Design and Modeling at a Glance

PLTW Design and Modeling (DM) is a nine-week, STEM unit of study. DM provides students opportunities to apply the design process to creatively solve problems. Students are introduced to the unit problem in the first activity and are asked to make connections to the problem throughout the lessons. Students learn to use methods for communicating design ideas through sketches, solid models, and mathematical models. Students will understand how models can be simulated to represent an authentic situation and generate data for further analysis and observations. Students work in teams to identify design requirements, research the topic, and engage stakeholders. Teams design a toy or game for a child with cerebral palsy, fabricate and test it, and make necessary modifications to optimize the design solution.

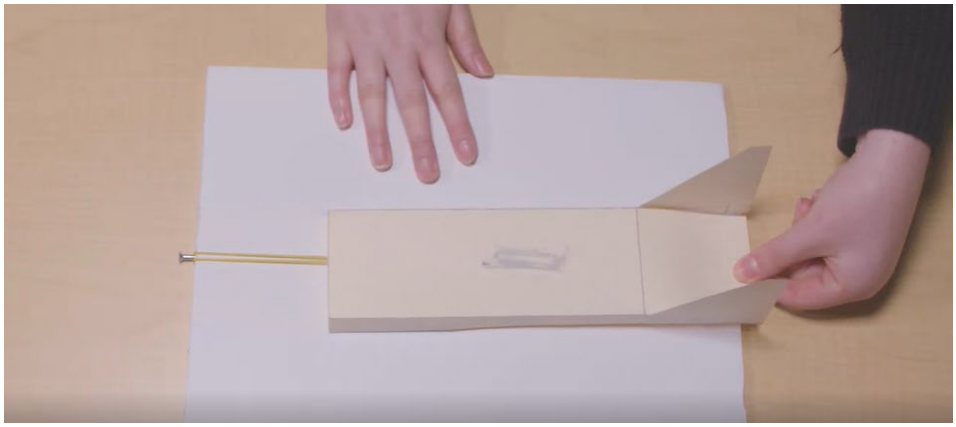
Design and Modeling uses the PLTW activity-, project-, and problem-based (APB) instructional design approach, which centers on hands-on, real-world activities, projects, and problems that help students understand how the knowledge and skills they develop in the classroom can be applied in everyday life. The APB approach scaffolds student learning through structured activities and projects that empower students to become independent in the classroom and help them build skill sets to apply to an open-ended, real-world problem. This approach provides students with unique opportunities to work collaboratively, identify problems, apply what they know, persevere through challenges, find unique solutions, and lead their own learning.

The student learning progression starts with basic concepts and practices in Lesson 1 and moves to more advanced concepts and practices in Lessons 2 and 3. Students learn and add more tools to their tool belts as they progress through the unit.

The following is an overview of the lessons in the PLTW Design and Modeling unit, including the end-of-unit problem.

Lesson 1: Introduction to Design

In Lesson 1, students discover the design process as they complete an instant design challenge to create an ankle foot orthosis. They go on to learn thumbnail, orthographic, isometric, and perspective sketching as methods for communicating design ideas effectively without the use of technology. Students use both U.S. Customary and Metric systems and apply measurement skills while dimensioning sketches. They create and launch paper air skimmers and complete statistical analysis on their results. In the lesson project, students conduct a mechanical dissection, while using sketches to communicate and document their findings.



Skimmer Launch

Activity 1.1 Foot Orthosis Instant Design Challenge

Students begin the unit with an instant design challenge where they work in teams to design, build, and test a foot orthosis. Students present their solutions to the class and together use a decision matrix to choose the solution that best meets the design requirements. Students are formally introduced to the design process and compare it to the process they followed. They reflect on their team collaboration to develop a set of team rules to follow throughout the unit.

Activity 1.2 A Picture Is Worth a Thousand Words

Students learn thumbnail, perspective, isometric, and multiview sketching as methods of modeling and communicating design ideas effectively without the use of technology. The activity ends with students using a multiview sketch to build a three-dimensional object with linking cubes and completing an isometric sketch of the object.

Activity 1.3 Measuring Matters

Students are introduced to both the U.S. Customary and Metric systems and accurately measure with rulers in both systems. They then learn how to analyze a sketch with dimensions. They apply these skills to accurately build and launch paper skimmers that slide across the floor. Students record all results to determine which skimmer travels the farthest.

Activity 1.4 Skimmer Statistics

Students explore the principles of basic statistical analysis. They use technology to create box-and-whiskers plots to statistically analyze their skimmer launch results.

Activity 1.5 Dialed In

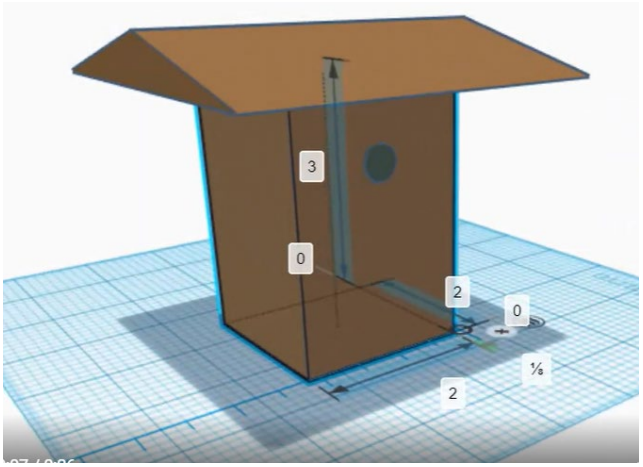
Students learn to use a dial caliper. They build and sketch three-dimensional structures and use dial calipers to measure and add dimensions to their sketches.

Project 1.6 Investigate the Inside

Students are presented with a design challenge for a client who wants to modify a foam cube toy for a child with retinoblastoma. To help this client, students work in teams to mechanically dissect the toy and sketch and dimension its pieces. Extension opportunities include students sketching and dimensioning modified toys.

Lesson 2: Solid Modeling

In Lesson 2, students use technology to transfer a two-dimensional representation to a three-dimensional solid model. Students learn how to use a computer-aided design (CAD) application to create solid models of various objects and designs.



Birdhouse Designed in Tinkercad™

During the design project, students work in teams and apply the design process to create a cube puzzle. Students create a solid model of their design using a CAD application and fabricate their design solution for testing. To complete statistical analysis from their testing results, students use a dynamic mathematics program to determine whether their design met the criteria and constraints.

Activity 2.1 Taking Modeling to Another Dimension

Students are introduced to Tinkercad solid modeling software. They work through tutorials to explore the tools in Tinkercad, and then use their knowledge and skills to create their own name tag.

Activity 2.2 For Good Measure

Students are introduced to additional methods of creating and modifying solid models. Using Tinkercad, they create a rectangular storage container of their choosing. Once built, they learn how to calculate the volume of their storage container. Extension opportunities for students include enhancing their model or creating a storage container with a different shape and calculating its volume.

Activity 2.3 It's For the Birds

Students are given a design challenge to build a solid model of a birdhouse. Students investigate bird habitat loss and follow a set of design requirements to 3D model a bird house that could be manufactured to help solve this problem.

Project 2.4 Puzzle Cube Design Challenge

Students use the design process to work in teams to design, build, and test a puzzle cube. Using a box-and-whiskers plot, they analyze how difficult their puzzle is to solve. Through this project, students use various types of modeling, such as sketching, solid modeling, prototyping, and mathematical modeling.

Lesson 3: Design Challenge

Students brainstorm and select a design solution to the Therapeutic Toy Design Challenge problem, based on design requirements. They establish team norms, collaborate, and recognize that solving authentic problems involves interdisciplinary skills such as engineering and biomedical science. Using the design process, students create a solid model of their design, build a prototype for design testing, and make necessary design modifications based on testing results.

Therapist Using a Therapeutic Toy

Problem 3.1 Therapeutic Toy Design

Students work in teams to apply knowledge and skills they acquired in the Design and Modeling unit. Students choose a profile for a child with cerebral palsy and follow the design process to design and fabricate a therapeutic toy for their child.