Unit 03 - Disciplines and Subsystem Design

Content Area:	**Science**
Course(s):	**Robotics A**
Time Period:	**Semester 1 & 2**
Length:	**15 weeks**
Status:	**Published**

Standards

CS.9-12.8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback.
CS.9-12.8.2.12.ED.3	Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
	Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.
	When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.
	Models (e.g., physical, mathematical, computer models)can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
	Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
	Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
	Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.
	Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
	Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed.
	Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

Enduring Understandings

- When developing a solution to a problem, often the well-planned and simplest solution is the most reliable.

- The engineering process we use in the real world for solving problems will often combine the application of both practical and scientific information.
- The engineering process will require comprehension of STEAM concepts when attempting to predict the outcome of an applied design.
- Movement within a mechanical system is a calculated process.
- Changes within a mechanical system may have a direct effect on the consistency of another aspect of the design.
- Physics and geometry play a large role in the design of a moving system and can be used to predict outcomes before testing.
- Passive assistance can be a very reliable and simple way of designing.
- A combination of movements/mechanisms is sometimes required for an effective design.

Essential Questions

1. What steps are necessary to select the appropriate subsystem for a specific robotic function?
2. How can data collection be utilized to enhance your design?
3. Why do we prototype designs and when is it necessary to do so?
4. Why might you prioritize higher speed with lower power and vice versa?
5. How does a change in load impact your design choices?
6. What benefits do different types of gears offer in mechanical design?
7. What mathematical calculations help determine the appropriate gear ratio for your design?
8. How can friction be leveraged to benefit your robot's drivetrain?
9. How can geometry assist in selecting the most efficient drivetrain for your robot?
10. How do degrees of freedom help you design a robot that can move and manipulate objects effectively?
11. When does a linkage system enable more diverse movement options for a robot?
12. How does using passive assistance give your robot a mechanical edge?
13. What are the benefits of automation in robotic design?
14. What types of tasks are best suited for automation?
15. What information do sensors need to provide the software end of robotic design to allow for automation?
16. When is software failure common during the engineering design process?

Knowledge and Skills

Knowledge:

- Subsystems are designed to complete a specific task but also must cooperate with other subsystems within the larger design.
- Changes to a subsystem may harm other subsystem functions, even if the one failing was not altered.
- Drivetrain selection and design are often overlooked but can impact efficiency if not carefully considered.
- Fewer moving parts or complex designs reduce the chances of mechanical failure.
- Simple designs that accomplish multiple tasks result in less complicated electrical and software designs.
- Leveraging mechanical advantage will result in the implementation of precise requirements for speed, power, and versatility in a design.
- Mathematical and Scientific equations should be used to prove concepts and a robot's ability before fabrication.
- While trial and error is part of the process, we can eliminate wasted time utilizing STEM principles during the fabrication stages of engineering design.
- Robot movement, direction, and exerted force can be controlled with mechanical design.
- The amount of consistent subsystem actuation should be considered when determining speed and power requirements.
- Sensors provide specific feedback to the user and software that should be leveraged when designing tasks for a design to complete.
- Multiple sensors can work together to create complex and predictable software outcomes.
- Software plays a critical role in the success of a design and may require physical changes to a robot for ideal results.
- Testing unproven software can be dangerous and precautions should be taken to ensure a safe environment.

Skills: SWBAT

- illustrate concepts of manipulators and accumulators.
- document each potential subsystem in engineering notebooks following standard procedure for technical drawings.
- differentiate between speed, power, and torque.
- experiment with the concepts of speed, power, and torque.
- prove the value of mechanical power transmission systems in robot design.
- calculate the mechanical advantage of gear input & output
- design gear ratios (and the mechanical advantage) in a system that gives them the versatility necessary to accomplish a specific task.
- communicate how applied force and friction are related.
- calculate wheel speed.
- critique the different types of drivetrains, defining their benefits and drawbacks.
- examine the three degrees of freedom presented during instruction.
- formulate a linkage system that will benefit their unique robot design
- question an overly complex subsystem and redesign for passive assistance.
- select sensors for specific robot feedback based on intended outcomes.
- design software for remote and autonomous robot control.

- test designs safely for themselves and those in the same environment.

Transfer Goals

Students will work in teams to build their robots for competition over several weeks. By the end of the unit, the entire fabrication and initial coding process will be completed. The final two steps of the engineering design process will occur in the course's last unit, with teams deciding which steps to repeat based on the successes and failures of their designs. This unit offers experience in all areas of robotics, allowing students to make informed decisions about what their robot needs to perform successfully during gameplay. The time required for testing and iterations will differ for each team, but opportunities for improvement will be available until time runs out and it is time to compete.

Resources

https://sites.google.com/whrhs-stu.org/ponzio/robotics/vex-edr/unit-03

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing