PLTW GTT AR Science Frameworks Template

PLTW Course: GTT Automation and Robotics

Science Strand and Substrand being addressed

Strand: The Nature of Science and Engineering Substrand: The Practice of Engineering

Science Standard being addressed 9.1.2.2

Overview:

Science Standard and Benchmarks

9.1.2.2.1

Science Standard: Engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.

Benchmark: Identify a problem and the associated constraints on possible design solutions.

Correlation to AAAS Atlas:

MN 9.1.2.2 = AAAS 3B/H6

Essential Understandings/Big Ideas:

Engineers investigate various mechanisms to determine and understand their purpose and applications. They use an analytical approach as they troubleshoot a malfunction in a system, test mechanisms to reduce the chance of system failure and find parts of a mechanism that are unreliable. Students solve problems in this lesson by using an analytical and creative process to meet a need or solve a specific problem, often using small-scale models and computer simulations.

What should students know and be able to do [at a mastery level] related to these benchmarks?

- Understand the design process.
- Construct a system that fits pre-determined criteria and solves problems.
- Be able to troubleshoot a identify the cause of a malfunction.
- Test and evaluate the product.

Misconceptions:

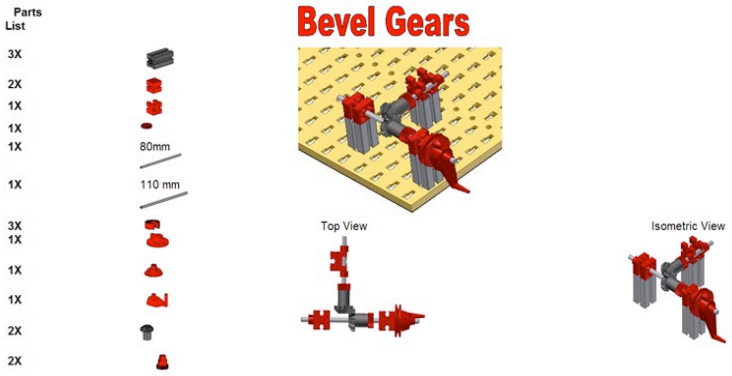
Student Misconceptions:

- There is only one design.
- Criteria and constraints are not important.
- Evaluation and testing a product are not important.

Teacher Resources:

Teacher Notes

- Examples of the creative design process.
- How to analytize something to meet a need or solve a specific problem.
- Use small-scale models and computer simulations.
- It is best to have physical examples of items that show simple gear movements to show students.
- Provide numerous moving examples of concepts being taught.
- Build sheets (example below) work well for students to follow as they construct and test mechanisms.



What is it that students struggle with the most and how can the teacher most effectively help students learn the concepts?

- Knowledge that designers have many options. Picking and choosing methods for each project works well.
- How to troubleshoot a malfunctioning system efficiently.
- Where are mechanisms used in real-life applications and what is their purpose? A guitar, a bicycle, an eggbeater, and a sewing machine all use gears to increase, decrease, or redirect power. Gears come in all sizes. A mechanical wind-up watch has very small gears, while the gears used to lift a bridge to allow ships to pass underneath are huge. Different gear configurations are used for different purposes. Think about a bicycle, an eggbeater, a sewing machine, a hand cranked drill, and a workshop vice. What do they have in common? All of them have at least one mechanism that provides movement. Some of the devices use human effort, while others use electricity. If the devices were taken apart, you would find a series of gears that redirect the applied force so they can accomplish their tasks. Gears come in all sizes. Small gears are found in mechanical watches, while very large gears are found in cranes that are used to raise large bridge sections into place. Some of the gears are encased in covers to protect them from their surroundings, while others are left out in the open.

New Vocabulary

- **Constraint -** A factor that restricts a project or system to achieve a higher level of production.
- **Criteria -** A standard by which something can be judged or decided.
- **Efficiency -** The ability to bring a desired result with the least waste of time, energy, or material.
- **Feedback -** Information about the output of a system that can be used to make adjustments.
- **Innovation -** An improvement of an existing technological product, system, or method of doing something.
- **Limitation -** Some factor that restricts the scope of activity or accomplishment.
- **Malfunction -** To function imperfectly or badly.
- **System -** A group of interacting, interrelated, or interdependent elements or parts that function together as a whole to accomplish a goal.
- **Threshold -** A level or point at which something would start or cease to happen or come into effect.
- **Trade-off -** A balancing of factors, all of which are not attainable at the same time; giving up of one thing in return for another.
- **Troubleshoot -** Locating and finding the cause of problems related to technological products or systems.

Vignette:

- Design a product using several mechanisms that are used to change speed, torque, and force, type of movement, and direction of movement. As students build different mechanisms they discover how they are used in the world today.
- Consider constraints.
- Communicate ideas with drawings and simple models.
- Plan work.
- Use suitable tools and techniques to construct.
- Evaluate the design.
- Suggest improvements.
- Try modifications.
- Identify solution.

Teacher: Which mechanism would be used to increase speed?
Student: Pulley and Belt
Teacher: Which mechanism would be used to increase torque or force?
Student: Simple Gear Train with Idler, Worm and Wheel and Crown and Pinion.
Teacher: How do you change types of motion using mechanisms?
Student: By arranging two or more pieces so that the motion of one compels the motion of the others.
Teacher: Name one mechanism used in areal-life application and what is its purpose?
Student: A Worm and Wheel is used on a Guitar and is used to tighten and the strings.

Additional Instructional Resources

Engineering paradise
https://www.youtube.com/watch?v=Y0DxmthvkKU

Honda - The Power of Dreams
https://www.honda.com/?from=dreams.honda.com&from=dreams.honda.com#/video_wi

Mechanisms
http://www.bbc.co.uk/schools/gcsebitesize/design/systemscontrol/mechanismsrev8.shtml

Assessment:

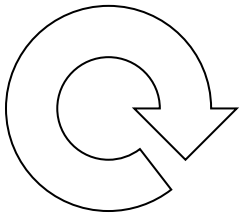
Assessment:

When you are riding a multi-speed bicycle up a steep hill, what do you do? Most likely you shift gears so you can get more power with the same amount of effort. Sometimes when a standard shift or four-wheel drive vehicle is being driven up a steep incline, the driver will downshift or engage the four-wheel drive so he or she can get more torque. Can you think of other examples where force or torque is changed to make a task easier?

This reading provides a review of the demonstration your teacher gave you on forces and torque. It will also give you an opportunity to review the calculation of gear ratios.

A force travels in a straight line.

Torque travels in a circular direction.

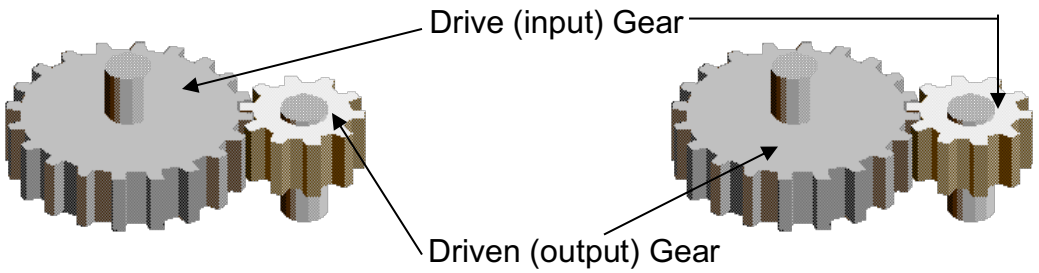


Gears turn in a circular direction. There is a relationship between torque and speed in gearing. A ten-speed bicycle has ten different gear selections. When you pedal up a hill, you use a gear train that provides more torque (turning force) but, in doing so, less speed.

When you pedal on flat land, you use a gear train that provides more speed, but in doing so, less torque within the gear train.

1. The gear train in which diagram below provides more torque? _____

2. The gear train in which diagram below provides more speed? _____



A B

3- 4. Fill in the spaces below to show the relationship between torque and speed in gear trains.

More torque = _____

More speed = _____

5 - 6. Fill in the spaces below showing the relationship between drive (input) gear and driven (output) gear in a simple gear train.

To increase torque, the driven (output) gear size _____.

To increase speed, the driven (output) gear size _____.

Differentiation:

Gifted and Talented:

- Require more troubleshooting and problem-solving to find the cause of a malfunction in a technological system.

Special Education:

- Students on an IEP and those who struggle could have extra handouts and related materials (computer simulations, videos and Internet links) made available to them.

English Language Learners

- Much of the vocabulary used in this area can be difficult for the ELL student. Using pictures which are shown in build sheets could help. Assembled models which could be looked at would also be of assistance to the ELL students.
- This information would have to be reinforced through the help of the ELL teacher.

Parents and Administration:

Administrative/Peer Classroom Observation

Students Are: (descriptive list)	**Teachers Are:** (descriptive list)
Building mechanisms	Questioning students
Documenting problems	Monitoring progress
Adjusting and making changes	Reinforcing success
Testing and Evaluating	Redirecting problems

Professional Learning Communities:

Reflection – Critical Questions regarding the teaching and learning of these benchmarks.

- In what areas did students perform best and what weaknesses are evident?
- How can this content be connected to other benchmarks in learning?
- Do students see the connection between force, torque and speed?
- Are students interpreting information correctly?
- What areas did students perform best and what weaknesses?

Materials – suggest articles and books for book study with PLC ~ Careers in Engineering.

Parent Resources:

- Parents can help their child learn about designas they observe how common cooking tools in the kitchen or repair tools in the workshop or garage are used.
- Encourage children to be willing to experiment with concepts which involve the design process.
- Allowing their children to practice problem solving skills at home.
- http://www.heath-teach.com/science_force_motion_and_simple_machines
- http://www.edheads.org/

References:

- Project Lead the Way , Gateway To Technology, Automation and Robotics course curriculum
- Minnesota Academic Standards - Science K - 12 2009 version
- AAAS Benchmarks
- http://www.project2061.org/publications/bsl/online/index.php?home=true