CTE CONTENT AREA: Technology Education
CONTENT MODULE TITLE: Design

MODULE DESCRIPTION

As human needs and wants are identified, it is the role of a designer to satisfy or solve for them. Design is a proactive, deliberate, and structured approach to solving problems. Designers must be able to clearly define a problem with constraints and parameters to be adhered to when designing a solution. The designer must consider the resources available such as time, materials, and money. Once the problem is clearly defined, possible solutions can be brainstormed, selected, prototyped, modeled, tested, and refined through a formal process that can be repeated and re-entered as the design evolves. Design can follow an engineering approach where efficiency and optimization are major considerations, or it can take an artistic approach where form and aesthetics are more important. Optimally, products made to meet our needs and wants will have a balance of form and function.

Problem solving may take a reactive approach through troubleshooting. Formal processes of managing, maintaining, and repairing technological systems are necessary to ensure that they operate as intended. Students should understand the role of researching and evaluating information about systems, how to experiment and evaluate data, and be able to predict outcomes in order to better control and maintain systems.

In this module, students will learn about the design and troubleshooting processes and how to effectively apply them when solving problems. This provides students opportunities to collaborate and work together toward common goals. By understanding and applying design processes, students will develop and apply real-world problem-solving skills and a greater appreciation for invention and innovation. These skills will transfer beyond the technology classroom and laboratory.

This module is intended as the third of five modules that can be completed in sequence or integrated with content with the other modules through laboratory activities and problem-based assignments.

GUIDING QUESTION

What do students need to understand about how to apply design processes to address human needs and wants?

MODULE CONTENT

Design
1. The Attributes of Design
    Students will
    a) Define design as a creative planning process used to develop products and systems
    b) Elaborate on how every design has the potential to be improved
    c) Define criteria and constraints and how they are applied as design requirements

2. Engineering Design
    Students will
    a) Define the steps of an engineering design process and their sequence and illustrate how they can be repeated
    b) Collaborate with others through brainstorming as an open group problem-solving process
    c) Demonstrate how modeling, testing, evaluating, and modifying are applied toward developing practical design solutions

3. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem-Solving
    Students will
    a) Apply troubleshooting methods to identify the cause of a malfunction in a technological system
    b) Differentiate between invention as turning imagination and ideas into new devices and systems and innovation as modifying existing products or systems to improve them
    c) Demonstrate how experimentation can be applied to evaluate and solve a technological problem

4. Career Pathways
    Students will
    a) Explain roles and functions of individuals engaged in engineering and design related careers
    b) Investigate education, training requirements and opportunities for career paths in engineering and design related fields
    c) Assess personal employability skills for technical careers and evaluate personal suitability for such careers

ILLUSTRATIVE ACTIVITIES by Theme Module

Career and Community Connections
Entrepreneurship
>   Each student researches and interviews a first-generation small business to inquire about the evolution of the company: how it began, what has changed, and how the owner used problem-solving to improve the business. Examples of businesses include a local retail store, a private contractor, a craftsman, a manufacturer, or a service provider. Students report the findings through a poster, written report, or presentation.

Communication and Interpersonal Relationships
Logo Design
>   Working in groups, students will design a logo that has meaning and communicates a message about an organization. Students design the logo so that it may be used for web communication, paper formats, or 3D printing as part of a product. As an alternative, students design the logo so that it could be used in a large collaborative installation, such as a community sign or monument. Students consider options for the installation, such as schools, sports teams, community organizations, parks, memorials, or businesses.

Financial and Consumer Literacy
Paper vs. Plastic

> Students investigate the different aspects of using paper and plastic bags for shopping in grocery and retail stores to include issues such as material sourcing, recycling, environmental impacts, biodegradability, and cost. Students evaluate the materials used in the bags, the lifecycle, and products that could be or are currently created from the material in the bags so that ecological impact of the bags' use is considered. Students create a poster or presentation to report findings and share it with others in the school and community. Identify alternate solutions for shopping bags or ways that they can be better recycled.

Health, Safety, and Wellness
Accessibility Organizer

> Students design an organizer that can be easily attached to an assistive device. Work with students to identify the uses for the organizer. Uses may include tools, personal care items, or school supplies. Students design the device to be easily attached and removed and so that it does not interfere with the user's mobility. Students should consider additional features that can be included, such as a writing or drawing surface. Students develop a prototype or model of the design. Alternative activities include an organizer for crutches, a walker, a motorized shopping cart, or a wheelchair.

Problem Solving and Innovation
Drone Product Packaging

> Students design a package for protecting a delicate object such as an egg for drone delivery that accommodates challenges required by using drone delivery, including compact, lightweight and fully protective packaging. Constraints include minimizing size, minimizing weight, using efficient material, and having a standardized connection for the drone. Students develop and execute a drop test to verify that the packaging protects the product from a fall. Students consider other important factors including collapsible packages, material options, ease of opening and closing, reusability, and recycling options.

Sustainability
Reverse Engineering

> Students disassemble a small device and identify and create a display of its working components. Working in small groups, students identify each component's name and function. Groups select one component and propose an alternate design solution to improve the product or allow the component to be repurposed for another use. Students develop models and 3D print replacement parts to test design alternatives. Examples include a toy, tool, or household device that is no longer of service or is broken.

STANDARDS ADDRESSED

New York State Career Development and Occupational Studies (CDOS) Standards
Intermediate Level
http://www.p12.nysed.gov/cte/

> Standard 1: Career Development
>> Students will be knowledgeable about the world of work, explore career options, and

relate personal skills, aptitudes, and abilities to future career decisions.
Standard 2: Integrated Learning
Students will demonstrate how academic knowledge and skills are applied in the workplace and other settings.
Standard 3a: Universal Foundation Skills
Students will demonstrate mastery of the foundation skills and competencies essential for success in the workplace.

Common Career Technical Core Standards
Career Ready Practices - www.careertech.org/career-ready-practices
1. Act as a responsible and contributing citizen and employee
2. Apply appropriate and academic and technical skills
3. Attend to personal health and financial well-being
4. Communicate clearly and effectively and with reason
5. Consider environmental, social, and economic impacts of decisions
6. Demonstrate creativity and innovation
7. Employ valid and reliable research strategies
8. Utilize critical thinking to make sense of problems and persevere in solving them
9. Model integrity, ethical leadership, and effective management
10. Plan education and career paths aligned to personal goals
11. Use technology to enhance productivity
12. Work productively in teams while using cultural global competence

International Technology and Engineering Education Association
Standards for Technological Literacy – www.iteea.org/39197.aspx
Standard 8: Students will develop an understanding of the attributes of design.
Standard 9: Students will develop an understanding of engineering design.
Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

RESOURCES

International Technology and Engineering Educators' Association
www.iteea.org
ITEEA is the international organization that represents technology and engineering educators. The organization supports an annual conference and publishes two journals, *Technology and Engineering Educator* and *Journal of Technology Education*. Many resources are available for classroom teachers including Engineering by Design. ITEEA developed and maintains the Standards for Technological Literacy.

New York State Technology and Engineering Educators' Association
www.nysteea.org
NYSTEEA represents technology and engineering educators across New York State. Their website has important information on technology content, current developments in technology and engineering education, professional development opportunities, and other resources important to technology educators.

New York State Department of Labor
New York State Career Zone
https://www.careerzone.ny.gov

> Career Zone is a no-cost online career exploration and planning tool developed by the New York State Department of Labor. It offers career and education information on thousands of careers, as well as, self-assessment and career planning tools. Career Zone is appropriate for users from middle school through adult.

United States Department of Labor
CareerOneStop
https://www.careeronestop.org

> CareerOneStop is the career, training, and job search website for the U.S. Department of Labor. The website serves job seekers, businesses, students, and career advisors with a variety of free online tools, information, and resources.

Association of Career and Technical Education
Career Planning Guide
https://www.acteonline.org/wp-content/uploads/2018/02/ACTE_CC_Paper_FINAL.pdf

> Research has identified middle school as a time when students can benefit the most from career exploration, a process of building self-awareness, learning about potential careers, and developing a plan for reaching future goals.

AdvanceCTE
Middle Level Career Interest Inventory
https://cte.careertech.org/sites/default/files/StudentInterestSurvey-English.pdf

> AdvanceCTE provides a Career Interest Inventory worksheet to use with students in helping them identify the potential matches to the 16career clusters available to them.

Career and Technical Education Technical Assistance Center of New York (CTE TAC)
http://nyctecenter.org/

> The Career and Technical Education Technical Assistance Center (CTE TAC) operates under a state contract to assist the New York State Education Department (NYSED) in carrying out its mission of improving the quality, access, and delivery of career and technical education through research-based methods and strategies resulting in broader CTE opportunities for all students.

NASA Engineering Design Resources
https://www.nasa.gov/audience/foreducators/best/edp.html

> NASA provides a wealth of STEM-related curriculum materials, activities, and other resources for students at all levels. This link connects directly to the engineering design process and related content.

Project Based Learning – Buck Institute for Education
https://www.bie.org/about/what_pbl

> This resource defines project-based learning and explains how teachers can

implement it through activities in their classroom. The processes presented on this site has many common elements with engineering design and technology education.

Informed Design – Hofstra University Center for STEM Research
https://www.hofstra.edu/academics/colleges/seas/ctl/ctl_informeddesign.html

"Drying by Design" is an instructional module utilizing the Informed Design process that integrates mathematical analysis and scientific inquiry with technology to make informed design decisions. Curriculum modules and information on Informed Design are available through this resource.