

Likewise, the OS manages upgrades to a computer's hardware (for example, installing more RAM), automatically updating settings in the rest of the system. Another task of the OS is to serve as a kind of traffic cop, allocating processing power and memory space among the various programs that might be running at once while holding back some resources for use by the OS itself.

Common operating systems are the Microsoft® Windows® series, the Macintosh® series, Android™ OS, and the UNIX® family of operating systems, which includes freeware and inexpensive versions of what is known as Linux®.



For more about machine languages, see the Programming merit badge pamphlet.

Applications

As digital devices become more powerful, and as people think up new ways that computers can help us at school, work, and home, new application programs are continually being written. There is no limit to how many applications can exist. The following are some of the most popular types of application programs, but there are many others adapted to particular needs in science, business, industry, and personal use.

Spreadsheet

A spreadsheet performs arithmetic on numbers, which are arranged in rows and columns. The rows and columns intersect to form boxes, called cells. A formula is a function performed on numbers in particular cells—for example, adding the number in cell A1 to the number in cell A2, and having the sum appear in cell A3.

The benefit of a spreadsheet is that if you change a number in one cell, the program immediately recalculates the totals in the other cells that are affected by the change. This allows you to perform “what if?” operations. For example, you can figure out how many more Scouts could go to summer camp if the troop raised an additional \$300 or \$400 at car washes.

Besides numbers, you can also type words in a spreadsheet, such as headings, names, and explanatory notes. Spreadsheets are useful for various types of reports, including fundraising reports, fitness logs, sports team records, travel budgets, currency conversions, and worksheets for car loans.

Database Manager (DBM) Program

Database manager (DBM) programs are used for organizing, storing, and keeping track of a set of information called a database. The data are organized in lines called records, with each record consisting of a number of fields. For each new record, the same set of fields is stored, with different contents in each field.

A troop attendance database could be set up with a record for each Scout in the troop. Each record would consist of fields for the Scout's name, patrol, rank, troop meeting attendance, campout attendance, and other events. An entry of “present” or “absent” could be made in the appropriate field of each Scout's record after each activity. The Scoutmaster could easily see who attended a particular event. The DBM program could also calculate the percentage of participation for each activity.

Word Processing Program

Word-processing software programs are tools that make writing—and formatting text—easier. Once words are typed into a document, they can easily be rearranged and corrected. Software may allow you to change the size and style (together, called the font) of the letters, as well as the color. You can easily align paragraphs to the left, right, or center; add bullets or underlining; adjust the amount of indentation at the beginning of a paragraph; and alter the width of margins.

Some programs let you add tables and graphics and will automatically number pages. You can check the spelling, make different versions of documents without completely retyping them, and print out your work.

With the “mail merge” command, you can insert names and addresses from a database program into a form letter to send out personalized letters to a large group—to every Scout in your troop, for example.



A DBM program can perform sorting and searches of the database information and produce neatly printed reports with graphs and charts.

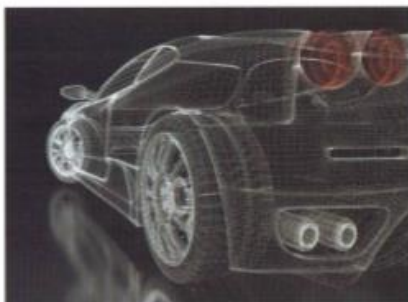
Presentation Program

A popular aid for public speaking, a presentation program lets you create screens or slides that list important points of your speech, as well as pictures, charts, graphs, and even sounds and animation. Slides you create can be projected onto a screen in front of your audience, and can be advanced from one slide to the next while you speak. Also, the text and graphics portion of your presentation can be printed and distributed as handouts for your audience.

Desktop Publishing and Graphic Design Software

Desktop publishing programs allow you to design (or lay out) a page with various elements, including words, pictures, and drawings. The programs have special tools for formatting text, such as setting a headline in big, bold type; sizing images to fit the layout; and adding color backgrounds, shading, boxes, lines, and other design elements. Using a desktop publishing program, you can design a newsletter, a poster, or even a book.

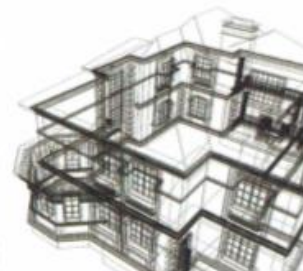
Graphics and design programs allow you to create and edit pictures or drawings. Paint or draw programs let you create images in two dimensions. Other programs allow you to draw in two or three dimensions and create sophisticated models.



Computer-Aided Drafting (CAD) Programs

Three-dimensional CAD programs can be used to create wireframes, or outlines of objects, and solid models, which can show texture, light, and shadows. Automotive engineers use CAD programs to design automobiles, down to each individual part. Other engineers use CAD to design circuit boards, bridges, or buildings.

CAD software is also used by architects to design rooms or entire buildings. A designer usually starts drawing the walls of the structure by dragging the cursor across the screen with the mouse, and the program automatically adds dimensions. You can place furniture in a room—using pull-down menus for couches, tables, etc.—and input exact measurements to match your own furniture.



CAD architecture software allows the user to create a floor plan like this that can be printed and shared.

Photo and Video Programs

Using photo-editing software, you can enhance digital pictures by cropping, sharpening, adjusting brightness and contrast, deepening color saturation, correcting color hues, and otherwise improving your pictures. You can then print the touched-up photos and save them as digital files.

Photo files can be saved at various resolution and compression levels, depending on how you will use an image. For printing, you want as high a resolution and as low a compression as possible, resulting in a large file size and sharp prints. For sending a photograph via email or displaying a photo on a website, you want low resolution and high compression, which produces a small file size that will quickly download to a viewer's computer.





Photo album programs help you organize your picture collection electronically on a hard drive or compact disc (CD or DVD). This software may also let you create slideshows of your pictures that can be stored on a CD or DVD for playback on a computer or TV.



Video editing programs turn a computer into a digital movie studio, allowing you to edit and enhance video footage taken from a digital device. The basic functions of these editing programs include cutting and rearranging video sections; adding transition effects such as fades and wipes between scenes; and adding titles and text, background music, and narration.



Most digital cameras come bundled with image editors.

Web Page Editors

Web page editors are programs that help you create websites without having to write HTML, the best-known markup language used on the World Wide Web. Typically, these programs help you design your page—positioning text and graphics—by selecting commands from toolbars and icons. The editing program automatically creates the underlying code needed. Most Web page editors also allow you to add advanced features such as animation and scrolling text. The programs offer some help in publishing the Web pages you have created onto the Internet.

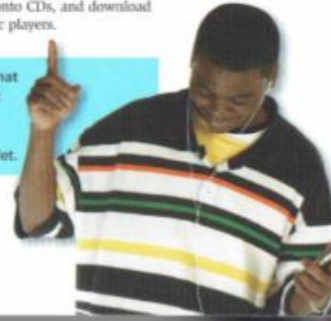
Financial Programs

Financial programs help users keep track of money. In their simplest form, they are like a checkbook that does all the addition and subtraction for you. Financial software has additional features that allow you to generate reports, helping you track how you spend your money by categorizing expenses (entertainment, phone, school, and so on). A program can also help you create a budget so that you won't overspend in particular categories. This kind of software can be linked to bank accounts over the Internet so a check register can be automatically updated, and funds can be transferred between checking and savings accounts.

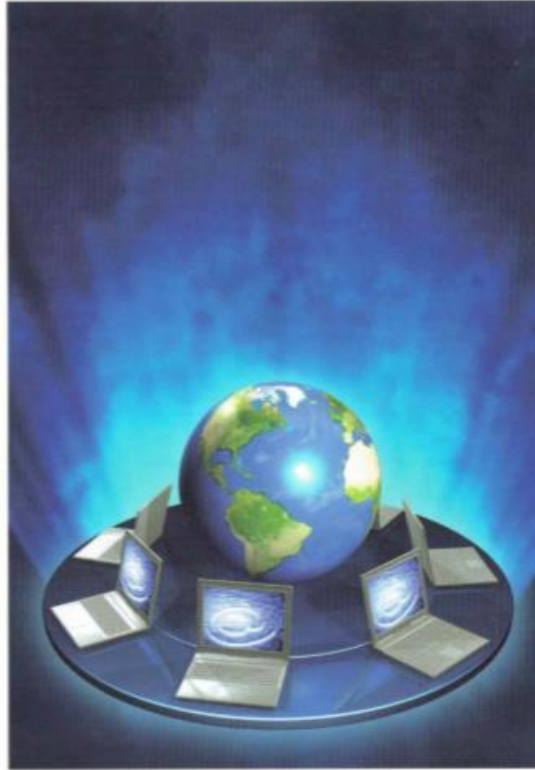
Media Players

Media players help organize music. You can use these programs to convert music from audio compact discs into files that can be stored digitally. You can also add songs that you have purchased. These programs let you create playlists of your favorite songs, "burn" songs onto CDs, and download your music files into portable music players.

It is important to remember that copyrighted song files cannot legally be shared over the Internet. See "Intellectual Property" later in this pamphlet.



See "The Internet and the World Wide Web" later in this pamphlet.



The Internet and the World Wide Web

Two or more computers working together can do far more than a single computer. When computers are linked, their connection is called a network. It might be a local area network (LAN) contained within a single building; or a wide area network (WAN) covering a large region of the country.

These small and mid-sized networks, in turn, are linked to form a much larger system that spans Earth. That system is called the Internet. The Internet, simply stated, is a network of networks. When connected to the Internet, any digital device can communicate with any other digital device around the globe that is also connected to the Internet.

The amazing thing about the Internet is that it does not rely on any one central computer to operate, nor even a central network. No one organization controls it. Instead, the Internet operates across numerous high-speed networks maintained by various Internet service providers (ISPs) and private networks operated by different companies.



Origins of the Internet

The Internet's origin can be traced to ARPANET, a small network launched in 1969 by the U.S. Department of Defense. ARPANET linked computers at various universities around the country. In 1974, researchers **Robert Kahn** and **Vinton Cerf** developed a way to join ARPANET with other similar networks. The networks were joined in 1983, and the Internet was born.

At first, all networks were connected to the Internet through a "backbone" network. ARPANET was the first backbone. Then came a high-speed network of supercomputers organized by the National Science Foundation. That backbone, in turn, was replaced by private high-speed networks.

For years, only universities, military agencies, and defense contractors used the Internet. But as private companies were allowed to join the Internet, and as local area networks started getting connected, it became possible for people everywhere to use the Internet, as well.



The supercomputer is the fastest type of computer made. This is Titan, one of the world's largest supercomputers.

World Wide Web

As the Internet grew, a better way was needed to access and display the vast stores of information it held. That better way was the World Wide Web, developed in 1990 by **Tim Berners-Lee**, a British physicist and software consultant at CERN, the European particle physics laboratory. The Web—consisting of documents called Web pages—would eventually bring graphics, pictures, sound, animation, and video to the Internet. However, its true brilliance was in the simple system of organization it provided.

One of Berners-Lee's two main innovations was the *uniform resource locator* (URL), a form of address that can be used on any Web page or other file on the Internet. His other important invention was *hypertext markup language* (HTML), a form of computer language for creating Web pages that link to other Web pages through clickable hypertext. A word in hypertext can be linked by way of a hidden URL to any other page, or part of a page, or file. Simply by clicking your cursor on the linked word, you can jump to some other location on the Internet, even if it is stored on a computer far from the page where you started.

Billions of Web pages are indexed on the World Wide Web—and an endless number of pages is possible.

The Incredible Optical Fiber

Optic and photonic devices help make today's Internet work. Lasers, fiber optics, photonic switches, and photonic displays allow digital devices anywhere in the world to connect to each other, exchange information, and visually display that information. All information, like movies, phone calls, and emails, are converted into binary data, or ones and zeros, similar to the dots and dashes of Morse code on a telegraph line.



Today, those ones and zeros of information known as "bits" are generated as pulses of light by turning a laser on and off. A small number of the bits are grouped together in what is called a packet with its own address or header, just like an old-fashioned letter, so they can get to the right place. These packets of light pulse and then travel along a strand of glass called an optical fiber.

An optical fiber is about the same size (approximately 100 micrometers, or millionths of a meter) as a hair on your head. It can transmit as much information as more than 30 feet (10 meters) in diameter of copper telephone cables. A single fiber can carry more than 1 million phone calls at the same time.

There are optical switches on the Internet that get those packets from your computer to your friend's computer, if it is an email, or from a special computer called a server, if it is a movie, video, website, etc. Near the end of the journey, the light pulses are converted back to electrical ones and zeros. Those electrical "bits" drive special photonic display devices (LEDs or LCDs) so you can see the information.

In summary, the vast amount of information on the Internet is available at your fingertips because optical fibers carry millions of times more bits of data over thousands of times greater distances than the copper cables they replaced. The only thing preventing you from getting even more information faster is the copper wire connecting you to the photonic Internet.

Web Browsers and Helper Software

To view Web pages, you need a software program called a Web browser. As Web pages add video, sound, and animation, additional software is needed to enable the browsers to use these multimedia elements. A helper software program "inserted" into a browser is referred to as a *plug-in*. When videos are uploaded to a popular website (YouTube, for example), the video files—no matter what format they were created with—are converted into Flash files, which are compressed (made smaller) for easy loading onto a Web page.



Another kind of helper software used in Web browsers is called a *cookie*. A cookie is a small data file transferred to your computer from a website. The cookie, which can contain information about you, such as your user name, language preferences, or shopping preferences, stays on your computer and is loaded into your Web browser the next time you visit the site. Cookies are retrieved from your computer each time you visit a website to allow your visits to have consistency.

Third-party cookies are another type of cookie that can be placed on your computer. Typically these cookies are placed on a computer to track Internet usage to be used in advertising and statistical analysis. All browsers allow you to manage and remove cookies that are stored on your computer.

Widely used plug-ins include Adobe® Flash® and Adobe® Acrobat®, which allow Web pages to display videos and PDF files. Most browser creators allow users to view and manage plug-ins or add-ins through the browser's Tools menu.

Protocols and Domains

Every device connected to the Internet can be identified by its unique Internet protocol (IP) address. Every computer connected to the Internet has an IP address, either a permanent one or a different one that is assigned to the computer each time it connects. A typical IP address looks like this: 23.67.64.152. This is the same as typing www.scouting.org into a Web browser. Finding devices by their IP addresses was difficult, so in 1983, the University of Wisconsin created the domain name system (DNS), which allows people to find a computer on the Internet by a unique name connected to the IP address. (These names form part of the website's URL.)

Domain names, such as "www.scouting.org," always have two or more parts separated by dots. The part of the name farthest to the right is the *top-level domain*—*.com*, *.net*, *.org*, *.gov*, *.edu*. The part to the left of the top-level domain ("scouting" in this example) is the *host name*. The top-level domain alone can tell you something about the website.

- *.com*, *.net*, and *.org*—for general use
- *.gov*—reserved for governmental agencies
- *.edu*—for educational institutions, such as schools and colleges

Once a particular domain name, such as www.scouting.org, has been registered, no one else can use it. A nonprofit group called ICANN (Internet Corporation for Assigned Names and Numbers) maintains the Internet domain name system. ICANN regulates the buying and selling of domain names, which is handled by various private companies.

Different countries have their own top-level domains. For example, *.uk* stands for United Kingdom, *.au* for Australia, *.jp* for Japan, *.ru* for Russia, and *.ca* for Canada. Websites with those letters at the end are likely to be based in those countries.



Internet Security

When most users type in a Web address, they usually start with the "www" part of the URL. But in front of that is an important part which tells the browser how to communicate the information: *http* (plain text) or *https* (encrypted). HTTP, which stands for *hypertext transfer protocol*, is a set of standards governing the exchange of data as text. This is the most common type of request sent through the Internet.

HTTPS, which stands for *hypertext transfer protocol secure*, adds an additional layer to HTTP by encrypting the information with Secure Sockets Layers (SSL) and adding more security around a Web request using security certificates. You will typically see *https* used whenever you are asked to log in to a website or send personal information.

Before sending personal information to a website that is requesting it, you should check that the site has appropriate security and a valid security certificate. Web browsers (Internet Explorer, Firefox, and others) know how to trust HTTPS websites and typically represent secure websites with a lock icon in the URL address bar. You can click on the lock to see information on the website and security information. Check that the name on the certificate matches the website you are visiting and that it is still valid. When in doubt, stop and do not use the website.





Instant Messaging, Texting, and Video Chatting

Digital technology has made possible new forms of communication. You know that email allows you to send a written message to any other email user in the world who has an email account that is connected to the Internet. Another form of digital communication is instant messaging (IM), by which people can communicate in real time, using digital devices. IM also lets users see whether a particular person is online and connected to make an instant-messaging exchange possible.

Another kind of instant messaging is text messaging, usually done through a cell phone, which contains computer chips. Texting is good for quick communication at times when phone calls might be disruptive or impractical, or when a person isn't available to take your call. Text messages can also be sent to order products or services, but you must be careful not to receive unwanted charges on your cell-phone bill this way.

Video chatting allows you and a friend to talk to and see each other, turning your digital device into a sort of video telephone. You can use your computer or other device with a camera attached to stream the video and audio back and forth. Another way to do this is through your cell phone or mobile device using specialized streaming software.

Search Engines

The Internet contains billions of pages of content. To find the information you need among all these pages, you use a search engine. Search engines use programs called *crawlers* to explore the Web and build indexes of Web pages.

To use a search engine, you simply type in your search term ("Boy Scout court of honor," for example), wait a moment, and then see a list of Web pages pop up that contain the term you submitted. You can click on any of the listed pages that you want to view.



Go Cyber

The Boy Scouts of America has a new recognition for youth members called the Cyber Chip. You are probably using digital media now more than ever for everything from research to socializing and for fun and games. Earning the Cyber Chip can help you learn how to stay safe while you are online and using social networks and the latest electronic gadgets. Topics include cyberbullying, cell phone use, texting, blogging, gaming, and identity theft. Find out more about the Cyber Chip by visiting www.scouting.org/cyberchip.



Tips for Online Safety

On the Internet, you can have fun, play games, and take care of business. You can find help with your hobbies and interests, learn all sorts of things, click your way to a wide world of instant information, and even read books. Along with the convenience of the Internet, however, comes some risk.



A computer can catch a malware infection from an email message, websites, downloaded programs, or infected disks.



Protect Yourself

When you are online, be careful to guard your privacy and protect yourself from potentially harmful situations. The following tips will help you stay safe. Your parent, merit badge counselor, or Scout leader may talk with you about other rules for Internet safety. This information is covered in the Cyber Chip. To review, here are a few tips for keeping yourself safe and being a good online Scout.

1. Follow your family's rules for going online. Respect any limits on how long and how often you are allowed to be online and what sites you can visit. Do not visit areas that are off-limits. Just as there are places you don't go to in real life, there are places to avoid on the Internet.
2. Protect your privacy. Never exchange emails or give out personal information such as your phone number, your address, your last name, where you go to school, or where your parents work, without first asking your parent's permission. Do not send anyone your picture or any photographs unless you have your parent's permission.



3. Do not open emails or files you receive from people you don't know or trust. If you get something suspicious, trash it just as you would any other junk mail. It may contain a virus that can harm your computer just by opening the email.
4. If you receive or discover information that makes you uncomfortable, leave it and tell your parent. Never respond to any message that is disturbing or hurtful.
5. Never agree to get together with someone you "meet" online. Tell your parents if someone you don't know tries to arrange a meeting with you.
6. Never share your Internet passwords with anyone (even if they sound "official") other than your parents or other responsible adults in your family.
7. Don't believe everything you see or read online. Along with some great information, the Internet has lots of junk. Learn to separate the useful from the worthless. Talk with your parents or merit badge counselor about ways to tell the difference.



Protect Your Computer and Other Digital Devices

Besides taking precautions to protect your personal safety online, you should protect your computer and other digital devices from a number of online dangers, including malware and theft of files. This applies not only to your home computer but also to any device that can be connected to the Internet such as cell phones and Internet-connected video game consoles.

Malware is a term covering several types of harmful files, including viruses (software codes designed to harm your computer in some way, such as by destroying files or causing your computer to malfunction); worms (files that infect your computer and send out copies of themselves from your computer over the network); and trojan horses (programs that appear to do something useful but actually are harmful). Another form of malware is spyware. Such programs, often attached to some useful software, "spy" on you, tracking your movements on the Web. Spyware can also install secret programs on your computer.

Keep Your Digital Devices Healthy

The following tips will help you keep your computer and other digital tools safe. Your parent, counselor, or librarian may talk with you about other rules for avoiding viruses.

1. Look carefully at the return address of all email messages you receive, especially those that arrive with attachments. Download a file only from someone you trust; even then, be suspicious. Sometimes a virus can be sent from a friend's computer without his knowledge if his computer is infected. Be particularly wary of a file attachment with a name ending with ".exe," which indicates an "executable" program file that may harm your system.
2. Install antivirus software on your computer and keep it updated. The software can be set to automatically look for viruses on your hard drive, to scan disks and files that you put into your computer, and to scan email attachments that you receive.
3. Do not open email that appears to be spam, or junk mail, which may only be trying to sell you something but could also introduce a virus into your computer or other device.
4. Back up your important files regularly onto optical storage media (CDs, DVDs), flash drives, or extra hard drives. (There are also online backup services available for a yearly fee.) It is prudent to make your backup redundant; that is, back up to more than one type of media. Be sure to scan your backup media for malware, too.
5. Buy software only from trusted sources. Unauthorized copies of software programs often contain viruses and should be avoided.
6. For added protection, use a firewall, which can consist of software, hardware, or both, to keep intruders from looking at and possibly stealing private information stored on your hard drive, such as passwords or credit card numbers. Using a firewall is particularly wise if you have a broadband connection to the Internet. The latest versions of Windows® and Macintosh® operating systems have built-in firewalls that you can activate to protect your computer online.
7. Keep your digital device software up-to-date. Software creators often release updates as they fix issues with their software that can lead to security problems. You can help protect your devices by keeping up to date with these releases. Never update your computer or other device without your parent's permission.



Digital Technology at Work

Today, digital-technology skills are useful in almost every profession. As technology has become cheaper and more powerful, it has spread into practically all aspects of business including agriculture, medicine, landscape design, and aerospace. Almost all industries use digital technology for at least one part of their operations. Employees use computers to perform various tasks. Companies use websites and social media to communicate with customers. Technology has become an integral piece of business.

Basic application programs—word processing, spreadsheets, etc.—are used throughout the economy. But beyond that, each industry uses specialized software, and often specialized technology, tailored for the specific needs of the trade.

- Graphic designers and special-effects creators use computers to produce special film sequences for movies and television commercials.
- Air-traffic controllers who guide commercial airplanes use sophisticated systems to help them do their jobs.
- Music publishers record and edit music digitally.
- Newspaper and magazine publishers use computers to edit and design print products and online publications.
- Professional translators use digital devices to automatically translate writing from one language into another.
- Doctors store and retrieve digital medical records of their patients and access medical information that can help diagnose and treat illness.



Computer-driven robots are used in manufacturing, where they provide precise control of sophisticated equipment.

- Hospitals use software-controlled robots for surgery and digital techniques for medical images.
- Architects use software, such as CAD, to help them design buildings.
- Retail workers such as cashiers and stockers use digital devices to track the store's inventory both into the store and then out through the registers.

The list of career uses for digital technology can be endless. When exploring any career field that interests you, look at how that field uses digital technology to enhance and simplify the work.



Video Games: More Than Just Fun

The video game business, which today employs thousands of people, did not exist before digital technology was invented. In only a few decades, the business has grown from a small niche market to a major industry. In 2012, more than 214 million video games were sold in the United States, or more than two games for every household in America. Globally, the video game industry sells more than 500 million games annually.

In the early days of video games, in the late 1970s and early 1980s, many games were developed by one or two people working alone on their computers. Graphics were simple. Game play was crude and unsophisticated. Today, however, video games are often large-scale productions involving entire teams of individuals working on different parts of the game.

Positions in the video game industry include lead programmers, special-effects programmers, audio programmers, sound engineers, composers, art directors, game designers, level designers, screenwriters, project managers, and game testers. Developing a game can take months or years of work and cost millions of dollars, but the profits of a successful game can be huge.

Recently, sales of video games reached over \$10 billion per year in the United States alone. If games played on social media and mobile apps are added, this figure rises to \$15.9 billion. Electronic games are played in 65 percent of American households.

Responding to the demand, more than 200 colleges, universities, and design schools now offer courses or degree programs in game development and digital media.



Preparing for Your Visit

As you prepare to visit a business or an industrial facility that uses digital technology, consider a grocery store, school, manufacturing facility, office, or even your local library. Here are some things to investigate on your visit.

1. What types of digital technology are used—scanners, printers, smart phones, tablets, price-check stations, and so on.
2. What types of software programs are most useful to the organization—inventories, office applications, or mobile apps, etc.
3. Whether any specialized software had to be written to meet the organization's particular needs.
4. What kind of digital technology skills the organization seeks in newly hired employees.
5. How the Internet has changed the way the organization operates. Ask whether the organization has a website and how many employees it takes to maintain the site. Ask if the organization participates in social media and whether it maintains a blog.



Recycling E-Waste

New and exciting digital technology emerges every day to capture our imaginations and improve our lives. Digital technology is changing so rapidly that yesterday's wonder gizmo is today's outdated trash, filling landfills with e-waste. Most discarded digital technology is loaded with toxic chemicals like lead, bromine, cadmium, chlorine, and mercury.

According to the Environmental Protection Agency, Americans throw away 125 million phones each year, creating 65,000 tons of waste. When digital technology is dumped in landfills, dangerous chemicals can leak into groundwater. When incinerated, the toxic chemicals contaminate the air. More than half the states have banned electronics from landfills.

Manufacturers recognize the environmental issues and are shifting to manufacturing processes that minimize the use of hazardous chemicals, including:

- Reducing or eliminating lead solder
- Using less hazardous resins in plastics
- Using mercury-free flat-panel liquid crystal displays (LCD) and arsenic-free glass
- Using bromine-free and chlorine-free printed circuit board laminates
- Moving to less toxic and reactive phosphorous-based flame-retardant chemicals

Because many recyclers are not equipped to responsibly recycle electronics, it is important to help ensure proper disposal of e-waste and use a certified recycler. Certified electronics recyclers meet high standards for data privacy, environmental responsibility, and employee health.

You can learn about certified recyclers by visiting the Environmental Protection Agency's website; see the resources section.

Similarly, using different types of waves, we turn on a TV set with a remote control. The remote control radiates invisible light waves that are picked up, or absorbed, by a device in the TV set. If you point the remote control at yourself, you don't feel anything. If you look at it, you don't see anything coming out when you push the button. Try using your remote control on your neighbor's or friend's TV. It may not work. That is because your TV and someone else's use slightly different waves.

Chemical Properties. When engineers study how a material interacts with other materials and external stimuli (stimulants), they are studying the material's chemical properties. Fire-resistant construction requires materials that do not burn easily. The liquids and solids in batteries are chosen because of their chemical properties. What kinds of chemical properties would you want in your materials if you were designing a match to light a fire?

Another important chemical property is resistance to corrosion. Materials can react with oxygen, water, salt, or just about any substance. What is important is the rate of reaction and how long the material must survive. A bridge over salt water may be expected to last 100 years, but a resealable plastic bag might be expected to last for only a year. How long would you expect the steel body of an automobile to last in Miami, Chicago, or Phoenix? Why might you expect any differences? (Hint: Consider temperature, humidity, salt air, and the road salt used to melt snow.)

Properties of Liquids. Liquids are sensitive to temperature and have a freezing point and a boiling point. Water turns to ice (a solid) when the temperature goes below 32 degrees Fahrenheit and becomes steam (a gas) when the temperature goes above 212 degrees Fahrenheit. Liquids can also evaporate (turn to gas), just by sitting long enough. Another important property of liquids is their resistance to motion, which is called viscosity. You can swim in water, but why would it be difficult to swim in a pool of honey? Because honey has a high viscosity.

Think of some liquids that you encounter in your daily activities and identify the ones with high or low viscosity.



Classifications of Materials

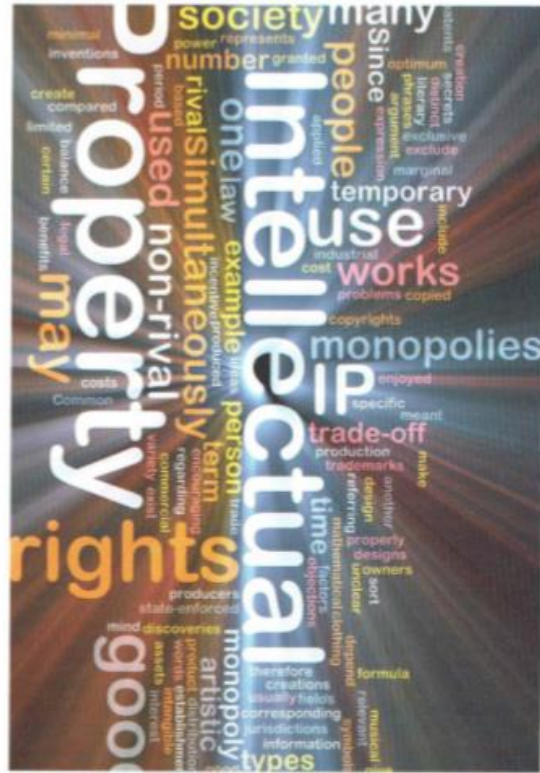
We have discussed the characteristics of materials that an engineer must consider. Now let's look at other considerations, including the type of material and the manufacturing method.

Materials are classified into metals, composites, ceramics, polymers, electronic materials, and other groups. For each class of materials, the method of manufacturing is important. Questions about how a material can be made into a given shape must be addressed. Engineers also must know how to model a material all the way from raw material to finished product. To do this, the engineer develops equations and computer programs to describe the material and its characteristics.



Imagine that you are an engineer with a company that makes all sorts of different products. The chief engineer has given you and the other engineers the task of developing new and superior versions of those products. Specifically, you want to improve the following.

- **Fishing rods:** In the past, they have been made from materials including bamboo, steel, and composites. What material might make a better rod?
- **Bicycles:** What might you look for in a material to build a better bike?
- **Shoes and sneakers:** What properties of a material would allow you to make a better sole and heel on a shoe?
- **Automobile bodies:** We are very cost-conscious in our imaginary corporation, because we still use gasoline in the engines. What properties of a material are important for building a better car body?



Intellectual Property

Ideas are referred to as *intellectual property*. Intellectual property laws are set up to protect unique and original ideas by establishing and defining the rights of those who create, own, and use them. The laws seek to balance the benefits of copying, sharing, and spreading ideas while making it worthwhile for people to produce new ideas.

Digital technology has made it much easier for people to copy, share, and spread ideas, whether or not they own the ideas. Technology allows people to mash up songs and videos, manipulate images, and duplicate and use apps on different devices. Creatively, this enables people with artistic skills to put new spins on existing ideas. When it comes to innovation, people can spend more time adjusting, enhancing, and tweaking ideas without the need to start from scratch.

There is a downside to copying, sharing, and spreading ideas—especially the ideas of others. Allowing people who create ideas to enjoy the recognition and to profit from their hard work is important in motivating people to produce new ideas and materials.

In the United States, everyone is entitled to intellectual property rights. For example, a record company has the right to protect and profit from a song that it produces and releases, just as an individual has the right to protect and profit from a song that he or she writes and performs. A record company may have the right to use a portion of another company's or artist's song in one of their songs, just as an individual may also use a portion of another person's or company's song. It all depends on the intellectual property laws and how they apply.

Laws help protect intellectual property. Every Scout needs to make sure he respects those laws and the intellectual property created by others.

A Scout Is Trustworthy

Scouting promotes hard work, creativity, and innovation, and acting in an honest and respectful fashion. Scouts should strive to create new ideas and use existing ideas in a manner that respects the hard work and the desires of the creators and owners of those ideas.

Intellectual Property Protections

Intellectual property, or IP, refers to creations that cannot be touched or held, such as ideas, plans, and designs. The major types of intellectual property protection include copyright, patents, trade secrets, and trademarks. Each type protects different aspects of ideas and has its own rules. The information below provides an overview.

Copyright

Copyright law protects the creative, original expression of an idea, not the idea itself. Examples of copyrighted works include books, magazine articles, movies, music, plays, sculptures, paintings, software, and photos. Under copyright law, protected items are called "works of authorship," and their creators are called "authors."

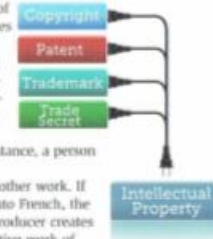
Copyright law gives the copyright owner a set of exclusive rights to:

- Reproduce the work.
- Make "derivative works" of the original work.
- Distribute copies of the work.
- Publicly perform the work.
- Publicly display a work.
- Perform an audio recording via a digital audio transmission.



Keep in mind that copyright protects a set of legal rights; it does not cover ownership of copies of the works themselves. Just because a reader owns a single copy of a book or movie on DVD does not mean the reader can legally make copies of those works. However, although the copyright owner has the right to publish, reproduce, and distribute a work, people are entitled to resell items they have legally purchased. For instance, a person can sell his or her books.

A "derivative work" is a work based on another work. If someone translates an English-language book into French, the French version is a derivative work. Also, if a producer creates a movie based on a book, the movie is a derivative work of the book.



Copying another person's ideas may or may not infringe upon or violate the person's intellectual property rights. Under certain circumstances and limitations, the legal doctrine known as "fair use" enables people to use a limited portion of copyrighted works without obtaining permission. You can learn more about copyright infringement and fair use at <http://boyslife.org/digitaltechnology>.

The length of copyright protection can vary. Typically it is the lifespan of the author plus 70 years, but under certain conditions it can be longer. The Library of Congress has tools that can help determine whether copyright protection on a work is still in force.

Ideas no longer protected by copyright are in the public domain. Anyone can use such ideas without obtaining permission or approval from the rights holder. For instance, Sir Arthur Conan Doyle's novels about Sherlock Holmes have entered into the public domain, allowing people to make new movies and television shows featuring Holmes or a Holmes-like character. These new creations have their own copyright protections.

Check out <http://boyslife.org/digitaltechnology> for more about copyright, patents, trademarks, and other intellectual property protections.



Look at the copyright notice on page 2 of this merit badge pamphlet. The information follows the copyright symbol: © (a circled capital C). What does the information tell you? Also look at the acknowledgments in the back of the pamphlet. What images in this publication are copyrighted? All merit badge pamphlets comply with intellectual property laws.

One major restriction imposed by copyright law is that you cannot make illegal copies of protected works. Trading in illegal copies of copyrighted works is called piracy.

Unfortunately, digital technology makes it easy to produce exact digital copies of certain kinds of intellectual property, including copyrighted software programs, games, music, photographs, books or articles, and movies. Worsening the problem is the illegal sharing of these pirated copies over the Internet through the use of file-sharing networks. These networks make piracy easy and seemingly secret.

Not all copying is illegal. When you buy recorded music, you usually are allowed to copy it for your personal use, say, in a portable music player. However, it is illegal to give copies of music or software to your friends. If you do, you are committing a crime. If you download pirated files into your computer, you also run the risk of downloading a virus that can harm your computer and data files.

Copying songs and books like this merit badge pamphlet is like stealing anything else, and it is wrong. You would not shoplift a CD at the music store or sneak in at a concert to listen for free. Similarly, you should not make copies of songs, books, and other copyrighted materials for friends.

Patent

A patent, issued by the U.S. government, grants certain exclusive rights in an invention for a limited term, typically 14 to 20 years. Patent law gives the inventor the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States. In exchange for these exclusive rights, the inventor must publicly disclose the invention. After the patent expires, anyone is free to use the invention.

In the United States, an inventor must file a patent application with the U.S. Patent and Trademark Office. The government will grant a patent only after an examiner has looked at the application and is satisfied that it meets the requirements. For more about patents and the rights of inventors, see the *Inventing merit badge pamphlet*.

Foreign governments also issue patents that provide protection within their countries.

Trade Secrets

Unlike copyright and patent law, trade secrets are covered by state law. In most states, the four requirements for trade secret protection are:

- The confidential information provides a competitive edge for a business.
- The information has value.
- The information is not generally known.
- The information's owner protects it through reasonable measures to maintain its secrecy.

As long as the business ensures that the information continues to meet these requirements, the business can maintain trade secret protection indefinitely. Unlike patents, no registration with a government agency is necessary to obtain or maintain trade secret protection.



The trademark symbol TM may be used with any mark. But the registered trademark symbol [®] may only be used by the owner of a mark following registration with the U.S. Patent and Trademark Office.

Trademarks

A trademark (identified with a TM or ®) is any word, name, logo, symbol, or device, or a combination of them, used to identify and distinguish the goods or products of a business. Some famous trademarks are Coca-Cola®, McDonald's®, and Apple®. You are also likely familiar with the trademarked logos of well-known companies, such as the golden arches of the McDonald's® restaurant chain. Unlike copyrights and patents, trademark rights continue indefinitely as long as the owner continues to use the mark.

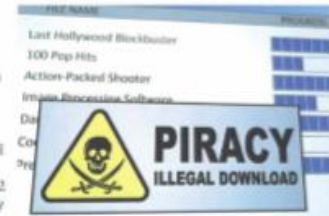
In the United States, it is possible to obtain limited protection of a mark without registration. As soon as a business starts using the mark, the business obtains some protection of the mark as an unregistered trademark. Registration of a mark with the U.S. Patent and Trademark Office gives the mark's owner additional benefits. Businesses can also obtain trademark registrations from foreign governments.



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Piracy

The unauthorized use of another person's intellectual property is called piracy. As an example, software piracy is a costly, worldwide problem. According to the Business Software Alliance's 2011 Global Software Piracy Study: "[T]he global piracy rate hovered at 42 percent in 2011 while a steadily expanding marketplace in the developing world drove the commercial value of software theft to \$63.4 billion." It is not a victimless crime.



The Federal Bureau of Investigation is charged by the U.S. government to investigate piracy and intellectual property theft. This includes ideas, inventions, and creative expressions, such as trade secrets, music, movies, and software. The FBI's



Anti-Piracy Warning Seal is used to help "detect and deter criminal violations of U.S. intellectual property laws by educating the public about the existence of these laws and the authority of the FBI to enforce them." You have probably seen this seal alongside the following text:

The unauthorized reproduction or distribution of a copyrighted work is illegal. Criminal copyright infringement, including infringement without monetary gain, is investigated by the FBI and is punishable by fines and federal imprisonment.



Glossary

analog. Describes a device or information that is continually variable, like a clock or a sound wave. The opposite of digital.

binary. A numbering system that uses only two digits. In digital technology, the two digits are 1 and 0, which represent turning an electronic circuit on and off.

bitmap. A grid on a computer screen made up of individual dots or pixels. The file name extension is ".bmp" and is a standard image format for personal computers.

browser. A program that lets users find and explore information on the World Wide Web, including text, graphics, sound, and video.

cloud computing. Applications and data storage, management, and processing offered over the Internet, on shared computing resources rather than individual personal devices.

compression. Shrinking a file. Compression can be lossless (preserving all the data in a file) or lossy, (some data is deleted).

cookie. A small file downloaded from a website to your computer to store information about your activity at the site, such as what items you placed in your "shopping cart" at a store website.

digitize. To change something such as a picture or a sound into a form that a computer can understand.



download. Transferring information "down" from someone else's computer to one's own computer, by way of a local area network connection or the Internet.

driver. A small computer program that allows the computer to communicate with a peripheral device, such as a printer or scanner.

field. Part of a database in which a specific type of information is stored, such as telephone numbers.



firewall. Software or hardware that protects a computer or a private network of computers from other computers on the Internet.

freeware. Software that is not copyrighted and can be used and copied by anyone. Also known as public-domain software.

hard drive. A rigid disk consisting of several platters that store information in magnetic form, usually installed inside a computer.

HTML (hypertext markup language). The basic language for displaying text and pictures on websites and linking Web pages together.



Integrated circuit

integrated circuit. A group of related circuits all manufactured together on a single chip.

local area network. A computer network within a single office, building, or other site.

lossless/lossy. Compression can be lossless (preserving all the data in a file) or lossy, in which some data is deleted.

machine code. A programming language made up of sets of binary codes that a computer uses to pass instructions back and forth among its parts. Sometimes called low-level code.

malware. Damaging or "malicious" software intended to disrupt a network or a single computer. Types of malware include viruses, worms, and trojan horses.

memory. Where a computer stores information, for example, in RAM or ROM, or on compact discs or hard drives.

microchip. Integrated circuit.

microprocessor. The "brain" of a microcomputer, or personal computer.

motherboard. The main circuit board of a computer, which contains the central processing unit.

network. A group of connected computers.

operating system. Software that allows the computer to perform basic functions.

output device. Any device such as a monitor, printer, or sound card that allows information to be sent out from a computer.

pixel. Short for picture element. A single dot on a computer screen.

port. A place on a computer where accessories and peripherals can be plugged in and connected.

protocol. The rules computers use to communicate with each other.

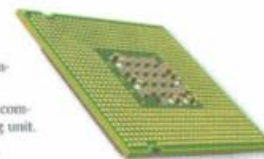
RAM (random-access memory). Temporary memory that the computer uses to store programs and information until the computer is turned off.

read. To retrieve information or a program from storage and put it into the computer's internal memory. The opposite of write.

resolution. Describes how much detail is used to print an image (in dots per inch, or DPI) or display it on a computer monitor (in number of pixels wide by number of pixels high).

ROM (read-only memory). Permanent, unchangeable memory used to store basic instructions the computer needs in order to operate.

router. A device or software that serves as a bridge between two or more networks. A router determines the best route for sending a packet of data to its destination.



Microprocessor



Ports



Router



security certificate. A digital certificate that authenticates business websites and secures email messages, allowing users to verify the identity of the company or person with whom they are doing business.

server. A computer on a network that manages shared resources, such as files or Web pages.



shareware. Software that a user pays for after trying it and deciding to use it.

sound digitizer. A circuit that converts sound into digital form.

trojan horse. A virus or harmful computer program disguised to look like a useful program, such as a screensaver.

uniform resource locator (URL). A location or address identifying where documents can be found on the Internet; also known as a Web address.

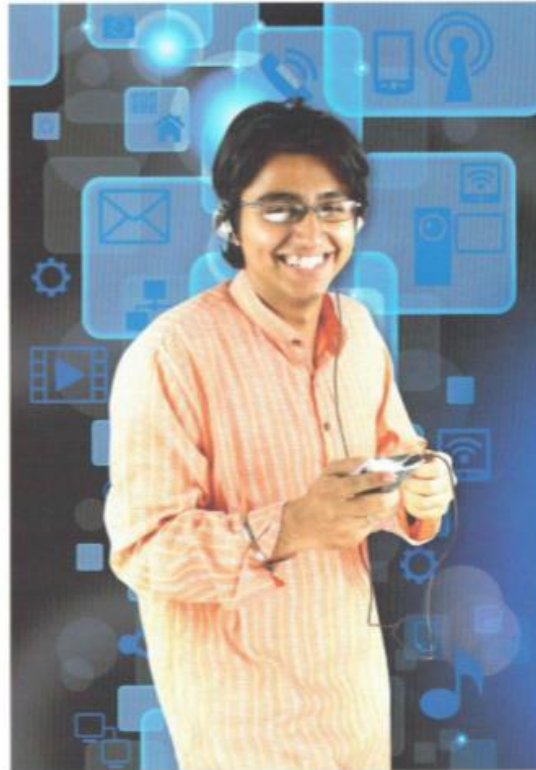
upload. To transfer information from one's own computer "up" to someone else's computer via a local area network or the Internet.



USB (universal serial bus) port. The device used to connect all such peripheral devices.

Wi-Fi (wireless fidelity). A method of connecting computers on a network with radio signals rather than wires.





Digital Technology Resources

Scouting Literature

Drafting, Electricity, Electronics, Engineering, Game Design, Graphic Arts, Inventing, Photography, Programming, and Robotics merit badge pamphlets

Visit the Boy Scouts of America's official retail website at <http://www.scoutstuff.org> for a complete listing of all merit badge pamphlets and other helpful Scouting materials and supplies.

Organizations and Websites

American Society for Engineering Education

Websites: <http://www.asee.org> and <http://www.engineeringk12.org>

Computer and Information Technology Occupations

Occupational Outlook Handbook: <http://www.bls.gov/oooh/computer-and-information-technology/home.htm>

The Computer History Museum

Website: <http://www.computerhistory.org>

Entertainment Software Association

Website: <http://www.theesa.com>

Environmental Protection Agency

Website: <http://www.epa.gov/epa-waste/index.htm>

IEEE (Institute of Electrical and Electronics Engineers)

Website: <http://www.ieee.org>

IEEE Computer Society

Website: <http://www.computer.org>

International Game Developers Association

Website: <http://www.igda.org>

International Intellectual Property Alliance

Website: <http://www.iipa.com>

Library of Congress

Website: <http://www.loc.gov>

Recording Industry Association of America

Website: <http://www.riaa.com>

U.S. Patent and Trademark Office

Website: <http://www.uspto.gov>

World Wide Web Consortium

Website: <http://www.w3c.org>

For more information and resources about digital technology, go to <http://boyslife.org/digitaltechnology>.

E-Waste Resources**Call2Recycle**

Website: <http://www.call2recycle.org>

Earth911

Website: <http://earth911.com>

Terracycle

Website: <http://www.terracecycle.com/en-US>

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Wikipedia.org/Appaloosa—page 30
 Wikipedia.org/Asim18—page 25
 Wikipedia.org/Guern—page 21 (top)
 Wikipedia.org/Adam Schuster—page
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 Brian Payne—pages 12 (bottom)
 and 49

Notes

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Though intended as an aid to Boy Scouts, Varsity Scouts, and qualified Venturers and Sea Scouts in meeting merit badge requirements, these pamphlets are of general interest and are made available by many schools and public libraries. The latest revision date of each pamphlet might not correspond with the copyright date shown below, because this list is corrected only once a year, in January. Any number of merit badge pamphlets may be revised throughout the year; others are simply reprinted until a revision becomes necessary.

If a Scout has already started working on a merit badge when a new edition for that pamphlet is introduced, he may continue to use the same merit badge pamphlet to earn the badge and fulfill the requirements therein. In other words, the Scout need not start over again with the new pamphlet and possibly revised requirements.

Merit Badge Pamphlet	Year	Merit Badge Pamphlet	Year	Merit Badge Pamphlet	Year
American Business	2013	Entrepreneurship	2013	Flamering	2013
American Culture	2013	Environmental Science	2006	Plant Science	2014
American Heritage	2013	Family Life	2005	Planting	2012
American Labor	2006	Farm Mechanics	2008	Puttery	2008
Animal Science	2014	Fingerprinting	2003	Programming	2013
Archaeology	2014	Fire Safety	2004	Public Health	2005
Archery	2013	First Aid	2007	Public Speaking	2013
Architecture and Landscape Architecture	2010	Fish and Wildlife Management	2004	Pulp and Paper	2008
Art	2013	Fishing	2013	Radio	2013
Astronomy	2013	Fly Fishing	2009	Railroading	2003
Athletics	2000	Forestry	2005	Reading	2003
Automotive Maintenance	2012	Game Design	2013	Reptile and Amphibian Study	2005
Avalanche	2014	Gardening	2013	Reptile Study	2012
Backpacking	2007	Genealogy	2005	Rubrics	2011
Basketry	2003	Geocaching	2010	Rowing	2014
Badminton	2005	Geology	2005	Safety	2013
Badminton (see Mask)	2005	Geography	2002	Scholarship	2013
Camping	2011	Graphic Arts	2013	Scholarship	2014
Canoing	2004	Hiking	2007	Scouting Heritage	2014
Chemistry	2004	Home Repairs	2012	Scuba Diving	2009
Chess	2011	Homemanship	2013	Sculpture	2007
Cinematography (see Movie-making)	2008	Indian Lore	2008	Search and Rescue	2012
Citizenship in the Community	2005	Insect Study	2008	Shotgun Shooting	2013
Citizenship in the Nation	2005	Inventing	2010	Shooting	2005
Citizenship in the World	2005	Javelin	2006	Small Boat Sailing	2004
Climbing	2011	Kayaking	2012	Snow Sports	2014
Coin Collecting	2008	Landscape Architecture (see Architecture)		Soil and Water Conservation	2004
Collections	2008	Law	2003	Space Exploration	2013
Communication	2005	Leatherwork	2013	Sports	2006
Composite Materials	2005	Lithology	2008	Stamp Collecting	2013
Computers		Marine Study	2002	Surveying	2004
(see Digital Technology)	2009	Medicine	2008	Sustainability	2013
Cooking	2013	Metalwork	2007	Swimming	2008
Crime Prevention	2005	Model Design and Building	2010	Tennis	2014
Cycling	2013	Motorboating	2008	Theater	2014
Dentistry	2006	Movie-making	2013	Traffic Safety	2006
Digital Technology	2013	Music and Bagging	2013	Truck Transportation	2005
Disability Awareness	2014	Nature	2014	Veterinary Medicine	2005
Dog Care	2012	Nuclear Science	2010	Water Sports	2007
Drafting	2008	Orientation	2009	Weather	2013
Electricity	2013	Orientation	2003	Walking	2012
Electronics	2004	Painting	2012	Wilderness Survival	2007
Emergency Preparedness	2012	Personal Fitness	2013	Wood Carving	2008
Energy	2005	Personal Management	2003	Woodwork	2011
Engineering	2008	Photography	2013		

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