Curriculum at a Glance

Project Lead The Way-Introduction to Engineering Design

Grade 9-12

Introduction to Engineering Design (IED) is a high school level foundation course in the PLTW Engineering Program. In IED students are introduced to the engineering profession and a common approach to the solution of engineering problems, an engineering design process. Utilizing the activity project-problem-based (APB) teaching and learning pedagogy, students will progress from completing structured activities to solving open-ended projects and problems that require them to develop planning, documentation, communication, and other professional skills. Through both individual and collaborative team activities, projects, and problems, students will problem solve as they practice common engineering design and development protocols such as project management and peer review. Students will develop skill in technical representation and documentation of design solutions according to accepted technical standards, and they will use current 3D design and modeling software to represent and communicate solutions. In addition the development of computational methods that are commonly used in engineering problem solving, including statistical analysis and mathematical modeling, are emphasized. Ethical issues related to professional practice and product development are also presented.

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<tr>
<th>Unit Description</th>
<th>Content and/or Skills</th>
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<td>Unit 1: Design Process</td>
<td>● Introduce students to the broad field of engineering and a design process that engineers use to develop innovative solutions to real problems.</td>
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<td>● 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.</td>
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<td>● A design process is presented as a structured method for approaching and developing solutions to a problem.</td>
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<td>● The art and skill of brainstorming is emphasized as students begin to develop skill in graphically representing ideas through concept sketching.</td>
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<td>Unit 2: Technical Sketching and Drawing</td>
<td>● Develop an understanding of the purpose and practice of visual representations and communication within engineering in the form of technical sketching and drawing.</td>
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- 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).
- 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
- 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 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
- 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.
- Students are introduced to three dimensional computer modeling. Learn to represent simple objects in a virtual 3D environment that allows for realistic interactions and animation.
- The modeling software is 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 | ● Students are provided opportunities to apply two- and three-dimensional geometric concepts and knowledge to problem solving and engineering design.  
  ● 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 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 | ● Students are exposed to the application of engineering principles and practices to reverse engineer a consumer product.  
  ● 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.  
  ● 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.  
  ● Students will assess the strengths and weaknesses of the product and the manufacturing process by which it was produced. |
| Unit 7: Documentation       | ● 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 be introduced to the reality of variation in dimensional properties of manufactured products.  
  ● Students 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.  
  ● Students will 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 | ● Students will learn advanced 3D computer modeling skills.  
|                                  | ● Students will learn to use mathematical functions to represent relationships in dimensional properties of a modeled object within the 3D environment.  
|                                  | ● Students will also 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               | ● Students will work as a collaborative team with geographically separate team members, thereby requiring virtual communications.  
|                                  | ● Students 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 and on the world. |

| Unit 10: Design Challenges        | ● 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. |