Getting the Message Across: Secure Communication

Making the Connection
Women in Engineering Programs & Advocates Network (WEPAN) Project
Funded by Lucent Technologies Foundation

1. This unit explores the security aspects of communication that are taken into account when transferring information.
2. This activity has students assuming the role of an engineer by designing and testing a method of passing information securely.
3. This activity has a resource page that provides background information.

Communication

Grades 9-12

Objective

The goal is for students to understand the basic security concepts that are considered when text information is transferred between people or locations. The digital world has made it necessary for information security to be a concern in many more people's lives. Previously only military leaders had to worry about sensitive information falling into the wrong hands. Now the average person is concerned about security since they are conducting bank transactions and making credit card purchases on the Internet. Software engineers and computer scientists use programming languages and develop communication protocols to protect data that is transmitted via the Internet. Cryptology, the study of codes helps to form the algorithms they will use to protect transmitted data. It is also important to carefully balance the level of security needed with the resources and time available.

Skills & Standards

- Assessment of systems to meet needs.
- Understand the role of society in development and use of technology.
- Use design process to brainstorm, research, develop a model and communicate the results.

Activity Outline

Materials required per group :
- Copies of activity sheets
- Clock or watch
- Optional: prize or incentive for group(s) who translates the messages fastest or creates a code that is most difficult to translate.

Time frame:
Part 1: 10 minutes
Part 2: 50 minutes

Overview of Presentation

Briefly explain engineering (See Presenter's Guide for more detail).
Engineers use scientific information to design and create useful things. In designing and creating, the engineer goes through a problem solving process in which logic is an important component.

Introduce the activity to the students.
Have a general discussion about information and security. Encourage the students to share knowledge they have about problems with information and security.

Begin the activity.
Before doing the activity, present the '*problem*' and '*who wants to know*'.

Do the activity.
Break the class into teams of two students. As the students work on the activity encourage them to think about patterns they observe as well as how they can create innovative solutions for security.

Reflect on the activity.
After the activity is completed spend time discussing what was discovered and learned. Discuss the advantages and disadvantages of configuring search engines in various ways. Explain that there are no right or wrong answers, just matters of preference.

Career Connection
Discuss what types of engineering jobs are involved with developing and programming methods of transferring information.

Activity: Getting the Message Across

The students will be asked to design a secure system for transferring information. The activity has been developed based on a traditional engineering design process which pose key questions – all identified in boldface type, that help the students approach the problem as engineers.

Part 1: Introduction

What's the problem? As technology allows more people to communicate, keeping those communications private becomes a more critical issue.

1. Lead a discussion about ways in which we communicate. What are ways we keep other people from intercepting these kinds of communications? (See Activity Resource Page).

Part 2: Coding

Who wants to know? A new TV game show, *Decipher the Code*, identifies contestants by having people figure out the correct message by translating the secret code in the fastest time. Create a code that the producer can use to select contestants.

1. Put students into teams of two (or 3 if you have an odd number of students). Be sure to have an even number of teams in the class. Give each team *Worksheet A: Create a Code.*
2. Ask students to create a code that they can use to encode two messages that will be given to them. Give students 10-15 minutes to complete the activity.
3. Give each team, two different messages from *Worksheet C: Sample Messages*. If there is time students can create their own messages. Remind students to use appropriate language and to create a message that is not more than 10 words or 45 characters. Students can identify a letter code to use as a space between words or you can suggest that students just leave a space between words. The former will take more time and is obviously more complex.
4. Have students encode the two messages using the code they created and write it on *Worksheet B: Encoding and Decoding Messages.*
5. Have students exchange the two messages with another group (e.g. Group 1 exchanges messages with Group 2; Group 3 exchanges messages with Group 4 etc.)
6. Give students 15-20 minutes to see if they can decode the messages of the other group.

How can you help solve the problem?

7. Discuss successful techniques for decoding the other group's messages. Were there patterns they looked for?
   Would more time have allowed students to translate the message? Discuss some of the existing methods used to protect information. (See Activity Resource Page).
8. Certain issues make simple codes easy to decipher with enough time. What are ways that issues like Frequency counting could be avoided? What other techniques besides encoding could be used to increase security/privacy? (See Activity Resource Page)

Will your suggestion(s) work? Students can evaluate and discuss their process for encryption. Where is the most time and energy spent – encoding the message, passing the message, or deciphering the message?

Which types of engineers can help you solve the problem? Software engineers and computer scientists use cryptography (the science of codes and ciphers) to create programs, protocols, and methods that help keep information secure. They have to make decisions about how secure information needs to be and what kind of resources is available to create that security.

Engineering Summary: Finish with a discussion about how students approached the problem like engineers.

Activity Resource Page

Background Information for Activity Leader

Cryptptology, the science of secret writing and ciphers, began in ancient times when rulers, like Julius Caesar, wanted to send information but couldn't trust the messenger. Early codes replaced every A with D , every B with E (so shifting every letter down by 3).
For example the phrase:

Meet me at noon.

Would be encoded

Phhw ph dw qrrq

These simple codes could be deciphered by looking for patterns and counting the frequency with which a letter appeared in the code. Two letter words, for example, usually contain a vowel. Looking at the above example, a cryptanalyst (someone who works to decipher codes), would try to guess what the two letter words might be and translate the other words according to the key that might be in use.

Over the years, more and more complicated keys have been developed where the spaces between words are encoded. Characters in the message are also replaced with multiple letters or numbers. However, the best cryptanalyst can still solve these codes with enough time, math, and computing power.

To further increase message security, methods of delivery and use of codes have been developed to hinder deciphering. One message, for example, might be split up into several parts. One of those parts might tell the receiver in which order to assemble the messages. Another method has the receiver and sender of a code use different codes at different times so that even if the message is taken, the interceptor won't have enough of a sample of the code to decipher it (since the code is constantly changes).

As communication has become a significant part of every day life, particularly with the advent of the Internet, information security has become a larger and larger issue. Computer scientists and software engineers work to implement cryptology and security schemes that keep people's privacy and important information from falling into the wrong hands. They use hardware as well as software technologies (like programming languages) to create methods and protocols that protect information.

Engineers and programmers must implement carefully designed algorithms. They must also balance the need and level of security with cost, convenience and computing power.

Questions to Ask

Keeping government military information secure requires millions of dollars worth of hardware and software. This type of sensitive information can take an authorized user several minutes or even hours to obtain access to. The casual home user may need a basic inexpensive program to keep their e-mail from being read if it is inadvertently intercepted. The home user wants to be able to quickly and easily encode their message and is willing to accept the risk of a less secure system in exchange for price and convenience.

As you go through this activity with the students you should encourage them to think about …

<u>Additional questions to ask</u>:

Q: How can computers help decode messages?
A: Many codes use mathematical formulas to encode data. Computers can systematically try each and every possible option. The more powerful the computer, the more rapidly it can try different options.

Q: Why does the government have laws about encryption?
A: The government (particularly law enforcement agencies) wants people to maintain their privacy by using encryption schemes. However, they also want to be able to gain access to information in the event it is being used for illegal purposes or contains valuable information. If the encryption being used can't be decoded by the government, illegal activities could be allowed to continue. Consequently, there are laws about the type and level of security that can be used to protect data. However, some people do feel that if the government has too much control over encryption, people's privacy could be too easily violated.

TIPS

Involve local experts to enhance the activity. Contact the engineering school at a local university, WEPAN at www.WEPAN.org or the Society of Women Engineers at www.SWE.org.

Vocabulary Words

Encryption - any procedure used to convert information into a code

Cipher – the key to a particular system of code

Expanding the Activity

Explore the idea of networks by having students figure out how to pass the message from one side of the classroom to the other. What's the shortest path? What if part of the path is unavailable? What is the value of redundant paths? What kind of structure is most effective (lines, trees, webs)?

Potential Safety Issues

None

Additional References

http://www.howstuffworks.com/encryption.htm
http://www.britannica.com/eb/article?eu=117762

Extensions for Advanced Students

Have students create mathematical algorithms for their codes (A becomes 456) and write a simple equation that would help people decode their message.

Worksheet A: Create A Code

Use the space below to write down the code you create for passing messages.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

1	2	3	4	5	6	7	8	9	0

Worksheet B: Encoding and Decoding Messages

Encode your first message here.

The group you give your message to will translate one message here.

Encode your second message here.

The group you give your message to will translate one message here.

After you translate the messages that the other group has given to you, give it back to the group to make sure you translated it correctly.

Worksheet C: Sample Messages

1. Humans make 2 million red blood cells a second.
2. An average size room holds 90 pounds of air.
3. Humans shed 50 million dead skin cells daily.
4. The fastest elevator travels 15 mph.
5. A human heart beats about 100,000 times a day.
6. Aircraft carriers move 6 inches per gallon of fuel.
7. The Great Wall of China is visible from space.
8. The toothbrush was invented in 1498.
9. Humans spend a third of their lives sleeping.
10. Steepest roller coaster drop is 88 degrees.
11. The tallest building in the world is 1,815 ft.
12. There are 293 ways to change a dollar.
13. No words rhyme with purple or silver.
14. The Hundred Year War lasted 116 years.
15. China is the most populated country.
16. Turkey is located on 2 different continents.
17. Jellyfish are the lightest animals.
18. Elvis Presley had a record 149 hit singles.
19. The Sears tower is the tallest building in the US.
20. The Blue Whale is the largest land mammal.
21. A human heart beats about 100,000 times a day.
22. Aircraft carriers move 6 in. per gallon of fuel.
23. Largest Great White ever caught was 37 feet long.
24. Driving to the sun would take 177 years at 60 mph.
25. The tallest building in the world is in Canada.
26. The subway in Washington DC has 96 miles of track.
27. The longest escalator in the US is 230 ft.