



Wayne, New Jersey

**Middle School Technology Department
7th Grade Tech Ed Curriculum Guide
August 2023
Revised**

Dr. Mark Toback, Superintendent
Mrs. Donna Reichman, Assistant Superintendent

This curriculum may be modified through varying techniques, strategies, and materials
as per an individual student's Individualized Educational Plan (IEP)

Approved by the Wayne Township Board of Education at the regular meeting held on

Wayne School District Curriculum Format

Content Area/ Grade Level/ Course:	Unit 1 Grade 7 STEM
Unit Plan Title:	The Design and Problem-Solving Process and Simple Machines Review
Time Frame	Seven Days

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

- 8.2.8.ED.1: Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
- 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.
- 8.2.8.ED.5: Explain the need for optimization in a design process.
- 8.2.8.ED.6: Analyze how trade-offs can impact the design of a product.
- 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).
- 8.2.8.ETW.1: Illustrate how a product is upcycled into a new product and analyze the short- and long-term benefits and costs.
- 8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital).
- 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact.
- 8.2.8.ETW.4: Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best.
- 8.2.8.EC.1: Explain ethical issues that may arise from the use of new technologies.
- 8.2.8.EC.2: Examine the effects of ethical and unethical practices in product design and development.

2022 New Jersey Student Learning Standards for Science

- **MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.**
- **MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**
 - **DCI:** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.
 - **PRACTICE:** Define a problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

- **CROSS-CUTTING CONCEPT:** All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment.
- **CROSS-CUTTING CONCEPT:** The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.
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- **MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**
 - **DCI:** The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.
 - **PRACTICE:** Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.

MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Interdisciplinary Standards: New Jersey Student Learning Standards For English Language Arts Companion Standards Grade 6-8

NJSLS.ELA-LITERACY.RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

NJSLS.ELA-LITERACY.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Unit Summary

Aimed at reviewing with students the engineering design process along with the six simple machines and involve the students in the process of creative problem solving. Utilizing various supplies students may build and focus on one or

more of the following topics/challenges: bridges, rubber band rover, prosthetic arm, candy grabber, and/or Rube Goldberg devices.

Essential Question(s)

- Why do we use the engineering design process to solve design challenges?
- How can the engineering design process benefit us in solving problems?
- How can engineering design be used to create solutions to a problem?
- How is it possible to find several valid solutions to a single problem?
- Why is it a good idea to keep testing a design?
- How does the design meet the criteria for success presented in the challenge?
- What constitutes evidence? When do you know you have enough evidence?
- Why is it necessary to justify and communicate an explanation?
- How can energy be transferred from one material to another? What happens to a material when energy is transferred to it?
- Where do you place the effort force and fulcrum in order to lift an object with the least amount of effort force?
- How are levers used to help complete work?
- What is the relationship between the effort force and the effort distance?
- How can a screw reduce the amount of work?
- How do simple machines transfer energy?

Enduring Understandings

- The Engineering Design Process is a method that is used to solve technological challenges to change and improve products for the way we live.
- The design process gives structure to creativity.
- The design loop allows engineers to find not “a” solution but the “best” solution to a problem.
- Changes take place because of the transfer of energy. Energy is transferred to matter through the action of forces. Different forces are responsible for the transfer of the different forms of energy.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. 21 st Century Themes		Check all that apply. 21 st Century Skills	
<input checked="" type="checkbox"/>	Global Awareness	<input checked="" type="checkbox"/>	Creativity and Innovation
<input checked="" type="checkbox"/>	Environmental Literacy	<input checked="" type="checkbox"/>	Critical Thinking and Problem Solving
<input type="checkbox"/>	Health Literacy	<input checked="" type="checkbox"/>	Communication
<input type="checkbox"/>	Civic Literacy	<input checked="" type="checkbox"/>	Collaboration
<input checked="" type="checkbox"/>	Financial, Economic, Business, and Entrepreneurial Literacy		

Student Learning Targets/Objectives (Students will know/Students will understand)

- That creativity is a process.
- The steps and function of each step of a design process.
- That engineering design is a multi-step process.
- Why revision and refinement are imperative to the design process.
- What a design loop is.
- That by utilizing the simple machines many jobs can be accomplished by one device.

Assessments (Pre, Formative, Summative, Other)

Denote required common assessments with an *

Quizzes/Tests – recall the processes involved in a design loop.

*Project Rubric

Self-assessment of performance task

*Teacher observation of student performance tasks for evidence of process and innovation.

Teaching and Learning Activities

<i>Activities</i>	<ul style="list-style-type: none">• Complete the design process review sheet and review solutions to the problems in teams.• Students in small groups will complete one or more of the topics/challenges.
<i>Differentiation Strategies</i>	<p>Strategy and flexible groups based on formative assessment or student choice</p> <p>One:One conferring with teacher</p> <p>Choice of narrative or persuasive text composition</p> <p>Differentiated checklists and rubrics (if appropriate)</p> <p>Student selected goals for writing</p> <p>Level of independence</p> <p>Craft additional leads and endings for mentor texts</p> <p>Consult mentor texts to support writing</p> <p>ELL Supports and Extension activities are included with each lesson</p> <p>Differentiation Strategies for Special Education Students</p> <p>Differentiation Strategies for Gifted and Talented Students</p> <p>Differentiation Strategies for ELL Students</p> <p>Differentiation Strategies for At Risk Students</p>

Resources

- Review lesson on the engineering and design process
<http://teachers.egfi-k12.org/lesson-engineering-design-process/>
- Worksheet for use in class
https://drive.google.com/file/d/1ULQrosa4ku3-xxm9ubwLSNYadOKwP_Dr/view?usp=sharing
- Simple machines website
http://science-class.net/archive/science-class/Physics/simple_machines.htm
- Prosthetic Arm
<https://static1.squarespace.com/static/55774404e4b07f2c7dc881a0/t/5eb9df1d5f22c75dffa15720/1589239584074/Prosthetic+Arm+Engineering+Challenge.pdf>
- Candy Grabber
https://docs.google.com/presentation/d/1rJOANzz_OUcYJmIQpJfnF_FR0MdThcFgWAZGH2-O40U/edit#slide=id.p
- Bridges
https://www.teachengineering.org/curricularunits/view/cub_brid_curricularunit
 - Rubberband Rovers
https://docs.google.com/presentation/d/1GinnHs77S9cltE6x5CqM4bhoS6wWjATGUxEdg_xlaJXw/edit?usp=sharing
 - <https://www.sciencebuddies.org/stem-activities/rubber-band-car>

Wayne School District Curriculum Format

Content Area/ Grade Level/ Course:	Unit 2 Grade 7 STEM
Unit Plan Title:	Circuitry - Smart Poles
Time Frame	3 weeks

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Unit Summary

Students are introduced to several key concepts of electronic circuits. They use the hands-on challenges to learn about some of the physics behind circuits, the key components in a circuit. Students will design and create devices and processes that use electricity and circuits. Students explore smart poles and their impact on the environment and

benefits to the community. Electrical engineers design the circuitry for the products we use every day. They also design computers and telecommunication devices, lighting and wiring for buildings, and operating electric power stations. Electrical engineers address energy conservation in our homes and businesses by developing better ways to design and implement circuits and electronic devices to efficiently use and ultimately save energy.

Essential Question(s)

- How can the flow of thermal energy be manipulated to perform useful tasks?
- Why is it important to understand heat transfer and storage?
- What advantages does solar energy provide over other types of energy?
- The Sun's corona has a temperature of millions of degrees. Why does it not incinerate us?
- Why do we use the engineering design process to solve design challenges?
- How can the engineering design process benefit us in solving problems?
- How can engineering design be used to create solutions to a problem?
- How is it possible to find several valid solutions to a single problem?
- Why is it a good idea to keep testing a design?
- How does the design meet the criteria for success presented in the challenge?
- Why is it necessary to justify and communicate an explanation?
- Why do streetlights provide safety to communities ?
- How do Smart Poles address climate change?
- How does energy consumption affect climate and communities nationwide?
- How does wind and solar generate energy?
- Why does a battery play an important role in generating electricity?
- What is the difference between an open vs closed circuit?

Enduring Understandings

- The movement of particles in matter affects the physical properties of substances and their heating.
 - Describe matter as being made of particles
 - Model the behavior of particles that make up matter to explain observable phenomena.
 - Explain, using particle motion, what happens during phase changes.
- Heating occurs through three methods: conduction, convection, and radiation.
 - Model heating through conduction, convection, and radiation as the motion of particles.
- Climate is regulated by complex interactions among components of the Earth system.
- Climate varies over space and time through both natural and man-made processes.
- Human activities are impacting the climate system.
- Electricity is a form of energy that can be transformed by moving electric charges doing work in various devices.

In this unit plan, the following 21st Century themes and skills are addressed.

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<input type="checkbox"/>	Civic Literacy	<input checked="" type="checkbox"/>	Collaboration

Student Learning Targets/Objectives (Students will know/Students will understand)

- Identify and describe how particles that make up matter move.
- Differentiate between heating and temperature.
- Identify the differences between conduction, convection and radiation
- Identify and describe series circuits.
- Construct basic series circuits.
- Understanding tools that benefit humans and have a minimal impact on the Earth and climate.

Assessments (Pre, Formative, Summative, Other)

*Denote required common assessments with an **

Self-assessment of performance task

*Teacher observation of student performance tasks for evidence of process and innovation.

*Rubric for creation and use of design

Quiz on conduction, convection and radiation

Video of stages (can be pictures along the way added into video format at the end) of the assigned project including design loop, use of circuitry, redesign discussion and final product.

Teaching and Learning Activities

Activities

- Review and discussion of radiation, conduction and convection
- Snap Circuits
- Paper circuits
- Smart Pole exploration
- Solar panel vehicle
- Makey Makey
- Paper Tower challenge

Differentiation Strategies

Begin with offering little to no advice and have students discuss different options so that they develop their own designs. Do not restrict their choice of materials or even offer examples of different devices. Have these students independently test their designs by designing their own experiments and ask them to justify their design choices either through a presentation or paper. Students could even modify their designs to determine the importance of individual aspects, such as the color of the box or how different insulators affect the temperature.

For students who need more help, interact with them through every stage of the planning and building process. Suggest the materials to use or restrict them so they do not have to make as many choices. Offer a variety of examples or simply instruct all the students to construct their ovens based on a provided design and instructions.

Strategy and flexible groups based on formative assessment or student choice

One:One conferring with teacher

Choice of narrative or persuasive text composition

Differentiated checklists and rubrics (if appropriate)

Student selected goals for writing

Level of independence

Craft additional leads and endings for mentor texts

Consult mentor texts to support writing

ELL Supports and Extension activities are included with each lesson

[Differentiation Strategies for Special Education Students](#)

[Differentiation Strategies for Gifted and Talented Students](#)

Resources

- Background reading on Solar heat
https://web.kamihq.com/web/viewer.html?source=extension_pdfhandler&file=http%3A%2F%2Fwww.re-energy.ca%2Fdocs%2Fsolar-heat-bg.pdf
- Saved by the sun - http://www.pbs.org/wgbh/nova/education/activities/3406_solar.html
- Energy from the Sun ideas
https://web.kamihq.com/web/viewer.html?source=extension_pdfhandler&file=http%3A%2F%2Fwww.need.org%2Ffiles%2Fcurriculum%2Fguides%2Fenergyfromthesunteacherguide.pdf
- Snap Circuits <https://stem.northeastern.edu/programs/ayp/fieldtrips/activities/snapcircuits/>
https://www.ripenfoundation.org/sites/default/files/ProgramDocs/STEM-Kits/SnapCircuits_Lessons.pdf
- Paper circuits <https://www.makerspaces.com/paper-circuits/>
- Smart Pole exploration <https://ariswind.sharefile.com/share/view/sd6f9d46aae98470f9cec5c46ec5610e6/fo64dad3-7c5b-48bf-9737-9731f531e482>
- Solar panel vehicle
https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p043/energy-power/how-to-build-solar-powered-car
- Makey Makey <https://makeymakey.com/pages/how-to>
- Paper Tower challenge https://www.teachengineering.org/activities/view/duk_tower_tech_act

Wayne School District Curriculum Format

Content Area/ Grade Level/ Course:	Unit 3 Grade 7 6404-Tech Education
Unit Plan Title:	Disaster Proof Housing
Time Frame	4 weeks

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Unit Summary

Natural disasters affect millions of people all over the world each year. In 2012, for example, extreme weather drove 32 million people from their homes. The biggest causes are floods and windstorms, accounting for 92.1 percent of homelessness, according to the World Bank, with earthquakes displacing just 4.4 percent. Nearly all of those made

homeless (97.7 percent) are from developing countries. People who live in the poorest countries are 10 to 1,000 times more likely to die in a natural disaster than people from countries in the top 20 percent. In other words a flood in the United States is not the same as a flood in rural India. Developing countries often fall into the “recovery trap.” They spend so much of their resources rebuilding after the last disaster that they are not ready for the next one. But city dwellers also are vulnerable: The number could be affected just by earthquakes and cyclones is expected to hit 1.5 billion by 2050. That’s where engineers come in. They design emergency shelters such as tents with cement-like sturdiness, figure out how to rescue survivors and transport supplies, and rebuild destroyed homes and infrastructure. In this activity, small groups of students explore the housing crisis caused by natural disasters. By applying appropriate technology and fluid mechanics groups will be able to design sustainable shelters that can withstand flooding, high winds, hurricanes, earthquakes, fires, landslides, tsunamis, extreme temperatures, tornadoes and/or volcanic eruptions .

Essential Question(s)

- What are the criteria and constraints of a successful solution?
- What is the process for developing potential design solutions?
- How can various design solutions be compared and improved?
- How are engineering, technology, science and society interconnected?
- What are the relationships among science, engineering, and technology?
- How do science, engineering, and the technologies that result from them affect the ways in which people live? How do they affect the natural world?
- How can I represent a large object accurately on paper or in a small model?
- How can I make larger representations of small objects?

Enduring Understandings

- How are buildings designed to withstand all kinds of natural disasters?
- What can we do to keep safe during a natural disaster?
- There are many global and local factors that both cause and affect our local weather. At times these factors are possible to predict.
- Natural and human actions have an impact on the sustainability of life.
- Explain how natural disasters occur

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. 21 st Century Themes		Check all that apply. 21 st Century Skills	
<input checked="" type="checkbox"/>	Global Awareness	<input checked="" type="checkbox"/>	Creativity and Innovation
<input checked="" type="checkbox"/>	Environmental Literacy	<input checked="" type="checkbox"/>	Critical Thinking and Problem Solving
<input checked="" type="checkbox"/>	Health Literacy	<input checked="" type="checkbox"/>	Communication
<input type="checkbox"/>	Civic Literacy	<input checked="" type="checkbox"/>	Collaboration
<input checked="" type="checkbox"/>	Financial, Economic, Business, and Entrepreneurial Literacy		

Student Learning Targets/Objectives (Students will know/Students will understand)

- Follow the engineering design process to develop solutions to address an urgent human need
- Understand the housing crisis caused by natural disasters, specifically flooding and high winds
- Apply principles of appropriate technology and fluid mechanics to design sustainable, disaster-proof housing

Assessments (Pre, Formative, Summative, Other)***Denote required common assessments with an ****

Self-assessment of performance task

Teacher observation of student performance tasks for evidence of process and innovation.

Video recording of the design/build/test process and wrap up the presentation with a “sales pitch” selling their structure to local authorities or international development groups.

Engineering Notebook

*Product documentation – The actual scale model, before and after testing.

Teaching and Learning Activities*Activities*

- Introduce the level and impact of climate disasters worldwide. Project focus is on flood- and wind-proof housing. Statistics from the World Bank, United Nations agencies and the International Red Cross are continually updated and can make a significant impact. Case study briefs can also be assigned as reading.
- (Optional) Have student groups do a Quick Build with simple materials. Quick Build goals can be a house that floats, withstands a heavy load, torrential downpours, wind or other factors related to natural disasters.
- Once the range of the problem is made clear, use videos to showcase solutions.
- Allow students time to research an area of world/natural disaster that they would like to design for. Students should identify relevant constraints and criteria. A Design Brief form is helpful at this point. Cost for actual structures (\$100-\$2,000), percentage of local material and labor, lifespan (2-5 years minimum), and number of inhabitants can be constraints. Criteria should be developed by students and should form part of the assessment for the project.
- Students need to understand static issues of buoyancy and dynamic issues of both air and water flow.
- Introducing Archimedes Principle and relevance of volume and weight in design. Concepts of dead load and live load. Test quick build prototype to see how much a small piece of foil can hold when surface area to volume is maximized.
- Introduce Bernoulli's Principle in terms of wind creating high velocity region of low pressure. Simple experiments with a piece of paper can convince students that the walls and roof can blow outward due to lateral wind flow.
- Forces and issues of loading in tension and compression should also be discussed. The impact of wind blowing perpendicular to the surface and weight of water are significant issues that need to be considered when testing. Comparisons of different types of building materials can be made.
- It is important that students focus on the use of local materials and technology. What works in the United States may not be a sustainable or culturally acceptable design somewhere else. Values such as empathy, cultural awareness, basic human dignity and a sense of home are critical for a successful project. Students could be asked to fully research available local materials and complete a “Bill of Materials.” with a cost limit between \$1,000 and \$2,000.
- Scale models need to be tested to meet appropriately scaled criteria. The idea of design of experiment (DOE) to verify claims is a significant one in new technologies. A simple form for recording testing rationale and data should be created indicating testing parameters, results, and observations. It is suggested that one test be a scale model load test, specified by the instructor, and that two additional tests be developed to test for compliance with criteria and constraints. This can include buoyancy, wind resistance, and flood resistance, along with students generated concerns such as portability, quick assembly, etc. These two additional tests should be student generated and instructor approved.

	<ul style="list-style-type: none"> ● Opportunities to modify should be given, and are very valuable in terms of the engineering design process. All modifications should be isolated (done one at a time) as much as feasible and a rationale for the modification should be required. ● Students should present their results in a video recording of the design/build/test process and wrap up the presentation with a “sales pitch” selling their structure to local authorities or international development groups. It is strongly suggested that groups keep all forms and notes in an Engineering Notebook (binder) in order to have thorough documentation of the process they followed. The Engineering Notebook should be part of the grade.
<i>Differentiation Strategies</i>	<p>Strategy and flexible groups based on formative assessment or student choice</p> <p>One:One conferring with teacher</p> <p>Choice of narrative or persuasive text composition</p> <p>Differentiated checklists and rubrics (if appropriate)</p> <p>Student selected goals for writing</p> <p>Level of independence</p> <p>Craft additional leads and endings for mentor texts</p> <p>Consult mentor texts to support writing</p> <p>ELL Supports and Extension activities are included with each lesson</p> <p>Differentiation Strategies for Special Education Students</p> <p>Differentiation Strategies for Gifted and Talented Students</p> <p>Differentiation Strategies for ELL Students</p> <p>Differentiation Strategies for At Risk Students</p>
Resources	
	<ul style="list-style-type: none"> ● Disaster proof housing http://teachers.egfi-k12.org/disaster-proof-housing/ ● Disaster engineering Activity page http://teachers.egfi-k12.org/disaster-engineering/ ● Building for hurricanes- Engineer design challenge https://pmm.nasa.gov/education/interactive/building-hurricanes-engineering-design-challenge ● Building for Hurricanes http://teachers.egfi-k12.org/building-for-hurricanes/ ● The fourth little pig - hurricane proof lesson https://alex.state.al.us/lesson_view.php?id=34276 ● Developing hurricane awareness https://www.nationalservice.gov/resources/disaster-services/developing-hurricane-awareness-science-exercise-students ● Project Hurricane defender (\$13) https://lessons.keslerscience.com/courses/stem-challenge-project-hurricane-defender-build-a-hurricane-proof-house ● Hurricanes https://www.teachengineering.org/lessons/view/cub_weather_lesson05 ● Earthquake engineering https://gystc.org/earthquake-engineering-stem-challenge/ ● Flooding https://www.stem.org.uk/elibrary/resource/34167

Wayne School District Curriculum Format

Content Area/ Grade Level/ Course:	Unit 4 Grade 7 STEM
Unit Plan Title:	Quick builds
Time Frame	Two weeks
2020 New Jersey Student Learning Standards – Computer Science and Design Thinking	
<ul style="list-style-type: none"> 8.2.8.ED.1: Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer. 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem. 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch). 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team. 8.2.8.ED.5: Explain the need for optimization in a design process. 8.2.8.ED.6: Analyze how trade-offs can impact the design of a product. 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches). 8.2.8.ETW.1: Illustrate how a product is upcycled into a new product and analyze the short- and long-term benefits and costs. 8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital). 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact. 8.2.8.ETW.4: Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best. 8.2.8.EC.1: Explain ethical issues that may arise from the use of new technologies. 8.2.8.EC.2: Examine the effects of ethical and unethical practices in product design and development. 	
2022 New Jersey Student Learning Standards for Science	
<ul style="list-style-type: none"> MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. <ul style="list-style-type: none"> <i>DCI: The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.</i> <i>PRACTICE: Define a problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.</i> <i>CROSS-CUTTING CONCEPT: All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment.</i> 	

- **CROSS-CUTTING CONCEPT:** *The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.*
- **MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**
 - **DCI:** *There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.*
 - **PRACTICE:** *Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.*
- **MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**
 - **DCI:** *Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process--that is, some of those characteristics may be incorporated into the new design.*
 - **PRACTICE:** *Analyze and interpret data to determine similarities and differences in findings.*
- **MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**
 - **DCI:** *The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.*
 - **PRACTICE:** *Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.*

MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Interdisciplinary Standards: New Jersey Student Learning Standards For English Language Arts Companion Standards Grade 6-8

NJSLS.ELA-LITERACY.RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

NJSLS.ELA-LITERACY.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Unit Summary

Students will be given the opportunity to work individually and as a team on various quick challenges. Most of these quick builds will be a one day exploration of a topic. These quick builds will be spread throughout the marking period for students to explore various strategies with solving problems on a small scale. Students may not go all the way through the engineering design process, instead they will be given a challenge and quickly "draft" a design to build. Working together, problem-solving, and planning to come up with solutions encourages interaction and cooperation with peers.

Essential Question(s)

- Why do we use parts of the engineering design process to solve quick build design challenges?
- How can parts of the engineering design process benefit us in solving problems in our daily lives?
- How can parts of the engineering design be used to create solutions to a problem?
- How is it possible to find several valid solutions to a single problem?
- Why is it a good idea to keep testing a design?
- What specific goal are you trying to achieve, and how will you know if you've been successful?
- How does the design meet the criteria for success presented in the challenge?
- How are science and engineering skills used to solve design problems?

Enduring Understandings

- The Engineering Design Process is a method that is used to solve technological challenges to change and improve products for the way we live.
- The design process gives structure to creativity.
- The design loop allows engineers to find not "a" solution but the "best" solution to a problem.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. 21 st Century Themes			Check all that apply. 21 st Century Skills		
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<input checked="" type="checkbox"/>		Financial, Economic, Business, and Entrepreneurial Literacy			

Student Learning Targets/Objectives (Students will know/Students will understand)

- Design and Build a tower following specific criteria
- Modify the tower using the engineering design process
- Design and Build a wooden plank track that turns around 180 degrees and returns the ball back to you.
- Design and Build a super launcher using various building materials
- Design and Build architecturally inspired cardboard furniture
- Design and build the strongest chair possible to support a given object
- Students that even a small pressure inside a large container can exert enormous forces on the walls of that container
- Students learn how a battery works in a simple circuit and how chemical energy changes to electrical energy
- Design, build and modify a paper helicopter
- Design and build a toy car powered by wind
- Design and build paper rocket powered by a straw
- Design and Test a digital battery through Xplolabs to solve problems

Assessments (Pre, Formative, Summative, Other)

*Denote required common assessments with an **

Quizzes/Tests – Vocabulary

*Self-assessment of performance task

*Teacher observation of student performance tasks for evidence of process and innovation.

*Group presentation content should demonstrate: a representative abstract description, an adequate graphic representation, descriptive introduction that describes (at minimum) the following: What type of product the invention relates to, how it combines two or more objects, a brief description of when, where, or how this invention would be used, an answer to the question that describes how the new invention creates an improvement for the target audience.

Teaching and Learning Activities

<i>Activities</i>	<ul style="list-style-type: none"> • KEVA planks • STEM Improv • 3D snowflake build • Turkey Origami flier • Super slinger • Paper rockets • Hydraulic elevator • Electric current from potatoes • Paper chair • Paper helicopter • Out of the box • Lithium battery
<i>Differentiation Strategies</i>	<p>Strategy and flexible groups based on formative assessment or student choice</p> <p>One:One conferring with teacher</p> <p>Choice of narrative or persuasive text composition</p> <p>Differentiated checklists and rubrics (if appropriate)</p> <p>Student selected goals for writing</p> <p>Level of independence</p> <p>Craft additional leads and endings for mentor texts</p> <p>Consult mentor texts to support writing</p> <p>ELL Supports and Extension activities are included with each lesson</p> <p>Differentiation Strategies for Special Education Students</p> <p>Differentiation Strategies for Gifted and Talented Students</p> <p>Differentiation Strategies for ELL Students</p> <p>Differentiation Strategies for At Risk Students</p>

Resources

- STEM improv: <https://youtu.be/c6-6oI4CccM>
- Paper Rockets <https://www.sciencebuddies.org/stem-activities/paper-rocket>
- 3D snowflake build <https://www.wikihow.com/Make-a-3D-Paper-Snowflake>
- Super Slinger: https://www.teachengineering.org/activities/view/wpi_empathy_activity1
- Turkey Origami flier <https://www.youtube.com/watch?v=TYkV5D7pJvE>
- Wind Powered Car <https://www.sciencebuddies.org/stem-activities/wind-powered-car>
- Out of The Box: <https://www.teachengineering.org/makerchallenges/view/uod-2101-out-of-box-cardboard-furniture-design-challenge>
- Hydraulic elevator <https://www.teachingexpertise.com/classroom-ideas/seventh-grade-stem-challenges/>
- Electric current from potatoes <https://www.teachingexpertise.com/classroom-ideas/seventh-grade-stem-challenges/>
- Paper helicopter <https://www.jpl.nasa.gov/edu/learn/project/make-a-paper-mars-helicopter/>
- Paper chair <https://www.nmmesa.org/wp-content/uploads/2020/04/MESA-Lesson-Packet-2.pdf>
- Xplorlabs: https://ulxplorlabs.org/battery-supply-chain/site/assets/uploads/2020/04/CS12208_Xplorlabs_Student-Guide_FI_NAL.pdf

