Engineers make a world of difference!

Students are introduced to the engineering design process, applying math, science, and engineering standards to identify and design solutions to a variety of real problems. They work both individually and in collaborative teams to develop and document design solutions using engineering notebooks and 3D modeling software.

Are you ready to design the future?

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 solve problems 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.

The following is a summary of the units of study that are included in the course for the 2014-2015 academic year. Alignment with NGSS, Common Core, and other standards will be available through the PLTW Alignment web-based tool. Activities, projects, and problems are provided to the teacher through the PLTW Learning Management System in the form of student-ready handouts, teacher notes, lesson planning resources, and supplementary materials.

The course requires a rigorous pace, and it is likely to contain more material than a skilled teacher new to the course will be able to complete in the first iteration. Building enthusiasm for and a real understanding of role, impact, and practice of engineering is a primary goal of the course.

IED Unit Summary

Unit 1	Design Process
Unit 2	Technical Sketching and Drawing
Unit 3	Measurement and Statistics
Unit 4	Modeling Skills
Unit 5	Geometry of Design
Unit 6	Reverse Engineering
Unit 7	Documentation

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Unit 8	Advanced Computer Modeling
Unit 9	Design Team
Unit 10	Design Challenges

Unit 1: Design Process
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
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
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 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. 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.

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Unit 5: Geometry of Design
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 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
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
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
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
In this unit students will work as a collaborative team with geographically separate team members, thereby

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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
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.

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