Creating Controllers

Activity Summary

Students will apply their design-thinking skills to create custom video game controllers. The goal being to make controllers more accessible to persons with disabilities, or to design for a video game with a unique control scheme.

Developed by Actua, 2022.

Delivery Environment	Activity Duration	Intended Audience
Lab	Four 50 minute classes	Grade 9 Electronics or Computer Science 20S Students

Achievement Goals

Learning Goals

Following this activity, students will:

- Identify the stages of the engineering design cycle, and determine which step in the process they are currently working on.
- Describe the path of the electric current running through their controller when keys are pressed.
- Design items that can be used by a wider audience and for a specific use.
- Discuss how design can be used to improve experiences and make them more inclusive.

Logistics

Section Title	Time	Group Size	Materials
Opening Hook	10 minutes	Whole Group	• Regular game controllers to pass around as manipulatives
Section1: Initial Controller Design	40 Minutes	Individual	• Paper and writing tools • Internet connected devices for research

Section 2: Controller Construction	100 Minutes	Individual	• Makey Makeys & associated wires
			• Conductive materials
			  ○ Ex. tin foil, copper wires, play dough, foil tape
			• Insulating materials
			  ○ Ex. electrical tape, foam, plasticine
			• Structural materials
			  ○ Ex. popsicle sticks
			• Hot glue guns

Section 3: Testing and Assessing	40 Minutes	Individual	• Multimeters with continuity test function • Laptops or Chromebooks to run games on Scratch • Troubleshooting checklist (to be projected)
Wrap-up	10 Minutes	Whole Group	• N/A

Safety Considerations

Safety considerations have been provided below to support safety during this activity, however they are not necessarily comprehensive. It is important that you review the activity and your delivery environment to determine any additional safety considerations that you should be implementing for the delivery of these activities.

- **Hot Glue Gun**
  - Keep away from the hot end of the glue gun. Be aware of glue that is still molten because it is still hot.
- **Emotional Safety**
  - Instructors should understand that students may have different lived experiences and prior knowledge of people living with (dis)abilities. These activities may involve or lead to discussions of sensitive topics. Ensure that students do not feel singled out for their (dis)abilities. Lead activities while being mindful of students' emotional safety and wellbeing (think about potential triggers).
  - Instructors should focus on guiding discussions towards empowering students living with disabilities.
- **Scissors**
  - Remind students of how to use scissors properly and safely. Ensure students are sitting down and have age appropriate scissors. Offer assistance when cutting thick materials, such as corrugated cardboard or popsicle sticks to help prevent injury.
- **Building Materials**
  - Building materials such as elastics, tape, and the motors could be used by students to hurt themselves or others. Instructors are to limit the quantity of materials being given out at once to students and to explain safety rules prior to handing out materials.

Curriculum Links

Grade 9 Electronics

- IA9.F2.3 - Demonstrate an understanding of the qualities of good design.
- IA9.F2.1 - Demonstrate an understanding of the problem solving process in designing and producing a product.
- IA9.EE5.1 - Identify basic electronics circuits such as series, parallel, combination, rectifier, oscillator, amplifier, pulse, and logic.
- IA9.EE7.1 - Identify several current innovations in electricity/electronics such as Computer Numerical Control, robotics and automation, digital communication, fibre optic networks, nano-technology, and circuit simulation software.

Grade 10 Computer Science

- 1.2.2 - Discuss the implications of the progressive development of computer hardware for the environment and for society.
- 3.2.3 - Identify the logical series of steps involved in solving a problem.
- 4.2.3 - Obtain input from the program user.
- 4.5.1 - Use existing code provided by the teacher to build a larger program.

Grade 9 Science

- S1-3-09 - Define electric current as charge per unit time and solve related problems.
- S1-3-11 - Identify the five sources of electrical energy and some associated technologies.
- S1-3-13 - Construct electric circuits using schematic diagrams.
- S1-3-14 - Use appropriate instruments and units to measure voltage, current, and resistance.

Activity Procedure

Opening Hook (10 Minutes)

1. Begin by exploring this video; Accessible Gaming (INDATAProject 4:06) with students.
2. Facilitate a class discussion about controller design. Pass around some controllers for students to examine and manipulate. What's good about the design? What could be improved? How could this controller be improved to become accessible to everyone? For example, making buttons easier to reach for short fingers, making grips bigger for big hands, etc.
3. Encourage students to consider how these controllers would or wouldn't work for people with physical disabilities. Could a traditional controller work for someone with one hand, or someone with reduced fine motor control?
4. End the discussion by talking about designing games with unique control schemes. For example, some games on the Nintendo Wii use motion controls, and games like Guitar Hero and Dance Dance Revolution that have dedicated, unique controllers.

Section 1: Initial Controller Design (40 Minutes)

1. Begin by discussing the engineering design cycle in Appendix A.
2. Explain how the Makey Makey works. When connected to a computer, the computer thinks the Makey Makey is just another keyboard. To "press" the keys, a connection needs to be made between the contacts for "earth" or ground, and the contact for the key you want to press. This connection can be made through many materials, like a wire, tin foil, a banana, or even the students themselves.
    a. Demonstrate this using a Makey Makey connected to a computer with a projector. Take advantage of the bright coloured alligator clips to demonstrate from afar.
3. Students should begin by identifying a need for a unique controller to either make a game more accessible, or to create a unique control scheme for a new or existing game.

4. Give students time for research. They should choose what game they would like to play with their controller, and decide if they will make a unique control scheme.
5. Encourage students to create multiple different designs, and discuss with a partner to choose the best one.
    a. Optional: to allow students to be creative and think without boundaries, conduct a brainstorming session without having informed students of the available materials.
    b. Tell students that if they want, they can bring in objects from home, like spring door stops or rubber gloves (both items used on the Makey Makey website for making controllers).
6. At the end of the class, ask students what parts of the design cycle they have completed so far? Where are they now? What is the next step?

Section 2: Controller Construction (100 Minutes)

1. Following on with the next step in the design cycle, students will begin to construct their controllers.
2. Encourage students to start with one input at a time.
    a. Ex. Start by getting the 'up' button working reliably, then move on to the 'down' button, then 'left', and so on.
3. Ideally, each student will have access to a laptop or device for all classes so they can test their controller throughout. If access to technology is restricted, students can do all of their construction, and connect to the game only in the testing phase.
4. If some students finish their controllers quickly, encourage them to add other features or find ways to improve their design to keep them engaged for the entire project.
    a. This is a good opportunity to extend the project with more inputs. Refer to the Modifications and Extensions section, under the heading Increasing inputs with the Makey Max Backpack.
2. Throughout this section, ask students what parts of the design cycle they have completed so far. Where are they now? What is the next step?

Section 3: Integration & Controller Showcase (40 Minutes)

1. Start with a brief review of the troubleshooting checklist in Appendix B. If something isn't working, students should complete this checklist as best as they can before seeking help from a classmate or the teacher.
2. Students will troubleshoot and test their controllers with the games they have chosen. Students should work collaboratively to troubleshoot.
3. When the controllers are working, students can showcase their designs to their classmates.Invite students to rotate through stations to test out other students' controllers.
    a. Each station should have some paper where students can write one or two sentences about what they liked about the controller and/or how it could be improved.

Wrap-up (10 mins)

1. Facilitate a group discussion with the students to debrief about the project.
    a. Review the engineering design cycle and have students identify examples of when they were at different stages.
    b. Discuss what went well, what didn't, and how things could be improved for next time.

Delivery Adaptations

Delivery adaptations identify ways the activity can be changed to accommodate student needs while maintaining the learning outcomes. Some examples of adaptations are a change in the physical space, the size of the group (individual vs group), or describing the steps. They help students reach their full potential while participating. ***Modifications*** *are ways to make the activity more accessible,* ***extensions*** *are ways to make the activity last longer or more challenging.*

Modifications

Whole Project

- The number of classes set aside for this project can be modified according to your group of students.

Section 1: Initial Controller Design

- Depending on how familiar students are with the engineering design cycle, the amount of time spent on explaining it can be adapted.

Extensions

Game design with Scratch

- Instead of using a pre-existing game, students can use Scratch to code a custom game.
- If students are creating a controller with a unique control scheme, designing a custom game will allow students to take it to the next level, designing a more complex or unique way of controlling their unique game.
- If students are designing an accessible controller, encourage them to design an accessible game to go with it. The game could include things like high contrast, large text, and dictation of text.

Increasing inputs with the Makey Max Backpack

- Students can use the extra inputs provided by the Makey Max Backpack to design a controller to work with a more complicated game, or to design a more complex controller and associated custom game.
- Note: the Makey Max Backpack itself isn't actually required for this extension. The Makey Max connects to the Makey Makey with the same pins found on other microcontrollers, so wires used for breadboarding can be used to connect with those same ports.

Using Arduinos

- Instead of the Makey Makey, use an Arduino connected to various different sensors. This will increase complexity.

Computer Numerical Control (CNC)

- Use technologies like laser cutting and 3D printing to manufacture parts for the controllers.
- Encourage students to use these technologies to create functional parts, instead of decorative ones.

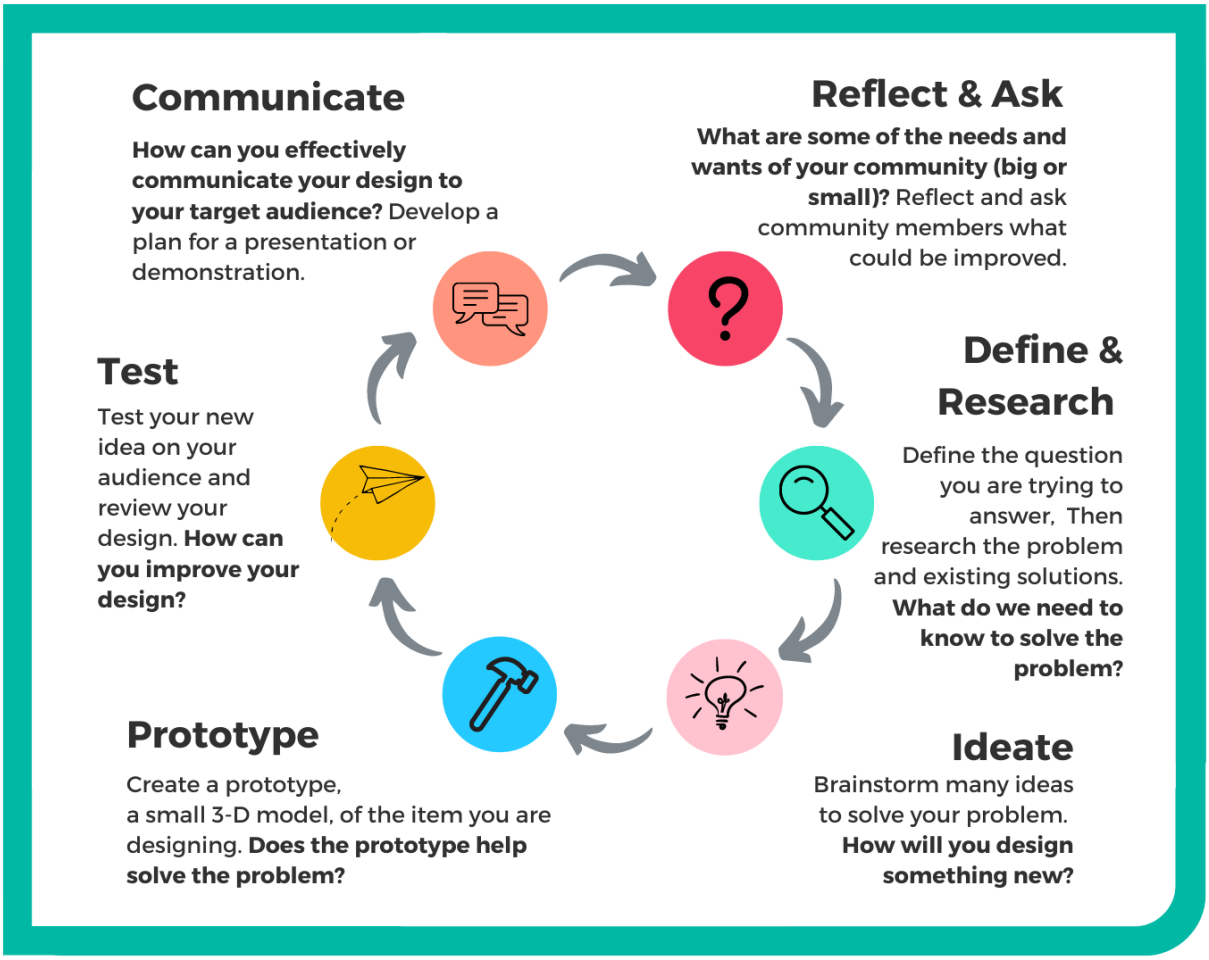
Appendices

Appendix A: Engineering Design Process

Engineering Design Process

The Engineering Design Process is an open-ended problem solving process focused on creativity and meeting people's needs. It is a collaborative way to find solutions to societal issues.

Start at "**Reflect & Ask**". You can go through the design process in any direction as many times as you want to before you have a final product!



Engineering Design Process

Use the spaces below to plan for each stage of the design process.

Reflect & Ask

What are some of the needs and wants of your community?

Define

What is the problem you are trying to solve?
What do we need to know to solve the problem?

Ideate

How will you design something new?

Prototype

Create a prototype. Does the prototype help solve the problem?

Test

Test your idea. How can you improve your design?

Communicate

Communicate your design to your target audience.
Start by developing a plan or draft.

Appendix B: Troubleshooting Checklist

Encourage students to develop their troubleshooting skills and go through this checklist before they come to you for help.

- Is the red cable plugged into the Makey Makey?
- Is the red cable plugged into the computer?
- Does the computer's USB port work? Try another port or plug something else in.
- Are the alligator clips making good contact with the Makey Makey?
- Are the alligator clips plugged into the correct spots on the Makey Makey?
- Are the alligator clips making good contact with your project?
- Are any contact points in your project making good connections?
- Are the wires with alligator clips in good condition? Use a continuity tester on either end to check this.
- Draw out how your circuit is supposed to work. Compare the drawing to your project.

References & Gratitude

Actua. (2022). *Cranial Illusions*.

INDATAProject (2021, October 23). *Accessible Gaming*. https://www.youtube.com/watch?v=ZpirIqb2WI0

Makey Makey. (2022). *Accessibility Guides Chapter*. https://makeymakey.com/pages/how-to

Makey Makey. (2022). *Accessibility Guide: Glove Controller*. https://makeymakey.com/blogs/how-to-instructions/accessibility-guide-glove-controller

Makey Makey (2022). *Hula Hoop Game Controller by Katie Butzu and Mark Lyons* https://makeymakey.com/blogs/how-to-instructions/hula-hoop-game-controller-by-katie-butzu-and-mark-lyons

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