Overview

Victor Frankenstein used body parts gathered randomly in order to piece together a creature closely resembling a human. He was able to give it “the spark of life” and behold, his creature stirred to life. Each of the body parts needed to perform the function they were originally designed for and work together in order for the creature to move, walk, and talk. Dr. Frankenstein needed to have a deep understanding of anatomy for this to happen.

In this makerspace lesson, students will research a particular body part and the mechanics of its movements. They will then build an automata body part that can be attached to a larger class automata “creature”. Each piece will need to work in accordance with the rest of the body, the goal being to have the “creature” move.

Grade(s):  P K 1 2 3 4 5 6 7 8 9 10 11 12

Suggested Time Frame: One to two weeks

Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.MG.1</td>
<td>Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</td>
</tr>
<tr>
<td>G.MG.3</td>
<td>Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</td>
</tr>
<tr>
<td>Science &amp; Engineering Practices Developing and Using Models 9-12</td>
<td>Develop a complex model that allows for manipulation and testing of a proposed process or system.</td>
</tr>
<tr>
<td>SL.9-12.1</td>
<td>Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on grade 9-10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.</td>
</tr>
</tbody>
</table>
Objectives

At the conclusion of the lesson, students will know or be able to

- Explain simple machines.
- Explain how geometric shapes are incorporated into simple machines and how they help the simple machine function.
- Collaboratively design and construct a body part using the Engineering Design Cycle.
- Utilize the Engineering Design Cycle to collaboratively design and construct a proper simple machine to act as a joint between two body parts.
- Analyze the Engineering Design Cycle as it pertains to the process of creating a moving class creature.

Key Terms

Energy transfer – the conversion of one form of energy into another, or the movement of energy from one place to another.

Automata – a mechanical figure or mechanism that acts as if by its own motive power; robot.

Simple machines – any of various elementary mechanisms formerly considered as the elements of which all machines are composed, including the lever, the wheel and axel, the pulley, the inclined plane, the wedge, and the screw.

Lever – a rigid bar that pivots about one point (a fulcrum) and that is used to move an object at a second point by a force applied at a third.

Pulley – a wheel with a grooved rim around which a cord passes that acts to change the direction of a force applied to the cord and is chiefly used to lift heavy weights.

Wheel and axel – a simple machine consisting of a cylinder to which a wheel is fastened so that torque applied to the wheel winds a rope or chain onto the axle.

Inclined plane – a flat surface with one end higher than the other, allowing for heavy objects to slide up to a higher point rather than be lifted; a ramp.

Wedge – a piece of wood, metal, or some other material having one thick end and tapering to a thin edge, that is driven between two objects or parts of an object to secure or separate them.

Screw – a special kind of inclined plane wrapped around a cylinder used to lift things or hold them together.
Materials

- Cardboard of various thicknesses
- Straws
- Craft sticks
- Twine
- Toothpicks
- Paper towel and toilet paper tubes
- Wooden dowels or skewer sticks
- Pipe cleaners
- Scissors
- Hot glue gun
- Hot glue sticks
- Various types of tape
- Body part cards (attached)

Procedure

1. Prior to the lesson, gather supplies that can be used to make various simple machines, such as cardboard, scissors, craft sticks, toothpicks, and twine. If needed, gather examples of simple machines for students to tinker with.

2. Allow students some time to tinker with the items.

3. Discuss the process Victor Frankenstein went through to gather body parts. Did he need to find multiples of one part that would fit the overall creature better?

4. Introduce or review the key terms. Discuss how energy is transferred within the human body (both conversion of energy from one form to another as well as the movement of energy from one place to another). Relate the movement of energy to automata mechanisms.
   Discuss simple machines and how they are used in the human body. Some examples include: teeth – wedges, lever – certain joints including the head/neck, elbow, and ankle, inclined plane – the foot, wheel and axle – shoulder joint, pulley – knee joint. Discuss how these all work. Discuss how our movements would be different if the example worked as a different simple machine (i.e. the shoulder joint working as a lever instead of a wheel and axle). You can show a video that demonstrates levers in the body. [https://www.youtube.com/watch?v=d1wS_OJzml](https://www.youtube.com/watch?v=d1wS_OJzml)

5. Discuss different geometric shapes that could be used to represent different parts of the body, i.e. a sphere for the head, a cylinder for the neck, a rectangular prism for the torso, a triangular prism for joints. Discuss the different geometric shapes found in simple machines and how those shapes relate to the machines function.

6. Discuss the Engineering Design Cycle
7. Divide class into groups. Assign each group a body part. They should then discuss the basic shapes that make up that body part and the type of simple machine that makes it move. Have each group do some sketches of their body part using basic geometric shapes.

8. Tell students they will be working in their groups to build different automata body parts out of cardboard and the other materials available for a class creature.

- Each body part needs to incorporate a geometric shape into its design. They should draw design ideas before building their working automata.
- Each body part will need to connect to another body part that a different group will create.
- The joint between the two parts will need to be functional, so communication among groups is vital.
- Each working joint should be represented by a simple machine also created out of the available materials.
• The Engineering Design Cycle must be implemented at all stages of the process.
• This step will take anywhere from several days to two weeks.

9. Each body part needs to incorporate a geometric shape into its design. They should draw design ideas before building their working automata.

10. Each body part will need to connect to another body part that a different group will create.

11. The joint between the two parts will need to be functional, so communication among groups is vital.

12. Each working joint should be represented by a simple machine also created out of the available materials.

13. The Engineering Design Cycle must be implemented at all stages of the process.

14. This step will take anywhere from several days to two weeks.

15. Groups should share their body parts with the class, discussing the process, difficulties encountered, and steps taken to improve upon the design. They should then co-demonstrate the working joint created between each group, discussing the process, difficulties, and improvements made. Each student should be able to explain the concept of the simple machine their joint demonstrated.

16. The creature can then be shared with other classes and/or showcased somewhere in the school.

Extensions

1. Writing prompt – Write the process the group undertook to create the design and the assembly of the final product. The description must be detailed enough for someone else to recreate it.

2. Students can draw a flip book showing how the body they collaboratively created moved.

3. Students can use tech tools such as Arduino or Raspberry Pi, sensors, motors, and other electronic components to turn their automata into a robotic creation.

4. Students can draw an anatomical image of the human body using three-dimensional geometric shapes to represent each body part.
Considerations

If there are not enough groups for all of the body parts, several can be combined (arm and hand can be assigned to one group, leg and foot can be assigned to one group).

Post and follow safety precautions for working with hot substances.

Assessments

Use or adapt the attached rubric
<table>
<thead>
<tr>
<th></th>
<th>Exceeds (3)</th>
<th>Meets (2)</th>
<th>Partially Meets (1)</th>
<th>Does Not Meet (0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>Worked well with others and discussed ideas in a fair, respectful, encouraging way and was considerate of the feelings of others; added a fair share of work to the final product.</td>
<td>Worked okay with others and discussed ideas in a fair, respectful way, but may not be encouraging. Considered the feelings of others; added a fair share of work to the final product.</td>
<td>Worked with others but did not contribute a fair share of work OR was discouraging and did not consider the feelings of everyone; added to the final product, but not a fair share.</td>
<td>Did not participate or discussed ideas in an unfair, disrespectful way; did not add to the final product.</td>
</tr>
<tr>
<td>Understanding of Simple Machines</td>
<td>Student was able to communicate a clear and correct understanding of all simple machines and their relationship to geometric shapes; could teach another about them.</td>
<td>Student was able to communicate a clear and correct understanding of simple machines and their relationship to geometric shapes.</td>
<td>Student was able to communicate a somewhat correct understanding of simple machines and their relationship to geometric shapes.</td>
<td>Student was unable to correctly understand geometric shapes.</td>
</tr>
<tr>
<td>Use of Geometric Shapes</td>
<td>Geometric shapes were properly and creatively incorporated into the body part.</td>
<td>Geometric shapes were properly incorporated into the body part.</td>
<td>Geometric shapes were incorporated into the body part but was not done so correctly.</td>
<td>Geometric shapes were not incorporated into the body part.</td>
</tr>
<tr>
<td>Rubric</td>
<td>Exceeds (3)</td>
<td>Meets (2)</td>
<td>Partially Meets (1)</td>
<td>Does Not Meet (0)</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Discussion</td>
<td>Student participated actively and contributed ideas to the class.</td>
<td>Student participated but only contributed one idea to the discussion.</td>
<td>Student paid attention, but did not participate or contribute ideas to class.</td>
<td>Student did not pay attention or contribute ideas to class.</td>
</tr>
<tr>
<td>Sharing of Work</td>
<td>Student was able to explain the entire design process, demonstrate the joint movement, answering all questions correctly and enthusiastically, maintaining proper eye contact and voice level.</td>
<td>Student was able to explain the entire process, demonstrate the joint movement, and answer all questions.</td>
<td>Student was able to explain most of the design process and demonstrate the joint movement.</td>
<td>Student did not explain the design process or demonstrate the joint movement.</td>
</tr>
<tr>
<td>Total N/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Body Part Cards

Torso  Left Hand

Head  Left Foot

Left Arm  Right Arm

Left Leg  Right Leg

Right Foot  Right Hand