

Introduction to Engineering

This session is intended as a review of the different types of engineering and how we use engineered products in our everyday lives. This portion will especially showcase engineering careers that may be interesting to girls.

The American Society of Engineering Education (ASEE) defines engineering as follows:

Engineering is the art of applying scientific and mathematical principles, experience, judgment, and common sense to make things that benefit people. Engineers design bridges and important medical equipment as well as processes for cleaning up toxic spills and systems for mass transit. In other words, engineering is the process of producing a technical product or system to meet a specific need.

Engineers have many different types of jobs to choose from, including research, design, analysis, development, testing, and sales positions. If you are interested in discovering new knowledge, you might consider a career as a research engineer. If you are imaginative and creative, design engineering may be for you. The work of analytical engineers most closely resembles what you do in your mathematics and science classes. If you like laboratory courses and conducting experiments, look into becoming a development engineer. Sales engineering could be a good choice if you are persuasive and like working with people.

Engineering work is also organized by traditional academic fields of study. The five largest of these are chemical, civil, electrical, industrial, and mechanical engineering. There are also more specialized engineering fields, including aerospace, ocean, nuclear, biomedical, and environmental engineering.¹

Teachers may consider asking an engineer to come into the classroom and speak about her job. Teachers can contact a local university that has an engineering department (check the university's website), a local engineering company, or a professional society, such as the American Society of Mechanical Engineers, the American Society of Civil Engineers, the Society of Women Engineers, or the National Society of Black Engineers.

Presentation on Communication Systems

a. Introduction to Communication Systems

Through this presentation, the students should gain an understanding of communication systems, including the concepts of a source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination. Students will also be introduced to different types of communication technologies and systems such as audio, visual, printed, and mass communication systems.

b. Introduction to Engineering Fields Involved in Communication Systems:

Students should learn more about the types of engineering that are involved

¹ Accessed at www.asee.org/precollege/engineering.cfm#whatiseng in January of 2004.

with the construction, maintenance, and use of telecommunication systems. Specific examples include civil engineering, telecommunications engineering, and electrical engineering.

Introduction to the Binary Number System

If you have had problems talking about the role of women in engineering, this is a good opportunity to point out the contributions of women in Computer Science.

During this session, students will be introduced to the concepts of binary language and the history of the binary number system. This lesson should include the following main points.

Historic Points

Although it is commonly believed that binary numbers were first used by the German mathematician Leibniz, new evidence indicates that binary numbers were used in India before the second century A.D, more than 1500 years before their use in the West. For example, an ancient musician named Pingala used binary code to notate musical meters in his text "Chhandahshastra," which translates to "the science of meters." Pingala, however, wrote binary numbers from right to left, rather than from left to right as we do today, and also started his values with 1, rather than 0. For example, in Pingala's form of binary, 0000 would be equal to 1, and 1000 would represent 2. See http://mathforum.org/epigone/historia_matematica/glaytheldwal for more information on the use of binary numbers in ancient Indian history.

When the German mathematician Leibniz began using binary around 1666, he was looking for a way to represent logical thought through a universal, mathematical language. He believed that the universe could be reduced to "on/off" units and used binary to represent naturally occurring opposites, such as yes and no, on and off, dark and light, and male and female. It wasn't until later, when popular belief started supporting this alternative way of thinking, that Leibniz began to refine his ideas and create the binary number system. See <http://www.gowcsd.com/master/ghs/math/furman/binary/hist.htm> for more information.

Another contributor to binary code was George Boole who created Boolean Logic. Boole was determined to find a way to encode logical arguments in an indicative language that could be manipulated and solved mathematically. Around 1854 he proposed a theory in his document, "An Investigation of the Laws of Thought, on Which Are Founded the Mathematical Theories of Logic and Probabilities," that logical processing could be reduced to only two objects. These objects are now the famous yes/no, true/false, zero/one approaches. Unfortunately, at the time Boole's idea was criticized and ignored by the academic community. More about George Boole can be found at <http://www.kerryr.net/pioneers/boole.htm>.

Today binary code is most often used in electronics and computer programs. The

¹ Accessed at www.asee.org/precollege/engineering.cfm#whatiseng in January of 2004.

first person to use binary to write a computer program, and still one of the few female pioneers of the computer age, was a woman named Ada Byron. Ada was mostly self-taught mathematically but communicated frequently with all of the great scientists of her time and was well respected in the field. She worked most closely with a man named Charles Babbage, who had created an “analytical engine.” In 1843, she used Bernoulli’s numbers and made them into something that was readable by the analytical engine, bypassing the step of the human controller. This project is now widely considered to be the first computer program. Ada is the only woman to have a computer programming language named after her. The Pascal-based language ADA is named after Ada Byron. For more information see <http://www.kerryr.net/pioneers/ada.htm>.

One of the first computer scientists was a Vassar graduate named Grace Murray Hopper. She started her career as a math professor and was later hired as a research fellow for the Bureau of Ordinance Computation Project at Harvard University, where she did computations on military machines through WWII. Grace’s best-known contribution to the world of computer science was the invention of the compiler, an intermediate program that translates English language instructions into the language of the target computer. She claims she did this because she was lazy and was hoping to go back to being a mathematician. Grace’s work, including subroutines and formula translation, foreshadowed many developments that are now the framework of digital computing. Her work helped bring computer science and technology to where it is today. More on Admiral Grace Hopper can be found at <http://www.sdsc.edu/ScienceWomen/hopper.html>.

Mathematical Points

1. Base ten (decimal) notation.
2. Place value.
3. Exponential notation.
4. Numbers as symbols used to communicate information.
5. Ways of translating binary numbers into decimals, and decimals into binary numbers.
6. Properties of binary numbers.

¹ Accessed at www.asee.org/precollege/engineering.cfm#whatiseng in January of 2004.