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# Park Hill School District

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## **High School PLTW Introduction to Engineering Design Curriculum**

**Course Description:** 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.

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**Scope and Sequence:**

<b>Time Frame</b>	<b>Unit</b>	<b>Instructional Topics</b>
4 weeks	Design and Problem Solving	Topic 1: Design Basics Topic 2: Visualization and Solid Modeling Topic 3: CAD Fundamentals Topic 4: Product Improvement
4 weeks	Assembly Design	Topic 1: Put It Together Topic 2: Take It Apart Topic 3: A Material World Topic 4: Fix It
4 weeks	Thoughtful Product Design	Topic 1: Responsible Design Topic 2: More Than Parts Topic 3: Solve a Problem
4 weeks	Making Things Move	Topic 1: You've Got to Move It Topic 2: May the Force Be With You Topic 3: Automating Motion Topic 4: Make It Move

**Essential Learning Outcomes:**

- ELO 1: Students engage in strategic and systematic design and inquiry processes in order to guide the development of an effective solution to the problem.
- ELO 2: Students engage in the design process as an iterative, systematic approach to problem solving, demonstrate curiosity, creativity, flexibility and adaptability to change.
- ELO 3: Students reflect critically on past experience using a design process to inform future progress.
- ELO 4: Students demonstrate their understanding that an experimental design process is a systematic approach to investigate a phenomenon and gain knowledge.
- ELO 5: Students use appropriate statistical methods and visualization techniques to justify claims based on evidence.
- ELO 6: Students demonstrate their understanding that professional practice is guided by professional ethics and standards and requires effective communication and collaboration.

# Unit 1: Design and Problem Solving

**Subject:** PLTW Introduction to Engineering Design

**Grade:** 9-12

**Name of Unit:** Design and Problem Solving

**Overview of Unit:** In this unit students review and apply an engineering design process to collaboratively design a carnival game. As part of the design process, students practice the art of brainstorming and begin to develop skills in graphically representing ideas through concept sketching. Students also have an opportunity to develop and test a solution and improve the design through iteration. In addition, students learn statistical techniques to evaluate design solutions and apply statistics to inform design decisions related to their game design.

## Topic 1: Design Basics

Activity	Title	ELO
Activity 1.1.1	Design as a Process	1, 2, 3, 4, 5, 6
Activity 1.1.2	Iterate and Redesign	1, 2, 3, 4, 5, 6
Activity 1.1.3	Concept Sketching	1, 2, 3, 4, 5, 6
Activity 1.1.4	Targeting Success Using Data	1, 2, 3, 4, 5, 6
Activity 1.1.5	Design a Game	1, 2, 3, 4, 5, 6

## Topic 2: Visualization and Solid Modeling

Activity	Title	ELO
Activity 1.2.1	Isometric Sketching	1, 2, 3, 4, 5, 6
Activity 1.2.2	Solid Modeling	1, 2, 3, 4, 5, 6
Activity 1.2.3	Multiview Drawings	1, 2, 3, 4, 5, 6
Activity 1.2.4	Fundamentals of Dimensioning	1, 2, 3, 4, 5, 6
Activity 1.2.5	Sketches, Extrusions, and Revolutions, Oh My!	1, 2, 3, 4, 5, 6
Activity 1.2.6	Charmed I'm Sure	1, 2, 3, 4, 5, 6

### Topic 3: CAD Fundamentals

Activity	Title	ELO
Activity 1.3.1	Measure It!	1, 2, 3, 4, 5, 6
Activity 1.3.2	Making Holes in CAD	1, 2, 3, 4, 5, 6
Activity 1.3.3	Constraining a Sketch	1, 2, 3, 4, 5, 6
Activity 1.3.4	CAD Modeling Skills	1, 2, 3, 4, 5, 6
Activity 1.3.5	Documenting a Design	1, 2, 3, 4, 5, 6
Activity 1.3.6	Section That!	1, 2, 3, 4, 5, 6
Activity 1.3.7	Design a Protective Case	1, 2, 3, 4, 5, 6

### Topic 4: Product Improvement

Activity	Title	ELO
Activity 1.4.1	Sweet Improvement	1, 2, 3, 4, 5, 6

## Unit 2: Assembly Design

**Subject:** PLTW Introduction to Engineering Design

**Grade:** 9-12

**Name of Unit:** Assembly Design

**Overview of Unit:** The goal of Unit 2 is that students continue to build skills in CAD in Lesson 2.1. Methods to physically join parts in an assembly, including mechanical fasteners, adhesives, press fits, and hinges, are presented. Interference and clearance fits are introduced, and students learn to specify tolerances to achieve desired fits between interacting parts.

CAD assembly modeling is presented, and students create simple bottom-up assemblies that realistically simulate physical mechanical systems. Assemblies are documented in CAD with assembly drawings. Finally, students are challenged to iterate on an earlier design to incorporate skills and knowledge that they have learned in this unit.

### Topic 1: Put It Together

Activity	Title	ELO
Activity 2.1.1	Tolerate This!	1, 2, 3, 4, 5, 6
Activity 2.1.2	Hold It Together!	1, 2, 3, 4, 5, 6
Activity 2.1.3	Putting It Together	1, 2, 3, 4, 5, 6
Activity 2.1.4	Document the Assembly	1, 2, 3, 4, 5, 6
Activity 2.1.5	Redesign a Protective Case	1, 2, 3, 4, 5, 6

### Topic 2: Take It Apart

Activity	Title	ELO
Activity 2.2.1	What is Reverse Engineering?	1, 2, 3, 4, 5, 6
Activity 2.2.2	Visual Analysis	1, 2, 3, 4, 5, 6
Activity 2.2.3	Functional Analysis and the Black Box	1, 2, 3, 4, 5, 6
Activity 2.2.4	Structural Analysis and Product Disassembly	1, 2, 3, 4, 5, 6

Activity 2.2.5	CAD Design Tools	1, 2, 3, 4, 5, 6
Activity 2.2.6	Top-down or Bottom-up?	1, 2, 3, 4, 5, 6
Activity 2.2.7	Design for Manufacturability and Assembly	1, 2, 3, 4, 5, 6
Activity 2.2.8	Design an Integrated Assembly	1, 2, 3, 4, 5, 6

### Topic 3: A Material World

Activity	Title	ELO
Activity 2.3.1	Material Properties	1, 2, 3, 4, 5, 6
Activity 2.3.2	Evaluating Materials	1, 2, 3, 4, 5, 6
Activity 2.3.3	CAD Material Appearance and Analysis	1, 2, 3, 4, 5, 6
Activity 2.3.4	Imagine the Future	1, 2, 3, 4, 5, 6

### Topic 4: Fix It

Activity	Title	ELO
Problem 2.4.1	Troubleshoot an Assembly	1, 2, 3, 4, 5, 6

## Unit 3: Thoughtful Product Design

**Subject:** PLTW Introduction to Engineering Design

**Grade:** 9-12

**Name of Unit:** Thoughtful Product Design

**Overview of Unit:** In this unit, students learn about reverse engineering. Then they identify and research the component materials and the material properties that contribute to their selection for use in the product. Students are introduced to life cycle analysis, systems thinking, and ethical considerations in design, and they compare the life cycle of common competing products (such as plastic versus paper shopping bags). This lesson emphasizes the importance of identifying measurable design criteria that define a successful solution and that can be used to evaluate a potential solution.

### Topic 1: Responsible Design

Activity	Title	ELO
Activity 3.1.1	Reverse Engineer a Product	1, 2, 3, 4, 5, 6
Activity 3.1.2	Product Life Cycle	1, 2, 3, 4, 5, 6
Activity 3.1.3	Sustainable Design	1, 2, 3, 4, 5, 6
Activity 3.1.4	Design Criteria and Constraints	1, 2, 3, 4, 5, 6
Problem 3.1.5	Consider the Impact	1, 2, 3, 4, 5, 6

### Topic 2: More Than Parts

Activity	Title	ELO
Activity 3.2.1	Human-Centered Design	1, 2, 3, 4, 5, 6
Activity 3.2.2	Whole systems Thinking	1, 2, 3, 4, 5, 6
Activity 3.2.3	Generative Design	1, 2, 3, 4, 5, 6
Activity 3.2.4	When Is “Good” Good Enough?	1, 2, 3, 4, 5, 6
Project 3.2.5	Gadget Design	1, 2, 3, 4, 5, 6



## Topic 3: Solve a Problem

Activity	Title	ELO
Activity 3.3.1	Establishing a Team	1, 2, 3, 4, 5, 6
Activity 3.3.2	Project Scheduling	1, 2, 3, 4, 5, 6
Project 3.3.3	The Engineering Consultant	1, 2, 3, 4, 5, 6

## Unit 4: Making Things Move

**Subject:** PLTW Introduction to Engineering Design

**Grade:** 9-12

**Name of Unit:** Making Things Move

**Overview of Unit:** In this unit, students begin the lesson by reverse engineering a mechanical device to identify simple machines and mechanisms that influence motion and contribute to the function of the device. Students identify different types of motion (rotary, oscillating, linear, and reciprocating) and investigate mechanisms that cause motion (including cams, gears, pulleys, chain and sprockets) and later use these mechanisms to create, transform, and control motion to solve a problem. Students will practice CAD skills by developing assembly models of the mechanisms they investigate and simulating motion in the CAD environment. To support efficient CAD modeling, students will also learn to use mathematical functions to represent dimensional relationships in a 3D solid model.

### Topic 1: You've Got to Move It

Activity	Title	ELO
Activity 4.1.1	Reverse Engineer Mechanism	1, 2, 3, 4, 5, 6
Activity 4.1.2	Cams Make the World Go Round	1, 2, 3, 4, 5, 6
Activity 4.1.3	Mechanisms of Motion	1, 2, 3, 4, 5, 6
Activity 4.1.4	Cams in Motion	1, 2, 3, 4, 5, 6
Activity 4.1.5	Design a Cam	1, 2, 3, 4, 5, 6
Activity 4.1.6	Simulating Cam Motion	1, 2, 3, 4, 5, 6
Project 4.1.7	Shoebox Automation	1, 2, 3, 4, 5, 6

### Topic 2: May the Force Be With You

Activity	Title	ELO
Activity 4.2.1	Force Springs Eternal	1, 2, 3, 4, 5, 6
Activity 4.2.2	Friction Is a Real Deal	1, 2, 3, 4, 5, 6

Activity 4.2.3	Fighting Friction	1, 2, 3, 4, 5, 6
Activity 4.2.4	Friction: Design Friend or Foe	1, 2, 3, 4, 5, 6
Activity 4.2.5	Automata Design Challenge	1, 2, 3, 4, 5, 6

### Topic 3: Automating Motion

Activity	Title	ELO
Activity 4.3.1	Circuit Basics	1, 2, 3, 4, 5, 6
Activity 4.3.2	Fun with Motors	1, 2, 3, 4, 5, 6
Activity 4.3.3	Automata Redesign	1, 2, 3, 4, 5, 6

### Topic 4: Make It Move

Activity	Title	ELO
Activity 4.4.1	All Together Now	1, 2, 3, 4, 5, 6
Activity 4.4.2	Move with Purpose	1, 2, 3, 4, 5, 6
Problem 4.4.3 (Optional)	Engineering for Change	1, 2, 3, 4, 5, 6