

Introduction to Engineering Design

	Performance Objectives	Show-Me Content	Show-Me Goals	National Standards	Alignment
1.1	History of Design				
1.	Develop an appreciation of how the history of art has influenced innovations in the field of engineering, and explain the impact of artistic expression as it relates to consumer products.	CA1, FA4, FA5	2.4	7:9-12M	A
2.	Research how artistic period and style have influenced product and architectural design.	FA4, FA5	1.2, 1.9	7:9-12M	A
3.	Investigate the design concept of form and function and explain its use in product design.	FA2	1.2, 2.1	9:9-12I	A
4.	Investigate the evolution of technology and be able to identify engineering achievements through history.	SS2, SC8	1.2	7:9-12G	A
5.	Research the chronological development and accelerating rate of change that innovations in tools and materials have brought about over time as it relates to a given consumer product.	SC8, SS2, H/PE6	1.2, 1.6	1:9-12K	A
6.	Identify two historical innovations that have led to the improved functionality of measurement tools.			7:9-12G	A
1.2	Professional Organizations				
1.	Research a given professional organization and summarize in a short PowerPoint presentation the range of services provided by the organization.	CA1, SS7	1.2, 2.1, 4.8		B
1.3	Career Opportunities				
1.	Identify career opportunities in design engineering and explain their job functions.	CA1, SS7	4.8		B
1.4	Education Requirements				
1.	Explore career opportunities in a given engineering field and list the educational requirements for each profession.	CA1, SS7	4.8		B
2.1	Design Process				
1.	Explain the seven steps of the design process and the activities that occur during each phase.	CA1, FA1	2.1	8:9-12H	C
2.	Explain the value of working as a team and the benefits of collaboration.	CA1	4.6	9:9-12J	D
3.	Describe the importance of focusing on detail when executing the design process.	CA1	2.1	8:9-12J	C
4.	Apply the steps of the design process to solve a variety of design problems.	FA1	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8	8:9-12H	C
2.2	Principles and Elements of Design				

1.	Investigate the principles and elements of design.	FA1		9:9-12I	I
2.	Identify the use of the principles and elements of design in various products, print media, and art forms.	CA5, FA2	1.5	9:9-12I	D
3.	Demonstrate an understanding of the principles and elements of design by incorporating them in design solutions.	FA1, FA2		9:9-12I	I
4.	Collect and display examples of the application of the principles and elements of design utilized in products, print media, and art forms.	CA5, FA2	1.8, 2.1	9:9-12I	D
3.1	Student Portfolio Development				
1.	Describe the proper elements of a fully developed portfolio.	CA1			D
2.	Discuss the ethical issues surrounding portfolio artifacts.	CA1, CA6	4.4		D
3.	Compare and contrast defined elements of a good portfolio.	CA6			D
4.	Develop a portfolio to organize and display evidence of their work.	CA4	1.8	11:6-8L	D
4.1	Sketching and Visualization				
1.	Apply proper sketching techniques and styles in the creation of sketches.	FA1	2.5		F
2.	Demonstrate the ability to produce two-dimensional geometric figures.	FA1, MA2	2.5	11:6-8J	E
4.2	Pictorial Sketching				
1.	Select and produce the appropriate pictorial style to best communicate solutions in the design process.	FA1	2.5	11:6-8J	F
2.	Create pictorial sketches to develop ideas in the design process.	FA1	2.5	11:6-8J	F
3.	Create sketches utilizing both the additive and subtractive methods to assess underlying geometric and perceptual principles.	FA1	2.5	11:6-8J	F
4.	Select a sketching method that is efficient in its use of color, form, and symbols representing abstract data.	FA1	2.5	11:6-8J	F
4.3	Annotated Sketching				
1.	Evaluate and select the necessary views to graphically communicate design solutions.	FA1	2.5	11:6-8J	G
2.	Interpret annotated sketches in the design analysis process.	CA5	1.5	17:9-12Q	G
3.	Integrate annotated sketches in presentations, portfolio, and documentation process.		1.8	12:9-12L	D
4.	Develop properly annotated sketches to accurately convey data in a design solution.	FA1	2.5	11:6-8L	G
5.1	Forms and Shapes				
1.	Define and contrast points, lines, and line segments.	MA2			I

2.	Identify major geometric shapes (isosceles triangle, right triangle, scalene triangle, rectangle, square, rhombus, trapezoid, pentagon, hexagon, and octagon).	MA2			I
3.	Construct various geometric shapes using a compass, ruler, and triangle.	MA2		11:6-8J	H
4.	Define the elements and types of angles.	MA2			I
5.	Construct and bisect various types of angles using a compass, ruler, and triangle.	MA2		11:6-8J	H
6.	Define terminology associated with arcs and circles.	MA2			I
7.	Construct arcs, circles, and ellipses using a compass, ruler, and triangle.	MA2		11:6-8J	H
5.2	Geometric Constraints				
1.	Distinguish and define geometric constraints.	MA4			I
2.	Identify the following geometric constraints in given three-dimensional models: horizontal, vertical, parallel, perpendicular, tangent, concentric, collinear, coincident, and equal.	MA4		11:6-8J	I
5.3	Coordinate Systems				
1.	Apply the right hand rule to identify the X, Y, and Z axes of the Cartesian Coordinate System.	MA4			I
2.	Apply a combination of absolute, relative, and polar coordinates to construct a three-dimensional model.	MA4		11:6-8J	H
3.	Define the origin planes in the Cartesian Coordinate System.	MA4			I
4.	Identify the origin and planar orientations of each side of a three-dimensional model.	MA4			I
6.1	Conceptual Model				
1.	Experience the creative thinking process.		3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8	9:6-8G, 9:9-12J	J
2.	Describe the difference between vertical and lateral thinking.	CA1	3.4	9:9-12J	I
3.	Categorize and select a solution to a problem.		3.6, 3.7	9:9-12L	J
4.	Communicate ideas in written and verbal formats.	CA1	2.1	11:9-12R	J
6.2	Graphical Modeling				
1.	Identify the different graphical methods of data representation.	MA2		11:6-8J	K
2.	Select the appropriate graphical format to illustrate a problem.		1.8	11:9-12P	K
3.	Analyze and develop a graphical representation of given data.	MA2	1.8, 2.5	11:9-12R	K

6.3	Physical Modeling				
1.	Describe the different physical modeling techniques.	FA1		9:6-8H	L
2.	Develop a model with correct proportions.	FA1	2.5	9:6-8H	L
3.	Select the appropriate modeling materials to complete a three-dimensional model	FA1		9:9-12K, 11:9-12O	L
6.4	Mathematical Modeling				
1.	Evaluate a problem using mathematical formulae.	MA4	3.1	11:9-12P	K
2.	Analyze a solution to a problem using the correct format of analysis.	MA4	3.7	11:9-12P	K
6.5	Computer Modeling				
1.	Generate a model from a sketch using a CAD software package.		2.5	11:6-8J	K
2.	Explain the difference between parametric and adaptive designs and be able to specify their uses.	CA1	1.8		K
3.	Produce a two-dimensional sketch using a CAD software package.		2.5	11:6-8J	K
4.	Apply geometrical and dimensional constraints to a sketch.	MA2		11:6-8K	L
5.	Generate a three-dimensional model.		2.5	11:6-8J	K
6.	Demonstrate the use of work features and how they are applied while constructing a solid model.			11:6-8J	L
7.	Recognize the use and need for work planes, axes, and points in the development of a computer model.	MA4			K
8.	Modify a sketch or feature of a model.			11:6-8J	L
7.1	Assembly Modeling				
1.	Demonstrate assembly modeling skills to solve a variety of design problems.	SC7	3.2, 3.3	11:9-12O	L
2.	Apply the base component effectively in the assembly environment.			11:6-8J	L
3.	Create and place components in the assembly modeling environment.		2.5	11:6-8J	L
4.	Create circular and rectangular patterns of components within an assembly model.		2.5	11:6-8J	L
5.	Replace components with modified external parts.			11:6-8J	L
6.	Perform part manipulation during the creation of an assembly model.			11:6-8J	L
7.	Explore and demonstrate assembly modeling skills to solve a variety of design problems.	SC7	3.2, 3.3	11:9-12O	L

7.2	Assembly Constraints				
1.	Demonstrate assembly modeling skills to solve a variety of design problems.	SC7	3.2, 3.3	11:9-12O	L
2.	Perform part manipulation during the creation of an assembly model.			11:6-8J	L
3.	Apply assembly constraints to successfully construct a multi-part object.		2.5	11:9-12O	L
7.3	Part Library				
1.	Utilize part libraries effectively during the assembly modeling process.		1.4	11:6-8J	L
2.	Demonstrate assembly modeling skills to solve a variety of design problems.	SC7	3.2, 3.3	11:9-12O	L
7.4	Sub Assemblies				
1.	Employ sub-assemblies during the production of assemblies.			11:6-8J	L
2.	Demonstrate assembly modeling skills to solve a variety of design problems.	SC7	3.2 3.3	11:9-12O	L
7.5	Driving Constraints				
1.	Apply drive constraints to simulate the motion of parts in assemblies.			11:9-12O	L
2.	Demonstrate assembly modeling skills to solve a variety of design problems.	SC7	3.2, 3.3	11:9-12O	L
7.6	Adaptive Design				
1.	Apply adaptive design concepts during the development of sketches, features, parts, and assemblies.		2.5, 3.6	11:6-8J	G, L
2.	Demonstrate assembly modeling skills to solve a variety of design problems.		3.2, 3.3	11:9-12O	L
8.1	Mass Properties				
1.	Demonstrate how to extract mass properties data from solid models.	MA2, SC1	2.1	11:9-12P	L
2.	Evaluate the accuracy of mass properties calculations.	MA2	1.7	11:9-12P	L
3.	Describe how analysis data can be used to update parametric models.	CA1, MA4	2.1	11:9-12P	L
4.	List and explain the various mass property calculations (e.g., volume, density, mass, surface area, centroid, moment of inertia, products of inertia, radii of gyration, principal axes, and principal moments) and how they are used to evaluate a parametric model.	CA1, SC1, SC2, MA2	1.8	11:9-12P	L
8.2	Tolerancing				
1.	Interpret and use correct tolerancing techniques when dimensioning solid models.		3.4	11:9-12P	L
2.	Solve tolerance problems, including limits and fits.	MA1, MA2		11:9-12P	L

3.	Explain the differences between clearance fit, interference fit, and allowance.	CA1	1.8		L
4.	Define and demonstrate an understanding of tolerancing.	CA1	1.8	11:9-12P	L
9.1	Working Drawings				
1.	Select the appropriate sheet size and title block for creating a drawing layout.		1.8		I
2.	Translate a three-dimensional drawing or model into corresponding orthographic drawing views.	FA1	2.5	11:6-8J	H
3.	Describe the purpose, and/or application, of the following drawing views: isometric view, section view, auxiliary view, and detail view.	CA1	2.1	11:6-8J	I
4.	Generate an isometric view from orthographic drawing views.	FA1	2.5	11:6-8J	H
5.	Determine the correct application for the various section views required to illustrate an object's internal detail.			11:6-8J	H
6.	Describe the purpose and application of hatch marks and a cutting plane line, as used in a section view.	CA1, MA2		11:6-8J 17:9-12Q	I
7.	Create the appropriate section view for a specified application.		2.5	11:6-8J	H
8.	Create a detail view that corresponds to the appropriate orthographic drawing view.		2.5	11:6-8J	H
9.	Create an auxiliary view to show the detail on an inclined surface of a drawing object.		2.5	17: 9-12Q	H
9.2	Dimensioning				
1.	List the common dimensioning standards.	CA1		17: 9-12Q	I
2.	Identify and demonstrate the use of common dimensioning systems.	CA1		17: 9-12Q	L
3.	Describe the characteristics and demonstrate the use of unidirectional and aligned dimensioning.	CA1	2.1	17:9-12Q	L
4.	Differentiate the use of size and location dimensions by applying these types of dimensions to annotated sketches and drawings.		2.1	17:9-12Q	L
5.	Demonstrate appropriate dimensioning rules and practices.		2.1	17:9-12Q	L
6.	Set up and integrate a customized common dimensioning standard.		2.5	17:9-12Q	L
7.	Identify and demonstrate dimensioning practices on section, auxiliary, and assembly models.	CA1	2.1	17:9-12Q	L
9.3	Annotation				
1.	Apply appropriate annotations on sketches and drawings.	CA4	2.5	12:9-12L 17: 9-12Q	G
2.	Formulate general and proprietary specifications to further communicate information relating to product design.	CA4	1.5, 1.8, 2.1	12:9-12L 17: 9-12Q	L

10.1	Communication Techniques				
1.	Demonstrate the following communication techniques: voice variation, eye contact, posture, attire, practice and preparation, and projecting confidence.	CA1, CA4	2.1	11:9-12R 12:9-12L	M
10.2	Presentation				
1.	Describe various forms of visual aids and when to use them in a presentation.	CA1, CA5	2.1	11:9-12R 17:9-12P	M
2.	Select the most appropriate type of visual aid for a presentation considering the audience and level of formality.	CA5	2.1	12:9-12L 17:9-12P	M
3.	Select the most appropriate type of written documentation for a presentation considering the audience and level of formality.	CA4	2.1	12:9-12L 11:9-12R	M
4.	Identify the elements of the various forms of written documentation.	CA1, CA4			M
11.1	Manufacturing Design Analysis				
1.	Appreciate team member involvement in the decision making process of designing a product.		4.6	2:9-12EE	D
2.	Categorize manufacturing specifications and constraints needed to produce a product.		3.1	2:9-12AA	N
3.	Evaluate material characteristics for manufacturing a specific product and identify the correct manufacturing process needed to produce that product.	SC1	3.7	19:9-12M	N
11.2	Process Planning				
1.	Evaluate and apply the correct machine process.		3.7	19:6-8F	N
2.	Recognize the need to limit the number of processes used to manufacture a product.	SS4	3.1	19:6-8H	N
3.	Describe process routing.	CA1		19:6-8H	N
11.3	Design for Automated Manufacturing				
1.	Describe the differences between CNC, FMS, and CIM.	CA1	2.1	19:6-8H	N
11.4	Materials, Procurement, Handling, and Cost				
1.	Explain the need for a company to minimize material handling by procurement of materials in a timely fashion and the JIT process.	CA1, SS4	2.1	18:9-12J	N
2.	Identify the need to perform a cost analysis of a product.	SS4	3.1	11:9-12N	O
11.5	Quality Control				
1.	Interpret data, which has been statically analyzed, to ensure product quality.	MA3	1.6	2:9-12DD 12:9-12P	O
11.6	Manpower and Facility Requirements				

1.	Identify the need to evaluate the areas of manpower and facility requirements.	SS4	3.1, 4.5	2:9-12EE	N
11.7	Packaging				
1.	Recognize the need to protect a product for shipping.	SS4	3.1, 4.7		O
2.	Analyze aesthetic requirements to enhance packaging for the consumer.	SS4		19:9-12R	O
12.1	Product Analysis				
1.	Define, explain, and demonstrate an understanding of common vocabulary words used in association with product cost analysis.	CA1	1.8		I
2.	Formulate a product cost analysis for a given product.	MA3	3.8	19:9-12R	O
12.2	Packaging Requirements				
1.	Demonstrate an understanding of packaging design requirements.		3.1, 3.7	19:9-12R	O
2.	Design a package for a given product.		2.5	11:9-12Q	O