Robotics Engineering Unit 2: The Game

Madison Public Schools

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

<table>
<tr><th rowspan="4">Established Goals</th><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">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).</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Connecticut Goals and Standards
Pre-Engineering Technology: 12
• Analyze and research between alternate solutions. ENG.02.06
• Brainstorm possible solutions. ENG.02.05
• 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 utilize the steps in the design process. ENG.02.01
• Describe the process for researching known, relevant information, constraints and limitations. ENG.02.03
• Describe the steps of the design process (e.g. create. evaluate. synthesis. final solution. findings. and present.) ENG.02.12</td><td>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 and over (iterated) to produce the best result.
U3 Robots are complex devices made up of systems that interact, relate and connect.</td><td>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 years challenge?
Q4 How do mechanical systems interact with each other in the overall function of the robot?</td></tr>
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Stage 1: Desired Results - Key Understandings

	Acquisition of Knowledge and Skill	
	Knowledge	**Skills**
• Describe work in mechanical systems. *ENG.11.05* • Explain rate in mechanical systems. *ENG.11.06* • Explain the effects of gear ratios. *ENG.11.04* • Identify the six simple machines and their applications. *ENG.11.01* • Redesign prototypes. *ENG.02.10* • Solve problems using appropriate units in engineering systems. *ENG.11.02* • Test a prototype. *ENG.02.09* **CSTA: Computer Science Standards (2017-)** *CSTA: 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* **Student Growth and Development 21st Century Capacities Matrix** *Creative Thinking* • Design: Students will be able to engage in an appropriate process to refine their product. *MM.2.3* *Self-Direction* • Perseverance: Students will be able to identify problem(s) and use appropriate strategies to continue toward a desired goal. *MM.4.2*	**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, accelleration, 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.	**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.