Two-Way Automata Motion

ACTIVITY OVERVIEW

STEM Focus Area: Engineering

Learning Goal: To build from basics of mechanical engineering and explore motion transfer

Youth Learning Target

- "I can make something move up and down with something that spins."
- "I can change what I'm making to improve it."
- "I can form a plan, draw sketches and create models of the plan."
- "I can problem solve and make adjustments in my plan to achieve my desired outcome."

LEARNING ENVIRONMENT

Activity Duration: 45min

Class Size: Small

Type of Space: Indoor

Age of Youth: Grades 6-8

Guiding Question: What is the question to explore OR the problem or challenge to solve?

How do mechanics work? How can simple machines be incorporated into everyday items? How can we incorporate multiple movements into the same machine as simply as possible?

Through this activity, youth will:

- Investigate various crank and cam systems that can be used to redirect motion in multiple ways
- Sketch their design prior to construction to include at least two cam systems connected to the same crank.
- Explore different material properties
- Assemble automata to explore basics of mechanical engineering utilizing more than one motion; expand to incorporate more than one item
- Design a personalized custom design that incorporates at least one range of motion and two personalized items

Facilitator Prep:

Facilitators will need to prepare materials before the activity and develop an understanding of what automata are and how they work. Facilitator should build an automata before as an example.

Literacy Connection: Great books to get youth support learning about Engineering *(available on Amazon).*

- Engineering for Teens by Pamela McCauley (Author)

- ✓ Predict and hypothesize
- ✓ Develop and use models
- ✓ Measure materials
- ✓ Observe
- ✓ Investigate
  - Record observations
  - Analyze and infer
- ✓ Share and communicate data
  - Interpret data
- ✓ Test and revise
- ✓ Draw conclusions and relationships
- ✓ Have voice and agency, make decisions and guide their own learning

PREPARATION

Materials

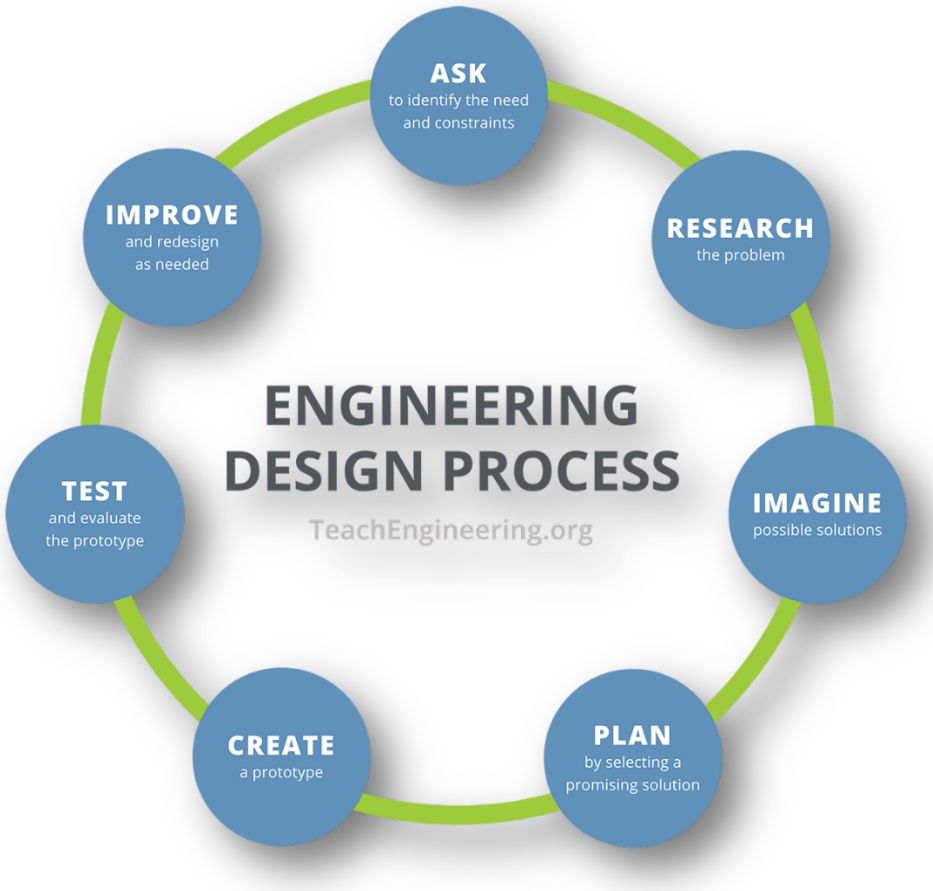
- Large plastic clear cups OR deli containers (1 per group)
- Straw segments; about ½" long (2/3 per group)
- Craft Foam pieces; small circles, around 1.5" in diameter (3-5 per group)
- Hot glue gun & glue sticks
- Bamboo skewers/dowel rods (2-3 per group)
- Tape
- Board
- Craft materials for decorations (craft foam, googly eyes, feathers, stickers, construction paper, etc

Room

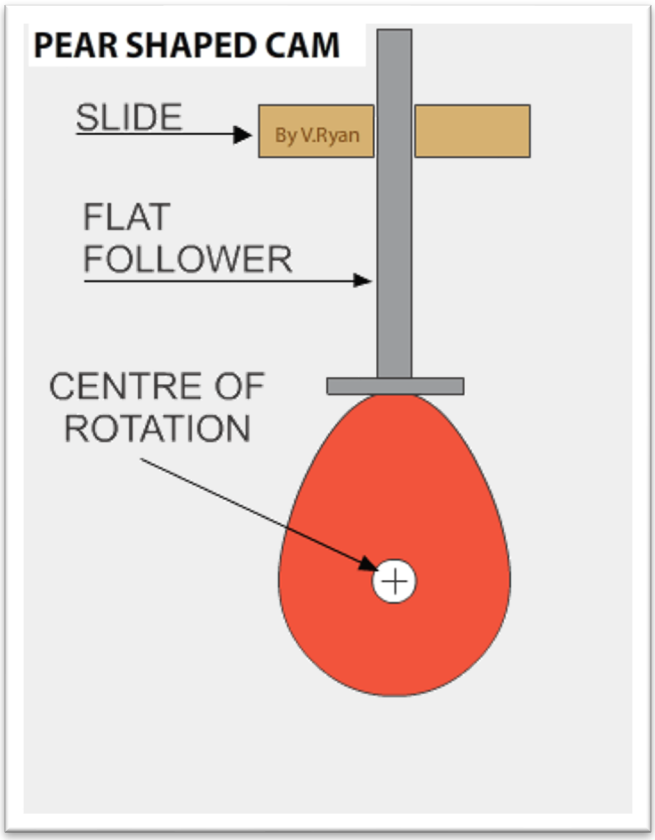
An informal setup would be best suited for this activity, ensuring each individual has enough space to access the materials and build their automata.

Content

- **Engineers** use what they understand about math and science to solve clearly defined problems.
- The **engineering design process** is a sequence of steps that offers engineers guidance as they try to solve problems. The process is designed to repeat particular steps as many times as needed, making improvements along the way.



- **Learning from failure** is a key part of the engineering design process.
- **Automata** are moving mechanical devices that imitate the movement of a humans, animals, or other living things
    - Watch - Automata, Mechanical Marvels in Wood—A Video Postcard: https://youtu.be/KGgR2zw0MLM
    - Watch – Automata Sampling: Automata Sampling
- **Cam mechanisms** are a rotating part of a machine that turns rotary motion (spinning) into linear motion (up & down or side to side).
    - Watch - What are CAMS?**:** https://www.youtube.com/watch?v=tzWQasmUfLY&ab_channel=VincentRyan
    - Parts of a cam system: center of rotation, CAM, follower, slide



- Build a cam system - https://www.nisenet.org/sites/default/files/automatasign.pdf
- Variations on a cam system - https://www.nisenet.org/sites/default/files/automata_motion_sheet.pdf

Inquiry

Your primary goal as facilitator is to encourage youth to explore and observe what causes motion and how to use the engineering design process. You can prompt those discussions with questions like the following:

- How do things move? What is motion?
- What simple machines do we see in our automata?
- What causes the automata to move?
- What can you change or add to alter the motion of the automata?
- How will the shape of the cam affect the motion of the follower?
- If their automata isn't working: Where does the automata seem to be broken? What would an engineer do? How can you improve it?

DoS:

- ✓ Organization: I practiced the activity/technology, prepared materials/extras/place to record youth ideas, and completed an activity (including timings).
- ✓ Materials: Materials are appropriate for teaching the learning goals; youth will be able to use them and will think they are appealing.
- ✓ Space Utilization: The space is set up appropriately for the activity and there will be no safety issues or distractions.
- ✓ Relevance: I have researched why the content matters to youth's everyday lives.
- ✓ Content Learning: I have become familiar with the content.
- ✓ Inquiry: I have become familiar with how authentic, age-appropriate inquiry practices look in this activity.

INTRODUCTION TO ACTIVITY (10 MINUTES)

Start with a conversation about the youths' experience with motion.

- How do things move? What is motion?
- Motion is when an object moves. Motion doesn't happen by itself. Something needs to get the object to move. The thing that gets the object to move is called force.
- What are some different ways things can move? (looking for side to side or up and down, spin around, etc)
    - When things move in a straight line, it's called "linear" motion. When they spin it's called "rotary" motion.

Review simple machines with the youth

- Inclined plane
- Wheel and Axle
- Pulley
- Screw
- Wedge
- Lever

Explain that they'll be using some of these simple machines to a more complex machine called an automata

- A automata is a moving mechanical device that imitates the movement of a human, animal, or other living thing
- Showing videos of automata might help the youth understand the intended result.
- While watching videos, highlight the use of cams.

Introduce cam mechanisms – what will be driving the movement of the automata the youth will be building.

- It might be useful to demonstrate building a cam system with the materials. Reference "Building a cam system" for this process.

Introduce the engineering design process – if a white board is available, draw it out as you describe it. You can also use a projector with a pre-made image of an engineering design process.

Explain that working backwards is often the best way to design something. First, start with the end. Ensure the last thing the product does is done well. Then build backwards until you have the beginning built.

The important design challenge is that they will have to build an automata that will create two distinct movements.

DoS:

- ✓ Space Utilization: I will use the space informally avoiding the lecture hall format.
- ✓ Purposeful Activities: This intro section gets youth on track for the learning goal.
- ✓ Content Learning: If age appropriate, I will accurately present content.
- ✓ Inquiry: In this or another section of the activity, youth carry out one or more inquiry practices.
- ✓ Relationships: I will make each youth feel welcome.
- ✓ Relevance: In this or another section, I will guide the youth in a sustained discussion of how the activity relates to their everyday lives.
- ✓ Youth Voice: In this or another section, I will allow youth the opportunity to make decisions about their learning experiences.

ACTIVITY ENGAGEMENT (15 MINUTES)

- Suggest they work backwards; starting with the end. “What will your automata do?” They can use this opportunity to decorate the vertical dowel. From there, they can design the cam system.
- Ask throughout the activity: “Where in the engineering design process are we right now?”
- If their automata isn’t working the way they want, ask these questions: Where does the automata seem to be broken? What would an engineer do? How can you improve it?

DoS:

- ✓ Space Utilization: I will use the space informally avoiding the lecture hall format.
- ✓ Participation: All youth will have access to the activity.
- ✓ Purposeful Activities: This core section helps youth to move toward the learning goal.
- ✓ Engagement: This activity has youth physically engaged with their hands and their minds.
- ✓ Inquiry: In this or another section of the activity, youth carry out one or more inquiry practices.
- ✓ Reflection: If appropriate, I will ask youth questions during the core activity that will help them make sense of what they are learning.
- ✓ Relationships: I will take steps to share my enthusiasm and create a nurturing, safe learning environment.
- ✓ Relevance: In this or another section, I will guide the youth in a sustained discussion of how the activity relates to their everyday lives.
- ✓ Youth Voice: In this or another section, I will allow youth the opportunity to make decisions about their learning experiences.

FINAL REFLECTION AND RELEVANCE (5 MINUTES)

Once everyone’s automata are completed, have a conversation about the engineering design process:

- What was your automata designed to do?
- Where in design process are we now?
- What are some ways that we can improve our linkages?

DoS:

- ✓ Space Utilization: Again, I will use the space informally.
- ✓ Participation: I will prompt youth who do not have access to the activity to participate.
- ✓ Purposeful Activities: The closing section helps youth to reach the learning goal.
- ✓ Content Learning: I will help youth make connections between different ideas. I will create opportunities for youth to ask questions/provide ideas that show a deeper level of understanding.
- ✓ Inquiry: In this or another section of the activity, youth carry out one or more inquiry practices.
- ✓ Reflection. I will provide youth with a sustained opportunity to make sense of their learning.
- ✓ Relevance: In this or another section, I will guide the youth in a sustained discussion of how the activity relates to their everyday lives.
- ✓ Youth Voice: In this or another section, I will allow youth the opportunity to make decisions about their learning experiences.

REFERENCES

- Automata –NISENET 2017: https://www.nisenet.org/catalog/automata