Madison Public Schools

Foundations of Engineering Unit 2: CO2 Car Dragster

Unit Focus

In this unit, students will apply the 8 step Engineering Design Process to design and create a solution to a complex problem. Students will go through the process in designing a CO2 dragster that will compete in a replicated drag racing event. Students will apply safety protocol as they design, create and test their CO2 dragster to be built for speed. Students will spend a significant amount of time assessing their dragster in a variety of tests and analyzing the data to help them predict the outcome of their design. During this whole process, students will document their work in their engineering report with the final analysis being done at the end and submitted.

Stage 1: Desired Results - Key Understandings

Established Goals

Common Core

Mathematics: 9

- Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. *CCSS.MATH.CONTENT.HSS.ID.A.2*
- Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. *CCSS.MATH.CONTENT.HSS.ID.B.5*
- Evaluate reports based on data. *CCSS.MATH.CONTENT.HSS.IC.B.6*

Connecticut Goals and Standards

Computer Aided Drafting and Design: 12

- Understand the orthographic projection process for developing multi-view drawings. *CADD.05.02*
- Explain and demonstrate the process for creating orthographic, isometric, section views, and auxiliary view.* *CADD.05.12*
- Explain the use and need for scaled drawings.*(E30) *CADD.05.17*

Pre-Engineering Technology: 12

- Analyze and research between alternate solutions. *ENG.02.06*
- Brainstorm possible solutions. *ENG.02.05*

Transfer

T1 Develop a product/solution that adheres to key parameters (e.g., cost, timeline, restrictions, available resources and audience).
T2 Explore and hone techniques, skills, methods, and processes to create and innovate
T3 Leverage connection(s) in other subject areas (including STEM) to make sense of a given problem, product, or solution.

Meaning

Understandings

U1 Both the tools I am using and the way I am using them impact the quality of the result, the safety of the shop environment, and the longevity of the equipment.
U2 A successful Engineering solution is grounded in attention to detail throughout the design and building process.
U3 Technological design involves tradeoffs among competing constraints and requirements.
U4 Communicating ideas accurately through the use of word, speech, and technical sketching/drawing improves
products and processes.
U5 Orthographic projection drawings are considered to be the official "language" of any design industry therefore all design professionals need to be fluent in this language.

Essential Questions

Q1 How do I select the appropriate tool to get the desired result?
Q2 How do my behaviors and actions affect the safety of myself and others?
Q3 What is the problem I am trying to solve through the design? How do I design this based on the constraints?
Q4 How do I make what I designed? When does the design need to be changed?
Q5 Why is the ability to read and understand the language of working drawings important for success in the design industry?

Stage 1: Desired Results - Key Understandings

- Build a prototype from plans. *ENG.02.08*
- Communicate processes and results. *ENG.02.11*
- Describe and demonstrate the components of personal and group laboratory safety. *ENG.06.05*
- Describe and use safety laboratory equipment. *ENG.06.06*
- Describe the process for researching known, relevant information, constraints and limitations. *ENG.02.03*
- Test a prototype. *ENG.02.09*
- Use all tools and equipment safely *ENG.06.03*
- Use the design process to solve problems by creating and refining prototypes. *ENG.02*
- Write technical reports. *ENG.05.02*

Technology Education (CTE)

- Design, Measurement, and Layout: Interpret technical drawings, rough drawings and sketches, and the use fractional measurement. *TE.WT.C*

Technology Essential Knowledge and Skills: 12

- Construct charts/tables/graphs from functions and data. *EKS.03.04*

NGSS/NSTA Science & Engineering Practices

NGSS Science & Engineering Practices: 9-12

- Ask questions to clarify and refine a model, an explanation, or an engineering problem. *SE.9-12.1.4*
- Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations. *SE.9-12.1.8*
- Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. *SE.9-12.2.3*
- Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. *SE.9-12.3.3*
- Select appropriate tools to collect, record, analyze, and evaluate data. *SE.9-12.3.4*
- Analyze data to identify design features or characteristics of the

Acquisition of Knowledge and Skill

Knowledge	Skills
K1 8 step Engineering Design Process and what evidence needs to be collected for an Engineering Report **K2** Six principle views (top, bottom, left, right, front & back) of a given object. **K3** The different line types are: Object, hidden, center, dimension, extension, cutting planes and section. **K4** An orthographic projection is a multi-view drawing used to show all of the features of an object. **K5** Statistical functions (Min, max, mean, mode and median) help find patterns within data	**S1** Hand sketch a 3 dimensional object Orthographically including all of the features. **S2** Identify and use appropriate tools to build their design (CO_2 Car) **S3** Develop a design (CO_2 car) within a given set of specifications. **S4** Analyze and interpret data to assess the performance of their solution. **S5** Express technical knowledge used in solving a problem in a clear, concise, and coherent manner within an engineering report. **S6** Create a full scale working drawing that displays all the pertinent information needed to create a part.

Stage 1: Desired Results - Key Understandings		
components of a proposed process or system to optimize it relative to criteria for success. *SE.9-12.4.6* • Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects *SE.9-12.6.3* • Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. *SE.9-12.6.4* • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. *SE.9-12.6.5* **Student Growth and Development 21st Century Capacities Matrix** *Critical Thinking* • Analyzing: Students will be able to examine information/data/evidence to make inferences and identify possible underlying assumptions, patterns, and relationships. *MM.1.2* *Creative Thinking* • Design: Students will be able to engage in an appropriate process to refine their product. *MM.2.3*		