High School PLTW Introduction to Engineering Design Curriculum

Course Description: Students use a problem-solving model to improve existing products and invent new ones, and they apply this model to solve problems in and out of the classroom. Using sophisticated three-dimensional modeling software, students communicate the details of products. Emphasis is placed on analyzing potential solutions and communicating ideas to others. © 2014 Project Lead The Way

Scope and Sequence:

<table>
<thead>
<tr>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Process</td>
</tr>
<tr>
<td>Technical Sketching and Drawing</td>
</tr>
<tr>
<td>Measurement and Statistics</td>
</tr>
<tr>
<td>Modeling Skills</td>
</tr>
<tr>
<td>Geometry of Design</td>
</tr>
<tr>
<td>Reverse Engineering</td>
</tr>
<tr>
<td>Documentation</td>
</tr>
<tr>
<td>Advanced Computer Modeling</td>
</tr>
<tr>
<td>Design Team</td>
</tr>
<tr>
<td>Design Challenges</td>
</tr>
</tbody>
</table>
Unit 1: Design Process

Subject: PLTW Introduction to Engineering Design
Grade: 9 - 12
Name of Unit: Design Process
Overview of Unit: The goal of Unit 1 is to introduce students to the broad field of engineering and a design process that engineers use to develop innovative solutions to real problems. Students become familiar with the traditional big four disciplines of engineering and the extensive array of career opportunities and engineering problems addressed within each discipline. A design process is presented as a structured method for approaching and developing solutions to a problem. The art and skill of brainstorming is emphasized as students begin to develop skill in graphically representing ideas through concept sketching.

Unit 2: Technical Sketching and Drawing

Subject: PLTW Introduction to Engineering Design
Grade: 9 - 12
Name of Unit: Technical Sketching and Drawing
Overview of Unit: The goal of Unit 2 is for students to develop an understanding of the purpose and practice of visual representations and communication within engineering in the form of technical sketching and drawing. Students build skill and gain experience in representing three-dimensional objects in two dimensions. Students will create various technical representations used in visualization, exploring, communicating, and documenting design ideas throughout the design process, and they will understand the appropriate use of specific drawing views (including isometric, oblique, perspective, and orthographic projections). They progress from creating free hand technical sketches using a pencil and paper to developing engineering drawings according to accepted standards and practices that allow for universal interpretation of their design.

Unit 3: Measurement and Statistics

Subject: PLTW Introduction to Engineering Design
Grade: 9 - 12
Name of Unit: Measurement and Statistics
Overview of Unit: The goal of Unit 3 is for students to become familiar with appropriate practices and the applications of measurement (using both U. S. Customary and SI units) and statistics within the discipline of engineering. Students will learn appropriate methods of making and recording measurements, including the use of dial calipers, as they come to understand the ideas of precision and accuracy of measurement and their implications on engineering design. The concepts of descriptive and inferential statistics are introduced as methods to mathematically represent information and data and are applied in the design process to improve product design, assess design solutions, and justify design decisions. Students are also provided Version 5/16/2014 © 2014 Project Lead The Way IED Course Outline | 5 with practice in unit conversion and the use of measurement units as an aid in solving practical problems involving quantities. A spreadsheet program is used to store, manipulate, represent, and analyze data, thereby enhancing and extending student application of these statistical concepts.
Unit 4: Modeling Skills

Subject: PLTW Introduction to Engineering Design  
Grade: 9 - 12  
Name of Unit: Modeling Skills  
Overview of Unit: This unit introduces students to a variety of modeling methods and formats used to represent systems, components, processes, and other designs. Students are provided experience in interpreting and creating multiple forms of models common to engineering as they apply the design process to create a design solution. Students create graphical models of design ideas using sketches and engineering drawings and create graphs and charts to represent quantitative data. In this unit students are introduced to three dimensional computer modeling. They learn to represent simple objects in a virtual 3D environment that allows for realistic interactions and animation. The modeling software is also used to provide an efficient method of creating technical documentation of objects. Students are provided the opportunity to create a physical model of a design solution to be used for testing purposes. Mathematical modeling is introduced, and students learn to find mathematical representations (in the form of linear functions) to represent relationships discovered during the testing phase of the design process.

Unit 5: Geometry of Design

Subject: PLTW Introduction to Engineering Design  
Grade: 9 - 12  
Name of Unit: Geometry of Design  
Overview of Unit: In this unit students are provided opportunities to apply two- and three dimensional geometric concepts and knowledge to problem solving and engineering design. Fluency in these geometric concepts is essential in every phase of the design process as problems are defined, potential solutions are generated to meet physical constraints, alternate design solutions are compared and selected, final designs are documented, and specifications are developed. Geometric concepts are also important in the appropriate application of geometric and dimensional relationships and constraints for effective use of three-dimensional computer modeling environments that employ parametric design functionality. In this unit students use geometric concepts and physical properties to solve a wide variety of problems, progressing from computations of surface area, weight, or volume in order to provide cost estimates to the identification of materials based on Version 5/16/2014 © 2014 Project Lead The Way IED Course Outline | 6 physical property observations. Students will also use 3D computer models to compute physical properties that can be used in problem solving and creation of design solutions.
Unit 6: Reverse Engineering

**Subject:** PLTW Introduction to Engineering Design  
**Grade:** 9 - 12  
**Name of Unit:** Reverse Engineering  
**Overview of Unit:** Unit 6 exposes students to the application of engineering principles and practices to reverse engineer a consumer product. Reverse engineering involves disassembling and analyzing a product or system in order to understand and document the visual, functional, and/or structural aspects of its design. In this unit students will have the opportunity to assess all three aspects of a product’s design. Students will learn the visual design elements and principles and their application in design. They will perform a functional analysis to hypothesize the overall function and sequential operations of the product’s component parts and assess the inputs and outputs of the process(es) involved in the operation of the product. Students will physically disassemble the product to document the constituent parts, their properties, and their interaction and operation. After carefully documenting these aspects of the visual, functional, and structural aspects of the product, students will assess the strengths and weaknesses of the product and the manufacturing process by which it was produced.

Unit 7: Documentation

**Subject:** PLTW Introduction to Engineering Design  
**Grade:** 9 - 12  
**Name of Unit:** Documentation  
**Overview of Unit:** In unit 7 students will enhance their basic knowledge of technical drawing representations learned earlier in the course to include the creation of alternate (section and auxiliary) views and appropriate dimensioning and annotation of technical drawings. Students will also be introduced to the reality of variation in dimensional properties of manufactured products. They will learn the appropriate use of dimensional tolerances and alternate dimensioning methods to specify acceptable ranges of the physical properties in order to meet design criteria. Students will apply this knowledge to create engineering working drawings that document measurements collected during a reverse engineering process. These skills will also allow students to effectively document a proposed new design. Students will use 3D computer modeling software to model the assembly of the consumer product, as such a model can be used to replicate functional operation and provide virtual testing of product design.
Unit 8: Advanced Computer Modeling

Subject: PLTW Introduction to Engineering Design  
Grade: 9 - 12  
Name of Unit: Advanced Computer Modeling  
Overview of Unit: In this unit students will learn advanced 3D computer modeling skills. These advanced skills include creating exploded and animated assembly views of multi-part products. Students will learn to use mathematical functions to represent relationships in dimensional properties of a modeled object within the 3D environment. Students will develop and apply mathematical relationships to enforce appropriate dimensional and motion constraints. Students will reverse engineer and model a consumer product, providing appropriate parametric constraints to create a 3D model and realistic operation of the product.

Unit 9: Design Team

Subject: PLTW Introduction to Engineering Design  
Grade: 9 - 12  
Name of Unit: Design Team  
Overview of Unit: In this unit students will work as a collaborative team with geographically separate team members, thereby requiring virtual communications. Through the design process, the team will experience shared decision making as they work to solve a new design challenge. They will reflect on the ethical responsibilities of engineers as they investigate different materials, manufacturing processes, and the short and long term impacts that their decision-making may potentially have on society or on the world.

Unit 10: Design Challenges

Subject: PLTW Introduction to Engineering Design  
Grade: 9 - 12  
Name of Unit: Design Challenges  
Overview of Unit: In this unit students will work in small collaborative teams, implement the design process, and use skill and knowledge gained during the course to solve a culminating design challenge and document and communicate their proposed solution.