The Engineering byDesign™ Program is built on the belief that the ingenuity of children is untapped, unrealized potential that, when properly motivated, will lead to the next generation of technologists, innovators, designers, and engineers.

The International Technology and Engineering Educators Association's STEM±Center for Teaching and Learning™ has developed the only standards-based national model for Grades K-12 that delivers technological literacy in a STEM context.

The model, Engineering byDesign™ is built on the Common Core State Standards (High School / Middle School), Next Generation Science Standards (K-12), Standards for Technological Literacy (ITEEA); Principles and Standards for School Mathematics (NCTM); and Project 2061, Benchmarks for Science Literacy (AAAS). Additionally, the Program K-12 has been mapped to the National Academy of Engineering's Grand Challenges for Engineering.

Using constructivist models, students participating in the program learn concepts and principles in an authentic, problem/project-based environment. Through an integrative STEM environment, EbD™ uses all four content areas as well as English-Language Arts to help students understand the complexities of tomorrow.

EbD TEEMS NxtGen – PreK
At-A-Glance

Intended Audience: PreK (ages 3-4)   **Course Length: 6-8 weeks**

In this TEEMS Building Block, preschool students will be introduced to the life cycles of plants, butterflies, and frogs. They will use a multisensory approach as they plant and observe seed growth, experience hands-on lessons, enjoy literature, and share with teachers and students the circle of life.

A Look at Life
- Students will be able to identify a seed as the origin of a plant and demonstrate the sequence of events in the life cycle of a plant.

Read Aloud, *I'm a Seed*
- Recognize similarities between characters / situations in a narrative and their own life experiences.
- Identify the front cover, back cover, and title page of a book.
- Students will use new vocabulary words to describe the life cycle of a plant.

A Home for Me
- Identify a terrarium and its purpose and list key differences between natural and human-made objects.
- Observe, describe, compare, and categorize human-made objects found discarded outdoors.

I Can Write
- Students will be better able to illustrate their understanding of the different parts of a plant and how a plant grows from a seed.

Exploring Seeds
- Students will investigate seeds and make predictions about plant growth.

Seeds/Plants
- Plant and water seeds and observe their sprouts and roots as they grow.
- Continue to develop an understanding of how a plant grows from a seed.

The Very Hungry Caterpillar
- Demonstrate or explain the life cycle of a butterfly.
- Recognize similarities between characters / situations in a narrative and their own experiences.
- Answer questions about unfamiliar words read along.

Caterpillar to Butterfly Part One
- Create their own "caterpillars" that will, over the next few days, transform into cocoons, and then into butterflies.
- Demonstrate a basic understanding of the metamorphosis process and describe what happened to the caterpillars and the cocoons, demonstrating a basic understanding of the metamorphosis process.

Math Integration
- Students will measure seeds and transplant them to a new home, while counting scoops.

Frog and Tadpole Life Cycle
- Recall events in the order in which they occurred in the text and illustrate the life cycle of a frog.

Engineering Design Process
- Students will discuss and plan a terrarium design project.

A Home for Plants
- Students will plan and create a collaborative terrarium project that demonstrates what they have learned about the life cycles of living organisms.

Welcome to My Home
- Communicate to classmates and teachers about the habitat that they have created.

EbD TEEMS NxtGen – Kindergarten
At-A-Glance

**Intended Audience: Kindergarten**   **Course Length: 6-8 weeks**

A Home for All Seasons engages young learners in hands-on inquiry and design as they explore animal homes. The Kindergarten **Building Block** integrates concepts of science, technology, engineering, and mathematics as students create various animal homes. Science and mathematics concepts that are reinforced include the basic needs of organisms, the environment in which organisms live, numbers and quantities, measurement, and shapes. Following guided inquiry activities, a design challenge provides an opportunity for students to apply knowledge and skills in a meaningful way as they design and build a birdhouse.

Objectives

- Distinguish between the natural world and the human-made world.
- Categorize objects as either natural or designed by humans.
- Ask questions and make predictions.
- Identify the main topic and retell details of text with prompting.
- Ask and answer questions about details in a text with prompting.
- Ask and answer questions about unknown words with prompting.
- Sort words into categories to gain a sense of the concepts represented by the categories.
- Communicate ideas and solutions through discussion, writing, drawing, and presentation.
- Determine the meaning and use of domain-specific words.
- Know that humans use tools and devices to help them do a variety of things.
- Understand how things are made and how they work.
- Describe how the use of tools and machines can be helpful or harmful.
- Describe basic needs of plants and animals (e.g., air, water, nutrients, shelter, and light).
- Identify physical characteristics of the environment necessary for animal survival in different environments (e.g., wetland, tundra, desert, forest, ocean).
- Generate questions about objects, organisms, or events that can be answered through scientific investigations.
- Identify and describe objects using names of geometric shapes.
- Draw and build shapes to model geometric shapes in the world.
- Describe how the type of structure determines how the parts are put together (homes of different animals).
- Describe familiar people, places, things, and events with relevant details and express ideas clearly (speaking).
- Demonstrate understanding of the organization and basic feature of Follow words from left to right.
- Collaboratively write informative text based on a specific topic.
- Describe measurable attributes of objects such as length or weight.
- Identify numbers used to represent quantities.
- Describe measurable attributes of objects such as length or weight.
- Name tools and describe their use.
- Identify appropriate tools or instruments for specific tasks and describe the information they can provide (e.g., Measuring: length – ruler, volume – beaker, temperature – thermometer).
- Name materials used to make things.
- Recognize that everyone can design solutions to problems.
- Apply a design process that includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others to solve a technological problem.
- Write and draw ideas and solutions during the design process.
- Construct an object using the design process.
- List different types of structures and their purposes (animal homes).

For More Information

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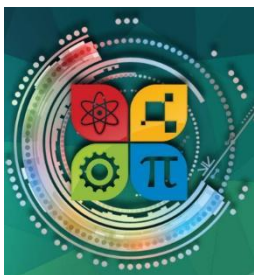
EbD TEEMS NxtGen – Grade 1
At-A-Glance

Intended Audience: 1ˢᵗ Grade **Course Length: 6-8 weeks**

Can You Hear Me? engages young learners in hands-on inquiry and design as they explore one of the greatest challenges of the 21st century: how we are able to hear and process sounds. This Building Block integrates concepts of science, technology, engineering, and mathematics through the environmental context of noise pollution. Science and mathematics concepts that are reinforced include the history of the telephone, echolocation, vibrations, and counting beats of a rhythm. By utilizing an experiential approach, students collaboratively investigate the issue of noise pollution, which is probably something that students do not realize is a form of pollution. Following guided inquiry activities, a design challenge provides an opportunity for students to apply knowledge and skills in a meaningful way as they design and create something that makes a sound and also helps them detect sounds. A *Grand Challenge for Engineering* identified by the National Academy of Engineering as "Reverse-Engineer the Brain" serves as a real-world inspiration for students to connect their learning with the present and the future.

Objectives

- Identify tools and techniques that people use to help them complete tasks.
- Name materials used to make things.
- Distinguish between the natural world and the human-made world.
- Identify science as a way of answering questions and explaining the natural world.
- Identify technology as a way of inventing tools and techniques to solve human problems.
- Categorize objects as either natural or designed by humans.
- Describe a product that has been made to meet a specific human need or want.
- Provide an example of how the way people live and work has changed throughout history because of technology.
- Recognize that everyone can design solutions to problems.
- Describe design as a creative process.
- Apply a design process that includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others to solve a technological problem.
- Write and draw ideas and solutions during the design process.
- Construct an object using the design process.
- Identify agricultural technologies that make it possible for food to be available year round and to conserve resources.
- Generate questions about objects, organisms, or events that can be answered through scientific investigations.
- Design, conduct, and/or describe the steps of an investigation to test one variable.
- State a conclusion consistent with information, observations, or data.
- Identify contributions that humans have made throughout the history of science and technology.
- Ask and answer questions about details in a text with prompting.
- Identify the main topic and retell key details of a text.
- Ask and answer questions to determine unknown words.
- Write informative text that includes the topic name, some facts supplied about the topic, and a closure.
- Answer questions on a provided topic following shared research.
- Describe familiar people, places, things, and events with relevant details and express ideas clearly.
- Accurately count beats using a variety of rhythms.
- Use vocabulary correctly (echolocation, vibrate).

For More Information

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EbD TEEMS NxtGen – Grade 2
At-A-Glance

Intended Audience: 2nd Grade **Course Length: 6-8 weeks**

From Nature to Me engages young learners in hands-on inquiry and design as they explore biomimicry (one of the most important challenges of the twenty-first century) and learn how we can obtain from nature the tools necessary for scientific discovery. This Building Block integrates concepts of science, technology, engineering, and mathematics through the environmental context of learning about bees and researching why they seem to be disappearing. By utilizing an experiential approach, students collaboratively begin to explore how animals spread seeds and how their environment is then suitable for habitation. Following guided inquiry activities, a design challenge allows students to create a device that will travel on land or air to disperse seeds. Thus, they will be engineering the tools of scientific discovery. This experience serves as a real-world inspiration for students to connect their learning with both the present and the future.

Objectives
- Distinguish between the natural world and the human-made world.
- Identify tools and techniques that people use to help them complete tasks.
- Describe how the use of tools and machines can be helpful or harmful particularly to the environment.
- Describe a product that has been made to meet a specific human need or want.
- Recognize that everyone can design solutions to problems.
- Describe design as a creative process.
- Apply a design process that includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others to solve a technological problem.
- Construct an object using the design process.
- Describe a manufacturing process or system used to produce a specific product in quantity.
- Generate questions about objects, organisms, or events that can be answered through scientific investigations.
- Design, conduct, and/or describe the steps of an investigation to test one variable.
- Identify appropriate tools or instruments for specific tasks and describe information they can provide (e.g., measuring: length – ruler, volume – beaker, temperature – thermometer).
- Categorize or sort objects using physical characteristics of the materials from which they are made.
- Identify earth resources and materials that come from the environment to meet the needs and wants of humans.
- Use physical properties (e.g., shape, size, color, texture, temperature, volume) to describe matter.
- Identify science as a way of answering questions and explaining the natural world.
- Identify technology as a way of inventing tools and techniques to solve human problems.
- Identify resources that come from basic materials (e.g., air, water, soil) and their uses.
- Describe how the effects of new ideas, new ways of doing things, and inventions can be good or bad.
- Identify contributions that humans have made throughout the history of science and technology.
- Create bar graphs to show specific amounts.
- Ask and answer who, what, where, when, and how questions about key details in a text.
- Identify the main topic and the focus of specific paragraphs in a text.
- Write informative text in which a topic is introduced, some facts supplied to develop points, and a conclusion is provided.
- Report on a topic with appropriate facts and relevant, descriptive details while speaking clearly at an understandable pace.
- Recognize that manufactured products are designed.

For More Information

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EbD TEEMS NxtGen – Grade 3
At-A-Glance

Intended Audience: 3rd Grade   **Course Length: 6-8 weeks**

Natural Hazards engages young learners in hands-on inquiry and design as they explore natural hazards that occur on the Earth. This Third Grade Building Block in the **EbD-TEEMS Integrative-STEM Curricula for K-6** integrates concepts of science, technology, engineering, and mathematics through the environmental context of natural hazards. Science and mathematics concepts that are reinforced include multiple hands-on, inquiry based activities such as creating designs, exploring regions of the Earth, and analyzing weather data as students learn about weather and climate, and the natural hazards that occur around the world. The final design challenge provides an opportunity for students to apply knowledge and skills in a meaningful way as they develop a design for a snow shoe to help people travel during a blizzard. A Grand Challenge for Engineering, identified by the National Academy of Engineering —Engineer the Tools of Scientific Discovery— serves as a real-world inspiration for students to connect their learning about Natural Hazards and design solutions that reduce the impacts of these hazards.

Objectives

- Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- Compare and contrast the most important points and key details presented in two texts on the same topic.
- Interpret data and graphs in order to describe typical weather conditions expected during particular seasons.
- Reason abstractly and quantitatively and use mathematical models.
- Create a design solution to reduce the impacts of a weather-related hazard by engineering a blizzard shoe design.
- Develop an understanding of the attributes of design and engineering design.
- Read *Wild Weather* by Melvin Berger in order to learn about the different types of weather hazards that happen on the Earth.
- Research a specific natural hazard and create a poster to display information about the hazard as well as possible impact solutions.
- Experiment with different materials to come up with the best combination that will keep a container warm while it is submerged in ice.
- Develop the abilities to apply the design process using appropriate tools strategically.
- Design a structure that will survive the shake table.
- Read about ancient rituals intended to produce rain and create a rain stick as a way to reduce the impact of having a drought by making it rain.
- Investigate using different materials to see how they perform against each other for waterproofing.
- Learn how to set up and use a STEM notebook in order to maximize knowledge of concepts and skills throughout this building block.
- Design a plan for a solution to help reduce the impact of a natural hazard that happens at home.
- Read the story about the life of Sir Francis Beaufort and review the Beaufort Wind Scale and read the Beaufort Wind Scale by answering questions.
- Build a house that will survive the wind of a fan and follow specific criteria for success and constraints on materials.
- Apply learning throughout this Building Block and design a shoe that will reduce the impact of the weather-related hazard while following the design process and meeting the criteria and constraints of the challenge.

EbD TEEMS NxtGen – Grade 4
At-A-Glance

Intended Audience: 4ᵗʰ Grade   **Course Length: 6-8 weeks**

The Power of Solar develops students' understanding of energy systems and related technologies, temperature, electricity, and sustainable sources of energy. In this Building Block, scientific inquiry and technological design are purposefully used as learning approaches in order to develop students' STEM literacy and higher-level thinking skills. Literacy strategies are integrated throughout lessons to support the development of reading, writing, and speaking skills. Core fourth grade math concepts and skills of decimals, perimeter, area, angles, points, lines, rays, and symmetry are reinforced through opportunities for application within meaningful STEM contexts.

Objectives

- Describe how tools are used to design, make, use, or assess technology.
- Identify science as a way of answering questions and explaining the natural world.
- Identify technology as a way of inventing tools and techniques to solve human problems.
- Identify earth resources and materials that come from the environment to meet the needs and wants of humans.
- Describe an example of common technological change in a community (e.g., transportation, communication) that has had either a positive or negative impact on society or the environment.
- Describe how the results of the use of technology can be good or bad.
- Describe how the effects of new ideas, new ways of doing things, and inventions can be good or bad.
- Draw inferences from a text, referring to details and examples in the text as evidence.
- Describe how results of the use of technology can be either good or bad.
- Describe how tools, machines, products, and systems use energy.
- Distinguish between a scientific fact and an opinion, providing clear explanations that connect claims and evidence.
- Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.
- Design, conduct, and/or describe the steps of an investigation to test one variable.
- Identify appropriate tools or instruments for specific tasks and describe information students can provide (Example: measuring = length - ruler, volume - beaker, temperature - thermometer).
- State a conclusion consistent with information, observations, or data.
- Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- Illustrate a complete direct current series circuit composed of a power source (battery or solar cell), wire, and bulb (LED or incandescent).
- Identify parts of a system and explain how the system may not work as planned if a part is missing.
- Write clear and coherent informative text in which the development and organization are appropriate to task, purpose, and audience.
- Identify technology as a way of inventing tools and techniques to solve human problems.
- Describe how tools and machines extend human capabilities in science and technology.
- Apply a design process that includes defining a problem, generating ideas, selecting a solution, making an item, evaluating it, and presenting results to solve a technological problem.
- Identify that requirements are the criteria or limits that must be met when designing or making a product.
- Identify specific resources (e.g., tools, materials, information, people, time) necessary to complete specified tasks.
- Apply a design process that includes defining a problem, generating ideas, selecting a solution, making an item, evaluating it, and presenting results to solve a technological problem.

EbD TEEMS NxtGen – Grade 5
At-A-Glance

Intended Audience: 5th Grade   **Course Length: 6-8 weeks**

Every Drop Matters engages learners in hands-on inquiry and design as they explore one of the greatest challenges of the 21st century: universal access to clean water. This Building Block integrates concepts of science, technology, engineering, and mathematics through the environmental context of water resource management and conservation. By utilizing an experiential approach, students collaboratively investigate global water issues and learn that stewardship and innovation can make a difference in solving the world's problems.

Objectives
- Identify earth resources and materials that come from the environment to meet the needs and wants of humans.
- Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
- Identify science as a way of answering questions and explaining the natural world.
- Identify technology as a way of inventing tools and techniques to solve human problems.
- Describe an example of a common technological change in a community (transportation, communication) that has had either a positive or negative impact on society or the environment.
- Distinguish changes in the environment as natural or human-made.
- Compare changes in the environment that are good or bad.
- Describe how the results of the use of technology can be good or bad.
- Identify contributions that humans have made throughout the history of science and technology.
- Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- Distinguish the difference between the different spheres and how they interact with each other.
- Distinguish between a scientific fact and an opinion, providing clear explanations that connect claims and evidence.
- Describe the movement of water on earth as it circulates through the phases of the water cycle.
- Generate questions about objects, organisms, or events that can be answered through scientific investigations.
- State a conclusion consistent with information, observations, and data.
- Use physical properties (shape, size, color, texture, temperature, volume) to describe matter.
- Provide an example of the effect that human waste has had on the environment (water).
- Determine the main idea of a text and support it with key details.
- Apply knowledge about a topic gained through research to the completion of a specified project.
- Design, conduct, and/or describe the steps of an investigation to test one variable.
- Identify tools, materials, and techniques used to make things or complete tasks.
- Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of a problem.
- Describe the design process as a method of developing solutions to problems.
- Apply a design process that includes defining a problem, generating ideas, selecting a solution, making an item, evaluating it, and presenting results to solve a technological problem.
- Describe how the effects of new ideas, new ways of doing things, and inventions can be good or bad.

For More Information

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EbD TEEMS NxtGen – Grade 6
At-A-Glance

Intended Audience: 6th Grade   **Course Length: 6-8 weeks**

Our World and Me serves as a capstone experience for sixth-grade learners using hands-on inquiry and design as they explore robotics through the engineering field of mechatronics. Mechatronics is an interdisciplinary engineering field that focuses on the integration of mechanical, electrical, and software systems. This curriculum extends ITEEA's **EbD-TEEMS Integrative-STEM Curricula for K-6** as the students create an interactive automaton that (1) educates others about environmental impacts caused by humans/technology, OR (2) presents a new idea on how to reduce human/technological impacts on the environment. Following guided inquiry activities, a design challenge provides an opportunity for students to apply knowledge and skills in a meaningful way as their automaton moves from a mere mechanical device to a robot.

Objectives

- Students will use the brainstorming guidelines to generate ideas.
- Students will collaborate as a team to select and share ideas regarding a selected topic. Students will view multiple videos (and other multimedia sources as appropriate) to gather information on the historical and cultural origins of automata and mechanical toys and record their observations in their engineering design notebooks.
- Students will use the practice of reverse-engineering to examine how an object/device works and record their observations in their engineering design notebooks.
- Students will use construction methods such as folding, cutting, gluing, and/or taping to construct a crank mechanism.
- Using the storyboard technique, students will observe how their crank mechanism works and create a five-panel storyboard and demonstration for class members who constructed a different crank mechanism.
- Students will identify and describe the types of motion found in their crank mechanism by using the terms oscillation, rotary, reciprocating, irregular, linear, and intermittent.
- Students will learn how three-dimensional figures are represented using nets made up of rectangles and apply these techniques in the context of solving real-world and mathematical problems.
- Students will use the skill of prototyping to construct a new display stand by either scaling up or scaling down from the original design.
- Students will practice using the Engineering Design Process to understand the Mini-Challenge Design Brief: Electrify!
- Students will read, interpret, and use electronic schematic symbols found in Technical Data Sheets, Standard Operating Procedure documents, and schematic diagrams; as well as schematic symbols used on electrical components (e.g., battery, battery holder) and instruments (e.g., digital multimeter).
- Students will use the digital multimeter (DMM) to perform electrical measurements including battery voltage checks and continuity checks of a designed circuit.
- Students will use Technical Data Sheets (TDS) to gain an understanding of various electrical components and will add information to the TDS based on their use of the components.
- Students will use Standard Operating Procedure documents (SOP) in the use of electrical components, tools, or processes.
- Students will arrange batteries in series and determine their effect on the motor's relative speed (e.g., low, medium, high) and direction (clockwise and counterclockwise).
- Students will construct schematic diagrams demonstrating the relative speed and the direction of the motor.
- Students will use a multimeter to determine the potentiometer's maximum resistance, left-center range, and right-center range.
- Students will use tools to connect devices to the Hummingbird Controller.
- Students will create expressions and sequences using Visual Programmer.

For More Information

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Exploring Technology
At-A-Glance

Intended Audience: 6ᵗʰ Grade   **Course Length: 18 weeks**

Meeting Engineering and Technology: Engineering and technology impact every individual and society as a whole.

- Introduction to Technology: Technology addresses our current wants and needs. Through innovation, humans have changed natural resources into products.

- Areas of Technology: Technology is a broad name for many fields of study.

- System Design: Technology is most useful when each facet of its creative design is carefully considered, such as its inputs, process, output, and feedback.

- Transforming Resources into Technology: The process of selecting necessary resources should be based upon the desired result of the technology being designed.

Design and Engineering: Technology exists to solve problems through the use of creative solutions that work best by demonstrating careful selection of resources to generate the best outcomes. Use of resources are a result of detailed and accurate plans based on ideas evolved through utilization of the Engineering Design Process in an Engineering Design Journal to ensure production of the technology designed solution is developed to achieve desired results.

- Documenting Ideas: Writing and sketching are important communication and documentation skills. An Engineering Design Journal (EDJ) is used to document class activities using narratives and sketches.

Invention and Innovation
At-A-Glance

Intended Audience: Grade 7   **Course Length: 18 weeks**

In this course, students learn all about invention and innovation. They have opportunities to study the history of inventions and innovations, including their impacts on society. They learn about the core concepts of technology and about the various approaches to solving problems, including engineering design and experimentation. Students apply their creativity in the invention and innovation of new products, processes, or systems. Finally, students learn about how various inventions and innovations impact their lives.

Introduction to Invention and Innovation: Create creative ways to turn ideas into real things.
- Inventing 101: How people of all times and places have increased their capability by innovating and inventing.
- Time will Tell! Inventions and innovations are the result of demands, values, and interests of individuals, industries, and societies.
- What's Your Problem? All technologies have flaws; there is no perfect design.

Engineering Design Process: A systematic problem-solving strategy, with criteria and constraints, used to develop many possible solutions to a problem, so as to satisfy human needs and wants. This process is iterative, and is informed by many factors such as human values, resources, environmental concerns and trade-offs in order to arrive at the best possible solution to the problem.
- The Process in Action: Technology involves many types of problems and different approaches to solve them, including troubleshooting, research and development, invention and innovation, and experimentation. The engineering design process must take all of these things into account.
- Working with the Design Process
- The Engineering Design Process in Action

Invention and Innovation in the Designed World: Invention and innovation are driven by human needs and wants and are influenced by the core concepts of technology: systems, resources, requirements, optimization and trade-offs, processes, and controls. These concepts are the cornerstone for creative design.
- Core Concepts of Technology: Core concepts; including systems, resources, requirements, optimization and trade-offs, processes, and controls; serve as cornerstones for the study of technology.
- Understanding the Scope of Technology Systems: In order to invent or innovate, a person must have an understanding of the technologies that exist in the modern world, and an ability to analyze and optimize technological designs.
- Real World Designing: Designers and inventors must consider the core concepts of technology and other resources such as scientific knowledge during the process of designing. They must also adhere to the criteria and constraints of a design.

Using Design and Creativity to Help Others: Improving daily life involves creatively using design concepts to solve problems.
- Technology Around You! Creativity is important to the process of invention and innovation. Innovation is the process of modifying an existing product, process, or system to improve it. Invention is a process of turning ideas and imagination into new products, processes, or systems.
- What is Design?
- Communicating Your Design? Communicating your design is important to the process of invention and innovation. As you brainstorm and collaborate, you create pictorial representations of your design. Accurate drawings and sketches can communicate your design ideas globally.
- Rube Goldberg Entertainment

Technology and Society: While technology has allowed humans to prosper, negative impacts have also resulted.
- **An iPod® Does That?** When humans develop and use technology systems and products, there is a direct influence on our economy, our culture, and our society. Additionally, the impacts of the development and use can produce positive and negative impacts.
- A Clean Solution to a Messy Problem and Getting from There to Here

Creating a Space Exploration Infrastructure: Constellation, one of NASA's latest space exploration program proposals, is a combination of large and small technology systems that will enable humans to travel to and explore the solar system.
- Establishing a Lunar Outpost
- Launch Vehicles and Earth Departure Stages
- Designing a Spacecraft Subsystem

For More Information

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Technological Systems
At-A-Glance

Intended Audience: Grade 8   **Course Length: 18 weeks**

Technological Systems is intended to teach students how systems work together to solve problems and capture opportunities. A system can be as small as two components working together (technical system/device level) or can contain millions of interacting devices (user system/network level). We often break down the Macro systems into less complicated Microsystems in order to better understand the entire system. However, technology is becoming more integrated and systems are becoming more dependent upon each other than ever before. Electronic systems are interacting with natural (e.g., bio) systems as humans use more and more monitoring devices for medical reasons. Electrical systems are interacting with mechanical and fluid power systems as manufacturing establishments become increasingly automated. This course gives students a general background on the different types of systems with a concentration on the connections between these systems.

Technological Systems, How They Work: Investigate technological systems through their function, design, development, interaction, and maintenance. Systems included in this exploration include communications, construction, manufacturing, bio-medical, and power energy.
- Development of Technological Systems: Technological Systems are developed to meet specific criteria and must be able to function to complete the systems loop.
- Design of Technological Systems: Technological systems are designed to meet a specific need while addressing design constraints.

Technological Systems, Issues and Impacts: Technological systems can impact the world in a variety of ways and can be both positive and negative.
- Social and Cultural Impacts: Human needs and interests in technological devices reflect social and cultural priorities.
- Environments and Economics: Technology can have both positive and negative impacts on the environment and the economy.

Technological System Interaction: Technological Systems are designed to meet a specific need and can address this need through a variety of functions, processes, and interactions with other systems.
- System Functions and Processes: Processes within systems serve different functions and can cause problems with the performance of the system if there is a malfunction.
- System Design and Development: Knowledge from a variety of fields is used in the development of products and systems and the completed system can be used in multiple applications.

Maintaining Technological Systems: Technical information comes in many forms, and is used to test, evaluate, and problem-solve within systems.
- Understanding Technical Information
- Problem Solving with Systems: At times, systems will need to be adjusted or repaired and tools and equipment must be used safely to maintain these systems.
- System Testing and Evaluation: Systems are designed with a specific purpose and controls are placed within systems to address their performance.

Technological Systems in the Designed World: A variety of different technological tools, processes, and materials can be integrated to form systems.
- Power and Energy Systems: Energy is needed to do work of any kind, by human, machine, system, or other means.
- Communication Systems: The process of communication can take place between humans, machines, and humans and machines.
- Constructing Specialized Manufacturing Environments: Production and manufacturing environments for biological and medical equipment and materials must align to standards that ensure the quality of the material produced.

The Refocus of NASA: Space transportation systems, although highly sophisticated and technologically advanced, employ the basic subsystems found in conventional transportation systems.
- Celebrating the Space Shuttle: The analysis of current technologies is essential to future technological change and innovation.
- The Future of the Space Program: Transportation systems are made up of subsystems that work together to function as a whole.

For More Information

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Engineering For All
At-A-Glance

Intended Audience: Grades 6-8   **Course Length: 12 weeks**

The Engineering for All (EfA) project has been funded by the National Science Foundation (Grant # DRL 1316601) to create, test, and revise two six-week modules for middle school technology education classes on the important social contexts of food and water. The units are built on four "drivers" that underpin the Engineering for All approach. These include:

- Promoting the potential of engineering as a social good.
- Revisiting unifying engineering and technology themes (i.e., design, modeling, systems, resources, and human values) in authentic social contexts.
- Using design-based engineering activities as authentic contexts for teaching and learning Science, Technology, Engineering and Mathematics (STEM) ideas and practices
- Using *informed design* as the core pedagogical methodology.

Vertical Farms: Fresh Food for Cities

In order to address the Grand Challenge of producing food for a growing world population, students become "experts" in designing and constructing hydroponic systems. Once their hydroponic systems are up and running and plants are growing, the students receive a message that their firm has been asked to design a hydroponic system for the wall of an existing apartment building.

Small teams compete to design the best possible system. Their work culminates in design drawing and a presentation to their classmates, who will consider each design on its merits, and then work together to plan the best possible design for their client. The overarching goal of this unit is for students to develop engineering design and systems analysis skills while coming to understand that engineering has great potential to be a social good by solving such critical problems as providing food and water for people around the world.

Water: The World in Crisis

To address the grand challenge of improving water availability and safety, students will explore issues of water scarcity, including the effects of unsafe water, water contaminants, and water filtration methods. The unit begins as students are told they have been accepted to be part of a team of engineering students working with the local chapter of Engineers across Borders. Students learn about the world water crisis and water scarcity and become "experts" in "traditional" design and construction of water filtration systems

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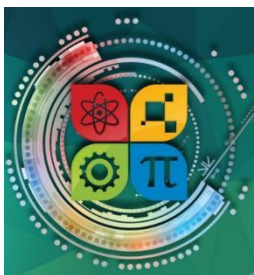
Foundations of Technology
At-A-Glance

Intended Audience: Grades 9-10   **Course Length: 36 weeks**

Foundations of Technology prepares students to understand and apply technological concepts and processes that are the cornerstone for the high school technology program. Group and individual activities engage students in creating ideas, developing innovations, and engineering practical solutions. Technology content, resources, and laboratory/classroom activities apply student applications of science, mathematics, and other school subjects in authentic situations.

- **Technological Inventions and Innovations**: a result of evolutionary technological development and systematic research and development.
    - o   The History of Technology
    - o   Inventions and Innovations: An Evolutionary Process
    - o   The Role of Research and Development: A Problem Solving Approach
    - o   Advertising and Marketing Effects on Technology

- **The Engineering Design Process**: a systematic iterative problem solving method that produces solutions to meet human wants and desires.
    - o   Engineering Design Process
    - o   Criteria and Constraints
    - o   Design Principles
    - o   Prototypes and Modeling
    - o   Collecting and Processing
    - o   Applying the Design

- **The Designed World**: A byproduct of the engineering design process, which transforms resources (tools/machines, people, information, energy, capital, and time) into usable products and services.
    - o   Energy and Power
    - o   Manufacturing
    - o   Construction
    - o   Information and Communication
    - o   Agriculture and Transportation
    - o   Telemedicine

- **Systems:** The building blocks of technology and users must properly maintain, troubleshoot, and analyze systems to ensure safe and proper function.
    - o   Core Technologies: Every system and product is made up of one or more of the nine core technologies: bio-, electrical, electronic, fluid, material, mechanical, optical, structural, and thermal technology.
    - o   Systems Model: The Universal Systems Model
    - o   Reverse Engineering
    - o   Troubleshooting

- **Lunar Plant Growth Chamber:** The engineering design process is a comprehensive, valuable tool that can be used to provide solutions to complex challenges, on Earth and beyond.
    - o   Space Exploration
    - o   Intermodal Transportation
    - o   Transportation Cycle
    - o   Decision Making and Management

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Game Art Design
At-A-Glance

Intended Audience: Grades 9-10   **Course Length: 36 weeks**

The video game industry is a multi-billion dollar industry with 58% of Americans playing video games (2013). The industry is one of the fastest growing markets as developers continue to create new and innovative products for unique entertainment experiences. This growth continues to provide a vital source of employment across the U.S. (ESA Entertainment Software Association). *Game Art and Design (GAD)* introduces students to the basic skills necessary to enter this growing industry. Game design refers to planning, designing, creating, and testing all types of games. Game designers will often work closely with other members of a team to create games for computers, video game consoles, phone apps, or the latest board game.

History and Ethics: Knowledge of the history of technology and societies helps people understand the world around them by seeing how people of all times and places have increased their capability by using their unique skills to innovate, improvise, and invent.
- Ancient Games
- History of Electronic Games
- Trends
- Game Ratings and Ethics: Knowledge of the history of technology and societies helps people understand the world around them by seeing how people of all times and places have increased their capability by using their unique skills to innovate, improvise, and invent.
- History of Cards

Job Readiness: Specific skills are necessary in order to obtain and keep a job in the competitive design industry.
- Skills in the Game Industry: Specific skills are necessary in order to obtain and keep a job in the competitive design industry.
- Execute the Documents Necessary to Enter the Game Industry.

Game Design Culture: Knowledge of the basic skills and components of any field makes one uniquely prepared to perform at a high level in that area.
- Social Game Interaction and Player Patterns
- Summarize Formal Game Elements, Objectives
- Summarize Formal Game Elements, Procedure and Rules
- Summarize Formal Game Elements, Probability
- Summarize Formal Game Elements, Resources and Boundaries
- Categorize Game Theory
- Categorize Game Genres

Prototype Production: The production of realistic models is a skill necessary in the design process as well as a tool used to sell a proposed product.
- Game Conceptualization
- Prototype Production

3D Game Design: Learning skills specific to an industry will better prepare an applicant for a job. 3D modeling and rendering are necessary skills for the game industry.
- Execute 3D Modeling and Texturing
- Produce 3D Animation and Character

2D Game Design: It is essential for Game Designers to fully understand the design process as well as the software skills needed to create successful designs.
- Illustrate Basic 2D Game Engine Design, Engine Components, and Genres

2D Game Production: The design and production of realistic models are necessary to sell a proposed product.
- Creating a 2D Game

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Technology and Society
At-A-Glance

Intended Audience: Grades 10-12   **Course Length: 36 weeks**

Technology and Society is different than other Engineering byDesign™ courses in that the goal is not to design an artifact or product but to design knowledge and wisdom to inform future decisions. Students develop "intangible" opinions, attitudes, and positions and then use these to inform their designs of products, systems, and services. This course prepares all students, whether they intend to be engineers, cosmetologists, or parents, to make informed decisions about their individual, community, and organizational uses of technology.

Skills for Analyzing Technology and Science Issues: Technology and science issues are multidimensional and require various critical and reflective thinking skills to clarify the issues before informed decisions should be made.
- Capturing My Ideas
- Ethics in Engineering
- The Right to Know
- A Stake in the Issue
- Point and Counterpoint

The Human-Technical Paradox: Because technology is an expression of human purpose and the interaction between the inventor and the artifact, technologists and scientists must consider the effects of their creations on themselves, others, and the environment.
- Olsen's Error
- It's Alive!
- Humans + Technology=?

Change by Design: Choices concerning the design, use, consumption, and disposal of various products must consider their impact on the future.
- Paper or Plastic? Making Knowledgeable Decisions
- Sustainability by Design
- Disposal by Design
- My Global Footprint
- Justice by Design

Contemporary Issues in Science and Technology: Positions on contemporary issues of technology and science should be supported with appropriate research and evidence.
- Engineering Disaster, Santa Susana
- Going Nuclear
- Gene Theft
- Climate Change
- Sugar, Good as Gold

Transportation and Space, Reuse and Recycle: When humans colonize space, they will need to adapt the technologies and processes of disposing and using waste and natural resources to overcome the challenges of this new environment.
- Introduction to Space Resources
- Commercialization of Space
- Reuse and Recycle Man-Made Resources

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Technology and Society

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Advanced Technological Applications
At-A-Glance

Intended Audience: Grades 10-12   **Course Length: 36 weeks**

In this course, students study four components of the Designed World:

- **Agriculture and Related Biotechnologies:** Explores how agricultural technologies provide increased crop yields and allow adaptation to changing and harsh environments, enabling the growth of plants and animals for various uses.
    - o   One Good Clone Deserves Another: Learn how to clone plants through a process called micro-propagation. Understanding how to get rid of contamination (especially bacteria) on the plant, isolating cells that are actively dividing, and then using growth hormones and nutrients in media to eventually produce large numbers of plants.
    - o   Too Hot To Handle? Genetically modified (GM) food. GM food is considered a "hot" topic, in that it is controversial and the source of much debate around the globe. Genetically modifying a plant is not given much thought until it is going to be consumed for food.
- **Entertainment and Recreation Technologies:** Provides a study of technological entertainment and recreation systems, with an examination of the differences between these technologies, of how their use enhances human leisure-time performance, and of the social, cultural, and environmental implications of their usage.
    - o   Surfing the Sound Waves: We all have different musical tastes. How are we able to differentiate between different musical genres and sounds? How do we hear music? Your ears are amazing! They can pick up sounds and translate them into information that your brain can understand. Hearing is the only sense that does not involve chemical reactions, but is based solely on physical movement.
    - o   The Sounds of Music: How can a piano, a harp, and a guitar all use strings to play the same notes and yet sound so different? How are musical instruments able to produce music and not just random noise? The shape and materials used to construct the instrument have a lot to do with the sound the instrument makes.
- **Information and Communication Technologies:** Examines how technology facilitates the gathering, manipulation, storage, and transmission of data and how this data can be used to create useful products.
    - o   Instant Information: We are currently living in the Information Age. The transition from agriculture to manufacturing, known as the Industrial Revolution, progressed into the Information Age, named because of the increased production, transmission, consumption, and reliance on information. One of the most significant developments of the Information Age is the internet or the "Information Superhighway."
- **Medical Technologies:** Provides an analysis of how medical technologies are used to increase the quality and length of human life and how increased use of technology carries potential consequences that require public debate
    - o   Timely Technology: Medical technologies have evolved immensely since ancient times. Many things that used to be thought of as futuristic have become the current practices of today. Human problems and needs are the driving force behind technological breakthroughs that have created innovative medical procedures, devices, and treatments.
    - o   Tests and Tools: An introduction to the important field of medical measurement and instrumentation.

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Advanced Design Applications
At-A-Glance

Intended Audience: Grades 11-12   **Course Length: 36 weeks**

Advanced Design Applications focuses on the three dimensions of technological literacy "knowledge, ways of thinking and acting, and capabilities" with the goal of students developing the characteristics of technologically literate citizens. It employs teaching/learning strategies that enable students to explore and deepen their understanding of "big ideas" regarding technology and makes use of a variety of assessment instruments to reveal the extent of understanding.

Objectives

- **Construction**: Construction technology involves the design of structures to meet various requirements.
    - The Incredible Shrinking Design: Various techniques and tools are used in technical drawing and modeling, including scales, measurement, and conversion.
    - Seeing Green: Construction technology involves the design of structures to meet various requirements and the development of plans for how those buildings can fit into the surrounding community environment.
- **Energy and Power:** The law of conservation of energy, when applied to renewable energies, involves trade-offs among competing constraints and requirements, including engineering, economic, political, social, and environmental considerations.
    - Measurement and Introduction to Energy: The law of conservation of energy, when applied to renewable energies, involves trade-offs among competing constraints and requirements, including engineering, economic, political, social, and environmental considerations.
    - Energy Transfer: Energy and Power are technologies that are necessary to use in the designed world. Reviewing simple machines and learning how they can be used to manipulate mechanical advantage will allow users to take advantage of energy and power that is generated.
- **Manufacturing**: Modern manufacturing technologies and processes can produce quality products that are essential for economic health and also enhance the quality of life for many people, while having a minimal negative impact on environment.
    - Under Pressure: The design and manufacture of products is affected by customer, societal, economic, political, and environmental concerns.
    - In Control: Computer controlled manufacturing has enabled engineers and designers to reduce costs in almost every aspect of production, from producing designs to packaging and shipping, in a safe, economical, and timely manner, as well as reduce the time and effort required by dozens of human workers.
- **Transportation**: Transportation varies culturally, but plays a vital role in each society and includes many subsystems to deliver products and services.
    - Safety First: Evaluating the benefits, limitations, and risks associated with existing and proposed technologies is essential to the engineering process and the success of the design solution.
    - Out of Control: Utilization of a variety of simple and complex technologies is essential to understanding methods of controlling new technologies.
- **SeaPerch:** Students learn about robotics, engineering, science, technology, and mathematics (STEM) while building and operating an underwater ROV as part of the *Advanced Design Applications* course.
    - From Submarines to ROVs: Conduct research on real-world uses of remotely operated vehicles.

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Advanced Design Applications, 3rd Edition

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Technological Design
At-A-Glance

Intended Audience: Grades 10-12   **Course Length: 36 weeks**

In **Technological Design**, engineering scope, content, and professional practices are presented through practical applications. Students in engineering teams apply technology, science, and mathematics concepts and skills to solve engineering design problems and innovate designs. Students research, develop, test, and analyze engineering designs using criteria such as design effectiveness, public safety, human factors, and ethics.

Introduction to Technological Design: The technological design approach exemplifies competencies of a technologically literate member of the 21st century society.
- Emerging Technologies
- Fundamentals of STEM
- Design, Research, and Develop
- Universal Design

Technological Design Skills: The process of developing and manufacturing a product requires planning, teamwork, and testing.
- Understanding the Impact of Product Design and Development
- Using the Design Process
- Developing a Prototype and Manufacturing Plan

Technological Design Fundamentals: Technological design fundamentals are based on systems thinking.
- Systems Thinking
- Communication Systems
- Complex Systems Thinking
- Systems Criteria and Constraints

Technology and Society: The use of technology can result in positive as well as negative impacts on society and the environment.
- Trade-Offs and Transfers
- Technology Impacting the Community
- Technology Impacting the Environment

The Designed World: All technological systems are interdependent and rely on one another. These technologies impact all facets of our society, culture, politics, and environment. People must utilize the Engineering Design Process to create, manage, and modify technological devices and systems within the designed world in a manner that has minimal negative impacts.
- Technological Design in Bio-Related/Agricultural Technologies
- Technological Design in Energy and Transportation
- Technological Design in Lean Manufacturing
- Technological Design in Sustainable Construction

Design Challenge: Lunar Plant Growth Chamber: The engineering design process is a comprehensive, valuable tool that can be used to provide solutions to complex challenges on Earth and beyond.
- When humans begin to live away from Earth, they will have to grow some of their own food.
- Choosing Plant Species
- Identifying Criteria and Specifying Constraints
- Designing the Lunar Plant Growth Chamber
- Building the Plant Growth Chamber

For More Information

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Engineering Design
At-A-Glance

Intended Audience: Grades 11-12　　　　　　　　**Course Length: 36 weeks**

This course focuses on how engineers apply their creativity, resourcefulness, mathematical, scientific, and technical knowledge and skills in the creation or refinement of technological products/systems. A key approach will be the employment of a sophisticated, sequential, and iterative design and development process to solve authentic engineering tasks/problems.

Fundamentals of Design Engineering: There are fundamental principles that impact human thinking and actions when engaged in the process of designing technological products. A combination of personal qualities such as creativity and resourcefulness and design constraints imposed by numerous factors are employed in a formal process to create new or refined technologies.

- Human Factors Affecting Design and Environmental Factors Affecting Design
- Industrial Factors Affecting Design
- Design through Research
- Market and Profit Influence
- Design – A Formal Process
- Analyzing and Interpreting Data – Prioritizing Design Constraints

Elements of Design: There are core technologies involving systems within a range of sophistication that are critical to all technological innovations, including mechanical, structural, fluid, optical, electrical, electronic, thermal, bio-technical, and material. Mathematical and scientific calculations and concepts are documented and used by engineers and designers for specific applications in all engineering fields. These documents are valuable reference materials used to ensure high quality designs.

- Design Requirements: Product design always includes requirements (criteria, constraints and efficiency) that require "trade-offs."
- Technology Systems – Using Models Requirements: There are nine "Core Technologies" that are fundamental to all technology systems that must be recognized and understood.

Structural Design: Modeling, Prototyping, and Protecting Ideas: A combination of personal abilities such as creativity, resourcefulness, and abstract thinking applied to a formal engineering design process, supported by full testing with documentation, can result in dynamic and dramatic technological invention or innovation.

- Patent Process: Technological innovation can lead to unintended, yet very useful, applications in other industries resulting in a "technological transfer."

- Mathematical and Computational Resources: Engineers use numerous and diverse resources to ensure accurate and appropriate calculations in all design work.

- Materials Science: Materials (natural, synthetic, or blended) provide many options for final product designs across all industries.

- Creativity in Design: Creativity varies in individuals, but can be enhanced and refined in all people.

Product and Systems Engineering and Analysis Management: Project management involves research-based techniques and strategies designed to control major business functions and ensure efficiency in the design and quality of a final product. A primary goal of any engineering enterprise is to identify problems to solve, predict overall value and success of the project, and then manage that project in the most cost-effective way.

- Managing Engineering Design, Quality Assurance, Evaluating, and Communicating Information.

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