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.

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. Each unit is listed below along with the Learning Cycles for the unit.

- **Technological Inventions and Innovations**: A result of evolutionary technological development and systematic research and development.
  - The History of Technology
  - Inventions and Innovations: An Evolutionary Process
  - The Role of Research and Development: A Problem-Solving Approach
  - 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.
  - Engineering Design Process
  - Criteria and Constraints
  - Design Principles
  - Prototypes and Modeling
  - Collecting and Processing
  - 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.
  - Energy and Power
  - Manufacturing
  - Construction
  - Information and Communication
  - Agriculture and Transportation
  - Telemedicine

- **Systems Engineering and Technology:** The building blocks of technology and users must understand, properly maintain, troubleshoot, and analyze systems to ensure their safe and proper function.
  - Systems Model: The Universal Systems Model
  - Core Technologies
  - Simple Machines
  - Electrical Fundamentals
  - Reverse Engineering
  - Engineering Systems

- **Design with CAD Systems:** CAD systems allow for engineers, technicians, and designers to communicate ideas effectively and efficiently while transcending barriers of location, time, and language.
  - AutoCAD command introduction and skill development
  - Community Design Project
  - Global Design Project
  - Industry Certification Preparation

For More Information

Contact Us At

ebdbuzzsupport@iteea.org

Foundations of Technology - ONLINE 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. Each unit is listed below along with the Learning Cycles for the unit. This course is student facing. Students may complete with minimal instructor input.

- **Technological Inventions and Innovations**: A result of evolutionary technological development and systematic research and development.
  - The History of Technology
  - Inventions and Innovations: An Evolutionary Process
  - The Role of Research and Development: A Problem-Solving Approach
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For More Information

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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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For More Information

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Computer Science Principles byDesign At-A-Glance

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

The **Computer Science Principles byDesign™** course was developed to introduce students to fundamental computer science principles as well as prepare students to take the AP CSP Exam. The course is organized using the College Board AP Computer Science Big Ideas and Computational Thinking Practices. In this course, students program using the Snap programming language, learn some of the most powerful ideas of computer science, demonstrate creativity, and discuss the social implications of computing, thinking deeply about how they can be personally active in promoting and reducing the possible harms.

- **Introduction to Programming**: an introduction to foundational concepts of programming.
  - Click Alonzo Game
  - Gossip and Greet
  - Modern Art with Polygons
  - Protecting Your Privacy
  - Follow the Leader
- **Abstraction**: an investigation into data structures and program control structures.
  - Improving Games by Using Variables
  - Making Art by Using Data Structures
  - Making Decisions by Using Predicates
  - Dealing with Complexity
  - Copyrights
- **Data Processing and Lists**: a focus on lists, abstraction, and higher order functions.
  - Contact Lists
  - Tic-Tac-Toe
  - Robots and Artificial Intelligence
  - Building Data Visualization Tools
  - Big Data
  - Optional Projects
- **How the Internet Works**: addresses network protocols and cybersecurity
  - Reliable Communication
  - Communication Protocols
  - Cybersecurity
  - Community and Online Interactions
  - AP CSP Explore Task
- **Algorithms and Simulations**: use several types of analysis to solve problems.
  - Search Algorithms
  - Models and Simulations
  - Timing Experiments
  - Unsolvable and Undecidable Problems
  - Computing in War
  - AP CSP Create Task
- **How Computers Work**: an overview of the history of computers, software, hardware, number bases, and binary data.
  - Computer Abstraction Hierarchy
  - Data Representation and Compression
  - A Brief History and Impact of Computers

For More Information

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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.

For More Information

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Advanced Technological Applications At-A-Glance

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

In the *Advanced Technological Applications* course, students study five components of the Designed World.

- **Engineering Design Graphics and Spatial Skills:** The purpose of this unit is to assist students in understanding the concepts and principles underlying orthographic projections; how to create 2D drawings and 3D solid models using CAD software and apply these techniques to solve real-world problems.
  - Primary Challenge: Designing for Assisted Living. Students create an accurate description of a moderately complex design and will modify an existing design using an *ADA* design brief.

- **Cybersecurity:** Today, there are approximately 3.2 billion internet users worldwide. With that many users, connecting to the internet leaves computers and users vulnerable. This unit is intended to help students become well informed about protecting their personal information online and maintaining a safe internet presence.
  - Primary Challenge: Public Service Announcement. Students will create a Public Service Announcement campaign to target specific age groups with age-appropriate cybersecurity tips. They will design and create computer-generated posters to distribute to three targeted groups: elementary ages, middle school ages, and high school ages through age 70.

- **Biotechnology:** Students will learn about current technological systems that employ organisms as tools as well as develop their own ideas as to how technological systems can be further improved with creativity.
  - Primary Challenge: Johanna's Market Stand. Students will solve a real-world problem for the end user, Johanna. The end user is interested in increasing her profits at her local farmer's market stand. The solution must incorporate the use of animals, plants, or microorganisms (or parts of these organisms) as tools.

- **Information Technology:** This unit is intended to help students gather, select, evaluate, and utilize diverse data to communicate the model to help make decisions about their design or solution and communicate their analysis and solution to diverse audiences. Students will learn to use Excel™ as a data analysis tool and Alice™ as a visualization/3D modeling tool for communication purposes.
  - Primary Challenge: Unjamming Traffic: Visualize to Communicate. Students (teams) will be responsible for designing and implement their traffic "un"-jamming model from the preliminary challenge through an animation in Alice.

- **Robotics:** The purpose of this unit is to expose students to principles of automation and enable them to understand automated technologies around them so they can make educated decisions about them and so they can create new ones. This unit culminates the *Advanced Technological Application* course by synthesizing concepts students learned through the course and providing students an opportunity to demonstrate their learning through hands-on and minds-on learning experiences.
  - Primary Challenge: Electromechanical Robotics. Students will be able to design a self-driving car program to navigate a course with obstacles.

For More Information

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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 Biotechnology /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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