Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 10 – Design Challenges

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="6">ESTABLISHED GOALS
It is expected that students will…

• G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
• G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
• G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
• G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
• G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">TRANSFER: Students will be able to independently use their learning to …

• T1 – Apply the design process to design a system, component, or process to meet desired needs within realistic constraints.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS: Students will understand that …

• U1 (Unit 1) – An engineering design process involves a characteristic set of practices and steps used to develop innovative solutions to problems.</td><td>ESSENTIAL QUESTIONS: Students will keep considering …

• EQ1 – Engineering has been referred to as the “stealth” profession. Do you think this is an appropriate label? Explain.
• EQ2 – If you had to describe one strategy that would most help an engineer be a good and effective designer, what would it be?</td></tr>
<tr><td colspan="2">Acquisition</td></tr>
<tr><td>KNOWLEDGE: Students will …

• K1 – Identify the steps in an engineering design process and describe the activities involved in each step of the process. U1</td><td>SKILLS: Students will …

• S1 – Develop and document an effective solution to a problem that meets specific design requirements. U1
• S2 – Document and describe the design process used in the solution of a problem and reflect on all steps of the design process. U1</td></tr>
</table>

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necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.		

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning
Project 10.1 Design Challenges	• Self/Peer review or evaluation prior to final submittal	• P10.1 Rubric • Conclusion Questions
Small Group/Class Discussion: Essential Question 1	• Teacher considers student responses and preconceptions in order to inform effective teaching	
Journal Entry: Essential Question 2		• Teacher assesses student responses

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems (B)	Knowledge and Skills
Project 10.1 Design Challenges	K1, S1, S2

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 1 – Design Process

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="4">ESTABLISHED GOALS
It is expected that students will…

• G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
• G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
• G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
• G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
• G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">TRANSFER: Students will be able to independently use their learning to …

• T1 – Apply the engineering design process to design a system, component, or process to meet desired needs within realistic constraints.
• T2 – Understand the role and impact of engineering and engineering solutions within a global, economic, environmental, and societal context.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS: Students will understand that …

• U1 – An engineering design process involves a characteristic set of practices and steps used to develop innovative solutions to problems.
• U2 – Brainstorming may take many forms and is used to generate a large number of innovative, creative ideas in a short time.
• U3 – Technical professionals clearly and accurately document and report their work using technical writing practice in multiple forms.
• U4 – Sketches, drawings, and images are used to record and convey specific types of information depending upon the audience and the purpose of the communication.
• U5 – Engineering consists of a variety of specialist sub-fields, with each contributing in different ways to the design and development of solutions to different types of problems.</td><td>ESSENTIAL QUESTIONS: Students will keep considering …

• Q1 -- When solving an engineering problem, how can we be reasonably sure that we have created the BEST solution possible? What is the evidence?
• Q2 – What is the most effective way to generate potential solutions to a problem? How many alternate solutions are necessary to ensure a good final solution?
• Q3 – What engineering accomplishment of the 20th century has had the greatest impact on society? Justify your answer.
• Q4 – What will be the biggest impact that engineering will have on society and your life in the 21st century? Justify your answer.
• Q5 – Engineering tends to be a male-dominated profession. Why is that?</td></tr>
</table>

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	Acquisition	
necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	***KNOWLEDGE:*** *Students will …* • K1 – Identify the steps in an engineering design process and describe the activities involved in each step of the process. U1 • K2 – Explain the concept of proportion and how it relates to freehand sketching. U4 • K3 – Identify and describe a variety of brainstorming techniques and rules for brainstorming. U2 • K4 – Differentiate between invention and innovation. U1 • K5 – Identify and differentiate between the work of an engineer and the work of a scientist. U5 • K6 – Identify and differentiate between mechanical, electrical, civil, and chemical engineering fields. U5	***SKILLS:*** *Students will …* • S1 – Generate and document multiple ideas or solution paths to a problem through brainstorming. U1, U2, U4 • S2 – Describe the design process used in the solution of a particular problem and reflect on all steps of the design process. U1 • S3 – Utilize an engineering notebook to clearly and accurately document the design process according to accepted standards and protocols to prove the origin and chronology of a design. U1, U3, U4 • S4 – Create sketches or diagrams as representations of objects, ideas, events, or systems. U4 • S5 – Explain the contributions of engineers from different engineering fields in the design and development of a product, system, or technology. U5 • S6 – Review and evaluate the written work of peers and make recommendations for improvement. U3

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Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems (B)	Knowledge and Skills
Activity 1.1 **Instant Challenge: Cable Car**	• Conclusion Questions #1-3		A1.1 Instant Challenge: Cable Car	S1
Small Group/Class Discussion: Essential Question – How might we create the best possible solution to a problem?	• Teacher considers student responses and preconceptions in order to inform effective teaching		A 1.2 Instant Challenge: Aerodynamic Distance	S1
Activity 1.2 **Instant Challenge Aerodynamic Distance**	• Conclusion Questions #1-3		A 1.3 Concept Sketching	K1, K2, S4
Activity 1.3 **Concept Sketching**	• Realistic and proportional representations in sketches	• Realistic and proportional representations in sketches • Conclusion questions #1-4	A 1.4 Product Improvement	S1, S4
Activity 1.4 **Product Improvement**	• Quantity and variety in brainstorming ideas.	• Realistic and proportional representations in sketches. • Conclusion questions #1-3	A 1.5 Deep Dive	K1, S2
Activity 1.5 **The Deep Dive**	• Appropriate classification of the tasks involved in a design process. • Conclusion Question #1,4,5,6	• Conclusion questions #2,3	A 1.6 Discover Engineering	K3, K5, K6, S5
Activity 1.6 **Discover Engineering**	• Understanding of appropriate descriptions of the roles and responsibilities of	• Conclusion questions # 1, 3	A 1.6b Engineering and Related STEM Careers (Optional)	S5, STEM Career Exploration

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	civil, chemical, mechanical and electrical engineers. • Conclusion question # 2, 4			
Activity 1.7 **What Is It?**	• Thorough peer review of essay using rubric. • Incorporation of suggested changes by author	• A 1.7 Rubric	A 1.7 What Is It?	K4, K6, S10, S5, S6
Activity 1.8 **Instant Challenge: Paper Bridge**	• Conclusion question #3 [Teamwork]	• Effective use and documentation of the design process (Engineering Notebook) • Design meets constraints and criteria of problem • Conclusion questions # 1, 2	A 1.8 Instant Challenge: Paper Bridge	K1, S1, S2, S3, S4
Activity 1.9 **Design Innovation**	• Appropriate classification of chosen design as invention or innovation • Appropriate research and documentation • Conclusion questions #2 - 4	• Conclusion question #1	A 1.9 Design Innovation	K6, S5
Unit Assessment Items	• All items	• All items		
Summative – EoC		• All items		

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 2 – Technical Sketching and Drawing

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Use the accepted practices and techniques of engineering graphics and technical drawings to clearly convey information and ideas.
- T2 – Poficiently apply spatial skills to conceptualize and understand objects in 3D space and visualize and understand mental rotation of objects and how they appear in different positions.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Technical drawings convey information according to an established set of drawing practices which allow for detailed and universal interpretation of the drawing.
- U2 – Hand sketching of multiple representations to fully and accurately detail simple objects or parts of objects is a technique used to convey visual and technical information about an object.
- U3 – Two- and three-dimensional objects share visual relationships which allow interpretation of one perspective from the other.
- U4 – The style of the engineering graphics and the type of drawing views used to detail an object vary depending upon the intended use of the graphic.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – How is technical drawing similar to and different from artistic drawing?
- Q2 – What can cause a technical drawing to be misinterpreted or to be inadequate when conveying the intent of a design to someone unfamiliar with the original problem or solution?
- Q3 – In what ways can technical drawings help or hinder the communication of problem solution in a global community?
- Q4 – Strong spatial-visualization skills have been linked to success in engineering. Why are spatial-visualization skills so important to engineering success?

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	Acquisition	
modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	***KNOWLEDGE:*** *Students will …* • K1 – Identify line types (including construction lines, object lines, hidden lines, and center lines) used on a technical drawing per ANSI Line Conventions and Lettering Y14.2M-2008 and explain the purpose of each line. U1 • K2 – Identify and define technical drawing representations including isometric, orthographic projection, oblique, and perspective views. U1, U4 • K3 – Identify the proper use of each technical drawing representation including isometric, orthographic projection, oblique, and perspective views. U1, U4	***SKILLS:*** *Students will …* • S1 – Apply tonal shading to enhance the appearance of a pictorial sketch and create a more realistic appearance of a sketched object. U1, U4 • S2 – Hand sketch isometric views of a simple object or part at a given scale using the actual object, a detailed verbal description of the object, a pictorial view of the object, or a set of orthographic projections. U1, U2, U4 • S3 – Hand sketch 1-point and 2-point perspective pictorial views of a simple object or part given the object, a detailed verbal description of the object, a pictorial view of the object, and/or a set of orthographic projections. U1, U2, U4 • S4 –Select flat patterns (nets) that fold into geometric solid forms. U3 • S5 – Hand sketch orthographic projections at a given scale and in the correct orientation to fully detail an object or part using the actual object, a detailed verbal description of the object, or a pictorial and isometric view of the object. U1, U2, U3, U4 • S6 – Determine the minimum number and types of views necessary to fully detail a part. U1, U4 • S7 – Choose and justify the choice for the best orthographic projection of an object to use as a front view on technical drawings. U1, U4

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning
A2.1 Isometric Sketching	• Peer/teacher assessment of Sketching tasks 4 – 8	• Essential Question 1 • Additional sketches from #6 and $8 • Conclusion Questions
Small Group/Class Discussion: Essential Question 1	Teacher considers student responses and preconceptions in order to inform effective teaching	
A2.2 Perspective Sketching	• Peer/teacher assessment of sketching tasks 3 – 5 • Conclusion Questions 1 - 2	• Additional sketches of puzzle pieces or from #5 • Conclusion Question 3
Class Discussion: Essential Question 2	Teacher considers student responses and preconceptions in order to inform effective teaching	
A2.3 Glass Box	• Conclusion Questions	
A2.4 Multi-view Sketching	• Peer/teacher assessment of sketching tasks 3 – 5 • Conclusion Questions 1 - 2	• Conclusion Question 3 – 5 • Additional sketches from Extending Your Learning
A2.5 Sketching Practice	• Conclusion Questions	• All tasks and and conclusion questions
Small Group/Class Discussion: Essential Questions 3 and 4	Teacher considers student responses and preconceptions in order to inform effective teaching	
Interim/Common Assessment	All items	All items
Summative – EoC		All items

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems (B)	Knowledge and Skills
A2.1 Isometric Sketching	K1, K2, K3, S1, S2
A2.2 Perspective Sketching	K1, K2, K3, S1, S3
A2.3 Glass Box	K1, K2, K3, S4, S5
A2.4 Multi-view Sketching	K1, K2, K3, S5, S6, S7
A2.5 Sketching Practice	K1, K2, K3, S1, S2, S3, S4, S5, S7

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 3 – Measurement and Statistics

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Analyze and interpret data in order to make valid and reliable claims or determine optimal design solutions.
- T2 – Apply mathematics and computational thinking (specifically ratios, rates, percentages, and unit conversions) to solve problems involving quantities and units (including derived or compound units).

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Error is unavoidable when measuring physical properties, and a measurement is characterized by the precision and accuracy of the measurement.
- U2 – Units and quantitative reasoning can guide mathematical manipulation and the solution of problems involving quantities.
- U3 – Dimensions are included on technical drawings according to accepted practice and an established set of standards so as to convey size and location information about detailed parts and their features.
- U4 – Statistical analysis of uni-variate data facilitates understanding and interpretation of numerical data and can be used to inform, justify, and validate a design or process.
- U5 – Spreadsheet programs can be used to store, manipulate, represent, and analyze data efficiently.

ESSENTIAL QUESTIONS*: Students will keep considering …*

- Q1 – Can statistics be interpreted to justify conflicting viewpoints? Can this affect how we use statistics to inform, justify and validate a problem solution?
- Q2 -- Why is error unavoidable when making a measurement?
- Q3 – When recording measurement data, why is the use of significant figures important?
- Q4 – What strategy would you use to teach another student how to use units and quantitative reasoning to solve a problem involving quantities? (For example, a problem like A3.2 number 4 or number 5.)
- Q5 – What would happen if engineers did not follow accepted dimensioning standards and guidelines but, instead, used their own individual dimensioning methods?
- Q6 – When measuring the length of a part, would an inaccurate (but precise) measuring instrument be more or less likely to indicate the actual measurement than an

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necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.		imprecise (but accurate) measuring instrument? Justify your answer.
	Acquisition	
	KNOWLEDGE: *Students will …* • K1 – Identify general rules for dimensioning on technical drawings used in standard engineering practice. U3 • K2 – Distinguish between sample statistics and population statistics and know appropriate applications of each. U4 • K3 – Distinguish between precision and accuracy of measurement. U1	***SKILLS:*** *Students will …* • S1 – 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. U1 • S2 – Use units to guide the solution to multi-step problems through dimensional analysis and choose and interpret units consistently in formulas. U2 • S3 – Convert quantities between units in the SI and the US Customary measurement systems. U2 • S4 – Convert between different units within the same measurement system including the SI and US Customary measurement systems. U2 • S5 – Dimension orthographic projections of simple objects or parts according to a set of dimensioning standards and accepted practices. U3 • S6 – Identify and correct errors and omissions in the dimensions applied in a technical drawing based on accepted practice and a set of dimensioning rules. U5 • S7 – Calculate statistics related to central tendency including mean, median, and mode. U4 • S8 – Calculate statistics related to variation of data including (sample and population) standard deviation and range. U4 • S9 – Represent data with plots on the real number line (e.g., dot plots, histograms, and box plots). U4 • S10 – Use statistics to quantify information, support design decisions, and justify problem solutions. U4 • S11 – Use a spreadsheet program to store and manipulate raw data. U5 • S12 – Use a spreadsheet program to perform calculations

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		using formulas. U5 • S13 – Use a spreadsheet program to create and display a histogram to represent a set of data.U5 • S14 – Use function tools within a spreadsheet program to calculate statistics for a set of data including mean, median, mode, range, and standard deviation. U5 • S15 – Use the Empirical Rule to interpret data and identify ranges of data that include 68 percent of the data, 95 percent of the data, and 99.7 percent of the data given the appropriate descriptive statistics. U4 • S16 – Choose a level of precision and accuracy appropriate to limitations on measurement when reporting quantities.U1 • S17 – Evaluate and compare the accuracy and precision of different measuring devices. U1, U4

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning
Activity 3.1a Linear Measurement with Metric Units	• Tasks #9 and #10 • Conclusion Questions	• Tasks similar to #9 and #10
Activity 3.1b Linear Measurement with US Customary Units	• Peer/teacher assessment of Tasks #10 and #11 • Conclusion Questions	• Tasks similar to #10 and #11
Journal Entry: Essential Question 2	Teacher considers student responses and preconceptions in order to inform effective teaching	
Activity 3.2 Unit Conversion	• Conclusion Questions	
Activity 3.2h Unit Conversion Homework		• Peer/teacher evaluation of all tasks
Journal Entry: Essential Question 4	Teacher considers student responses and preconceptions in order to inform effective teaching	
Activity 3.3 Making Linear Measurements	• Optional task from #5 • Conclusion Questions	• Optional task from #5
Activity 3.3 Making Linear Measurements ALTERNATE	• Conclusion Questions	• Optional task from A3.3 #5
Activity 3.4 Linear Dimensions	• Peer/teacher assessment of task #10 • Conclusion Questions	• Extend Your Learning #11 – 13. • Follow instructions for #8 with another puzzle cube piece
Class Discussion: Essential Question 5	Teacher considers student responses and preconceptions in order to inform effective teaching	

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems (B)	Knowledge and Skills
Activity 3.1a Linear Measurement with Metric Units	S1
Activity 3.1b Linear Measurement with US Customary Units	S1
Activity 3.2 Unit Conversion	S2, S3, S4
Activity 3.2h Unit Conversion Homework	S2, S3, S4
Activity 3.3 Making Linear Measurements	S1
Activity 3.3 Making Linear Measurements ALTERNATE	S1
Activity 3.4 Linear Dimensions	K1, S5, S6

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Activity 3.5 Applied Statistics	• Conclusion Questions	• Follow instructions for #2 with alternate Automoblox data
Activity 3.6 Instant Challenge: Fling Machine		• Conclusion Questions
Activity 3.7 Statistical Analysis with Excel Statistical Analysis Examples	• Peers compare results of Parts 2 and Parts 3 • Conclusion Questions	• Conclusion Question 1
Activity 3.8 Precision and Accuracy of Measurement	• Peer/teacher assessment of task #3 • Conclusion Questions	
Small Group/Class Discussion or Journal Entry: Essential Question 3 and Essential Question 6	Teacher considers student responses and preconceptions in order to inform effective teaching	
Activity 3.9 Statistics and Quality		• Peer/teacher assessment of all tasks
Small Group/Class Discussion: Essential Question 1	Teacher considers student responses and preconceptions in order to inform effective teaching	
Activity 3.10 Instant Challenge: Oil Spill (Optional)	• Conclusion Questions	
Unit Assessment Items	• All items	• All items
Summative – EoC		• All items

Activity 3.5 Applied Statistics	S7, S8, S9
Activity 3.6 Instant Challenge: Fling Machine	S7, S8, S9, S10, S14
Activity 3.7 Statistical Analysis with Excel Statistical Analysis Examples	K2, S11, S12, S13
Activity 3.8 Precision and Accuracy of Measurement	K2, K3, S1, S9, S10, S11, S12, S13, S14, S15, S16, S17
Activity 3.9 Statistics and Quality	S1, S10, S11, S12, S13, S14
Activity 3.10 Instant Challenge: Oil Spill (Optional)	S7

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 4 – Modeling Skills

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Use the engineering design process to design a system, component, or process to meet desired needs within realistic constraints.
- T2 – Create and use mathematical/computational models or simulations to represent design solutions or support explanations.
- T3 – Develop and use multiple types of models to analyze systems, components or processes and/or to solve problems.
- T4 – Use current engineering tools (ex., spreadsheet software, CADD software) in problem solving and engineering design.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Technical professionals use a variety of models to represent systems, components, processes and other designs including graphical, computer, physical, and mathematical models.
- U2 – Computer aided drafting and design (CAD) software packages facilitate the creation of virtual 3D computer models of parts and assemblies.
- U3 – 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.
- U4 – Technical professionals clearly and accurayely

ESSENTIAL QUESTIONS: *Students will keep considering …*

- EQ1 – How should one decide what information and/or artifacts to include in a portfolio? Should a portfolio always include documentation on the complete design process?
- EQ2 – Did you use every possible type of model during the design and construction of your puzzle cube? Describe each model that you used?
- EQ3 – How reliable is a mathematical model?

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practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	document and report their work using technical writing practice in multiple forms. • U5 – An equation is a statement of equality between two quantities that can be used to describe real phenomenon and solve problems. • U6 – Solving mathematical equations and inequalities involves a logical process of reasoning and can be accomplished using a variety of strategies and technological tools. • U7 – A function describes a special relationship between two sets of data and can be used to represent a real world relationship and to solve problems.	
	Acquisition	
	KNOWLEDGE: *Students will …* • K1 – Explain the term "function" and identify the set of inputs for the function as the domain and the set of outputs from the function as the range. U7 • K2 – Be familiar with the terminiology related to and the use of a 3D solid modeling program in the creation of solid models and technical drawings. U2 • K3 – Differentiate between additive and subtractive 3d solid modeling methods. U2	***SKILLS:*** *Students will …* • S1 – Develop and/or use graphical, computer, physical and mathematical models as appropriate to represent or solve problems. • S2 – Fabricate a simple object from technical drawings that may include an isometric view and orthographic projections. U1, U5 • S3 – Create three-dimensional solid models of parts within CAD from sketches or dimensioned drawings using appropriate geometric and dimensional constraints. U1, U2 • S4 – Generate CAD multi-view technical drawings, including orthographic projections and pictorial views, as necessary, showing appropriate scale, appropriate view selection, and correct view orientation to fully describe a simple part according to standard engineering practice. U1, U2 • S5 – Construct a testable prototype of a problem solution. U1, U3

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		• S6 – Analyze the performance of a design during testing and judge the solution as viable or non-viable with respect to meeting the design requirements. U3 • S7 – Create a set of working drawings to detail a design project. U1, U2 • S8 – Organize and express thoughts and information in a clear and concise manner. U4 • S9 – Utilize project portfolios to present and justify design projects. U4 • S10 – Use a spreadsheet program to graph bi-variate data and determine an appropriate mathematical model using regression analysis. U1, U7 • S11 – 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. U1, U5 • S12 – Solve equations for unknown quantities by determining appropriate substitutions for variables and manipulating the equations. U6 • S13 – Use function notation to evaluate a function for inputs in its domain and interpret statements that use function notation in terms of a context. U7 • S14 – Build a function that describes a relationship between two quantities given a graph, a description of a relationship, or two input-output pairs. U1, U7 • S15 – Interpret a function to solve problems in the context of the data. U6, U7 • S16 – Interpret the slope (rate of change) and the intercept (constant term) of a linear function in the context of data. U1, U5 • S17 – Compare the efficiency of the modeling method of an object using different combinations of additive and subtractive methods. U2

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning
P4.1 Puzzle Design Challenge		• P4.1 Rubric • Conclusion Questions
Class Discussion: Essential Question 1	• Teacher considers student responses and preconceptions in order to inform effective teaching	
A4.1a Puzzle Part Combinations	• Puzzle piece sketches • Conclusion Questions	
A4.1b Graphical Modeling	• Peer review of sketches per task #6	
A4.1c Mathematical Modeling	• Peers compare/correct answers to Parts 2 and 3	• Conclusion Questions
Small Group/Class Discussion: Essential Question 3	• Teacher considers student responses and preconceptions in order to inform effective teaching	
A4.1d Software Modeling Introduction (Digital STEAM)	• Conclusion Questions	
A4.1e Software Modeling Introduction (Video Download)	• Conclusion Questions	
A4.1f Software Modeling Introduction Reference	n/a	n/a
A4.1g Model Creation	• Peers compare physical properties of 3D models in Inventor and identify mistakes. • Conclusion Questions	• Student modeling of a simple solid object similar to those included in activity from a dimensioned isometric view

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems (B)	Knowledge and Skills
P4.1 Puzzle Design Challenge	S1, S2, S3, S4, S5, S6, S7, S8, S9
A4.1a Puzzle Part Combinations	S1
A4.1b Graphical Modeling	S1, (S2), S8
A4.1c Mathematical Modeling	K1, S1, S10, S11, S12, S13, S14, S15, S16
A4.1d Software Modeling Introduction (Digital STEAM)	K2, S1
A4.1e Software Modeling Introduction (Video Download)	K2, S1
A4.1f Software Modeling Introduction Reference	
A4.1g Model Creation	K2, K3, S1, S3, S17

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Journal Entry: Essential Question 3		• Teacher assesses student responses
A4.2 Puzzle Cube Package (Optional)	• Conclusion Questions	• A4.2 Rubric
Unit Assessment Items	• All items	• All items
Summative – EoC		• All items

A4.2 Puzzle Cube Package (Optional)	(S1, S2, S5)

Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 5 – Geometry of Design

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Use current engineering tools (ex., spreadsheet software, CADD software) to create models, solve problems and perform engineering design.
- T2 – Apply geometric concepts and methods to describe and model objects and solve problems.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Geometric shapes and forms are described and differentiated by their characteristic features.
- U2 – 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.
- U3 – Computer aided design (CAD) and drafting software packages incorporate the application of a variety of geometric and dimensional constraints and model features to accurately represent objects.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- EQ1 – What advantage(s) do Computer Aided Design (CAD) and Drafting provide over traditional paper and pencil design? What advantages does paper and pencil design provide over CAD?
- EQ2 – Which high school math topic/course, Algebra or Geometry, is more closely related to engineering? Justify your answer.
- EQ3 – How does the material chosen for a product impact the design of the product?

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	Acquisition	
to use the techniques, skills, and modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	***KNOWLEDGE:*** *Students will …* • K1 – Identify types of polygons including a square, rectangle, pentagon, hexagon, and octagon. U1, U2 • K2 – Differentiate between inscribed and circumscribed shapes. U1, U2 • K3 – 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) and the results when applied to sketch features within a 3D solid modeling environment. U1, U2, U3 • K4 – Distinguish between the meanings of the terms weight and mass. U2 • K5 – Define the term "physical property" and identify the properties of length, volume, mass, weight, density, and surface area as physical properties. U2 • K6 – Identify three-dimensional objects generated by rotations of two-dimensional shapes and vice-versa. U1	***SKILLS:*** *Students will …* • S1 – 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. U1, U2 • S2 – Create three-dimensional solid models of parts within CAD from sketches or dimensioned drawings using appropriate geometric and dimensional constraints and model features. U1, U3 • S3 – Measure mass with accuracy using a scale and report the measurement using an appropriate level of precision. U2 • S4 – Measure volume with accuracy and report the measurement with an appropriate level of precision. U2 • S5 – 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). U2 • S6 – Solve volume problems using volume formulas for rectangular solids, cylinders, pyramids, cones, and spheres. U2 • S7 – Use physical properties to solve design problems (e.g., design an object or structure to satisfy physical constraints or minimize cost). U2 • S8 – 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.U2, U3 • S9 – 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. U2, U3

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Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems (B)	Knowledge and Skills
Journal Entry: Essential Question 2	Teacher considers student responses and preconceptions in order to inform effective teaching			
A5.1 Calculating Properties of Shapes	• Peers compare answers for task #10	• Conclusion Questions	A5.1 Calculating Properties of Shapes	K1, K2, S1, S2
A5.2a Geometric Constraints		• Conclusion Questions	A5.2a Geometric Constraints	K1, K3, S2
A5.2b Introduction to CAD Modeling Skills	• Conclusion Questions		A5.2b Introduction to CAD Modeling Skills	K1, K2, K3, S2
P5.3 Determining Density	• Peers compare answers and make corrections to Extend your learning task responses.	• Conclusion Questions • Determine density of teacher supplied object made of unknown material and make prediction of material.	P5.3 Determining Density	K4, S3, S4, S5, S6
A5.4 Calculating Properties of Solids	• Peers compare answers and make corrections to all tasks	• Conclusion Questions	A5.4 Calculating Properties of Solids	K4, K5, S1, S5,S6, S7
A5.5a CAD Model Features Part 1	• Peer review and comparison of 3D model(s) including physical properties	• Conclusion Questions	A5.5a CAD Model Features Part 1	K3, K6, S2
A5.5b CAD Model Features Part 2	• Peer review and comparison of 3D model(s) including physical properties	• Conclusion Questions	A5.5b CAD Model Features Part 2	K3, S2

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A5.6 Physical Property Analysis	• Peers compare answers, identify errors and correct mistakes	• Construct teacher generated 3D model and answer questions similar to those for Examples 1, 2, and 3 • Conclusion Questions	A5.6 Physical Property Analysis	S5, S7, S6, S7, S8, S9
Small Group/Class Discussion: Essential Questions 2 and 3	Teacher considers student responses and preconceptions in order to inform effective teaching			
A5.7 Instant Challenge: Choremaster	• Conclusion Questions		A5.7 Instant Challenge: Choremaster	K1 (Unit 1), S2 (Unit 1), S3 (Unit 1)
Unit Assessment Items	• All items	• All items		
Summative – EoC		• All items		

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 6 – Reverse Engineering

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Communicate technical information or ideas in multiple formats including orally, graphically, textually and mathematically, as appropriate.
- T2 – Plan and conduct an investigation or test a design to gather data to document a design, build and revise models, and/or solve a problem.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – 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.
- U2 – Visual elements and principles of design are part of an aesthetic vocabulary that is used to describe the visual characteristics of an object, the application of which can affect the visual appeal of the object and its commercial success in the marketplace.
- U3 – Technical professionals use the results of reverse engineering for many different purposes such as discovery, testing, forensics, improvement or redesign, and producing technical documentation of a product.
- U3 (Unit 1) – Technical professionals clearly and accurately document and report their work using technical writing practice in multiple forms.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – Why are many consumer product designs not commercially successful?
- Q2 – When, if ever, is it acceptable for a company to reverse engineer and reproduce a successful consumer product designed by another person/company?

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<table>
<tr>
<td rowspan="3">modern engineering tools necessary for engineering practice.
• G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
• G7 – Demonstrate an understanding of professional and ethical responsibility.
• G8 – Demonstrate an ability to function on multidisciplinary teams.
• G9 – Demonstrate an ability to communicate effectively.
• G10 – Gain knowledge of contemporary issues.
• G11 – Recognize the need for, and develop an ability to engage in life-long learning.</td>
<td>• U4 (Unit 1) – Sketches, drawings, and images are used to record and convey specific types of information depending upon the audience and the purpose of the communication.</td>
<td></td>
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<tr>
<td colspan="2">Acquisition</td>
</tr>
<tr>
<td>KNOWLEDGE: Students will …

• K1 – Identify and describe the visual principles and elements of design apparent in a natural or man-made object. U1, U2
• K2 – Describe the process of reverse engineering. U1, U2
• K3 – Explain the various reasons to perform reverse engineering including discovery, documentation, investigation, and product improvement. U1, U3</td>
<td>SKILLS: Students will …

• S1 – Explain how the visual elements and principles of design affect the aesthetics and commercial success of a product. U1, U2
• S2 – Perform a functional analysis of a product in order to determine the purpose, inputs and outputs, and the operation of a product or system. U1
• S3 – Perform a structural analysis of a product in order to determine the materials used and the form of component parts as well as the configuration and interaction of component parts when assembled (if applicable). U1
• S4 – Select and utilize technology (software and hardware) to create high impact visual aids. U3 (Unit 1), U4, (Unit 1)</td>
</tr>
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Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems (B)	Knowledge and Skills
Activity 6.1 Elements and Principles of Design Identification	• Peer assessment of visual analysis	• Conclusion Questions	Activity 6.1 Elements and Principles of Design Identification	K1, S1
Activity 6.2 Visual Analysis Automoblox		• Assessment of visual analysis • Conclusion Questions	Activity 6.2 Visual Analysis Automoblox	K1, S1
Activity 6.2a Visual Analysis ALTERNATE		• Assessment of visual analysis • Conclusion Questions	Activity 6.2a Visual Analysis ALTERNATE	K1, S1
Project 6.3 Functional Analysis Automoblox	• Peers compare black box model	• Conclusion Questions	Project 6.3 Functional Analysis Automoblox	K2, K3, S2
Project 6.3a Functional Analysis ALTERNATE	• Peers compare black box model	• Conclusion Questions	Project 6.3a Functional Analysis ALTERNATE	K2, K3, S2
Small Group/Class Discussion: Essential Question 2	• Teacher considers student responses and preconceptions in order to inform effective teaching			
Activity 6.4 Structural Analysis Automoblox	• Peers compare answers to #4 and #5	• Conclusion Questions	Activity 6.4 Structural Analysis Automoblox	K2, S3, S3
Activity 6.4a Product Disassembly ALTERNATE	• Peers compare answers responses	• Conclusion Questions	Activity 6.4a Product Disassembly ALTERNATE	K2, S3
Journal Entry: Essential Question 1		• Teacher assesses student responses		
Activity 6.5 Product Reverse Engineering Presentation		• P6.5 Rubric • Conclusion Questions	Activity 6.5 Product Reverse Engineering Presentation	K1, K2, S1, S4
Unit Assessment Items	• All items	• All items		
Summative – EoC		• All items		

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 7 – Documentation

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Define a design problem that involves criteria and constraints that may include social, technical and/or environmental considerations. T2 – Use the engineering design process to design a system, component, or process to meet desired needs within realistic constraints.
- T3 – Communicate technical information or ideas in multiple formats including orally, graphically, textually and mathematically, as appropriate.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Specific notes (such as hole and thread notes), and general notes (such as general tolerances) in combination with dimensions are included on technical drawings according to accepted practice and an established set of standards so as to convey size and location information about detailed parts, their features, and their configuration in assemblies.
- U2 – Computer aided drafting and design (CAD) software packages facilitate virtual modeling of assemblies and the creation of technical drawings. They are used to efficiently and accurately detail assemblies according to standard engineering practice.
- U3 – A degree of variation always exists between specified dimensions and the measurement of a manufactured object which is controlled by the use of

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 -- What are the consequences to the final solution if the design problem is poorly communicated?
- Q2 – How does one know that a given design solution is the best possible solution?
- Q3 – Engineering is described as the application of math, science and technology to solve problems. Does this description imply that designing an enhancement to an Automoblox vehicle is the work of an engineer? Justify your answer.
- Q4 – What quality makes a set of drawings sufficient to adequately represent the design intent?
- Q5 – Is it always necessary to indicate a tolerance for every dimension on a technical drawing? Justify your answer.
- Q6 -- Stephen Covey includes *Begin with the End in Mind*

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necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	tolerances on technical drawings. • U4 – A problem and the requirements for a successful solution to the problem should be clearly communicated and justified. • U5 – A solution path is selected and justified by evaluating and comparing competing design solutions based on jointly developed and agreed-upon design criteria and constraints. • U1 (Unit1) – Technical drawings convey information according to an established set of drawing practices which allow for detailed and universal interpretation of the drawing. • U4 (unit 1) – The style of the engineering graphics and the type of drawings views used to detail an object vary depending upon the intended use of the graphic.	as one of the seven habits listed in his book The 7 Habits of Highly Effective People. How can this habit make an engineer more effective? • Q7- In your opinion which step of the design process is most important to successfully innovate or invent a new product? Justify your answer.
	KNOWLEDGE: *Students will …* • K1 – Identify and differentiate between size dimensions and location dimensions. U1, U1 (Unit 1) • K2 – Identify and correctly apply chain dimensioning or datum dimensioning methods to a technical drawing. U1, U1 (Unit 1) • K3 – Identify dimensioning standards commonly used in technical drawing. U1, U1 (Unit 1) • K4 – Identify the shapes of two-dimensional cross sections of three dimensional objects. U6 • K5 – Identify, define and explain the proper use of a section view in technical drawing. U1 (unit 1), U4 (Unit 1) • K6 – Read and interpret a hole note to identify the size and type of hole including through, clearance, blind,	***SKILLS:*** *Students will …* • S1 – Hand sketch a scaled full or half section view in the correct orientation to fully detail an object or part given the actual object, a detailed verbal description of the object, a pictorial view of the object, or a set of orthographic projections. U1 (Unit 1), U4 (Unit 1) • S2 – Generate section views using CAD according to standard engineering practice. U1, U2, U1 (Unit 1) • S3 – Dimension a section view of a simple object or part according to a set of dimensioning standards and accepted practices. U1, U2, U1 (Unit1) • S4 – Annotate (including specific and general notes) working drawings according to accepted engineering practice. Include dimensioning according to a set of dimensioning rules, proper hole and thread notes, proper tolerance annotation, and the inclusion of other notes necessary to fully describe a part according to standard

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	counter bore, and countersink holes. U1, U1 (Unit 1) • K7 – Identify and differentiate among limit dimensions, a unilateral tolerance, and a bilateral tolerance. U3 • K8 – Differentiate between clearance and interference fit. U3 • K9 – Explain each assembly constraint (including mate, flush, insert, and tangent), its role in an assembly model, and the degrees of freedom that it removes from the movement between parts. U2	engineering practice. U1, U2, U1 (Unit 1) • S5 – Create specific notes on a technical drawing to convey important information about a specific feature of a detailed object, and create general notes to convey details that pertain to information presented on the entire drawing (such as units, scale, patent details, etc.). U1, U2, U1 (Unit 1) • S6 – Model and annotate (with a hole note) through, clearance, blind, counter bore, and countersink holes. U1, U2, U1 (Unit 1) • S7 – Compare the effect of chain dimensioning and datum dimensioning on the tolerance of a particular specified dimension. U1, U3 • S8 – Determine the specified dimension, tolerance, upper limit, and lower limit for any given dimension and related tolerance (or any distance that is dependent on given dimensions) shown on a technical drawing. U1, U1, U3 • S9 – Determine the allowance between two mating parts of an assembly based on dimensions given on a technical drawing. • S10 – Identify the type of fit given a drawing, a description, or a physical example of two mating parts. U1, U3, U1 (Unit) • S11 – Create assemblies of parts in CAD and use appropriate assembly constraints to create an assembly that allows correct realistic movement among parts. Manipulate the assembly model to demonstrate the movement. U2 • S12 – Create a CAD assembly drawing. Identify each component of the assembly with identification numbers and create a parts list to detail each component using CAD. U1, U2 • S13 – Analyze information gathered during reverse engineering to identify shortcoming of the design and/or opportunities for improvement or innovation. U7, U14 • S14 – Define and justify a design problem and express

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		the concerns, needs, and desires of the primary stakeholders. U4 • S15 –Present and justify design specifications, and clearly explain the criteria and constraints associated with a successful design solution. U4 • S16–Write a design brief to communicate the problem, problem constraints, and solution criteria. U4 • S17 – Support design ideas using a variety of convincing evidence. U5 • S18 – Jointly develop a decision matrix based on accepted outcome criteria and constraints. U5 • S19 – Clearly justify and validate a selected solution path. U5 • S20 – Create a set of working drawings to detail a design project. U1, U2, U1 (Unit 1)

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning
Activity 7.1 More Dimensioning	• Peer assessment of dimensioning per #6	• Conclusion Questions • Create dimensioned drawings of teacher provided pat similar to those included in activity
Activity 7.2 Sectional Views	• Peer review of #6 prior to completing #7	• Conclusion Questions • Sketch section view of teacher provided part (e.g. tape dispenser)
Activity 7.3 Tolerances	• Self-assessment based on correct answers provided by teacher • Correction of responses and self-reflection/journal entry as to why responses were incorrect	• Conclusion Questions
Journal Entry: Essential Question 5		• Teacher assesses student responses
Project 7.4 Assembly Model	• Peer/teacher assessment of assembly models	• Conclusion Questions
Project 7.5 Engineering Documentation Automoblox	• Self/Peer assessment using P7.5 Rubric	• Conclusion Questions • P7.5 Rubric

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems (B)	Knowledge and Skills
Activity 7.1 More Dimensioning	K1, K2, S1, S2, S4
Activity 7.2 Sectional Views	K3, K4, K5 ,K6 S1, S2, S3, S4, S5, S6
Activity 7.3 Tolerances	K6, K7, K8, S6, S7, S8, S9
Project 7.4 Assembly Model	K9, S10, S11
Project 7.5 Engineering Documentation Automoblox	S12, S19

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Project 7.5a Engineering Documentation ALTERNATE	• Self/Peer assessment using P7.5 Rubric	• Conclusion Questions • P7.5 Rubric	Project 7.5a Engineering Documentation ALTERNATE	S12, S19
Project 7.6 Design Brief (Apollo 13)	• Conclusion Questions		Project 7.6 Design Brief (Apollo 13)	S13, S14, S15
Small Group/Class Discussion: Essential Question 1, 2, and/or 4	• Teacher considers student responses and preconceptions in order to inform effective teaching			
Journal Entry: Essential Question 6		• Teacher assesses student responses		
Problem 7.7 Automoblox Product Enhancement	• Conclusion Questions	• Design Problem Rubric	Problem 7.7 Automoblox Product Enhancement	S1, S2, S4, S8, S9,S12, S13, S14, S15, S16, S17, S18, S19
Small Group/Class Discussion: Essential Question 3	• Teacher considers student responses and preconceptions in order to inform effective teaching			
Journal Entry: Essential Question 7		• Teacher assesses student responses		
Unit Assessment Items	• All items	• All items		
Summative – EoC		• All items		

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 8 – Advanced Computer Modeling

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Transfer

TRANSFER:*Students will be able to independently use their learning to …*

- T1 – Use mathematical and computational thinking to represent phenolmenon and solve engineering problems.
- T2 -- Use current engineering tools (ex., spreadsheet software, CADD software) to create models, solve problems and perform engineering design.
- T3 – Communicate technical information or ideas in multiple formats including orally, graphically, textually and mathematically, as appropriate.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Parametric computer aided design (CAD) software packages facilitate 3D virtual modeling of parts and assemblies using parameters, such as geometric constraints (the relationships between geometric entities) as well as numeric constraints (dimensions) used to determine the shape and size of geometry and models.
- U2 – A parametic numeric constraint (dimension) can be represented by a function (equation) that mathimatically describes the relationship between that dimension and other related dimension(s).
- U1 (Unit1) – Technical drawings convey information according to an established set of drawing practices which allow for detailed and universal interpretation of the drawing.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – Are working drawings always necessary in order to communicate the design of a consumer product? Justify your answer.
- Q2 – Animated assemblies are not typically included as part of the technical documentation of a design. How can 3D animated assembly models of an object or a proposed design be used in the design process? Beyond the design process?

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• G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	• U4 (unit 1) – The style of the engineering graphics and the type of drawings views used teo detail an object vary depending upon the intended use of the graphic.	
	Acquisition	
	KNOWLEDGE: *Students will …* • K1 – Identify, define, and explain the proper use of an auxiliary view in technical drawing. U1 (unit 1), U4 (Unit 1)	***SKILLS:*** *Students will …* • S1 – Use advanced modeling features to create three-dimensional solid models of complex parts and assemblies within CAD and with little guidance given the actual part using appropriate geometric and dimensional constraints. U1 • S2 – Formulate equations and inequalities to represent relationships between quantities. U2 • S3 – Using a CAD application, create relationships among part features and dimensions using parametric formulas. U1, U2, U3 • S4 – Create an exploded assembly view of a multip-part product. Identify each component of the assembly with identification numbers and create a parts list to detail each component using CAD. U1 • S5 – Perform a peer review of technical drawings and offer constructive feedback based on standard engineering practices. U1, U1(Unit 1) • S6 (Optional) – Hand sketch an auxiliary view in the correct orientation to fully detail an object or part given the actual object, a detailed verbal description of the object, a pictorial view of the object, or a set of orthographic projections. U1 (Unit 1), U4 (Unit 1) • S7 (Optional) – Generate an auxiliary view using CAD according to standard engineering practice. U1 (Unit 1), U4 (unit 1)

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Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems (B)	Knowledge and Skills
Project 8.1 Model Button Maker	• Conclusion Questions • Peer comparison of physical properties of parts		Project 8.1 Model Button Maker	S1
Project 8.1a Model Miniature Train (Optional)	• Conclusion Questions • Peer comparison of physical properties of parts		Project 8.1a Model Miniature Train (Optional)	S1
Activity 8.2 Parametric Constraints	• Conclusion Questions	• Completion of #3 Optional task	Activity 8.2 Parametric Constraints	K1, S1, S2, S3
Activity 8.2a Parametric Constraints Practice (Optional)		• Ask students to justify their work in verbal or written form	Activity 8.2a Parametric Constraints Practice (Optional)	(K1, S2, S3)
Activity 8.3 Auxiliary Views (Optional)	• Peer assessment and then revision of activity tasks	• Assessment of task #3 • Conclusion Quesitons	Activity 8.3 Auxiliary Views (Optional)	(K1, S6, S7)
Small Group/Class Discussion: Essential Question 1	• Teacher considers student responses and preconceptions in order to inform effective teaching			
Activity 8.4 Working Drawings (Button Maker)	• Self-evaluation and/or peer evaluation using A8.4 Rubric	• A8.4 Rubric • Conclusion Questions	Activity 8.4 Working Drawings (Button Maker)	S1, S4, S5
Activity 8.4a Working Drawings Miniature Train (Optional)	• Self-evaluation and/or peer evlatuation of activity tasks	• Conclusion Questions	Activity 8.4a Working Drawings Miniature Train (Optional)	(K1, S1, S4, S6, S7)
Journal Entry: Essential Question 2		• Teacher assesses student responses		
Activity 8.5 Instant Challenge: Air Vehicle		• Conclusion Questions	Activity 8.5 Instant Challenge: Air Vehicle	K1 (Unit 1), S2 (Unit 1), S3 (Unit 1)
Unit Assessment Items	• All items	• All items		

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Summative – EoC		• All items		

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Curriculum Framework – Introduction to Engineering Design (2015-2016)
Unit 9 – Design Team

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Communicate effectively using virtual/remote communication tools.
- T2 – Function effectively on a multidisciplinary team.
- T3 – Perform research to gather information, define problems, provide evidence, and/or justify decisions in the process of solving a problem.
- T4 – Apply the design process to design a system, component, or process to meet desired needs within realistic constraints.
  T5 – Understand professional and ethical responsibilities related to engineering.
- T6 – Communicate technical information or ideas in multiple formats including orally, graphically, textually and mathematically, as appropriate.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Engineering has a global impact on society and the environment.
- U2 – Research derived from a variety of sources (including subject matter experts) is used to facilitate effective development and evaluation of a design problem and a successful solution to the problem.
- U3 – Specific oral communication techniques are used to effectively convey information and communicate with an audience.
- U4 – Engineering design and practices are governed by ethics, values, and laws.
- U5 – Effective design teams can improve the efficiency

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 -- Is it ever advantageous to create a design or solve a problem individually as opposed to using a team approach? Explain.
- Q2 – What strategy would you use to form a design team in order to obtain the best solution possible?
- Q3 -- What does it mean to be “ethical” in your work? Do engineers need to be taught to be “ethical”?
- Q4 -- It has been said that, “Having a vision without action is a daydream; Taking action without a vision is a nightmare!” How does this apply to engineering design?

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modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	and effectiveness of the design process. • U6 – Virtual design teams include people in different locations who collaborate using communication methods other than face-to-face contact. • U7 – 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. • U8 – Styles and modes of professional correspondence are tailored to the type of audience and intended goals. • U9 – Project planning tools and management skills are often used in the process of solving engineering design problems.	
	KNOWLEDGE: *Students will …* • K1 – Identify and describe the steps of a typical product lifecycle (including raw material extraction, processing, manufacture, use and maintenance, and disposal). U1 • K2 – Identify and explain how the basic theories of ethics relate to engineering. U4 • K3 – Identify team member skill sets needed to produce an effective team. U6 • K4 – Define the term group norms and discuss the importance of norms in creating an effective team environment.U5, U7 • K5 – Identify the advantages and disadvantages of virtual design teams compared to traditional design teams. U5, U6	***SKILLS:*** *Students will …* • S1 – Assess the development of an engineered product and the impact of the product on society and the environment. U1 • S2 – Utilize research tools and resources (such as the Internet; media centers; market research; professional journals; printed, electronic, and multimedia resources; etc.) to validate design decisions and justify a problem solution. U2 • S3 – Summarize key ideas in information sources including scientific and engineering texts, tables, diagrams, and graphs. U2 • S4 – Deliver organized oral presentations of work tailored to the audience. U3 • S5 – Organize and express thoughts and information in a clear and concise manner. U6 • S6 – Participate on a virtual team using remote collaboration tools to support team collaboration and

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		problem solving. U5, U6, U7 • S7 – Identify appropriate technology to support remote collaboration among virtual design team members (such as asynchronous communications, audio and video conferencing, instant messaging, synchronous file editing, and file transfer). U6 • S8 – Demonstrate positive team behaviors and contribute to a positive team dynamic. U7 • S9 -- Contribute equitably to the attainment of group goals based on assigned roles. U1, U11, U12 • S10 – Practice appropriate conflict resolution strategies within a team environment. U1, U11, U12 • S11 – Identify an appropriate mode of two-way communication based on the audience and intended goal of the communication. U8 • S12 –Use an appropriate and professional tone and vernacular based on the audience of the correspondence. U8 • S13 –Document correspondence and conversations in an accurate and organized manner. U8 • S14 – Create and utilize a Gantt chart to plan, monitor, and control task completion during a design project. U9 • S15 – Adjust voice and writing style to align with audience and purpose. U3 • S16 – Deliver organized oral presentations of work tailored to the audience. U3

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B) (U/L level)	Assessment FOR Learning	Assessment OF Learning
A 9.1 Product Lifecycle	• Self/peer-evaluation using A9.1 • Conclusion Questions	• A9.1 Rubric • Conclusion Questions

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems (B)	Knowledge and Skills
A 9.1 Product Lifecycle	K1, S1, S2, S3, S4

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B9.2 Engineering Design Ethics Design Brief	• Peer assessment of deliverables	• Conclusion Questions	B9.2 Engineering Design Ethics Design Brief	K2, S1, S2, S3, S5
Journal Entry: Essential Question 3		• Teacher assesses student responses		
P9.3 Virtual Design Challenge	• A9.3.d Periodic Teammate Evaluation • A9.3.e Periodic Self Evaluation	• Multiple rubrics • Conclusion Questions	P9.3 Virtual Design Challenge	S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16
A9.4 Team Norms		• Conclusion Questions	A9.4 Team Norms	K3, K4, S8, S9
Small Group/Class Discussion: Essential Questions 1 and/or 2	• Teacher considers student responses and preconceptions in order to inform effective teaching			
A9.5 Product Research Documentation	• Teacher questioning and student verbal justification of the product choices		A9.5 Product Research Documentation	S2, S3
Journal Entry: Essential Question 4		• Teacher assesses student responses		
Unit Assessment Items	• All items	• All items		
Summative – EoC		• All items		

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