Grade 5 STEAM - Unit 2 - Paper Engineering

Unit Focus

The arts provide means for individuals to collaborate and connect with others in an enjoyable inclusive environment as they create, prepare, and share artwork that bring communities together. In this unit, the students will collaborate as they use an iterative process, through engineering design, to create a paper vehicle that is powered via technology. The students will then run their vehicles through a course to see whose design can survive the rigors of the track. The unit will launch with a "wonder" YouTube video viewing the art of Chie Hitotsuyama. The students will use the video as inspiration for developing their own paper designs.

Stage 1: Desired Results - Key Understandings

Standard(s)

Standards

- Common Core
  - *Mathematics: 5*
    - Classify two-dimensional figures into categories based on their properties.
    - Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles. *(CCSS.MATH.CONTENT.5.G.B.3)*
    - Classify two-dimensional figures in a hierarchy based on properties. *(CCSS.MATH.CONTENT.5.G.B.4)*
    - Mathematical Practices
    - Make sense of problems and persevere in solving them. *(CCSS.MATH.MP.1)*
    - Construct viable arguments and critique the reasoning of others. *(CCSS.MATH.MP.3)*
    - Attend to precision. *(CCSS.MATH.MP.6)*
- CSTA: Computer Science Standards (2017-)
  - *CSTA: 3-5*
    - Algorithms & Programming *(1B-AP)*
    - Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. *(1B-AP-11)*
    - Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. *(1B-AP-12)*
    - Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences. *(1B-AP-13)*
    - Test and debug (identify and fix errors) a program or algorithm to ensure it runs as *(1B-AP-15)*
    - Describe choices made during program development using code comments, presentations, and demonstrations. *(1B-AP-17)*
- National Core Arts Standards
  - *Visual Arts: 5*
    - Investigate, Plan, Make: Generate and conceptualize artistic ideas and work. *(VA:Cr1.1.5)*
    - Combine ideas to generate an innovative idea for art-making. *(VA:Cr1.1.5.a)*

Transfer

Students will be able to independently use their learning to...
T1 Work together on a common goal to meet deadlines through addressing challenges and problems along the way both individually and collectively.

Meaning

Understanding(s)	Essential Question(s)
Students will understand that... **U1** Collaboration with others can improve product creation by incorporating different perspectives in the final design. **U2**Complex problems can more easily be solved by breaking them down in smaller components and solving for those. **U3** A deliberate design process can be used for generating ideas, testing theories, creating innovative artifacts or solving authentic problems. **U4** Programmers debug and revise their programs to improve the stability of the program.	*Students will keep considering...* **Q1** How does collaboratively reflecting on a design help us experience it more fully and develop it more completely? **Q2** How can I break a problem down into manageable parts? **Q3** How did it go / how did it turn out so far? How does it measure up to the established criteria? What is important to focus on next? **Q4** How do designers learn from trial and error?

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
Students will know... **K1** A chassis is the base frame of a wheeled conveyance.	*Students will be skilled at...* **S1** Using the design process to create a model.

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▪ Investigate: Organize and develop artistic ideas and work. *(VA:Cr2.1.5)* ▪ Demonstrate quality craftsmanship through care for and use of materials, tools, and equipment. *(VA:Cr2.2.5.a)* • Next Generation Science Standards (content standards) ○ *Elementary Standards: 5* ▪ Motion and Stability: Forces and Interactions *(5-PS2)* ▪ Support an argument that the gravitational force exerted by Earth on objects is directed down. *(5-PS2-1)* ▪ Engineering Design *(3-5-ETS1)* ▪ Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. *(3-5-ETS1-1)* ▪ Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. *(3-5-ETS1-2)* ▪ Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. *(3-5-ETS1-3)* • Next Generation Science Standards (DCI) ○ *Science: 5* ▪ ENGINEERING, TECHNOLOGY & APPLICATIONS OF SCIENCE ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. *(ETS1.5.A1)* ▪ Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. *(ETS1.5.B1)* ▪ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. *(ETS1.5.B2)* ▪ Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. *(ETS1.5.B3)* ▪ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. *(ETS1.5.C1)* • NGSS/NSTA Science & Engineering Practices ○ *NGSS Science & Engineering Practices: 3-5* ▪ Asking Questions and Defining Problems: A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas. *(SE.3-5.1)* ▪ Ask questions about what would happen if a variable is changed. *(SE.3-5.1.1)* ▪ Identify scientific (testable) and non-scientific (non-testable) questions. *(SE.3-5.1.2)*	**K2** Basic terminology of block coding: loop, conditional, variables, nesting, bugs, and debugging. **K3** Engineers couple creativity and imagination with analytical skills to solve problems. **K4** Mechanical engineering is the branch of engineering dealing with the design, construction, and use of machines.	**S2** Using blocks that contain a loop, conditional, and/or variable to complete a specified task. **S3** Creating working models from reused materials. **S4** Using a ruler to assistant in a mechanical engineering design. **S5** Using block coding to create a solution to a problem.

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▪ Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. *(SE.3-5.1.3)* ▪ Use prior knowledge to describe problems that can be solved. *(SE.3-5.1.4)* ▪ Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. *(SE.3-5.1.5)* ▪ Developing and Using Models: A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs. *(SE.3-5.2)* ▪ Identify limitations of models. *(SE.3-5.2.1)* ▪ Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. *(SE.3-5.2.2)* ▪ Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. *(SE.3-5.2.3)* ▪ Develop and/or use models to describe and/or predict phenomena. *(SE.3-5.2.4)* ▪ Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. *(SE.3-5.2.5)* ▪ Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. *(SE.3-5.2.6)* ▪ Planning and Carrying Out Investigations: Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions. *(SE.3-5.3)* ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. *(SE.3-5.3.1)* ▪ Evaluate appropriate methods and/or tools for collecting data. *(SE.3-5.3.2)* ▪ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. *(SE.3-5.3.3)* ▪ Make predictions about what would happen if a variable changes. *(SE.3-5.3.4)* ▪ Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. *(SE.3-5.3.5)* ▪ Analyzing and Interpreting Data: Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern		

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technology makes the collection of large data sets much easier, providing secondary sources for analysis. Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective. *(SE.3-5.4)* ▪ Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. *(SE.3-5.4.2)* ▪ Analyze data to refine a problem statement or the design of a proposed object, tool, or process. *(SE.3-5.4.4)* ▪ Use data to evaluate and refine design solutions. *(SE.3-5.4.5)* ▪ Constructing Explanations and Designing Solutions: The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints. *(SE.3-5.6)* ▪ Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). *(SE.3-5.6.1)* ▪ Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. *(SE.3-5.6.2)* ▪ Identify the evidence that supports particular points in an explanation. *(SE.3-5.6.3)* ▪ Apply scientific ideas to solve design problems. *(SE.3-5.6.4)* ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. *(SE.3-5.6.5)* **Madison Public Schools Profile of a Graduate** ○ Design: Engaging in a process to refine a product for an intended audience and purpose. *(POG.2.2)* ○ Collective Intelligence: Working respectfully and responsibly with others, exchanging and evaluating ideas to achieve a common objective. *(POG.3.1)*		