			Design and Modeling Grade 7 **Unit #1**
Course/Subject: Design and Modeling	**Grade:** 7th	**Introduction to Design**	**Suggested Timeline: 18 Days**

Grade Level Summary	The design process is a methodical process used to solve a problem or create a new product. All engineering professions use this process as their cornerstone. When solving a problem, you are using the design process. Students will develop skills related to problem solving, sketching, and will set up and begin maintaining an engineering notebook and portfolio.
Grade Level Units	Unit 1: Introduction to Design Unit 2: Modeling and Statistical Analysis Unit 3: Design Challenge

Unit Title	Introduction to Design
Unit Summary	Students discover the design process as they complete an instant design challenge to create an ankle foot orthosis. They learn thumbnail, orthographic, isometric, and perspective sketching as methods for communicating design ideas effectively without the use of technology. The use of a common measurement system is essential for communicating and fabricating designs. Students learn conversions between two measurement systems and apply measurement skills while dimensioning sketches. Students conduct a mechanical dissection in the lesson project to better understand how objects and parts interact while using sketches to communicate and document their findings.

Unit Essential Questions:

1. How is a design process used to effectively develop a design solution that solves a problem or addresses a design opportunity?
2. Why is communication of design ideas with teams and with stakeholders important throughout the design process?
3. What role do team norms play in making a collaborative team more successful?
4. Why is communication of design ideas with teams and with stakeholders important throughout the design process?
5. How are sketches used to document and communicate design ideas with accuracy?
6. Why are accurate measurement, precise dimensioning, and thorough documenting necessary for both mechanical dissection and creative problem solving?

Key Understandings:

1. An engineering design process involves a characteristic set of practices and steps.
2. Sketches, drawings, and images are used to record and convey specific types of information depending upon the audience and the purpose of the communication.
3. Brainstorming may take many forms and is used to generate a large number of innovative, creative ideas in a short time.
4. 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.
5. A problem and the requirements for a successful solution to the problem should be clearly communicated and justified.

7. How are sketches used to document and communicate design ideas with accuracy? 8. What role do team norms play in making a collaborative team more successful? 9. Why are accurate measurement, precise dimensioning, and thorough documenting necessary for both mechanical dissection and creative problem solving?	

Focus Standards Addressed in the Unit:	
Standard Number	*Standard Description*
3.4.7.C1	Describe how design, as a creative planning process, leads to useful products and systems.
3.4.7.C2	Explain how modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.
CC.2.3.7.A.1	Solve real-world and mathematical problems involving angle measure, area, surface area, circumference, and volume.

Important Standards Addressed in the Unit:	
3.4.7.D2	Select and safely use appropriate tools, products and systems for specific tasks.
3.4.7.A3.	Explain how knowledge gained from other fields of study has a direct effect on the development of technological products and systems.
CC.2.2.7.B.3	Model and solve real world and mathematical problems by using and connecting numerical, algebraic, and/or graphical representations.

Misconceptions:	**Proper Conceptions:**
1. Computers are always available these days so learning to use hand sketching is a waste of time.	1. While computers are often available, they will not always be the most convenient tool for creating sketches. Being able to generate a quick, understandable hand sketch of your thoughts will often convey exactly what your clients or team members need to see for them to make critical decisions throughout the design process.
2. If someone is not artistic, they will not be able to create sketches and drawings.	2. While having artistic skills can certainly enhance your sketches and drawings, understanding the geometry required to represent objects through sketches and drawings is more important. If a sketch conveys the intended information – even without any artistic flair – then it has served its purpose.
3. Sketches need to be made with various artistic strokes.	3. Technical sketching and artistic sketching are not necessarily the same. An artistic sketch could be used to convey the same information as a technical sketch, but a technical sketch need not be an artistic sketch. Properly describing the geometry and other operational features of an object is the primary goal of a technical sketch.
4. View placement and alignment in a multi-view technical drawing is not important.	4. In the US convention dictates that the front, top, and right side views are properly oriented and aligned with each other in a multi-view drawing. Horizontal and vertical lines that represent the same edge in the front/top and front/right views should align.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
• Design Process • Problem Statements	• Follow the steps of the design process to arrive at the solution to a given problem • Clearly define and validate the problem for which a solution is needed.	• The ability to be creative to solve real world problems. • Students will be able to take on additional rules in a team environment. • Students will be engaged to think critically.

Academic Vocabulary:

• Accuracy • Annotation • Cerebral Palsy (CP) • Collaboration • Constraint • Criteria • Decision matrix • Design process	• Dial Caliper • Dimension • Documentation • Isometric sketch • Mechanical dissection • Modification • Multiview sketch • Observation	• Occupational Therapy • Optimal • Orthographic projection • Perspective sketch • Precision • Prototype • Solution • Surface Area • Thumbnail Sketch

Assessments:

- **Design Challenges** – Students will be given a problem through a design brief for which they will develop a solution in teams within one class period.
- **Homework** – Occasional homework assignments will be given to reinforce classroom concepts. Homework will be graded for completeness (including level of documentation of work) and will be used to formatively assess if additional instruction is needed.
- **Engineering Notebook Checks** – Students will maintain a formal engineering notebook to document their work throughout the course. Periodic checks will assess proper notebook format and content. Certain projects will be completely contained within the engineering notebook and will be assessed according to the rubric provided for that project.
- **Oral Presentations** – Students will report project solutions via oral presentations to the class. Content and presentation style will be assessed according to a standard rubric for each project.
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Differentiation:

- Provide graphic organizers
- Provide multiple concrete examples
- Pair stronger students with struggling students for peer assistance.

Interdisciplinary Connections:

- Design process – Scientific method
- Sketching - Art
- Writing skills- English
- Research process - English

Additional Resources:

- http://static.pdesas.org/content/documents/Academic_Standards_for_Science_and_Technology_and_Engineering_Education_(Elementary).pdf - Standards for Science and Technology 7th grade
- http://www.uspto.gov/ - US Patent Office website
- http://www.cerebralpalsy.org - Information on Cerebral Palsy

Created By:
Blake Moore

			Design and Modeling Grade 7 **Unit #2**
Course/Subject: Modeling and Statistical Analysis	**Grade:** 7th	**Modeling and Statistical Analysis**	**Suggested Timeline: 15 Days**

Grade Level Summary	The design process is a methodical process used to solve a problem or create a new product. All engineering professions use this process as their cornerstone. When solving a problem, you are using the design process. Students will develop skills related to problem solving, sketching, and will set up and begin maintaining an engineering notebook and portfolio.
Grade Level Units	Unit 1: Introduction to Design Unit 2: Modeling and Statistical Analysis Unit 3: Design Challenge

Unit Title	Modeling and Statistical Analysis
Unit Summary	In this lesson, students transfer a two-dimensional representation to a three-dimensional solid model with technology. Students study basic geometric shapes within a mathematical model and use combinations of geometric primitives to form more complex shapes. During the design project, students work in teams and apply the design process to create a puzzle cube. Students create a solid model using a computer-aided design (CAD) application and fabricate their design solution for testing. Students use a dynamic mathematics program to complete statistical analysis from their testing results to determine if their design met the criteria and constraints.

Unit Essential Questions:

1. How is a design process used to effectively develop a design solution that solves a problem or addresses a design opportunity?
2. How does using a CAD application benefit an engineer?
3. Why is it important for an engineer to be aware of the criteria and the constraints when designing a project?
4. How does documentation play a critical role in each step of the design process?
5. How can mathematical modeling help designers understand a design?
6. How can computational thinking be applied when developing an engineering solution?
7. Why would a designer choose to communicate a solid object design with two-dimensional sketches rather than a three-dimensional model?
8. Why is it important for an engineer to be aware of the criteria and constraints when designing a project?

Key Understandings:

1. 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.
2. Statistical analysis of uni-variate data facilitates understanding and interpretation of numerical data and can be used t inform, justify, and validate a design.
3. Technical drawings convey information according to an established set of drawing practices which allow for detailed and universal interpretation of the drawing.
4. An engineering design process involves a characteristic set of practices and steps.
5. Sketches, drawings, and images are used to record and convey specific types of information depending upon the audience and the purpose of the communication.
6. Computer aided drafting and design (CAD) software packages facilitate virtual modeling of parts and

9. How does documentation play a critical role in each step of the design process? 10. How do coordinate systems help engineers with their modeling? 11. How is design testing data used to improve design solutions? 12. How does using a CAD application benefit an engineer? 13. Why is it important for an engineer to be aware of the criteria and constraints when designing a project? 14. How does documentation play a critical role in each step of the design process? 15. What is the role of statistical analysis in the design process?	assemblies and the creation of technical drawings. They are used to efficiently and accurately detail parts and assemblies according to standard engineering practice. 7. Technical professionals clearly and accurately document and report their work using technical writing practice in multiple forms. 8. An engineering design process involves a characteristic set of practices and steps. 9. Brainstorming may take many forms and is used to generate a large number of innovative, creative ideas in a short time. 10. Spreadsheet programs can be used to store, manipulate, represent, and analyze data.

Focus Standards Addressed in the Unit:	
Standard Number	*Standard Description*
3.4.7.A1	Explain how different technologies involve different sets of processes.
3.4.7.D3	Use data collected to analyze and interpret trends in order to identify the positive or negative effects of a technology.

Important Standards Addressed in the Unit:	
CC.2.1.7.D.1	Analyze proportional relationships and use them to model and solve real-world and mathematical problems.
CC.2.3.7.A.1	Solve real-world and mathematical problems involving angle measure, area, surface area, circumference, and volume.
CC.3.6.6-8.C	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Misconceptions:	**Proper Conceptions:**
1. If someone is not artistic, they will not be able to create sketches and drawings.	1. While having artistic skills can certainly enhance your sketches and drawings, understanding the geometry required representing objects through sketches and drawings is more important. If a sketch conveys the intended information – even without any artistic flair – then it has served its purpose.
2. Computers are always available these days so learning to use hand sketching is a waste of time.	2. While computers are often available, they will not always be the most convenient tool for creating sketches. Being able to generate a quick understandable hand sketch of your thoughts will often convey exactly what your clients or team members need to see for them to make critical decisions throughout the design process.
3. View placement and alignment in a multi-view technical drawing is not important.	3. In the US convention dictates that the front, top, and right side views are properly oriented and aligned with each other in a multi-view drawing. Horizontal and vertical lines that represent the same edge in the front/top and front/right views should align.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
● 3-D Sketching ● Multiview Sketching	● Represent 3-D objects on a 2-D plane using oblique, isometric, and perspective pictorial sketching concepts. ● Use two or more orthographic 2-D projections of an object to communicate the 3-D shape of the object.	● The ability to be creative to solve realworld problems. ● Students will be able to use prior knowledge to solve problems. ● Students will be able to take on additional rules in a team environment. ● Students will be engaged to think critically.

Academic Vocabulary:

● Additive method ● Algorithm ● Algorithm thinking ● Analyze ● Box-and-whisker plot ● Computational thinking ● Computer-aided design(CAD) ● Coordinate plane ● Design statement	● Feedback ● Geometric primitive ● Iteration ● Line segment ● Lower-quartile median ● Mathematical model ● Mean ● Median ● Model	● Ordered pair ● Perpendicular lines ● Polygon ● Problem decomposition ● Problem statement ● Section View ● Solid Modeling ● Subtractive method ● Three-dimensional ● Tree diagram ● Two-dimensional ● Upper-quartile median ● Vertices

Assessments:

- **Design Challenges** – Students will be given a problem through a design brief for which they will develop a solution in teams within one class period.
- **Homework** – Occasional homework assignments will be given to reinforce classroom concepts. Homework will be graded for completeness (including level of documentation of work) and will be used to formatively assess if additional instruction is needed.
- **Engineering Notebook Checks** – Students will maintain a formal engineering notebook to document their work throughout the course. Periodic checks will assess proper notebook format and content. Certain projects will be completely contained within the engineering notebook and will be assessed according to the rubric provided for that project.
- **Oral Presentations** – Students will report project solutions via oral presentations to the class. Content and presentation style will be assessed according to a standard rubric for each project.
- **Unit Tests / Unit Projects** – Each unit will include a summative written test or project. Projects may be assessed through a presentation, engineering notebook review, electronic submission, or a combination of one or more of these. Rubrics and design briefs will be provided with each project to clearly communicate the content and performance expectations for that project.

Differentiation:

- Provide graphic organizers
- Provide multiple concrete examples
- Pair stronger students with struggling students for peer assistance.
- Break extended projects into smaller identifiable milestones with checkpoints along the way

Interdisciplinary Connections:

- Design process – Scientific method
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Additional Resources:

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			Design and Modeling Grade 7 **Unit #2**
Course/Subject: Modeling and Statistical Analysis	**Grade:** 7th	**Modeling and Statistical Analysis**	**Suggested Timeline: 15 Days**

Grade Level Summary	The design process is a methodical process used to solve a problem or create a new product. All engineering professions use this process as their cornerstone. When solving a problem, you are using the design process. Students will develop skills related to problem solving, sketching, and will set up and begin maintaining an engineering notebook and portfolio.
Grade Level Units	Unit 1: Introduction to Design Unit 2: Modeling and Statistical Analysis Unit 3: Design Challenge

Unit Title	Modeling and Statistical Analysis
Unit Summary	In this lesson, students transfer a two-dimensional representation to a three-dimensional solid model with technology. Students study basic geometric shapes within a mathematical model and use combinations of geometric primitives to form more complex shapes. During the design project, students work in teams and apply the design process to create a puzzle cube. Students create a solid model using a computer-aided design (CAD) application and fabricate their design solution for testing. Students use a dynamic mathematics program to complete statistical analysis from their testing results to determine if their design met the criteria and constraints.

Unit Essential Questions:

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