Syracuse City School District
Career and Technical Education Program
Course Syllabus
8th Grade CTE: High-Tech Manufacturing and Design

Course Description

The core question addressed in this career and technical education course is: How is the design process used to solve challenges that benefit humanity? Students discover why a design process is applied to create or improve a product rather than just creating something. Students will explore how models and mathematics are utilized to translate artistic designs into prototypes and tools for manufacturing. Students will proceed through the design process by experiencing project-based learning. Project-based learning enables students to learn key skills as they work through the design and creation of a product in a guided manner. A key component embedded within the 10-week course is an introduction to careers related to high tech manufacturing including varied engineering and technical professions such as mechanical, civil, chemical, electrical, and manufacturing engineering, welding, fabrication, electronics technology, CAD technology, and mechatronics manufacturing technology. Technical writing, communication and working in teams is a major focus of the course.

There are 5 projects offered in the accompanying suggested resource. This curriculum is designed so that depending on the level of technology available, student interest, and teacher preparation there is a choice point within the semester. Therefore, there are two different second projects: one focuses on reverse engineering where students redesign a package, and the other focuses on rapid prototyping that incorporates 3D design and printing. Students address similar big ideas regarding the design process, application of math and communication. The first, third and fourth projects offered in the accompanying resources are consistent.

AVID (Advancement Via Individual Determination)

SCSD is an AVID school district. AVID is a college and career readiness system whose mission is to close the opportunity gap by preparing all students for college readiness and success in a global society. Part of the AVID system is focused on instruction which is centered around WICOR (Writing, Inquiry, Collaboration, Organization and Reading). WICOR strategies are designed to help students engage with content, take ownership of their learning, and become independent learners. WICOR strategies are incorporated into each unit.

Work-Based Learning

- Students will be exposed to a wide variety of applications for design and modeling across varied professions in the high-tech manufacturing industry.
- Students will interview working professionals from different careers and occupations demonstrating application of design, modeling and prototyping through Career Coaching.
- Students will participate in field trips to high school CTE Pathway programs and local workplaces to broaden their ideas about application of the high-tech manufacturing industry.
- Students will be mentored by current high school CTE students and will create and maintain a portfolio of their work-based learning experiences throughout the course.

Course Objectives

Students will be able to:

- Identify steps in the design process.
- Summarize tasks involved in each step of the design process.
- Apply research to determine possibilities.
- Articulate needs of an identified end user.
- Develop a problem statement.
- Read and analyze technical texts for background information.
- Identify why a redesign may be needed.
- Articulate or determine criteria and constraints an end product may need to satisfy.
- Determine design considerations.
- Apply a decision matrix to determine a solution to pursue.
- Create and communicate initial ideas through sketch or model.
- Demonstrate application of mathematics or technology tools such as 3D modeling to evaluate a design or solution.

- Demonstrate how prototypes and models are tested in various ways to refine the product.
- Synthesize results to determine revisions.
- Apply technical writing to communicate the process and outcomes through an outline of an engineering report.
- Write a summary of the project, process, and learning.
- Communicate feedback to others.
- Describe potential careers within the high-tech manufacturing industry.
- Summarize information related to careers of interest.
- Create and deliver a formal presentation on design solutions.
- Explain and demonstrate the CCTC Career Ready Practices.
- Assess and describe their own strengths and abilities and areas where they need to grow and develop.
- Explain and demonstrate what professionalism looks like at school and in the workplace.
- Explain and demonstrate effective communication and teamwork skills.
- Demonstrate creativity, collaboration, and perseverance.

Equipment and Supplies

- **School will provide:** All required materials.
- **Student will provide:** NA.

Textbook

N/A

Grading

40% Class Work Assignments and Assessments
60% Projects, Presentations

Additional Course Policies

Students are expected to:

- Be on time for class.
- Produce their best work, including being prepared for in-class presentations.
- Participate in class including contributing to discussions and critiquing their own and others' work, as well as diligently working on their own projects during the class period.
- Seek help when needed.
- Be attentive during class, ask questions if they do not understand something, and offer their opinions.

Course Calendar

Quarter	Units of Study
1	**Introduction to High Tech Manufacturing and Design** **Design Process** **Reverse Engineering OR Rapid Prototype** **Bridging the Gap: Implementing Design Process** **Technical Communication** **Career Exploration** **Formal Presentations**

Syracuse City School District
Career and Technical Education Program
Scope and Sequence
8th Grade High-Tech Manufacturing and Design

Time Frame Unit of Study	Key Questions	Key Learning Targets (Students will know and be able to)	Assessment Evidence of Learning	Possible Projects/Activities	CCTC and NYS Standards
Weeks 1-2 **Introduction to High Tech Manufacturing** **Design Process** **(Launch and Set-up, Ask and Empathize, Imagine, Plan)** **NOTE: AT THIS POINT INSTRUCTION WILL FOLLOW 2A OR 2B**	• What are the expectations for students in the 8th grade CTE class? • What is high-tech manufacturing? • What are some careers within this field? • How is a design process used to solve challenges that benefit humanity? • Why is the design process used instead of just creating something? • What do we already know about design? • What do we need to know about design? • How do we research to locate information? • How do we evaluate information for reliability and usefulness? • How can literacy strategies support comprehension of technical reading? • How do we summarize key information? • What is a problem statement and how does that help guide the work? • How do we revise questions as information is uncovered? • Why are many ideas for potential solutions beneficial? • How are many ideas narrowed to one idea to	• Identify and describe classroom policies and procedures. • Define high tech manufacturing. • Identify sample careers related to high tech manufacturing professions. • Explain how design proceeds creation of products. • Compare and contrast the design process and just creating something. • Identify the steps in the design process. • Summarize the tasks involved in each step of the design process. • Articulate what they already know in regard to project deliverables. • Develop relevant questions to guide learning and understanding. • Research and explore possibilities for a given project. • Apply literacy strategies to support comprehension of technical reading. • Integrate and evaluate information provided through different modes such as video and text. • Summarize key points from research. • Articulate needs of an identified end user. • Develop a problem statement that clarifies the purpose or focus of the design. • Evaluate questions to answer, refine or reformat need-to-know statements as information and personal experiences build. • Demonstrate brainstorming to generate a variety of diverse ideas. • Apply use of a decision matrix to analyze their design ideas. • Develop a testing plan to evaluate their final solution.	**Written** • Assignments • Self-Assessment • Design Journal **Performance** • Class Presentation • Online Career Portfolio • Teacher Observation	• Unit 1: Trash to Treasure (days 1-10)	**Career Ready Practices** CRP 1,4,7,10,12 **ELA** 8R 1,2 8W 2,5,6,7 8SL 1,4,5,6 8L 1,2,3,4,6 **Literacy** 6-8 RST 1,2,4 6-8 WHST 2,5,6,7 **CSDF** 7-8.CT.10 7-8.DL.2

Time Frame Unit of Study	Key Questions	Key Learning Targets (Students will know and be able to)	Assessment Evidence of Learning	Possible Projects/Activities	CCTC and NYS Standards
	further develop? • How is a design idea evaluated to determine if it works?	• Identity criteria and constraints to use to evaluate design.			
Weeks 3-5 for 2A **Reverse Engineering** **(Launch and Task Analysis, Ask and Define, Imagine, Plan, Create, Evaluate and Improve, and Communicate and Celebrate)**	• How can an existing molded product package be redesigned into a package made from a single sheet of foldable material? • How can environmental impact be reduced by changing the material used and decreasing material waste during manufacturing? • What is reverse engineering? • How do we summarize key information? • How can literacy strategies support comprehension of technical reading? • How are the characteristics of a package identified? • How are criteria and constraints identified? • How might a product (flat-packed package) be improved? • How is a problem statement beneficial in the design process? • How does brainstorming benefit creating a design? • How are ideas prioritized and narrowed prior to creating a model? • How are decisions regarding dimensions of designs determined using mathematics? • What is surface area?	• Articulate what they already know in regard to project deliverables. • Develop relevant questions to guide learning and understanding. • Analyze technical texts for background information on green packaging, package design, and reverse engineering. • Demonstrate use of literacy strategies to enhance understanding of technical information. • Summarize key points from technical reading. • Define green packaging design. • Define reverse engineering. • Identify considerations for designing packages. • Demonstrate use of brainstorming protocols to expand thinking and possibilities. • Apply the process of reverse engineering to determine the characteristics of a modeled package. • Determine the criteria and constraints the project will need to satisfy. • Develop and communicate an initial problem statement for the project including key constraints and criteria. • Demonstrate use of brainstorming protocols to expand thinking and possibilities for their design. • Demonstrate use of a decision matrix to narrow design ideas to feasible or workable solutions. • Explain how mathematical thinking supports efficient design with less waste. • Explain mathematical net of solid objects and surface area. • Create a sketch of their design with dimension and materials.	**Written** • Assignments • Self-Assessment • Design Journal **Performance** • Class Presentation • Teacher Observation	• Unit 2A: Reverse Engineering (days 1-16)	**Career Ready Practices** CRP 1,4,6,8,12 **ELA** 8R 1,2 8W 2,5,6,7 8SL 1,4,5,6 8L 1,2,3,4,6 **Literacy** 6-8 RST 1,2,4 6-8 WHST 2 **CSDF** 7-8.CT.10 7-8.DL.2

Time Frame Unit of Study	Key Questions	Key Learning Targets (Students will know and be able to)	Assessment Evidence of Learning	Possible Projects/Activities	CCTC and NYS Standards
	• What is a mathematical net? • How does knowing a mathematical net reduce the waste of material? • How does a sketch inform a prototype? • Why is application of math important in design development? • What is a testing plan? • How is a design communicated? • How is surface area calculated? • How can waste be calculated by use of a mathematical net? • How can percent efficiency of a mathematical net be calculated? • What information does a prototype provide? • How is a design tested? • How is the effectiveness of a design determined? • How does a model inform manufacturing? • How does a project advance from design to prototype? • Why might a design be revised? • What makes an effective presentation? • How does a team work effectively and efficiently?	• Determine the best layout for design that reduces waste. • Articulate why a sketch is beneficial prior to development of a prototype. • Explain how mathematical calculations support efficient and effective design. • Explain a testing plan that aligns with design criteria and constraints. • Develop a written description of the problem and the solution including the materials and how they are eco-friendly. • Demonstrate calculation of surface area of a mathematical net of a product (package). • Demonstrate calculation of waste produced by a mathematical net. • Demonstrate calculation of the percent efficiency of a mathematical net. • Create a prototype of the design. • Evaluate the prototype through a test plan. • Evaluate and revise or improve the design. • Evaluate effectiveness of the design. • Identity improvements to the product design based on evaluation of the model. • Explain how a model informs further development of a design or product. • Summarize the application of the design process. • Explain possible reasons for revisions. • Demonstrate concise and clear communication. • Demonstrate team members taking individual responsibility, demonstrating good communication skills, and striving for common goals.			
Weeks 3-5 for 2B **Rapid Prototyping**	• How are mathematical models used to translate artistic designs into prototypes and tools for manufacturing?	• Articulate what they already know in regard to project deliverables. • Develop relevant questions to guide learning and understanding.	**Written** • Assignments • Design Journal • Self-Assessments **Performance**	Unit 2B: Rapid Prototype (days 1-17)	**Career Ready Practices** CRP 1,4,6,8,11,12 **ELA** 8R 1,2 8W 2,5,6,7

Time Frame Unit of Study	Key Questions	Key Learning Targets (Students will know and be able to)	Assessment Evidence of Learning	Possible Projects/Activities	CCTC and NYS Standards
(Launch and Task Analysis, Ask and Define, Imagine, Plan, Create, Evaluate and Improve, and Communicate and Celebrate)	• How are decisions regarding dimensions of designs determined using mathematics? • What are the benefits of 3D printing a design? • How are products (coins) produced? • How can literacy strategies support comprehension of technical reading? • How do we summarize key information? • What makes a design meaningful? • What is rapid prototyping? • What are some technologies used in rapid prototyping? • What is 3D printing? • How is a problem statement beneficial in the design process? • How does brainstorming benefit creating a design? • How are ideas prioritized and narrowed prior to creating a model? • How does a decision matrix support good decisions? • How does a sketch inform a prototype? • Why is application of math important in design development? • How is mass and density used to calculate volume? • How can dimensions be determined based on target volume? • How is the size of the prototype determined? • What determines a final	• Analyze technical texts for background information on rapid prototyping and coin production. • Demonstrate use of literacy strategies to enhance understanding of technical information. • Summarize key points from technical reading. • Compare the variety of designs found on a product (coins are suggested). • Describe how a design is representative of person, event, or idea. • Explain rapid prototyping. • Explain how 3D printing works. • Develop and communicate initial problem statement for project including key constraints and criteria. • Demonstrate use of brainstorming protocols to expand thinking and possibilities for their design. . • Demonstrate use of a decision matrix to narrow design ideas to feasible or workable solutions. • Articulate why a sketch is beneficial prior to development of a prototype. • Explain how mathematical calculations support efficient and effective design. • Demonstrate calculation of volume. • Determine dimensions based on target volume and end users' needs. • Create a sketch of design that includes dimensions and all faces of the product. • Construct useful feedback for peers. • Summarize feedback provided by peers. • Analyze and apply key ideas from feedback to revise design. • Demonstrate use of 3D modeling to draw a coin with an image. • Demonstrate use of 3D modeling software to enact design ideas. • Evaluate the effectiveness of design using a 3D-printed model.	• Class Presentation • Teacher Observation		8SL 1,4,5,6 8L 1,2,3,4,6 **Literacy** 6-8 RST 1,2,4 6-8 WHST 2 **CSDF** 7-8.CT.10 7-8.DL.2

Time Frame Unit of Study	Key Questions	Key Learning Targets (Students will know and be able to)	Assessment Evidence of Learning	Possible Projects/Activities	CCTC and NYS Standards
	design? • What is the purpose of feedback prior to development of a prototype? • How does feedback impact design? • How do technology tools support modeling of a prototype? • How is the effectiveness of a design determined? • How does a model inform manufacturing? • How does a project advance from design to prototype? • Why might a design be revised? • What makes an effective presentation? • How does a team work effectively and efficiently?	• Identity improvements to product design based on evaluation of the 3D printed model. • Explain how a model or prototype informs further development of a design or product. • Summarize the application of the design process. • Explain possible reasons for revisions. • Demonstrate concise and clear communication. • Demonstrate team members taking individual responsibility, demonstrating good communication skills, and striving for common goals.			
Weeks 6-8 **Bridging the Gap: Implementing Design Process** **(Launch and Task Analysis, Ask and Define, Imagine, Plan, Create, Evaluate and Improve, and Communicate and Celebrate)**	• How do engineers use physical models and mathematical models to test and improve designs? • Why do bridges fail? • What do designers do to prevent bridge collapse? • What are different types of bridges? • What are compression and tension forces? • What is the impact of forces on bridge design? • What is a problem statement? • How does brainstorming support design? • How does the use of simulation support design? • How do constraints	• Describe how engineers use models to test a design before moving to larger scaled builds (for example, the safety of bridges). • Explain how models can be physical models or mathematical models such as those from a simulation. • List factors contributing to the failure of bridges. • Explain what designers can do to prevent bridge collapse. • Identify different types of bridges. • Define compression and tension force. • Describe how forces are used in bridge design. • Develop a problem statement. • Demonstrate use of brainstorming protocols. • Explain how simulation and other tests support design development. • Apply technical knowledge of forces to refine and revise design ideas.	**Written** • Assignments • Design Journal • Self-Assessment/Reflection **Performance** • Class Presentation • Project Design and Model • Teacher Observation	• Unit 3: Bridging the Gap (days 1-16) NOTE: Due to timing, portions of this unit may need to be collapsed or omitted.	**Career Ready Practices** CRP 1,2,4,6,8,12 **ELA** 8W 2 8SL 1,4,5,6 8L 1,2,3,4,6 **Literacy** 6-8 RST 1,4 6-8 WHST 2 **CSDF** 7-8.CT.10 7-8.DL.2

Time Frame Unit of Study	Key Questions	Key Learning Targets (Students will know and be able to)	Assessment Evidence of Learning	Possible Projects/Activities	CCTC and NYS Standards
	impact design? • What is a bill of materials? • How can costs be estimated? • How does a sketch support a design? • What is a prototype? • How is the final cost calculated? • How is a design evaluated? • How do test results impact revisions and improvements?	• Evaluate designs given constraints and considerations of the project. • Develop a bill of materials. • Calculate estimated cost to build design. • Define prototype. • Sketch a scaled drawing of a design prototype. • Create a prototype. • Calculate final cost of a design. • Evaluate design/prototype according to testing criteria. • Determine improvements based on test results. • Describe improvements made (or might be made) and how they will benefit final design.			
Week 9-10 **Technical Communication** **Career Exploration** **Formal Presentations**	• How are designs and processes communicated? • How is a technical report different from a literacy (ELA) report? • What are key components of an engineering report? • How does an outline clarify communication? • What tools assist in creating a professional report? • How does feedback inform revisions? • How are learning experiences and reflections communicated? • What are careers related to high tech manufacturing and engineering that are of interest? • What are the educational and licensing requirements for a career	• Compare and contrast key elements of technical writing and literary responses. • Identify six basic sections of an engineering report. • Develop a detailed outline of an engineering report based on one of the design experiences this semester. • Demonstrate use of Microsoft Word skills and tools. • Summarize in written format a project. • Demonstrate providing feedback to peers. • Demonstrate application of feedback to revise written work. • Apply editing skills to refine a technical report. • Produce a project reflection. • Articulate possible careers of interest that incorporate mathematical models and artistic designs to develop prototypes and tools for manufacturing including engineering career paths and technician career paths. • Articulate educational and experiential requirements for 1 or more career fields related to high tech manufacturing.	**Written** • Assignments • Self-reflection • Technical Writing Project • Self-Assessment • Career Infographic **Performance** • Class Presentation • Teacher observation • Online Career Portfolio	• Unit 4: Formal Communication (days 1-10)	**Career Ready Practices** CRP 1,2,4,7,10,11,12 **ELA** 8R 1,2 8W 2,5,6,7 8SL 1,4,5,6 8L 1,2,3,4,6 **Literacy** 6-8 RST 1,2,4 6-8 WHST 2,3,4,5,6,7 **CSDF** 7-8.CT.10 7-8.DL 2

Time Frame Unit of Study	Key Questions	Key Learning Targets (Students will know and be able to)	Assessment Evidence of Learning	Possible Projects/Activities	CCTC and NYS Standards
	of potential interest? • What are salary and working environments for a career of potential interest? • What traits, interests and skills do I have that might match a career in high tech manufacturing? • What makes an effective presentation?	• Articulate benefits and working environments for 1 or more career fields within high tech manufacturing. • Analyze their interests and skills as related to 1 or more professions related to high tech manufacturing. • Communicate to classmate key aspects of a high-tech manufacturing related career. • Identity components and skills for an effective presentation. • Develop and deliver a formal presentation of a design solution.			

Standards

CCTC: Common Career and Technical Core

Career Ready Practices

1	Act as a responsible and contributing citizen and employee.
2	Apply appropriate academic and technical skills.
3	Attend to personal health and financial well-being.
4	Communicate clearly and effectively and with reason.
5	Consider the environmental, social, and economic impacts of decisions.
6	Demonstrate creativity and innovation.
7	Employ valid and reliable research strategies.
8	Utilize critical thinking to make sense of problems and persevere in solving them.
9	Model integrity, ethical leadership, and effective management.
10	Plan education and career paths aligned to personal goals.
11	Use technology to enhance productivity.
12	Work productively in teams while using cultural global competence.

Full Text: Career Ready Practices

8th Grade Reading Standards (Literary and Informational Text)

Key Ideas and Details	
8R1	Cite textual evidence to strongly support an analysis of what the text says explicitly/implicitly and make logical inferences. (RI&RL
8R2	Determine one or more themes or central ideas of a text and analyze their development over the course of the text; summarize a text. (RI&RL)
8R3	In literary texts, analyze how particular lines of dialogue or events propel the action, reveal aspects of a character, or provoke a decision. (RL) In informational texts, analyze how individuals, events, and ideas are introduced, relate to each other, and are developed. (RI)
Craft and Structure	
8R4	Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings. Analyze the impact of specific word choices on meaning, tone, and mood, including words with multiple meanings. (RI&RL)
8R5	In literary texts, and informational texts, compare and contrast the structures of two or more texts in order to analyze how the differing structure of each text contributes to overall meaning, style, theme, or central idea. (RI&RL)
8R6	In literary texts, analyze how the differences between the point of view, perspectives of the characters, the audience, or reader create effects such as mood and tone. (RL) In informational texts, analyze how the author addresses conflicting evidence or viewpoints. (RI)
Integration of Knowledge and Ideas	
8R7	Evaluate the advantages and disadvantages of using different media—text, audio, video, stage, or digital—to present a particular subject or idea and analyze the extent to which a production remains faithful to or departs from the written text. (RI&RL)
8R8	Trace and evaluate an argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient and recognizing when irrelevant evidence is introduced. (RI&RL)
8R9	Choose and develop criteria in order to evaluate the quality of texts. Make connections to other texts, ideas, cultural perspectives, eras, and personal experiences. (RI&RL)

8th Grade Writing Standards

Text Types and Purposes	
8W1	Write arguments to support claims with clear reasons and relevant evidence.
8W1a	Introduce a precise claim, acknowledge and distinguish the claim(s) from a counterclaim, and organize the reasons and evidence logically.
8W1b	Support claim(s) with logical reasoning and relevant evidence, using credible sources while demonstrating an understanding of the topic or text.
8W1c	Use precise language and content-specific vocabulary to argue a claim.
8W1d	Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
8W1e	Provide a concluding statement or section that explains the significance of the argument presented.
8W1f	Maintain a style and tone appropriate to the writing task.
8W2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
8W2a	Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast,8 and cause/effect
8W2b	Develop a topic with relevant facts, definitions, concrete details, quotations, or other information and examples; include formatting, graphics, and multimedia when useful to aid comprehension.
8W2c	Use precise language and content-specific vocabulary to explain a topic
8W2d	Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
8W2e	Provide a concluding statement or section that explains the significance of the information presented.
8W2f	Establish and maintain a style appropriate to the writing task.
8W3	Write narratives to develop real or imagined experiences or events using effective techniques, relevant descriptive details and clear sequencing.
8W3a	Engage the reader by establishing a point of view and introducing a narrator and/or characters.

8W3b	Use narrative techniques, such as dialogue, pacing, description, and reflection to develop experiences, events, and/or characters.
8W3c	Use a variety of transitional words, phrases, and clauses to convey sequence, signal shifts from one time frame or setting to another and show the relationships among experiences and events.
8W3d	Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events.
8W3e	Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.
8W4	Create a poem, story, play, artwork, or other response to a text, author, theme or personal experience; explain divergences from the original text when appropriate.
8W5	Draw evidence from literary or informational texts to support analysis, reflection, and research. Apply the grade 8 Reading Standards to both literary and informational text, where applicable.
Research to Build and Present Knowledge	
8W6	Conduct research to answer questions, including self-generated questions, drawing on multiple sources, refocusing the inquiry when appropriate. Generate additional related questions that allow for multiple avenues of exploration.
8W7	Gather relevant information from multiple sources; assess the credibility and accuracy of each source; quote or paraphrase the data and conclusions of others; avoid plagiarism and follow a standard format for citation.

8th Grade Speaking and Listening

Comprehension and Collaboration	
8SL1	Engage effectively in a range of collaborative discussions with diverse partners; express ideas clearly and persuasively and build on those of others.
8LS1a	Come to discussions prepared, having read or researched material under study; draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
8SL1b	Follow norms for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed.
8SL1c	Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
8SL1d	Acknowledge new information expressed by others, and, when warranted, qualify or justify personal views in light of the evidence presented.
8SL2	Analyze the purpose of information presented in diverse formats (e.g., including visual, quantitative, and oral) and evaluate the motives (e.g., social, commercial, political) behind its presentation.
8SL3	Delineate a speaker's argument and specific claims, evaluating for sound reasoning, and the relevance and sufficiency of the evidence; identify when irrelevant evidence is introduced.
Presentation of Knowledge and Ideas	
8SL4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear enunciation.
8SL5	Integrate digital media and/or visual displays in presentations to clarify information, strengthen claims and evidence, and add elements of interest to engage the audience.
8SL6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

8th Grade Language Standards

Conventions of Academic English	
8L1	Demonstrate command of the conventions of academic English grammar and usage when writing or speaking*.
8L2	Demonstrate command of the conventions of academic English capitalization, punctuation, and spelling when writing*.
Knowledge of Language	
8L3	Use knowledge of language and its conventions when writing, speaking, reading, or listening.
8L3a	Use verbs in the active and passive voice and in the conditional and subjunctive mood to achieve particular effects (e.g., emphasizing the actor or the action; expressing uncertainty or describing a state contrary to fact).
Vocabulary Acquisition and Use	

8L4	Determine or clarify the meaning of unknown and multiple-meaning words and phrases, choosing flexibly from a range of strategies.
8L4a	Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.
8L4b	Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., precede, recede, secede).
8L4c	Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses) to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
8L4d	Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
8L5	Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
8L5a	Interpret figures of speech including irony and puns in context.
8L5b	Use the relationship between particular words to better understand each of the words.
8L5c	Distinguish among the connotations of words with similar denotations (e.g., bullheaded, willful, firm, persistent, resolute).
8L6	Acquire and accurately use general academic and content-specific words and phrases; apply vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Core Conventions Skills for Grades 6-8

- Ensure that pronouns are in the proper case (subjective, objective, and possessive).
- Recognize and correct inappropriate shifts in pronoun number and person.
- Recognize and correct pronouns that have unclear or ambiguous antecedents.
- Explain the function of phrases and clauses in general, as well as in specific sentences.
- Place phrases and clauses within a sentence, recognizing and correcting misplaced and dangling modifiers.
- Use simple, compound, complex, and compound-complex sentences to signal differing relationships among ideas.
- Explain the function of verbals (gerunds, participles, infinitives).
- Form and use verbs in the active and passive voice.
- Recognize and correct inappropriate verb shifts.

Core Punctuation and Spelling Skills for Grades 6-8

- Use punctuation (commas, parentheses, dashes, hyphens) to clarify and enhance writing.
- Use punctuation (comma, ellipsis, dash) to indicate a pause or break.
- Use an ellipsis to indicate an omission.

Full text found at NYS ELA Standards.

NYS Literacy Standards: NYS Next Generation 6-12 Literacy Standards in History/Social Studies, Science, and Technical Subjects

Reading Standards for Literacy in Science and Technical Subjects 6	
6-8RST 1	Cite specific evidence to support analysis of scientific and technical texts, charts, graphs, diagrams, etc. Understand and follow a detailed set of directions.
6-8RST 2	Determine the central ideas or conclusions of a source; provide an accurate, objective summary of the source distinct from prior knowledge or opinions.
6-8RST 3	Describe how and why scientific ideas and reasoning are developed and modified over the course of a text, source, argument, etc.
6-8RST 4	Determine the meaning of symbols, key terms, and other content-specific words and phrases as they are used in scientific or technical sources.
6-8RST 5	Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.
6-8RST 6	Identify purpose and/or point of view when an author is presenting information, describing a procedure, discussing an experiment, etc. Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, etc. on the same topic.
6-8RST 7	Identify and match scientific or technical information presented as text with a version of that information presented visually (e.g., in a flowchart, diagram, model, graph, or table).
6-8RST 8	For scientific sources, distinguish between observation and inference-based judgments, and reasoned judgment and opinion. For technical sources, distinguish between facts and reasoned judgment.
6-8RST 9	Compare and contrast the information gained from two or more experiments, simulations, videos, multimedia sources, readings from texts, graphs, charts, etc. on the same topic.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6	
6-8WHST 1	Write arguments focused on discipline-specific content.
6-8WHST 2	Write informative/explanatory text focused on discipline-specific content.
6-8WHST 3	Write narratives to understand an event or topic, appropriate to discipline-specific norms, conventions, and tasks.
6-8WHST 4	Write responses to texts and to events (past and present), ideas, and theories that include personal, cultural, and thematic connections.
6-8WHST 5	Conduct short research projects to answer a question (including a self-generated question by the end of grade 8), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
6-8WHST 6	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source by applying discipline-specific criteria used in the social sciences or sciences; and quote or paraphrase the data/accounts and conclusions of others while avoiding plagiarism and following a standard format for citation.
6-8WHST 7	Draw evidence from informational texts to support analysis, reflection, and research.

Full Text: New York State 6-8 Next Generation ELA Standards at a Glance

NYS K-12 Computer Science and Digital Fluency Learning Standards: Grade Band 7-8

Sub concept	Standard	
Impacts of Computing		
Society	7-8.IC.1	Compare and contrast tradeoffs associated with computing technologies that affect individuals and society.
	7-8.IC.2	Evaluate the impact of laws or regulations on the development and use of computing technologies and digital information.
Ethics	7-8.IC.3	Identify and discuss issues of ethics surrounding computing technologies and current events.
	7-8.IC.4	Identify and discuss issues related to the collection and use of public and private data.
	7-8.IC.5	Analyze potential sources of bias that could be introduced to complex computer systems and the potential impact of these biases on individuals.
Accessibility	7-8.IC.6	Assess the accessibility of a computing device or software application in terms of user needs.
Career Paths	7-8.IC.7	Explore a range of computer science related career paths.
Computational Thinking		
Modeling and Simulation	7-8.CT.1	Compare the results of alternative models or simulations to determine and evaluate how the input data and assumptions change the results.
Data Analysis and Visualization	7-8.CT.2	Collect and use digital data in a computational artifact.
	7-8.CT.3	Refine and visualize a data set in order to persuade an audience.
Abstraction and Decomposition	7-8.CT.4	Write a program using functions or procedures whose names or other documentation convey their purpose within the larger task.
	7-8.CT.5	Identify multiple similar concrete computations in a program, then create a function to generalize over them using parameters to accommodate their differences.
Algorithms and Programming	7-8.CT.6	Design, compare and refine algorithms for a specific task or within a program.
	7-8.CT.7	Design or remix a program that uses a variable to maintain the current value of a key piece of information.
	7-8.CT.8	Develop or remix a program that effectively combines one or more control structures for creative expression or to solve a problem.
	7-8.CT.9	Read and interpret code to predict the outcome of various programs that involve conditionals and repetition for the purposes of debugging.
	7-8.CT.10	Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences.
Network and System Design		
Hardware and Software	7-8.NSD.1	Design a user interface for a computing technology that considers usability, accessibility, and desirability.
	7-8.NSD.2	Design a project that combines hardware and software components.
	7-8.NSD.3	Identify and fix problems with computing devices and their components using a systematic troubleshooting method or guide.
Networks and the Internet	7-8.NSD.4	Design a protocol for transmitting data through a multi-point network.
	7-8.NSD.5	Summarize how remote data is stored and accessed in a network.

Cybersecurity		
Risks	7-8.CY.1	Determine the types of personal information and digital resources that an individual may have access to that needs to be protected.
Safeguards	7-8.CY.2	Describe physical, digital, and behavioral safeguards that can be employed in different situations.
	7-8.CY.3	Describe trade-offs of implementing specific security safeguards.
	7-8.CY.4	Describe the limitations of cryptographic methods.
Response	7-8.CY.5	Describe actions to be taken before and after an application or device reports a security problem or performs unexpectedly.
Digital Literacy		
Digital Use	7-8.DL.1	Type on a keyboard while demonstrating proper keyboarding technique, with increased speed and accuracy.
	7-8.DL.2	Communicate and collaborate with others using a variety of digital tools to create and revise a collaborative product.
	7-8.DL.3	Compare types of search tools, choose a search tool for effectiveness and efficiency, and evaluate the quality of search tools based on returned results.
	7-8.DL.4	Select and use digital tools to create, revise, and publish digital artifacts.
	7-8.DL.5	Transfer knowledge of technology in order to explore new technologies.
Digital Citizenship	7-8.DL.6	Explain the connection between the persistence of data on the Internet, personal online identity, and personal privacy.
	7-8.DL.7	Describe safe, appropriate, positive, and responsible online behavior and identify strategies to combat negative online behavior.

Full Text: New York State 7-8 Computer Science and Digital Fluency Learning Standards

SCSD Grade 8

Unit 1: Trash-to-Treasure

CTE Content Focus:

12 INSTRUCTIONAL DAYS

Unit Focus	Unit Text Set
This is project 1 out of 3 projects. Students will learn various aspects of engineering and manufacturing. This project is intended to refresh students' understanding of the engineering design process used in the 7th-grade curricula (Game Design and Teen Entrepreneurship). Students will design a marketable product for an intended customer however the item must be made from mostly reusable materials. **A 4th Communication unit will ask students to pick their favorite project and develop a formal presentation (or a poster presentation) on their design process and an engineering report outline. Each student will need to keep track of their process and notes in their design journal because they will individually develop a poster presentation.**	Video: "Where Does Trash End Up" Video: What is an Empathy Map?
Unit Anchor Charts/Instructional Tools	
Design Journal Instructions Design Journal Checklist – Teacher version Design Journal Checklist – Student version Team Contract **Design Process Organizer** Project Scenario Know/NTK chart **Design Process Cards** (**pdf version**) Team Meetings Research Notes Organizer Empathy Map Canvas Design Process Organizer Trash-to-Treasure Rubric	

Guiding Questions & Big Ideas

Driving Questions: “How can we use a design process to solve challenges that benefit humanity?” and “Why use a design process instead of just creating something?”

Big Ideas:

- Modern manufacturing produces many convenient products that make improve our everyday life; however, as products outlive their usefulness many wind up in landfills. One way to help decrease the amount of stuff in landfills is to find new uses for old things (Reuse).

Final Tasks

- A marketable product made from found materials.
- Documented Engineering Design process in Notebook and Graphic Organizer

Culturally and Historically Responsive Framework	Essential Learning Concepts
Identity: How will the unit help students to learn something about themselves and/or others? Students will design for a target custom of their choosing. They will complete an empathy map to think deeply about their target customer and their needs. Skills: How will the unit build students' skills in the content area? Intellect: How will the unit build students' knowledge and mental powers? This unit builds on skills from the 7th-grade CTE projects. Students will develop their knowledge to solve this challenge through research, reflective writing, and creating. Criticality: How will the unit engage students' thinking about power and equity and the disruption of oppression? N/A Joy: How will the unit allow students to experience joy through their learning? Students will experience joy through creating something of their design.	Students will be able to… • Identify the steps in the design process and summarize the tasks involved in each step of the process. • Research and explore what might be possible for this project. • Understand the needs of their end user. • Develop a problem statement. • Brainstorm and develop design ideas to solve their problem. • Narrow down design ideas to one idea to further develop. • Use a decision matrix to analyze their design ideas. • Develop a testing plan to evaluate their final solution. • Develop a creation plan for their design idea. (Sketch and written plan. • Develop a prototype of their design idea. • Document their process in their design journal. • Implement a testing protocol to test and evaluate their design. • Write instructions for creating their design ideas. • Write a summary of their evaluation of their testing results.
SEL Benchmarks	**Integrated Standards**
	NY Digital Literacy Standards: • 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences. • 7-8.DL.2 Communicate and collaborate with others using a variety of digital tools to create and revise a collaborative product.

Unit 1: Trash-to-Treasure

Key Vocabulary		Oral Language	Writing
Design Process Empathize Brainstorming Decision Matrix	Create	Team meetings Whole class discussions Jigsaw discussions with justifications	Chalk Talk K/NTK Design Journal Summarizing Instructions for creating design.

Teacher Preparation & Notes

You will need to secure a pile of found objects for students to create their products. It helps to have a starting pile to get students thinking about what they might be able to do or use. You can ask people in your school building to donate, find things around your house, or even ask students to scour their homes for items to bring in. Possible items include soda cans, plastic bottles, old clothes, old shoes, cardboard food containers such as cereal boxes, old plastic food containers such as those for holding deli meat, etc. An optional part of the launch will be to have students come into the classroom to the pile of collected items. It is also helpful to have a space in your classroom designated for the items for students to peruse prior.

Since this project is to refresh students' understanding of the design process consider how you want to track their documentation and how you will check them off at each phase. One idea is to have students document their process in their design journals. They will need to get your signature, initials, sticker, or stamp after each phase before they can move on to the next phase. Students will also be asked to keep this Design Process Organizer in their design journals to track what they did in each phase and reflect on how the phase helped them solve their design challenge.

This is a continuation of projects students experienced in the 7th-grade CTE curricula. Students were introduced to the design journal, team contract, and how to collaborate with each other. Consider how you want to re-introduce students to these concepts. Below are supports and tools used in the 7th-grade projects along with some new resources for team building.

- Design Journal – students are expected to keep a written design journal, typically in the form of a composition notebook.
  - Design Journal Instructions
  - Design Journal Checklist – Teacher version
  - Design Journal Checklist – Student version – can be printed, cut out, and pasted into their design journal.
- Team Contract
- Compass Points – students have done this protocol as a way to learn how to work as a team.
- Other team building activities – these were not previously done but can help get students connected and working as a team.
  - Save Sam the Worm
  - Team-Building Activities for Middle School

Finally, students will complete three projects in teams, but they will each need to keep detailed notes because they will independently develop a poster presentation at the end of the course to display their favorite project and how they used the design process to solve their problem.

Day	Learning Targets & Standards	Texts & Tasks	Supports
1 - 2	Launch and Set-up	**Launch Activity – Create Something** • This will work best with students sitting and working in teams of 4. • Set up student tables with a sampling of "trash" (plastic bottles, old pens, plastic bags, paper from the recycling bin, etc.). • Ask students to create something with trash in the next 10 minutes. • After students finish, invite groups to share their creations and how they went about deciding what to create. • From student responses, guide students to make connections to mindsets and attitudes that helped them work together (or possibly did not help them). • Tell students that as we go into this project, we will be exploring the difference between creating something (just as they did here) and designing something. • In their teams, ask students to create a Venn diagram in their journals with "creating" in one circle and "designing" in the other. Have them discuss and document the similarities and differences between creating and designing. **Launch Activity – America the Beautiful Chalk Talk** • Have the pictures from this slide deck printed out, placed on chart paper, and hung or placed around the room. (Note: the pictures are of both beautiful scenes and scenes littered with trash. They are taken from the internet, but you can bring in your own pictures that may reflect your local community). • Have students rotate between the pictures and using sticky notes or writing on chart paper write comments about the pictures. • Lead students in a whole class discussion on what they noticed from the pictures and what is a problem they see between the pictures.	Pictures Video: "Where Does Trash End Up" Project Scenario Know/NTK chart Team Contract

Day	Learning Targets & Standards	Texts & Tasks	Supports

		• Show students the video, "Where Does Trash End Up", the bigger problem faced with sending our trash to landfills.
		• Have students discuss and share their reactions to the video.
		• Introduce that one way we can help is to reduce the amount of waste that ends up in landfills.
		
		Task Analysis & Team Contract
		• Divide students into their design teams of 2 – 4 students.
		• introduce the two guiding questions for this project and hand out the project scenario:
		  ○ How can we use a design process to solve challenges that benefit humanity?
		  ○ Why use a design process instead of just creating something?
		• Have students highlight the scenario and ask any clarifying questions about the expectations of the project.
		• Have students start their Know/NTK chart for this project. If needed, probe them to add things they learned from last year about the design process and how to design an item for a target customer.
		• Have student teams develop their team contract.	

2	**Ask & Empathize Phase** • Identify the steps in the design process and summarize the tasks involved in each step of the process.	**Design Process Review** • Arrange students so they are working with teams of 3 – 4 students. Give each team a set of cut-out design process cards (pdf version) (cards A and cards B) and a large piece of paper to arrange and tape the cards. • Have students pair the design process phase name (Card Set A) with what is typically done in each phase (Card Set B). The answer key is given. Students check in with the teacher who will provide feedback on which pairings are correct. • Once students have the correct pairs, have them tape them to the paper in the order of how they are typically used to solve a problem. Students may also want to draw arrows between phases. Bonus if they also show and discuss the iterative nature of the design process. • After all groups have a correct design process visual, students watch this video on IDEO's Shopping Cart Design and write on their chart examples	Design Process Cards (pdf version)

Day	Learning Targets & Standards	Texts & Tasks	Supports
		of what the designers did in each phase of the process. (Note: The video is a little dated, but it is one of the best videos out there documenting a design process from beginning to end.) • These charts can be hung in the classroom and serve as anchor charts for the Design Process. **Ask & Empathize Introduction** • Give students the Design Process Organizer to tape into their design journals. As they go through each phase, students will use this to reflect on what they did and how it is helping them to solve their design problem. • Remind students that they are now in the Ask & Empathize phase and will be defining their approach to the design challenge of turning trash into treasure.	
3 – 4	**Ask & Empathize** • Research and explore what might be possible for this project. • Understand the needs of their end user. • Develop a problem statement.	**Team Meeting and Internet Exploration** • Goal: Sometimes, before beginning to think about whom they want to design for, students need to see what is possible. If students do not need this, feel free to jump to the Empathy Map. • Students revisit their K/NTK chart to add what they now know or remember about the design process, check off any answered questions, and write any questions they now have about their project. • Team discusses possibilities of what they might do or whom they may design a product for and document their thinking in their design journals. They may also discuss questions that need to be answered first from their K/NTK to better understand the problem or learn more about an intended user. If needed, they divide questions among each member of the team to look for possible answers or ideas in the internet search. • Students conduct internet searches for ideas of what is possible. Remind them that this is not about finding the idea they will create, only what is out there. Give them this research notes organizer if needed to capture their ideas to share back with their design team. • After their internet search, students come back to their team, share what they discovered, and revisit and revise their K/NTK chart.	Research Notes Organizer K/NTK chart Video: What is an Empathy Map? Empathy Map Canvas Design Process Organizer Team Meetings Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports

		Empathy Map
		• Show students the Video: What is an Empathy Map? to remind students what an empathy map is and how it helps with the design process. (Note: We are not asking students to complete an empathy interview for this project, instead they will use the empathy map to pull out information about their end-user based on their prior knowledge about this type of person. However, if you have the time and would like to, you can add in an empathy interview activity for students to do.)
		• In their teams, students determine and describe their intended user: age range, hobbies, likes, dislikes, job or daily activities.
		• Give each team a copy of the Empathy Map Canvas and discuss and populate their empathy map.
		• After populating their map, the team discusses insights they now have about their end-user and possible needs. They may also discuss "Hates and Greats". Below are some questions to help guide their conversations:
		  ○ What do we now know about the end-user? (insights)
		  ○ What might they need? (needs)
		  ○ What problems do they encounter?
		  ○ They hate it when… (Hates)
		  ○ It would be great if… (Greats)
		• The team determines what might be a problem they can solve and use the language below to help them form a formal problem statement.
		  ○ "<Insert Target Customer> needs a way to _____ <insert need pr problem> _____ so that they can _____. We plan to design _____ that will _____."
		• Students turn in the problem statement for feedback and ultimate approval by the teacher.
		
		Design Process Reflection
		• This ends the "Ask & Empathize" section of the design process. Have students reflect on this stage of the process using their Design Process Organizers.
		• Invite students to share their thinking with the class, especially around	

Day	Learning Targets & Standards	Texts & Tasks	Supports
		how this part of the process helped them to better define and understand the problem they will solve.	

5 – 6	**Imagine**
	• Brainstorm and develop design ideas to solve their problem.
		Phase Launch
		• Tell students they are now entering the Imagine phase. Refer back to their Design Process charts they made at the beginning of this unit.
		• The goal of the imagine phase is to get lots of ideas on paper without worrying about what is possible.
		
		Brainstorming Practice
		• **Goal:** An essential skill in the imagine section is brainstorming – a group discussion to generate lots of ideas to solve problems. This activity will give students practice in brainstorming before doing it for their problem.
		• In their design teams, or teams of four, give each team a paper clip.
		• Teams use one of the scenarios below to practice brainstorming. You can choose one for the whole class to do or give them the option to decide what to do. Teams have 5 minutes to come up with as many ideas as possible. The team with the most ideas wins (you can decide what they win).
		  ○ Give each team paper clips and have them brainstorm ideas for how to use a paper clip (or clips).
		  ○ Give each team a blank coffee mug or cup and have them brainstorm ideas for how to improve it.
		  ○ Think of a movie each member of the team knows well. Brainstorm ideas for an alternate ending.
		  ○ Brainstorm ideas for how to improve the school.
		• As teams are working, make note of any observations about how they are brainstorming. What body language are you seeing? How are students talking and sharing with each other? How are ideas being formed? You may also need to encourage students to not edit their ideas and to put everything down on paper.
		• As a whole class discuss what the brainstorming process was like. Below are some possible discussion questions:
		  ○ What did the brainstorming process feel like?
		  ○ What was your most creative ideas? When did they happen in
			K/NTK Chart
			
			Brainstorming Practice
			
			Brainstorming Protocols
			
			Design Process Organizer
			
			Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
		the process? ○ What do you need to remember about brainstorming when you brainstorm in your teams? **Preparation for brainstorming** • In the 7th-grade Entrepreneur project, students were introduced to a few brainstorming protocols. Either you choose or have the students choose a brainstorming protocol that will be best for them. Below is a summary of the protocols. Follow the link for the detailed protocols. ○ 1-2-4 Brainstorming – good if students are needed more internet search time to see what is out there before brainstorming. Students individually develop or find a solution, then pairs of students brainstorm a solution. Finally, a team of 4 develops a solution. ○ Step Ladder Brainstorming – good for teams of at least teams of four – two students start brainstorming while the rest look on, then one student joins, and finally all students join the brainstorming. ○ 6-3-5 Brainwriting – good if students are struggling with having team conversations or with smaller groups. You can pair groups together to provide ideas on each other's problems. Students start with the 6-3-5 Brainstorming Organizer and fills in the top row with ideas then they rotate papers in rounds. In each round, students add new ideas to the next row. **Team Brainstorming** • Optional: Before brainstorming, students may need to get ideas from the internet. Give them 10 minutes to explore what is out there now they have a better understanding of the problem they are trying to solve. • Either using one of the Brainstorming Protocols or within a team meeting, students brainstorm ideas to solve their problem. The goal is 5 sketched design ideas (3 is the bare minimum, 10 would be fantastic) • Students submit their ideas to the teacher for feedback and check off the completion of this phase.	

Day	Learning Targets & Standards	Texts & Tasks	Supports
		Design Process Reflection • This ends the "Imagine" section of the design process. Have students reflect on this stage of the process using their Design Process Organizers. • Invite students to share their thinking with the class, especially around how this part of the process helped them to better understand and develop ideas for solving their problem. Also discuss, "What is it important to have a lot of ideas instead of going with our first idea?	
7	**Plan** • Narrow down design ideas to one idea to further develop. • Use a decision matrix to analyze their design ideas.	**Phase Launch** • Tell students they are now entering the plan phase. Refer back to their Design Process charts they made at the beginning of this unit. • The goal of the plan phase is to narrow their design ideas to one possible solution and to determine how we will test their ideas once they are created. • They will also be introduced to the Decision Matrix to help them analyze their design ideas. They have not yet worked with this tool. Decision Matrix Introduction • Goal: Students develop an understanding of how to use a decision matrix for making design decisions. • Give student teams a copy of the Decision Matrix Example. It includes the directions and a blank decision matrix. • Lead students through the example using the directions provided on the handout. • Label different parts of your classroom as the cereal choices: Froot Loops, Lucky Charms, Cheerios, Honey Nut Cheerios, and Cinnamon Toast Crunch • Ask student teams to go to the cereal that their group chose as the best. Have teams share with within their like-groups why they made that choice and determine who should be the spokesperson for the group. • Each cereal team will go around and share their justification on why that is the best cereal. Allow any student who wishes to change choices if someone's justification persuaded them.	K/NTK Chart Design Journal Decision Matrix Example Decision Matrix Design Process Organizer

Day	Learning Targets & Standards	Texts & Tasks	Supports

		• Lead students in a discussion to try and persuade other groups of their choice.
		• After the discussion, lead students in a whole class debrief and reflection.
		  ○ What were the best criteria or constraints to determine the best cereal?
		  ○ How did you arrive at your decision? How did the decision matrix help or hinder you?
		
		Team Discussion – Decision Matrix
		• Students revisit their ideal solution.
		• Students review their design ideas and narrow down to the top 3 – 5 best ideas and label or name each idea so they can easily refer to them later.
		• Give each student team a blank copy of the Decision Matrix with the directions. Note: They have already completed steps 1 & 2.
		• Students turn in their design choice and justification to the teacher for feedback and check-off.	

8	**Plan** • Develop a testing plan to evaluate their final solution. • Develop a creation plan for their design idea. (Sketch and written plan)	**Testing Plan – Introduction** • Goal: To help students know how to develop a potential test to determine the effectiveness of their created solution. • Note: we do this in the "plan" phase so we plan a test that fits the criteria and constraints and not justify what we created. (i.e., our solution needs to fit the test, not the test fit the solution). • Give students the Testing Protocol Example. Students are given two example problems and their testing protocol information and then asked to add another possible test for each problem. • As students are working, take note of how easy or difficult it is for them to come up with possible testing procedures. Invite students to share their ideas to help struggling students learn what might be possible testing procedures. **Team Meeting – Testing Protocol, Final Sketch, and Creation Plan** • In their teams, students revisit the K/NTK Charts to document what they have learned and what still needs to be decided before developing their	K/NTK Chart Design Journal Testing Protocol Example Testing Protocol Organizer Design Process Organizer

Day	Learning Targets & Standards	Texts & Tasks	Supports

		prototype.
		• Students determine who will do the following tasks before creating their prototype. Students can decide to work on everything as a team or divide the tasks between each team member.
		  ○ Write the testing protocol using the Testing Protocol Organizer.
		  ○ Develop a final sketch of their design idea with rough dimensions.
		  ○ Write the creation plan for how they will build their prototype. They will need to outline the process they will use and determine who will be responsible for each step of the creation process.
		• Students complete tasks and turn them into the teacher for feedback and final approval.
		
		Design Process Reflection
		• This ends the "Plan" section of the design process. Have students reflect on this stage of the process using their Design Process Organizers.
		• Invite students to share their thinking with the class, especially around how this part of the process helped them to narrow down their design ideas and plan for the creation phase.	

9 – 10	**Create**
	• Develop a prototype of their design idea.
	• Document their process in their design journal.
		Prototype Creation
		• Students develop their prototype.
		• Remind students they will need to capture their process in their design journals and through pictures, so they can write their instructions for other people to replicate their design.
		• If needed, have students determine roles for the creation process.
		  ○ **Project Manager** – ensures that each person on the team has a task and is contributing to successfully completing their project.
		  ○ **Materials Manager** – Responsible for procuring materials for their teams (within the classroom).
		  ○ **Questioner/Spy Master** – The one person who can ask a question of the teacher or look at what other groups are doing and report back to the group.
		  ○ **Documentarian** – Takes pictures of each stage of the process and captures notes on the process (this will be later used to write up the instructions).
			K/NTK
			
			Design Journal
			
			Design Process Organizer

Day	Learning Targets & Standards	Texts & Tasks	Supports
		Design Process Reflection • This ends the "Create" section of the design process. Have students reflect on this stage of the process using their Design Process Organizers. • Invite students to share their thinking with the class, especially how did the other phases contribute to their success in this phase?	
11 – 12	**Evaluate & Improve** • Implement a testing protocol to test and evaluate their design. • Write instructions for creating their design ideas. • Write a summary of their evaluation of their testing results.	**Testing & Improving Design Ideas** • Students run their testing protocols to test the effectiveness of their design ideas. • Students write a summary of their findings and how they would improve their design. • Students write up their design instructions. • Give students the Trash-to-Treasure Rubric so they can self-assess if they have everything needed to complete the project. **Design Process Reflection** • This ends the "Evaluate and Improve" sections of the design process. Have students reflect on this stage of the process using their Design Process Organizers. • Invite students to share their thinking with the class, especially what did they learn when performing their tests? How did evaluating the test results help them determine next steps for their design idea? **Final Design Process Discussion** • Lead students in a whole class discussion on our driving questions, "Why use a design process instead of just creating something?" and "How can we use a design process to solve challenges that benefit humanity?" **Informal Class Presentations** Students will develop a formal presentation of their favorite project at the end of the course, however, have student teams share their work with the rest of the class and celebrate their success.	K/NTK Design Journal Design Process Organizer

SCSD Grade 8

High Tech Manufacturing and Design

Unit 2a: Reverse Engineering

CTE Content Focus: High Tech Manufacturing and Design

16 INSTRUCTIONAL DAYS

Unit Focus	Unit Text Set
This is project 2 out of 3 projects students will solve the problem of redesigning a 3D molded package into a package that can be "flat-packed" and assembled on site. They will also refine their 2D to 3D spatial skills as they learn how 3D nets apply to package design. **A 4th Communication unit will ask students to pick their favorite project and develop a formal presentation (or a poster presentation) on their design process and an engineering report outline. Each student will need to keep track of their process and notes in their design journal because they will individually develop a poster presentation.**	Video: Smart Packaging Reduces Environmental Impact Articles: • Green Package Design: Waste Not, Want Not • What is Reverse Engineering? • How to Effectively Redesign Product Packaging Video: Structural Packing: How to Improve a Net
Unit Anchor Charts/Instructional Tools	
• Launch: Origami Box Video • Reverse Engineering Project Scenario • Know/NTK chart • Team Contract • Team meetings • Design Journal • Text coding • GIST Summary • Internet research • Reverse Engineering – 3D Package Exploration • Reverse Engineering – Flat-packed Package Exploration • Nets and Surface Area Pre-Assessment (answer key) • Mathematical Nets Exploration – Student Version • Mathematical Net Cards (Card set A & B) • Mathematical Nets Exploration Teacher Version	

• Geometric Prints Pack • Brainstorming • Decision Matrix • Testing Plan • Surface Area Calculations Example • Surface Area Calculation Directions • Common Area Formulas Sheet • Reverse Engineering Project Rubric	

Guiding Questions & Big Ideas
Driving Question: How can we redesign an existing molded product package into a package made from a single sheet of foldable material? Big Ideas: • We can reduce environmental impact by changing the material we use and examining how much material is wasted in manufacturing. • Reverse engineering is a process of examining products to learn how they do what they do and discover ways we can improve them.

Final Tasks

Students will create a flat-packed package prototype and scaled drawing of their 2D net. Students will calculate the efficiency of their design by calculating the amount of waste versus usable surface area.

Culturally and Historically Responsive Framework	Essential Learning Concepts
Identity: How will the unit help students to learn something about themselves and/or others? Students will be working in a team and will learn more about how they can work effectively with other students. **Skills: How will the unit build students' skills in the content area?** **Intellect: How will the unit build students' knowledge and mental powers?** The project is designed to put students in the role of designers. They will own their designs and build knowledge as they work through the design process.	Students will be able to… • Read and analyze technical texts for background information on green packaging, package design, and reverse engineering. • Define green packaging design. • Define reverse engineering. • Identify considerations for redesigning packages. • Reverse Engineer a 3D molded package to understand its characteristics. • Determine criteria and constraints my package will need to satisfy. • Reverse Engineer a flat-packed package to understand its characteristics.

Criticality: How will the unit engage students' thinking about power and equity and the disruption of oppression? N/A **Joy: How will the unit allow students to experience joy through their learning?** We will celebrate their design and hard work at the end of the unit. Throughout the process, students will be encouraged through challenges.	• Determine design considerations for a flat-packed package. • Match the mathematical net of an object or package to its corresponding 3D Solid. • Explore design ideas for their flat-packed package Design. • Understand and apply the process of laying out a mathematical net so it reduces the waste of material. • Understand and apply the process of laying out a mathematical net so it reduces the waste of material. • Use a decision matrix to determine a pathway forward for their package design. • Create a detailed sketch of their mathematical net for their package design. • Write a testing plan to test their design idea. • Write a description of their package design. • Calculate the surface area of a mathematical net of a package. • Calculate waste produced by a mathematical net. • Calculate the percent efficiency of a mathematical net. • Create and test a prototype of their design. • Evaluate and suggest improvements for their design. • Present their design to classmates.
SEL Benchmarks	**Integrated Standards**
	NY Digital Literacy Standards: • 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences. • 7-8.DL.2 Communicate and collaborate with others using a variety of digital tools to create and revise a collaborative product.

Unit 2a: Reverse Engineering

Key Vocabulary		Oral Language	Writing
Green Packaging Reverse Engineering Redesign 2D nets	3D solids Surface Area Efficiency	Team meetings Jigsaw Reading and Discussion	K/NTK Chart GIST Summary Design Journal Notes

Teacher Preparation & Notes

In every project in this series, students are expected to keep a design journal and work with a team. Below are the design journal checklists and team contracts used in previous projects.

- Design Journal – students are expected to keep a written design journal, typically in the form of a composition notebook.
  - Design Journal Instructions
  - Design Journal Checklist – Teacher version
  - Design Journal Checklist – Student version – can be printed, cut out, and pasted into their design journal.
- Team Contract

You will need to secure package items. You will need both 3D molded, plastic, or Styrofoam containers for students to reverse engineering and redesign into a flat-packed container. Examples include toy packages, Styrofoam food containers, or plastic food containers. Local restaurants might be good places to get food container donations. You will also need selections of flat-packed containers for students to reverse engineer and analyze how they work and practice surface area calculations and learn about nets of 3D objects. While one aspect of this project is how companies can reduce waste and decrease the amount of trash that ends up in landfills for long amounts of time, students could also examine plastic containers or packages around their home that can be redesigned with a flat-packed container (For example, cardboard file boxes instead of plastic file bins) Examples include unused (or very clean) pizza boxes, tissue boxes, cereal boxes, clean Chinese food containers, or other packing boxes. It is helpful to have a mix of different types of constructed for students to examine and learn from.

Day	Learning Targets & Standards	Texts & Tasks	Supports

1	**Launch & Task Analysis**	**Launch – Let's do some Origami.**
		• Before class, prepare enough square sheets of paper for each student. One side of traditional origami paper is white and the other is printed with a pattern or solid color. While not necessary for the end product, the difference helps when following along with the video.
		• Show the following videos to the class, Origami Box Video.
		• Plan on starting and stopping the video so students can keep up. Expect fun and frustration, laughs and groans. Validate behaviors important to the project ahead, such as persistence and attention to detail.
		• Ask students what surprised them about turning a sheet of paper into a box? What made the box work? You may also want to unfold an example box and have students examine the fold lines.
		• Show the video, Smart Packaging Reduces Environmental Impact, that highlights the large impact of small material reductions in packaging.
		• Use a think-pair-share activity to conclude the viewing. Have each student list.
		  ○ Examples of wasteful packaging they observed,
		  ○ prediction of the end-product of this project, and
		  ○ Skills/knowledge needed to complete the project.
		• Pair students. Ask each pair to combine their lists and post them on chart paper. Allow students to participate in a short gallery walk to see what other teams have identified. Facilitate a brief discussion on the similarities and differences between the responses.
		
		Task Analysis & Team Contract
		• Divide students into their design teams of 2 – 4 students.
		• Introduce the guiding question, How can we redesign an existing molded product package into a package made from a single sheet of foldable material?" for this project and hand out the project scenario.
		• Have students highlight the scenario and ask any clarifying questions about the expectations of the project.
		• Have students start their Know/NTK chart for this project. If needed, probe them to add things they learned from last year about the design process and how to design an item for a target customer.
		• Have student teams develop their team contract.
			Origami Box Video
			
			Video: Smart Packaging Reduces Environmental Impact
			
			Reverse Engineering Project Scenario
			
			Know/NTK chart
			
			Team Contract
			
			Team meeting
			
			Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
2 - 3	**Ask & Define** • Read and analyze technical texts for background information on green packaging, package design, and reverse engineering. • Define green packaging design. • Define reverse engineering. • Identify considerations for redesigning packages.	**Background Reading – Jigsaw Reading and GIST Summary** • Assign each person in a design team a different article to read. Word versions of each article are provided for ease of printing so students can mark up the text or be able to provide a digital copy to use the MS Word text reading function. Links to the original sources are also provided to examine pictures or follow helpful links. ○ Green Package Design: Waste Not, Want Not – note, this is a long article and is best divided between two students. Pages 1- 3 give the basics of green package design. Pages 4 – 8 give examples from companies that made their packaging greener. ○ What is Reverse Engineering? ○ How to Effectively Redesign Product Packaging • Regroup students into like-article groups. Students will read and highlight the article for important facts about green, eco-friendly packaging, packaging design, and reverse engineering. It is recommended that students use a reading technique such as text coding to mark up their articles as they read. Below are possible symbols they can use: ○ ☆ indicates an important fact about package design, green packaging, or reverse engineering. ○ ! indicates an important connection or thought inspired by this part of the text (along with writing in the margin about their connection or thought). ○ ? indicates a selection of text that inspires a question or is confusing (along with a question written in the margin). ○ Circle any unfamiliar words. (You may want to give students time to look up word definitions and share them in class) • After reading, in their like-article groups, each student goes around and shares: ○ Round 1: Important facts from their article ○ Round 2: Questions and Confusions – then students try to answer each other's questions or confusion. ○ Round 3: List unfamiliar words – either have students give these	Articles • Green Package Design: Waste Not, Want Not • What is Reverse Engineering? • How to Effectively Redesign Product Packaging Text coding GIST Summary K/NTK chart Team meetings Internet research

Day	Learning Targets & Standards	Texts & Tasks	Supports

		to you so you can prepare a vocabulary lesson or have students look up words and add them to their design journal for future reference.
		• Give each like-article team a GIST Summary handout. Collaboratively they use the organizer to prepare a summary to share with their design team about the most important facts they learned from the article and the discussion.
		
		Team Meeting
		• Students meet back in their design teams and share their article summary and any other important facts they found.
		• Students revisit their K/NTK Chart
		  ○ Add to their Know column what they learned.
		  ○ Check off answered questions.
		  ○ Add new NTKs or questions.
		• If students have more questions about package design, green packaging or materials, or reverse engineering, have them divide up the questions to be answered between their team members. Each student research for answers and takes notes in their design journal. Tell them to remember to keep track of their sources along with the notes.
		• Students come back to their team members and share what they learned and add it to their K/NTK Charts.
		• Teams decide on the top 3 – 5 things they need to keep in mind for designing their package. This can be a good exit ticket.
		
		Optional – Brainstorming 3D Packages
		• Goal: In the next section, students will choose a package to redesign. You can make that choice for them, in which case you can skip this step, or you can have them brainstorm ideas for what they may want to bring in to redesign.
		• Show students pictures or bring in a selection of actual 3D molded packages.
		• In their teams, have students brainstorm other places they have seen 3D molded packages.	

Day	Learning Targets & Standards	Texts & Tasks	Supports
		• Invite each group to share their ideas and track them on a class list. • Each team uses this list to consider what they can bring in and would like to redesign.	

3 – 4	**Ask & Define**
	• Reverse Engineer a 3D molded package to understand its characteristics.
	• Determine criteria and constraints my package will need to satisfy.
		Reverse Engineer a 3D Molded Package
		• Goal: Students will pick the package they will be redesigning and learn how it works and what it is intended to do through the process of reverse Engineering. Students will determine the constraints and criteria their redesigned package will need to have to do the same function as the old package. They will also need to determine at least one improvement goal for their new package beyond the ones stated in the project scenario (i.e., eco-friendly material, flat-packed).
		• Have the package displayed (or have students bring one they would like to redesign). Each design team picks one package they would like to redesign.
		• You will also need to have beads, beans, or similar to use as a volume measuring devices and something to measure volumes such as graduated cylinders or measuring cups.
		• Give each student design team a copy of the Reverse Engineering – 3D Package Exploration directions. This will include the directions and the Reverse Engineering Organizer.
		• After students have completed the Reverse Engineering – 3D Package Exploration have students present their findings to the class. They will present:
		  ○ The package you or your team chose.
		  ○ The important information in your Reverse Engineering Graphic Organizer for the package.
		  ○ Point out anything about the package that might be important to the bigger project.
		  ○ Any other important ideas you learned or any questions you have.
			Reverse Engineering – 3D Package Exploration
			
			Design Teams
			
			Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports

4 – 5	**Ask & Define**
	• Reverse Engineer a flat-packed package to understand its characteristics.
	• Determine design considerations for a flat-packed package.
		Reverse Engineering – Flat-packed Package
		• Goal: Students may have used flat-packed containers in their everyday life, but they may not have ever carefully examined how they are constructed. This will also help students begin to consider how nets of 3D objects (namely rectangular prisms work).
		• Note: Students will need to be careful when unfolding the packages because these can be used for the lesson on surface area.
		• Give each team a different flat-packed package option. It is helpful to have different design types students can present and learn from each other how different boxes use different techniques for going from a 2D material to a 3D shape.
		• Give each student design team a copy of the Reverse Engineering – Flat-packed Package Exploration directions. This will include the directions and the Reverse Engineering Organizer.
		• After students have completed the Reverse Engineering – Flat-packed Package Exploration have students present their findings to the class. They will present:
		  ○ The package you or your team chose.
		  ○ The important information in your Reverse Engineering Graphic Organizer for the package.
		  ○ Point out anything about the package that might be important to the bigger project.
		• Any other important ideas you learned or any questions you have.
		
		Team Meeting – Problem Statement
		• Students revisit their K/NTK Chart and update it with
		  ○ What they learned from reverse engineering explorations (KNOW)
		  ○ Check-off questions answered.
		  ○ Add new questions they need to consider (NTK)
		• Students meet in their design teams and develop a problem statement for their package design. This will include what type of package they are redesigning and what criteria and constraints the new package will need to include.
			Reverse Engineering – Flat-packed Package Exploration
			
			Design Teams
			
			Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
6 – 7	**Imagine** • Match the mathematical net of an object or package to its corresponding 3D Solid. • Explore design ideas for their flat-packed package Design.	**Team Brainstorming Session 1** • Students meet in their teams to brainstorm ideas for their package design. Tell them this is only their first brainstorming session and not to get too attached to any of their design ideas. • Students may need to research on the internet for ideas. Should they do this, direct them to sketch the idea in their design journal and add notes about what they like about the idea and what they do not like about the idea. **Mathematical Notes** • The math in this project relies on two related concepts: mathematical nets of solid objects and surface area. The lessons below are designed to engage students in learning about these concepts as they apply to package design. • You may want to give students this pre-assessment (answer key) to get an understanding of their ability to relate to these concepts and divide students into math-ability-like groups through these activities so you can scaffold the activities appropriately or eliminate an activity as needed. • The activities are also used to provide students with background knowledge relating to flat-packed package design so they can more easily brainstorm ideas for their package design. **Math Activity 1 – Mathematical Nets** • Goal: Students will be able to connect a mathematical net with its 3D solid object. Students will also explore different package design shapes. • Give each student team (or math team) a copy of the Mathematical Nets Exploration activities. • Part 1 has students doing an internet search to explore and find different nets for different package shapes. • For part 2, students will need Card Set A (mathematical nets) and Card Set B (3D Solids) from Mathematical Net Cards already cut out (it is suggested to use card stock if available so you can reuse them). They will check their understanding of mathematical nets by connecting the net with the 3D shape. Card Set C will be used in the surface area activity.	Nets and Surface Area Pre-Assessment (answer key) Mathematical Nets Exploration – Student Version Mathematical Net Cards (Card set A & B) Mathematical Nets Exploration Teacher Version Brainstorming Team Meetings Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
		• Refer to the Mathematical Nets Exploration Teacher Version for notes on how to further support students and the answer key for the card set. **Team Brainstorming Session 2** • If not already in their design teams, students go back to their design team and share ideas they found during the exploration for their package design. • Students sketch at least one more design idea for their team in their design journal.	
8 – 9	**Imagine** • Understand and apply the process of laying out a mathematical net so it reduces the waste of material.	**Math Activity 2 – Mathematical Net Layout** • Goal: One way to be more eco-friendly is to fully use our material. Material that gets cut away is waste. We can reduce this waste by maximizing how we use space on a sheet of material. This can be achieved by laying out our net on the space efficiently. • Show students the Video: Structural Packing: How to Improve a Net • Have students take notes in their design journal of the process. • The Geometric Prints Pack from MathGeekMama.com has a selection of package nets for students to choose and redesign for a more efficient net layout. Either assign student teams an example one or have them choose. Each team will need at least two copies (but more would be helpful): one to build as is and one to cut and rearrange to find a better net layout that uses less space. • In their teams have students collaborate to determine the best layout for their net that reduces waste. • Invite teams to present their findings to the whole class. **Team Brainstorming Session 3 – Final Brainstorming** • If not already in their design teams, students go back to their design team. • Students brainstorm ideas for both their package redesign and how it will be laid out on the material. • Students may also want to brainstorm and consider any graphics or other branding ideas they want to include on their packaging.	Video: Structural Packing: How to Improve a Net Geometric Prints Pack Brainstorming Team Meetings Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
		• The goal is for students to have at least 5 ideas (3 at the minimum)	

10	**Plan**
	• Use a decision matrix to determine a pathway forward for their package design.
	• Create a detailed sketch of their mathematical net for their package design.
	• Write a testing plan to test their design idea.
	• Write a description of their package design.
		Team Meeting and Planning
		• Students review their ideas and narrow them down to the best 5 ideas, then use a Decision Matrix to determine the best idea to move forward. They may need to do one for the actual package and one for any graphics they would like to include on the package.
		• Students submit their design idea to the teacher for feedback and approval.
		• Before moving on to the creation phase students will need to have:
		  ○ A detailed sketch of their design with dimensions and materials.
		  ○ A testing plan – one test will be a volume test similar to what they did with the Reverse Engineering a 3D package and one should be for one of their criteria. This will also need to be checked by the teacher to see if appropriate materials are available.
		  ○ A written description of the problem and their solution including the materials they propose the package to eventually be made of and how they are eco-friendly.
		• Students work as a team to accomplish the tasks. They can decide to divide up the labor or work together on each one.
			Decision Matrix
			
			Testing Plan
			
			Design Journal

11 - 12	**Plan** • Calculate the surface area of a mathematical net of a package. • Calculate waste produced by a mathematical net. • Calculate the percent efficiency of a mathematical net.	**Mathematics Teacher Notes** • This may be a good lesson to use the Pre-assessment to put students in like math-ability groups. Students who are comfortable with area calculations can work on more complex shapes, whereas students who need extra help may need more simple designs such as mostly rectangles. The use of calculators is highly encouraged. • The math students are getting ready to do is not hard, but it is long. Here is a fully worked-out example of the process students will undergo. It is suggested they divide the surface area calculations up as a group to make it go quicker. Engineering math can sometimes be able systematically doing simple math repeatedly to fully work through a problem. Use the example problem as needed to help students to do or keep track of their mathematics. • The general process students will go through is	Surface Area Calculations Example Surface Area Calculation Directions Common Area Formulas Sheet Mathematical Net Cards (Card set A & C)

Day	Learning Targets & Standards	Texts & Tasks	Supports
		○ Take an example box and draw lines to indicate different shapes on the box (basically draw a line where there is a crease). ○ Number each shape so they can refer back to it. ○ Measure and calculate the area of each individual shape that makes up the package and add up for the total surface area of the actual package. ○ Lay the box on paper and draw a rectangle around the box. The rectangle represents the material the box was cut out of. ○ Calculate the area of the rectangle. ○ Subtract the area of the rectangle (aka original material) from the surface area of the package to get the amount of waste generated. ○ Divide the surface area of the package by the area of the material (big rectangle) and multiply by 100% to get an efficiency rating of the design. • Once students work through this one problem, they can determine how and who will do the calculations for their package design. **Surface Area & Waste Calculations** • Goal: Students will learn how to calculate the surface area of the net for their design, the amount of waste their design will produce, and the overall efficiency of their design (Net surface area/Area of material used x 100%). • Determine how you want to divide students up and assign each math team a box from the Reverse Engineering a Flat-Pack Package activity. • Give each student a copy of the Surface Area Calculation Directions and the Common Area Formulas Sheet, rulers, tape, and a large piece of paper (enough to lay out the package on and present their final calculations). Students should keep track of their calculations in their design journal) • In teams, students work through finding the surface area of their assigned package, the amount of waste, and the %efficiency. Rotate and help and encourage students as needed.	

Day	Learning Targets & Standards	Texts & Tasks	Supports
		• Invite groups to present their findings and any insights they gained as they worked through this math challenge. • If students need more surface area practice or as an assessment of what they learned, give students card set A (mathematical Nets) & C (surface areas) and have them match the surface area with the mathematical net. (Answer Key: A1 – SA2; A2 – SA4, A3 – SA5, A4 – SA1, A5 – SA6, A6 – SA3)	
13 – 15	**Create, Evaluate & Improve** • Create and test a prototype of their design. • Evaluate and suggest improvements for their design.	**Teacher Note**: Student teams may move through the Create, evaluate, and improve phases at different rates. You may want to provide daily team meetings so students can check in on their progress and make sure everyone on the team has a task to do. **Team Meeting** • Students revisit their K/NTK chart and add information they learned or discovered about surface area. • Students develop a Plan for who will complete the following tasks and when. Give students the Reverse Engineering Project Rubric to help them complete their tasks and check they have all the elements. ○ Prototype of their package design (this does not need to be made from the actual material, but students will need to be able to say what material they would use and why). ○ Any graphics proposed for the final product. (These can be mocked up using MS Publisher, PPT, MS Paint, or similar) ○ Surface area calculations: Surface area of the proposed net, amount of waste produced per package, and % efficiency of the design. ○ Final scaled sketch of the design with dimensions and improvement notes. ○ Testing plan enacted and data collected – Volume test plus one additional test. ○ Final written description of their design which includes a brief description of the problem, their proposed solution, results from testing, and improvement suggestions. ○ Optional: Time-allowing students may want to create a 2nd	Design Journal Testing Plan Reverse Engineering Project Rubric

Day	Learning Targets & Standards	Texts & Tasks	Supports
		prototype based on testing results. **Create, Evaluate & Improve** • Student teams work through creating, evaluating, and improving their prototype. • Each morning teams may want to meet to set up goals for the day before work. • Students track their progress in their design journals. • At the end of each day, have students write in their design journals their accomplishments that day and goals for the next day.	
16	**Communicate and Celebrate** • Present their design to classmates.	**Presentation and Celebration**: Students will do formal presentations at the end of this course; however, have students informally present their designs in class. Celebrate their hard work and success. **Design Journal Reflection**: What surprised you about the package design process? What did you like about this project? What did you not like about this project?	Design Journal

SCSD Grade 8

High Tech Manufacturing and Design

Unit 2b: Rapid Prototyping

CTE Content Focus: High Tech Manufacturing and Design

17 INSTRUCTIONAL DAYS

Unit Focus	Unit Text Set
This is project 2 out of 3 projects students will solve the problem of developing a prototype for a coin that showcases a local historical event or a high-interest topic. **A 4th Communication unit will ask students to pick their favorite project and develop a formal presentation (or a poster presentation) on their design process and an engineering report outline. Each student will need to keep track of their process and notes in their design journal because they will individually develop a poster presentation.**	Videos: • 3D Printing and How Does it Work? • How are Coins Made (7 minutes) • How are Challenge Coins Made (10 minutes) Articles: • The Captivating Chemistry of Coins • Coin Production • Difference Between 3D Printing and Rapid Prototyping • 3D Printing: What You Need to Know
Unit Anchor Charts/Instructional Tools	
Project Scenario Know/NTK chart Team Contract Team meetings Design journal Text Coding Jigsaw Reading GIST Summary Webwalk Math Lesson • Math Pre-assessment • Math Activity 1: Volume & Density • Math Activity 2: Sizing a Coin • Volume, Height, Diameter spreadsheet Gallery Walk Feedback Solid Edge Tutorial Testing Protocol	

Guiding Questions & Big Ideas

Driving Question: How do we use mathematical models to translate artistic designs into prototypes and tools for manufacturing?

Big Ideas:

- Engineers and designers use mathematics to make decisions about the dimensions of designs.
- 3D printing is a way to evaluate a design visually using relatively cheap materials.

Final Tasks

Students will design a coin that showcases a local historical event or place or around a high-interest topic. This coin will be printed out on the 3D printer to inspect how the visual design will look and feel.

Culturally and Historically Responsive Framework

Identity: How will the unit help students to learn something about themselves and/or others? Students will be working in a team and will learn more about how they can work effectively with other students.

Skills: How will the unit build students' skills in the content area?
Intellect: How will the unit build students' knowledge and mental powers? The project is designed to put students in the role of designers. They will own their designs and build knowledge as they work through the design process.

Criticality: How will the unit engage students' thinking about power and equity and the disruption of oppression? N/A

Joy: How will the unit allow students to experience joy through their learning? We will celebrate their design and hard work at the end of the unit. Throughout the process, students will be encouraged through challenges.

Essential Learning Concepts

Students will be able to…

- Read and analyze technical texts for background information on rapid prototyping and coin production.
- Develop a problem statement for my coin design.
- Brainstorm ideas for our team's coin design.
- Use a decision matrix to narrow design ideas to one workable solution.
- Calculate the target volume of a coin based on the mass and density of the material.
- Determine the dimensions of my coin based on the target volume and what will work best for users of the coin.
- Finalize our design idea.
- Determine the diameter and thickness of our coin.
- Give and receive feedback.
- Revise my design ideas based on feedback.
- Use 3D modeling software to draw a coin with an image.
- Use 3D modeling software to enact our design ideas.
- Evaluate the effectiveness of my coin design using a 3D-printed model.
- Improve my coin design based on my evaluation of the 3D-printed model.
- Present my design to classmates.

SEL Benchmarks	**Integrated Standards**
	NY Digital Literacy Standards: • 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences. • 7-8.DL.2 Communicate and collaborate with others using a variety of digital tools to create and revise a collaborative product.

2b: Rapid Prototyping

Key Vocabulary		Oral Language	Writing
3D modeling Rapid Prototyping 3D printing Volume	Die Die Striking Density Cylinder	Think, pair, share Team meetings Jigsaw reading discussions Math collaborative groups Whole group share & present	GIST summary of an article Design journal notes and reflections

Teacher Preparation & Notes

In every project in this series, students are expected to keep a design journal and work with a team. Below are the design journal checklists and team contracts used in previous projects.

- Design Journal – students are expected to keep a written design journal, typically in the form of a composition notebook.
  - Design Journal Instructions
  - Design Journal Checklist – Teacher version
  - Design Journal Checklist – Student version – can be printed, cut out, and pasted into their design journal
- Team Contract

Day	Learning Targets & Standards	Texts & Tasks	Supports

1	**Launch & Task Analysis**	**Launch**
		• Ask students to share what they know about 3D printing.
		• Show students the video, "3D Printing and How Does it Work?"
		• After viewing, have each student list ideas for:
		  ○ A tentative definition of 3D Printing
		  ○ Positives of 3D Printing
		  ○ Drawbacks to 3D Printing
		• Have students share their thinking with a partner.
		
		Task Analysis & Team Contract
		• Divide students into their design teams of 2 – 4 students.
		• Introduce the guiding question, "How do we use mathematical models to translate artistic designs into prototypes and tools for manufacturing?" for this project and hand out the project scenario.
		• Have students highlight the scenario and ask any clarifying questions about the expectations of the project.
		• Have students start their Know/NTK chart for this project.
		• Have student teams develop their team contract.
		• Have student teams share at least one item from their K/NTK chart with the class for a class K/NTK Chart.
			Video: "3D Printing and How Does it Work?"
			
			Project Scenario
			
			Know/NTK chart
			
			Team Contract
			
			Team meeting
			
			Design Journal

2 – 3	**Ask & Define**
	• Read and analyze technical texts for background information on rapid prototyping and coin production.
		Coin Production
		• Goal: To build students' background knowledge on coin production.
		• Show students one of the videos on Coin Production
		  ○ How are Coins Made (7 minutes)
		  ○ How are Challenge Coins Made (10 minutes)
		• Ask students to take notes in their design journals on
		  ○ 3 – three things that you learned about the coin production process
		  ○ 2 – design considerations you will need to make for your coin design
			Videos:
			• How are Coins Made (7 minutes)
			• How are Challenge Coins Made (10 minutes)
			
			Articles:
			• The Captivating Chemistry of Coins

Day	Learning Targets & Standards	Texts & Tasks	Supports
		○ 1 – question to add to your K/NTK document • In their teams, students share their 3-2-1 and add new knowledge about coin production and the design considerations to their Know column of their K/NTK Chart and any new questions to their NTK column. • Invite different groups to share their thinking and add to the class K/NTK chart. **Background Reading – Jigsaw Reading and GIST Summary** • Assign each person in the design team a different article to read (feel free to simplify the process and choose one coin-related article and one 3D printing-related article instead of all four articles). PDF versions of each article are provided for ease of printing so students can mark up the text: ○ The Captivating Chemistry of Coins (4 pages) ○ Coin Production (2.5 pages) ○ Difference Between 3D Printing and Rapid Prototyping (2.25 pages) ○ 3D Printing: What You Need to Know (6 pages, toughest read) • Regroup students into like-article groups. Students will read and highlight the article for important facts about coin production or rapid prototyping. It is recommended that students use a reading technique such as text coding to mark up their articles as they read. Below are possible symbols they can use: ○ ☆ indicates an important fact about package design, green packaging, or reverse engineering. ○ ! indicates an important connection or thought inspired by this part of the text (along with writing in the margin about their connection or thought). ○ ? indicates a selection of text that inspires a question or is confusing (along with a question written in the margin). ○ Circle any unfamiliar words. (You may want to give students time to look up word definitions and share them in class)	• Coin Production • Difference Between 3D Printing and Rapid Prototyping • 3D Printing: What You Need to Know Text Coding Jigsaw Reading GIST Summary Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports

		• After reading, in their like-article groups, each student goes around and shares:
		  ○ Round 1: Important facts from their article
		  ○ Round 2: Questions and Confusions – then students try to answer each other's questions or confusion.
		  ○ Round 3: List unfamiliar words – either have students give these to you so you can prepare a vocabulary lesson or have students look up words and add them to their design journal for future reference.
		• Give each like-article team a GIST Summary handout. Collaboratively they use the organizer to prepare a summary to share with their design team the most important facts they learned from the article and the discussion.
		
		Team Meeting
		• Students meet back in their design teams and share their article summary and any other important facts they found.
		• Students revisit their K/NTK Chart
		  ○ Add to their Know column what they learned
		  ○ Check off answered questions
		  ○ Add new NTKs or questions
		• If students have more questions about rapid prototyping or coin production, have them divide up the questions to be answered among their team members. Each student performs internet research for answers and takes notes in their design journal. Tell them to remember to keep track of their sources along with the notes.
		• Students come back to their team members and share what they learned and add it to their K/NTK Charts.
		• Teams decide on the top 3 – 5 things they need to keep in mind for designing their coins. This can be a good exit ticket.	

4	**Ask & Define** • I can develop a problem statement for my coin design.	**Syracuse History Exploration Individual Webwalk** • Goal: While students live in the city, they may not know about its history or features beyond their immediate neighborhoods. This is meant to give students time to virtually explore their city.	Webwalk with various internet sites on the history of Syracuse, NY

Day	Learning Targets & Standards	Texts & Tasks	Supports

		• Students do a Webwalk of the history of Syracuse using the internet sites below (feel free to add your own). As students visit the sites, students write about one local event that piqued their interest.
		  ○ Story Map: Historic Sites and Districts in the City of Syracuse, from ArcGIS
		  ○ Story Map: Discover Syracuse on the Onondaga Creekwalk, from ArcGIS
		  ○ How did Syracuse Get its Name, from Onondaga Historical Association – click on "Explore" for more historical resources
		  ○ Syracuse, New York, from Britannica
		  ○ History of Syracuse, New York, from Wikipedia
		• Students share their highlights in their teams.
		
		Team Meeting – Problem Statement
		• Students meet in their teams to discuss and determine what topic, event, or place within Syracuse, they want to design their coin around. (At the teacher's discretion, students can choose to design their coin around something of high interest to them such as a favorite sport, game, or hobby).
		• Students also discuss different design elements they want to include in their coin.
		• Students write a problem statement that restates key constraints in the project scenario along with their specific design focus and criteria.
			Design Journal
			
			Team meeting
			
			Problem statement

5 – 6	**Imagine** • I can brainstorm ideas for our team's coin design. **Plan** • I can use a decision matrix to narrow design ideas to one workable solution.	**Team Brainstorming Session – 1-2-4 Brainstorming** • Note: The directions below use a version of the 1-2-4 Brainstorming method. If you have teams of 2 you would skip the last step. Feel free to choose an alternate method for brainstorming from our brainstorming protocols or another one you are familiar with. • Each student independently develops an idea for the front of the coin and the back of the coin. This can be a digital version where students use pictures they find on the internet or draw themselves or a hand-sketched drawing. Students keep track of their idea in their design journals (if working digitally, students can print their designs out and tape or paste them into their journals).	1-2-4 Brainstorming Brainstorming Protocols Decision Matrix Team meetings Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
		• Students pair up with a member of their design team, share their ideas, and develop one more idea together (one for the front of the coin and one for the back of the coin). • The full design team comes together to share their ideas and develop one more idea (one for the front of the coin and one for the back of the coin). **Team Meeting – Decision Matrix** • The design team reviews all the ideas for the front of the coin and the back of the coin and narrows down the ideas to their top 3 – 5 choices for each side of the coin. • Students use the decision matrix to determine the best idea for the front of the coin. • Students repeat the process to determine the best idea for the back of the coin. • The team submits these ideas to the teacher for feedback and approval.	
7 – 9	**Plan** • I can calculate the target volume of a coin based on the mass and density of the material. • I can determine the dimensions of my coin based on the target volume and what will work best for users of the coin.	**Teacher Note**: Below are mathematical activities to guide students through the process of determining the size of a coin using the starting mass constraints, the density of the coin material, and how the coin will feel in a person's hand. The math procedures are at a 6th-grade level; however, the process is complex. These lessons are meant to give students a feel for how engineers approach mathematics and make design decisions about the size of objects and to give students more experience with coins. In particular, what materials they are made from and the typical sizes of coins. The activities can be done in math-ability-like groups, so each student gets an experience with math. At least one or two students will repeat the calculations in their design team for their specific design. **Pre-Assessment** • Give students the pre-assessment to determine their challenges and strengths around the math needed for this project. • Divide students into math-ability-like groups based on the pre-assessment.	Math Pre-assessment Math Activity 1: Volume & Density Math Activity 2: Sizing a Coin Volume, Height, Diameter spreadsheet

Day	Learning Targets & Standards	Texts & Tasks	Supports
		Math Activity 1: Calculating Volume from Density • Lead student math groups through the Math Activity 1. • Students will look up the density of common metals used in coin production. • You will assign each team two metals to use in their volume calculations. These will be used to create a chart as a whole class. It will be helpful to have some groups doing the same metals so they can compare answers. • The answer key gives two different ways of finding the volume from density: an algebraic solution and a graphical solution. **Math Activity 2** • Lead student math groups through the Math Activity 2. • Students will explore the diameter and thicknesses of common coins. It helps to have multiple versions of the same type of coin when measuring thickness. Students can stack them, measure the height of the stack, then divide by the number of coins in the stack to find the thickness (i.e., height) of one coin. • Determining the diameter and thickness of a coin based on a target volume can be an iterative process. To make this process easier, the instructions in the activity ask students to use this Volume, Height, Diameter spreadsheet. There will be multiple "correct" solutions; however, you will need to help students to think about how thin is too thin for a coin and what is the best diameter for a coin that can fit in a typical hand.	
10 – 11	**Plan/Create** • I can finalize our design idea. • I can determine the diameter and thickness of our coin.	**Team Meeting and Work** • Students will prepare for a gallery walk of their design ideas. Their poster will need to show a cleaned-up sketch or digital rendering of the designs for the front and back of their coin. The poster will also need to include the proposed material of the coin along with the diameter and thickness of the coin with a sketch drawn to the actual size. Posters can be chart paper with design ideas and calculations taped or written on it. • Student teams determine who will work on each component of the	Team Meeting Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
		project: ○ Front of Coin ○ Back of Coin ○ Coin material and calculations • Students work on their assignments for the group. • After everything is complete, students prepare a "poster" or similar of their design idea along with coin material and proposed dimensions	
12	**Plan/Test/Improve** • I can give and receive feedback. • I can revise my design ideas based on feedback.	**Gallery Walk Feedback** • Note: This is also a good opportunity for getting feedback from an outside audience such as teachers or other students. The goal of this feedback session is to see if their designs are recognizable and if the dimensions make sense. • Students post their design posters around the room. • Students (and visitors) rotate between each design and leave feedback on a post-it note about: ○ What local event, place, or social theme is the design showcasing? (Is the design easily recognizable) ○ One strength of the design ○ One possible improvement of the design ○ Do you think the dimensions of the coin will work? • If using post-it notes, students can write on the sticky side of the post-it note. When the notes are placed on the chart paper, the feedback is not easily visible. **Team Meeting – Incorporating Feedback** • Students meet back in their design teams and review the feedback. • They determine a task list for improving their design ideas and determine who will do which task. • Students work on tasks and update their design ideas.	Gallery Walk Feedback Team Meeting Design Journal
13 - 15	**Plan/Create** • I can use 3D modeling software to draw a coin with an image.	**3D Modeling Tutorials** • Lead students through tutorials to teach the skills they will need to draw their coin in the 3D modeling software. • This tutorial gives the basic process for drawing a 3D coin in SolidEdge. The basic steps include:	Solid Edge Tutorial Team Meeting Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports

	• I can use 3D modeling software to enact our design ideas.	• Create a cylinder with the dimensions of your coin (draw a circle, extrude it the distance equal to the coin thickness). It will be small and thin, so you will need to zoom in.
		• Add a digital image of your chosen design on top of the coin.
		• Use the drawing tools (typically spline) to recreate the design on the top of the coin.
		• Delete the reference picture and extrude the drawing to give it the raised edge. (Note: if you want different parts of the design to be different thicknesses, you will need to create separate 2D drawings and then extrude those as well).
		• Use the fillet feature to round off edges.
		
		Create the coin and dies in 3D Modeling Software
		• In their design teams, students determine who will create which part of the coin. Since 3D printers print on a flat surface, and 3D printing is meant to test the visual imaging of the design, students will render the front and back of the coins separately. If you have an advanced group or a group of four students, consider challenging students to also make the dies of the coin. In summary, each student in the team will own a different part of the coin-making process:
		  ○ Front of coin
		  ○ Back of coin
		  ○ Front of the coin die
		  ○ Back of coin die
		• Students create their coins. They may want to use YouTube as a means for learning 3D modeling techniques to enact the design they want.
		• Teacher prints the coins using a 3D printer for students to use in testing.	

16	**Evaluate and Improve** • I can evaluate the effectiveness of my coin design using a 3D-printed model.	**Testing and Evaluating Coins** • After printing, students examine the coin to see if their visuals and text are clear and represent their vision for the coin. • If student groups also create dies for their coin, they will use this testing protocol to test their dies with playdough. They will compare the	Testing Protocol Team Meeting Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
	• I can improve my coin design based on my evaluation of the 3D-printed model.	playdough coin with the 3D-printed coin. • Student teams will decide if any improvements are necessary. • Time allowing, students update their 3D models to reflect the changes.	
17	**Communicate and Celebrate** • Present their design to classmates.	**Presentation and Celebration**: Students will do formal presentations at the end of this course; however, have students informally present their designs in class. Celebrate their hard work and success. **Design Journal Reflection**: What surprised you about the coin design process? What did you like about this project? What did you not like about this project?	Design Journal

SCSD Grade 8

Unit 3: Bridging the Gap

CTE Content Focus: High Tech Manufacturing and Design

16 INSTRUCTIONAL DAYS

Unit Focus	Unit Text Set
This is project 3 out of 3 projects. Students will solve the problem of designing a bridge for a new bike path over a stream that also can accommodate emergency vehicles. Students will build, test and improve a prototype of their bridge to scale. **A 4th Communication unit will ask students to pick their favorite project and develop a formal presentation (or a poster presentation) on their design process and an engineering report outline. Each student will need to keep track of their process and notes in their design journal because they will individually develop a poster presentation.**	Videos of Bridge Collapses: • Minneapolis Bridge Collapse • Tacoma Narrows Bridge Collapse • Civil Engineering Students Bridge Testing Article: "Why do Bridges Collapse" Article with read-aloud: "Study Answers Questions on Why Bridges Collapse" Article: "Types of Bridges"
Unit Anchor Charts/Instructional Tools	

• Bridge Project Scenario
• Design Journal
  ○ Instructions
  ○ Teacher Checklist
  ○ Student Checklist
• Know/NTK Chart
• Team Contract
• Text Coding
• Card Sort Bridges
• Forces in Bridges Lesson
• Decision Matrix
• Bridge Testing Protocol
• Bridge Material Costs Organizer
• Bridge Project Rubric	

Guiding Questions & Big Ideas

Driving Question: How do engineers use models to test and improve bridge designs?

Big Ideas:

- Engineers use models to test the safety of bridges before moving to larger scaled builds.
- Models can be physical models or mathematical models such as those from a simulation.

Final Tasks

Students will create a prototype and scaled drawing of a bridge that spans across a river. Students may build two prototypes of their bridge. One that is tested; one that is based on improvements from the test.

Culturally and Historically Responsive Framework	Essential Learning Concepts
Identity: How will the unit help students to learn something about themselves and/or others? Students will continue to learn and reflect on how they work within a team. **Skills: How will the unit build students' skills in the content area?** **Intellect: How will the unit build students' knowledge and mental powers?** Students will continue their use of the engineering design process from prior projects to this project. Students will learn about forces in bridges through reading and experimenting with simulation software. **Criticality: How will the unit engage students' thinking about power and equity and the disruption of oppression?** N/A **Joy: How will the unit allow students to experience joy through their learning?** At the end of the unit, students will celebrate their success and perseverance.	Students will be able to… • List why bridges fail. • Explain what designers can do to prevent bridge collapse. • Identify different types of bridges. • Define compression and tension force. • Describe how forces are used in bridge design. • Develop a problem statement for my team's approach to this problem. • Brainstorm bridge design ideas. • Use a bridge simulator to test bridge ideas. • Use my knowledge of forces to refine my bridge design idea. • Determine the best bridge design given the constraints of this project. • Develop a bill of materials. • Calculate the estimated cost of my bridge construction. • Sketch a final scaled drawing of my bridge prototype. • Build a prototype of my bridge design. • Calculate the final total cost of my bridge design. • Evaluate my bridge on how well it held weight and cost efficiency. • Determine improvements based on test results. • Improve and retest my bridge design. • Describe the improvements made and how they will help the bridge hold more weight or be more cost-effective.

SEL Benchmarks	Integrated Standards
	NY Digital Literacy Standards: • 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences. • 7-8.DL.2 Communicate and collaborate with others using a variety of digital tools to create and revise a collaborative product.

Unit 3: Bridging the Gap

Key Vocabulary		Oral Language	Writing
Force Compression Tension Bill of Materials (BOM)	Prototype	Team Meetings Whole group sharing Informal presentations	Design Journal Reflective writing

Teacher Preparation & Notes

In every project in this series, students are expected to keep a design journal and work with a team. Below are the design journal checklists and team contracts used in previous projects.

- Design Journal – students are expected to keep a written design journal, typically in the form of a composition notebook.
  - Design Journal Instructions
  - Design Journal Checklist – Teacher version
  - Design Journal Checklist – Student version – can be printed, cut out, and pasted into their design journal.
- Team Contract

Day	Learning Targets & Standards	Texts & Tasks	Supports

1	**Launch & Task Analysis**	**Launch – When Bridges Go Wrong!**
		• Show students the following bridge collapse videos. You may choose to show one or all. As students watch allow for their reactions and excitement. Have them capture in their design journals what they saw or heard about what contributed to the bridge collapsing.
		  ○ Minneapolis Bridge Collapse
		  ○ Tacoma Narrows Bridge Collapse (this will probably be the most exciting for your students)
		  ○ Civil Engineering Students Bridge Testing
		• Have students share their thinking and notes in small discussion groups (2 – 4 students). Invite students to share their thoughts about what led to bridges collapsing.
		
		Task Analysis & Team Contract
		• Divide students into their design teams of 2 – 4 students.
		• Introduce the guiding question, *"How do engineers use models to test bridge designs? (or a secondary question, "How do we prevent future bridge collapse?")* for this project and hand out the project scenario.
		• Have students highlight the scenario and ask any clarifying questions about the expectations of the project.
		• Have students start their Know/NTK chart for this project. If needed, probe them to add things they learned from past projects about the design process.
		• Have student teams develop their team contract.
			Design Journal
			
			Bridge Collapse Videos
			
			Know/NTK Chart
			
			Team Contract

2	**Ask & Define** • I can list why bridges fail. • I can explain what designers can do to prevent bridge collapse.	**Readings & Capture – Why do bridges collapse?** • **Goal: This is meant to deepen student understanding of why bridges collapse and help them to think about what they might need to consider in their designs.** • **Give each student a copy of the article, "Why do Bridges Collapse". You may also access it digitally by following this link. (An alternate or additional resource is, "Study Answers Questions on Why Bridges Collapse", this article also includes a feature to listen to the article)** • **Tell students that they need to take special note of the causes of bridge collapses and what can designers do about it.** • **Students use Text Coding as they read the text:**	Article: "Why do Bridges Collapse" Article with read-aloud: "Study Answers Questions on Why Bridges Collapse" Text Coding

Day	Learning Targets & Standards	Texts & Tasks	Supports
		○ ☆ indicates an important fact about bridge collapse or prevention. ○ ! indicates an important connection or thought inspired by this part of the text (along with writing in the margin about their connection or thought). ○ ? indicates a selection of text that inspires a question or is confusing (along with a question written in the margin). ○ Circle any unfamiliar words. (You may want to give students time to look up word definitions and share them in class) • In their design teams, students share the facts they learned about why bridges collapse and add important notes to the KNOW column of their K/NTK chart. Students add any new questions based on the article to the NTK section of their chart and check off any answered questions. • Invite student groups to share at least one important consideration they need to make when designing their bridge.	
3 – 5	**Ask & Define** • I can identify different types of bridges. • I can define compression and tension force. • I can describe how forces are used in bridge design.	Types of Brides Card Sort and Reading • Give each student group a set of cards (Card Set A: Types of Bridges, Card Set B: Pictures of Bridges, and Card Set C: Descriptions of Each Type) • You can either give each a copy of the resource, "Types of Bridges" or have them use the internet to search for answers. • Have students use their resources to determine which bridge picture goes with the type of bridge. Introduction to Forces • Have students pair up and stand up. Tell them to put their hands together and lean on each other. Explain that this is Compression – a force that compresses or pushes things together to create stability. • Next have students hold hands tightly, plant their feet securely on the ground and lean back. Explain that this is Tension – a force that uses pulling or stretching to keep things stable. • Explain that in bridge designs we use these two forces to ensure that bridges remain standing.	Types of bridges card sort Article: "Types of Bridges" Lesson on Forces in Bridges West Point Bridge Design Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
		Compression/Tension – need to do something tangible. • Implement the lesson on Forces in Bridges. The teacher version is on pages 1 – 4 with teacher notes highlighted in yellow. The student version is on pages 5 – 9. • The lesson requires students to use West Point Bridge Design Software so you will want to make sure it is loaded on your class computers. • Students will keep track of their notes in their Design Journal	

5	**Ask & Define**
	• I can develop a problem statement for my team's approach to this problem.
		Team Meeting
		• Team revisits their K/NTK chart:
		  ○ Add new knowledge
		  ○ Check-off questions answered
		  ○ Add new questions they will need to consider for their project
		• Students revisit the project scenario and pay close attention to the constraints of this bridge design.
		• Students brainstorm and discuss ideas for what they might want to include in their bridge design (for example: since this is a bike bridge in nature, they may want to make sure their bridge incorporates a nature theme design)
		• Students develop an official problem state that restates the constraints from the project description and at least one other goal for their bridge.
		• Students submit their problem statement to the teacher for feedback and approval.
			Team Meeting
			
			Project Scenario
			
			Design Journal

6 – 7	**Imagine** • I can brainstorm bridge design ideas. • I can use a bridge simulator to test bridge ideas. • I can use my knowledge of forces to refine my bridge design idea.	Team Brainstorming Session • In their teams, students brainstorm 3 – 5 ideas for how their bridge will look. If students get stuck on only 1 – 2 ideas, challenge them to try different types of bridges for their ideas. • Each person on the team takes one of their ideas to build and test in West Point Bridge Design. Westpoint Bridge – Test Brainstormed ideas • Each student will work to re-create one of their brainstormed options using West Point Bridge Design. Challenge them to get their bridge design down to the cheapest costs by changing sizes and types of members. • The goal is to give students an idea of how sizes and types of members	Team Meetings West Point Bridge Design software Design Journal Know/NTK Chart

Day	Learning Targets & Standards	Texts & Tasks	Supports

		play into bridge design as well as deepen their understanding of how to use forces to make changes in their designs.
		• Have students write in their design journal:
		  ○ What decisions are you making as you work to make the cheapest bridge possible?
		  ○ What are the considerations we need to make as we build our final bridge?
		
		Team Discussion
		• Teams share and discuss what they learned while simulating their bridge ideas using West Point Bridge Design and share considerations they will need to make.
		• Students go through each design idea and write the pros and cons for each idea based.
		• Invite students to share as a whole class lessons learned.
		• Update the Know/NTK Chart.	

8 – 9	**Plan** • I can determine the best bridge design given the constraints of this project. • I can develop a bill of materials. • I can calculate the estimated cost of my bridge construction. • I can sketch a final scaled drawing of my bridge prototype.	Team Meeting – Decision matrix • Student teams use a decision matrix (introduced in previous projects) to determine their best idea. • Students submit their idea to the teacher for approval. Teacher Notes on Scale • For this project, the scale students will use is 5ft = 1 in. This will ensure that the bridge will span a gap in the classroom of 12 inches. The bridge will have a decking (the space where the bicycles will go through) of 2 inches wide. • There are no constraints on how tall the bridge needs to be, but you may want to have students calculate the projected height based on this scale. Testing Protocol Overview • Share the scale and the dimensions of their bridge prototypes will need to be.	Decision Matrix Bridge Testing Protocol Bridge Material Costs Handout Design Journal Team Meetings Know/NTK Chart

Day	Learning Targets & Standards	Texts & Tasks	Supports
		• Give students a copy of the Bridge Testing Protocol. • Have students read it independently and highlight important information, then share in their teams the important information they learned and how/if it will affect their bridge designs. • Have students ask any clarifying questions as a whole class about how the bridges will be tested. Bill of Materials (BOM) & Detailed Sketch of their Bridge Design • Introduce students to the concept of a bill of materials – a list of all materials needed to construct a final product. • Give each student a copy of the Bridge Material Costs Handout. Each student will need to keep track of the information in their Design Journals. • In teams students will need to determine the material cost of their bridge. The goal is to keep the cost under $10 according. • They will also need to consider how they want to construct their designs and draw each section of the bridge on banner or poster paper to scale. This will help in the construction of the bridge because they can overlay wax paper on cut and glue members together using their sketch as a reference. • Students can decide to work together on each component or divide who does what. • For students doing the scaled sketching, you may need to hold mini workshops (4-5 student rotations) for using a ruler to neatly draw the design to scale. • Before getting materials, students need to submit their final sketch and their BOM with the estimated cost for your approval. • Update Know/NTK Chart.	
10 – 11	**Create** • I can build a prototype of my bridge design. • I can calculate the final total cost of my bridge design.	Prototype Creation • Students “buy” Materials from the teacher. • At the teacher’s discretion, should they need to buy additional materials, they can increase the costs. If students need to buy extra materials, they will need to make a note of what materials and the total	Time to create their prototype. Design Journal

Day	Learning Targets & Standards	Texts & Tasks	Supports
		costs in their design journal and update the total cost for their bridge construction. • Students build their bridge prototype and document accomplishments and challenges in their design journal.	
12	**Evaluate** • I can evaluate my bridge on how well it held weight and cost efficiency. • I can determine improvements based on test results.	Bridge Testing • Use the Bridge Testing Protocol as a guide to test bridge prototypes. • Have students document observations of each bridge testing in their design journals (this will help students learn from everyone's design and not just their own.) Team Discussion • Students calculate the ratio of the amount held to the weight of the bridge and the amount held to the cost of the bridge. Collect these and post them on a class chart to compare outcomes. • Teams discuss the success points of their bridge and what they would like to do differently to improve their design. • Update Know/NTK Chart. Whole class discussion • Compare ratios to determine the best bridge design. Have students discuss what made it the best. • Have students share what they learned from the testing and what they would like to do differently in their 2nd prototype.	Bridge Testing Protocol Team Discussion Whole class discussion Design Journal Know/NTK Chart
Add 2 – 3 days to the total length of the project.	**Improve** (optional – if you will have students do a 2nd prototype) • I can improve and retest my bridge design. • I can describe the improvements made and how they will help the bridge hold more weight or be more cost-effective.	Improve – Optional • Have students sketch an improved bridge design based on test results. • You may want to have students retest or just have a revised prototype to share how it is an improved design. • You may also want students to recalculate the total cost of the new bridge.	Design Journal Time to create

Day	Learning Targets & Standards	Texts & Tasks	Supports
13	**Communicate**	Reflection and Celebration • Students will do a more formal report and reflection at the end of the course but have them share their final bridge design with the class. • Celebrate their success and perseverance through this challenge. Provide students with feedback using the Bridging the Gap Rubric.	Reflection and Celebration

SCSD Grade 8

High Tech Manufacturing and Design

Unit 4: Formal Communication

CTE Content Focus: High Tech Manufacturing and Design

10 INSTRUCTIONAL DAYS

Unit Focus	Unit Text Set
This is the 4th unit in the High-Tech Manufacturing and Design course. This unit focuses on professional communication and career exploration in High Tech Manufacturing and Design. Students have previously done three projects (Trash-to-Treasure, Reverse Engineering or Rapid Prototyping, and Bridging the Gap). Students will individually choose one they would like to write their engineering report outline on and present to the class. **Finally, students will wrap up this course by researching one of the careers of interest within the high-tech manufacturing and design field and develop an infographic on that career to add to their career portfolio.**	Video: "Making an Outline" Presentation Videos • "Bad Presentation Masterclass" • "Bad Presentation" • "Be a More Confident Public Speaking" Article: Tips for PowerPoint Presentations

Unit Anchor Charts/Instructional Tools	
Design Journal Feedback Sessions Smithsonian's Read, Set Design Challenge Concept/Bubble Map or Storyboard Engineering Report Outline Handout Executive Summary Worksheet Engineering Report Outline Rubric Improve Games • 5 Improv Activities Your Middle Schools Were Made For • Improv Games for Middle School Presentation Rubric Presentation Comment Cards	

Guiding Questions & Big Ideas

How can I communicate my design story through writing and presenting?

Final Tasks

Students will write an engineering report outline, develop a career infographic and deliver a formal presentation on their favorite project.

Culturally and Historically Responsive Framework	Essential Learning Concepts
Identity: How will the unit help students to learn something about themselves and/or others? While this is mostly an independent unit, students will be put in feedback teams to give and receive feedback from their peers on their writing and presentation. Students will use improv games to start considering how to be more confident in front of an audience. **Skills: How will the unit build students' skills in the content area?** Students will use a project they most liked to learn how to write an engineering report outline and deliver a presentation. **Intellect: How will the unit build students' knowledge and mental powers?** This is mostly a summary unit of what they have worked on throughout this section of the course. **Criticality: How will the unit engage students' thinking about power and equity and the disruption of oppression?** N/A **Joy: How will the unit allow students to experience joy through their learning?** Design Challenges, Improve games, and celebration of hard work at the end	Students will be able to… • Write a detailed outline of an engineering report detailing my solution. • Write a summary of my project. • Give and receive feedback on writing. • Explore a career of interest related to high tech manufacturing and engineering. • Plan and deliver a formal presentation of a design solution.
SEL Benchmarks	**Integrated Standards**
	NY Digital Literacy Standards: • 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences. • 7-8.DL.2 Communicate and collaborate with others using a variety of digital tools to create and revise a collaborative product.

Unit 4: Formal Communication

Key Vocabulary		Oral Language	Writing
		Feedback sessions Improv Games Formal Presentation	Graphic Organizers Engineering Report Outline PowerPoint Presentation Design Journal

Teacher Preparation & Notes
This is an independent project in that each student will select a prior project to write an engineering report outline on and present to the class on what they learned from the project; however, you will want to assign students to feedback workshop groups. This is meant for students to have a core group to work alongside and get feedback from at different points of the project. This unit has three main products: engineering report, career infographic, and formal presentation. The engineering report and career infographic can be done in any order but will help students write their final presentations. The unit outline below asks students to include in their presentation a slide about the career they researched within high tech manufacturing and design. If you want to keep the presentation solely about their chosen project, then I suggest saving the career infographic section until after the presentation.

Day	Learning Targets & Standards	Texts & Tasks	Supports
1	Launch & Teaming	**Set-up** • Ask students to choose the project they most want to write and present their work to an outside audience. • Assign students to their feedback teams. They will work alongside other students to get feedback on their written and presentation work. • Ask students to pick a project they would like to write their engineering report on and do a formal presentation about. Teams can be students doing their presentations on the same project or mixed teams. **Group Connecting Activity** • Goal: This is meant to help the new feedback team connect with each other and introduce how to communicate designs to an outside audience. • This activity is based on the Smithsonian's Read, Set Design Challenge. (For reference, here is a video that explains the process)	Smithsonian's Read, Set Design Challenge

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		• Give each group a paper bag of found materials that include a fastener item, a surface item, and a structure item.
		  ○ Fastener items (pipe cleaners, rubber bands, paper clips, etc.)
		  ○ Surface items (coffee filters, cardboard squares, balloons, paper, etc.)
		  ○ Structure items (straws, popsicle sticks, tin foil, etc.)
		• Print and cut out the challenge cards and put a different one in each team's bag of materials. (Feel free to write your own fun prompt.)
		• Give each team a bag and tell them that their team's job is to find a solution to the challenge using only the materials in the bag. They will have 15 minutes to create their solution.
		• After 15 minutes, have each team share their challenge and design with the class.
		• Ask students to reflect and share:
		  ○ What did they learn about themselves as they were solving their challenge?
		  ○ In the team presentations, what did they hear or see that helped them to understand someone's design?	

2 – 3	I can write a detailed outline of an engineering report detailing my solution.	**Review Notes**
		• Allow students to choose which graphic organizer works best for them: Concept/Bubble Map or Storyboard. Each map has the six basic sections of an engineering report.
		  ○ Problem Description
		  ○ Background Research/Information (this may include the top brainstorm ideas they considered)
		  ○ Testing Plan
		  ○ Proposed Solution
		  ○ Results
		  ○ Conclusion & Next Steps
		• Give students time to review their design journal notes from their project and pull out important concepts, ideas, or information for each section.
		
		Outlining
		• Goal: Students will only write one paragraph for their Engineering Report Outline, the rest will be in outline format. This section is to help them
			Design Journal
			
			Concept/Bubble Map or Storyboard
			
			Video: "Making an Outline"

Day	Learning Targets & Standards	Texts & Tasks	Supports

		understand how to outline (if they have not already been exposed to outlining).
		• Ask students what they know about outlining. Use this to gauge whether or not you need to go in-depth with the whole class.
		• Show students the video, "Making an Outline" up to timestamp 2:50.
		• In their teams, have students pair off. In their pairs, students choose a topic that is familiar to them (such as the plot of their favorite book, how to play their favorite game, or their favorite sport).
		  ○ Students discuss and then determine the main ideas. Students write them in their design journal using Roman numerals I, II, III, IV, etc. leaving room for supporting details.
		  ○ Students share and discuss supporting details for each main idea and add them as A, B, C, etc. in their design journals.
		  ○ Students finally fill in examples or other details on their outline.
		• Invite student groups to share their outline with the class and pull out important features that show good outlining techniques.	

3 – 4	I can write a detailed outline of an engineering report detailing my solution.
	
	I can write a summary of my project.
		Writing Engineering Report Outline
		• Give students the engineering report outline handout.
		• Give students time to write the outline for their engineering report using MS Word. They can use their graphic organizers as starting points. The Main Sections are already given, they will need to add the details:
		  I. Problem Description
		  II. Background Research/Information (this may include the top brainstorming ideas they considered)
		  III. Testing Plan
		  IV. Proposed Solution
		  V. Results
		  VI. Conclusion & Next Steps
		• As students need it, show them basic MS Word Skills such as:
		  ○ Insert Pictures
		  ○ Adding captions to pictures
		  ○ Page Break – [CTRL] + [Enter]
		• As students finish, show them how to set up a title page in MS Word by inserting a cover page.
			Engineering Report Outline Handout
			
			Executive Summary Worksheet

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		Writing an Executive Summary (optional) • An executive summary is a paragraph that tells the reader in 4 – 5 sentences what information can be found in their outline. • After students finish their outline, have them write a summary of their design project. If needed, give them the Executive Summary Worksheet to brainstorm what they will write. It gives sentence prompts for what needs to go into their executive summary.	

5	I can give and receive feedback on writing.	**Feedback Sessions**
		• In their feedback teams, students switch outlines. In rounds, have students check their partner's outline for the items below. You may need to show students how to use the comment feature in Word to leave feedback.
		  ○ Outline conventions – Is there enough detail? Does it follow the correct outline convention?
		  ○ Visuals – Are there enough visuals to explain their product and show the results of their prototype testing? What might need to be added or deleted?
		  ○ Correct capitalization
		  ○ Correct punctuation
		  ○ Text speak spotter (optional) – are all words and phrases spelled out?
		  ○ Technical Vocabulary spotter (optional) – highlight technical words used – are there other ways to incorporate learned technical vocabulary?
		• Students return papers with notes and revise their outlines.
		• Students turn in their final outlines for feedback from the teacher. (Engineering Report Outline Rubric)
		
		Optional: Bibliography
		• Introduce the online tool, Scribbr (or similar). Using an article from one of the projects, demonstrate how to input information into Scribbr, then copy and paste the citation on the last page of their document. Repeat with a website.
		• Students use Scribbr to document their sources and paste into their Engineering Report Outline.
			Feedback Sessions
			
			Engineering Report Outline Rubric
			
			Scribbr

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5 - 6	I can explore a career of interest related to high tech manufacturing and engineering.	**High Tech Manufacturing and Engineering Career Exploration**
		• Students were exposed to possible careers in the High-Tech Manufacturing and Engineering pathways throughout this course. This is a chance for students to pick a career that they might be interested in learning more about.
		
		Career List (feel free to add others)
		• Civil Engineer
		• Mechanical Engineer
		• Chemical Engineer
		• Electrical Engineer
		• Transportation Engineer
		• Manufacturing Engineering
		• Industrial Engineer
		• Robotics Engineer
		• Welder
		• Fabricator
		• Electronics Technician
		• Machinist
		• Computer-Aided Design (CAD) technician
		• Mechatronics Engineering Technician
		• CNC Operator or Programmer
		
		Introduce what information students will need to include in their infographic:
		• Must-haves:
		  ○ Title with the name of career (or job)
		  ○ Brief description
		  ○ Salary information
		  ○ Education needed.
		  ○ Skills needed.
		  ○ Exciting visuals
		  ○ Summary of what makes this an exciting career choice.
		• Recommended-haves.
		  ○ Job growth - will there be jobs in this career in the future?
		  ○ Career pathway - how do I grow in this career?
			https://www.mynextmove.org/

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		Career Research • Have students visit https://www.mynextmove.org/ to get basic information about their chosen career. • Have students search for at least one example job entry for their chosen career using a job search engine such as Indeed.com or similar. Have them note the salary information, skills and education needed, and, what would a person do in this job. • If they need more information, guide them to research using Google. **Career Infographic** • Students can plan their infographic using the same Storyboard technique they used to plan their written product and design their game. • To plan their layout, students can cut out the individual sections of the storyboard organizer and arrange them on a blank sheet of paper or in their design journal to get a general idea of how they want their infographic to look. • If they need ideas, here is a resource with examples of career-related infographics. Have students use an online tool such as Canva or MS Publisher or MS Sway. To help kids become familiar with the program, you may want to plan for some "play and exploration time" with the software before diving into producing their infographic.	

7 - 10	I can plan and deliver a formal presentation of a design solution.	**Improve Games**
		• Goal: Students need a break from writing and research and start thinking about how to stand up in front of an audience with confidence. Improve games help students get outside their comfort zone in a fun, lighthearted way.
		• Choose a series of improv games and ask for volunteers or randomly ask students to participate. Have fun with this.
		  ○ 5 Improv Activities Your Middle Schools Were Made For
		  ○ Improv Games for Middle School
		• After several games, ask students to consider, "What might we learn from doing these improv games that will help us present our designs
			Improve Games
			• 5 Improv Activities Your Middle Schools Were Made For
			• Improv Games for Middle School
			
			Presentation Videos
			• "Bad Presentation Masterclass"
			• "Bad Presentation"

Day	Learning Targets & Standards	Texts & Tasks	Supports

		confidently in front of an audience?"
		
		How to Present with Confidence
		• Show students the video, "Bad Presentation Masterclass" or this video from students performing a "Bad Presentation".
		  ○ In their teams, ask them to list what made this presentation bad.
		  ○ Invite students to share with the class to produce a list of "Presentation Don'ts."
		• Ask students to discuss and brainstorm things that make a "Good" Presentation. Have students share and start a class "Presentation Dos" List.
		• Share them the video, "Be a More Confident Public Speaking", and write in their design journal:
		  ○ 3 – things that were the same as the class Presentation Do's and Don'ts list
		  ○ 2 – new things to add to the lists
		  ○ 1 – skill they want to focus on in their presentation (personal presentation goal)
		
		Presentation Planning
		• If students need it, have them read through and take notes in their design journal on Tips of PowerPoint Presentations.
		• Give students time to develop their PPT for a 3 – 5-minute presentation on their favorite design. This is not a PPT of their engineering report outline. The presentation should focus on
		  ○ The problem they solved.
		  ○ Their solution – what is good about it?
		  ○ What they learned in the project.
		  ○ One slide on the career they explored.
		
		Presentation Feedback Sessions – In their feedback teams, each student will run through their presentation.
		• Presentation – 5 minutes
		• Warm Feedback – 2 minutes
		• Improvement Feedback – 2 minutes
		• Rotate
			• "Be a More Confident Public Speaking"
			
			Article: Tips of PowerPoint Presentations
			
			Feedback Sessions
			
			Presentation Rubric
			
			Presentation Comment Cards

Day	Learning Targets & Standards	Texts & Tasks	Supports
		Presentation day • Depending on your class size and depending on how many outside audience members you will have, you may want to divide your class into 2 – 4 groups that will present concurrently. • Students present their favorite project. • Use this presentation rubric for more detailed feedback. • Use these presentation comment cards for students and outside audience members to give their feedback. **Celebrate –** Celebrate students' hard work and accomplishments.	