West Windsor-Plainsboro Regional School District

Unit 1: Intro to Design and Engineering and the Design Loop	
Content Area:Technology Education	
Course & Grade Level: D&E 7th Grade	
Summary and Rationale	
Students will be introduced to the concepts of design and engineering while setting the tone for the school year and becoming accustomed to classroom expectations and interactions. The design and engineering loop is an organizational agent when it comes to solving problems through building, engineering and prototyping. Students will use this loop - "Ask, Research, Imagine, Plan, Create, Test, Improve" - to guide them through their design process with the mindset of finding a problem and brainstorming multiple solutions to find and create the best possible outcome.	
Recommended Pacing	
5 days	
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
Standard: Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.8.CT.2	Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1)
New Jersey Student Learning Standards for Computer Science and Design Thinking	
Standard: 8.2 Standards for Design Thinking by the End of 7th Grade	
CPI #	**Cumulative Progress Indicator (CPI)**
8.2.8.ED.2	Identify the steps in the design process that could be used to solve a problem.
8.2.8.ED.5:	Explain the need for optimization in a design process.
ISTE (International Society for Technology in Education) Student Standards	
CPI #	**Cumulative Progress Indicator (CPI)**
ISTE 1.3.d	Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE 1.4.d	Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-minded problems.
Instructional Focus	
Unit Enduring Understandings	
● Engineering design is a systematic, creative, and iterative process. ● The process includes generating ideas, choosing the best solution, and making, testing, and redesigning models or prototypes. ● Engineering design requirements and specifications involve making trade-offs between competing requirements and desired design features.	
Unit Essential Questions	
● Why do we use the engineering design process to solve design challenges? ● How can the engineering design process benefit us in solving problems in our daily lives? ● What is the role of testing, criticism and feedback in the engineering design process?	
Objectives	
● Students will understand the progression of the course through basic introduction to the content and class procedures and expectations in order to prepare for the school year.	

- Students will implement the design process that they learned in theory and apply it to their own process in practice by outlining the necessary steps within the design loop and following those steps to organize and complete projects efficiently and successfully.
- Students will recognize the variety of solutions when solving real-world problems by brainstorming multiple outcomes and finding the best possible solution to the problem they are trying to solve..

Students will know:

- That engineering design is a multi-step process
- Why revision and refinement are imperative to the design process
- There are multiple solutions to most problems, each with their own trade-offs.

Students will be able to:

- Understand and implement classroom and school rules, procedures,and expectations
- Identify, create and utilize a design loop to solve a problem
- Test and evaluate possible solutions
- Identify strengths and weaknesses of design elements

Evidence of Learning

Assessment

Unit 1 project

Resources

Design and engineering design loop graphic

Unit 2: Safety and Measurement	
Content Area: Technology Education	
Course & Grade Level: 7th Grade Design and Engineering	
Summary and Rationale	
Machine and tool usage is essential within the Design and Engineering classroom and will give students hands-on skills that they otherwise may not be exposed to. Students will learn how to safely operate the drill press, band saw, scroll saw and sanders so that those tools and machines will be available to the students for all future projects. In the lesson, students will also review ruler usage, measurements and the importance of material optimization through careful planning. First, students will learn about general lab procedures and safety such as attire, behavior and clean up. Then, students will be introduced to each machine through a teacher demonstration; after each individual demonstration there will be a short quiz review and test on each machine's safety and operation. Students will then have to physically apply that knowledge in a small project that will encompass all the new machines they have learned about.	
Recommended Pacing	
9 days	
New Jersey Student Learning Standards for Computer Science and Design Thinking	
Standard: 8.2 Standards for Design Thinking by the End of 7th Grade	
CPI #	**Cumulative Progress Indicator (CPI)**
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.
ISTE (International Society for Technology in Education) Student Standards	
CPI #	**Cumulative Progress Indicator (CPI)**
ISTE 1.4.a	Students know and use a deliberate design process for generating ideas, testing, theories, creating innovative artifacts or solving authentic problems.
1.6.a	Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
Standard: Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
Instructional Focus	
Unit Enduring Understandings	
● Following proper safety procedures and rules will minimize potential hazards ● Measuring material for optimization and accuracy	
Unit Essential Questions	
● How is safety both personal and societal/classroom responsibility? ● How does behavior and awareness affect safety? ● What can be done to prevent injury or harm to classmates and classroom resources?	
Objectives ● Students will measure materials and models by using rulers and tape measures to accurately mark and plan out their material and builds. ● Students will safely operate tools and machinery by following lab rules and procedures in order to create a safe and responsible classroom environment.	
Students will know:	

- Appropriate classroom/shop attire, procedures and protocols
- Accuracy in measurement is critical to the outcome of projects and designs
- to identify signs of machine malfunctions

Students will be able to:

- Safely and appropriately use powered and manual tools.
- Select the appropriate tool for the desired outcome
- Measure accurately
- demonstrate appropriate shop behavior

Evidence of Learning
Assessment: Students must achieve a 100% on all safety quizzes.
Student Demonstration
Resources
Core Text:

Unit 3: Tower Building and Force Tests	
Content Area: Technology Education	
Course & Grade Level: 7th Grade Design and Engineering	
Summary and Rationale	
Forces are acting all around us, even though they may not be apparent or visible. In this unit, students will learn about the forces that might affect different pieces of architecture and about how preventative engineering can be applied in order to reduce the damage done on those structures if disaster should strike. First students will learn about trusses and how they work to prevent external forces from causing structural collapse. Students will then work in small groups to build two small, balsa wood towers with different structures and will test those towers with weights to see how much those towers can hold. Then, students will assess the reasoning as to why those towers collapsed and what structures within the design prevented immediate collapses.	
Recommended Pacing	
6 days	
New Jersey Student Learning Standards for Computer Science and Design Thinking	
Standard: 8.2 Standards for Design Thinking by the End of 7th Grade	
CPI #	**Cumulative Progress Indicator (CPI)**
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
ISTE (International Society for Technology in Education) Student Standards	
CPI #	**Cumulative Progress Indicator (CPI)**
1.4.c	Students develop, test and refine prototypes as part of a cyclical design process
1.3.d	Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
Standard: Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.8.CT.2	Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option
Instructional Focus	
Unit Enduring Understandings	
● natural, compression, tension and torsion are forces that act within a truss tower. ● trusses are a formation of “beams” that create a more secure framework within a structure	
Unit Essential Questions	
● What forces act upon a tower? ● How can a tower be engineered to hold more weight and withstand more force? ● Why are trusses more stable?	
Objectives ● Students will understand the concept of internal and external forces by building truss structures/towers in order to test truss strengths and to visually represent the forces within the design.	

- Students will build with the design loop in mind by utilizing what they have learned about trusses in order to identify the problem, brainstorm and plan the solution, build weight sustaining structures, then analyze their results in order to improve their designs.

Students will know:

- How trusses can improve a structure's integrity
- The difference between internal and external forces and identify them within a structure

Students will be able to:

- build truss towers with a stronger than expected structure
- use classroom resources responsibly and carefully
- build collaboratively within a group to reach an end goal

Evidence of Learning

Assessment: 2 Balsa wood Towers

Planning packet

Resources

Balsa wood
hand tools
hot glue gun

Unit 4: Simple Machines	
Content Area: Technology Education	
Course & Grade Level: 7th Grade Design and Engineering	
Summary and Rationale	
Simple machines are found in most modern technology and mechanical products. In order to better understand simple machines and their functions, students will be responsible for building a track for a marble that is composed of simple machines which interact with one another through one continuous flow of movement. The teacher will introduce simple machines one by one, discussing how forces interact with them and their main functions. By applying what they have learned about the design and engineering loop, students will then work collaboratively in groups to brainstorm, research, plan and build an autonomous marble maze; the main constraints are that a single drop of a marble is the "activator" for the track and that the next and only user interaction with the build is not until a marble lands in a marked, stationary end point. The class time allotted for this project will be treated mainly as open lab periods where students will be working in teams.	
Recommended Pacing	
12 days	
New Jersey Student Learning Standards for Computer Science and Design Thinking	
Standard: 8.2 Standards for Design Thinking by the End of 7th Grade	
CPI #	**Cumulative Progress Indicator (CPI)**
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.NT.3:	Examine a system, consider how each part relates to other parts, and redesign it for another purpose.
ISTE (International Society for Technology in Education) Student Standards	
CPI #	**Cumulative Progress Indicator (CPI)**
1.5.d	Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
Standard: Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.8.TL.2	Gather data and digitally represent information to communicate a real-world problem
Instructional Focus	
Unit Enduring Understandings	
• Simple machines are essential to daily human life • Simple machines can be used for different functions and can be applied to one another to create complex machines	
Unit Essential Questions	
• What are simple machines and their functions? • How do simple machines benefit daily human life? • How can simple machines interact in order to create one continuous reaction?	
Objectives	

- Students will use simple machines by incorporating them into a continuous marble track in order to understand their functions and qualities
- Students will collaborate by planning, brainstorming and building in a group setting to come up with one cohesive project.

Students will know:

- how to plan and brainstorm for a physical design before the building begins
- how to identify and apply simple machines

Students will be able to:

- brainstorm, plan, and build a marble maze made of simple machines
- work cohesively in a group environment

Evidence of Learning

Assessment: final build

Sketch plan

Resources

Recycled material
classroom supplies

Unit 5: Ergonomics and Prototyping	
Content Area: Technology Education	
Course & Grade Level: 7th Grade Design and Engineering	
Summary and Rationale	
The goal of this unit is to open the students' minds to designing from the perspective of the user. In one of the previous units, students began to understand the importance of brainstorming as many solutions as possible in order to reach the best option for solving a problem. In this unit, students will incorporate a new framework called ergonomic engineering, or human-factor engineering, and will plan their projects with the user's functional and aesthetic needs at the forefront of the design process. Ergonomics is defined as "the study of people's efficiency in their working environment"; the students will be exploring the application of ergonomics to engineering - designing for the sake of aiding human physical and psychological needs and preferences. Students will create prototypes of designs that aid human physical, day-to-day needs. When prototyping, the goal is not to build a " perfect" project with no more necessary changes or revisions, but to build one that looks similar to the final product, with maybe a few functions left out such as electronics or full mechanical function. Some features may not be attainable due to lack of knowledge or resources, especially at a beginner level of understanding. Students will use SketchUp for their planning stages and then build prototypes out of recycled material.	
Recommended Pacing	
15 days	
New Jersey Student Learning Standards for Computer Science and Design Thinking	
Standard: 8.2 Standards for Design Thinking by the End of 7th Grade	
CPI #	**Cumulative Progress Indicator (CPI)**
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.3	Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
ISTE (International Society for Technology in Education) Student Standards	
CPI #	**Cumulative Progress Indicator (CPI)**
1.6.d	Students publish or present content that customizes the message and medium for their intended audiences.
1.7.b	Students use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
Standard: Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.8.TL.2	Gather data and digitally represent information to communicate a real-world problem
Instructional Focus	
Unit Enduring Understandings	
● Ergonomic engineering is designing and creating for the user needs and preferences. ● Some items and physical designs may not suit all humans	

Unit Essential Questions

- What is ergonomic engineering?
- How is engineering affected by human factors and needs?
- How can a design make a task more effective?
- Why is it important to see the user's perspective when solving a problem through design?

Objectives

- Students will apply ergonomic engineering to their design process by keeping user preference/needs in mind in order to design an item that makes a task more efficient.
- Students will acquire new planning skills and methods by designing for an original build and planning the physical build in a virtual 3D setting in order to prepare for physical prototyping.

Students will know:

- how to apply ergonomic engineering to a design plan
- how to utilize SketchUp as a planning tool
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Students will be able to:

- build an item that aids a daily task through the lense of ergonomic engineering
- identify reasoning for technology in the real-world that has been designed for a specific human need

Evidence of Learning

Assessment: Physical Prototype

SketchUp prototype

Resources

SketchUp
Design lab

Unit 6: 3D Design for Wellness	
Content Area: Technology Education	
Course & Grade Level: 7th Grade Design and Engineering	
Summary and Rationale	
Mental and physical wellness have become such prominent and important topics in our day-to-day lives. In this unit, students will take what makes them happy and well and apply it to a 3D diorama by creating their "Happy Place". A classroom discussion will initiate the lesson about how colors, shapes, items and different activities can help a person's wellness. Then students will brainstorm and design a single-room space where their wellness can thrive and expand. Then students will create this happy place as a physical diorama using classroom tools and materials. Students will be taking what they have learned in SketchUp and applying it on a slightly larger scale while incorporating their own interests and comforts in the design, encompassing the design loop, ergonomic engineering and creative interior design.	
Recommended Pacing	
20 days	
New Jersey Student Learning Standards for Computer Science and Design Thinking	
Standard: 8.2 Standards for Design Thinking by the End of 7th Grade	
CPI #	**Cumulative Progress Indicator (CPI)**
8.2.8.ITH.1	Explain how the development and use of technology influences economic, political, social, and cultural issues.
ISTE (International Society for Technology in Education) Student Standards	
CPI #	**Cumulative Progress Indicator (CPI)**
1.6.c	Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
Standard: Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.5.CT.4:	Apply critical thinking and problem-solving strategies to different types of problems such as personal, academic, community and global (
Instructional Focus	
Unit Enduring Understandings	
● Wellness is experienced differently depending on the person. ● Wellness can be found in a variety of mediums and environments ● Wellness can be communicated and achieved through different medium and can be a goal within a design	
Unit Essential Questions	
● What is mental/physical wellness? ● How can something be engineered for wellness? ● How can wellness be incorporated into a designed space?	

- Why is it important to see the user's perspective when solving a problem through design?

Objectives

- Students will recognize their own methods for wellness by creating their own virtual safe space in order to cater the design for their own well being.
- Students will discover the possibilities of interior design by conceptually designing a designated, 3D virtual space for wellness in order to explore the necessities of a wellness space.

Students will know:

- how to apply ergonomic engineering to a design plan
- wellness methods that aid their happiness
- the necessities of interior design

Students will be able to:

- design a 3D virtual space with furniture, decorations, and items that promote personal wellness
- identify aspects of a room that can aid or hinder mental well being
- recognize what wellness methods are most useful to them

Evidence of Learning

Assessment: Physical Prototype

SketchUp 3D space

Resources

SketchUp
planyourroom.com

Unit 7: Game Design	
Content Area: Technology Education	
Course & Grade Level: 7th Grade Design and Engineering	
Summary and Rationale	
Students will end the year by working in groups to create a table top game. Using all the tools, resources and material the class has to offer, students will combine all they have learned over the course of the year to produce an interactive, mechanical game. Mechanical does not mean there needs to be anything electronic within the design, it only entails moving parts as the interface to the project. Students will work collaboratively and will be aided in creating their own schedule for completion, planning their materials and prototyping their designs. Functionality and aesthetics will all be taken into account for this project, meaning that the project should not only look attractive, but should also stay functional through multiple uses. Students will then showcase their designs during "Game Day" and will interact and play with the other projects in the class.	
Recommended Pacing	
20 days	
New Jersey Student Learning Standards for Computer Science and Design Thinking	
Standard: 8.2 Standards for Design Thinking by the End of 7th Grade	
CPI #	**Cumulative Progress Indicator (CPI)**
8.2.8.NT.3	Examine a system, consider how each part relates to other parts, and redesign it for another purpose
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.
ISTE (International Society for Technology in Education) Student Standards	
CPI #	**Cumulative Progress Indicator (CPI)**
ISTE 1.1.b	Students build networks and customize their learning environments in ways that support the learning process
1.4.d	Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
1.7.c	Students contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
Standard: Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.8.CI.2	Repurpose an existing resource in an innovative way
Instructional Focus	
Unit Enduring Understandings	
● Simple machines are found in most machines we use today, even games ● Games in the modern world have developed into highly computer based entities, but began mainly as simple/complex machines with physical interactive components ● Creating a schedule with periodic goals before beginning a project is a beneficial system to incorporate when designing or engineering	

Unit Essential Questions

- How can simple machines be used to create an interactive/competitive activity?
- How can one design a product for sustainable/long-term use?
- What is human interface and how does it apply to the design?

Objectives

- Students will demonstrate academic responsibility by creating their own goals and schedules in order to take accountability for their work.
- Students will design with creativity and functionality in mind by taking on artistic and engineering roles within a group in order to build a fun, interactive game for their peers to play.

Students will know:

- How to plan ahead for large projects
- the history of games and how they have developed
- plan a structure using sketching, 3D prototyping and physical prototyping.

Students will be able to:

- create interactive games by combining simple concepts
- construct a functional system with a simple human interface
- test and review functions within a system
- work collaboratively to plan and create a design

Evidence of Learning

Assessment: Final Game Build

Planning documents
Sketch/3D protoypes

Resources

SketchUp
Classroom tools/machines