Engineering Design and Development

Grade 12

Unit 1

Subject	Grade	Unit	Suggested Timeline
Engineering Design and Development	12	1 – Research / Problem Presentation and Solution Requirements	8 weeks

Grade Level Summary

Engineering Design and Development (EDD) is the capstone course in Project Lead The Way's (PLTW) high school engineering pathway. The course offers NHS seniors who are interested in design and engineering or other technical careers an opportunity to define and justify an engineering problem. After carefully defining the design requirements and creating multiple solution approaches, teams of students select an approach, create, and test their solution prototype. EDD requires students to apply the engineering design process, engage in professional communication and collaboration, develop technical documentation, and communicate their solution to peers and professionals. While progressing through the engineering design process, students will work closely with experts and will continually hone their organizational, communication and interpersonal skills, their creative and problem solving abilities, and their understanding of the design process. EDD is intended for seniors who have completed at least three other NHS engineering design courses during their high school career.

Grade Level Units

Unit 1 – Research / Problem Presentation and Solution Requirements
Unit 2 – Design Generating / Defending an Original Solution
Unit 3 – Prototype and Test Creating / Testing a Prototype
Unit 4 – Evaluate Project / Process Evaluation, Reflection, Recommendations
Unit 5 – Final Project Presentation and Documentation – Going Beyond EDD

Unit Title

Research / Problem Presentation and Solution Requirements

Unit Overview

In Unit 1, students will identify a problem for which they will design a solution during the remainder of the course. In the first lesson, students will write a clear problem statement and validate the problem by documenting credible sources that indicate that the problem exists. Validation is carried out through research and input from experts and mentors. Once their work is defined, students are asked to perform additional research in order to justify the problem by confirming that the expense and effort involved with solving the problem is warranted based on need and cost. Students will explore and analyze prior solution attempts. Based on their research, student will create a testable design requirement which will be used to explore possible solutions. The students will present a project proposal to ensure the project is justified and that all prior solution attempts have been explored.

Unit Essential Questions

1. What are the global challenges facing our world?
2. What are the roles and responsibilities of engineering in society?
3. What makes a problem one worth solving?
4. Why is it crucial to use a design process when trying to solve complex problems?
5. What are the fundamental aspects of any engineering design process?
6. What is the importance of beginning a design project with a well-defined problem statement?
7. How do design requirements help guide designers to the most effective solution?

Key Understandings

1. An accurately written problem statement identifies a need and guides the design process that will be used in engineering design problems.
2. An accurately written problem statement aids in determining whether the result of the engineering design and development process has solved the identified problem.
3. Experts are professionals that have specific knowledge in an area of interest and can guide the research needed for accurate justification and solutions to design problems.
4. Market research aids business and industry in making better decisions about the development and marketing of new products.

	5. Effective market research focuses on potential users and buyers to gauge whether a problem is worth the investment required for it to be solved. 6. Most innovations and inventions require time and capital that are not available to individuals, so it is necessary to communicate the need and available market to an entity that can provide the necessary resources. 7. Engineers utilize math and science principles, concepts, and laws to solve problems.

Focus Standards Addressed in the Unit	
3.4.10.C1	Apply the components of the technological design process.
3.4.12.C2	Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
CC.1.2.11-12.G	Integrate and evaluate multiple sources of information presented in different media or formats (e.g. visually, quantitatively) as well as in words in order to address a question or solve a problem.
CC.1.3.11-12.J	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
CC.1.4.11-12.A	Write informative/ explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately.
CC.1.4.11-12.B	Write with a sharp distinct focus identifying topic, task, and audience.
CC.1.4.11-12.F	Demonstrate a grade-appropriate command of the conventions of standard English grammar, usage, capitalization, punctuation, and spelling.
CC.1.4.11-12.U	Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments and information.
CC.1.4.11-12.V	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CC.1.4.11-12.X	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.
CC.1.5.11-12.A	Initiate and participate effectively in a range of collaborative discussions on grades level topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CC.1.5.11-12.C	Integrate multiple sources of information presented in diverse formats and media (e.g. visually, quantitative, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
CC.1.5.11-12.D	Present information, findings, and supporting evidence, conveying a clear and distinct perspective; organization, development, substance, and style are appropriate to purpose, audience, and task.
CC.1.5.11-12.E	Make strategic use of digital media in presentations to add interest and enhance understanding of findings, reasoning, and evidence.
CC.2.1.HS.F.3	Apply quantitative reasoning to choose and Interpret units and scales in formulas, graphs and data displays.
CC.2.2.HS.D.1	Interpret the structure of expressions to represent a quantity in terms of its context.
CC.2.2.HS.C.2	Graph and analyze functions and use their properties to make connections between the different representations.
CC.2.2.HS.C.6	Interpret functions in terms of the situation they model.

CC.2.4.HS.B.1	Summarize, represent, and interpret data on a single count or measurement variable.
CC.2.4.HS.B.2	Summarize, represent, and interpret data on two categorical and quantitative variables.
CC.2.4.HS.B.3	Analyze linear models to make interpretations based on the data.

Important Standards Addressed in the Unit	
3.4.10.B4	Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention.
CC.1.2.11-12.A	Determine and analyze the relationship between two or more central ideas of a text, including the development and interaction of the central ideas; provide an objective summary of the text.
CC.1.2.11-12.B	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences and conclusions based on and related to an author's implicit and explicit assumptions and beliefs.
CC.1.2.11-12.D	Evaluate how an author's point of view or purpose shapes the content and style of a text.
CC.1.2.11-12.F.	Evaluate how words and phrases shape meaning and tone in texts.
CC.1.3.11-12.I,	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 11-12 reading and content, choosing flexibly from a range of strategies and tools.
CC.1.4.11-12.G	Write arguments to support claims in an analysis of substantive topics.
CC.1.4.11-12.M	Write narratives to develop real or imagined experiences or events.
CC.1.4.11-12.T	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
CC.1.5.11-12.B	Evaluate how the speaker's perspective, reasoning, and use of evidence and rhetoric affect the credibility of an argument through the author's stance, premises, links among ideas, word choice, points of emphasis, and tone.
CC.2.2.HS.D.10	Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically.
CC.2.2.HS.C.1	Use the concept and notation of functions to interpret and apply them in terms of their context.
CC.2.2.HS.C.5	Construct and compare linear, quadratic and exponential models to solve problems.
CC.2.4.HS.B.4	Recognize and evaluate random processes underlying statistical experiments.
CC.2.4.HS.B.5	Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.
CC.2.4.HS.B.6	Use the concepts of independence and conditional probability to interpret data.
CC.2.4.HS.B.7	Apply the rules of probability to compute probabilities of compound events in a uniform probability model.

Misconceptions	**Proper Conceptions**
1. Any problem is worth solving.	1. A problem must be justified and validated before designing a solution. Factors including but not limited to market, existing solutions, and resources are important considerations.
2. Any solution to a problem is a valid solution.	2. There are many potential solutions to any problem and all of those solutions may be valid to a certain degree. A well-defined problem statement along with focused

	criteria and constraints establishing requirements for a successful solution will increase the potential for a solution that best solves the problem.
3. Students will discount the need to document their work because they feel that they know what they are doing.	3. Documenting your work is an important part of engineering so that you can: reference your work for error analysis and correction, allow others to follow and duplicate or modify your work, and provide a detailed historical reference of your solution process.
4. In a team setting, it's best to let the strongest member do most of the work to obtain the best possible solution.	4. An effective team consists of members that all have their own specific responsibilities. A team leader may plan and organize the team, but no single member should be allowed to unilaterally complete the team's final product. Not using the input of each member creates inefficiencies and ignores ideas that will likely inspire a better solution.

Concepts

- Problem Definition
- Research of Existing Solutions
- Establishing Solution Requirements

Competencies

- Write clear, complete, and concise problem statements
- Evaluate current and past products to inform the creation of a problem statement. Document research that validates and justifies the problem statement.
- Identify the target market for a potential solution to the identified problem and conduct market research to identify criteria and constraints that a successful solution must satisfy.

Vocabulary

Advertise
Aesthetic
American Psychological Association (APA)
Articulate
Association
Assumptions
Audience Analysis
Available Market
Bias
Bibliography
Bioengineering
Biotechnology
Boolean
Business Plan
Capital
Chemical Technology
Competition
Concise
Consumer
Copyright
Culture
Demographics
Descriptive Abstract
Design Proposal
Environmental Protection Agency (EPA)
Fact
Focus Group
Forecast
Innovation Portal
Inter Library Loan
Intermodalism
International Standard Book Number (ISBN)
Internet
Interview
Iterative Process
Journal
Justifiable
Justify

Vocabulary (cont'd)

Management	Process	Scope Creep
Manufacturing Process	Process Documentation	Self-Assessment
Market	Product	Service Life
Market Research	Product Development Lifecycle	Stakeholders
Market Share	Product Life	Statement of Work (SOW)
Marketing	Professionalism	Survey
Media	Project Life Cycle	Systems-Oriented Thinking
Media Center	Project Management	Target Market
Mediation	Project Portfolio	Tasks
Mentor	Pros and Cons	Time Line Chart
Methodologies	Recycle	Time Management
MLA Style Manual	Research	Trade Secret
Moral	Research and Development (R&D)	Trademark
Plan	Research Methodologies	Trend Analysis
Planning	Resource	Valid
Problem	Responsibilities	Validity
Problem Identification	Resume	Value Creation
Problem Solving	Science	Vitae
Problem Statement	Scope	Work

Assessments

Engineering Notebook Checks – Students will maintain a formal engineering notebook to document their work throughout the course. Periodic checks will assess proper notebook format and content.

Oral Presentations – Students will periodically present their progress to their teacher and peers.

Unit Tests / Unit Projects – Each unit may include a summative written test or project. Projects may be assessed through a presentation, engineering notebook review, electronic submission, or a combination of one or more of these.

Suggested Strategies to Support Design of Coherent Instruction

Charlotte Danielson's Framework for Teaching: Domain 3 Instruction

4.4.10.C1 Apply the components of the technological design process.

This concept of the engineering design process is the cornerstone of the course. Deliberately and intentionally discuss the process in the context of each problem, no matter how small so that students build a habit of using the process for **all** problems.

Creating a concise and specific problem statement is the primary goal of this unit. Model both good and bad problem statements as a part of regular instruction. Have students write, share, and comment on problem statements regularly to formatively assess their understanding of what makes good problem statements. A solid problem statement will build the foundation for a successful project.

Differentiation:

- Provide graphic organizers
- Provide multiple concrete examples
- Break extended projects into smaller identifiable milestones with checkpoints along the way
- Pair stronger students with struggling students for peer assistance

Interdisciplinary Connections:

- Design process – Scientific method
- Research process – English / Social Studies
- Writing skills – English
- Sketching - Art

Additional Resources:

- ***http://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf*** International Society for Technology in Education standards.
- ***https://www.asme.org/*** American Society of Mechanical Engineers – additional resources specific to the practice of mechanical engineering

- ***http://www.asce.org/*** American Society of Civil Engineers – additional resources specific to the practice of civil engineering
- ***http://www.ieee.org/*** Institute of Electrical and Electronics Engineers – additional resources specific to the practice of electrical engineering
- ***https://www.aiche.org/*** American Institute of Chemical Engineers – additional resources specific to the practice of chemical engineering
- ***http://www.uspto.gov/*** US Patent Office website

Created By:
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Engineering Design and Development

Grade 12

Unit 2

Subject	Grade	Unit	Suggested Timeline
Engineering Design and Development	12	2 – Design Generating / Defending an Original Solution	5 weeks

Grade Level Summary

Engineering Design and Development (EDD) is the capstone course in Project Lead The Way's (PLTW) high school engineering pathway. The course offers NHS seniors who are interested in design and engineering or other technical careers an opportunity to define and justify an engineering problem. After carefully defining the design requirements and creating multiple solution approaches, teams of students select an approach, create, and test their solution prototype. EDD requires students to apply the engineering design process, engage in professional communication and collaboration, develop technical documentation, and communicate their solution to peers and professionals. While progressing through the engineering design process, students will work closely with experts and will continually hone their organizational, communication and interpersonal skills, their creative and problem solving abilities, and their understanding of the design process. EDD is intended for seniors who have completed at least three other NHS engineering design courses during their high school career.

Grade Level Units

Unit 1 – Research / Problem Presentation and Solution Requirements
Unit 2 – Design Generating / Defending an Original Solution
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Unit 5 – Final Project Presentation and Documentation – Going Beyond EDD

Unit Title

Design Generating / Defending an Original Solution

Unit Overview

Based on the design requirement identified through research in the previous unit, in Unit 2 students develop multiple solution possibilities. Through an evaluation process that involves feedback from experts and stakeholders, and the application of a decision matrix or other comparable data-driven process, students will select the best potential solution to pursue. Students will refine the final selected solution path and provide evidence that the solution selected is viable.

Unit Essential Questions

1. What role does the market place play in engineering design?
2. What are the attributes of successful project planning and management?
3. Why should I do independent research before contacting stakeholders or seeking expert support?
4. Why is intellectual property so important in engineering design?
5. What is the difference between invention and innovation?

Key Understandings

1. Specifications for a design solution provide clear parameters for a successful design solution.
2. Engineers use a decision matrix to compare preliminary design solutions by assessing each alternate design based on the design requirements specified.
3. A design should be continually checked and critiqued by experts and stakeholders in order to guide the design process and ensure a successful solution.
4. The use of optimization improves the final design solution by aligning the solution with the specifications imposed.
5. Multiple factors affect the commercial success of a consumer product.
6. Drawings and sketches are used to organize, record, and communicate ideas.
7. Engineers use working drawings to show all of the information needed to make a part, subassembly, or a complete design solution.

	8. Engineers use a peer review process to review and evaluate design solutions to provide feedback and implement necessary revisions. 9. Engineers and designers have ethical responsibilities to clients, peers, their profession, and the general public. 10. Product development will result in consequences, both good and bad, that must be considered when deciding whether or not to develop a product. 11. A business plan formalizes the goals of a company and provides a plan for reaching those goals that can be used to both guide the company's policies and strategies and to solicit outside support and financing.

Focus Standards Addressed in the Unit	
3.4.10.C1	Apply the components of the technological design process.
3.4.12.C2	Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
CC.1.2.11-12.G	Integrate and evaluate multiple sources of information presented in different media or formats (e.g. visually, quantitatively) as well as in words in order to address a question or solve a problem.
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CC.1.5.11-12.C	Integrate multiple sources of information presented in diverse formats and media (e.g. visually, quantitative, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
CC.1.5.11-12.D	Present information, findings, and supporting evidence, conveying a clear and distinct perspective; organization, development, substance, and style are appropriate to purpose, audience, and task.
CC.1.5.11-12.E	Make strategic use of digital media in presentations to add interest and enhance understanding of findings, reasoning, and evidence.
CC.2.1.HS.F.3	Apply quantitative reasoning to choose and Interpret units and scales in formulas, graphs and data displays.
CC.2.2.HS.C.2	Graph and analyze functions and use their properties to make connections between the different representations.

CC.2.2.HS.C.3	Write functions or sequences that model relationships between two quantities.
CC.2.2.HS.C.6	Interpret functions in terms of the situation they model.
CC.2.2.HS.D.1	Interpret the structure of expressions to represent a quantity in terms of its context.
CC.2.2.HS.D.2	Write expressions in equivalent forms to solve problems.
CC.2.2.HS.D.7	Create and graph equations or inequalities to describe numbers or relationships.
CC.2.3.HS.A.13	Analyze relationships between two-dimensional and three-dimensional objects.
CC.2.3.HS.A.14	Apply geometric concepts to model and solve real world problems.
CC.2.4.HS.B.3	Analyze linear models to make interpretations based on the data.

Important Standards Addressed in the Unit	
CC.1.2.11-12.A	Determine and analyze the relationship between two or more central ideas of a text, including the development and interaction of the central ideas; provide an objective summary of the text.
CC.1.2.11-12.B	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences and conclusions based on and related to an author's implicit and explicit assumptions and beliefs.
CC.1.2.11-12.D	Evaluate how an author's point of view or purpose shapes the content and style of a text.
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CC.1.4.11-12.M	Write narratives to develop real or imagined experiences or events.
CC.1.4.11-12.T	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
CC.1.5.11-12.B	Evaluate how the speaker's perspective, reasoning, and use of evidence and rhetoric affect the credibility of an argument through the author's stance, premises, links among ideas, word choice, points of emphasis, and tone.
CC.2.2.HS.C.1	Use the concept and notation of functions to interpret and apply them in terms of their context.
CC.2.2.HS.C.5	Construct and compare linear, quadratic and exponential models to solve problems.
CC.2.2.HS.C.6	Interpret functions in terms of the situation they model.
CC.2.2.HS.D.3	Extend the knowledge of arithmetic operations and apply to polynomials.
CC.2.2.HS.D.8	Apply inverse operations to solve equations or formulas for a given variable.
CC.2.2.HS.D.9	Use reasoning to solve equations and justify the solution method.
CC.2.2.HS.D.10	Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically.

CC.2.3.HS.A.1	Use geometric figures and their properties to represent transformations in the plane.
CC.2.3.HS.A.4	Apply the concept of congruence to create geometric constructions.

Misconceptions	**Proper Conceptions**
1. Any solution to a problem is a valid solution.	1. There are many potential solutions to any problem and all of those solutions may be valid to a certain degree. A large pool of possible solutions will enhance the chances of finding the best solution. A data driven selection process helps eliminate emotion when choosing a potential solution to develop into a final solution.
2. Students will discount the need to document their work because they feel that they know what they are doing.	2. Thorough documentation is critical at every stage of the design process. As teams decide which potential solution they will develop, "discarded" solutions should be documented as such for future reference.
3. Engineering is nothing but constantly using math and science.	3. Engineering is a profession focused on solving problems using research, creativity, communication, and innovation in addition to the application of concepts from math and science.
4. All new products are inventions.	4. Few new solutions are truly inventions. More often, designers utilize existing solutions as inspiration or the basis for new solutions through innovation.

Concepts

- Generation, Analysis, and Selection of Design Concept
- Application of STEM Principles and Practices
- Consideration of Design Viability

Competencies

- Generate and document multiple potential solutions, develop decision matrices to compare and rank potential solutions
- Create a set of working drawings to document proposed design and communicate professionally with experts and mentors to obtain feedback. Participate in peer reviews of conceptual solutions.
- Perform competitive product analyses, cost estimates, and a consideration of design consequences for proposed design to justify further development.

Vocabulary

Advertise
Aesthetic
Alternatives
American National Standards Institute (ANSI)
American Psychological Association (APA)
American Society of Mechanical Engineers (ASME)
American Standard Testing Methods (ASTM)
Analysis
Articulate
Artifact
Assembly
Assumptions
Brainstorming
Closed-Loop Recycling
Concept
Conceptual
Constraint
Convention
Cost Effective
Cost-benefit Analysis
Criteria
Decision Matrix
Design Brief
Design Principle
Design Process
Design Statement
Designer
Detailed Sketches

Vocabulary (cont'd)

Develop	Matrix	Precision
Downcycling	Mean	Reliability
Ecological Design	Measure	Renewable
Efficient	Measurement	Requirements
Emphasis	Meter	Reverse Engineering
Energy	Metric System	Schematic
Engineering Design	Multiview Projection	Sketch
Ergonomics	Natural Material	Specification
Evolution	Nomenclature	Standardization
Form	Non-biodegradable	State of the Art
Form, Fit, and Function	Non-durable Goods	Sustainable
Freehand	Nonrenewable Resource	Sustainable Design
Graphic Design	Obsolescence	Technical Drawing
Hypothesis	Orthographic Projection	Technical Working Drawing
Illustrate	Perspective Drawing	Virtual
Innovation Portal	Precise	Working Sketches
Mathematics		

Assessments

Engineering Notebook Checks – Students will maintain a formal engineering notebook to document their work throughout the course. Periodic checks will assess proper notebook format and content.

Oral Presentations – Students will periodically present their progress to their teacher and peers.

Unit Tests / Unit Projects – Each unit may include a summative written test or project. Projects may be assessed through a presentation, engineering notebook review, electronic submission, or a combination of one or more of these.

Suggested Strategies to Support Design of Coherent Instruction

Charlotte Danielson's Framework for Teaching: Domain 3 Instruction

The primary goals of Unit 2 are:

1. Generate multiple potential solutions to the problem defined in the previous unit
2. Choose a potential solution that will be developed as a final solution to the problem defined in the previous unit.

Students have completed these tasks in prior NHS design courses but this will be the first time that they are completing them for a self-generated problem. Provide students with example decision matrix criteria for generic concepts to model the types of evaluations that they should be making when evaluating their conceptual solutions and which one will become the solution they develop. Specific criteria for each problem may benefit from the input of outside experts.

Differentiation:

- Provide graphic organizers
- Provide multiple concrete examples
- Break extended projects into smaller identifiable milestones with checkpoints along the way
- Pair stronger students with struggling students for peer assistance

Interdisciplinary Connections:

- Design process – Scientific method
- Research process – English / Social Studies
- Writing skills – English
- Sketching - Art

Additional Resources:

- ***http://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf*** International Society for Technology in Education standards.
- ***https://www.asme.org/*** American Society of Mechanical Engineers – additional resources specific to the practice of mechanical engineering

- ***http://www.asce.org/*** American Society of Civil Engineers – additional resources specific to the practice of civil engineering
- ***http://www.ieee.org/*** Institute of Electrical and Electronics Engineers – additional resources specific to the practice of electrical engineering
- ***https://www.aiche.org/*** American Institute of Chemical Engineers – additional resources specific to the practice of chemical engineering
- ***http://www.uspto.gov/*** US Patent Office website

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Engineering Design and Development

Grade 12

Unit 3

Subject	Grade	Unit	Suggested Timeline
Engineering Design and Development	12	3 – Prototype and Test Creating / Testing a Prototype	12 weeks

Grade Level Summary

Engineering Design and Development (EDD) is the capstone course in Project Lead The Way's (PLTW) high school engineering pathway. The course offers NHS seniors who are interested in design and engineering or other technical careers an opportunity to define and justify an engineering problem. After carefully defining the design requirements and creating multiple solution approaches, teams of students select an approach, create, and test their solution prototype. EDD requires students to apply the engineering design process, engage in professional communication and collaboration, develop technical documentation, and communicate their solution to peers and professionals. While progressing through the engineering design process, students will work closely with experts and will continually hone their organizational, communication and interpersonal skills, their creative and problem solving abilities, and their understanding of the design process. EDD is intended for seniors who have completed at least three other NHS engineering design courses during their high school career.

Grade Level Units

Unit 1 – Research / Problem Presentation and Solution Requirements
Unit 2 – Design Generating / Defending an Original Solution
Unit 3 – Prototype and Test Creating / Testing a Prototype
Unit 4 – Evaluate Project / Process Evaluation, Reflection, Recommendations
Unit 5 – Final Project Presentation and Documentation – Going Beyond EDD

Unit Title

Prototype and Test Creating / Testing a Prototype

Unit Overview

In Unit 3, students will create a testable prototype and an unbiased testing plan based on the defined design requirements to determine the effectiveness of the solution created. Throughout the prototype creation and testing process, students will find ways to perform incremental progress tests to verify that their solution is on track. Virtual designs will be created with 3D modeling software to investigate physical aspects of the prototype build before expending resources and materials. Teams will create project schedules and hold progress meetings to manage their projects. The entire process will be documented, revised, and adjusted as necessary to enhance the potential for a successful solution.

Unit Essential Questions

1. Why are test criteria important when designing evaluation tests?
2. What determines the next step in a design process?
3. What justifies expenditure of resources to try and solve a problem?
4. Why is it important for engineers and designers to utilize known scientific and mathematical principles?

Key Understandings

1. Material and equipment requirements are defined by creating a materials and cost analysis during the prototyping phase of a project.
2. Virtual solutions for designs allow engineers to plan, test, and prepare for building a prototype.
3. Designers must consider characteristics such as strength and weight of materials and fastening procedures to be sure that the final design meets design specifications.
4. Prototypes can generally be broken down into subsystems in order to isolate problems and conduct incremental testing.
5. Engineers write step-by-step instructions for the prototype assembly to guide the fabrication of the design solution.
6. Prototyping provides the engineer with a scaled working model of the design solution.
7. The construction of a physical model can enhance the quality, efficiency, and productivity of the final product.

	8. In order to gather useful data, specific criteria for success or failure of a test must be determined before testing commences. 9. Prototype testing is a controlled procedure that is used to evaluate a specific aspect of a design solution. 10. A detailed description of the testing procedure helps to ensure that the results of the testing of the design solution are valid. 11. Data can be classified as either quantitative because it can be measured or qualitative because it describes a quality or categorization.

Focus Standards Addressed in the Unit	
3.4.10.C1	Apply the components of the technological design process.
CC.1.2.11-12.G	Integrate and evaluate multiple sources of information presented in different media or formats (e.g. visually, quantitatively) as well as in words in order to address a question or solve a problem.
CC.1.3.11-12.J	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
CC.1.4.11-12.A	Write informative/ explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately.
CC.1.4.11-12.B	Write with a sharp distinct focus identifying topic, task, and audience.
CC.1.4.11-12.F	Demonstrate a grade-appropriate command of the conventions of standard English grammar, usage, capitalization, punctuation, and spelling.
CC.1.4.11-12.R	Demonstrate a grade appropriate command of the conventions of standard English grammar and spelling.
CC.1.4.11-12.U	Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments and information.
CC.1.4.11-12.V	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CC.1.4.11-12.W	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
CC.1.4.11-12.X	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.
CC.1.5.11-12.A	Initiate and participate effectively in a range of collaborative discussions on grades level topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CC.1.5.11-12.C	Integrate multiple sources of information presented in diverse formats and media (e.g. visually, quantitative, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
CC.1.5.11-12.D	Present information, findings, and supporting evidence, conveying a clear and distinct perspective; organization, development, substance, and style are appropriate to purpose, audience, and task.
CC.1.5.11-12.E	Make strategic use of digital media in presentations to add interest and enhance understanding of findings, reasoning, and evidence.

CC.2.1.HS.F.3	Apply quantitative reasoning to choose and Interpret units and scales in formulas, graphs and data displays.
CC.2.2.HS.C.2	Graph and analyze functions and use their properties to make connections between the different representations.
CC.2.2.HS.C.3	Write functions or sequences that model relationships between two quantities.
CC.2.2.HS.D.1	Interpret the structure of expressions to represent a quantity in terms of its context.
CC.2.2.HS.D.2	Write expressions in equivalent forms to solve problems.
CC.2.2.HS.D.7	Create and graph equations or inequalities to describe numbers or relationships.
CC.2.3.HS.A.13	Analyze relationships between two-dimensional and three-dimensional objects.
CC.2.3.HS.A.14	Apply geometric concepts to model and solve real world problems.
CC.2.4.HS.B.1	Summarize, represent, and interpret data on a single count or measurement variable.
CC.2.4.HS.B.2	Summarize, represent, and interpret data on two categorical and quantitative variables.
CC.2.4.HS.B.3	Analyze linear models to make interpretations based on the data.

Important Standards Addressed in the Unit	
CC.1.2.11-12.F.	Evaluate how words and phrases shape meaning and tone in texts.
CC.1.3.11-12.I,	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 11-12 reading and content, choosing flexibly from a range of strategies and tools.
CC.1.4.11-12.G	Write arguments to support claims in an analysis of substantive topics.
CC.1.4.11-12.M	Write narratives to develop real or imagined experiences or events.
CC.1.4.11-12.P	Create a smooth progression of experiences or events using a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome; provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.
CC.1.4.11-12.R	Demonstrate a grade appropriate command of the conventions of standard English grammar and spelling.
CC.1.4.11-12.T	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
CC.1.5.11-12.B	Evaluate how the speaker's perspective, reasoning, and use of evidence and rhetoric affect the credibility of an argument through the author's stance, premises, links among ideas, word choice, points of emphasis, and tone.
CC.2.2.HS.C.1	Use the concept and notation of functions to interpret and apply them in terms of their context.
CC.2.2.HS.C.5	Construct and compare linear, quadratic and exponential models to solve problems.
CC.2.2.HS.D.8	Apply inverse operations to solve equations or formulas for a given variable.
CC.2.2.HS.D.9	Use reasoning to solve equations and justify the solution method.
CC.2.2.HS.D.10	Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically.

CC.2.3.HS.A.1	Use geometric figures and their properties to represent transformations in the plane.
CC.2.3.HS.A.4	Apply the concept of congruence to create geometric constructions.
CC.2.4.HS.B.4	Recognize and evaluate random processes underlying statistical experiments.
CC.2.4.HS.B.5	Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.
CC.2.4.HS.B.6	Use the concepts of independence and conditional probability to interpret data.
CC.2.4.HS.B.7	Apply the rules of probability to compute probabilities of compound events in a uniform probability model.

Misconceptions	**Proper Conceptions**
1. As long as it works, my prototype is a valid solution.	1. Function is only one aspect of design. Visual principles and elements of design, physical handling, cost, and other product specific considerations must also be made when evaluating the level of success for a prototype.
2. I know what I want in a solution, that is all that matters.	2. Students must discount their own preconceptions of what a valid solution must be. Input from all stakeholders including designers, potential customers, and outside experts must be considered if the best potential solution is to be developed.
3. At this point in the design process it is too late to modify our chosen solution path.	3. It is not only acceptable but it is expected that going backwards in the engineering design process will be part of the process. If at any point an adjustment or re-evaluation is required, this should be done to make sure that the potential for designing the best possible solution is increased.

Concepts

- Construction of a Testable Prototype
- Prototype Testing and Data Collection Plan
- Testing, Data Collection, and Analysis

Competencies

- Evaluate prototype materials and fastening methods, create a virtual prototype design, identify prototype subsystems, and create a step-by-step plan for building a prototype.
- Create a list of testing criteria, select a valid testing method, and justify the testing method that will be used to evaluate the success or failure of the prototype.
- Conduct testing based on the established method and criteria, document the testing process and results, and make modifications based on the testing results.

Vocabulary

Accuracy
Accurate
American National Standards Institute (ANSI)
American Standard Testing Methods (ASTM)
Analysis
Assembly
Calibrate
Change Order
Communication System
Construction
Control
Control Group
Correlate
Critical Design Review
Custom Production
Data
Data Element
Data Set
Dependent Variable
Engineering Change Order
Experimentation
Extrapolate
Fabricate
Feedback

Vocabulary (cont'd)

Finite Element Analysis (FEA)
Fit
Fluid Power
Formula
Frequency
Function
Functioning Prototype
Hand Tool
Histogram
Hydraulics
Hydroponics
Incremental Testing
Independent Variable
Innovation Portal
Input
Interpolate
Kinetic Energy
Margin of Error
Material
Material Cost Analysis
Mechanism
Median
Mock-up
Mode
Model
Normal Distribution
Occupation Safety and Health Administration (OSHA)
Optimization
Output
Parameter
Parts List
Pneumatics
Potential Energy
Power
Power System
Power Tool
Presentation Prototype
Produce
Protocol
Prototype
Qualitative
Qualitative Data
Quality
Quality Control
Quantitative
Quantitative Data
Range
Ratio
Refinement
Repeatability
Safety
Sample
Scale
Scale Model
Scientific Approach
Scientific Inquiry
Scientific Method
Simple Machine
Skill
Statistical Analyses
Statistics
Structure
Subsystem
System
Test
Test
Test Criteria
Test Procedure
Test Reliability
Test Validity
Theory
Tool
Trial and Error
Troubleshoot
Working Drawings

Assessments

Engineering Notebook Checks – Students will maintain a formal engineering notebook to document their work throughout the course. Periodic checks will assess proper notebook format and content.

Oral Presentations – Students will periodically present their progress to their teacher and peers.

Unit Tests / Unit Projects – Each unit may include a summative written test or project. Projects may be assessed through a presentation, engineering notebook review, electronic submission, or a combination of one or more of these.

Suggested Strategies to Support Design of Coherent Instruction

Charlotte Danielson's Framework for Teaching: Domain 3 Instruction

At this step in the design process, students will have the greatest natural tendency to plow ahead with at least some degree of disregard for the problem and design statements that act as the foundation for the design of a successful solution. Quick, frequent opportunities for students to consider the foundational steps in the design process – whether as a class or in small groups – will help ground them so that they do not forget what defines success and failure for their design.

Differentiation:

- Provide graphic organizers
- Provide multiple concrete examples
- Break extended projects into smaller identifiable milestones with checkpoints along the way
- Pair stronger students with struggling students for peer assistance

Interdisciplinary Connections:

- Design process – Scientific method
- Research process – English / Social Studies
- Writing skills – English
- Sketching - Art

Additional Resources:

- ***http://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf*** International Society for Technology in Education standards.
- ***https://www.asme.org/*** American Society of Mechanical Engineers – additional resources specific to the practice of mechanical engineering
- ***http://www.asce.org/*** American Society of Civil Engineers – additional resources specific to the practice of civil engineering
- ***http://www.ieee.org/*** Institute of Electrical and Electronics Engineers – additional resources specific to the practice of electrical engineering
- ***https://www.aiche.org/*** American Institute of Chemical Engineers – additional resources specific to the practice of chemical engineering
- ***http://www.uspto.gov/*** US Patent Office website

Created By:
Rick Geesaman

Engineering Design and Development

Grade 12

Unit 4

Subject	Grade	Unit	Suggested Timeline
Engineering Design and Development	12	4 – Evaluate Project / Process Evaluation, Reflection, Recommendations	6 weeks

Grade Level Summary

Engineering Design and Development (EDD) is the capstone course in Project Lead The Way's (PLTW) high school engineering pathway. The course offers NHS seniors who are interested in design and engineering or other technical careers an opportunity to define and justify an engineering problem. After carefully defining the design requirements and creating multiple solution approaches, teams of students select an approach, create, and test their solution prototype. EDD requires students to apply the engineering design process, engage in professional communication and collaboration, develop technical documentation, and communicate their solution to peers and professionals. While progressing through the engineering design process, students will work closely with experts and will continually hone their organizational, communication and interpersonal skills, their creative and problem solving abilities, and their understanding of the design process. EDD is intended for seniors who have completed at least three other NHS engineering design courses during their high school career.

Grade Level Units

Unit 1 – Research / Problem Presentation and Solution Requirements
Unit 2 – Design Generating / Defending an Original Solution
Unit 3 – Prototype and Test Creating / Testing a Prototype
Unit 4 – Evaluate Project / Process Evaluation, Reflection, Recommendations
Unit 5 – Final Project Presentation and Documentation – Going Beyond EDD

Unit Title

Evaluate Project / Process Evaluation, Reflection, Recommendations

Unit Overview

At this point in the design process, it is critical to seek and document feedback from all stakeholders. The designers should reflect on all design decisions and the analysis that was generated from the testing process. Although their testing criteria should have included elements that consider all stakeholders, upon completion of their prototype teams will have one more opportunity to step back and evaluate their entire design process to this point. Finally, the designers can begin to formulate next steps including the potential to revisit any previous steps in the design process if needed. There is a distinct possibility that students may not have completed a valid solution to their chosen problem at this point. Reflecting back on what may be considered a "failed project" can often be more valuable than having found success when it comes to future design efforts.

Unit Essential Questions

1. Why is teaming often more effective than individuals working alone when solving a complex problem?
2. Do I need to create a solution that solves the problem to successfully complete this course?

Key Understandings

1. The results of prototype testing are used to refine the design and to improve the design solution.
2. Design reviews are used at crucial stages of the design process to gather input and perspective in order to determine how to proceed with a design.

Focus Standards Addressed in the Unit

3.4.10.C1	Apply the components of the technological design process.
3.4.12.C2	Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
CC.1.2.11-12.G	Integrate and evaluate multiple sources of information presented in different media or formats (e.g. visually, quantitatively) as well as in words in order to address a question or solve a problem.
CC.1.3.11-12.J	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate

	independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
CC.1.4.11-12.A	Write informative/ explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately.
CC.1.4.11-12.B	Write with a sharp distinct focus identifying topic, task, and audience.
CC.1.4.11-12.F	Demonstrate a grade-appropriate command of the conventions of standard English grammar, usage, capitalization, punctuation, and spelling.
CC.1.4.11-12.R	Demonstrate a grade appropriate command of the conventions of standard English grammar and spelling.
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CC.1.4.11-12.V	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CC.1.4.11-12.X	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.
CC.1.5.11-12.A	Initiate and participate effectively in a range of collaborative discussions on grades level topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CC.1.5.11-12.C	Integrate multiple sources of information presented in diverse formats and media (e.g. visually, quantitative, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
CC.1.5.11-12.D	Present information, findings, and supporting evidence, conveying a clear and distinct perspective; organization, development, substance, and style are appropriate to purpose, audience, and task.
CC.1.5.11-12.E	Make strategic use of digital media in presentations to add interest and enhance understanding of findings, reasoning, and evidence.
CC.2.1.HS.F.3	Apply quantitative reasoning to choose and Interpret units and scales in formulas, graphs and data displays.
CC.2.4.HS.B.1	Summarize, represent, and interpret data on a single count or measurement variable.
CC.2.4.HS.B.2	Summarize, represent, and interpret data on two categorical and quantitative variables.
CC.2.4.HS.B.3	Analyze linear models to make interpretations based on the data.

Important Standards Addressed in the Unit	
3.4.10.B4	Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention.
CC.1.2.11-12.A	Determine and analyze the relationship between two or more central ideas of a text, including the development and interaction of the central ideas; provide an objective summary of the text.
CC.1.2.11-12.B	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences and conclusions based on and related to an author's implicit and explicit assumptions and beliefs.
CC.1.2.11-12.D	Evaluate how an author's point of view or purpose shapes the content and style of a text.
CC.1.2.11-12.F.	Evaluate how words and phrases shape meaning and tone in texts.
CC.1.3.11-12.I,	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 11-12 reading and content, choosing flexibly from a range of strategies and tools.

CC.1.4.11-12.G	Write arguments to support claims in an analysis of substantive topics.
CC.1.4.11-12.M	Write narratives to develop real or imagined experiences or events.
CC.1.4.11-12.T	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
CC.1.5.11-12.B	Evaluate how the speaker's perspective, reasoning, and use of evidence and rhetoric affect the credibility of an argument through the author's stance, premises, links among ideas, word choice, points of emphasis, and tone.
CC.2.4.HS.B.4	Recognize and evaluate random processes underlying statistical experiments.
CC.2.4.HS.B.5	Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.
CC.2.4.HS.B.6	Use the concepts of independence and conditional probability to interpret data.
CC.2.4.HS.B.7	Apply the rules of probability to compute probabilities of compound events in a uniform probability model.

Misconceptions

1. A working prototype means there is no need to reflect upon the process.
2. We have already considered outside input earlier in the process so there is no need to seek additional input.

Proper Conceptions

1. Until a product has gone to final production, there are many opportunities to review the design process that has occurred and make refinements and adjustments. If the schedule allows it, this is the ideal time to look at the big picture which may have been neglected when building and testing the prototype.
2. After being embedded in the design of a product for an extended period of time, there is always a risk of losing objectivity. An external stakeholder with some distance from the project can add the needed objectivity at this stage in the design process.

Concepts

- Documentation of External Evaluation
- Reflection of the Design Project
- Presentation of the Designer's Recommendations

Competencies

- External feedback is documented, evaluated, and incorporated as appropriate
- Design and participate in a critical design review to evaluate the prototype and formulate a plan to advance the process.
- Identify, define, and implement any necessary modifications based on test results

Vocabulary

Accountability
American Society of Mechanical Engineers (ASME)
Assessment
Benchmark
By-product
Conclusion
Consequence
Critique
Evaluate
Evaluation
Executive Summary
Expository
Feasible
Functioning Prototype
General Notes
Impact
Innovation Portal
Inquiry Methods
International Organization for Standardization (ISO)
Technical Research Paper
Technical Writing
Trade-off

		Value Verify

Assessments

Engineering Notebook Checks – Students will maintain a formal engineering notebook to document their work throughout the course. Periodic checks will assess proper notebook format and content.

Oral Presentations – Students will periodically present their progress to their teacher and peers.

Unit Tests / Unit Projects – Each unit may include a summative written test or project. Projects may be assessed through a presentation, engineering notebook review, electronic submission, or a combination of one or more of these.

Suggested Strategies to Support Design of Coherent Instruction

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Differentiation:

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- Provide multiple concrete examples
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Interdisciplinary Connections:

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- Sketching - Art

Additional Resources:

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- ***https://www.asme.org/*** American Society of Mechanical Engineers – additional resources specific to the practice of mechanical engineering
- ***http://www.asce.org/*** American Society of Civil Engineers – additional resources specific to the practice of civil engineering
- ***http://www.ieee.org/*** Institute of Electrical and Electronics Engineers – additional resources specific to the practice of electrical engineering
- ***https://www.aiche.org/*** American Institute of Chemical Engineers – additional resources specific to the practice of chemical engineering
- ***http://www.uspto.gov/*** US Patent Office website

Created By:

Rick Geesaman

Engineering Design and Development
Grade 12
Unit 5

Subject	Grade	Unit	Suggested Timeline
Engineering Design and Development	12	5 – Final Project Presentation and Documentation – Going Beyond EDD	4 weeks

Grade Level Summary

Engineering Design and Development (EDD) is the capstone course in Project Lead The Way's (PLTW) high school engineering pathway. The course offers NHS seniors who are interested in design and engineering or other technical careers an opportunity to define and justify an engineering problem. After carefully defining the design requirements and creating multiple solution approaches, teams of students select an approach, create, and test their solution prototype. EDD requires students to apply the engineering design process, engage in professional communication and collaboration, develop technical documentation, and communicate their solution to peers and professionals. While progressing through the engineering design process, students will work closely with experts and will continually hone their organizational, communication and interpersonal skills, their creative and problem solving abilities, and their understanding of the design process. EDD is intended for seniors who have completed at least three other NHS engineering design courses during their high school career.

Grade Level Units

Unit 1 – Research / Problem Presentation and Solution Requirements
Unit 2 – Design Generating / Defending an Original Solution
Unit 3 – Prototype and Test Creating / Testing a Prototype
Unit 4 – Evaluate Project / Process Evaluation, Reflection, Recommendations
Unit 5 – Final Project Presentation and Documentation – Going Beyond EDD

Unit Title

Final Project Presentation and Documentation – Going Beyond EDD

Unit Overview

At the conclusion of the design process, students will be asked to present and defend the process and their decisions. A formal presentation will be prepared and delivered to a jury of professionals who will offer feedback and advice. For students who successfully complete a design that may be of value beyond the classroom, guidance will be provided to investigate what resources are available for the next steps.

Unit Essential Questions

1. How do you decide what key points are most important when given limited time to present findings?
2. If your process results in the design of an authentic solution, what step could be taken with that solution beyond this course?
3. Why is the thorough documentation of the design process important?

Key Understandings

1. The use of presentation software allows designers to present visual aids and project information in a professional manner.
2. The media format used for a presentation is chosen in order to effectively communicate the design solution process to a target audience.
3. Presentations and displays of work provide the means to effectively promote and justify the implementation of a project.
4. A well-done presentation can enhance the perception of the quality of work completed for a team project.

Focus Standards Addressed in the Unit

3.4.10.C1	Apply the components of the technological design process.
CC.1.2.11-12.G	Integrate and evaluate multiple sources of information presented in different media or formats (e.g. visually, quantitatively) as well as in words in order to address a question or solve a problem.

CC.1.3.11-12.J	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
CC.1.4.11-12.A	Write informative/ explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately.
CC.1.4.11-12.B	Write with a sharp distinct focus identifying topic, task, and audience.
CC.1.4.11-12.F	Demonstrate a grade-appropriate command of the conventions of standard English grammar, usage, capitalization, punctuation, and spelling.
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CC.1.4.11-12.X	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.
CC.1.5.11-12.A	Initiate and participate effectively in a range of collaborative discussions on grades level topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CC.1.5.11-12.C	Integrate multiple sources of information presented in diverse formats and media (e.g. visually, quantitative, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
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CC.1.5.11-12.E	Make strategic use of digital media in presentations to add interest and enhance understanding of findings, reasoning, and evidence.
CC.2.1.HS.F.3	Apply quantitative reasoning to choose and Interpret units and scales in formulas, graphs and data displays.
CC.2.2.HS.C.2	Graph and analyze functions and use their properties to make connections between the different representations.
CC.2.4.HS.B.1	Summarize, represent, and interpret data on a single count or measurement variable.
CC.2.4.HS.B.2	Summarize, represent, and interpret data on two categorical and quantitative variables.
CC.2.4.HS.B.3	Analyze linear models to make interpretations based on the data.

Important Standards Addressed in the Unit	
3.4.10.B4	Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention.
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CC.1.4.11-12.T	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
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CC.2.4.HS.B.4	Recognize and evaluate random processes underlying statistical experiments.
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CC.2.4.HS.B.6	Use the concepts of independence and conditional probability to interpret data.
CC.2.4.HS.B.7	Apply the rules of probability to compute probabilities of compound events in a uniform probability model.

Misconceptions

1. Without a working solution to our chosen problem, there is no value to preparing a presentation.

Proper Conceptions

1. This course is about following an engineering design process to solve a problem. While each group's goal should be to solve their problem with a valid working solution, this is an educational experience and a great deal can be learned by and shared from even a "failed" design.

Concepts

- Presentation of the Project and Project Portfolio
- Writing Like an Engineer

Competencies

- Gather data and information compiled throughout the project and create a project portfolio and presentation of the design solution
- Create a formal summary of the project to complete project documentation

Vocabulary

Audience
Body Language
Brevity
Chain of Events Pattern
Chronological Pattern
Clarity
Deliverables
Displays of Work
Documentation
Engineering Design Process
    Portfolio Scoring Rubric
Engineering Notebook
Entrepreneur
Innovation Portal
Intellectual Property
Intonation
Juried Presentation
Jury
Licensing
Milestones
Outcome Documentation
Peer Review
Persuasion
Persuasive
Portfolio
Provisional Patent

		Risk Royalties Solution Stakeholders Technical Research Paper Technical Writing Three-Panel Kiosk Display Tradeshow Verify

Assessments

Engineering Notebook Checks – Students will maintain a formal engineering notebook to document their work throughout the course. Periodic checks will assess proper notebook format and content.

Oral Presentations – Students will periodically present their progress to their teacher and peers.

Unit Tests / Unit Projects – Each unit may include a summative written test or project. Projects may be assessed through a presentation, engineering notebook review, electronic submission, or a combination of one or more of these.

Suggested Strategies to Support Design of Coherent Instruction

Charlotte Danielson's Framework for Teaching: Domain 3 Instruction

This is the chance for the students to shine and show off the work they have done for the entire year. Provide a general outline of information that students should include in their presentations and portfolios but the exact content and structure of the presentation is for the students to decide.

Differentiation:

- Provide graphic organizers
- Provide multiple concrete examples
- Break extended projects into smaller identifiable milestones with checkpoints along the way
- Pair stronger students with struggling students for peer assistance

Interdisciplinary Connections:

- Design process – Scientific method
- Research process – English / Social Studies
- Writing skills – English
- Sketching - Art

Additional Resources:

- ***http://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf*** International Society for Technology in Education standards.
- ***https://www.asme.org/*** American Society of Mechanical Engineers – additional resources specific to the practice of mechanical engineering
- ***http://www.asce.org/*** American Society of Civil Engineers – additional resources specific to the practice of civil engineering
- ***http://www.ieee.org/*** Institute of Electrical and Electronics Engineers – additional resources specific to the practice of electrical engineering
- ***https://www.aiche.org/*** American Institute of Chemical Engineers – additional resources specific to the practice of chemical engineering
- ***http://www.uspto.gov/*** US Patent Office website

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