

The Core Technologies: Why Are They Important To Technology Educators?

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In 1993, Maryland identified the “core technologies” as a major content organizer for programs in technology education. Technology Education: A Maryland Curricular Framework, published by the Maryland State Department of Education states:

"The learner demonstrates knowledge of the core technologies from which all technology systems are derived, which include: mechanical technology, structural technology, fluid technology, electrical technology, electronics technology, optical technology, thermal technology, bio technology, and materials technology." Expectancy 1.2.5, page 22.

The *Technology For All Americans* project which is currently developing national standards for technology education has, similarly, included the core technologies as contexts for the study of technology. Identifying these core technologies as "physical and biological systems" they are part of the "intellectual domain of technology." Why are they so important?

What are the core technologies? The core technologies are the “basic building blocks” from which all technology systems are created. Engineers, technologists, technicians, and craftspersons create technology systems for the purpose of providing hardware (materials, devices and structures), software (information media), and energy to meet human needs and desires. The number of technology systems possible seems infinite. New systems will continue to be created so long as there are resources to do so and there are problems to be solved.

We see from our daily experiences that individuals are great users of technology systems. Enterprises and institutions are also great users of technology systems. The right hand block in the model (below) identifies some of these enterprises and institutions.

Imagine that we could store the “core technologies” on shelves. We could go to those shelves and use technologies according to our needs in solving problems. For example, if a need were to be satisfied by developing an airplane, one of the technologies we would have to take from the shelf would be structural technology. It would serve us in creating the airplane body, wings and various other parts. However, the same structural technology shelf would serve us to solve a problem that could be satisfied by developing a chair. Each of the “core technologies” could be described as “generic” within its own category, or “shelf”, until it is employed in the creation of a special technology system. The “core technology shelves” represent all the technologies we use to create technology systems that solve problems and extend human capabilities.

The core technologies are fundamental to the understanding of technology systems. People create technology systems to satisfy their basic needs and desires. These systems may be as simple as a paper clip or as complex as the space shuttle but they all are produced by people creatively combining core technologies. The paper clip is a combination of mechanical, structural and materials technology. An understanding of how it effectively meets our need to hold papers together is gained through an analysis of mechanical and structural design concepts and the properties of the materials used. Likewise, an understanding of how the space shuttle does its work can be attained by identifying and examining the numerous applications of the core technologies in this complex technology system.

What is it that students need to know about the core technologies? Obviously, a person could spend a lifetime studying only one tiny facet of one of the core technologies, but there is some general information that students should be aware of. After an introduction to the definitions of each core technology, elementary school students should be able to identify the core technologies present in a particular example of technology. When presented with a toaster, they should readily describe where they see examples of thermal technology, electrical technology, mechanical technology, and structural technology at work. Middle school students

should be able to apply knowledge of the core technologies to the solution of practical problems. They should make decisions about the use of various technologies based on cost, performance, environmental impact, and safety considerations as they design and construct problem solutions. To do this they will demonstrate knowledge of the science concepts applied in core technologies and the use of mathematics to measure, analyze, describe and predict system performance. High school students should be knowledgeable about the common components used in each core technology system, basic system design, simple controls, and system performance evaluation. They will use this information to assess, manage, design, and produce technology systems.

What do the core technologies do for technology educators? The core technologies offer technology teachers a science and mathematics-based content that supports the activities in which their students are already involved. These technologies are the bridge between science concepts and real-world technology. They provide numerous opportunities to describe, analyze, and predict physical phenomena using mathematics.

The core technologies provide a relatively stable taxonomy by which to analyze technology systems. As technology systems evolve, they will most likely continue to be combinations of these nine technologies. This means that technology teachers can develop activities that will be relevant to whatever technology systems arise.

The applications of technology by individuals and by human enterprises and institutions are many and diverse. Individuals make use of technology in personal and family life on a daily basis to make life easier, better and more enjoyable. On a different scale, our enterprises and institutions depend on technology systems for their functioning and productivity.

The dominant manner of structuring curricula for technology education has been to organize courses around applications of technology systems in selected enterprises such as manufacturing and communications. Many technology educators believe that such a model is neither the most desirable basis nor the most practical basis for curricular structuring in technology education.

It is recognized by those familiar with technology education that manufacturing, construction, transportation, and information and communication represent the enterprises most frequently used as a basis for organizing technology education curriculum. An important question to ask is, "Why do we not organize our curricula in such a way as to include all of the other enterprises and institutions such as education, health and medicine, law enforcement, recreation, commerce, and the military that are also major users of technology." The answer to this question relates to practicality.

Two major reasons are presented for not organizing technology education curricula to account for so many enterprises.

1. There are too many human enterprises, which make applications of technology systems. It would be impractical to offer courses, which relate to all of them.
2. There would be considerable overlap and repetition. Many of the technology systems applied by one enterprise are also applied in others.

While it seems impractical to organize our curricula around the applications of technology in an extensive variety of human enterprises, choosing only a few enterprises seems arbitrary. Our choices of manufacturing, construction, transportation and communication have roots in the late evolution of industrial arts. As organizers, they have carried over into technology education. When considering the significance of technological systems applied in other human enterprises, our focus on these four areas is artificially limiting.

These points in opposition to organizing curricula around human enterprises is not intended to suggest that enterprise applications of technology are unimportant. Such applications by specialized enterprises are important for students to know about as examples. They serve as

examples of ways in which technology systems solve problems to meet human needs and desires. Enterprise applications of technology should serve as examples, rather than serving as curricular organizers.

Summary The core technologies are the bridge between science concepts and real-world technology. They provide numerous opportunities to describe, analyze, and predict physical phenomena using mathematics. Technology education activities that require students to create technology are enhanced by instruction related to the core technologies. Students planning careers in technical areas will find that an understanding of the core technologies is applicable to all engineering-related endeavors.

Incorporating instruction on the core technologies does not preclude programs based on technological processes such as “engineering design and development” or those based on enterprises that utilize technology such as “manufacturing.” It is unique in that it is a body of knowledge that is recognized by the science and mathematics communities as a logical and valuable enhancement to their disciplines. The core technologies offer technology teachers a precise, mathematics-based, content that supports the activities in which their students are already involved. Including the study of the core technologies in all technology education programs is relevant, practical, and complimentary to the general education of all students.



Core Technologies: The Building Blocks of Technology Systems Video Transcript

The following is a presentation of the Baltimore Museum of Industry, the Museum that Works, celebrating Baltimore and Maryland's people, their culture, work, and inventiveness as reflected in area industry and technology. And now, Core Technologies: The Building Blocks of Technology Systems.

Trains and boats and planes are familiar to all of us. So, too, are microwaves and computers and can openers. What may be unfamiliar is that all of them have a common denominator. They're technology systems created by people.

Whenever human beings have been faced with needs or wants that could not be met, they've invented or improved upon existing technology systems to solve the problem.

On this program, we'll look at what technology systems are, who develops them, and where they're applied. We'll also identify certain core technologies and look at the systems they've produced.

A technology system is defined as a group of resources working together to solve problems and extend human capabilities. To develop a technology system, such as an automobile or a microwave oven, people use nine core technologies or building blocks.

First, mechanical technology: the production and control of motion, like that of an agitator in a washing machine.

Second, electrical technology: a method of producing and getting work from electrical energy, like that found in a hair dryer.

Number three, electronic technology: the use of small amounts of electricity to process and communicate information, like that used in the operation of televisions and computers.

Number four, structural technology: the manipulation of materials that can be used to shelter and support. Bridges, airplane wings, and satellite dishes are some of the results.

Number five, fluid technology: the use of gasses and liquids to apply force, like the pneumatic air brakes on trucks and the landing gears on airplanes.

Number six, optical technology: the production and use of light to collect information and do work. Light bulbs, fiberoptic telephone communications, and laser compact discs are examples.

Number seven, thermal technology: the production and control of heat energy to do work, like that performed by refrigerators, toasters, and jet engines.

Number eight, biotechnology: the use of biological organisms to achieve desired outcomes. The stain eating enzymes found in detergents and the alteration of plant genes to produce better crops illustrate some of these desirable outcomes.

And number nine, materials technology: the production alteration and combination of materials, like that found in the manufacturing of paper and the derivation of aluminum from bauxite ore.

An understanding of the core technologies makes it possible to create new technologies or to apply existing technologies to new situations. From the simplicity of an hammer to the intricacy of jet fighters, the core technologies are used to produce technology systems with a wide range of sizes and complexities.



The responsibility for developing these systems lies with a team of technologists. Scientists, engineers, technicians, and craftspeople collaborate to bring an idea to life.

To develop the fuselage and wings of an airplane, for instance, the technology team would use structural technology. This core technology focuses the efforts of the team on materials and production techniques that will ensure strength and stability for the aircraft.

Those very same technologies can be applied to other projects where material integrity is important. The design of a chair, for instance, applies the same structural principles as designing a cargo jet.

Many, if not most, technology systems draw from a number of core technologies, which may be represented as items stored on shelves.

For instance, to make a bicycle, the frame comes first, which means the first shelves to be emptied are material and structural. For pedals, sprockets, and the chain drive, the engineering team refers to mechanical technology. And to fill the tires with air, the pneumatics in fluid technology need to flow properly.

Computers, laser printers, washing machines, furnaces; practically all the conveniences of modern life depend on the understanding and application of multiple core technologies.

To build what is arguably the most complex and demanding of our machines, require that we practically empty the core technology shelves. The U.S. Space Shuttle is a marvel of technology that carries into orbit all of the critical operations necessary to protect and preserve human life.

To maintain radio communications with earth, for instance, electronics technology is needed. To control the shuttle's cabin temperature, thermal technology is employed. And for the various experimental manufacturing processes aboard, biotechnology comes off the shelf. To withstand the harsh environment of space, particularly during re-entry, materials technology provides the protective shield. And without mechanical technology, it wouldn't be possible to close the door on the cargo bay. And without fluid technology, lowering the landing gear would be problematic.

The Space Shuttle is indeed a larger-than-life demonstration of the significance of the core technologies.

An understanding of the nine core technologies and their applications, prepares students for rewarding technical careers. By drawing on the core technologies, technology education students can use materials, equipment, and their imaginations to create prototypes of everything from robots to new enabling devices for the handicapped.

And, with luck, those prototypes will make them the star techs of the next generation!

Produced by Prince George's County Public Schools, Office of Television Resources.

This has been a presentation of the Baltimore Museum of Industry and the Maryland Center for Career and Technology Education, helping to build world-class career and technology educators in support of Maryland's educational needs.



CORE Technology / STEM Analysis Problem Worksheet

The Core Technologies as defined in Maryland are the major content elements used to create technology devices and systems. They can be identified singularly or in combination in all technology devices. They are related to specific areas of scientific discovery and experimentation, and maybe uniquely defined by their application of specific scientific principles and concepts. They also provide experimental application and functional application of mathematic theorems and proofs as they operate.

Assignment:

Using this worksheet, identify a common technology device found in everyday use, determine which CORE Technologies were inherent in its design and development and identify the science principles and concepts and mathematics principles, theorems and proofs that are at the basis of it's functioning. *[Sketches and drawings may be used as needed to enhance the analysis explanation.]*

► Technology Device or System Analyzed:

► CORE Technologies Basic to Design, Development & Function:

[See the reverse side of this page for more information on CORE Technologies.]

► Science Principles and Concepts Basic to Design, Development & Function:

► Mathematics Principles, Theorems and Proofs Basic to Design, Development & Function:

► Reference Sources:

The Maryland Core Technologies – Descriptions

Materials technology - the technology of producing, altering and combining materials. Applications: producing paper from wood, producing aluminum from ore, drilling holes in wood, annealing to soften metal, casting ceramic, welding metal, laminating wood.

Mechanical technology - the technology of putting together mechanical parts to produce, control and transmit motion.

Applications: gear systems in a car transmission, brakes on a bicycle, agitator in a washing machine.

Electrical technology - the technology of producing, storing, controlling, transmitting and getting work from electrical energy. Applications: power plant generator, flashlight battery, light switch, electric motor in a can opener, door bell, electric heater, blow dryer.

Electronic technology - the technology of using small amounts of electricity for controlling; detecting; and information collecting, storing, retrieving, and communicating. Applications: thermostat for controlling temperature, a metal detector, video tape recorder, computer, pocket calculator, telephone, radio, television.

Structural technology - the technology of putting parts and materials together to create supports containers, shelters, and connectors. Applications: legs on a chair or table, city water tower, swimming pool, buildings, roadways, bridges, storm sewer, airplane wing, satellite antenna dish.

Fluid technology - the technology of using fluid, either gaseous (pneumatics) or liquid (hydraulics) to apply force or to transport. Applications: pneumatics: air brakes on a truck, tires on a car, airfoils on an airplane, warm air heating ducts and fan in a building hydraulics: brakes on a car, plumbing in school.

Optical technology - the technology of producing light; controlling light; using light for information collection, processing, storage, retrieval and communication; and using light to do work. Applications: light bulb, LED (Light Emitting Diode), lenses to magnify and reduce, laser speed detector, laser compact disk, fiber optic telephone communication, laser cutting tools, laser surgery instruments furnace.

Thermal technology - the technology of producing, storing, controlling, transmitting and getting work from heat. Applications: furnace, hot water heater, toaster, insulation, heat exchanger (radiator, condenser), refrigerator, jet engine, hot air balloon.

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Technology Device or System Analyzed: Door Hinges

► CORE Technologies Basic to Design, Development & Function:

[See the reverse side of this page for more information on CORE Technologies.]

Materials technology - the technology of producing, altering and combining materials.

Steel is an engineered material using iron and carbon to make a strong material that can be shaped and formed into the two parts of the hinge. The material must be strong but not brittle as the force of a door "hanging" from a hinge is multiplied by the lever action of the swinging door.



Mechanical technology - the technology of putting together mechanical parts to produce, control and transmit motion.

The two movable parts of the hinge are connected with a pin at the fulcrum of the hinge leaves that act as a lever to allow the door to move as the door frame is stationary.

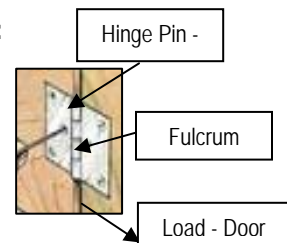
Structural technology - the technology of putting parts and materials together to create supports, containers, shelters, and connectors.

The door hinge is designed to be fastened to a fixed door frame and a door as a movable component. The hinge must work as a "movable support structure" for the door and frame acting as a structural member of a building.

► Science Principles and Concepts Basic to Design, Development & Function:

Simple Machines – Levers - The hinge is an example of a Class 2 lever - the load is situated between the fulcrum and the force. The wider the door the more force that is generated on the hinge joint where the two plates of the hinge meet.

Simple Machines – Wheel & Axle - The wheel and axle is a simple machine. A wheel and axle is a modified lever of the first class[1] that rotates in a circle around a center point or fulcrum. The hinge pin serves as the axle in this application of a simple machine principle.

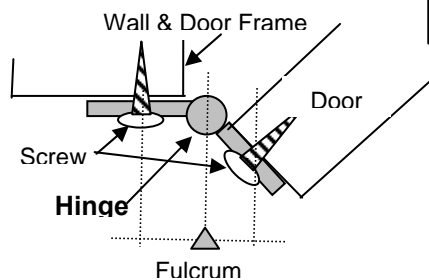
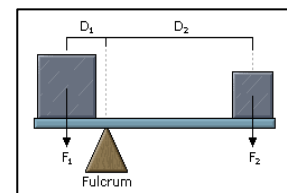


► Mathematics Principles, Theorems and Proofs Basic to Design, Development & Function:

Mechanical Advantage - The Force applied to the hinge as the door pivots around the fixed leaf of the hinge on the hinge pin can be calculated as the Mechanical Advantage of the lever. The force applied (at end points of the lever) is proportional to the ratio of the length of the lever arm measured between the fulcrum (pivoting point) and application point of the force applied at each end of the lever. Mathematically, this is expressed by $M = Fd$.

The principle of the lever tells us that the above is in static equilibrium, with all forces balancing, if:

$$F_1 \times D_1 = F_2 \times D_2.$$



► Reference Sources:

<http://en.wikipedia.org>

http://mechanical-engineering.suite101.com/article.cfm/classes_of_levers

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