



**EDCP 471**  
**Lecture Notes**  
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**Big Ideas in Design & Technology**

1. Big Ideas or Core Ideas or Benchmarks or Generalizations or Key Concepts or Cross-Cutting Concepts
  - a. Big Ideas
    - i. Hudson (1997, p. 26): "Big ideas" are defined as large concepts or principles that facilitate integration of smaller facts and concepts and the relationship between them.
    - ii. BC MoE, *Glossary of Curriculum Terms* (2016): Big Ideas are statements that are central to one's understanding in an area of learning. A Big Idea is broad and abstract. It contains key concepts that generally are timeless and transferable to other situations. Big Ideas are the key concepts, principles, and theories that are used to organize knowledge within an area of learning. A Big Idea is a statement of an idea that is central to an area of learning or across disciplines and that links numerous understandings into a coherent whole.
    - iii. BC MoE *Curriculum Overview* (2017): The Big Ideas consist of generalizations and principles and the key concepts important in an area of learning. They reflect the "Understand" component of the Know-Do-Understand model of learning. The big ideas represent what students will understand at the completion of the curriculum for their grade. They are intended to endure beyond a single grade and contribute to future understanding.
  - b. Generalizations
    - i. Schur (1970, p. 80): a statement which asserts a relationship between two or more concepts and is used in a similar manner as "principle" or "theory."
    - ii. Tirrell (1994, p. 15): A concept is a general idea or abstraction that represents a class or category of things, actions, or ideas that have certain common characteristics.... A generalization is a universally applicable statement at the highest level of abstraction.
  - c. From "smaller facts and concepts" or concrete things to big ideas or generalizations and vice versa.
    - i. A big idea or generalization is an abstraction but there should be a way to link or trace back to the concrete (e.e., the Swiss army knife):



Figure 1. Abstracted Swiss Army Knife (Kelsey Fritsch, <https://kelsey4142.wordpress.com/drawing-i/>)

- d. Concepts (e.g., Core Concepts, Key Concepts, etc.)
    - i. Barr, Graham, Hunter, Keown, and McGee (1997, p. 10): A concept is an abstraction, which pulls together a number of facts. Concepts group certain facts together and help organise them and make sense of them by revealing patterns of similarity and difference. To be understood, concepts need to be constructed by the learner under the guidance of the teacher.
    - ii. Barr, Graham, Hunter, Keown, and McGee (1997, p. 10): A concept is an abstraction, which pulls together a number of facts. Concepts group certain facts together and help organise them and make sense of them by revealing patterns of similarity and difference. To be understood, concepts need to be constructed by the learner under the guidance of the teacher.
    - iii. New Zealand Ministry of Education (2011): Key concepts are the ideas and understandings that we hope will remain with our students long after they have left school and have forgotten much of the detail. Key concepts sit above context but find their way into every context. Students need time and opportunity to explore these concepts, to appreciate the breadth, depth, and subtlety of meaning that attaches to them, to learn that different people view them from different perspectives, and to understand that meaning is not static. By approaching these concepts in different ways and by revisiting them in different contexts within a relatively short time span, students come to refine and embed understandings.  
<https://seniorsecondary.tki.org.nz/English/Key-concepts/What-are-key-concepts>
2. **Big Ideas in BC MoE's Technology Education Curriculum**
- a. Grades K-3
    - i. Designs grow out of natural curiosity.
    - ii. Skills can be developed through play.
    - iii. Technologies are tools that extend human capabilities.
  - b. Grades 4-5
    - i. Designs can be improved with prototyping and testing.
    - ii. Skills are developed through practice, effort, and action.
    - iii. The choice of technology and tools depends on the task.
  - c. Grades 6-8
    - i. Design can be responsive to identified needs.
    - ii. Complex tasks require the acquisition of additional skills.
    - iii. Complex tasks may require multiple tools and technologies.
  - d. Grade 9
    - i. Social, ethical, and sustainability considerations impact design.
    - ii. Complex tasks require the sequencing of skills.
    - iii. Complex tasks require different technologies and tools at different stages.
  - e. Grades 10
    - i. User needs and interests drive the design process.
    - ii. Social, ethical, and sustainability considerations impact design.
    - iii. Complex tasks require different technologies and tools at different stages.
  - f. Grades 11-12
    - i. Design for the life cycle includes consideration of social and environmental impacts
    - ii. Personal design interests require the evaluation and refinement of skills.
    - iii. Tools and technologies can be adapted for specific purposes.
3. Databases of big ideas for design and technology education
- a. The challenge for teachers is to add to the resource pool of big ideas rather than subtract from the pool or database. Big ideas are living ideas, meaning that they require attention and revision over time. The best database of big ideas for D&T is the international *Standards for Technological Literacy*

4. **Benchmarks or Big Ideas** in the international *Standards for Technological Literacy* (see also Appendix B in *Tech Tally: Approaches to Assessing Technological Literacy*)
- a. **Standard 1: The Characteristics and Scope of Technology**
    - i. Benchmarks for Grades K–2
      1. The natural world and human-made world are different.
      2. All people use tools and techniques to help them do things.
    - ii. Benchmarks for Grades 3–5
      1. Things that are found in nature differ from things that are human-made in how they are produced and used.
      2. Tools, materials, and skills are used to make things and carry out tasks.
      3. Creative thinking and economic and cultural influences shape technological development.
    - iii. Benchmarks for Grades 6–8
      1. New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.
      2. The development of technology is a human activity and is the result of individual and collective needs and the ability to be creative.
      3. Technology is closely linked to creativity, which has resulted in innovation.
      4. Corporations can often create demand for a product by bringing it onto the market and advertising it.
    - iv. Benchmarks for Grades 9–12
      1. The nature and development of technological knowledge and processes are functions of the setting.
      2. The rate of technological development and diffusion is increasing rapidly.
      3. Inventions and innovations are the results of specific, goal-directed research.
      4. Most development of technologies these days is driven by the profit motive and the market.
  - b. **Standard 2: The Core Concepts of Technology**
    - i. Benchmarks for Grades K–2
      1. Some systems are found in nature, and some are made by humans.
      2. Systems have parts or components that work together to accomplish a goal.
      3. Tools are simple objects that help humans complete tasks.
      4. Different materials are used in making things.
      5. People plan in order to get things done.
    - ii. Benchmarks for Grades 3–5
      1. A subsystem is a system that operates as a part of another system.
      2. When parts of a system are missing, it may not work as planned.
      3. Resources are the things needed to get a job done, such as tools and machines, materials, information, energy, people, capital, and time.
      4. Tools are used to design, make, use, and assess technology.
      5. Materials have many different properties.
      6. Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.
      7. Requirements are the limits to designing or making a product or system.
    - iii. Benchmarks for Grades 6–8
      1. Technological systems include input, processes, output, and at times, feedback.
      2. Systems thinking involves considering how every part relates to others.
      3. An open-loop system has no feedback path and requires human intervention, while a closed-loop system uses feedback.
      4. Technological systems can be connected to one another.
      5. Malfunctions of any part of a system may affect the function and quality of the system.
      6. Requirements are the parameters placed on the development of a product or system.
      7. Trade-off is a decision process recognizing the need for careful compromises among competing factors.
      8. Different technologies involve different sets of processes.

9. Maintenance is the process of inspecting and servicing a product or system on a regular basis in order for it to continue functioning properly, to extend its life, or to upgrade its quality.
  10. Controls are mechanisms or particular steps that people perform using information about the system that causes systems to change.
- iv. Benchmarks for Grades 9–12
    1. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems.
    2. Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems.
    3. The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop.
    4. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.
    5. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
    6. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints.
    7. New technologies create new processes.
    8. Quality control is a planned process to ensure that a product, service, or system meets established criteria.
    9. Management is the process of planning, organizing, and controlling work.
    10. Complex systems have many layers of controls and feedback loops to provide information.
- c. **Standard 3: The Relationships Among Technologies and the Connections Between Technology and Other Fields of Study**
- i. Benchmarks for Grades K–2
    1. The study of technology uses many of the same ideas and skills as other subjects.
  - ii. Benchmarks for Grades 3–5
    1. Technologies are often combined.
    2. Various relationships exist between technology and other fields of study.
  - iii. Benchmarks for Grades 6–8
    1. Technological systems often interact with one another.
    2. A product, system, or environment developed for one setting may be applied to another setting.
    3. Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.
  - iv. Benchmarks for Grades 9–12
    1. Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function.
    2. Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields.
    3. Technological ideas are sometimes protected through the process of patenting.
    4. Technological progress promotes the advancement of science and mathematics.
- d. **Standard 4: The Cultural, Social, Economic, and Political Effects of Technology**
- i. Benchmarks for Grades K–2
    - a. The use of tools and machines can be helpful or harmful.
  - ii. Benchmarks for Grades 3–5
    1. When using technology, results can be good or bad.
    2. The use of technology can have unintended consequences.
  - iii. Benchmarks for Grades 6–8
    1. The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology’s development and use.
    2. Technology, by itself, is neither good nor bad, but decisions about the use of products and systems can result in desirable or undesirable consequences.
    3. The development and use of technology poses ethical issues.

4. Economic, political, and cultural issues are influenced by the development and use of technology.
- iv. Benchmarks for Grades 9–12
  1. Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.
  2. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.
  3. Ethical considerations are important in the development, selection, and use of technologies.
  4. The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.

**e. Standard 5: The Effects of Technology on the Environment**

- i. Benchmarks for Grades K–2
  1. Some materials can be reused and/or recycled.
- ii. Benchmarks for Grades 3–5
  1. Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.
  2. The use of technology affects the environment in good and bad ways.
- iii. Benchmarks for Grades 6–8
  1. The management of waste produced by technological systems is an important societal issue.
  2. Technologies can be used to repair damage caused by natural disasters and to break down waste from the use of various products and systems.
  3. Decisions to develop and use technologies often put environmental and economic concerns in direct competition with one another.
- iv. Benchmarks for Grades 9–12
  1. Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling.
  2. When new technologies are developed to reduce the use of resources, considerations of trade-offs are important.
  3. With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.
  4. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.
  5. Humans devise technologies to reduce the negative consequences of other technologies.
  6. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.

**f. Standard 6: The Role of Society in the Development and Use of Technology**

- i. Benchmarks for Grades K–2
  1. Products are made to meet individual needs and wants.
- ii. Benchmarks for Grades 3–5
  1. Because people’s needs and wants change, new technologies are developed, and old ones are improved to meet those changes.
  2. Individual, family, community, and economic concerns may expand or limit the development of technologies.
- iii. Benchmarks for Grades 6–8
  1. Throughout history, new technologies have resulted from the demands, values, and interests of individuals, businesses, industries, and societies.
  2. The use of inventions and innovations has led to changes in society and the creation of new needs and wants.
  3. Social and cultural priorities and values are reflected in technological devices.
  4. Meeting societal expectations is the driving force behind the acceptance and use of products and systems.
- iv. Benchmarks for Grades 9–12
  1. Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.

2. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures.
3. A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies.

**g. Standard 7: The Influence of Technology on History**

- i. Benchmarks for Grades K–2
  1. The way people live and work has changed throughout history because of technology.
- ii. Benchmark for Grades 3–5
  1. People have made tools to provide food, to make clothing, and to protect themselves.
- iii. Benchmarks for Grades 6–8
  1. Many inventions and innovations have evolved using slow and methodical processes of tests and refinements.
  2. The specialization of function has been at the heart of many technological improvements.
  3. The design and construction of structures for service or convenience have evolved from the development of techniques for measurement, controlling systems, and the understanding of spatial relationships.
  4. In the past, an invention or innovation was not usually developed with the knowledge of science.
- iv. Benchmarks for Grades 9–12
  1. Most technological development has been evolutionary, the result of a series of refinements to a basic invention.
  2. The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials.
  3. Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape.
  4. Early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how.
  5. The Iron Age was defined by the use of iron and steel as the primary materials for tools.
  6. The Middle Ages saw the development of many technological devices that produced long-lasting effects on technology and society.
  7. The Renaissance, a time of rebirth of the arts and humanities, was also an important development in the history of technology.
  8. The Industrial Revolution saw the development of continuous manufacturing, sophisticated transportation and communication systems, advanced construction practices, and improved education and leisure time.
  9. The Information Age places emphasis on the processing and exchange of information.

**h. Standard 8: The Attributes of Design**

- i. Benchmarks for Grades K–2
  1. Everyone can design solutions to a problem.
  2. Design is a creative process.
- ii. Benchmarks for Grades 3–5
  1. The design process is a purposeful method of planning practical solutions to problems.
  2. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.
- iii. Benchmarks for Grades 6–8
- iv. Design is a creative planning process that leads to useful products and systems.
  1. There is no perfect design.
  2. Requirements for design are made up of criteria and constraints.
- v. Benchmarks for Grades 9–12
  1. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using

specifications, refining the design, creating or making it, and communicating processes and results.

2. Design problems are seldom presented in a clearly defined form.
3. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.
4. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.

**i. Standard 9: Engineering Design**

i. Benchmarks for Grades K–2

1. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
2. Expressing ideas to others verbally and through sketches and models is an important part of the design process.
3. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
5. When designing an object, it is important to be creative and consider all ideas.
6. Models are used to communicate and test design ideas and processes.

ii. Benchmarks for Grades 3–5

1. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
2. When designing an object, it is important to be creative and consider all ideas.
3. Models are used to communicate and test design ideas and processes.

iii. Benchmarks for Grades 6–8

1. Design involves a set of steps, which can be performed in different sequences and repeated as needed.
2. Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.
3. Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

iv. Benchmarks for Grades 9–12

1. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.
2. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
3. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.
4. The process of engineering design takes into account a number of factors.

**j. Standard 10: The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving**

i. Benchmarks for Grades K–2

1. Asking questions and making observations helps a person to figure out how things work.
2. All products and systems are subject to failure. Many products and systems, however, can be fixed.

ii. Benchmarks for Grades 3–5

1. Troubleshooting is a way of finding out why something does not work so that it can be fixed.
2. Invention and innovation are creative ways to turn ideas into real things.
3. The process of experimentation, which is common in science, can also be used to solve technological problems.

iii. Benchmarks for Grades 6–8

1. Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system.
2. Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it.
3. Some technological problems are best solved through experimentation.

- iv. Benchmarks for Grades 9–12
  1. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.
  2. Technological problems must be researched before they can be solved.
  3. Not all problems are technological, and not every problem can be solved using technology.
  4. Many technological problems require a multidisciplinary approach.

**k. Standard 11: Apply the Design Process**

- i. Benchmarks for Grades K–2
  1. Brainstorm people’s needs and wants and pick some problems that can be solved through the design process.
  2. Build or construct an object using the design process.
  3. Investigate how things are made and how they can be improved.
- ii. Benchmarks for Grades 3–5
  1. Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements for solving a problem.
  2. The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.
  3. Test and evaluate the solutions for the design problem.
  4. Improve the design solutions.
- iii. Benchmarks for Grades 6–8
  1. Apply a design process to solve problems in and beyond the laboratory classroom.
  2. Specify criteria and constraints for the design.
  3. Make two-dimensional and three-dimensional representations of the designed solution.
  4. Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.
  5. Make a product or system and document the solution.
- iv. Benchmarks Grades 9–12
  1. Identify the design problem to solve and decide whether or not to address it.
  2. Identify criteria and constraints and determine how these will affect the design process.
  3. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.
  4. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
  5. Develop and produce a product or system using a design process.
  6. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

**l. Standard 12: Use and Maintain Technological Products and Systems**

- i. Benchmarks for Grades K–2
  1. Discover how things work.
  2. Use hand tools correctly and safely and be able to name them correctly.
  3. Recognize and use everyday symbols.
- ii. Benchmarks for Grades 3–5
  1. Follow step-by-step directions to assemble a product.
  2. Select and safely use tools, products, and systems for specific tasks.
  3. Use computers to access and organize information.
  4. Use common symbols, such as numbers and words, to communicate key ideas.
- iii. Benchmarks for Grades 6–8
  1. Use information provided in manuals, protocols, or by experienced people to see and understand how things work.
  2. Use tools, materials, and machines safely to diagnose, adjust, and repair systems.
  3. Use computers and calculators in various applications.
  4. Operate and maintain systems in order to achieve a given purpose.



- iv. Benchmarks for Grades 9–12
  1. Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.
  2. Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it.
  3. Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision.
  4. Operate systems so that they function in the way they were designed.
  5. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.

**m. Standard 13: Assess the Impact of Products and Systems**

- i. Benchmarks for Grades K–2
  1. Collect information about everyday products and systems by asking questions.
  2. Determine if the human use of a product or system creates positive or negative results.
- ii. Benchmarks for Grades 3–5
  1. Compare, contrast, and classify collected information in order to identify patterns.
  2. Investigate and assess the influence of a specific technology on the individual, family, community, and environment.
  3. Examine the trade-offs of using a product or system and decide when it could be used.
- iii. Benchmarks for Grades 6–8
  1. Design and use instruments to gather data.
  2. Use data collected to analyze and interpret trends in order to identify the positive and negative effects of a technology.
  3. Identify trends and monitor potential consequences of technological development.
  4. Interpret and evaluate the accuracy of the information obtained and determine if it is useful.
- iv. Benchmarks for Grades 9–12
  1. Collect information and evaluate its quality.
  2. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.
  3. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology.
  4. Design forecasting techniques to evaluate the results of altering natural systems.

**n. Standard 14: Medical Technologies**

- i. Benchmarks for Grades K–2
  1. Vaccinations protect people from getting certain diseases.
  2. Medicine helps people who are sick to get better.
  3. There are many products designed specifically to help people take care of themselves.
- ii. Benchmarks for Grades 3–5
  1. Vaccines are designed to prevent diseases from developing and spreading; medicines are designed to relieve symptoms and stop diseases from developing.
  2. Technological advances have made it possible to create new devices, to repair or replace certain parts of the body, and to provide a means for mobility.
  3. Many tools and devices have been designed to help provide clues about health and to provide a safe environment.
- iii. Benchmarks for Grades 6–8
  1. Advances and innovations in medical technologies are used to improve healthcare.
  2. Sanitation processes used in the disposal of medical products help to protect people from harmful organisms and disease, and shape the ethics of medical safety.

3. The vaccines developed for use in immunization require specialized technologies to support environments in which a sufficient amount of vaccines is produced.
  4. Genetic engineering involves modifying the structure of DNA to produce novel genetic make-ups.
- iv. Benchmarks for Grades 9–12
1. Medical technologies include prevention and rehabilitation, vaccines and pharmaceuticals, medical and surgical procedures, genetic engineering, and the systems within which health is protected and maintained.
  2. Telemedicine reflects the convergence of technological advances in a number of fields, including medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psychology.
  3. The sciences of biochemistry and molecular biology have made it possible to manipulate the genetic information found in living creatures.

**o. Standard 15: Agricultural and Related Biotechnologies**

- i. Benchmarks for Grades K–2
1. The use of technologies in agriculture makes it possible for food to be available year round and to conserve resources.
  2. There are many different tools necessary to control and make up the parts of an ecosystem.
- ii. Benchmarks for Grades 3–5
1. Artificial ecosystems are human-made environments that are designed to function as a unit and are comprised of humans, plants, and animals.
  2. Most agricultural waste can be recycled.
  3. Many processes used in agriculture require different procedures, products, or systems.
- iii. Benchmarks for Grades 6–8
1. Technological advances in agriculture directly affect the time and number of people required to produce food for a large population.
  2. A wide range of specialized equipment and practices is used to improve the production of food, fiber, fuel, and other useful products and in the care of animals.
  3. Biotechnology applies the principles of biology to create commercial products or processes.
  4. Artificial ecosystems are human-made complexes that replicate some aspects of the natural environment.
  5. The development of refrigeration, freezing, dehydration, preservation, and irradiation provide long-term storage of food and reduce the health risks caused by tainted food.
- iv. Benchmarks for Grades 9–12
1. Agriculture includes a combination of businesses that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemical, and other useful products.
  2. Biotechnology has applications in such areas as agriculture, pharmaceuticals, food and beverages, medicine, energy, the environment, and genetic engineering.
  3. Conservation is the process of controlling soil erosion, reducing sediment in waterways, conserving water, and improving water quality.
  4. The engineering design and management of agricultural systems require knowledge of artificial ecosystems and the effects of technological development on flora and fauna.

**p. Standard 16: Energy and Power Technologies**

- i. Benchmarks for Grades K–2
1. Energy comes in many forms.
  2. Energy should not be wasted.
- ii. Benchmarks for Grades 3–5
1. Energy comes in different forms.
  2. Tools, machines, products, and systems use energy in order to do work.
- iii. Benchmarks for Grades 6–8
1. Energy is the capacity to do work.

2. Energy can be used to do work, using many processes.
  3. Power is the rate at which energy is converted from one form to another or transferred from one place to another, or the rate at which work is done.
  4. Power systems are used to drive and provide propulsion to other technological products and systems.
  5. Much of the energy used in our environment is not used efficiently.
- iv. Benchmarks for Grades 9–12
1. Energy cannot be created nor destroyed; however, it can be converted from one form to another.
  2. Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others.
  3. It is impossible to build an engine to perform work that does not exhaust thermal energy to the surroundings.
  4. Energy resources can be renewable or nonrenewable.
  5. Power systems must have a source of energy, a process, and loads.

**q. Standard 17: Information and Communication Technologies**

- i. Benchmarks for Grades K–2
1. Information is data that has been organized.
  2. Technology enables people to communicate by sending and receiving information over a distance.
  3. People use symbols when they communicate by technology.
- ii. Benchmarks for Grades 3–5
1. The processing of information through the use of technology can be used to help humans make decisions and solve problems.
  2. Information can be acquired and sent through a variety of technological sources, including print and electronic media.
  3. Communication technology is the transfer of messages among people and/or machines over distances through the use of technology.
  4. Letters, characters, icons, and signs are symbols that represent ideas, quantities, elements, and operations.
- iii. Benchmarks for Grades 6–8
1. Information and communication systems allow information to be transferred from human to human, human to machine, and machine to human.
  2. Communication systems are made up of a source, encoder, transmitter, receiver, decoder, and destination.
  3. The design of a message is influenced by such factors as intended audience, medium, purpose, and the nature of the message.
  4. The use of symbols, measurements, and drawings promotes a clear communication by providing a common language to express ideas.
- iv. Benchmarks for Grades 9–12
1. Information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information.
  2. Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine.
  3. Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.
  4. Communication systems are made up of source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination.
  5. There are many ways to communicate information, such as graphic and electronic means.
  6. Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

**r. Standard 18: Transportation Technologies**

- i. Benchmarks for Grades K–2
1. A transportation system has many parts that work together to help people travel.
  2. Vehicles move people or goods from one place to another in water, air or space, and on land.

3. Transportation vehicles need to be cared for to prolong their use.
  - ii. Benchmarks for Grades 3–5
    1. The use of transportation allows people and goods to be moved from place to place.
    2. A transportation system may lose efficiency or fail if one part is missing or malfunctioning or if a subsystem is not working.
  - iii. Benchmarks for Grades 6–8
    1. Transporting people and goods involves a combination of individuals and vehicles.
    2. Transportation vehicles are made up of subsystems, such as structural propulsion, suspension, guidance, control, and support, that must function together for a system to work effectively.
    3. Governmental regulations often influence the design and operation of transportation systems.
    4. Processes, such as receiving, holding, storing, loading, moving, unloading, delivering, evaluating, marketing, managing, communicating, and using conventions are necessary for the entire transportation system to operate efficiently.
  - iv. Benchmarks for Grades 9–12
    1. Transportation plays a vital role in the operation of other technologies,
    2. such as manufacturing, construction, communication, health and safety, and agriculture.
    3. Intermodalism is the use of different modes of transportation, such as highways, railways, and waterways as part of an interconnected system that can move people and goods easily from one mode to another.
    4. Transportation services and methods have led to a population that is regularly on the move.
    5. The design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques.
- s. Standard 19: Manufacturing Technologies**
- i. Benchmarks for Grades K–2
    1. Manufacturing systems produce products in quantity.
    2. Manufactured products are designed.
  - ii. Benchmarks for Grades 3–5
    1. Processing systems convert natural materials into products
    2. Manufacturing processes include designing products, gathering resources, and using tools to separate, form, and combine materials in order to produce products.
    3. Manufacturing enterprises exist because of a consumption of goods.
  - iii. Benchmarks for Grades 6–8
    1. Manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning them.
    2. Manufactured goods may be classified as durable and non-durable.
    3. The manufacturing process includes the designing, development, making, and servicing of products and systems.
    4. Chemical technologies are used to modify or alter chemical substances.
    5. Materials must first be located before they can be extracted from the earth through such processes as harvesting, drilling, and mining.
    6. Marketing a product involves informing the public about it as well as assisting in its sales and distribution.
  - iv. Benchmarks for Grades 9–12
    1. Servicing keeps products in good operating condition.
    2. Materials have different qualities and may be classified as natural, synthetic, or mixed.
    3. Durable goods are designed to operate for a long period of time, while non-durable goods are designed to operate for a short period of time.
    4. Manufacturing systems may be classified into types, such as customized production, batch production, and continuous production.
    5. The interchangeability of parts increases the effectiveness of manufacturing processes.

6. Chemical technologies provide a means for humans to alter or modify materials and to produce chemical products.
  7. Marketing involves establishing a product's identity, conducting research on its potential, advertising it, distributing it, and selling it.
- t. Standard 20: Construction Technologies**
- i. Benchmarks for Grades K–2
    1. People live, work, and go to school in buildings, which are of different types: houses, apartments, office buildings, and schools.
    2. The type of structure determines how the parts are put together.
  - ii. Benchmarks for Grades 3–5
    1. Modern communities are usually planned according to guidelines.
    2. Structures need to be maintained.
    3. Many systems are used in buildings.
  - iii. Benchmarks for Grades 6–8
    1. The selection of designs for structures is based on factors such as building laws and codes, style, convenience, cost, climate, and function.
    2. Structures rest on a foundation.
    3. Some structures are temporary, while others are permanent.
    4. Buildings generally contain a variety of subsystems.
  - iv. Benchmarks for Grades 9–12
    1. Infrastructure is the underlying base or basic framework of a system.
    2. Structures are constructed using a variety of processes and procedures.
    3. The design of structures includes a number of requirements.
    4. Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use.
    5. Structures can include prefabricated materials.
5. **Additional Sources** of Big Ideas in D&T
- a. Kranzberg's Laws <https://thefrailestthing.com/2011/08/25/kranzbergs-six-laws-of-technology-a-metaphor-and-a-story/>
    - i. First Law: "Technology is neither good nor bad; nor is it neutral." By which he means that, "technology's interaction with the social ecology is such that technical developments frequently have environmental, social, and human consequences that go far beyond the immediate purposes of the technical devices and practices themselves, and the same technology can have quite different results when introduced into different contexts or under different circumstances."
    - ii. Second Law: Invention is the mother of necessity. "Every technical innovation seems to require additional technical advances in order to make it fully effective."
    - iii. Third Law: Technology comes in packages, big and small. "The fact is that today's complex mechanisms usually involve several processes and components."
    - iv. Fourth Law: Although technology might be a prime element in many public issues, nontechnical factors take precedence in technology-policy decisions. "... many complicated sociocultural factors, especially human elements, are involved, even in what might seem to be 'purely technical' decisions." "Technologically 'sweet' solutions do not always triumph over political and social forces."
    - v. Fifth Law: All history is relevant, but the history of technology is the most relevant. "Although historians might write loftily of the importance of historical understanding by civilized people and citizens, many of today's students simply do not see the relevance of history to the present or to their future. I suggest that this is because most history, as it is currently taught, ignores the technological element."
    - vi. Sixth Law: Technology is a very human activity-and so is the history of technology. "Behind every machine, I see a face—indeed, many faces: the engineer, the worker, the businessman or businesswoman, and, sometimes, the general and admiral. Furthermore, the function of the technology is its use by human beings—and sometimes, alas, its abuse and misuse."
  - b. Petrina, *Advanced Teaching Methods for the Technology Classroom* (2007, pp. 188-189):
    - i. Technology is central to action, cognition and emotion.
    - ii. The food we eat, the water we drink and the air we breathe involve technological decisions.
    - iii. The scale and scope of technology are now extended toward two extremes of life: toward microscopic and macroscopic levels. Technologies now extend inward to minute cellular, molecular and even atomic levels of our bodies and outward to the

massive complexes of power plants, urban centers and greenhouse gasses affecting the entire planet.

- iv. Technology is increasingly imperfect and at the root of global public disasters such as nuclear meltdowns and local private disasters such as industrial cancer.
- v. Technology is increasingly integrated with all aspects of life, from amusement to domesticity to work. Technology is increasingly integrated into our bodies, leaving many to conclude that we are cyborgs. The artificial world and integrated circuit are ambient; increasingly, technology is habitat.
- vi. Technology is increasingly final in that its effects are increasingly difficult to reverse. The elimination of species, ozone layer depletion and greenhouse gasses are significant for their finality.
- vii. The monies directed toward technology amount to an increasingly large share of budgets in industry, the military and government.
- viii. Values, rights, liberties and choices are affected by technology on immediate, personal levels.
- ix. Technology is necessary for human existence. Personal livelihoods are dependent on technology for leisure, subsistence and work.
- x. Technology is a fundamental area of culture and human endeavor, and is inextricably interwoven with history, culture, nature and society; also, it is integrative in nature.
- xi. Technology is problematic and paradoxical for individuals and society.
- xii. The ubiquity and immediacy of technology redefine our perceptions of the world and ourselves. The new media technologies play ever more pervasive and invasive roles in our lives.
- xiii. Increasingly, technology must be regulated and its direction subjected to limitations and determined democratically. There is tension between personal and social choice. Education is the only reliable route toward technological decision making and democratic choice.