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Engineering Your Future:

A Collection of Engineering Resources

What is an engineer? I had no idea until I was a junior in academy. Dr. Jon Cole, a long-time professor at Walla Walla University (then College) in College Place, Washington, came to talk to students at Platte Valley Academy in Shelton, Nebraska, about engineering and then described the program at Walla Walla. On that day, I knew I would be an engineer, and I have been for more than 35 years. Now I teach engineering at Walla Walla University, where it is my privilege to pass on to students the blessing of an Adventist engineering program.

The world has changed since I graduated from the engineering program in 1986, and engineers designed the devices and tools that made many of those changes possible. Engineers solve problems and improve people's ability to function effectively and efficiently. With the expansion of technology, engineers must adapt to better understand the human side of technology. Everyone can benefit from these skills. Currently, K-8 schools in the North American Division (NAD) must meet learning standards for engineering; however, we need standards for 9-12 schools to prepare students for college or pursue technical careers.

Most teachers haven't been trained in engineering, so this is a big task. Finding resources to teach engineering can seem overwhelming. Here are some suggestions to help you get started.

What Is Engineering?

Engineering is problem-solving in a disciplined way. Engineers take science, math, psychology, sociology, and other classes containing knowledge that they can use to make the world safer, more comfortable, and more entertaining for humans and God's other creatures. The National Science Foundation (NSF)'s video *What Is Engineering?* is a good introduction.[1]

What Makes Good Engineers?

I have observed that good engineers share common characteristics such as persistence, curiosity, and a desire to make things better. They have learned problem-solving, science, and math, how to work in teams, and how to learn from mistakes—both their own and others.

What if Students Think They're Not Good at Math?

"The path to engineering success is through mathematics."[2] Students need a solid mathematics and science foundation before entering college to succeed in engineering. However, "The idea that some folks are 'math people' and some are not is a myth that pervades Western society. This damaging idea has been challenged in recent years by neuroscience showing that mathematics is a subject, like all others, that is learned through hard work and practice."[3] Researchers have found that "By the time students are in high school, they have already made implicit decisions about pursuing or not pursuing advanced mathematics and science courses, and these choices are determined by earlier success."[4] At all levels, we can push back on the idea that math ability is innate. Persistence is key to becoming an engineer, especially for girls and students in underrepresented groups.[5]

Where Does Engineering Fit Into the Curriculum?

Since we live in an engineered world, engineering can fit into many parts of the curriculum. The ethics and effects of engineering are important in even more

content areas such as history, communication, ethics, and learning to collaborate. This article provides some resources for including engineering in specific parts of the curriculum.

History and Engineering

We know little about early engineers, yet we can see the results of their work. As well as being a great Scrabble word, *qanat* is an underground canal that brings water to fields for irrigation. UNESCO listed the Persian Qanat on its World Heritage List under Outstanding Universal Value.[6] Their web page (http://whc.unesco.org/en) has many resources on the qanats and other engineering projects.

We know the person who invented locks: Ch'iao Wei-Yo in China.[7] The locks became more useful after a well-known engineer, Leonardo da Vinci, invented an improved lock gate that we still use today.[8] We think of da Vinci as an artist, but he was known more as an engineer during his lifetime. Both art and engineering were combined in the entertainments he directed. These were like the productions Disney does today.[9]

There are numerous examples of art combined with engineering. From beautiful cathedrals and bridges to ornate architectural designs of transportation hubs, cityscapes, and other structures (i.e., the Eiffel Tower, St. Louis Arch, or structures that become synonymous with a specific place), engineers are consistently integrating art with science, technology, art, and mathematics (STEAM) since these areas go together well.[10]

Engineering, Communication, and Teamwork

The construction of the Israelite sanctuary in the desert combined engineering, communication, and teamwork. God gave Bezalel and Aholiab the ability to design and to work metals, wood, and jewels. The two of them could not have completed the sanctuary alone in their lifetimes. Fortunately, God also made them able to teach others.[11] With their leadership and teamwork, the job was completed quickly.

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Today's engineers work almost exclusively in teams. The jobs are too complex for any one person to do alone. Many engineering faculty use a set of tools from CATME.org (named after its first project, Comprehensive Assessment of Team Member Effectiveness) to assign students to teams, teach them to evaluate the effectiveness of their teams and members. Researchers have extensively validated these tools for use in engineering classrooms.[12] More recently, Ferguson, Ohland, and Cao found indications that CATME may work in K-12 classrooms.[13] The research underlying the CATME tools found five main categories of teamwork skills:

- *Contributing to the team's work* is the ability to add value to a team's work/project.
- *Interacting with teammates* refers to the way individuals communicate within their teams.
- *Keeping the team on track* (timekeeping) and identifying and measuring the completion of goals at each stage of the project.
- *Expecting quality* means working collaboratively to produce the best possible team outcomes.
- *Having relevant knowledge, skills, and abilities* refers to the basic knowledge of individual team members and ways of developing those skills, if lacking.[14]

These skills can be taught and practiced separately from engineering as well as in engineering projects. In the past five years, my students come to our program with better teamwork skills than students when I started, so I appreciate the education they received in elementary and secondary school.

Engineering and Ethics

Engineers can do amazing things. They can use their abilities for the good of everyone. However, from the Tower of Babel to weapons of mass destruction to computer viruses and malware, engineering has been used for evil. Engineering associations such as the National Society of Professional Engineers (NSPE) have developed codes of ethics for their members to follow. These codes vary in their details, but this statement from the NSPE Code sums them up well: "Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and

equity, and must be dedicated to the protection of the public health, safety, and welfare."[15] Younger students may not be ready to grapple with some of the complex ethical issues engineers can face, but at every instructional level, engineering must be taught with the philosophy that upholds the strict requirement to prevent harm to anyone.

General Engineering Resources

The NSF provides various resources for teachers, students, and parents on its website, tryengineering.org,[16] which is updated frequently with new resources for teachers, students, and volunteers. You can often find local engineers who will be happy to visit your class or host a field trip. Usually, you know someone who knows an engineer. If not, looking online and at local news stories can help you find engineers to ask.

Engineers on YouTube also create excellent resources. *Practical Engineering*[17] is by a civil engineer who provides content dealing with bridges, roads, water, buildings, and related things. *Engineering Explained* focuses on how cars work. *Real Engineering* provides, as their tagline states, "interesting answers to simple questions." There are many more, but these are the top three that kept my son interested. More engineering resources are only a web search away. Enjoy learning and teaching about engineering!

This resource has been peer reviewed.

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NOTES AND REFERENCES

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