PLTW - INTRODUCTION TO ENGINEERING DESIGN (IED)
Course Description and Objectives

Ever tried to design something new or draw up an idea you wanted to share with your friends and wondered how you could communicate your idea? Or, have you wondered how someone designed that new MP3 player or sleek new phone? Then Introduction to Engineering Design ™ is the course for you. The major focus of the course is learning how to take an idea through a design process that will eventually be manufactured or produced. As you learn about various aspects of engineering and engineering design, such as how engineers communicate through drawing, you will apply what you learn through various activities, projects, and problems. For example, after learning about the different techniques engineers use in determining how to design a product, you and your teacher will have the flexibility to explore the design and engineering processes to solve problems that are of interest to you. The course covers the following:

- The Role of an Engineer
- The Design Process
- Product Design
- Product Analysis and Improvement
- Designing as an Engineer

In addition, you will use Inventor, which is a state of the art 3-D design software package from AutoDesk, to help you design solutions to different design projects. Working in teams, you will learn about documenting your solutions, solving problems, and communicating your solutions to other students and members of the professional community of engineering and engineering design.

Introduction to Engineering Design ™ is intended to serve as a foundation course within the Project Lead The Way® course sequence. All of the topics learned in this course will be used in future courses.

IED UNIT AND LESSON OBJECTIVES

Unit 1 – Introduction to Design
Preface

This unit is an introduction to different facets of design and will emphasize the following: evolution and history of design, the steps in a design process, the importance of proper sketching techniques, measurement and tools used in design, and the use of those tools and techniques to innovate or invent solutions to problems. You will be introduced to a variety of skill building opportunities that will enhance your design skills and prepare you for the remaining units in this course.

Concepts

1. There are many design processes that guide professionals in developing solutions to problems.
2. A design process most used by engineers includes defining a problem, brainstorming, researching, identifying requirements, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing, refining, making, and communicating results.
3. Engineers create sketches to quickly record, communicate, and investigate ideas.
4. Engineers apply dimensions to drawings to communicate size information.
5. Statistical analysis of measurements can help verify the quality of a design or process.
6. Engineers use Computer Aided Design modeling systems to quickly generate and annotate working drawings.

Performance Objectives

It is expected that students will:

- Apply engineering notebook standards and protocols when documenting their work during the school year.
- Identify and apply group brainstorming techniques and the rules associated with brainstorming.
- Research a product's history, develop a PowerPoint presentation, list chronologically the major innovations to a product, and present findings to a group.
- Use online and published works to research aspects of design problems.
- Identify the design process steps used in given scenarios and be able to list the steps, if any are missing.
- Identify, sketch, and explain the function of points, construction lines, object lines, and hidden lines.
- Plot points on grid paper to aid in the creation of sketches and drawings.
- Explain the concepts of technical sketching and drawing.
- Sketch an isometric view of simple geometric solids.
- Explain how an oblique view of simple geometric solids differs from an isometric view.
- Sketch one-point, two-point, and three-point perspectives of simple geometric solids.
- Describe the concept of proportion as it relates to freehand sketching.
- Sketch multiview drawings of simple geometric solids.
- Determine the front view for a given object.
- Research and design a CD cover or book jacket on the origins of the measurement systems.
- Measure and record linear distances using a scale to a precision of 1/16 inch and 1 mm.
- Measure and record linear distances using a dial caliper to a precision of 0.001 inch.
- Add and subtract U.S. standard and metric linear measurements.
- Convert linear distance measurements from inches to millimeters and vice versa.
- Apply linear dimensions to a multiview drawing.
- Calculate the mean, mode, median, and range of a data set.
- Create a histogram of recorded measurements showing data elements or class intervals, and frequency.
- Brainstorm and sketch possible solutions to an existing design problem.
- Select an approach that meets or satisfies the constraints given in a design brief.
- Create simple extruded solid Computer Aided Design (CAD) models from dimensioned sketches.
- Generate dimensioned multiview drawings from simple CAD models.
- Measure and Fabricate parts for a functional prototype from the CAD multiview drawings.
- Assemble the product using the CAD modeling software.
- Test and evaluate the prototype and record results.
- Apply geometric and numeric constraints to CAD sketches.
- Identify the purpose of packaging in the design of consumer products.

Unit 2 – Design Solutions

Preface

This unit advances your design skills in the area of geometric shapes and solids, dimensioning, 3D modeling software, and an advanced design. You will learn how to calculate area and properties of solids. You will be introduced to working in teams and what it takes to come to a consensus. The unit will end with you using the design process to create a solution to a prescribed problem.

Concepts

1. Geometric shapes describe the two or three dimensional contours that characterize an object.
2. The properties of volume and surface area are common to all designed objects and provide useful information to the engineer.
3. Working drawings should contain only the dimensions that are necessary to build and inspect an object.

4. Solid modeling programs allow the designer to create quality designs for production in far less time than traditional design methods.
5. Engineers use CAD models, assemblies, and animations to check for design problems, verify the functional qualities of a design, and communicate information to other professionals and clients.
6. A design process most used by engineers includes defining a problem, brainstorming, researching, identifying requirements, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing, refining, making, and communicating results.
7. Teamwork requires constant communication to achieve the goal at hand.
8. Fluid Power Concepts could be used to enhance design solutions.

Performance Objectives

It is expected that students will:

- Identify common geometric shapes and forms by name.
- Calculate the area of simple geometric shapes.
- Calculate the surface area and volume of simple geometric forms.
- Identify and explain the various geometric relationships that exist between the elements of two-dimensional shapes and three-dimensional forms.
- Identify and define the axes, planes, and sign conventions associated with the Cartesian coordinate system.
- Apply geometric and numeric constraints to CAD sketches.
- Utilize sketch-based, work reference, and placed features to develop solid CAD models from dimensioned drawings.
- Explain how a given object's geometry is the result of sequential additive and subtractive processes.
- Explain the differences between size and location dimensions.
- Differentiate between datum dimensioning and chain dimensioning.
- Identify and dimension fillets, rounds, diameters, chamfers, holes, slots, and screw threads in orthographic projection drawings.
- Explain the rules that are associated with the application of dimensions to multiview drawings.
- Identify, sketch, and explain the difference between general tolerances, limit dimensions, unilateral, and bilateral tolerances.
- Differentiate between clearance and interference fits.
- Sketch and model an auxiliary view of a given object to communicate the true size and shape of its inclined surface.
- Describe the purpose and demonstrate the application of section lines and cutting plane lines in a section view drawing.
- Sketch a full and half section view of a given object to communicate its interior features.
- Identify algebraic relationships between the dimensional values of a given object.
- Apply assembly constraints to individual CAD models to create mechanical systems.
- Perform part manipulation during the creation of an assembly model.
- Explain how assembly constraints are used to systematically remove the degrees of freedom for a set of components in a given assembly.
- Create an exploded model of a given assembly.
- Determine ratios and apply algebraic formulas to animate multiple parts within an assembly model.
- Create and describe the purpose of the following items: exploded isometric assembly view, balloons, and parts list.
- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision making matrix.

- Select an approach that meets or satisfies the constraints given in a design brief.
- Create solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods.
- Apply geometric numeric and parametric constraints to form CAD modeled parts.
- Generate dimensioned multiview drawings from simple CAD modeled parts.
- Assemble the product using the CAD modeling software.
- Explain what constraints are and why they are included in a design brief.
- Create a three-fold brochure marketing the designed solution for the chosen problem, such as a consumer product, a dispensing system, a new form of control system, or extend a product design to meet a new requirement.
- Explain the concept of fluid power, and the difference between hydraulic and pneumatic power systems

Unit 3 – Reverse Engineering
Preface

Reverse Engineering is an important process in the redesign of products. Designers get an opportunity to breakdown and analyze each part of the product to see how they operate. The information gathered during this process can help the designer or team determine what they can do to make the product better and optimize manufacturing potential to increase company profits.

The process of Reverse Engineering involves analyzing the products function, structure, and visual elements. In this unit, you will get an opportunity to visit all three aspects of a product. You will use the information learned during these procedures and suggest possible changes you would make to improve a product.

Concepts

1. Visual design principles and elements constitute an aesthetic vocabulary that is used to describe an object.
2. Engineers perform reverse engineering on products to study their visual, functional, and structural qualities.
3. Operational conditions, material properties, and manufacturing methods help engineers determine the material makeup of a design.
4. Objects are held together by means of joinery, fasteners, or adhesives.
5. Engineers analyze designs to identify shortcomings and opportunities for innovation.
6. Engineers use reference sources and computer-aided design (CAD) systems to calculate the mass properties of designed objects.

Performance Objectives

It is expected that students will:

- Identify visual design elements within a given object.
- Explain how visual design principles were used to manipulate design elements within a given object.
- Explain what aesthetics is, and how it contributes to a design's commercial success.
- Identify the purpose of packaging in the design of consumer products.
- Identify visual design principles and elements that are present within marketing ads.
- Identify the intent of a given marketing ad and demographics of the target consumer group for which it was intended.
- Identify the reasons why engineers perform reverse engineering on products.
- Describe the function of a given manufactured object as a sequence of operations through visual analysis and inspection (prior to dissection).
- Describe the differences between joinery, fasteners, and adhesives.
- Identify the types of structural connections that exist in a given object.
- Use dial calipers to precisely measure outside and inside diameter, hole depth, and object thickness.

- Identify a given object's material type.
- Identify material processing methods that are used to manufacture the components of a given commercial product.
- Assign a density value to a material, and apply it to a given solid CAD model.
- Perform computer analysis to determine mass, volume, and surface area of a given object.
- Write design briefs that focus on product innovation.
- Identify group brainstorming techniques and the rules associated with brainstorming.
- Use decision matrices to make design decisions.
- Explain the difference between invention and innovation.

Unit 4 – Design Problems
Preface

This unit is designed to combine the knowledge and information learned in the previous units to an open ended design problem. You will apply the design process to create a solution to a problem that currently exists. You will also learn that by-products are created as a result of the solution, and what impacts they have on the environment and society. You will learn how to affectively market a product and create a virtual team to complete the tasks needed to solve real world problems.

Concepts

1. Market research and demographics provide useful information to companies for developing effective product advertising strategies.
2. Graphic designers are concerned with developing visual messages that make people in a target audience respond in a predictable and favorable manner.
3. The material of a product, how the material is prepared for use, its durability, and ease of recycling all impact a product's design, marketability, and life expectancy.
4. A conscious effort by product designers and engineers to investigate the recyclable uses of materials will play a vital role in the future of landfills and the environment.
5. Design teams establish group norms through brainstorming and consensus to regulate proper and acceptable behavior by and between team members.
6. Virtual teams rely on communications other than face-to-face contact to work effectively to solve problems.

Performance Objectives

It is expected that students will:

- Create a brainstorming list of different products made from common materials that are used daily.
- Research and construct a product impact timeline presentation of a product from the brainstorming list and present how the product may be recycled and used to make other products after its lifecycle is complete.
- Identify the five steps of a product's lifecycle and investigate and propose recyclable uses for the material once the lifecycle of the product is complete.
- Explain why teams of people are used to solve problems.
- Identify group norms that allow a virtual design team to function efficiently.
- Establish file management and file revision protocols to ensure the integrity of current information.
- Use internet resources, such as email, to communicate with a virtual design team member throughout a design challenge.
- Identify strategies for addressing and solving conflicts that occur between team members.
- Create a Gantt chart to manage the various phases of their design challenge.