Course Description
In this foundational course, students are taught to understand and apply the design process, create sketches, use computer software to design models, understand mass property calculations and parametric modeling, understand cost analysis, quality control, staffing needs, packing and product marketing, explore career opportunities in design engineering and understand what skills and education these jobs require, and develop portfolios to display their designs and present them properly to peers, instructors and professionals.

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<td>Intended Grade Level</td>
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<td>Prerequisite</td>
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<td>Limited Engineering, or</td>
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PLTW INTRODUCTION TO ENGINEERING DESIGN (IED)

STRAND 1
Students will gain an appreciation for design history and career opportunities in the engineering field.

Standard 1
Develop an appreciation of how the history of art has influenced innovations in the field of engineering, and explain the impact of artistic expression as it relates to consumer products.
- Research how artistic period and style have influenced product and architectural design.
- Explore the design concept of form and function and explain its use in product design.

Standard 2
Explore the evolution of technology and be able to identify engineering achievements through history.
- Research the chronological development and accelerating rate of change that innovations in tools and materials have brought about over time as it relates to a given consumer product.
- Review the history of measurement tools and identify two innovations that have led to improved functionality of that tool.

Standard 3
Explore a given professional organization and summarize in a short PowerPoint presentation the range of services provided by the organization.
- Identify career opportunities in design engineering and explain the respective job functions.

STRAND 2
Students will be introduced to the design process and elements of design.

Standard 1
Apply the steps of the design process to solve a variety of design problems.
- List the steps of a design process and explain the activities that occur during each phase.
- Assess the value of working as a team and understand the benefits of collaboration.
- Realize the importance of focusing on detail when executing the design process.

Standard 2
Investigate the principles and elements of design and demonstrate the use of the design process and the incorporation of design solutions.
- Identify the use of the principles and elements of design in various products, print media, and art forms.
- Express their understanding of the principles and elements of design by incorporating them in design solutions.
Collect and display examples of the application of the principles and elements of design utilized in products, print media, and art forms.

**STRAND 3**

**Students will create and develop a portfolio.**

**Standard 1**

Develop a portfolio to organize and display evidence of work.

- Identify the proper elements of a fully developed portfolio.
- Identify and discuss the ethical issues surrounding portfolio artifacts.
- Compare and contrast defined elements of a good portfolio specified in the PowerPoint presentation to the sample provided in the PLTW Design Resource Guide.

**STRAND 4**

**Students will learn to visualize and create sketches.**

**Standard 1**

Develop properly annotated sketches to accurately convey data in a design solution.

- Demonstrate the ability to produce two-dimensional geometric figures.
- Select and produce the appropriate pictorial style to best communicate solutions in the design process.
- Integrate proper sketching techniques and styles in the creation of sketches.
- Formulate pictorial sketches to develop ideas, solve problems, and understand relationships during the design process.
- Create sketches utilizing both the additive and subtractive methods to assess underlying geometric and perceptual principles.
- Select a sketching method that is efficient in its use of color, form, and symbols representing abstract data.
- Augment pictorial sketches with shading to improve communication.
- Evaluate and select the necessary views to graphically communicate design solutions.

**Standard 2**

Interpret annotated sketches in the design analysis process.

**Standard 3**

Integrate annotated sketches in presentations, portfolio, and documentation process.

**STRAND 5**

**Students will create geometric shapes and relationships.**

**Standard 1**

Define and contrast points, lines and line segments.
Standard 2
Define the elements and types of angles.

Standard 3
Using a compass, ruler and triangle, construct and bisect various types of angles.

Standard 4
Identify major geometric shapes:
- Isosceles triangle
- Right triangle
- Scalene triangle
- Rectangle
- Square
- Rhombus
- Trapezoid
- Pentagon
- Hexagon
- Octagon

Standard 5
Define terminology associated with arcs and circles.

Standard 6
Using a compass, ruler and triangle students will construct various geometric shapes.
- Arcs
- Circles
- Ellipses

Standard 7
Apply a combination of absolute, relative, and polar coordinates to construct a three-dimensional model.
- Apply the right hand rule to identify the X, Y, and Z axes of the Cartesian coordinate system.
- Define the origin planes in the Cartesian coordinate system.
- Identify the origin and planar orientations of each side of a three-dimensional model.

Standard 8
Distinguish and define geometric constraints.
- Insert indicator text
- Insert indicator text
- Insert indicator text

Standard 9
Students will identify geometric constraints in given three-dimensional models.
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- Horizontal
- Vertical
- Parallel
- Perpendicular
- Tangent
- Concentric
- Collinear
- Coincident
- Equal

**STRAND 6**

Students will create solid models.

**Standard 1**
Experience the creative thinking process.
- Recognize the difference between vertical and lateral thinking.
- Categorize and select a solution to a problem.
- Communicate their idea through written and verbal formats.
- Identify the different graphical method of data representation.
- Select the appropriate graphical format to a problem.
- Analyze and develop graphical representation of given data.
- Understand the different physical modeling techniques.
- Present a model with its correct proportions.
- Select the appropriate modeling materials to complete a three-dimensional model.

**Standard 2**
Evaluate a problem using mathematical formulae.

**Standard 3**
-Analyze a solution to a problem using the correct format of analysis.

**Standard 4**
Explain the difference between parametric and adaptive designs and be able to specify their uses.

**Standard 5**
Interpret a sketch and generate a model using a computer and a CAD software package.
- Understand and demonstrate the use of work features and how they are applied while constructing a solid model.
- Recognize the use and need of work planes, axes, and points in the development of a computer model.
- Draw a two-dimensional sketch using a CAD package.
- Apply geometrical and dimensional constraints to a sketch.
- Demonstrate the ability to generate a three-dimensional model.
Demonstrate the ability to modify a sketch or feature of a model.

**STRAND 7**

**Students will create models of assemblies.**

**Standard 1**
Explore and demonstrate assembly-modeling skills to solve a variety of design problems.
- Understand and apply the base component effectively in the assembly environment.
- Place and create components in the assembly-modeling environment.
- Create circular and rectangular patterns of components within an assembly model.
- Replace components with modified external parts.
- Perform part manipulation during the creation of an assembly model.
- Apply assembly constraints to successfully construct a multi-part object.
- Employ sub-assemblies during the production of assemblies.
- Utilize part libraries effectively during the assembly modeling process.

**Standard 2**
Understand and apply drive constraints to simulate the motion of parts in assemblies.

**Standard 3**
Explore, understand, and apply adaptive design concepts during the development of sketches, features, parts, and assemblies.

**STRAND 8**

**Students will analyze and verify the model.**

**Standard 1**
Demonstrate how to extract mass properties data from their solid models.

**Standard 2**
List and explain the various mass property calculations and how they are used to evaluate a parametric model.
- Volume
- Density
- Mass
- Surface area
- Centroid
- Moment of inertia
- Products of inertia
- Radii of gyration
- Principal axes
- Principal moments
Standard 3
Evaluate the accuracy of mass properties calculations.

Standard 4
Describe how analysis data can be used to update parametric models.

Standard 5
Interpret and use correct tolerancing techniques when dimensioning solid models.
  • Understand and solve tolerance problems, including limits and fits.
  • Understand the differences between clearance fit, interference fit, and allowance.

**STRAND 9**
Students will create fully dimensioned working drawings.

**Standard 1**
Translate a three-dimensional drawing or model into corresponding orthographic drawing views.
  • Select the appropriate sheet size and title block for creating a drawing layout.

**Standard 2**
Describe the purpose, and/or application, of the following drawing views:
  • Isometric view
  • Section view
  • Auxiliary view
  • Detail view

**Standard 3**
Generate an isometric view from orthographic drawing views.

**Standard 4**
Create the appropriate section view for a specified application.
  • Determine the correct application for the various section views required to illustrate an object’s internal detail.
  • Describe the purpose and application of hatch marks and a cutting plane line, as used in a section view.

**Standard 5**
Create an auxiliary view to show the detail on an inclined surface of a drawing object.

**Standard 6**
Create a detail view that corresponds to the appropriate orthographic drawing view.

**Standard 7**
Identify and demonstrate the use of common dimensioning systems.
  • List the common dimensioning standards.
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- Describe the characteristics and demonstrate the use of unidirectional and aligned dimensioning.
- Differentiate the use of and demonstrate an understanding of size and location dimensions by applying these types of dimensions to annotated sketches and drawings.
- Demonstrate appropriate dimensioning rules and practices.
- Set up and integrate the use of a customized common dimensioning standard.
- Identify and demonstrate the use of dimensioning practices on section, auxiliary, and assembly models.
- Define and demonstrate an understanding of tolerancing, and solve tolerance problems.

**Standard 8**

Apply appropriate annotations on sketches and drawings.

- Understand and formulate general and proprietary specifications to further communicate information relating to product design.