Murrieta Valley Unified School District **Board Submission: April 2015**
HIGH SCHOOL COURSE OUTLINE

Course Title:	Introduction to Design (PLTW)
Department:	Industrial Technology
Course #:	2445
Grade Level/s:	9 or 10
Length of Course:	Year
Prerequisite/s:	Concurrent enrollment in Algebra or higher
UC/CSU (A-G) Req:	(F) Visual and Performing Arts Note – Introduction to Design is the same course as PLTW's Introduction to Engineering and Design with the addition of supplemental units of instruction and projects that address California's Visual and Performing Arts content standards. These supplemental units can be found at http://www.pltwca.us/share/ID_Supplemental_Unit.pdf
Brief Course Description:	Introduction to Design is the first course in the Project Lead the Way (PLTW) Engineering sequence. The major focus for this course is to expose students to the elements and principles of visual design using the engineering design process. Projects will focus on design factors such as aesthetics, format, geometric shape/form, perspective drawing, scale, proportion, and presentation techniques. Students will use computers as a medium/tool for design of project components such as sketching techniques, orthographic drawing, 2D+, 3D modeling and rendering. Assignment requirements are based on color, form and aesthetics with emphasis on the stages of the design process and critical thinking skills. In addition to the design process and principles of visual design, students will focus on research and analysis, teamwork, various communication methods, engineering standards, and technical documentation. Through hands-on projects, students will apply engineering standards while documenting their work and designs in an engineer's notebook. Students will design solutions to solve proposed problems and communicate solutions to peers and members of the professional community. The course assumes no previous knowledge, but students are to be concurrently enrolled in appropriate mathematics and science courses.

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I. GOALS

The student will:

A. Be able to express an understanding of the history and principles of engineering and design

B. Be able to express an understanding of the elements and principles of visual design

C. Know and understand various design factors such as aesthetics, format, geometric shapes, form, perspective drawings, scale and proportion

D. Be able to create both 2-D and 3-D drawings of an object

E. Be able to create, store, and print 3-D models and assemblies using Autodesk Inventor

F. Be able to determine mass properties of drawn objects

G. Be able to properly annotate drawings to American National Standards Institute (ANSI) standards

H. Be able to prepare and deliver a presentation

I. Understand the relationship between engineering design, production and marketing

J. Have a comprehensive portfolio of their best work to be included in their engineering notebook

II. OUTLINE OF CONTENT FOR MAJOR AREAS OF STUDY

Semester I

A. Unit 1: Design Process
   1. Intro to a Design Process
      a. Apply engineering notebook standards and protocols when documenting their work during the school year
      b. Identify and apply group brainstorming techniques and the rules associated with brainstorming
      c. Research a product's history, develop a PowerPoint presentation, list chronologically the major innovations to a product, and present findings to a group
      d. Use online and published works to research aspects of design problems
      e. Identify the design process steps used in given scenarios and be able to list the steps, if any are missing
   2. Intro To Technical Sketching and Drawing
      a. Identify, sketch, and explain the function of points, construction lines, object lines, and hidden lines
      b. Plot points on grid paper to aid in the creation of sketches and drawings
      c. Explain the concepts of technical sketching and drawing
      d. Sketch an isometric view of simple geometric solids

e. Explain how an oblique view of simple geometric solids differs from an isometric view
f. Sketch one-point, two-point, and three-point perspectives of simple geometric solids
g. Describe the concept of proportion as it relates to freehand sketching
h. Sketch multi-view drawings of simple geometric solids
i. Determine the front view for a given object

3. Measurement and Statistics
   a. Research and design a CD cover or book jacket on the origins of the measurement systems
   b. Measure and record linear distances using a scale to a precision of 1/16 inch and 1 mm
   c. Measure and record linear distances using a dial caliper to a precision of 0.001 inch
   d. Add and subtract U.S. standard and metric linear measurements
   e. Convert linear distance measurements from inches to millimeters and vice versa
   f. Apply linear dimensions to a multi-view drawing
   g. Calculate the mean, mode, median, and range of a data set
   h. Create a histogram of recorded measurements showing data elements or class intervals, and frequency
4. Project – Puzzle Cube
   a. Brainstorm and sketch possible solutions to an existing design problem
   b. Select an approach that meets or satisfies the constraints given in a design brief
   c. Create simple extruded solid Computer Aided Design (CAD) models from dimensioned sketches
   d. Generate dimensioned multi-view drawings from simple CAD models
   e. Measure and fabricate parts for a functional prototype from the CAD multi-view drawings
   f. Assemble the product using the CAD modeling software
   g. Test and evaluate the prototype and record results
   h. Apply geometric and numeric constraints to CAD sketches
   i. Identify the purpose of packaging in the design of consumer products

B. Unit 2: Design Exercises
1. Geometric Shapes and Solids
   a. Identify common geometric shapes and forms by name
   b. Calculate the area of simple geometric shapes
   c. Calculate the surface area and volume of simple geometric forms
   d. Identify and explain the various geometric relationships that exist between the elements of two-dimensional shapes and three-dimensional forms
   e. Identify and define the axes, planes, and sign conventions associated with the Cartesian coordinate system
   f. Apply geometric and numeric constraints to CAD sketches
   g. Utilize sketch-based, work reference, and placed features to develop solid CAD models from dimensioned drawings
   h. Explain how a given object's geometry is the result of sequential additive and subtractive processes

2. Dimensions and Tolerances
    a. Explain the differences between size and location dimensions
    b. Differentiate between datum dimensioning and chain dimensioning
    c. Identify and dimension fillets, rounds, diameters, chamfers, holes, slots, and screw threads in orthographic projection drawings
    d. Explain the rules that are associated with the application of dimensions to multi-view drawings
    e. Identify, sketch, and explain the difference between general tolerances, limit dimensions, unilateral, and bilateral tolerances
    f. Differentiate between clearance and interference fits
3. Advanced Modeling
    a. Sketch and model an auxiliary view of a given object to communicate the true size and shape of its inclined surface
    b. Describe the purpose and demonstrate the application of section lines and cutting plane lines in a section view drawing
    c. Sketch a full and half section view of a given object to communicate its interior features.
    d. Identify algebraic relationships between the dimensional values of a given object
    e. Apply assembly constraints to individual CAD models to create mechanical systems
    f. Perform part manipulation during the creation of an assembly model
    g. Explain how assembly constraints are used to systematically remove the degrees of freedom for a set of components in a given assembly
    h. Create an exploded model of a given assembly
    i. Determine ratios and apply algebraic formulas to animate multiple parts within an assembly model
    j. Create and describe the purpose of the following items: exploded isometric assembly view, balloons, and parts list
4. Advanced Designs
    a. Brainstorm and sketch possible solutions to an existing design problem
    b. Create a decision making matrix
    c. Select an approach that meets or satisfies the constraints given in a design brief
    d. Create solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods
    e. Apply geometric numeric and parametric constraints to form CAD modeled parts
    f. Generate dimensioned multi-view drawings from simple CAD modeled parts
    g. Assemble the product using the CAD modeling software
    h. Explain what constraints are and why they are included in a design brief
    i. 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
    j. Explain the concept of fluid power, and the difference between hydraulic and pneumatic power systems

C. Supplemental Art Curriculum (to be added during the first semester)

Content Overview & Curriculum Outline	**Connections**
An Introduction to Art *Self-Expression art project*	Help develop student's ability to generate original ideas
The Elements and Principles of Design The *Key Element of Line*	Technical Sketching & Visual Design Principles & Elements
Shape, Form and Value *Basic Geometric Shapes*	Technical / Perspective Sketching Geometric Shapes
The Element of Color *Color Theory & Kaleidoscope Project*	Intro mixing and color schemes for future project considerations
Stages of the Design Process *Artistic Media Essay – Using the Design Process*	The Design Process Overview Introduction to Research
Critical Analysis of Product Design *Form Follows Function w/ an IED project*	Connect to any Design Project or Open-ended Design Problem
Art History *Written Research Assignment*	Structure for required content in Art History for Visual Arts Standards
Studio Project One *Art Gallery and Landscape Design*	Optional Design Project
Style and Technique *Cont. Written Research Assignment*	Optional Supplement to Art History
Studio Project Two *Personal Sketchbook and Portfolio*	Portfolio Development

Semester II

A. Unit 3: Reverse Engineering
   1. Visual Analysis
      a. Identify visual design elements within a given object
      b. Explain how visual design principles were used to manipulate design elements within a given object
      c. Explain what aesthetics is, and how it contributes to a design's commercial success
      d. Identify the purpose of packaging in the design of consumer products
      e. Identify visual design principles and elements that are present within marketing ads
      f. Identify the intent of a given marketing ad and demographics of the target consumer group for which it was intended
   2. Functional Analysis
      a. Identify the reasons why engineers perform reverse engineering on products
      b. Describe the function of a given manufactured object as a sequence of operations through visual analysis and inspection (prior to dissection)
   3. Structural Analysis
      a. Describe the differences between joinery, fasteners, and adhesives
      b. Identify the types of structural connections that exist in a given object
      c. Use dial calipers to precisely measure outside and inside diameter, hole depth, and object thickness
      d. Identify a given object's material type

e. Identify material processing methods that are used to manufacture the components of a given commercial product
f. Assign a density value to a material, and apply it to a given solid CAD model
g. Perform computer analysis to determine mass, volume, and surface area of a given object

4. Product Improvement By Design
   a. Write design briefs that focus on product innovation
   b. Identify group brainstorming techniques and the rules associated with brainstorming
   c. Use decision matrices to make design decisions
   d. Explain the difference between invention and innovation

B. Unit 4: Open-Ended Design Problems
1. Engineering Design Ethics
   a. Create a brainstorming list of different products made from common materials that are used daily
   b. 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
   c. Identify the five steps of a product's lifecycle
2. Design Teams
   a. Explain why teams of people are used to solve problems
   b. Identify group norms that allow a virtual design team to function efficiently
   c. Establish file management and file revision protocols to ensure the integrity of current information
   d. Use internet resources, such as email, to communicate with a virtual design team member throughout a design challenge
   e. Identify strategies for addressing and solving conflicts that occur between team members
   f. Create a Gantt chart to manage the various phases of their design challenge

III. ACCOUNTABILITY DETERMINANTS

A. Key Assignments
1. Lesson 1.1: Introduction to a Design Process (11 days)
2. Lesson 1.2: Introduction to Technical Sketching and Drawing (11 days)
3. Lesson 1.3: Measurement and Statistics (10 days)
4. Lesson 1.4: Puzzle Cube (17 days)
5. Lesson 2.1: Geometric Shapes and Solids (10 days)
6. Lesson 2.2: Dimensions and Tolerances (9 days)
7. Lesson 2.3: Advanced Modeling Skills (19 days)
8. Lesson 2.4: Advanced Designs (12 days)
9. Lesson 3.1: Visual Analysis (8 Days)
10. Lesson 3.2: Functional Analysis (4 Day
11. Lesson 3.3: Structural Analysis (15 Days)
12. Lesson 3.4: Product Improvement By Design (16 Days)
13. Lesson 4.1: Engineering Design Ethics (8 Days)
14. Lesson 4.2: Design Teams (25 Days)

B. Assessment Methods

Assessment of student performance will include but not be limited to:

1. Participation, effort, skill mastery and quality of work presentations 10%
2. Engineers notebook / portfolio 25%
3. Tests and quizzes 25%
4. Individual projects/group projects/final projects 40%

IV. INSTRUCTIONAL MATERIALS AND METHODOLOGIES

A. Required Textbook(s)

Not applicable, as all instructional materials will be supplied through PLTW-Engineering

B. Supplementary Materials

1. See attached form with detailed list of supplemental materials required
2. Approximately $600 in class set materials
3. Approximately $150 per class section materials ($150 x # of sections)
4. Autodesk software included through PLTW-Engineering
5. School sites will use department funds and/or Perkins funds to purchase

C. Instructional Methodologies

Introduction to Design is a project-based engineering design course that engages students in a variety of activities that combine direct instruction with project work. Demonstrations, project briefs and round table critical thinking/brainstorming sessions are used to introduce new projects. Students are expected to apply the elements and principles of art learned during instructional time to each project. Each stage of the design process is identified and given a deadline. Students evaluate each other's work and the quality of process during instructor led critiques. Real world connections are enhanced through guest lecturers and community based field trips to institutions such as local engineering companies and corporate design centers.