the loss of a talented female professor at her institution and felt that it reflected poorly on the program:

> *Paula, regarding a research university*: "As of last spring, one of them [a female professor] left, and the reason was she wanted to spend more time with her kids and they wouldn't let her teach part-time. Now, when they lost her, I lost a lot of respect for that department, a whole lot of respect. Because, you know, they keep trying to encourage us, you know, to get more women into the field, yet... they pull this kind of crap, you know, and it makes me mad."

Other students, mostly those at the two-year colleges and comprehensive universities, accused some SME&T professors of "age bias" (i.e., favoring older students). At these institutions, it is not rare for 18-year-olds to be mixed with reentry students who are sometimes over 50 years of age.

Summary of Recent Graduate Focus Groups

Six focus groups of recent graduates were conducted, which included a diverse mix of 36 individuals who had completed their undergraduate education within the last three years. Recent graduates had much to say about their experiences in SME&T courses as undergraduates, transition to the workplace, the value of SME&T preparation, skills and attributes needed by employers, and diversity issues in SME&T preparation and the workplace.

SME&T Courses

The findings on SME&T courses are divided into four sections: introductory vs. advanced courses, quality of instruction/assessment, technology/technical currency, and competitiveness.

Introductory Versus Advanced Courses. Recent graduates agreed with current students that introductory SME&T courses were problematic. Their main concern centered on the large sizes of these courses, as well as the lecture format. Graduates who had taken SME&T courses with smaller class sizes (i.e., students in two-year colleges, liberal arts colleges, and comprehensive universities) usually had better early SME&T experiences. They did not "have to go through those large, weed-out courses that will kill you," as one graduate put it. To these students, a very important feature of smaller courses was the opportunity to have a more personal relationship with the professor. Two graduates compared the quality of instruction in small versus large classes, in this case—courses at comprehensive colleges versus courses at research universities:

> *Roger, regarding experiences at a comprehensive college*: "... and at [name of larger research university], Physical Chemistry was the weed-out class ... and he [the professor] was having 55 to 60 students in a class, and half of the class was failing and that sort of thing. Here [at the college] we had seven or eight students who were very, very supportive, [and the professor was] holding your hand the whole way through it and she said 'I want you to learn this ...'"

> *Katherine, regarding experiences at a comprehensive college*: "But I think they kept the classes small enough where they could really concentrate on the personal problems, issues, concerns, whatever it might be. That is one thing, whether it be computers or history or economics, whatever it was, the class was never too large where you really got consumed by a bunch of people around you.... It was really personal – a personalized approach, and I think that is what makes this college more successful than, say, a [larger, nearby research institution] in a big lecture hall. With this one, you can go right up to the teacher, and you know where they are."

Like current students, recent graduates also enjoyed their advanced courses more than their introductory courses. Two-year graduates were very pleased with the practical applications provided in much of their second-year course work, and research graduates said that the advanced courses were excellent because they emphasized the understanding of concepts more than memorization of facts. Advanced SME&T courses were described as more intensive, directed, personal, group oriented, challenging, and tailored to the learners.

Graduates of liberal arts colleges noted a special problem pertaining to the availability of advanced SME&T courses. Some graduates of two-year and comprehensive universities also remarked that the availability of certain courses had been a problem during their course of study, especially if a required or

prerequisite course was offered every other year. In one extreme instance, a graduate felt that it had cost her dearly:

> *Rhiannon, regarding experiences at a comprehensive college*: "... that was a requirement, not an elective that I had a choice with, and it was actually a prerequisite to other things, which was a problem for me. I graduated a year later than I really had to because they only offered certain courses every other year.

Quality of Instruction/Assessment

Graduates seemed relatively pleased with the quality of instruction they received, even though most of their courses had been lecture based. The types of professors that SME&T graduates valued most were approachable, affable, helpful, familiar with their students' knowledge base, and willing to let them make mistakes in order to learn.

According to recent graduates, students can (and do) play active roles in ensuring that they get top-notch instruction by talking with other students about their experiences with particular instructors. Graduates had complaints about some SME&T instructors who did not seem to care about teaching. Faculty tenure systems were discussed as one reason why professors do not focus more of their time and energy on teaching. Some of the more savvy graduates realized those tenure systems usually reward research over teaching ability. One graduate of a comprehensive institution, where teaching is supposed to be more of a focus, remarked that professors should be treated "like teachers, not publishers."

Recent graduates also complained about foreign-born teachers or teachers who had problems with English. They said SME&T courses were difficult enough without language barriers. Graduates had mixed responses concerning the types of assessment they encountered in their SME&T courses. Some thought they should have had more regular and varied assessments to keep them up-to-date in their studies (as did current students); others thought that it was the responsibility of the student to stay on top of the material.

Technology/Technical Currency

Like current SME&T students, graduates reported that technology often helped them better understand certain concepts in the laboratory. One student said that the lab techniques he had been using at his liberal arts college were so up-to-date that he was using some of them in his current research:

> *Elvis, regarding his experiences at a liberal arts college*: "A lot of the techniques that I used in the labs are the techniques that I use to do the research now."

However, some two-year college and liberal arts college graduates complained that instructors needed to better integrate technology into their classrooms and make more of an effort to keep up with the rapid changes in technology. There was general agreement that many instructors were often "behind the times." Some graduates also complained about a lack of computer hardware at their schools.

Some graduates echoed current students' concerns about not being as marketable because they had not been exposed to the latest computer languages (they mentioned C and C++ specifically). These graduates had completed their schooling a few years ago without learning either language. They considered taking the languages in their spare time away from their jobs, but thought their colleges should have made these languages a requirement for majors. These same graduates also recommended that colleges provide courses on computer hardware with "real-life applications."

Competitiveness

Unlike current students, graduates reported little competitiveness among classmates during their SME&T preparation. It may be that they remember their more recent years of college better, when, according to current students, there tends to be less competition.

Transition to the Workplace

Recent graduates recognized the value of coops or internships in helping them find jobs after graduation, often with the company they worked for during their coop or internship. Graduates also said that work experiences helped them define what it was that they wanted to do. Other students noted the "catch 22" that without any job experience, it was difficult to find a job.

Some graduates did have problems finding jobs. Graduates from comprehensive institutions reported the most difficult time with their transitions and remarked that they did not receive help from their career placement centers or school-sponsored job fairs.

Graduates believed that more industry/higher-education partnerships would help student's transition from school to the workplace. Such partnerships could also potentially enhance the undergraduate experience by bringing employers into the classroom.

Value of SME&T Preparation

In general, recent graduates were quite pleased with the value of the education they had received. Many graduates (especially research university and liberal arts college graduates) agreed that one of the best qualities of a SME&T education is that "it teaches you to think in a certain way." The following comments were in response to a question asking graduates whether they would recommend SME&T study to an incoming student:

> *Christina, regarding a research university*: "As far as the technical area [goes], I'd definitely do it because I think your job prospects are almost unlimited when you have a technical degree, compared to some other nontechnical degrees."

> *Nicole, regarding a research university*: "I also know employers, I think, look at you with more respect if you have that background, because they know it's not an easy program, and they also know, whether or not you realize it, [that] you have that very logical thought process that you use every single day ... It's a very solid background."

> *Keith, regarding a research university*: "– the whole beauty of the SME&T education is being able to learn how to logically solve a problem. The logical pursuit of answers."

> *David, regarding a liberal arts college*: "I consider [it] in more of laying a foundation in your mind – how to think logically and attack problems."

Other graduates believed that the SME&T preparation they had received was valuable despite the fact that "what you really need to know you will learn on the job." They believed that it is critical for graduates to bring basic scientific abilities to the job.

Some graduates noted that there was a "ceiling" on the value of an undergraduate SME&T degree, as these comments by students with engineering degrees indicate:

Keith, regarding a research university: "If you want to live in the United States, you can't really make a very good living as an engineer because businesses don't respect engineers. It's more or less, you get out as an engineer and then you'll make—you'll get raises up to about the $50,000-a-year level and you'll stay there."

Christina, regarding a research university: "When you look at the starting salary for engineers compared to other folks…it's wonderful, but within a couple of years, there really is not that much growth."

Another graduate agreed that technical careers do flatten out and felt that if he wanted to advance, he would have to develop his business skills.

Skills and Attributes Needed by Employers

Recent graduates thought that the following skills were most desired by employers: technical competence in a subject area, writing and communication skills, flexibility (e.g., a willingness to turn to management and other areas for advancement), and business skills. Like employers themselves, graduates repeatedly commented that employers were looking for well-rounded individuals who would fit well into their work climate. Liberal arts graduates felt particularly well prepared in terms of breadth and were satisfied with their choice of undergraduate institution. Graduates of research universities generally did not feel as broadly prepared and faulted their SME&T programs for not giving them much flexibility in selecting courses and for not requiring language arts courses.

One research university graduate disagreed that SME&T preparation should focus on breadth, such as courses in teamwork or communications skills, versus depth in SME&T preparation:

Nicole, regarding a research university: "Employers, I think, need to be careful. You can teach someone in a seminar better speaking skills. You can't send someone to a weeklong seminar in physics. You [the student] are paying a lot of money. We have a great amount of expertise; [I would rather they] teach me the engineering skills. Also, just on a personality level, if someone is extremely introverted, you can send them to three different classes but – guess what? – they are not going to be an inspirational speaker. So, it is good to round yourself out, but I think there are other ways you can do it, rather than spending your tuition dollars in your very short time here in developing those skills."

Most recent graduates agreed that, although it might be good to have a broad/general undergraduate degree, it is better to be prepared in some sort of SME&T specialty, if possible. The liberal arts graduates knew they were at a distinct disadvantage due to the limitations of their course offerings.

Diversity Issues in the Workplace

All recent graduates agreed that women and minorities need more role models in science and that there are far too many obstacles in the way of underrepresented students who want to succeed in SME&T. One young woman's experience demonstrates the persistence of gender bias and the lack of role models in SME&T fields:

Nicole, regarding a research university: "I was in a facilities and services department, comprised predominantly of engineers. The only female role model we had, did very well for herself, she was the director of HR. What I have also seen are some women who are doing very well. Their

careers are undermined, because their competition is thinking, 'She got the job because she is female, not because she had the same skill set and just beat me out, or she had the same skill set and they were looking at numbers, so she inched me out.'"

She went on to say:

[When] "you graduate as a female with an engineering degree, entry-level opportunities are there. ... When you get into the working world, senior management is making decisions on your career, and they are older, they don't have exposure to female engineers, and it is a very difficult concept for them … it is a culture change for them …"

Other recent graduates related stories of female SME&T graduates not getting certain jobs or promotions that they deserved. Males, who generally agreed that women had a tougher time of it at work, reported many of these anecdotes. Some of the graduates worked for government subcontractors who were forced to consider diversity in hiring to meet certain quotas. Often, this resulted in overworking the limited number of female employees, who commonly were assigned to multiple projects.

Some underrepresented graduates said that they benefited from both formal and informal mentoring programs sponsored by their employers. Female graduates felt that having a mentor was important for a successful professional life.

Summary of Parent Focus Groups

Composition of Groups

Thirteen parents participated in the focus groups. The parents tended to focus on aspects of college life that were important to them as parents (e.g., safety, living arrangements, and peer support for academic success). For example, when asked to make recommendations about how to improve the quality of the program at her daughter's institution, one parent said:

> *Michael, whose daughter attended a comprehensive college*: "I cannot really tell them how to improve, because I am satisfied and I am not in a position, really, because I was too much removed from her experience here to really honestly answer that question – except more parking, parking, parking!"

Parents were also less informed than other focus group participants regarding the quality of SME&T education. Thus, the number of parent groups was reduced from the planned number, and the number of other groups increased to maximize the cost-effectiveness of the study.

Quality of SME&T Preparation

With just a few exceptions, most parents were very pleased with the quality of the general preparation their sons and daughters received at the undergraduate level. However, they had little to say about SME&T preparation specifically. Their impressions of quality were based primarily on the reputation of the institution as a whole. Parents could offer very little feedback with respect to whether an institution's technology was up-to-date. When asked about quality, parents had this to say:

> *Dawn and James, regarding a research university*: "So far, I think [the quality of education] is good. We have had other relatives who've gone here before, so, based on that we're seeing quality that has lasted over 20 years. My brother went here, and he's now a physician and he's doing quite well."

> *Carlette, regarding a research university*: [Name of school] "Engineering has an excellent record, good reputations of different professors. At my daughter's graduation speech (she was salutatorian), a couple of faculty came up to her and said 'That's a top program over there at [Name of school].'"

> *Laura, regarding a research university*: "People will ask where my son went to school, and I will say he goes to [name of school], the cash signs go into their eyes. I keep telling my son that if you walk out of the [name of school] campus with a degree in engineering, you are going to be making such and such. The outside world is telling them, if you get a degree from [name of school], you are going to make mega bucks!

Transitions

Unlike other groups, parents tended to discuss "transitions" in terms of the move from high school to higher education, rather than the move from higher education to employment. In the former case, they expressed a general concern (not focused on SME&T) that colleges should do more to facilitate the transition from high

school to college (e.g., special summer programs to teach "survival skills" to underrepresented entering freshmen).

> *Nancy, regarding a comprehensive college*: [With respect to transition from high school to college] "It is a form of orientation, but it is more of a career orientation … It helps you decide where you are going and what you are doing and why you are doing it. Everyone is required to take it."

Parents in both groups strongly supported work experience opportunities because they believed that SME&T education should be linked to the application of knowledge (this was their one criticism of SME&T preparation). They also felt that work experience increased their students' chances of finding a job and being successful in the work environment.