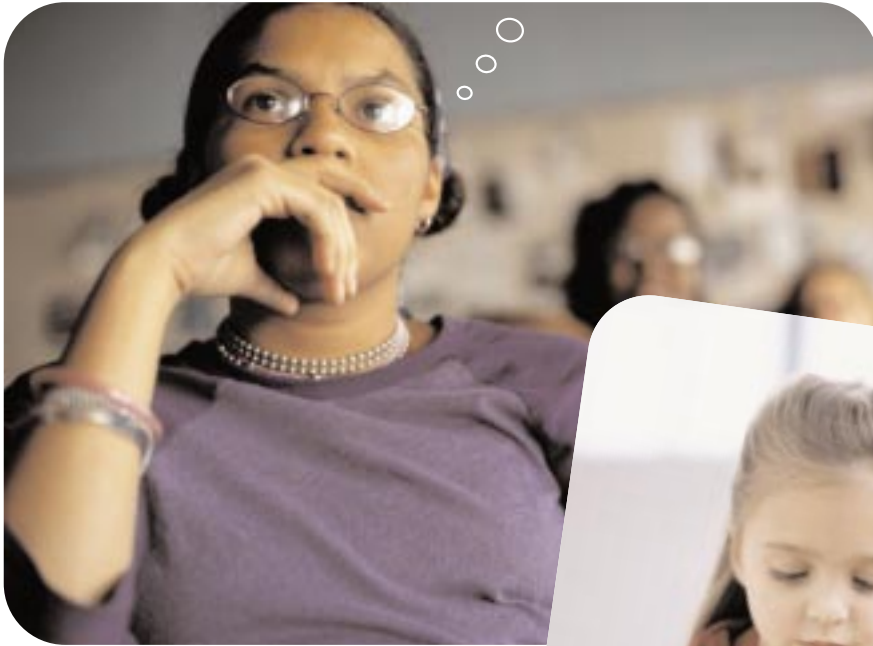


So this is what engineers do?



I didn't know that!



I need to check this out...



Presenter's Guide

# Making the Connection

# Project Personnel

**Susan Staffin Metz**, project director, is co-founder and President of WEPAN, and Executive Director of the Lore-El Center for Women in Engineering and Science at Stevens Institute of Technology.

**Martha Cyr**, Ph.D., technical director of project activities, is Director of the Center for Engineering Educational Outreach and Assistant Research Professor in the mechanical engineering department at Tufts University.

**Karen Samuelson**, P.E., is a licensed mechanical engineer and educational consultant.

**Merredith Portsmore** is Education & Technology Program Manager of the Center for Engineering Educational Outreach at Tufts University.

**Elizabeth Chalk** is Program Coordinator for the Lore-El Center for Women in Engineering and Science and for the WEPAN Administrative Center at Stevens Institute of Technology.

## Advisory Board

**Dorothy Bennett, Ph.D.**

Research Scientist

Center for Children and Technology

**Patricia Campbell, Ph.D.**

President

Campbell-Kibler Associates, Inc.

**Jane Daniels, Ph.D.**

Director, Women in Engineering Programs

Purdue University

**Cinda-Sue Davis, Ph.D.**

Director - Women in Science & Engineering

University of Michigan

**Corinna Lathan, Ph.D.**

Assistant Professor of Biomedical Engineering

The Catholic University of America

**Marsha Matyas, Ph.D.**

Education Officer

American Physiological Society

## Sites

Site directors were responsible for identifying presenters, arranging presentations at local and regional schools, pilot testing, evaluating and disseminating *Making the Connection* materials.

**MassPEP, Inc.**

Lisa Ackerman, P.E.

**Michigan Technological University**

Chris S. Anderson

Educational Opportunity

**North Carolina State University**

Laura Bottomley, Ph.D.

College of Engineering

**St. Louis Community College at Florissant Valley**

Amy White

**Stevens Institute of Technology**

Kathleen Hadford

Lore-El Center for Women in Engineering & Science

**University of Central Florida**

Jacqueline Smith

SPACE/MEP

**University of Colorado, Boulder**

Jill Tietjen, P.E.

College of Engineering

**University of Missouri - Columbia**

Marjorie Leavene

College of Engineering

**The University of Texas at El Paso**

Elsa Villa

College of Engineering

**The University of Texas at Arlington**

Lynn L. Peterson, Ph.D.

College of Engineering

**Virginia Polytechnic Institute & State University**

Nancy G. Love, Ph.D.

College of Engineering

## Contributors

Over 100 individuals including classroom teachers, women engineers and engineering students and others were involved as presenters and evaluators of *Making the Connection* materials. Their voluntary effort will reach more than 7,000 students by 2002.

## About WEPAN

WEPAN, Women in Engineering Programs & Advocates Network, was founded as a nonprofit 501(C)(3) educational organization in 1990. WEPAN's mission is to be a catalyst for change to enhance the success of women in the engineering profession.

Funded by Lucent Technologies Foundation

Presenter's Guide

# Making the Connection

**Susan Staffin Metz**  
**Karen Samuelsen**

**WE PAN** Women in Engineering  
Programs & Advocates Network

*Engineering a diverse future for the engineering profession*

# How to Use This Guide

**This guide offers information on many topics. Each presenter should review the sections that will be helpful for her or his individual presentation.**

Thank you for volunteering to share the exciting field of engineering with students! WEPAN, with support from the Lucent Technologies Foundation, has developed this presenter's guide as a tool to assist speakers with a variety of backgrounds and expertise, including classroom teachers, practicing engineers, student engineers, and engineering administrators, to prepare for—and get the most from—this experience. Therefore, we have compiled this resource which includes: guidelines and a suggested format for your presentation; background information and interesting facts about the field of engineering; and strategies for communicating effectively with students at all grade levels from elementary to high school.

This presenter's guide has been designed to complement the activities in the *Making the Connection* series on the enclosed CD. However, presenters will find this guide useful with any activity created to introduce engineering to students.

The activities in this series, which involve students in engineering-based problem-solving activities will comprise a major portion of your classroom visit. These combined resources should help to create fun, engaging and interesting experiences that will increase students' understanding of this field and the diverse individuals who have pursued engineering careers. Your presentation should leave a positive impression about the profession and the opportunities it holds.

Each presenter is encouraged to scan the presenter's guide in its entirety and then to identify sections that will be most useful. For example, teachers might wish to carefully review sections on engineering and its various disciplines, while engineers might find the information in the section, "Math and Science Literacy at the Elementary/Middle/High School Levels," more helpful. We do recommend that all external presenters plan in advance to speak with the teacher, to gauge students' prior knowledge, level of comprehension, and experiences with engineering.

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# I Your Presentation

**For presenters who are not classroom teachers:**  
Talk to the teacher prior to your classroom presentation. Discuss how you and the classroom teacher can team teach the activity.

**For classroom teachers:**  
Try to include a woman engineer or engineering student in the presentation, particularly if it is more than one class period.  
For help, contact WEPAN ([www.wepan.org](http://www.wepan.org)) to identify a WEPAN member at a local engineering school, the Society of Women Engineers ([www.swe.org](http://www.swe.org)), or ask a parent who is an engineer.

Your classroom visit will be one very important vehicle to help share positive information about engineers and engineering with elementary, middle, or high school students. It may include some background information, some interaction with students about the field of engineering and what engineers do, and a hands-on activity to get them involved in the kinds of problem-solving typical of engineers. The following outline provides a recommended format for a one-class-period presentation.

Presenters are urged to speak with teachers in advance of the presentation to gauge the time available or to determine the feasibility of visiting for two class periods. Given the time constraints involved in a school setting, it is important to have a well-planned timetable for your visit. The presentation described below is one effective format presenters may use. **Note:** The time allocations are intended as guidelines only; individual presentations, as well as class periods, may vary.

## **Introduction** 5 minutes

If you are introducing yourself, tell the students your name, the organization you work for, and give a brief description of what you do, making sure to use terminology comprehensible for students' grade level. You may also want to share some personal information to establish a rapport with the students. (See the section "Speaking to Students.") This may also be a good time to elicit students' knowledge and perceptions about engineers as a way to get them involved in the presentation right away, and then to break down some of the stereotypes the students may have.

During your introduction, let the students know that they can stop you during your presentation if they have any questions. Remind them that there is no such thing as a stupid question.

## **About Engineering** 5 minutes

Experience with students has shown that they prefer presentations that are interactive rather than lecture style. So, instead of simply defining what engineering is and what engineers do, have the students think for a moment and take a guess. Ask students who have relatives who are engineers to supply some insights to the class.

You may want to highlight some of the individual disciplines within engineering, using concrete examples when possible. Encourage the students to volunteer names of everyday items that relate to the disciplines you describe. Refer to pages 7-9 of this presenter's guide for an overview of the engineering disciplines.

## **Activity** 30–40 minutes

Presenters should review the *Making the Connection* activities with the classroom teacher. You will note that each activity suggests a grade level. The class you are

working with may be above or below the suggested level, so select accordingly. In order to make the activity as successful as possible, consider the following:

- Utilize equitable teaching strategies. (See pages 13-14 for more information.)
- Be sure to make connections to engineering throughout the activity.
- Make connections to the students' regular coursework, especially the math and science coursework.
- Make sure that all students are participating; do not let one or two students dominate. Nametags can be very helpful with elementary school students (first names in big print) because they allow you to call on students by name. Older students do not usually like nametags.
- During the activity, give plenty of positive feedback.
- Remember that enthusiasm is contagious, so be enthusiastic!
- Encourage collaboration rather than competition. Emphasize that engineers, as well as engineering students, work together and support each other.
- Have expectations that are appropriate for the grade level of the students. (See pages 15-17 for more information.)
- Be proactive rather than reactive. Anticipate the fact that some students will not want to participate in the activity. Try to discern who those students are and encourage them to take part.

### **Questions** 5 minutes

Students are sometimes uncomfortable verbalizing their questions. Consider having students write a question on an index card at the beginning or end of the presentation. Have a student volunteer(s) read the questions that have been collected.

Offer praise to students who do volunteer questions to encourage others to do the same. If possible, stay after the presentation to provide an opportunity for the more reserved students to approach you.

### **Evaluation and Conclusion** 5 minutes

An informal discussion of what the students learned would be a useful way to conclude the visit. Asking them to identify several facts they learned or myths that were dispelled provides a good way to conclude and summarize the experience. This will provide you with feedback on the key points the students understood—or didn't understand—as a result of the presentation. This type of recap should not be confused with asking the students what they thought of the presentation; students might feel uncomfortable being asked to assess the presenter or the presentation.

**Try to involve all students, including those who do not raise their hands.**

**Allow at least 5 seconds of "wait time" before calling on the first students after introducing a question.**

# II Engineering FAQ'S

## Why Reach Out to Students?

A 1998 Harris Poll conducted for the American Association of Engineering Societies (AAES) provides evidence of the need for increased awareness about engineering through educational programs for students as well as educators at the primary and secondary levels. This poll revealed that 45% of Americans feel that they are “not very well informed” and 16% feel they are “not at all informed” about engineering and engineers. Among women, the percentages increased to 55% and 23% respectively. So, despite the contributions to society made by engineers, engineering remains a “stealth profession.”<sup>1</sup>

One of the primary reasons for the lack of public understanding is that in the primary and secondary curricula in the U.S. there are virtually no references or connections to engineering. The lack of exposure and role models in television shows, movies and books also contribute to the fact that the public is uninformed about engineering.<sup>2</sup> The end result is that although U.S. students have a command of mathematics and science from their high school coursework, they have no idea of the nature of engineering until they complete introductory courses in college.<sup>3</sup> This means that a large population of students, those not enrolled in engineering or scientific courses, never receives an introduction to this profession.

In addition to a lack of information on engineering, there is the problem of the sexual stereotyping of this profession. The image of engineering as a “white male” profession probably dates back to the mid-19th century. At that time engineers were responsible for building machines of war, and engineering was taught at the military academies. Today, although the profession has changed, this masculine stereotype persists. Literature on career development indicates that “sexual stereotyping of occupations begins at a very young age and for many individuals this stereotyping remains.... throughout life.”<sup>4</sup> Unfortunately, the negative stereotypes that exist relative to the engineering profession are especially discouraging to young women.<sup>5</sup>

*Making the Connection* addresses the issue of the lack of information available in primary and secondary schools. It includes a series of three activities for five educational levels ranging from approximately Grades 3-12. The activities focus on three areas including the environment, communications and sports. They are designed to:

- Highlight the contributions engineers make to improve the quality of our lives.
- Dispel the stereotypes of engineering: as a field for “white nerdy males.”
- Make the connection between students’ math and science courses and engineering.
- Explore the skills and interests needed to become an engineer.

Although anyone willing to prepare can be a presenter, we encourage female engineers or female engineering students to team teach the activity with the classroom teacher. In doing so, they will serve as positive role models to both male and female students.

**Though engineers have played a pivotal role in developing the technologies that maintain our nation’s economic, environmental and national security, few Americans understand what engineers do.**

**These activities are designed to make the connection between math, science and engineering, and relate the contributions of engineers to students’ lives.**

### Engineers:

- **Are creative**
- **Work with people not only machines**
- **Need to communicate effectively**

## What is Engineering?

A famous engineer once said “Scientists discover what is, but engineers create what has never existed...”<sup>6</sup> Clearly there are links between science and engineering in that engineers and scientists both use their knowledge of math and science to solve problems. Students should understand that the preparation for a career in either field involves taking a lot of math and science classes. They should also be aware that it is not necessary to “ace” all of their math and science classes, or even enjoy all of them, to successfully prepare for a career in either science or engineering.

Science and engineering, while linked, are not synonymous. In order to help students appreciate engineering, this distinction must be made clear. Scientists are involved in discovering new knowledge and testing and formulating theories. It is the responsibility of scientists to integrate new findings into the existing body of knowledge.

Engineering, on the other hand, deals with the application of principles, experiences and judgments to solve problems or make things that benefit people. Engineers are generally thought of as innovators who try to make the world a better place by developing technical products or systems that meet a need or solve a problem.

An example of how the work of scientists and engineers complement each other may be helpful. A scientist, working in a laboratory, might develop the molecular structure of a new kind of plastic. Engineers would then use this new material to design a wide array of products, from toys to artificial limbs. Other engineers could be concerned with how to produce and recycle those products in ways that are both inexpensive and environmentally-friendly.

## What are Some Important Engineering Disciplines?

Just as science is divided into separate fields such as biology, chemistry and physics, engineering is divided into a variety of disciplines. The five largest engineering disciplines are chemical, civil, electrical, industrial and mechanical. Engineers within all of these disciplines can work in product-oriented companies, government or academia.

**Chemical Engineering** Chemical engineers are involved in the development of products with new chemicals and materials. They work on a variety of projects in chemical and oil companies, and in industries like food and household products, plastics and automotive parts.

**Civil Engineering** The design and construction of buildings, bridges, tunnels and transportation systems are the responsibilities of civil engineers. They work closely with architects and environmental engineers.

**Electrical Engineering** Electrical engineering deals with electricity and

**“Engineering is a great profession. There is the fascination of watching a figment of imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it creates homes and jobs, elevates the standard of living and adds to the comforts of life. That is the engineer’s high privilege.”**

Herbert Hoover,  
31st President  
of the United States

**If we took away everything that engineers have given us, we would be left with a pretty dull life.**

**Engineers will deal with many of the major issues in society in the years ahead. These include:**

**Energy**

**Environment**

**Healthcare**

**Information**

**Transportation**

how it is used. Electrical engineers are found in a variety of companies including the computer, communications and automotive industries.

**Industrial Engineering** Industrial engineers are concerned with the way people, materials and equipment work together. They design systems that help people to function more efficiently.

**Mechanical Engineering** Engineers within this discipline tend to focus on one of three aspects of mechanical engineering; design, manufacturing or energy/power. Cars, airplanes and toys are just a few of the areas in which mechanical engineers work.

There are also other, more specialized fields, including the following:

**Aerospace Engineering** Aerospace engineering involves the design, testing and production of aircraft, missiles and spacecraft. The work of aerospace engineers is important to commercial aviation, the defense industry and the space program.

**Biomedical Engineering** This is an interdisciplinary field combining mechanical, electrical and chemical engineering to study the human body. A person with an interest in both engineering and medicine might consider this discipline.

**Computer Science and Engineering** Computer scientists and engineers are involved in the development of both hardware and software for computers. They work on computer-related systems like CD-ROMs, modems and monitors, as well as cutting-edge projects including robotics and virtual reality systems.

**Environmental Engineering** Keeping the water, air and soil healthy are the responsibilities of environmental engineers. To accomplish this goal they deal with issues including waste management, pollution control and irrigation.

**Materials Science & Metallurgical Engineering** These engineers study, develop and produce materials to be used in a variety of products. Ceramic superconductors used in computer chips, lightweight metals found in aircraft and the specialized materials needed for medical applications are examples of their work.

### **Why Study Engineering?**

Thanks to a good economy and a growing demand for technological developments in the U.S., the employment outlook for engineering graduates is excellent. Within

some engineering disciplines, the unemployment level is at an all time low level.<sup>8</sup> As a result, most engineering graduates with a bachelor's degree can find well-paying jobs in their field. Compensation levels for engineers are, in general, greater than the average for all college graduates.

There are many other benefits to a career in engineering besides the monetary ones. The dean of engineering at UCLA offers the following "top 10" rewards and opportunities of an engineering career.<sup>9</sup>

1. Job satisfaction
2. Variety of career opportunities
3. Challenging work
4. Intellectual development
5. Potential to benefit society
6. Financial security
7. Prestige
8. Professional environment
9. Technological and scientific discovery
10. Creative thinking

An engineering background can also be a valuable asset in other professions such as medicine, law, education, business and politics. Many successful engineers have worked in the field to accomplish great things; others have branched out to other fields. Some examples of accomplished women engineers include:

**Bonnie Dunbar**, space shuttle astronaut. She is considered one of the most experienced female astronauts in the world.

**Sheila Widnall**, Secretary of the U.S. Air Force. She is the first woman to head a branch of America's armed forces.

**Julie Williams Byrd**, an engineer who designs and builds custom-made lasers for NASA to investigate the makeup of the atmosphere.

**Patsy Sherman**, engineer at 3M Company. An accident in which an assistant spilled some drops of a resistant compound on Patsy's sneaker resulted in the development of Scotchgard™.

**Emily Roebling** was in charge of the completion of the Brooklyn Bridge; her name is inscribed in one of the pilings of the bridge.

**Admiral Grace Hopper**, inventor of the computer compiler, which translates instructions in English into the language of the target computer.

**Lillian Moller Gilbreath**, mother of 12, author, engineer and industrial psychologist. In 1926, she became the first woman member of the American Society of Mechanical Engineers.

**An indication of how highly American businesses value engineers is that the starting salaries for engineers tend to be higher than for the average college graduate.**

**For more profiles of women engineers, go to the National Academy of Engineering website at [www.nae.edu](http://www.nae.edu) "Celebration of Women in Engineering."**

You may also recognize some of the following names of men who have engineering backgrounds:

**Thomas Edison**, invented the light bulb, phonograph and over 1,000 other devices.

**Elijah McCoy**, invented an oiling device for industrial machinery. The “real McCoy” refers to his device.

**Alexander Graham Bell**, invented the telephone. Also helped produce the photophone, iron lung, and audiometer.

**Alexander Calder**, sculptor and artist, who used engineering design principles to invent the art form known as mobiles.

**Robert N. Noyce**, co-founder of Intel Corporation. He was a pioneer of semi-conductor development.

**William R. Hewlett**, co-founder of Hewlett-Packard. He invented the audio oscillator, the first practical method of generating audio signals.

**Lee de Forest**, “father of radio,” invented the triode, a vacuum tube which is the basis for the radio.

**Harold Eugene Edgerton** invented the stroboscope. This machine takes rapid series of pictures at rates of up to 2000 frames per second. Also used for the strobe light effect.

### **What About Women & Minorities in Engineering?**

The fall 1999 engineering enrollment data reveals that women comprise 20% of the undergraduates in engineering.<sup>10</sup> It should be noted that this percentage is at an historic high largely due to the fact that the number of males in engineering is declining. Since the mid-1980s the male undergraduate enrollment in engineering has decreased over 20% while the enrollment for females has remained fairly constant.<sup>11</sup> In addition, aggregated totals such as this can mask the wide degree of variation found across the engineering disciplines. For example, in mechanical and electrical engineering the percentages of females receiving bachelor’s degrees are 13% and 14% respectively, while in chemical engineering, women received 36% of the bachelor’s degrees.<sup>12</sup>

Data on minority participation in engineering has been collected since the late 1970s. Since that time the percentages of underrepresented minorities in engineering has increased, but the percentage is less than that of the minority population as a whole. In 1999, African Americans constituted 12% of the U.S. population but only 5% of the bachelor’s degrees in engineering. For Hispanics the

numbers are 10% and 6.5% respectively. Native Americans received only 0.5% of the bachelor's degrees granted in engineering in 1999. It is interesting to note that among African American students, women are represented in significantly higher proportions (37%) than any other racial or ethnic group including white women.<sup>13</sup>

New research has begun to identify reasons for the persistent disparity in the enrollment in engineering among underrepresented groups.<sup>14</sup> The lack of role models and peer groups for women and minorities has some impact, as do entrenched faculty attitudes and pedagogy. In addition, the culture of the engineering profession itself plays a role.

# III Preparing for Class

This section is primarily for presenters who are not classroom teachers.

## Speaking to Students

A successful presentation, combined with hands-on experience with engineering, may excite students, encourage them to learn more, and perhaps consider a career in engineering. For that reason, it is important for a presenter to understand what makes a successful presentation for elementary, middle and high school students. The following are some key elements for successful presentations and discussions with students.<sup>15</sup>

*Know your audience.* You can learn many things about your audience by speaking to the teacher before your presentation. He or she will be able to tell you the students' ages, racial/ethnic background, and math/science levels. In addition, the teacher can provide you with some insights on the topics the class has and will cover that relate to your presentation. Other information on students' math and science literacy levels is on pages 14-17.

*Get students to listen.* Obviously, students must be listening to benefit from what you have to say. To get their attention you must get them involved. If the students are chattering, wait until they quiet down. To get their attention, try asking a question that requires an answer. Good teachers know that students enjoy participating in discussions rather than listening to a lecture on a topic. With that in mind, you should consider a presentation style that incorporates both interaction and lecture at the appropriate times. In addition, remember that a sense of humor will make you more approachable and your presentation more enjoyable.

*Make the presentation positive.* All careers have their ups and downs. In discussing yours, it is appropriate to focus on the positive aspects with a balanced perspective for credibility. You should be honest, but do not dwell on the problems you may have encountered. Students should not be left with the idea that your difficulties are issues for all engineers or engineering students.

*Involve students in your presentation.* Although students generally enjoy participating, they may be too intimidated to do so. One activity that may get students involved is to ask them to name something they used today that an engineer invented. Here are just a few of the possibilities: microwave oven, CD player, hairdryer, bus, television.

*Simplify your vocabulary.* One way to turn students off is to use words that they do not understand. It is difficult to discuss engineering without using some technical terms, acronyms or jargon. When it is necessary to use these terms, ask students if they know or can figure out the meanings, and then be sure to define them clearly. An example could be the phrase "computer software." This phrase is such a part of the common vernacular that it may seem to need no definition. However, since students may not understand the distinction between hardware and software, this phrase presents a good example of a useful definition.

**Making a presentation to elementary school students is not the same as making one to older students. They differ in many ways, not just the language that is used.**

**A helpful book to read to improve your presentation skills is: *Effective Presentation Skills: Revised Edition* by Steve Mandel, 1993**

*Relate engineering to the students' lives.* Everyone likes to see the relevance in what they are learning. Some students need to relate to a topic before they can learn.<sup>16</sup> For this reason it is important to show students the part engineers play in producing common items that they use, like compact disc players or telephones.

*Use visual aids.* Using common household items or sample products from your company will make your presentation more interesting to students. When possible, have something for the students to take home with them. Something as simple as a handout is sufficient.

*Use descriptive examples.* Share the range of work environments available to engineers. While downtown offices might appeal to some, university classrooms, research labs, and construction sites might appeal to others. The opportunity for travel and working with teams of people with different backgrounds is also part of engineering.

Students in the classroom will want to know something about you as a person and as an engineer. Revealing a little about yourself will help you to establish a rapport with the students. The following are suggestions of the kinds of information you may want to share.<sup>17</sup>

- Information about your family or hobbies
- Relevant personal and professional experiences
- Positive and negative experiences in math and science courses
- People who encouraged or discouraged you from becoming an engineer
- A description of what you do on the job
- Reflections on your career choice
- Experiences at the college you attended
- Concerns you had about studying engineering

## **Classroom Communication**

Educators agree that students in a classroom all learn differently. Studies about student learning styles use a variety of classifications to highlight these differences between students. Some people use the descriptions auditory, kinesthetic, and visual to classify students. Others use terms like abstract sequential, random sequential, abstract random and concrete random. Whatever terminology is used, the message remains the same. Students learn in a variety of ways. Since this is the case, instructors must use a variety of teaching styles to reach all of the students.

Students within a classroom will also communicate in a variety of ways. Some students will raise their hands quickly, even when they do not know the answer. Other students will carefully weigh a question and consider the possible responses prior to raising their hands. Some students are comfortable in competitive situations while others enjoy consensus building. It is important to utilize equitable teaching techniques to ensure that all students have an opportunity to contribute their thoughts and ideas.

**Begin by having students name the things they used that day that were created by engineers (TV, car, hot water system, refrigerator, packaged food).**

**A varied presentation style will help you to hit the learning styles and communication patterns of all students.**

**Do not allow the students to fall into stereotypical roles when they are in groups. For example, make sure that the girls are not given the role of secretary or recorder while the boys play the more active role in the group for the entire activity.**

Research has shown that gender plays a role in communication and interactions. In the classroom setting, male and female students sitting side-by-side may experience the same situation differently. In addition, teachers may unconsciously treat male and female students in a different manner. Unfortunately, these different experiences tend to lead girls/women to feel less capable and confident as students. Cultural influences also impact the way that students interact or perceive the actions of others. In order to ensure gender and cultural equity in teaching you should consider the following:<sup>18</sup>

*Inclusive language* – Rather than use terms like chairman or manpower use the more generic terms, chairperson and workforce. Use masculine and feminine pronouns interchangeably, or find gender-neutral terms to refer to people. By using inclusive language you will be acknowledging the presence and value of all students in the classroom.

*Analogies* – Use analogies that cut across gender, racial, cultural and religious lines, or use a wide variety of analogies. For example, making an analogy involving soccer rather than football when discussing trajectory is more inclusive. Both boys and girls play soccer and it is a sport that is played worldwide.

*Generalizations* – Because they don't apply to everyone, generalizations can be exclusive rather than inclusive. For example, don't assume that all students live in a house, have two parents, or have a religious affiliation.

*Stereotypical jokes* – While jokes in general can be very effective in the classroom setting, sexist, racial, cultural or religious jokes are inappropriate and can be offensive. While you may not tell jokes of this sort, you need to be aware that your acceptance of a stereotypical joke delivered by a student can be equally detrimental.

*Comments on appearance* – Instructors are much more likely to compliment female students than male students. Although they may be meant as compliments, these statements can send the message that a woman's appearance is more notable than her academic abilities.

In addition to these issues, presenters will also want to bear in mind a few other things. First, it is important to use visuals that reflect diversity. If you are bringing a handout or poster with you, make sure that it shows men and women of a variety of races. That way, all students can see themselves as engineers. Make sure that you avoid segregation in the classroom, especially if you break up into groups. This includes segregation based on gender as well as race.

## **Math and Science Literacy**

Presenters may wonder what types of examples, analogies, and science and math challenges the students they'll be visiting will be able to understand and appreciate. This section provides presenters with a general perspective on the kinds of computational abilities, scientific experiences and vocabularies that students in each of these grade levels may possess.

It's important to note, however, that these are generalizations about what students should know, based on national educational standards and benchmarks. They may not be accurate for an advanced class or a group of educationally disadvantaged students who are performing below their grade level.

#### ELEMENTARY SCHOOL LEVEL

For students in elementary school, the emphasis should be on gaining experience with natural phenomena and enjoying the process of exploration. Throughout the elementary grades, students will make observations and explain their findings. They become increasingly more adept at observing, measuring and recording data. In the later elementary grades, they should be able to communicate their results in a variety of ways, including words, charts and graphs. Some students in this age group will be ready to offer explanations for the phenomena they observe.

Good communication between an engineer and the general public is sometimes impeded by the use of technical language. Given that elementary students may have knowledge of scientific principles but little experience with technical jargon, it is important for classroom visitors to limit their use of technical terms.

*Benchmarks for Science Literacy*<sup>19</sup> states that by the end of 5th grade, students should be able to:

- Add, subtract, multiply and divide whole numbers mentally, on paper and with a calculator.
- Use fractions and decimals, translating when necessary between decimals and commonly encountered fractions.
- Judge whether measurements and computations of quantities such as length, area, volume, weight or time are reasonable.
- Choose appropriate materials when making simple mechanical constructions and repairing things.
- Measure and mix dry and liquid materials (in the kitchen, garage or laboratory), exercising reasonable safety.
- Keep a notebook that describes observations made, and carefully distinguishes actual observations from ideas.
- Use calculators to determine area and volume from linear dimensions, and find aggregate amounts or difference between quantities.
- Make safe electrical connections with various plugs, sockets and terminals.
- Back up their statements with facts found in books, articles and databases.
- Recognize when comparisons might not be fair because some conditions are not kept the same.
- Seek better reasons for believing something than “Everybody knows that...” or “I just know” and discount such reasons when given by others.

**When presenting to elementary school students, communicate the fun of engineering.**

**Even elementary age students can be expected to support their statements with numerical data and facts found in reference materials.**

**Middle school students have a wealth of prior knowledge and experiences, that they can bring to the engineering activity.**

**Help students to become appropriately skeptical of their own findings and the findings of others.**

#### MIDDLE SCHOOL LEVEL

Students at the middle school level continue forming attitudes, values and skills that will last throughout their lives. These attitudes shape the decisions the students make regarding college and careers. Unfortunately, poor decisions made during this time can significantly impact what the students will study, which may close the doors to scholastic and career opportunities in the future. For that reason it is particularly important to make a conscious effort to encourage all students in the middle grades to continue to take mathematics and science courses.

According to *Benchmarks for Science Literacy*,<sup>20</sup> by the end of 8th grade, students should be able to:

- Work with percentages.
- Compare equivalent forms of numbers such as fractions, decimals and percents.
- Calculate circumferences, areas and volumes for simple figures and solids.
- Find means and medians.
- Use scale drawings to estimate actual distances and sizes.
- Determine the unit in which an answer should be expressed.
- Round off answers to the proper number of significant figures.
- Express numbers like 1,000, and 1,000,000 as powers of 10.
- Estimate the probabilities of certain outcomes.
- Have experience with scientific equipment as well as computers and calculators.
- Use instruments to measure length, volume, weight, time and temperature.
- Have experience using cameras and tape recorders.
- Begin to use computers as scientists do.
- Have experience storing and retrieving data, as well as preparing charts and tables from their data.
- Read and understand simple tables and graphs produced by others.
- Find information in reference materials.
- Understand writing that incorporates circle charts, bar and line graphs, two-way data tables, diagrams, and symbols.
- Find and describe locations on maps with rectangular and polar coordinates.

By the end of the 8th grade, students should be both open to and skeptical of scientific findings. They should expect claims to be supported by appropriate evidence and question statements made by people who are not experts in the field. Middle school students should be able to criticize faulty reasoning in the arguments of others. They should be able to make comparisons of items and understand that tradeoffs are sometimes made in the decision making process.

## HIGH SCHOOL LEVEL

During the high school years, preparation for entrance into the workforce or higher education becomes increasingly important. Students become more aware that their academic choices and achievement will affect their career opportunities.

Presenters should note that the computational and science skills within an individual class at the high school level may vary greatly, depending on the science and mathematical tracks of the students, the individual schools' science and math emphasis and the availability of facilities like computers and science labs. For these reasons, although all students should have some experience with the following (according to *Benchmarks for Science Literacy*<sup>21</sup>), their level of expertise will vary greatly.

- Use ratios and proportions.
- Substitute numbers into algebraic formulas.
- Express very large and small numbers using scientific notation.
- Recall the relationships between numbers like 10, 1,000, and 1,000,000.
- Estimate a calculated answer and trace the source of any disparity between the estimate and the actual answer.
- Properly use measuring instruments like beakers, thermometers, pipettes and meters.
- Follow instructions from the teacher or those from a manual, when learning to use new instruments.
- Use computers to produce graphs and tables, and make spreadsheet calculations.
- Understand the effects of measurement errors on any calculations they make.
- Have a great deal of laboratory experience with metric units.
- Have a fairly broad vocabulary of scientific and technical terms from the science and mathematics classes they have taken.
- Utilize charts, graphs, tables and scale drawings to summarize data or support a claim.
- Access and then restate or summarize the findings of others.

One big change between high school students and younger students is in their ability to criticize data or the arguments of others. High school students should be skeptical of their own results, as well as those of others. They should wonder about the probability of certain events occurring by chance, and they should be able to suggest alternate ways of interpreting data. It is useful to keep in mind that while high school students may have these skills, they may need to be prodded to use them.

**Ask the teacher about the math and science levels of the students to whom you will be presenting.**

**Even though high school students have a large vocabulary of scientific and technical terms, you still need to be careful about using too much technical jargon in your presentation.**

# Endnotes

- <sup>1</sup>Louis Harris and Associates. (1998). *American Perspectives on Engineers & Engineering*. Conducted for the American Association of Engineering Societies. Washington, D.C.
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- <sup>3</sup>Adelman, C. (1998). *Women and Men of the Engineering Path: A Model for Analysis of Undergraduate Careers*. U.S. Department of Education and The National Institute for Science Education. Washington, D.C.
- <sup>4</sup>Herr, E.L. & Cramer, S.H. (1988). *Career Guidance and Counseling Through the Life Span*. Harper Collins Publishers.
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- <sup>6</sup>Professor Theodore von Karman, originator of the Jet Propulsion Laboratory
- <sup>7</sup>Society of Women Engineers. *Engineering*. Brochure published by Ford Motor Company.
- <sup>8</sup>Graduating Engineer & Computer Careers Online. [www.graduatingengineer.com](http://www.graduatingengineer.com)
- <sup>9</sup>Landis, R. (1995). *Studying Engineering*. Discovery Press.
- <sup>10</sup>*Engineering and Technology Enrollments - Fall, 1999*. Engineering Workforce Commission of the American Association of Engineering Societies, Inc.
- <sup>11</sup>National Science Foundation. (1998). *Science & Engineering Indicators - 1998*. Appendix table 2-14.
- <sup>12</sup>Engineering and Technology Degrees - 1990-1999. Engineering Workforce Commission of the American Association of engineering Societies, Inc.
- <sup>13</sup>National Science Foundation. (2000). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000*, p. 23.
- <sup>14</sup>Ibid. p. 43
- <sup>15</sup>Metz, S.S. (1996). Designing Labs and Presentations for Pre-College Students. *Increasing Access for Women in Engineering*. WEPAN
- <sup>16</sup>McCarthy, B. (1987). *Four-Mat System: Teaching to Learning Styles with Right/Left Mode Techniques*.
- <sup>17</sup>Metz, S.S. (1996). Designing Labs and Presentations for Pre-College Students. *Increasing Access for Women in Engineering*. WEPAN

<sup>18</sup> Henes, R. (1994). *Creating Gender Equity In Your Teaching*. College of Engineering, University of California, Davis.

<sup>19</sup> American Association for the Advancement of Science. (1995). *Project 2061: Benchmarks for Science Literacy*, Washington, DC..

<sup>20</sup> Ibid.

<sup>21</sup> Ibid.

# Related Websites

## **American Society for Engineering Education**

[www.asee.org/precollege](http://www.asee.org/precollege)

## **American Society of Mechanical Engineers**

Pre-college Programs

[www.asme.org/educate/k12](http://www.asme.org/educate/k12)

## **Discover Engineering On-line**

[www.discoverengineering.org](http://www.discoverengineering.org)

## **Educational Development Center**

Imagination Place

[www.edc.org/CCT/imagination\\_place](http://www.edc.org/CCT/imagination_place)

## **Get Tech**

[www.gettech.org](http://www.gettech.org)

## **NASA for Kids**

[www.nasa.gov/kids.html](http://www.nasa.gov/kids.html)

## **National Academy of Engineering**

Celebration of Women in Engineering

[www.nae.edu/cwe](http://www.nae.edu/cwe)

## **National Engineers Week**

Pre-college Activities

[www.eweek.org](http://www.eweek.org)

## **Society of Women Engineers**

Career Development

[www.swe.org](http://www.swe.org)

## **Try Science**

[www.tryscience.org](http://www.tryscience.org)



For more information, visit [www.WEPAN.org](http://www.WEPAN.org)

WEPAN Administration Center  
Lore-El Center for Women in Engineering and Science  
Stevens Institute of Technology  
Castle Point on Hudson  
Hoboken, NJ 07030  
ph. 201-216-5245  
fx. 201-216-5175  
[echalk@stevens-tech.edu](mailto:echalk@stevens-tech.edu)



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Castle Point on Hudson  
Hoboken, NJ 07030  
ph. 201-216-5245  
fx. 201-216-5175  
[echalk@stevens-tech.edu](mailto:echalk@stevens-tech.edu)  
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