

Career & Technology

Introduction to Engineering Design

Unit Name			First 6 Weeks		
Academic Alignment with TEKS	CTE TEKS	Content/Vocabulary	Guiding Questions	Activities	Resources and Web links
§110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	1.1 Introduction to a Design -Apply engineering notebook standards and protocols when documenting their work during the school year. -Identify and apply group brainstorming techniques and the rules associated with brainstorming. -Research a product's history, develop a PowerPoint presentation, list chronologically the major innovations to a product, and present findings to a group. -Use online and published works to research aspects of design problems. -Identify the design process steps used in given scenarios and be able to list the steps, if any are missing.	Assessment Constraint Design Process Engineers Notebook Invention Process Sequential Target Consumer Brain Storming Design Designer Evolution Iterative Product Solution Time Line Chart Client Design Brief Engineer Innovation Problem Identification Research Standard	1. What is the design process and how is it used? 2. Why is brainstorming important when modifying or improving a product? 3. What is meant by constraints and criteria? 4. What are common constraints put on a product? 5. What comes to mind when you hear the words evolution of a product? 6. What kinds of situations might keep a designer from moving sequentially through a design process? 7. What is an engineer's notebook and how is it used? 8. Why do engineers use graphics to record and communicate information?	Activity 1.1.1 Beverage Container Activity 1.1.2 Product Evolution	
§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	1.2 Introduction to technical Sketching and Drawing -Identify, sketch, and explain the function of points, construction lines, object lines, and hidden lines. -Plot points on grid paper to aid in the creation of sketches and drawings. -Explain the concepts of technical sketching and drawing. -Sketch an isometric view of simple geometric solids. -Explain how an oblique view of simple geometric solids differs from an isometric view. -Sketch one-point, two-point, and three-point perspectives of simple geometric solids. -Describe the concept of proportion as it relates to freehand sketching. -Sketch multiview drawings of simple geometric solids.	Construction Line Edge Grid Isometric Sketch Line Weight Multiview Drawings Orthographic Projection Plane Projection Line Scale Size Technical Working Drawing Views Depth Ellipse Height Line Manufacture Oblique Sketch Pictorial Sketch Profile Proportion Shape Solid	1. Why is sketching an important engineering skill? 2. What is the difference between sketching and drawing? 3. What does the term <i>isometric sketch</i> mean? 4. What does the term <i>oblique sketch</i> mean? 5. What is perspective sketching? 6. What advantages do pictorial drawings have over multiview drawings? 7. What are the three main views of a sketch or drawing that are required to depict an object? 8. Why should you not erase construction lines?	Activity 1.2.1 Isometric Sketches Activity 1.2.2 Oblique Sketches Activity 1.2.3 Perspective Sketches Activity 1.2.4 Multiview Sketches	



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	<p>-Determine the front view for a given object.</p>	<p>Vanishing Point Width</p>	<p>9. If you are given an object with an unknown function and told to create a sketch of it, how would you determine what the front view would look like?</p> <p>10. What is orthographic projection?</p>		
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§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	1.3 Μεασυρεμεντ ανδ Στατιστιχσ <ul style="list-style-type: none"> • Research and design a CD cover or book jacket on the origins of the measurement systems. • Measure and record linear distances using a scale to a precision of 1/16 inch and 1 mm. • Measure and record linear distances using a dial caliper to a precision of 0.001 inch. • Add and subtract U.S. standard and metric linear measurements. • Convert linear distance measurements from inches to millimeters and vice versa. • Apply linear dimensions to a multiview drawing. • Calculate the mean, mode, median, and range of a data set. • Create a histogram of recorded measurements showing data elements or class intervals, and frequency. 	American National Standards Institute (ANSI) Accuracy Caliper Class Interval Convert Data Data Set Dimension Dimension Lines English System Extension Lines Frequency Graph Histogram International Organization for Standardization (ISO) Mean Measure Median Metric System Mode Normal Distribution Numeric Constraint Precision Scale Standard Statistics Two-Dimensional Unit Variation	<ol style="list-style-type: none"> 1. Why did our ancestors create measurement standards? 2. Who is responsible for establishing measurement standards that are used by engineers and manufacturers today? 3. What methods do engineers use to communicate an object's dimensional information? 4. What problems could result from incorrectly converting measurements from one system to another? 5. What factors influence the precision of a measuring tool? 6. What information can a designer use from a statistical analysis of a product? 	Project 1.3.1 History of Measurement Activity 1.3.2 English and Metric Linear Measurements Activity 1.3.3 fischertechnik@ Block Measurement Activity 1.3.4 Linear Dimensions Activity 1.3.5 Applied Statistics	
§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3	1.4 Puzzle Cube <ul style="list-style-type: none"> • Brainstorm and sketch possible solutions to an existing design problem. • Select an approach that meets or satisfies the constraints given in a design brief. • Create simple extruded solid Computer Aided Design (CAD) models from dimensioned sketches. • Generate dimensioned multiview drawings from simple CAD models. • Measure and Fabricate parts for a functional prototype from the CAD multiview drawings. • Assemble the product using the CAD modeling software. • Test and evaluate the prototype and record results. • Apply geometric and numeric constraints to CAD sketches. • Identify the purpose of packaging in the design 	Annotate Assembly Drawing Computer-Aided Design or Computer-Aided Drafting (CAD) Design Brief Design Statement Extrusion Geometric Constraint Logo Manufacturer's Joint Marketing Mock-up Model Numeric Constraint Origin Packaging Plane Prototype Scale Model Scoring Solid Modeling	<ol style="list-style-type: none"> 1. Why is a design process so important to follow when creating a solution to a problem? 2. What two-dimensional shapes are most often associated with three-dimensional forms? 3. What is the difference between a geometric constraint and a numeric constraint? 4. Why would you create a prototype of a product before the actual production takes place? 	Project 1.4.1 Puzzle Design Challenge Activity 1.4.2 Puzzle Part Combinations Activity 1.4.3 Puzzle Cube Package	



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IPC4	of consumer products.	Three-Dimensional Two-Dimensional			

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§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26	2.1 Γεωμετρικ Σηαπεσ ανδ Σολιδσ <ul style="list-style-type: none"> Identify common geometric shapes and forms by name. Calculate the area of simple geometric shapes. Calculate the surface area and volume of simple geometric forms. Identify and explain the various geometric relationships that exist between the elements of two-dimensional shapes and three-dimensional forms. Identify and define the axes, planes, and sign conventions associated with the Cartesian coordinate system. Apply geometric and numeric constraints to CAD sketches. Utilize sketch-based, work reference, and placed features to develop solid CAD models from dimensioned drawings. Explain how a given object's geometry is the result of sequential additive and subtractive processes. 	Acute Triangle Angle Area Axis Computer-Aided Design or Computer-Aided Drafting (CAD) Cartesian Coordinate System Chamfer Circle Circumscribe Counterbore Countersink Cylinder Diameter Ellipse Extrusion Geometric Constraint Inscribe Mass Numeric Constraint Obtuse Triangle Origin Parallelogram Pattern Pi Plane Polygon Prism Quadrilateral Radius Rectangle Regular Polygon Revolution Right Triangle Rotation Round Solid Solid Modeling Space Square Surface Area Tap Taper Three-Dimensional Triangle Two-Dimensional Vertex Volume Working Drawings	<ol style="list-style-type: none"> What are some examples of simple geometric shapes? What two-dimensional shapes are most often associated with three-dimensional forms? For what reasons might a designer need to know the volume and surface area of an object? What is the difference between a geometric constraint and a numeric constraint? What kind of additive and subtractive processes are used to manufacture actual physical objects? 	Project 2.1.1 Shape and Measurement Madness Activity 2.1.2 Calculating Properties of Shapes Activity 2.1.3 Making Sketches in CAD Activity 2.1.4 Calculating Properties of Solids Activity 2.1.5 CAD Model Features Project 2.1.6 Modeling Creation	

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<p>§111.34. Geometry G1 G2 G5 G6 G7 G11</p> <p>§110.31. English Language Arts and Reading, English I E1 E11 E17-26</p>	<p>2.2 Dimensions and Tolerances</p> <ul style="list-style-type: none"> • Explain the differences between size and location dimensions. • Differentiate between datum dimensioning and chain dimensioning. • Identify and dimension fillets, rounds, diameters, chamfers, holes, slots, and screw threads in orthographic projection drawings. • Explain the rules that are associated with the application of dimensions to multiview drawings. • Identify, sketch, and explain the difference between general tolerances, limit dimensions, unilateral, and bilateral tolerances. • Differentiate between clearance and interference fits. 	<p>Aligned Dimension American National Standards Institute (ANSI) American Society of Mechanical Engineers (ASME) Arrowheads Baseline Dimensioning Bilateral Tolerance Chain Dimensioning Datum Datum Dimension Dimension Dimension Lines Dual Dimensions Extension Lines General Notes Leaders Least Material Condition (LMC) Limits of Dimension Local Notes Location Dimension Maximum Material Condition (MMC) Nominal Size Reference Dimension Size Dimensions Tolerance Unidirectional Dimension Unilateral Tolerance Working Drawings</p>	<ol style="list-style-type: none"> 1. What is a working drawing? 2. What are dimensioning standards and how are they used? 3. What determines the location of the origin or datum from which all of the edges and features of an object are dimensioned? 4. What is a tolerance? 5. What effect can trailing zeroes in the dimension text have on the cost of a part? 6. Why is it necessary to use common units on a drawing for all dimensions? 	<p>Activity 2.2.1 What Is Wrong with this Picture? Activity 2.2.2 Model Dimensioning Activity 2.2.2a General Rules for Dimensioning Activity 2.2.3 Tolerances</p>	
<p>§111.34. Geometry G1 G2 G5 G6 G7 G11</p> <p>§110.31. English Language Arts and Reading, English I E1 E11 E17-26</p>	<p>2.3 Advanced Modeling Skills</p> <ul style="list-style-type: none"> • Sketch and model an auxiliary view of a given object to communicate the true size and shape of its inclined surface. • Describe the purpose and demonstrate the application of section lines and cutting plane lines in a section view drawing. • Sketch a full and half section view of a given object to communicate its interior features. • Identify algebraic relationships between the dimensional values of a given object. • Apply assembly constraints to individual CAD models to create mechanical systems. • Perform part manipulation during the creation of an assembly model. • Explain how assembly constraints are used to systematically remove the degrees of freedom for a set of components in a given assembly. • Create an exploded model of a given assembly. • Determine ratios and apply algebraic formulas to animate multiple parts within an assembly model. • Create and describe the purpose of the following items: exploded isometric assembly 	<p>Assembly Assembly Drawing Auxiliary View Balloons Blind Hole Break Line Broken-Out Section Chamfer Clearance Fit Component Constraint Counterbore Countersink Cutting Plane Line Degree of Freedom Detail Drawing Documentation Exploded Assembly Fillet Foreshorten Formula Full Section Half Section Interference Key Keyseat Keyway Parameter Parametric modeling Parts List</p>	<ol style="list-style-type: none"> 1. What are the six degrees of freedom that an object has in space? 2. How do assembly constraints differ from geometric and numeric constraints? 3. What is the difference between an assembly and a subassembly? 4. For what reason might an engineer need to create an auxiliary view of an object? 5. For what reason might an engineer need to create a section view of an object? 6. What is a title block? 7. What information is typically on a title block? 8. What is an assembly drawing? 9. What purpose do balloons and a parts list serve in an assembly drawing? 10. What kind of information may be included in a parts list? 	<p>Project 2.3.1 Arbor Press Project 2.3.1a Miniature Train Activity 2.3.2 Parametric Constraints Activity 2.3.3 Auxiliary Views Activity 2.3.4 Sectional Views Activity 2.3.5 Assembly Models Activity 2.3.6 Arbor Press Drawings</p>	



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	view, balloons, and parts list.	Phantom Line Ratio Rib Rotation Round Scale Section Lines Sectional View Spotface Subassembly Tap Taper Title Block Translation Working drawings			
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§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	2.4 Advanced Design <ul style="list-style-type: none"> Brainstorm and sketch possible solutions to an existing design problem. Create a decision making matrix. Select an approach that meets or satisfies the constraints given in a design brief. Create solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods. Apply geometric numeric and parametric constraints to form CAD modeled parts. Generate dimensioned multiview drawings from simple CAD modeled parts. Assemble the product using the CAD modeling software. Explain what constraints are and why they are included in a design brief. Create a three-fold brochure marketing the designed solution for the chosen problem, such as a consumer product, a dispensing system, a new form of control system, or extend a product design to meet a new requirement. Explain the concept of fluid power, and the difference between hydraulic and pneumatic power systems 	Accuracy Assembly Assembly Drawing Component Consensus Constraint Decision Matrix Design Brief Design Process Design Statement Designer Fluid Power Hydraulics Marketing Multiview Drawing Pneumatics Problem Statement Purpose Solid Modeling Target Consumer Team	1.What is a design brief? 2.Why is a design process so important to follow when creating a solution to a problem? 3.What is the purpose of design constraints? 4.What is a decision matrix and why is it used? 5.What does consensus mean, and how do teams use it to make decisions? 6.How are visual design principles and elements used to capture a consumer's attention? 7.How is the design of a consumer product different then the design of a product used to help a manufacturing process? 8.What is fluid power? 9.What is the difference between hydraulic and pneumatic power systems? 10. How does the use of fluid power aid the use of electronics or other power systems?	Project 2.4.1 Design Challenge	
§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	3.1 Visual Analysis <ul style="list-style-type: none"> Identify visual design elements within a given object. Explain how visual design principles were used to manipulate design elements within a given object. Explain what aesthetics is, and how it contributes to a design's commercial success. Identify the purpose of packaging in the design of consumer products. Identify visual design principles and elements that are present within marketing ads. Identify the intent of a given marketing ad and demographics of the target consumer group for which it was intended. 	Aesthetic Asymmetry Audience Analysis Balance Color Contrast Demographics Element Emphasis Form Gestalt Graphic Design Harmony Juxtapose Line Market Research Message Analysis Pattern Pictograph Principle Proportion Radial Symmetry	1.What is meant by the phrase The Language of Design? 2.What are visual design elements? 3.What are visual design principles? 4.What makes a designed object aesthetically pleasing or eye catching? 5.Why do people associate a design's aesthetic value with its functional efficiency and structural resilience? 6.How does the gestalt principle explain the way in which the human mind perceives visual patterns? 7.What is graphic design and how is it different from product design? 8.What information can be gained from demographic research and why is it used in marketing? 9.Why must a graphic designer understand the demographics of the intended audience? 10. How are visual design principles	Activity 3.1.1 Visual Design Principles and Elements of Design Identification Activity 3.1.2 Visual Design Principles and Elements Study Activity 3.1.3 What's going on in this graphic design?	



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		Rhythm Scale Shape Space Survey Symbol Symbolism Symmetry Texture Typography Unity Value Variety	and elements used to capture a consumer's attention?		

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Academic Alignment with TEKS	CTE TEKS	Content/Vocabulary	Guiding Questions	Activities	Resources and Web links
§110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	3.2 Functional Analysis <ul style="list-style-type: none"> Identify the reasons why engineers perform reverse engineering on products. Describe the function of a given manufactured object as a sequence of operations through visual analysis and inspection (prior to dissection). 	Black Box Model Function Hypothesis Input Mechanism Observation Output Process Reverse Engineering System	<ol style="list-style-type: none"> What is the purpose of reverse engineering? What is the difference between a product's visual and functional qualities? 	Activity 3.2.1 Product Observation	
§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	3.3 Structural Analysis <ul style="list-style-type: none"> Describe the differences between joinery, fasteners, and adhesives. Identify the types of structural connections that exist in a given object. Use dial calipers to precisely measure outside and inside diameter, hole depth, and object thickness. Identify a given object's material type. Identify material processing methods that are used to manufacture the components of a given commercial product. Assign a density value to a material, and apply it to a given solid CAD model. Perform computer analysis to determine mass, volume, and surface area of a given object. 	Adhesive Adhesive Bonding Analysis Competitor Compression Fastener Hypothesis Joinery Manufacturing Process Mass Mechanical Fastener Non-Renewable Resource Part Interaction Renewable Resource Reverse Engineering Snap-Fit Stress Surface Area Teardown Tension Torsion Volume	<ol style="list-style-type: none"> What are the differences between joinery, fasteners, and adhesives? What is the difference between an adhesive and a solvent? How does a design's material makeup impact the joinery, fasteners, and adhesive methods used to hold its components together? What factors influence the selection of a material for use in a design? For what reasons might a designer need to know the mass, volume, and surface area of an object? What is the difference between an object's mass and an object's weight? What is the difference between force and stress? 	Optional Activity 3.3.1a Wood Joinery Identification Optional Activity 3.3.1b Wood Fasteners and Adhesives Classification Optional Activity 3.3.1c Metal Joining Process Identification Optional Activity 3.3.1d Metal Fasteners and Adhesive Classification Optional Activity 3.3.1e Plastic Welding Procedure Identification Optional Activity 3.3.1f Plastic Fasteners & Bonding Classification Activity 3.3.2 Product Disassembly Activity 3.3.2a Product Disassembly Chart Activity 3.3.2b Materials Usages Charts Activity 3.3.3 Mass Property Analysis Optional Activity 3.3.3a-g Mass Property Analysis Extras Project 3.3.4 Product Disassembly Display	
§110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry.	3.4 Product Improvement <ul style="list-style-type: none"> Write design briefs that focus on product innovation. Identify group brainstorming techniques and the rules associated with brainstorming. Use decision matrices to make design decisions. Explain the difference between invention and innovation. 	Appendix Bias Brainstorming Criteria Decision Matrix Descriptive Abstract Executive Summary Innovation Invention Product Purpose	<ol style="list-style-type: none"> What is the purpose of reverse engineering a product? What practices are associated with group brainstorming? Why is brainstorming as a team important when modifying or improving a product? What are some factors to consider when enhancing an existing product? What function does the design 	Activity 3.4.1 Writing a Design Brief Activity 3.4.1a Child Toy Design Brief Activity 3.4.2 The Deep Dive Problem 3.4.3 Product Improvement	



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IPC3 IPC4		Technical Report	brief serve in the design process? 6. What are the elements of a technical report?		
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Academic Alignment with TEKS	CTE TEKS	Content/Vocabulary	Guiding Questions	Activities	Resources and Web links
§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	4.1 Engineering Design Ethics <ul style="list-style-type: none"> • Create a brainstorming list of different products made from common materials that are used daily. • Research and construct a product impact timeline presentation of a product from the brainstorming list and present how the product may be recycled and used to make other products after its lifecycle is complete. • Identify the five steps of a product's lifecycle and investigate and propose recyclable uses for the material once the lifecycle of the product is complete. 	Attorney General By-product Carcinogen Ecosystem EPA Ergonomics Ethical Ethics Hazard Impact Landfill OSHA Product lifecycle Raw Material Recycle Refurbish Refuse Residue Trade-off Waste	<ol style="list-style-type: none"> 1. What is meant by engineering design ethics? 2. What is ethics? 3. Why is it important to understand ethics and how it relates to product design? 4. Why is it important to study a product's lifecycle? 5. What factors influence the selection of materials to make a product? 6. What do you think of when you hear the word impact? 7. How can a manufacturing process impact an environment? 8. How do ethics impact the production of products? 9. What global and human impacts must be considered by all involved with the design, manufacture and distribution of products? 10. Why is it important to have clear, accurate, and detailed communication among all involved in the design, manufacture and distribution process? 11. What laws exist in the United States to protect humans and the environment? 	Activity 4.1.1 Product Lifecycle Problem 4.1.2 Engineering Design Ethics Design Brief	
§111.34. Geometry G1 G2 G5 G6 G7 G11 §110.31. English Language Arts and Reading, English I E1 E11 E17-26 §112.42. Integrated Physics and Chemistry. IPC3 IPC4	4.2 Design Teams <ul style="list-style-type: none"> • Explain why teams of people are used to solve problems. • Identify group norms that allow a virtual design team to function efficiently. • Establish file management and file revision protocols to ensure the integrity of current information. • Use internet resources, such as email, to communicate with a virtual design team member throughout a design challenge. • Identify strategies for addressing and solving conflicts that occur between team members. • Create a Gantt chart to manage the various phases of their design challenge. 	Arbitration Consensus Critique Evaluate Gantt Chart Mediation Negotiation Norms Open-Ended Protocol Storming Synergy Virtual Team	<ol style="list-style-type: none"> 1. Why are teams of people used to solve problems? 2. What are group norms? 3. What does consensus mean, and how do teams use it to make decisions? 4. What is the purpose of a Gantt chart? 5. What types of communication methods do virtual teams rely on in the absence of face-to-face contact? 6. How do teams deal with individual team members' weaknesses? 7. What methods do teams use to formally address conflict between team members? 	Project 4.2.1 Virtual Design Challenge Activity 4.2.2 Team Norms	



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