Robotics Engineering Unit 2: The Game

Unit Focus

In competitive robotics the robots are typically divided down into subsystems that perform different functions. Some of these systems will stretch throughout the robot while others will consist of only a single mechanism. An example list of subsystems is shown below:

- Object Manipulation
- DC Motors
- Mechanical Power Transmission
- Drivetrain
- Lifting Mechanism

In order for the overall robot to function effectively, each of these systems must work together. Students will be asked to utilize any two of these five subsystems along with accompanying Engineering Notebook entries as part of the overall design process. In order to design any one of these systems, one must have knowledge of all the others which will be briefly informally discussed throughout the unit. Any requirements on the way these subsystems interact as part of the systems integration would be treated as Specifications (design constraints) in Step 3 of the design process. The PBA will span most of the unit and have students develop a robot to compete in the "Skills Challenge" the current VEX EDR game. The Engineering Notebook will be graded after each learning activity and transfer task.

Stage 1: Desired Results - Key Understandings

Standard(s)

CSTA: Computer Science Standards (2017)
6-8

- Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals. (2-AP-12)
- Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (2- AP-13)
- Seek and incorporate feedback from team members and users to refine a solution that meets user needs. (2-AP-15)
- Systematically test and refine programs using a range of test cases. (2-AP-17)
- Document programs in order to make them easier to follow, test, and debug. (2-AP-19)

Connecticut Goals and Standards
Pre-Engineering Technology: 12

- Describe and utilize the steps in the design process. (ENG.02.01)
- Describe the process for researching known, relevant information, constraints and limitations. (ENG.02.03)
- Brainstorm possible solutions. (ENG.02.05)
- Analyze and research between alternate solutions. (ENG.02.06)
- Build a prototype from plans. (ENG.02.08)

Transfer

Students will be able to independently use their learning to...
T1 Explore and hone techniques, skills, methods, and processes to create and innovate
T2 Develop a product/solution that adheres to key parameters (e.g., cost, timeline, restrictions, available resources and audience).

Meaning

Understanding(s)	Essential Question(s)
Students will understand that... **U1** All robots are designed with a purpose in mind, and these purposes can vary greatly. **U2** Once a design has been completed and a solution implemented, the solution must be tested and improved until it is acceptable. This improvement is done using the process of iteration, where steps of the design process are repeated over	*Students will keep considering...* **Q1** How does my individual performance impact the product of my team? **Q2** When is failure a success? **Q3** What is the best design for a robot to compete in this year's challenge?

Stage 1: Desired Results - Key Understandings

- Test a prototype. (ENG.02.09)
- Redesign prototypes. (ENG.02.10)
- Communicate processes and results. (ENG. 02.11)
- Describe the steps of the design process (e.g. create. evaluate. synthesis. final solution. findings. and present.) (ENG.02.12)
- Describe and demonstrate the components of personal and group laboratory safety. (ENG. 06.05)
- Identify the six simple machines and their applications. (ENG.11.01)
- Solve problems using appropriate units in engineering systems. (ENG.11.02)
- Explain the effects of gear ratios. (ENG.11.04)
- Describe work in mechanical systems. (ENG. 11.05)
- Explain rate in mechanical systems. (ENG. 11.06)

ITEEA - Standards for Technological Literacy

Technological Literacy: K-12

- Students will develop an understanding of the attributes of design. (8)
- Students will develop an understanding of engineering design. (9)
- Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. (10)
- Students will develop the abilities to apply the design process. (11)
- Students will develop the abilities to use and maintain technological products and systems. (12)
- Students will develop the abilities to assess the impact of products and systems. (13)

NGSS/NSTA Science & Engineering Practices

NGSS Science & Engineering Practices: 9-12

- Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. (SE.9-12.1.1)
- 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 a complex model that allows for manipulation and testing of a proposed process or system. (SE.9-12.2.5)
- 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)

Madison Public Schools Profile of a Graduate

- Self-Awareness: Examining current performance critically to identify steps/strategies to persist. (POG.4.1)
- Decision Making: Make responsible decisions, based on potential outcomes. (POG.4.2)

and over (iterated) to produce the best result.
U3 Robots are complex devices made up of systems that interact, relate and connect.

Q4 How do mechanical systems interact with each other in the overall function of the robot?

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
Students will know... **K1** Current game format and rules. **K2** Strategic Design is the process of determining what a robot should be able to do. **K3** In the case of a cost-benefit analysis within the Strategic Design of a competition robot, the "cost" is the level of difficulty of the given task, while the "benefit" is the number of points earned or denied by the same task. **K4 Classical Mechanics formulas:** Speed, Rotational speed (cycles or degrees), torque, force, power **K5 Gear Formulas:** Gear ratio, gear reduction, output torque, speed & compound gear reduction **K6 Vocabulary:** Speed, rotational speed, acceleration, force, torque, degrees of freedom, classical mechanics, Omni-Directional Drivetrain, traction, power transmission, object manipulators, object accumalators, gears (spur, bevel, crown, worm, helical, epicyclic and rack), friction, static friction, kinetic friction, coefficient of friction, drivetrains (Ackermann "Car Style" Steer, skid steer and swerve steer), turning torque, turning scrub and linkages.	*Students will be skilled at...* **S1** Identify the game pieces within the game environment and modify the robot to manipulate the pieces in an efficient manner. **S2** Use gear ratio's to adjust the mechanical advantages so the motors can do the work within their power limits. **S3** Design and build a drivetrain system that accounts for the friction/traction requirements of the current game. **S4** Design and build a lifting mechanism to elevate and/or reorient the current game pieces. **S5** Apply the concepts of speed, power, and torque with DC motors to calculate key details of the design.