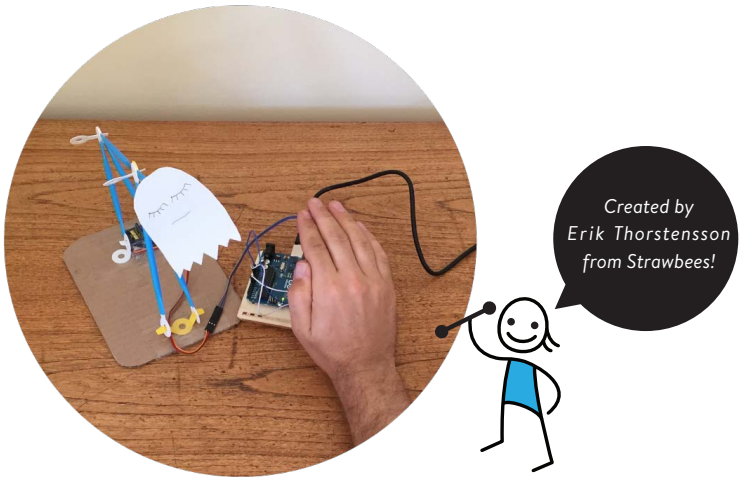


NAME

Animated Character

DESCRIPTION OF ACTIVITY

In this experiment you will learn how to build one of the most common mechanical systems, the four-bar linkage.
To make it a bit more fun we have added a character to the equation.

The students will explore how the length of the straws and how their programming affects the structures movement. The photoresistor will control how your structure moves due to the level of light it receives.

Adjust the group size depending on amount of Arduinos and level of programming skills.

To find an example of the animated character, click HERE

LEARNING GOALS

- Learn how sensor input can be mapped to servo output

- Students will explore the change in motion that comes from trying out different lengths of the bars in the classic four-bar linkage. Depending on age of the class the amount of information about the four-bar linkage can be varied.

- Work individually or in groups as you see fit. The more mechanical characters the broader the range of movement will be and the more you will understand about both the four-bar linkage and motor control.

PRE-REQUISITE KNOWLEDGE/SKILL

Connecting an Arduino and uploading the program (modifying the code is optional)

MATERIALS NEEDED

Cardboard, 15 Strawbees (13 singles, 2 doubles), 4 straws, 1 microservo, 1 arduino, 1 breadboard, 1 photoresistor, 1 10kΩ resistor, 7 cables, tape, pen, paper, scissors and a computer.

CLASS DURATION

DURATION	*ACTIVITY*	*TIPS*
15 min	Introduction	The time can vary from group to group and can be adapted to the available time. Preparing the cardboard base & servo attachments cuts time etc.
30 min	Build your base and structure	
10 min	Make servo attachment	
10 min	Attach servo to base structure	
15 min	Attach your mechanical structure	
15 min	Programming	
15 min	Connect Arduino to the servo	
20 min	Add a character	

ADDITIONAL CHALLENGE

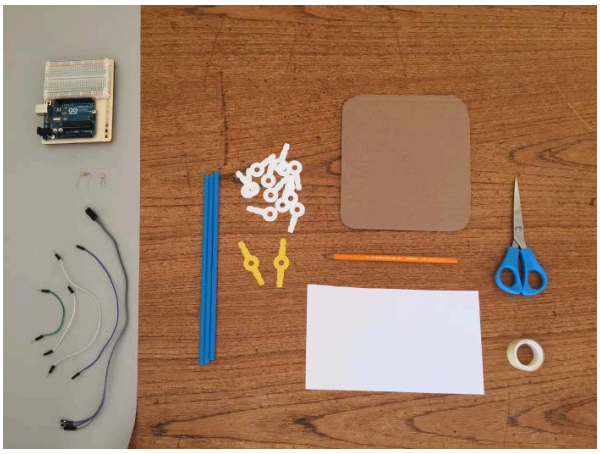
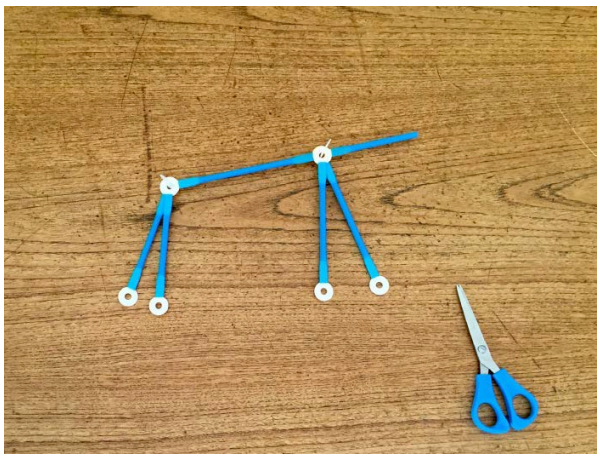
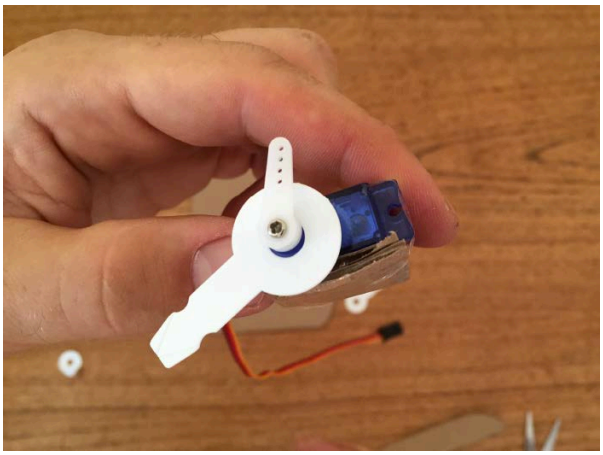
- Add lights or switch the lightsensor to another analogue input

- Make the character do something or add mechanical movement with additional struts

- Let the students google for interesting four-bar linkage systems

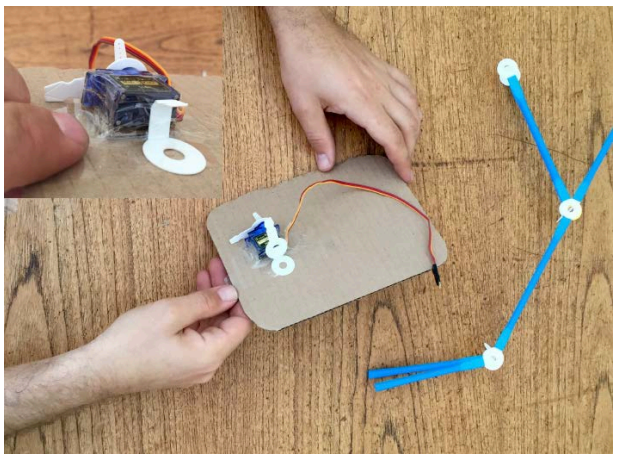
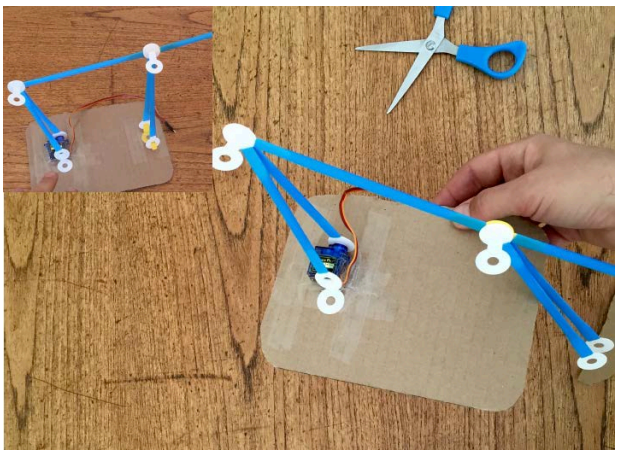
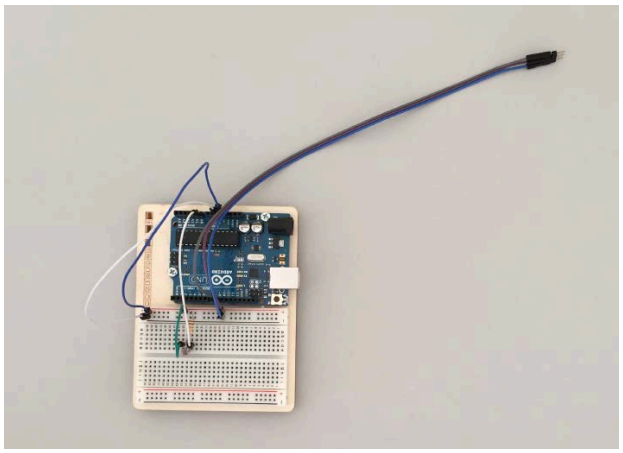
- Add an environment. Make the character move in front of a backdrop or pop out of a box

STEP - BY - STEP INSTRUCTIONS

IMAGES	*NOTES*
	1. INTRODUCTION (15 min) Talk about mechanical linkages and introduce the magical four-bar linkage system to the class. Show examples of where this kind of mechanical systems are used, such as excavators, table lamps and other objects. Engineers often use the four-bar linkage and now it's your time to try them out. Get all the needed material and if the students have not played with Strawbees before they can try them out for a couple of minutes to understand how they work and get into connecting. Play the Strawbees intro video if needed. Strawbees intro video can be found HERE
	2. BUILD YOUR BASE AND STRUCTURE (30 min) Cut out the 15x24cm cardboard base. Then start exploring with your mechanical structure. Show how to connect Strawbees with low friction. The front and back leg pairs have to have the same length so start with just one leg front and one leg back to investigate movement. The ratio between the length of the straws will make the mechanical structure move in different ways. What happens if your foremost straws are shorter than the back straws and vice-versa? When you have a nice movement going, copy the front and back legs to make it 3D. More pictures can be found under additional resources.
	3. MAKE SERVO ATTACHMENT (10 min) The servo needs to be elevated from the platform so the servo arm can move free from the surface of the base. Use two or three layers of cardboard to lift the servo up and secure it to the servo with tape. Make sure nothing gets in the way of the arms movement. Also make sure the cardboard is not bigger than the servo. More pictures can be found under additional resources.

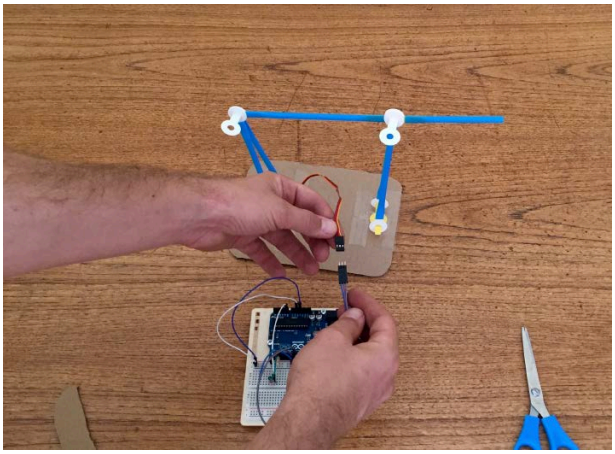
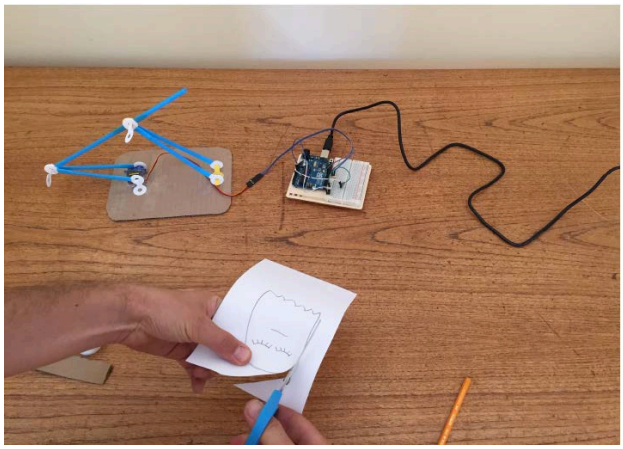
Note:
Feel free to include links to videos too!

STEP - BY - STEP INSTRUCTIONS

IMAGES	*NOTES*
	4. ATTACH SERVO TO BASE STRUCTURE (10 min) Secure the servo to the cardboard base with a piece of tape parallell to the servo arm from front to back. Secure this tape with two pieces of tape perpendicular to the first and keep it close to the servo. Attach a folded Strawbee opposite to the servo arm center. Secure it in position with tape to the servo and to the base. This connection point makes it possible to connect the leg on the opposite side of the servo, making a triangle strong enough to hold the upper straw suspended in the air. More pictures can be found under additional resources. Examples of how to attach the servo can be found HERE
	5. ATTACH YOUR MECHANICAL STRUCTURE (15 min) Attach the rear part of the structure to the servo arm and the folded Strawbee. Make sure the servo arm slides into the straw when connecting. Fold a double Strawbee so the arms are pointing slightly upwards, around 45°. This will be the swivel point. Try out different locations for the placing of front leg swivel point. More pictures can be found under additional resources.
	6. PROGRAMMING (15 min) Option 1: Upload our example code and vary the values according to your structure. Start with small values around the centre for the movement. Option 2: Let the students program their Arduino using adafruits servo instructions. What values show in the serial monitor when it gets direct light? What is the lowest light value? What happens if you change the outer limits for how far your mechanical structure can move? Find circuit diagram for Arduino under additional resources. Find example code for the Arduino under additional resources.

Note:
Feel free to include links to videos too!

STEP - BY - STEP INSTRUCTIONS

IMAGES	*NOTES*
	7. CONNECT ARDUINO TO THE SERVO (15 min) Connect the servo arm to the Arduino. Try out the test program. Let the students play with modifying the code and movement for a while. Change start and stop values for the servo to react the way you want depending on sensor value. Steps 6 & 7 can be interchanged or jumped between freely. Sometimes the character can inspire movement and vice versa. What happens to the character when it sees bright light? Does it jump forward, or fall down, or jump back into a cave like a troll?
	8. ADD A CHARACTER (20 min) Draw a character and add it to your moving structure. What character suits your movement. What happens to the character when it sees darkness or light? Now it's playtime! By holding your hand above the Arduino/photoresistor your character will start moving. Maybe dim the light in the room and see what happens to all the characters. When could a similar system be used in your everyday life? What if someone tries stealing your cookies, could this help you stop the thief? More pictures can be found under additional resources.

Note:
Feel free to include links to videos too!