



PASSAIC COUNTY TECHNICAL INSTITUTE
STEM Academy
45 Reinhardt Road
Wayne, NJ

Essentials of Engineering

Course # S9300

November 2017



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Essentials of Engineering

Students explore the concepts of Engineering (EoE) is a foundational level course in the engineering program. In EoE students are introduced to the engineering profession and a common approach to the solution of engineering problems, an engineering design process. Utilizing the activity-project-problem-based (APB) teaching and learning pedagogy, students will progress from completing structured activities to solving open-ended projects and problems that require them to develop planning, documentation, communication, and other professional skills.

Through both individual and collaborative team activities, projects, and problems, students will solve problems as they practice common engineering design and development protocols such as project management and peer review. Students will develop skills in technical representation and documentation of design solutions per accepted technical standards, and they will use current 3D design and modeling software to represent and communicate solutions. In addition, the development of computational methods that are commonly used in engineering problem solving, including statistical analysis and mathematical modeling, are emphasized. Ethical issues related to professional practice and product development are also presented.

The curriculum is aligned with New Jersey Student Learning Standards in Math, English Language Arts and World History, NJSL-Science, including Career Ready Practices and acceptable 21st Century, Career and Technical cluster standards.

The course requires a rigorous pace, and builds enthusiasm for and a real understanding of role, impact, and practice of engineering as the primary goal of this course.



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Engineering Curriculum Unit 1

Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Design Process		
Learning Objectives			
Unit 1 Design Process			
This unit provides an introduction to the broad field of engineering and a design process that engineers use to develop innovative solutions to real problems. Students become familiar with the traditional big four disciplines of engineering and the extensive array of career opportunities and engineering problems addressed within each discipline. A design process is presented as a structured method for approaching and developing solutions to a problem. The art and skill of brainstorming is emphasized as students begin to develop skill in graphically representing ideas through concept sketching.			
Science Standards & Practices	English & Language Arts Standards	Mathematics Standards	
<p><u>Science & Engineering Practice</u></p> <p>NJSLS- S HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>Science & Engineering Practice - Science and Engineering Practice - Engaging in Argument from Evidence - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.</p> <p>Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.</p> <p>Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.</p> <p>Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.</p>	<p><u>NJSLS for ELA</u></p> <p>NJSLSA.R.1 - Reading - Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.</p> <p>NJSLSA.R.7 - Reading - Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.</p> <p>NJSLSA.R.10 - Reading - Read and comprehend complex literary and informational texts independently and proficiently.</p> <p>NJSLSA.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJSLSA.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>NJSLSA.W.5 - Writing - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.</p> <p>NJSLSA.W.6 - Writing - Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS 7.G.A.2 Draw (with technology, with ruler and protractor as well as freehand) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle</p> <p>NJSLS HS G.CO.D.12 Make geometric constructions Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.</p> <p>NJSLS HS G.CO.D.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.</p> <p>NJSLS HS G-GMD.A. Explain volume formulas and use them to solve problems 1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments. 2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures. 3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve</p>	



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	<p>NJSLSA.W.7 - Writing - Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.</p> <p>NJSLSA.W.8 – Writing- Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.</p> <p>NJSLSA.W.9 - Writing - Draw evidence from literary or informational texts to support analysis, reflection, and research.</p> <p>NJSLSA.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p> <p>NJSLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLSA.SL.2 - Speaking and Listening - Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.</p> <p>NJSLSA.SL.4 - Speaking and Listening - Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.</p> <p>NJSLSA.SL.5 - Speaking and Listening - Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.</p> <p>NJSLSA.SL.6 - Speaking and Listening - Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.</p> <p>NJSLSA.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <p>NJSLSA.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p>	<p>problems.★ B. Visualize relationships between two-dimensional and three-dimensional objects 4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.</p>
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NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.W.1 - Writing - Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

NJSLS 9-10.W.1.a - Writing - Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.

NJSLS 9-10.W.1.b - Writing - Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.

NJSLS 9-10.W.1.c - Writing - Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

NJSLS 9-10.W.1.d - Writing - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.W.1.e - Writing - Provide a concluding statement or section that follows from and supports the argument presented.

NJSLS 9-10.W.2.a - Writing - Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

NJSLS 9-10.W.2.b - Writing - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.



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NJSLS 9-10.W.2.d - Writing - Use precise language and domain-specific vocabulary to manage the complexity of the topic.

NJSLS 9-10.W.2.e - Writing - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.W.2.f - Writing - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

NJSLS 9-10.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

NJSLS 9-10.W.5 - Writing - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

NJSLS 9-10.W.7 - Writing - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

NJSLS 9-10.W.8 - Writing - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

NJSLS 9-10.W.9 - Writing - Draw evidence from literary or informational texts to support analysis, reflection, and research.

NJSLS 9-10.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

NJSLS 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions



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(one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

NJSLS 9-10.SL.4 - Speaking and Listening - Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

NJSLS 9-10.SL.5 - Speaking and Listening Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

NJSLS 9-10.SL.6 - Speaking and Listening Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

NJSLS 9-10.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

NJSLS 9-10.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

NJSLS 9-10.L.2.c - Language Spell correctly.

NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

NJSLS 9-10.RST.8 - Reading Science/Technical Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.



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NJSLS 9-10.WHST.1 - Writing HS/S/T Write arguments focused on discipline-specific content.

NJSLS 9-10.WHST.1.a - Writing HS/S/T - Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

NJSLS 9-10.WHST.1.b - Writing HS/S/T - Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

NJSLS 9-10.WHST.1.c - Writing HS/S/T - Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

NJSLS 9-10.WHST.1.d - Writing HS/S/T - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.WHST.1.e - Writing HS/S/T - Provide a concluding statement or section that follows from or supports the argument presented.

NJSLS 9-10.WHST.2 - Writing HS/S/T - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

NJSLS 9-10.WHST.2.a - Writing HS/S/T - Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

NJSLS 9-10.WHST.2.b - Writing HS/S/T - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

NJSLS 9-10.WHST.2.d - Writing HS/S/T - Use precise language and domain-specific vocabulary to manage the



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	<p>complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.</p> <p>NJSLS 9-10.WHST.2.e - Writing HS/S/T - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</p> <p>NJSLS 9-10.WHST.2.f - Writing HS/S/T - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).</p> <p>NJSLS 9-10.WHST.4 - Writing HS/S/T - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>NJSLS 9-10.WHST.5 - Writing HS/S/T - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>NJSLS 9-10.WHST.7 - Writing HS/S/T - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.</p> <p>NJSLS 9-10.WHST.8 - Writing HS/S/T - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.</p> <p>NJSLS 9-10.WHST.9 - Writing HS/S/T - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>NJSLS 9-10.WHST.10 - Writing HS/S/T - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline- specific tasks, purposes, and audiences.</p>	
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NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum



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NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.

NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.

NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.

NJSLS Career Ready Practices – See Addendum

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. When solving an engineering problem, how can we be reasonably sure that we have created the **best** solution possible? What is the evidence?
2. 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?
3. What engineering accomplishment of the 20th century has had the greatest impact on society? Justify your answer.
4. What will be the biggest impact that engineering will have on society and your life in the 21st century? Justify your answer.
5. Engineering tends to be a male-dominated profession. Why is that?

Anchor Text

Introduction to Engineering Design © 2017 Project Lead The Way, Inc.
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Informational Texts (3-5)

See Inkling.com

Short Texts (1-3)

Formative & Summative Assessments

Formative: Kahoot, Plickers, Exit tickets, etc.
Summative: PLTW Computer Based Assessments, Project Scoring Rubrics

Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)

Inkling.com, Canvas

Labs

- 1.1 Develop engineering notebook standards and protocols
- 1.2 Identify Brainstorming techniques
- 1.3 Chronological product research
- 1.4 Identify the design process steps

Suggested Time Frame: 4 weeks



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Engineering Curriculum Unit 2

Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Technical Sketching and Drawing		
Learning Objectives			
<p>Unit 2 Technical Sketching and Drawing This unit develops an understanding of the purpose and practice of visual representations and communication within engineering in the form of technical sketching and drawing. Students build skill and gain experience in representing three-dimensional objects in two dimensions. Students will create various technical representations used in visualization, exploring, communicating, and documenting design ideas throughout the design process, and they will understand the appropriate use of specific drawing views (including isometric, oblique, perspective, and orthographic projections). They progress from creating free hand technical sketches using a pencil and paper to developing engineering drawings according to accepted standards and practices that allow for universal interpretation of their design.</p>			
Science Standards & Practices	English & Language Arts Standards	Mathematics Standards	
<p><u>NJSLS - Science Standards</u></p> <p>NJSLS HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>Science & Engineering Practice - Engaging in Argument from Evidence - Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.</p> <p>Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.</p>	<p><u>NJSLS for ELA</u></p> <p>NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>NJSLS HS G.CO.D.12 Make geometric constructions Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.</p> <p>NJSLS HS G.CO.D.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.</p>	



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specific scientific or technical context relevant to grades 9–10 texts and topics.

NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

NJSLS CTE_9.3.ST-SM.2 - Apply science and mathematics concepts to the development of plans, processes and projects that address real world problems.

NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.

NJSLS CTE 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.

NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.

NJSLS Career Ready Practices – See Addendum

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Demonstrate creativity and innovation.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. How is technical drawing similar to and different from artistic drawing?
2. 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?
3. In what ways can technical drawings help or hinder the communication of problem solution in a global community.
4. Strong spatial-visualization skills have been linked to success in engineering. Why are spatial-visualization skills so important to engineering success?

Anchor Text

Introduction to Engineering Design © 2017 Project Lead The Way, Inc.
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Informational Texts (3-5)

See Inkling.com

Short Texts (1-3)

Formative & Summative Assessments

Formative: Kahoot, Pickers, Exit tickets, etc.
 Summative: PLTW Computer Based Assessments, Project Scoring Rubrics

Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)

Inkling.com, Canvas



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Labs	
1.5	Utilize sketch-based work reference
1.6	Develop solid CAD models from dimensioned drawings
Suggested Time Frame:	4 weeks

Engineering Curriculum Unit 3

Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Measurement and Statistics		

Learning Objectives		
<p>Unit 3 Measurement and Statistics</p> <p>The purpose of this unit is for students to become familiar with appropriate practices and the applications of measurement (using both U. S. Customary and SI units) and statistics within the discipline of engineering. Students will learn appropriate methods of making and recording measurements, including the use of dial calipers, as they come to understand the ideas of precision and accuracy of measurement and their implications on engineering design. The concepts of descriptive and inferential statistics are introduced as methods to mathematically represent information and data and are applied in the design process to improve product design, assess design solutions, and justify design decisions. Students are also provided with practice in unit conversion and the use of measurement units as an aid in solving practical problems involving quantities. A spreadsheet program is used to store, manipulate, represent, and analyze data, thereby enhancing and extending student application of these statistical concepts.</p>		
Science Standards & Practices	English & Language Arts Standards	Mathematics Standards
<p><u>NJSLS - Science Standards</u></p> <p>NJSLS-S HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>Science and Engineering Practice - to determine relationships, including quantitative relationships, between independent and dependent variables.</p> <p>Science and Engineering Practice - Developing and Using Models - Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.</p> <p>Science and Engineering Practice - Planning and Carrying Out Investigations - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.</p>	<p><u>NJSLS for ELA</u></p> <p>NJSLSA.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p> <p>NJSLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLSA.9-10.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS N.Q.1 - Quantities - Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>NJSLS N.Q.2 - Quantities Define appropriate quantities for the purpose of descriptive modeling.</p> <p>NJSLS N.Q.3 - Quantities - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>NJSLS A.CED.3 - Creating Equations - Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</p> <p>NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe</p>



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<p>Science and Engineering Practice - Planning and Carrying Out Investigations - Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.</p> <p>Science and Engineering Practice - Analyzing and Interpreting Data - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.</p> <p>Science and Engineering Practice - Constructing Explanations and Designing Solutions - Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.</p> <p>Science and Engineering Practice - Constructing Explanations and Designing Solutions - Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Construct, use, and/or present an oral and written argument or counterarguments based on data and evidence.</p>	<p>shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p> <p>NJSLSA 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLSA 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLSA 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.</p> <p>NJSLSA 9-10.RST.7 - Reading Science/Technical - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.</p> <p>NJSLSA 9-10.WHST.10 - Writing HS/S/T - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>	<p>objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>NJSLS S.ID.1 - Interpreting Categorical and Quantitative Data Represent data with plots on the real number line (dot plots, histograms, and box plots).</p> <p>S.ID.4 - Interpreting Categorical and Quantitative Data - Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.</p>
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NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

<p><u>NJSLS Career & Technical Education Standards – See Addendum</u></p> <p>NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.</p> <p>NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.</p> <p>NJSLS CTE 9.3.ST.6 - Demonstrate technical skills needed in a chosen STEM field.</p> <p>NJSLS CTE 9.3.ST-SM.1 - Apply science and mathematics to provide results, answers and algorithms for engineering and technological activities.</p> <p>NJSLS CTE 9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.</p>
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NJSLS Career Ready Practices – See Addendum

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Employ valid and reliable research strategies.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. Can statistics be interpreted to justify conflicting viewpoints? Can this affect how we use statistics to inform, justify and validate a problem solution?
2. Why is error unavoidable when making a measurement?
3. When recording measurement data, why is the use of significant figures important?
4. What strategy would you use to teach another student how to use units and quantitative reasoning to solve a problem involving quantities?
5. What would happen if engineers did not follow accepted dimensioning standards and guidelines but, instead, used their own individual dimensioning methods?
6. 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 imprecise (but accurate) measuring instrument?

Anchor Text

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Informational Texts (3-5)

See Inkling.com

Short Texts (1-3)

Formative & Summative Assessments

Formative: Kahoot, Plickers, Exit tickets, etc.
 Summative: PLTW Computer Based Assessments, Project Scoring Rubrics

Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)

Inkling.com, Canvas

Labs

- 1.7 Mathematical modeling
- 1.8 Understanding of dimensioning
- 1.9 Statistical process control

Suggested Time Frame: 4 weeks

Engineering Curriculum Unit 4



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Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Modeling Skills		
Learning Objectives			
Unit 4 Modeling Skills			
This unit introduces students to a variety of modeling methods used to represent systems, components, and processes in design. Students are provided experience in interpreting and developing multiple forms of models common to engineering. They create graphical models to precisely define design parameters. Student learn to develop mathematical representations (in the form of linear functions) to represent relationships, identify patterns and inform design decisions. Computer modeling is introduced, and students use modeling software to create CAD models to represent simple objects in a virtual 3D environment. The modeling software also provides an efficient method for students to create technical documentation of objects. Students are also provided opportunities to create physical models of design elements and use the models for testing purposes.			
Science Standards & Practices	English & Language Arts Standards	Mathematics Standards	
<p><u>NJSLS - Science Standards</u></p> <p>NJSLS-S - HS.ETS1.2 - Engineering Design - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>NJSLS-S - HS.ETS1.3 - Engineering Design - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>NJSLS-S - HS.ETS1.4 - Engineering Design - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p> <p>NJSLS-S - DCI - ETS1.B - Engineering Design - Developing Possible Solutions When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)</p> <p>Science & Engineering Practice – Science and Engineering Practice - Asking questions and defining problems Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. - that arise from examining models or a theory, to clarify and/or seek additional information and relationships. - to determine relationships, including quantitative relationships, between independent and</p>	<p><u>NJSLS for ELA</u></p> <p>NJSLSA.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJSLSA.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>NJSLSA.W.6 - Writing - Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.</p> <p>NJSLSA.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p> <p>NJSLSA.SL.2 - Speaking and Listening - Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.</p> <p>NJSLSA.SL.5 - Speaking and Listening - Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.</p> <p>NJSLSA.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <p>NJSLSA.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS N.Q .1 - Quantities - Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>NJSLS N.Q.2 - Quantities Define appropriate quantities for the purpose of descriptive modeling.</p> <p>NJSLS N.Q.3 - Quantities - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>NJSLS A.SSE.1 - Seeing Structure in Expressions Interpret expressions that represent a quantity in terms of its context.</p> <p>NJSLS A.SSE.1.a - Seeing Structure in Expressions Interpret parts of an expression, such as terms, factors, and coefficients.</p> <p>NJSLS A.CED.1 - Creating Equations - Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</p> <p>NJSLS A.CED.2 - Creating Equations - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</p> <p>NJSLS A.CED.4 - Creating Equations - Rearrange formulas to highlight a quantity of interest, using the same reasoning</p>	



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dependent variables. - to clarify and refine a model, an explanation, or an engineering problem.

Science and Engineering Practice - Developing and Using Models - Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Science and Engineering Practice - Developing and Using Models - Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Science and Engineering Practice - Developing and Using Models - Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Science and Engineering Practice - Developing and Using Models - Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Science and Engineering Practice - Planning and Carrying Out Investigations - Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.

Science and Engineering Practice - Planning and Carrying Out Investigations - Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Science and Engineering Practice - Analyzing and Interpreting Data - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Science and Engineering Practice - Analyzing and Interpreting Data - Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

NJSLS 9-10.W.2.a - Writing - Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

NJSLS 9-10.W.2.b - Writing - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

NJSLS 9-10.W.2.d - Writing - Use precise language and domain-specific vocabulary to manage the complexity of the topic.

NJSLS 9-10.W.2.e – Writing- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.W.2.f - Writing - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

NJSLS 9-10.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

NJSLS 9-10.W.10 – Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R .

NJSLS A.REI.3 - Reasoning with Equations and Inequalities - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

NJSLS A.REI.10 - Reasoning with Equations and Inequalities - Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

NJSLS F.IF.1 - Interpreting Functions - Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x . the graph of f is the graph of the equation $y = f(x)$.

NJSLS F.IF.2 - Interpreting Functions - Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

NJSLS F.IF.5 - Interpreting Functions - Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

F.IF.6 - Interpreting Functions - Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

NJSLS F.IF.7.a - Interpreting Functions Graph linear and quadratic functions and show intercepts, maxima, and minima.

NJSLS F.BF.1 - Building Functions Write a function that describes a relationship between two quantities.

NJSLS F.LE.5 - Linear, Quadratic, and Exponential Models Interpret the parameters in a linear or exponential function in terms of a context.

NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).



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<p>Science and Engineering Practice - Analyzing and Interpreting Data - Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.</p> <p>Science and Engineering Practice - Analyzing and Interpreting Data - Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.</p> <p>Science and Engineering Practice - Using Mathematics and Computational Thinking - Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.</p> <p>Science and Engineering Practice - Using Mathematics and Computational Thinking - Apply techniques of algebra and functions to represent and solve scientific and engineering problems.</p> <p>Science and Engineering Practice - Using Mathematics and Computational Thinking - Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m³, acre-feet, etc.)</p> <p>Science and Engineering Practice - Constructing Explanations and Designing Solutions - Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.</p> <p>Science and Engineering Practice - Constructing Explanations and Designing Solutions - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Make and defend a claim based on evidence about the natural world or the effectiveness of a</p>	<p>NJSLS 9-10.SL.5 - Speaking and Listening - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.</p> <p>NJSLS 9-10.L.1 – Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <p>NJSLS 9-10.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <p>NJSLS 9-10.L.2.c - Language Spell correctly.</p> <p>NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.</p> <p>NJSLS 9-10.RST.7 - Reading Science/Technical - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.</p> <p>NJSLS 9-10.WHST.2 - Writing HS/S/T - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <p>NJSLS 9-10.WHST.2.a - Writing HS/S/T - Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</p> <p>NJSLS 9-10.WHST.2.b - Writing HS/S/T Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.</p>	<p>NJSLS G.MG.3 - Modeling with Geometry - Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p> <p>NJSLS S.ID.6 - Interpreting Categorical and Quantitative Data - Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.</p> <p>NJSLS S.ID.6.a - Interpreting Categorical and Quantitative Data - Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.</p> <p>NJSLS S.ID.6.c - Interpreting Categorical and Quantitative Data Fit a linear function for a scatter plot that suggests a linear association.</p> <p>NJSLS S.ID.7 - Interpreting Categorical and Quantitative Data Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.</p> <p>NJSLS S.ID.8 - Interpreting Categorical and Quantitative Data Compute (using technology) and interpret the correlation coefficient of a linear fit.</p> <p>NJSLS S.IC.1 - Making Inferences and Justifying Conclusions - Understand statistics as a process for making inferences about population parameters based on a random sample from that population.</p>
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design solution that reflects scientific knowledge and student-generated evidence.

Science and Engineering Practice - Engaging in Argument from Evidence - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).

Crosscutting Concepts - Scale, Proportion, and Quantity - Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

NJSLS 9-10.WHST.2.d - Writing HS/S/T - Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

NJSLS 9-10.WHST.2.e - Writing HS/S/T - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.WHST.2.f - Writing HS/S/T - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

NJSLS 9-10.WHST.4 - Writing HS/S/T - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

NJSLS 9-10.WHST.10 - Writing HS/S/T - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.

NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.

NJSLS CTE 9.3.ST-SM.1 - Apply science and mathematics to provide results, answers and algorithms for engineering and technological activities.

NJSLS CTE 9.3.ST-SM.2 - Apply science and mathematics concepts to the development of plans, processes and projects that address real world problems.

NJSLS CTE 9.3.ST-SM.4 - Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.

NJSLS Career Ready Practices – See Addendum

Act as a responsible and contributing citizen and employee.
 Apply appropriate academic and technical skills.
 Communicate clearly and effectively and with reason.
 Consider the environmental, social and economic impacts of decisions.
 Demonstrate creativity and innovation.
 Employ valid and reliable research strategies.



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Utilize critical thinking to make sense of problems and persevere in solving them.
 Model integrity, ethical leadership and effective management.
 Use technology to enhance productivity.
 Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. 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?
2. Did you use every possible type of model during the design and construction of your cube? Describe each model that you used?
3. How reliable is a mathematical model?

Anchor Text

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Informational Texts (3-5)

See Inkling.com

Short Texts (1-3)

Formative & Summative Assessments

Formative: Kahoot, Plickers, Exit tickets, etc.
 Summative: PLTW Computer Based Assessments, Project Scoring Rubrics

Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)

Inkling.com, Canvas

Labs

- 1.10 Generate dimensioned Multiview drawings.
- 1.11 Fabricate parts for a functional prototype.
- 1.12 Assemble, test and evaluate the prototype and record results.

Suggested Time Frame: 4 weeks

Engineering Curriculum Unit 5

Content Area:	Essentials of Engineering	Grade(s)	9
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Unit Plan Title:	Geometry of Design
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Learning Objectives

Unit 5 Geometry of Design

In this unit students are provided opportunities to investigate two- and three-dimensional geometric concepts and apply statics to engineering decision making and problem solving. Fluency in these geometric concepts is essential in every phase of the design process as problems are defined, potential solutions are generated to meet physical constraints, alternate design solutions are compared and selected, final designs are documented, and specifications are developed. Geometric concepts are also important in the appropriate application of geometric and dimensional relationships and constraints for effective use of three-dimensional computer modeling environments that employ parametric design functionality. In this unit students develop an understanding of static equilibrium and use geometric concepts and physical properties to solve a wide variety of problems including estimating costs, investigating physical



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properties to identify materials, and iterating designs to meet design specifications. Students will also use 3D computer models to compute physical properties that can be used in problem solving and creation of design solutions.

Science Standards & Practices	English & Language Arts Standards	Mathematics Standards
<p><u>NJSLS - Science Standards</u></p> <p>NJSLS-S - Crosscutting Concepts - Structure and Function The way an object is shaped or structured determines many of its properties and functions.</p>	<p><u>NJSLS for ELA</u></p> <p>NJLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJLSA.SL.6 - Speaking and Listening - Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.</p> <p>NJLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLS 9-10.SL.6 - Speaking and Listening - Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.</p> <p>NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.RST.3 - Reading Science/Technical - Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.</p> <p>NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS N.Q.2 - Quantities Define appropriate quantities for the purpose of descriptive modeling.</p> <p>NJSLS N.Q.3 - Quantities - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>NJSLS A.CED.4 - Creating Equations - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R.</p> <p>NJSLS A.REI.3 - Reasoning with Equations and Inequalities - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>NJSLS A.REI.4.b - Reasoning with Equations and Inequalities - Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.</p> <p>NJSLS G.GMD.3 - Geometric Measurement and Dimension - Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.</p> <p>NJSLS G.GMD.4 - Geometric Measurement and Dimension</p> <p>Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.</p> <p>NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>NJSLS G.MG.2 - Modeling with Geometry - Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).</p> <p>NJSLS G.MG.3 - Modeling with Geometry - Apply geometric methods to solve design problems (e.g., designing an object</p>



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domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.

NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.

NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.

NJSLS CTE 9.3.ST-SM.2 - Apply science and mathematics concepts to the development of plans, processes and projects that address real world problems.

NJSLS Career Ready Practices – See Addendum

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Employ valid and reliable research strategies.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. 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?
2. Which high school math topic/course, Algebra or Geometry, is more closely related to engineering? Justify your answer.
3. How does the material chosen for a product impact the design of the product?

Anchor Text

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Informational Texts (3-5)

See InKling.com

Short Texts (1-3)

Formative & Summative Assessments

Formative: Kahoot, Plickers, Exit tickets, etc.
 Summative: PLTW Computer Based Assessments, Project Scoring Rubrics



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Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)

Inkling.com, Canvas

Labs

- 1.13 Geometric relationships
- 1.14 The Cartesian coordinate system
- 1.15 Geometric and numeric constraints to CAD

Suggested Time Frame: 4 weeks

Engineering Curriculum Unit 6

Content Area:	Essentials of Engineering	Grade(s)	9
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Unit Plan Title:	Reverse Engineering
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Learning Objectives

Unit 6 Reverse Engineering

This unit exposes students to the application of engineering principles and practices to reverse engineer a consumer product. Reverse engineering involves disassembling and analyzing a product or system in order to understand and document the visual, functional, and/or structural aspects of its design. In this unit students will have the opportunity to assess all three aspects of a product's design. Students will learn the visual design elements and principles and their application in design. They will perform a functional analysis to hypothesize the overall function and sequential operations of the product's component parts and assess the inputs and outputs of the process(es) involved in the operation of the product. Students will physically disassemble the product to document the constituent parts, their properties, and their interaction and operation. After carefully documenting these aspects of the visual, functional, and structural aspects of the product, students will assess the strengths and weaknesses of the product and the manufacturing process by which it was produced.

Science Standards & Practices	English & Language Arts Standards	Mathematics Standards
<p><u>NJSLS - Science Standards</u></p> <p>NJSLS-S - Crosscutting Concepts - Structure and Function - Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.</p> <p>Crosscutting Concepts - Structure and Function - The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.</p>	<p><u>NJSLS for ELA</u></p> <p>NJSLSA.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJSLSA.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>NJSLSA.W.6 - Writing - Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.</p> <p>NJSLSA.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS G.GMD.3 - Geometric Measurement and Dimension - Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.</p> <p>NJSLS G.GMD.4 - Geometric Measurement and Dimension - Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.</p> <p>NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>NJSLS G.MG.3 - Modeling with Geometry - Apply geometric methods to solve design problems (e.g., designing an object</p>



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	<p>NJSLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLSA.SL.2 - Speaking and Listening - Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.</p> <p>NJSLSA.SL.4 - Speaking and Listening - Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.</p> <p>NJSLSA.SL.5 - Speaking and Listening - Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.</p> <p>NJSLSA.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <p>NJSLSA.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <p>NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.W.2.d - Writing - Use precise language and domain-specific vocabulary to manage the complexity of the topic.</p> <p>NJSLS 9-10.W.2.e - Writing - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</p> <p>NJSLS 9-10.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)</p> <p>NJSLS 9-10.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p>	<p>or structure to satisfy physical constraints or minimize cost; working with topographic grid systems based on ratios).</p>
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NJSLS 9-10.SL.1 - Speaking and Listening Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

NJSLS 9-10.SL.4 - Speaking and Listening - Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

NJSLS 9-10.SL.5 - Speaking and Listening - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

NJSLS 9-10.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

NJSLS 9-10.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

NJSLS 9-10.L.2.c - Language Spell correctly.

NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

NJSLS 9-10.WHST.2 - Writing HS/S/T - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

NJSLS 9-10.WHST.2.a - Writing HS/S/T - Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.



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NJSLS 9-10.WHST.2.b - Writing HS/S/T - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

NJSLS 9-10.WHST.2.d - Writing HS/S/T - Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

NJSLS 9-10.WHST.2.e - Writing HS/S/T - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.WHST.4 - Writing HS/S/T - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

NJSLS 9-10.WHST.10 - Writing HS/S/T - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline- specific tasks, purposes, and audiences.

NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

- NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.
- NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.
- NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.
- NJSLS CTE 9.3.ST-SM.1 - Apply science and mathematics to provide results, answers and algorithms for engineering and technological activities.
- NJSLS CTE 9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.

NJSLS Career Ready Practices – See Addendum

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Demonstrate creativity and innovation.
- Employ valid and reliable research strategies.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.



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Essential Questions (3-5)	
1. Why are many consumer product designs not commercially successful? 2. When, if ever, is it acceptable for a company to reverse engineer and reproduce a successful consumer product designed by another person/company? 3. What laws and ethical standards are in place to maintain the integrity of intellectual property and patents?	
Anchor Text	
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Informational Texts (3-5)	
See InKling.com	
Short Texts (1-3)	
Formative & Summative Assessments	
Formative: Kahoot, Plickers, Exit tickets, etc. Summative: PLTW Computer Based Assessments, Project Scoring Rubrics	
Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)	
InKling.com, Canvas	
Labs	
1.16 Visual design principles 1.17 Aesthetics of design 1.18 Purpose of packaging	
Suggested Time Frame:	3 weeks

Engineering Curriculum Unit 7

Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Documentation		
Learning Objectives			
Unit 7 Documentation			
In this unit students' will enhance their basic knowledge of technical drawing representations learned earlier in the course to include the creation of alternate (section and auxiliary) views and appropriate dimensioning and annotation of technical drawings. Students will also be introduced to the reality of variation in dimensional properties of manufactured products. They will learn the appropriate use of dimensional tolerances and alternate dimensioning methods to specify acceptable ranges of the physical properties in order to meet design criteria. Students will apply this knowledge to create engineering working drawings that document measurements collected during a reverse engineering process. These skills will also allow students to effectively document a proposed new design. Students will use 3D computer modeling software to model the assembly of the consumer product, as such a model can be used to replicate functional operation and provide virtual testing of product design.			
Science Standards & Practices	English & Language Arts Standards	Mathematics Standards	



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NJSLS - Science Standards

NJSLS-S - HS.ETS1.2 - Engineering Design - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

NJSLS-S HS.ETS1.3 - Engineering Design - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

NJSLS-S HS.ETS1.4 - Engineering Design - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

NJSLS-S DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems - Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3)

NJSLS-S DCI - ETS1.B - Engineering Design - Developing Possible Solutions - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

NJSLS-S DCI - ETS1.C - Engineering Design - Optimizing the Design Solution - Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)

Science & Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant.

Science and Engineering Practice - Asking questions and defining problems - Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

NJSLS for ELA

NJSLSA.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

NJSLSA.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

NJSLSA.W.6 - Writing - Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

NJSLSA.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

NJSLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

NJSLSA.SL.2 - Speaking and Listening - Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

NJSLSA.SL.5 - Speaking and Listening - Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

NJSLSA.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

NJSLSA.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas, concepts, and

NJSLS for Mathematics

NJSLS N.Q.3 - Quantities - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

NJSLS G.GMD.4 - Geometric Measurement and Dimension - Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

NJSLS G.MG.3 - Modeling with Geometry Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).



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<p>Science and Engineering Practice - Developing and Using Models - Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.</p> <p>Science and Engineering Practice - Constructing Explanations and Designing Solutions - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).</p>	<p>information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJSLS 9-10.W.2.a - Writing - Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</p> <p>NJSLS 9-10.W.2.b - Writing - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.</p> <p>NJSLS 9-10.W.2.d - Writing - Use precise language and domain-specific vocabulary to manage the complexity of the topic.</p> <p>NJSLS 9-10.W.2.e - Writing - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</p> <p>NJSLS 9-10.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)</p> <p>NJSLS 9-10.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p> <p>NJSLS 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLS 9-10.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <p>NJSLS 9-10.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <p>NJSLS 9-10.L.2.c - Language Spell correctly.</p> <p>NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the</p>	
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college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9 - 10 texts and topics.

NJSLS 9-10.RST.7 - Reading Science/Technical - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

NJSLS 9-10.WHST.2 - Writing HS/S/T - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

NJSLS 9-10.WHST.2.a - Writing HS/S/T - Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

NJSLS 9-10.WHST.2.b - Writing HS/S/T - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

NJSLS 9-10.WHST.2.d - Writing HS/S/T - Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

NJSLS 9-10.WHST.2.e - Writing HS/S/T - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.WHST.4 - Writing HS/S/T - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

NJSLS 9-10.WHST.10 - Writing HS/S/T - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for



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a range of discipline- specific tasks, purposes, and audiences.

NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

- NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.
- NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.
- NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.
- NJSLS CTE 9.3.ST-ET.6 - Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.
- NJSLS CTE 9.3.ST.5- Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.

NJSLS Career Ready Practices – See Addendum

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Consider the environmental, social and economic impacts of decisions.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. What are the consequences to the final solution if the design problem is poorly communicated?
2. How does one know that a given design solution is the best possible solution?
3. 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
4. What quality makes a set of drawings sufficient to adequately represent the design intent?
5. Is it always necessary to indicate a tolerance for every dimension on a technical drawing? Justify your answer.
6. In your opinion which step of the design process is most important to successfully innovate or invent a new product? Justify your answer.
7. Stephen Covey includes Begin with the End in Mind 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?

Anchor Text

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Informational Texts (3-5)

See InKling.com

Short Texts (1-3)

Formative & Summative Assessments

Formative: Kahoot, Plickers, Exit tickets, etc.
 Summative: PLTW Computer Based Assessments, Project Scoring Rubrics

Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)



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Inkling.com, Canvas	
Labs	
1.19 Design brief constraints 1.20 Create a brochure marketing the designed solution 1.21 The concept of fluid power 1.22 Presentations of Engineering Notebooks	
Suggested Time Frame:	4 weeks

Engineering Curriculum Unit 8

Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Advanced Computer Modeling		

Learning Objectives		
<p>Unit 8 Advanced Computer Modeling In this unit students will learn advanced 3D computer modeling skills. These advanced skills include creating animated assembly views of multi-part products and using mathematical functions to represent relationships to enforce dimensional and motion constraints. Students will use the skills and knowledge previously built in the course to develop and document the solution to a design challenge using an iterative design process.</p>		
Science Standards & Practices	English & Language Arts Standards	Mathematics Standards
<p><u>NJSLS - Science Standards</u></p> <p>Science & Engineering Practice - Asking questions and defining problems Ask questions - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. - that arise from examining models or a theory, to clarify and/or seek additional information and relationships. - to determine relationships, including quantitative relationships, between independent and dependent variables. - to clarify and refine a model, an explanation, or an engineering problem.</p>	<p><u>NJSLS for ELA</u></p> <p>NJSLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS A.SSE.1 - Seeing Structure in Expressions Interpret expressions that represent a quantity in terms of its context.</p> <p>NJSLS A.CED.1 - Creating Equations - Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</p> <p>NJSLS A.CED.2 - Creating Equations - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</p> <p>NJSLS A.CED.3 - Creating Equations - Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</p>



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	<p>NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9 - 10 texts and topics.</p>	<p>NJSLS A.REI.3 - Reasoning with Equations and Inequalities Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>NJSLS F.LE.5 - Linear, Quadratic, and Exponential Models Interpret the parameters in a linear or exponential function in terms of a context.</p> <p>NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p>
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NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

NJSLS CTE 9.3.ST.1 Apply engineering skills in a project that requires project management, process control and quality assurance.

NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.

NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.

NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.

NJSLS Career Ready Practices – See Addendum

Apply appropriate academic and technical skills.
 Communicate clearly and effectively and with reason.
 Demonstrate creativity and innovation.
 Utilize critical thinking to make sense of problems and persevere in solving them.
 Model integrity, ethical leadership and effective management.
 Use technology to enhance productivity.
 Work productively in teams while using cultural global competence.

Essential Questions (3-5)

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

Anchor Text

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Informational Texts (3-5)

See InKling.com

Short Texts (1-3)



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Formative & Summative Assessments	
Formative: Kahoot, Plickers, Exit tickets, etc. Summative: PLTW Computer Based Assessments, Project Scoring Rubrics	
Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)	
Inkling.com, Canvas	
Labs	
1.23 Auxiliary, full and half section views 1.24 Algebraic relationships between the dimensional values 1.25 Exploded isometric assembly view, balloons, and parts list in engineering design	
Suggested Time Frame:	3 weeks

Engineering Curriculum Unit 9

Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Design Team		
Learning Objectives			
<p>Unit 9 Design Team In this unit students' will work as a collaborative team with geographically separate team members, thereby requiring virtual communications. Through the design process, the team will experience shared decision-making as they work to solve a new design challenge. They will reflect on the ethical responsibilities of engineers as they investigate different materials, manufacturing processes, and the short and long term impacts that their decision- making may potentially have on society or on the world.</p>			
Science Standards & Practices	English & Language Arts Standards	Mathematics Standards	
<p><u>NJSLS - Science Standards</u></p> <p>NJSLS-S HS.ETS1.2 - Engineering Design - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>NJSLS-S HS.ETS1.3 - Engineering Design - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>NJSLS-S HS.ETS1.4 - Engineering Design - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous</p>	<p><u>NJSLS for ELA</u></p> <p>NJSLSA.R.1 - Reading - Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.</p> <p>NJSLSA.R.7 - Reading - Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.</p> <p>NJSLSA.R.10 - Reading - Read and comprehend complex literary and informational texts independently and proficiently.</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>NJSLS G.MG.3 - Modeling with Geometry - Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p>	



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<p>criteria and constraints on interactions within and between systems relevant to the problem.</p> <p>NJSLS-S DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems - Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3)</p> <p>NJSLS-S DCI - ETS1.B - Engineering Design - Developing Possible Solutions - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)</p> <p>NJSLS-S DCI - ETS1.C - Engineering Design - Optimizing the Design Solution - Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)</p> <p>NJSLS-S DCI - ESS3.A - Earth and Human Activity - Natural Resources - All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)</p> <p>NJSLS-S DCI - ESS3.C - Earth and Human Activity - Human Impacts on Earth Systems - Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)</p> <p>Science & Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant.</p> <p>Science and Engineering Practice - Asking questions and defining problems - Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.</p> <p>Science and Engineering Practice - Asking questions and defining problems - Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.</p>	<p>NJSLSA.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJSLSA.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>NJSLSA.W.6 - Writing - Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.</p> <p>NJSLSA.W.7 - Writing - Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.</p> <p>NJSLSA.W.8 - Writing - Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.</p> <p>NJSLSA.W.9 - Writing - Draw evidence from literary or informational texts to support analysis, reflection, and research.</p> <p>NJSLSA.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p> <p>NJSLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLSA.SL.2 - Speaking and Listening - Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.</p> <p>NJSLSA.SL.4 - Speaking and Listening - Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.</p> <p>NJSLSA.SL.5 - Speaking and Listening - Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.</p> <p>NJSLSA.SL.6 - Speaking and Listening - Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.</p>	
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<p>Science and Engineering Practice - Developing and Using Models - Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.</p> <p>Science and Engineering Practice - Constructing Explanations and Designing Solutions - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).</p> <p>Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.</p> <p>Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.</p> <p>Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.</p>	<p>NJSLSA.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <p>NJSLSA.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <p>NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJSLS 9-10.W.2.a - Writing - Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</p> <p>NJSLS 9-10.W.2.b - Writing - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.</p> <p>NJSLS 9-10.W.2.d - Writing - Use precise language and domain-specific vocabulary to manage the complexity of the topic.</p> <p>NJSLS 9-10.W.2.e - Writing - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</p> <p>NJSLS 9-10.W.2.f - Writing - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).</p> <p>NJSLS 9-10.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)</p>	
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NJSLS 9-10.W.7 - Writing - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

NJSLS 9-10.W.8 - Writing - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

NJSLS 9-10.W.9 - Writing - Draw evidence from literary or informational texts to support analysis, reflection, and research.

NJSLS 9-10.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

NJSLS 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

NJSLS 9-10.SL.1.b - Speaking and Listening - Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.

NJSLS 9-10.SL.1.c - Speaking and Listening - Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.

NJSLS 9-10.SL.1.d - Speaking and Listening - Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.



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NJSLS 9-10.SL.4 - Speaking and Listening - Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

NJSLS 9-10.SL.5 - Speaking and Listening - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

NJSLS 9-10.SL.6 - Speaking and Listening - Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

NJSLS 9-10.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

NJSLS 9-10.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

NJSLS 9-10.L.2.c - Language Spell correctly.

NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.RST.4 - Reading Science/Technical - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

NJSLS 9-10.WHST.1 - Writing HS/S/T Write arguments focused on discipline-specific content.

NJSLS 9-10.WHST.2 - Writing HS/S/T - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

NJSLS 9-10.WHST.2.a - Writing HS/S/T - Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting



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(e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

NJSLS 9-10.WHST.2.b - Writing HS/S/T - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

NJSLS 9-10.WHST.2.d - Writing HS/S/T - Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

NJSLS 9-10.WHST.2.e - Writing HS/S/T - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.WHST.2.f - Writing HS/S/T - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

NJSLS 9-10.WHST.4 - Writing HS/S/T - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

NJSLS 9-10.WHST.7 - Writing HS/S/T - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

NJSLS 9-10.WHST.8 - Writing HS/S/T - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

NJSLS 9-10.WHST.9 - Writing HS/S/T - Draw evidence from informational texts to support analysis, reflection, and research.

NJSLS 9-10.WHST.10 - Writing HS/S/T - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for



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a range of discipline- specific tasks, purposes, and audiences.

NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.

NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.

NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.

NJSLS CTE 9.3.ST.3 - Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.

NJSLS CTE 9.3.ST.4 - Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.

NJSLS Career Ready Practices – See Addendum

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Employ valid and reliable research strategies.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. Is it ever advantageous to create a design or solve a problem individually as opposed to using a team approach? Explain.
2. What strategy would you use to form a design team in order to obtain the best solution possible?
3. What does it mean to be “ethical” in your work? Do engineers need to be taught to be “ethical”?
4. 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?

Anchor Text

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Informational Texts (3-5)

See Inkling.com

Formative & Summative Assessments

Formative: Kahoot, Plickers, Exit tickets, etc.
 Summative: PLTW Computer Based Assessments, Project Scoring Rubrics

Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)

Inkling.com, Canvas



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Labs	
1.26 Team use to solve problems 1.27 File management and file revision protocols for integrity 1.28 Virtual design team 1.29 Gantt charting	
Suggested Time Frame:	3 weeks

Engineering Curriculum Unit 10

Content Area:	Essentials of Engineering	Grade(s)	9
Unit Plan Title:	Design Challenges		

Learning Objectives

Unit 10 Design Challenges
 In this unit student's will work in small collaborative teams, implement the design process, and use skill and knowledge gained during the course to solve a culminating design challenge and document and communicate their proposed solution.

Science Standards & Practices	English & Language Arts Standards	Mathematics Standards
<p><u>NJSLS - Science Standards</u></p> <p>NJSLS-S - HS.ETS1.2 - Engineering Design - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>NJSLS-S HS.ETS1.3 - Engineering Design - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>NJSLS-S HS.ETS1.4 - Engineering Design - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous</p>	<p><u>NJSLS for ELA</u></p> <p>NJLSA.R.7 - Reading - Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.</p> <p>NJLSA.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJLSA.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p>	<p><u>NJSLS for Mathematics</u></p> <p>NJSLS G.MG.1 - Modeling with Geometry - Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>G.MG.3 - Modeling with Geometry - Apply geometric methods to solve design problems (e.g., designing an object</p>



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<p>criteria and constraints on interactions within and between systems relevant to the problem.</p> <p>NJSLS-S DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems - Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3)</p> <p>NJSLS-S DCI - ETS1.B - Engineering Design - Developing Possible Solutions - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)</p> <p>NJSLS-S DCI - ETS1.C - Engineering Design - Optimizing the Design Solution - Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)</p> <p>Science & Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant.</p> <p>Science and Engineering Practice - Asking questions and defining problems - Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.</p> <p>Science and Engineering Practice - Developing and Using Models - Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.</p> <p>Science and Engineering Practice - Constructing Explanations and Designing Solutions - Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</p> <p>Science and Engineering Practice - Engaging in Argument from Evidence - Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.</p>	<p>NJSLSA.W.6 - Writing - Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.</p> <p>NJSLSA.W.8 - Writing - Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.</p> <p>NJSLSA.W.9 - Writing - Draw evidence from literary or informational texts to support analysis, reflection, and research.</p> <p>NJSLSA.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.</p> <p>NJSLSA.SL.1 - Speaking and Listening - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.</p> <p>NJSLSA.SL.2 - Speaking and Listening - Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.</p> <p>NJSLSA.SL.5 - Speaking and Listening - Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.</p> <p>NJSLSA.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <p>NJSLSA.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <p>NJSLSA.L.6 - Language - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p> <p>NJSLS 9-10.W.2 - Writing - Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.</p> <p>NJSLS 9-10.W.2.a - Writing - Introduce a topic; organize complex ideas, concepts, and information to make important</p>	<p>or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p>
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Science and Engineering Practice - Engaging in Argument from Evidence - Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Science and Engineering Practice - Engaging in Argument from Evidence - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).

connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

NJSLS 9-10.W.2.b - Writing - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

NJSLS 9-10.W.2.d - Writing - Use precise language and domain-specific vocabulary to manage the complexity of the topic.

NJSLS 9-10.W.2.e - Writing - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.W.2.f - Writing - Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

NJSLS 9-10.W.4 - Writing - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

NJSLS 9-10.W.10 - Writing - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

NJSLS 9-10.SL.1 - Speaking and Listening - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

NJSLS 9-10.SL.5 - Speaking and Listening - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

NJSLS 9-10.L.1 - Language - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.



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NJSLS 9-10.L.2 - Language - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

NJSLS 9-10.L.2.c - Language Spell correctly.

NJSLS 9-10.L.6 - Language - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

NJSLS 9-10.WHST.2 - Writing HS/S/T Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

NJSLS 9-10.WHST.2.a - Writing HS/S/T - Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

NJSLS 9-10.WHST.2.b - Writing HS/S/T - Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

NJSLS 9-10.WHST.2.d - Writing HS/S/T - Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

NJSLS 9-10.WHST.2.e - Writing HS/S/T - Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

NJSLS 9-10.WHST.4 - Writing HS/S/T - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

NJSLS 9-10.WHST.10 - Writing HS/S/T - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline- specific tasks, purposes, and audiences.



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NJSLS CTE & Career Readiness Practices(s) Addressed in this unit

NJSLS Career & Technical Education Standards – See Addendum

NJSLS CTE 9.3.ST.1 Apply engineering skills in a project that requires project management, process control and quality assurance.

NJSLS CTE 9.3.ST.2 - Use technology to acquire, manipulate, analyze and report data.

NJSLS CTE 9.3.ST-ET.2 - Display and communicate STEM information.

NJSLS CTE 9.3.ST-ET.3 - Apply processes and concepts for the use of technological tools in STEM.

NJSLS Career Ready Practices – See Addendum

Act as a responsible and contributing citizen and employee.
 Apply appropriate academic and technical skills.
 Communicate clearly and effectively and with reason.
 Consider the environmental, social and economic impacts of decisions.
 Demonstrate creativity and innovation.
 Employ valid and reliable research strategies.
 Utilize critical thinking to make sense of problems and persevere in solving them.
 Model integrity, ethical leadership and effective management.
 Use technology to enhance productivity.
 Work productively in teams while using cultural global competence.

Essential Questions (3-5)

1. Engineering has been referred to as the “stealth” profession. Do you think this is an appropriate label? Explain.
2. If you had to describe one strategy that would most help an engineer be a good and effective designer, what would that trait be?
3. Collaboration and communication between design team members is essential to delivering a quality engineered product to market, provide the challenges your team faced and what strategies you implemented to resolve them to submit your design? How will this affect future team formation, communication and collaboration?

Anchor Text

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Informational Texts (3-5)

See InKling.com

Short Texts (1-3)

Formative & Summative Assessments

Formative: Kahoot, Plickers, Exit tickets, etc.
 Summative: PLTW Computer Based Assessments, Project Scoring Rubrics



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Resources (websites, Canvas, LMS, Google Classroom, documents, etc.)

Inkling.com, Canvas

Labs

- 1.30 Design briefs that focus on product innovation
- 1.31 Rules associated with brainstorming
- 1.32 Decision matrices
- 1.33 Invention / Innovation

Suggested Time Frame: 3 weeks