2019--2020 COURSE SYLLABUS
Engineering Design with SolidWorks

John F. Kennedy High School (052713)

Course Created - Aug 7, 2018

Basic Course Information

Title:
Engineering Design with SolidWorks

Transcript abbreviations:
Engineering Design 1P/BAS 100, Engineering Design 2P/BAS 101

Length of course:
Full Year

Subject area:
Visual & Performing Arts (F) / Interdisciplinary Arts

UC honors designation?
No

Prerequisites:
None (Recommended)

Co-requisites:
Integrated mathematics (Recommended)

Integrated (Academics / CTE)?
Yes

Grade levels:
9th, 10th, 11th, 12th

Course learning environment:
Classroom Based

Instructor: Dave Indreland
david-indreland@scusd.edu
916.395.5090 Ext. 506506

COURSE OBJECTIVE

Students will be able think through the design process and apply knowledge of current technology software and manufacturing machines to produce their finished designs in a safe and ethical manner.

ATTENDANCE

Class attendance is extremely important in this class as we are working with hardware and software available only in our room. Given these time constraints and very little homework, I

expect bell to bell effort to accomplish our work. If you are absent, classwork may be made up and you are responsible to get assignment, complete it, and turn it in to your drop box.

EVALUATIONS AND EXPECTATIONS

Students will be evaluated on current topics, projects, tests, quizzes, homework, lab work, performance (LAB) testing and their individual portfolio. Students are expected to turn in first-class work. Other expectations include: *NO late work* accepted for full credit without prior approval; being on-time to class/labs; and all assignments must be original work.

GRADING POLICY

A=100-90
B=89-80
C=79-70
D=69-60
F=59-0

DAILY IN-CLASS PROCEDURES

- Take off your hats and hoods, turn off your cell phone, and put it away. If I hear or see your cell phone during class it will be taken and given to the VP.
- Find instructions and daily objective as to what equipment you will need (drafting tools, computer, etc.).
- At the end of class, make sure all materials are returned to the correct place and that your area is clean. I will dismiss you, not the bell.
- No food or drinks in class. We have a water fountain in class. Water and electronics ***do not*** mix.

SAFETY MISCONDUCT:

Tools and machines will be used in this course, so safety infractions where students intentionally endanger themselves and/or others will be cause for removal from the course. Students must pass a safety course in order to stay in the class.

ACADEMIC MISCONDUCT/INTEGRITY

Students found to be turning in work which is not their own or cheating (copying or plagiarizing), fabrication which is intentionally using or attempting to use unauthorized material/equipment resulting in falsification of any information or citation in an academic course including academic dishonesty to intentionally or knowingly helping or attempting to help another student to commit an act of academically dishonest behavior will receive a zero for that assignment and a parent contact will be made. Further acts of this nature may result in removal from the course.

PARENTS AS PARTNERS/Extra Help

When a student's grade falls below 70% they will be informed and urged to attend an intervention / collaboration time with a teacher. These will occur on Monday thru Friday after school between 3:20pm-4:30pm. Special times and days may be pre-arranged. Please contact me for any special considerations in the classroom/lab for your student.

Course Description

Course overview:

Engineering Design with SolidWorks is the introductory course for a Manufacturing and Product Development CTE Pathway. The methods of design, art and aesthetics are introduced to teach techniques used by product designers, engineers, and architects, both contemporary and historical. Drawing style and techniques include orthographic projection, perspective drawing and dimensioning. Students will use the core elements of art: Line, Shape, Form, Tone, Space, Texture and Color. Using the core elements of art, students will use visual expression to demonstrate creativity and mastery of course content. Students evolve from freehand and technical sketching to 3D parts modeling in SolidWorks. Students explore the world of computer assisted engineering, reverse engineering and rapid prototyping. Both the world of architectural and mechanical drawings and designs will be covered in this course. Students will create a comprehensive portfolio of drawings both pencil drawn and computer assisted. These portfolios will be used for final assessment and turned in to the college for articulated college credit for this course.

Course content:

Unit 1: History of Architecture and Engineering

Students will understand that architecture is a visual art. They will utilize a variety of techniques to “read” and “study” buildings, the stories they have to tell, the people who built them, and those who use them. Students will learn the characteristics that identify a certain building style and match them to homes in their community. They will understand that the house styles of the United States demonstrate a broad variety of architecture over the country's four centuries and that architecture in the United States is as diverse as its multicultural society and has been shaped by many internal and external factors and regional distinctions. Students will further explain why engineers/ architects design different types of homes in different locations and provide several examples of different home designs engineers/ architects might use for different climates (such as thick walls for desert climates, peaked roofs for snowy areas, elevated foundations for tropical climates). Students learn the wide range of building materials used to construct homes in different climates. Finally, historical bridges in North America will be discussed both as a societal impact and technical achievement.

Unit Assignment(s):

Example assignment #1: Students will do research on a famous engineer and prepare a formatted two page paper on the engineer and accomplishments.

Example assignment #2: Students will select an architectural example that has cultural relevance and give a short presentation to the class.

Example assignment #3: Short quiz on building materials types and purpose.

Unit 2: Design Process

The goal of Unit 2 is to introduce students to the broad field of the design process as applied to both engineering and architecture whereby those professionals use it to develop innovative solutions to real problems. Students become familiar with the traditional big four disciplines of engineering and the extensive array of career opportunities and engineering problems addressed within each discipline. A design process is presented as a structured method for approaching and developing solutions to a problem or needs of a client. The art and skill of brainstorming is emphasized as students begin to develop skill in graphically representing ideas through concept sketching. A variety of design challenges will be completed throughout this unit to familiarize students with the cyclical nature of the design process. Students will practice a seven step design process and learn about the process of building prototypes and design revisions. Design documentation and product life cycle software will be introduced.

Unit Assignment(s):

Example assignment #1: Students will choose and research five engineering careers of interest. For each engineering career, they will turn in one written paragraph explaining the type of work done by this type of engineer. Second, they will turn in another written paragraph explaining the educational journey to become this professional.

Example assignment #2: Students will work in groups of three to create an engineering change order. Each group will receive a written prompt about a simple product that has a known specific design flaw. They will discuss and follow a process to produce a documented design change.

Example assignment #3: Using a seven step design process, students will make a paper airplane. This plane will be documented with proof of multiple solutions and design revisions. The plane will be graded on how well the product matched the documented design process.

Unit 3: Technical Sketching and Drawing
The goal of Unit 3 is for students to develop an understanding of the purpose and practice of visual representations and communication within architecture and engineering in the form of technical sketching and drawing. This in depth unit will give students skills in orthographic projection, dimensioning, perspective drawing, two point perspective drawing, and 2D and 3D hand drawn representations. These drawing skills will be utilized throughout the year as students build skill and gain experience in representing three-dimensional objects in two dimensions. Students will create various technical representations used in visualization, exploring, communicating, and documenting design ideas throughout the design process, and they will understand the appropriate use of specific drawing views (including isometric, oblique, perspective, and orthographic projections). They progress from creating free hand technical sketches using a pencil and paper to developing CAD drawings according to accepted standards and practices that allow for universal interpretation of their design. Students will learn the value of communication through drawing of ideas.

Unit Assignment(s):
Example assignment #1: Every student will produce multiple hand drawings showing the use of multiple planes with use of a datum or WCS. The use of orthographic projection must be included.

Example assignment #2: Students will draw organic shapes such as fruit and cartoons to develop the core elements of art.

Example assignment #3: Students draw a 3D courthouse prospective drawing using proper shading and pencil technique.

Example assignment #4: Students organize the 20+ drawings and build a portfolio. Drawings are scanned to create a digital portfolio.

Unit 4: 3D CAD with SolidWorks
Students explore the mechanical world through a series of drawings, learning software, user configurations, and managing software functions. Managing the design tree and plane selection. Proper use of a WCS is learned along other fundamental 3D CAD set up constraints. Students draw over 20 solid 3D models that grow in complexity. Student are introduced to software tutorials, the course textbook and online resources. Students learn drawing standards and templates (ANSI and ISO) and dimensioning. Blue print reading and drawings with classical dimensioning, engineering specifications and call outs.

Unit Assignment(s):
Example assignment #1: Draw a four piece puzzle that mates on two planes. When assembled, this puzzle will be one stacked block with defined dimensions.

Example assignment #2: Students take a mechanical 3D solid model and create a blue print and title block with proper dimensioning.

Example assignment #3: Students will retrieve their digital portfolio from the prior unit and choose two hand drawings to convert into a solid model. This reinforces the concept of pencil to software development.

Unit 5: Measurement and Statistics
The goal of Unit 5 is for students to become familiar with appropriate practices and the applications of measurement (using U.S. Customary, Architectural and SI units). Students will understand that architects and engineers create blueprints using scale measurements. This allows a drawing for a large building to fit on a sheet of paper while keeping the drawing proportional. Architectural plans are extremely precise and filled with important details such as framing techniques, materials to use, window and door placement, and room sizes. Being able to interpret the design plans is important. Students will also learn appropriate

methods of making and recording measurements, including the use of measuring tools, as they come to understand the ideas of precision and accuracy of measurement and their implications on engineering design. The concepts of descriptive and inferential statistics are introduced as methods to mathematically represent information and data and are applied in the design process to improve product design, assess design solutions, and justify design decisions. With various design challenges in this unit, students will complete multi-step engineering calculations, make predictions based on data, use the data to inform decisions

Unit Assignment(s):

Example assignment #1: Students will demonstrate the use of measuring tools (Dial Calipers and Measuring Tape) by recording the size of know objects.

Example assignment #2: Students will be given a number of pre drawn buildings, structures and floor plans. The assignment is to scale the drawing to a defined size.

Example assignment #3: Students will scale a mechanical drawing to make the part fit in a small 3D printer for building a small scale prototype.

Unit 6: Intermediate 3D CAD with SolidWorks

This unit uses more advanced features of SolidWorks to help create an engineered solution to a complex problem. Add color and patterns to objects and make multiple views in a drawing. Make parts assemblies with more than 15 parts and use the mechanical and gear mates features to perform a motion test. Use of layers, hatch, text, dimensions and a title block. The use of hole wizard and mechanical fasteners. Importing parts from SolidWorks toolbox, libraries and online resources such as GrabCAD. Students learn file types and management of files. Parts are paper printed using PDF and JPEG. Students create STL files and 3D print their first parts.

Unit Assignment(s):

Example assignment #1: Students will design a simple gearbox using imported gears and fasteners. All other parts must be an original design. Parts must have proper mates and have mechanical motions.

Example assignment #2: 3D print the designed gearbox part and hand assemble. The gearbox must have good fit and function and be able to mechanically turn by hand.

Example assignment #3: Convert a mechanical part to a jpg and paper print.

Example assignment #4: Collect all digital parts drawn and add to student portfolio.

Unit 7: Modeling and Constructions

This unit introduces students to a variety of modeling methods and formats used to represent buildings, systems, components, processes, and other designs. Students will understand that there are two basic types of construction: commercial and residential. Commercial construction includes buildings like schools, stores, factories, businesses, etc. Students are provided experience in interpreting and creating blueprint designs as well as multiple forms of models common to engineering as they apply the design process to create a design solution. Students will use software to transform hand drawn blueprints to working CAD models. Students will create graphical models of design ideas using sketches and engineering drawings and create graphs and charts to represent quantitative data. Students will also be introduced to three-dimensional computer modeling used in construction. They will learn to represent simple objects in a virtual 3D environment that allows for realistic interactions and animation. The modeling software is also used to provide an efficient method of creating technical documentation of objects. Students are provided the opportunity to create a physical model of a design solution to be used for testing purposes. Mathematical modeling is introduced, and students learn to find mathematical representations (in the form of linear functions) to represent relationships discovered during the testing phase of the design process.

Unit Assignment(s):

Example assignment #1: Students will create a floor plan of a single family home. The first drawing will be pencil drawn, transferred to CAD and added to the student portfolio.

Example assignment #2: Students will use the floor plan from assignment #1 and create a frame structure in CAD. Proper framing methods and specifications of the building industry will be used in this 3D model.

Example assignment #3: Students will build a 3D model of the house to scale using balsa wood beams. The frame model should be exhibit grade of quality to show a potential customer.

Unit 8: Reverse Engineering

Unit 8 exposes students to the application of engineering principles and practices to reverse engineer a consumer product. Reverse engineering involves disassembling and analyzing a product or system in order to understand and document the visual, functional, and/or structural aspects of its design. In this unit students will have the opportunity to assess all three aspects of a product's design. Students will learn the visual design elements and principles and their application in design. They will perform a functional analysis to hypothesize the overall function and sequential operations of the product's component parts and assess the inputs and outputs of the process (es) involved in the operation of the product. Students will physically disassemble the product to document the constituent parts, their properties, and their interaction and operation. After carefully documenting these aspects of the visual, functional, and structural aspects of the product, students will assess the strengths and weaknesses of the product and the manufacturing process by which it was produced. Technical sketching and drawing both by hand and using CAD software will be used to document all parts of the reverse engineering process. It will also be an option for students to make an engineering change order, showing innovation, with the object being investigated.

Unit Assignment(s):

Example assignment #1: Study the design of a product, disassemble, measure and make technical drawings by hand. Transfer hand drawing to CAD.

Example assignment #2: Identify a component within the assembly that is has a high probability of failure based up design and cycle of mechanical parts. Redesign improved parts in CAD and 3D print the replacement and test.

Example assignment #3: Write a one page explanation of the newly modified part and why the engineering change was created. The point of failure should be well documented and explained rational for creating a revised part.

Example assignment#4: Using technical writing skills, create simple instructions on how to assemble the consumer product that is being reverse engineering in this unit. The instructions must be clear. The use of pictures and exploded views are mandatory.

Unit 9: Forces

Review of physics concepts and Newton's Laws. Gravity, Tension and Compression, Truss design, Seismic design, Structural Design, Lateral Resistance, foundations and frames. The use of proper engineering methods for high quality structures and the need for building codes. Students will model a small wooden bridge in CAD software and use design process for improvement. The assembly will receive a CAD simulation of loads and help to predict the strength of structure.

Unit Assignment(s):

Example assignment #1: Students will be paired for a bridge build competition amongst the class. The bridges will be mechanically assembled and glued.

Example assignment #2: Present the bridge and simulated load test results. Load the bridge and see if the breaking point and loads simulation were correct.

Course Materials

Textbooks

Title	Author	Publisher	Edition
SolidWorks/ Part 1 & 2-Basic Tools & Advanced Techniques	Tran, Paul	Schroff Development Corp. Publications	2012
Architecture Drafting and Design.	Hepler, Donald & Wallach, Paul & Hepler, Dana	Glenco McGraw-Hill	1998
Engineering Design	Singer& Lyons	Delmar Learning	2012

Websites

Title	URL	Affiliated Institution or Organization
Solidwize	https://solidwize.com/	Solidworks Gold Partner