Unit 5 Geometry of Design

Unit 5 – Concepts & Objectives

Concepts	Objectives
An engineering design process involves a characteristic set of practices and steps.	• Complete a design project utilizing all steps of a design process, and find a solution that meets specific design requirements.
A problem and the requirements for a successful solution to the problem should be clearly communicated and justified.	• Define and justify a design problem, and express the concerns, needs, and desires of the primary stakeholders.
Brainstorming may take many forms and is used to generate a large number of innovative, creative ideas in a short time.	• Generate and document multiple ideas or solution paths to a problem through brainstorming.
Physical models are created to represent and evaluate possible solutions using prototyping technique(s) chosen based on the presentation and/or testing requirements of a potential solution.	• Construct a testable prototype of a problem solution.
Problem solutions are optimized through evaluation and reflection and should be clearly communicated.	• Identify limitations in the design process and the problem solution and recommend possible improvements or caveats.
The scientific method guides the testing and evaluation of prototypes of a problem solution.	• Analyze the performance of a design during testing and judge the solution as viable or non-viable with respect to meeting the design requirements.
Spreadsheet programs can be used to store, manipulate, represent, and analyze data.	• Use a spreadsheet program to store and manipulate raw data. • Use a spreadsheet program to graph bi-variate data and determine an appropriate mathematical model using regression analysis. • Use function tools within a spreadsheet program to calculate statistics for a set of data including mean, median, mode, quartiles, range, **interquartile range,** and standard deviation. **Note: Interquartile range is included for continuous improvement beyond 2012-2013.**
An equation is a statement of equality between two quantities that can be used to describe real phenomenon and solve problems.	• Construct a scatter plot to display bi-variate data, investigate patterns of association, and represent the association with a mathematical model (linear equation) when appropriate. **Note: This aligns with the 2012-2013 PREVIEW curriculum.**
Solving mathematical	• Solve equations for unknown quantities by determining

equations and inequalities involves a logical process of reasoning and can be accomplished using a variety of strategies and technological tools.	appropriate substitutions for variables and manipulating the equations.
Units and quantitative reasoning can guide mathematical manipulation and the solution of problems involving quantities.	• Convert quantities between units in the SI and the US Customary measurement systems. • Convert between different units within the same measurement system including the SI and US Customary measurement systems.
Error is unavoidable when measuring a physical property and a measurement is characterized by the precision and accuracy of the measurement.	• Measure linear distances (including length, inside diameter, and hole depth) with accuracy using a scale, ruler, or dial caliper and report the measurement using an appropriate level of precision. • Measure mass with accuracy using a scale and report the measurement using an appropriate level of precision. • Measure volume with accuracy and report the measurement with an appropriate level of precision.
Two- and three-dimensional objects share visual relationships which allow interpretation of one perspective from the other.	• Identify three dimensional objects generated by rotations of two-dimensional shapes and vice-versa.
Physical properties of objects are used to describe and model objects and can be used to define design requirements, as a means to compare potential solutions to a problem, and as a tool to specify final solutions.	• Define the term “physical property” and identify the properties of length, volume, mass, density, surface area, centroid, principle axes, and center of gravity as physical properties. • Solve volume problems using volume formulas for rectangular solids, cylinders, pyramids, cones, and spheres. • Solve real world and mathematical problems involving area and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, right prisms, cylinders, and spheres. • Calculate a physical property indirectly using available data or perform appropriate measurements to gather the necessary data (e.g., determine area or volume using linear measurements or determine density using mass and volume measurements). • Use physical properties to solve design problems (e.g., design an object or structure to satisfy physical constraints or minimize cost).
Functions describe a special relationship between two sets of data and can be used to represent real world relationships and to solve problems. **Note: This aligns with the 2012-2013 PREVIEW curriculum.**	• Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. **Note: This aligns with the 2012-2013 PREVIEW curriculum.** • Interpret the slope (rate of change) and the intercept (constant term) of a linear function in the context of data. **Note: This aligns with the 2012-2013 PREVIEW curriculum.**
Geometric shapes and forms are described and differentiated by their characteristic features.	• Identify types of polygons including a square, rectangle, pentagon, hexagon, and octagon. • Identify and differentiate geometric constructions and constraints such as horizontal lines, vertical lines, parallel lines, perpendicular lines, colinear points, tangent lines, tangent circles, and concentric

	circles. • Identify types of angles including an acute angle, obtuse angle, straight angle, and right angle.
Computer aided drafting and design (CAD) software packages facilitate virtual modeling of parts and assemblies and the creation of technical drawings. They are used to efficiently and accurately detail parts and assemblies according to standard engineering practice.	• Create three-dimensional solid models of parts within CAD from sketches or dimensioned drawings using appropriate geometric and dimensional constraints.
Computer aided drafting and design (CAD) software packages allow virtual testing and analysis of designs using 3D models, assemblies, and animations.	• Assign a specific material (included in the software library) to a part and use the capabilities of the CAD software to determine the mass, volume, and surface area of an object for which a 3D solid model has been created. • Assign a density value to a new material (not included in the software library) and apply the material to a 3D solid model within CAD software in order to determine the physical properties of the object.
In order to be an effective team member, one must demonstrate positive team behaviors and act according to accepted norms, contribute to group goals according to assigned roles, and use appropriate conflict resolution strategies.	• Demonstrate positive team behaviors and contribute to a positive team dynamic.

Essential Questions (Unit-Specific)

1. What are physical properties and why are they important to the design of a product?
2. What advantage does Computer Aided Design and Drafting (CAD) provide over traditional paper and pencil design?
3. How does the material chosen for a product impact the design of the product?

Essential Questions (Course-Wide)

1. How does the design process promote the development of good solutions to technical problems?
2. How can an engineer or technical professional effectively communicate ideas and solutions in a global community?
3. How do inventors and innovators impact and shape society?