THE EDUCATION FUND

FOR EXCELLENCE IN MIAMI-DADE PUBLIC SCHOOLS

2022-2023

Ideas with IMPACT

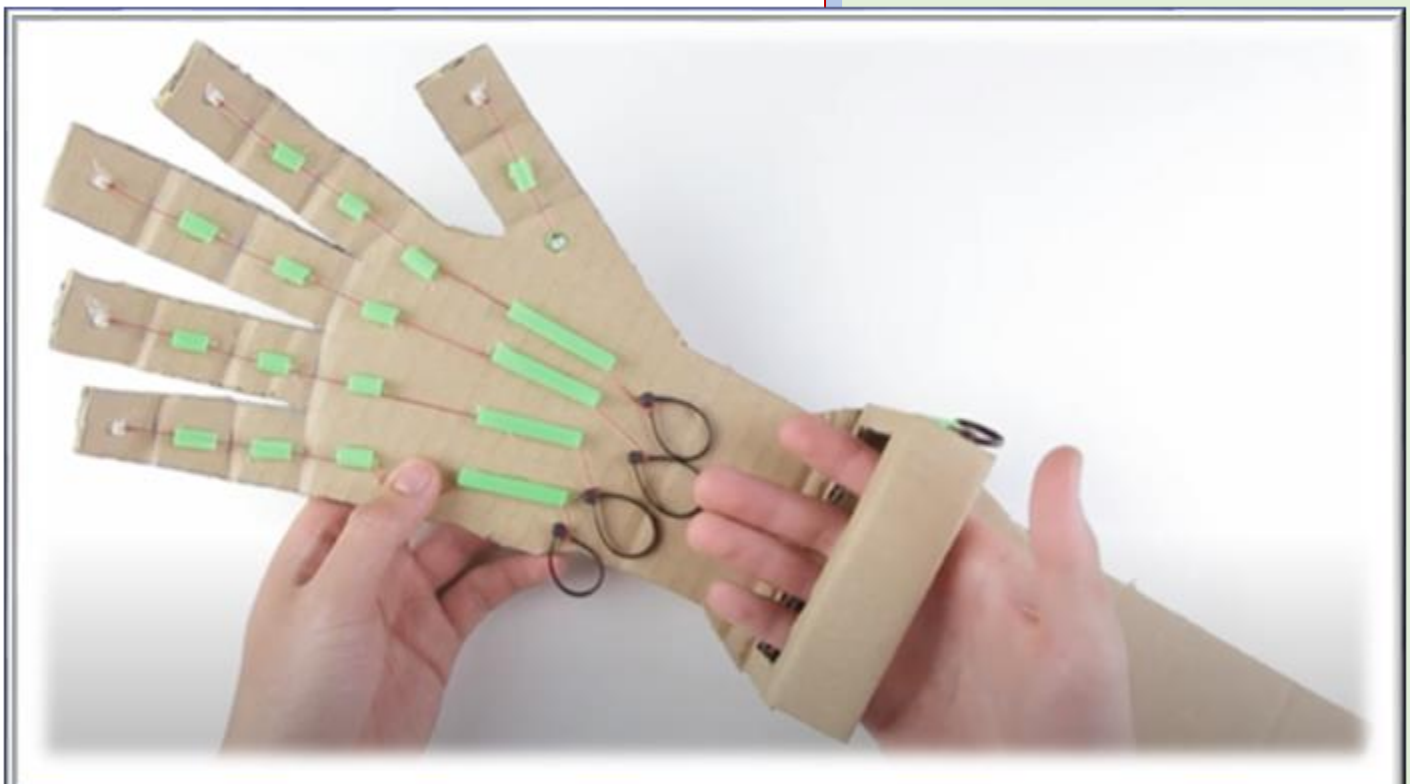
Idea Packet Sponsored by:

FPL

Robotic Cardboard Hand Model Build

High School Physics, Middle School Science, & Elementary STEM Labs

Robotic Cardboard Hand



Rebeca G. Hernandez

William H. Turner Technical Arts High School

Table of Contents

Introduction

HISTORY

Robots exist to study complex dynamic applications that have been created in many styles and sizes, with their designs governed by the overall functions. Since their inception robots have aided humans in improving automation of products, education, medical fields, agriculture, public service, industrial applications, and many other technological applications. Typically, robots usually work in industry and behind the scenes in many different types of jobs to facilitate workload. Some examples of robotic hands are in factories, construction, prosthetics, surgery, vehicles-transportation, among other applications.

RECENT RESEARCH

Electrical, mechanical, and software engineers investigate how to make robots move and work like humans, combining knowledge from several disciplines including physics, chemistry, biology, and other sciences. There is an increasing demand for repetitive work in which robots can function efficiently to improve production. Robots are also used in the arm forces, in public service fields, in science, and in industry where they are can do and go where it is dangerous for humans. Several other examples are the following: the DaVinci in surgery, the Boston Dynamics in the arm forces, the warehouse robots of Amazon Prime, the search and rescue robots used all around the world, the bomb squad robots, the robots that travel inside caves, around volcanos, inside the pyramids for scientific research, and even those that are used inside humans that are part of recent nano technology.

WORK

I was part of MDC STEM Academy in collaboration with Dade County Public Schools. As a result, I spent a week working with students, teaching the engineering process and the scientific process applied to models, and STEM style model creation with the application of several projects. Students had to create four different model prototypes, figuring out how to convert what they had previously learned into working models. These activities that can be done in high school physics, can also be done in middle school, or even elementary. They provide students with hands-on STEM experience and engineering experiments while exposing them to sample models of different STEM careers (science, technology, engineering, and math). This report features an example of a robotic hand made from cardboard, straws, string, tie raps, and glue gun glue that can be modified for any classroom.

IN THE CLASSROOM

The Robotic Cardboard Hand model can be reproduced in your classroom. Having students produce their own robotic cardboard hand provides them with hands-on activities and engineering experimental applications while exposing them to career opportunities in STEM (science, technology, engineering, and math).

This Packet contains several lab activities that were modified by me to have students interact, collaborate, and explore a side of science and technology that most have never done before. Students explore the physiology, anatomy, functionality, and applications of robotic hands. They build their robotic hands and then attempt to use them in different functions. Students then describe, draw, and explain their observations. Students realize how forces, pressure, elasticity, spring-like movements, and the speed at which their cardboard hands can move are critical to their design. Calculation applications depend on the grade level of the students and the class at which they are doing their project. The teacher is free to apply the appropriate grade level math and science concepts that will aid the students in how robot interactions affect our daily lives.

Robotic Cardboard Hand

(High School Physics & Honors Physics)

HISTORY / THEORY

Robots exist to study complex dynamic applications that have been created in many styles and sizes, with their designs governed by the overall functions. Since their inception robots have aided humans in improving automation of products, education, medical fields, agriculture, public service, industrial applications, and many other technological applications. Typically, robots usually work in industry and behind the scenes in many different types of jobs to facilitate workload. Some examples of robotic hands are in factories, construction, prosthetics, surgery, vehicles-transportation, among other applications.

The first robotic arm, which Devol and Engleberger called the Unimate #001, was made in 1959.

ABOVE:

DEVOL & ENGLEBERGER

ABOVE:

UNIMATE ROBOTIC ARM BY DEVOL

Unimate introduced the first industrial robotic arm in 1961, it has subsequently evolved into the PUMA arm. In 1963 the Rancho arm was designed; Minsky's Tentacle arm appeared in 1968, Scheinman's Stanford arm in 1969, and MIT's Silver arm in 1974. Aird became the first cyborg human with a robotic arm in 1993. The Unimate was the first industrial robot ever built. It was a hydraulic manipulator arm that could perform repetitive tasks. It was used by car makers to automate metalworking and welding processes. The inventor was George Devol.

Robotic hands that appear and act like human hands are constructed in a way that makes them very similar to the real thing. In fact, most of these hands feature tendons (cables) and fingers that work together much like human hands do to open and close for the manipulation of objects. An end-effector, also called a robot hand, can be attached to the end of the chain. As other robotic mechanisms, robot arms are typically classified in terms of the number of degrees of freedom. A highly dexterous, human-like robotic hand with fingertip touch sensors can delicately hold eggs, use tweezers to pick up computer chips and crush drink cans. The hand could eventually be used as a prosthetic or in robots that use artificial intelligence to manipulate objects.

Most current robotic prostheses work by recording—from the surface of the skin—electrical signals from muscles left intact after an amputation. Some amputees can guide their artificial hand by contracting muscles remaining in the forearm that would have controlled their fingers. And also like the human hand, it has fingertip sensors. The hand is also just 22 centimeters long. Overall, it has 20 joints, which gives it 15 degrees of motion—it is also strong, able to exert a crushing force of 34 Newtons—and it weighs just 1.1.kg. Grasping various objects. A computer-controlled mechanical arm is called a robotic arm. However, a robotic arm is just one of many types of different mechanical arms. Mechanical arms can be as simple as tweezers or as complex as prosthetic arms. People who have lost have had an advanced mind-controlled robotic arm.

OBJECTIVES

- Build a working robotic hand model (from components provided)
- Apply Energy to Dynamics and Fluid Dynamics in a model robotic hand
- Qualitatively compare various positions and functionality of a working robotic hand model
- Explore applications of spring constant in robotic hand models
- Describe robotic hand functions, anatomy & Physical capabilities
- Calculate the pressure indirectly by using lab plastic syringes by attaching them to the strings, pulling, and having a spring scale attached to the other end for quantitative force values
- Calculate the spring force knowing the displacement of the string and/or fingers
- Calculate the spring constant from your values
- Research and explore spring constant applications in Robotic arms/hands

SC.912.P.12.1
Distinguish between scalar and vector quantities and assess which should be used to describe an event.
SC.912.P.12.2
Analyze the motion of an object in terms of its position and velocity as a function of time.
SC.912.P.12.3
Interpret and apply Newton's three Laws of Motion. Force and Pressure applications.
SC.912.P.5.2
Kinetic Energy (organization of matter)
SC.912.P.10.1
Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.
SC.912.P.10.2
Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantity.

PROBLEM STATEMENT

State your claim

HYPOTHESIS

State your "if", "then" statement.

MATERIALS

Cardboard	Glue gun and glue sticks
straws	Zip ties
scissors	String or thread

PROCEDURE

1	Obtain corrugated cardboard about 10” x 20”
2	Place left hand face down onto cardboard from elbow to fingertips (do the opposite for left handers)
3	Trace hand and arm image onto the cardboard
4	Cut out hand and arm (arm section straight, not thin)
5	Mark 3 lines for every finger where they bend and cut ½ way through on the back side of those line marks
6	Glue very small, cut pieces of straws onto the inner, bending part of the hand’s fingers (15 total)
7	Glue 4 long, cut pieces of straws onto the palm side of the hand, including the thumb’s part
8	Put string, thread, or yarn through the straws, glued to the tips and zip ties at the end that you will pull
9	Make sure that the string, thread, or yarn is about 20”, to give you plenty of “slack”
10	Place “wrist” section of cardboard onto main frame so that your hand can grab it as you pull the strings. The thickness and length of this box-like piece depends on the user’s hand size.
11	Calculate the pressure indirectly by using lab plastic syringes by attaching them to the strings, pulling, and having a spring scale attached to the other end for quantitative force values
12	Calculate the spring force knowing the displacement of the string and/or fingers
13	Calculate the spring constant from your values
14	Research and explore spring constant applications in Robotic arms/hands

PRELIMINARY QUESTIONS/DESCRIPTIONS

How can a robotic hand model be created and built?
What kinds of materials are needed to build a simple robotic hand model?
What type of forces are needed to have a robotic cardboard hand model function?
What effects does the cardboard robotic hand sustain when attempting to have it function correctly?
What types of robotic hands applications exist in the real world?
How can the pressure created onto the strings by pulling on them be calculated?
How can you obtain the force on the string and/or fingers of the cardboard hand when used?
How can you calculate the spring constant from your force and displacement values?

DRAWINGS OF SET UP (ON SEPARATE SHEET)

Students create a technical drawing of their robotic hand with borders, labels, and appropriate titles according to their grade levels.

DATA / CALCULATIONS

Obtain the following values for the robotic hand when pulling on the strings with a spring scale and measure one of the displacements between straw sections in meters.

Note: To find the Spring Constant use **F = -kX** where F is the force applied, X is the distance or displacement, and k is the spring constant. The spring constant is found by dividing the Force by the displacement/distance the string moves from an original position to another making it unitless.

Finger	Distance (m)	Force (N)	Spring Constant
Thumb			
Pointer			
Middle			
Ring			
Little			

ANALYSIS / OBSERVATONS / RESULTS

1. Describe your observations.
2. Draw your observations, including the hand's function, motion, and ability to hold objects.
3. Explain your results.

CONCLUSION (STEAM OR ENGINEERING)

1. State whether your hypothesis was correct or incorrect.
2. What basic, fundamental law / scientific principle is behind your reasoning for your stated claim / hypothesis for your data / observations are evident?
3. Suggest a new research question or a new hypothesis
4. Suggest a new way to modify the experiment.

EXTENSIONS (STEAM OR ENGINEERING)

5. Use other materials to build another robotic hand.
6. Investigate types of robotic hands used in real life.
7. Investigate the ability of robotic hands to lift and carry objects and how they can do this.
8. Design a robotic hand to do other applications (high school or honors).
9. Design a vex robotic hand that can help improve our everyday lives.
10. Program the vex robotic to pick up different objects
11. Research YouTube Robotic Hand videos and create a power point with research and descriptions of recent applications.

Robotic Cardboard Hand
(Middle School Physical Science)

HISTORY / THEORY

Robots exist to study complex dynamic applications that have been created in many styles and sizes, with their designs governed by the overall functions. Since their inception robots have aided humans in improving automation of products, education, medical fields, agriculture, public service, industrial applications, and many other technological applications. Typically, robots usually work in industry and behind the scenes in many different types of jobs to facilitate workload. Some examples of robotic hands are in factories, construction, prosthetics, surgery, vehicles-transportation, among other applications.

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- Describe robotic hand functions, anatomy & Physical capabilities

BENCHMARKS

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9	Make sure that the string, thread, or yarn is about 20", to give you plenty of "slack"
10	Place "wrist" section of cardboard onto main frame so that your hand can grab it as you pull the strings. The thickness and length of this box-like piece depends on the user's hand size.

PRELIMINARY QUESTIONS/DESCRIPTIONS

How can a robotic hand model be created and built?
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DRAWINGS OF SET UP (ON SEPARATE SHEET)

Students create a technical drawing of their robotic hand with borders, labels, and appropriate titles according to their grade levels.

ANALYSIS / OBSERVATONS / RESULTS

1. Describe your observations.
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CONCLUSION (STEAM OR ENGINEERING)

1. State whether your hypothesis was correct or incorrect.
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3. Suggest a new research question or a new hypothesis
4. Suggest a new way to modify the experiment.

EXTENSIONS (STEAM OR ENGINEERING)

1. Use other materials to build another robotic hand.
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4. Design a robotic hand to do other applications (high school or honors).
5. Design a vex robotic hand that can help improve our everyday lives.
6. Research YouTube Robotic Hand videos and create a power point with research and descriptions of recent applications.

NOTE: The cut straw cannot be too large or the cardboard or cardstock paper that is used by the students will not bend correctly.

Robotic Cardboard Hand 1st SAMPLE LESSON PLAN (You can modify)

Lesson Plan: Wind Engineering	**Teacher:** Rebeca Hernandez	**Date:**

Objective (s):
SC.912.P.12.1
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Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantity. ***Cognitive Complexity:*** Level 2: Basic Application of Skills & Concepts
Cognitive Level: High

Student(s) Should be able to:

- Build a working robotic hand model (from components provided)
- Apply Energy to Dynamics in a model robotic hand
- Qualitatively compare various positions and functionality of a working robotic hand model
- Explore applications of spring constant in robotic hand models
- Describe robotic hand functions, anatomy & Physical capabilities

Next Generation SSS Standard(s):
Standard 1: Practice of Science
ScC.912.N.1.1
SC.912.N.1.2
SC.912.N.1.5
SC.912.N.1.6
Standard 3: The Role of Theories Hypotheses, and Models
SC.912.N.3.5
Standard 10: Energy
SC.912.P.10.1
SC.912.P.10.2
And
SC.912.P.12.1-3

Agenda: (sequence of class activities)

I. Demo
II. Lecture
III. Measurements
   A. Of cardboard cutting larger than hand & arm length
   B. Fingers should be an inch longer than the original person's
IV. Home Learning:
   A. Lab writeup – finish it
   B. Work on CRISS 3-column style vocabulary

MATERIALS

Cardboard	Glue gun and glue sticks
straws	Zip ties
scissors	String or thread

Strategies:
Class Discussion
Lecture
Demonstration
Group work
Individual Instruction
CRISS vocabulary
Technical Drawings

Assessments:
Observation
Paper
STEM model building
Lab process

Daily Physics Strategies/ Routines:

(pacing guides)
Modeling building
Socratic dialogue
Engineering process
inquiry
cooperative groups

VAKT
Visuals, hands on
Small groups sharing
Clustering problems
Report writing
drawing

Lab Activity:

1	Obtain corrugated cardboard about 10" x 20"
2	Place left hand face down onto cardboard from elbow to fingertips (do the opposite for left handers)
3	Trace hand and arm image onto the cardboard
4	Cut out hand and arm (arm section straight, not thin)
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10	Place "wrist" section of cardboard onto main frame so that your hand can grab it as you pull the strings. The thickness and length of this box-like piece depends on the user's hand size.

Vocabulary:

Motion
Force
tension
Pressure
Extension
Pull
Push
hold
Spring force
Energy
Kinetic energy
Potential energy
Elastic potential energy
Dexterity
Spring constant (high levels)

ESE / ESOL / SPED:

Log Journal
Word Wall /under TV sharing VAKT
Report Writing
Concept Building
Small Groups

Robotic Cardboard Hand 2nd SAMPLE LESSON PLAN (You can modify)

PROJECT PLAN: ROBOTIC CARDBOARD HAND	TOPIC: ROBOTIC CARDBOARD HAND MODEL BUILD	Subject: Applications of forces in robotic technology
Enter your concept map of unit idea here	TEACHER	Rebeca G. Hernandez
Hands-on building a robotic cardboard hand model, make it functional, tested for force, pressure, spring constant, and work-energy application of grabbing an item or multiple items. Qualitatively analyze the functionality of a robotic cardboard hand model. Obtain quantitative measurements for the forces applied onto the fingers whith a spring scale.	GRADE	9, 10, 11, & 12 {can be used in Middle School}

KEY LEARNING(S)	UNIT ESSENTIAL QUESTIONS	OPTIONAL INSTRUCTIONAL TOOLS
Scientific Method to STEM/STEAM application Force, Pressure, Spring Constant, and Work-Energy applications Function analysis of robotic cardboard hand model when applying usage with different objects. Research real world applications of robotic hands/arms.	How can a robotic hand model be created and built? What kinds of materials are needed to build a simple robotic hand model? What type of forces are needed to have a robotic cardboard hand model function? What effects does the cardboard robotic hand sustain when attempting to have it function correctly? What types of robotic hands applications exist in the real world?	• Build a working robotic hand model (from components provided) • Apply Energy to Dynamics in a model robotic hand • Qualitatively compare various positions and functionality of a working robotic hand model • Explore applications of spring constant in robotic hand models • Describe robotic hand functions, anatomy & Physical capabilities • Draw a simple technical drawing of the robotic hand model created

CONCEPT #1	CONCEPT #2	CONCEPT #3	CONCEPT #4
Motion, inertia, speed, velocity, & acceleration	Force	pressure	Energy/Spring Constant
LESSON ESSENTIAL QUESTIONS #1	**LESSON ESSENTIAL QUESTIONS #2**	**LESSON ESSENTIAL QUESTIONS #3**	**LESSON ESSENTIAL QUESTIONS #4**
How can we build a robotic cardboard hand that can pick up light objects?	How do forces and pressures affect the ability of a robotic hand to function? What force interactions occur when a robotic hand is being used in different applications?	What pressures can a robotic cardboard hand apply when picking up objects?	How do spring-like forces and spring constant analysis affect the ability of a robotic hand to function?
VOCABULARY #1	**VOCABULARY #2**	**VOCABULARY #3**	**VOCABULARY #4**
Motion, inertia, speed, velocity, & acceleration vectors	Force, momentum, area, spring constant	Pressure, force, area, pressure gradient, contour lines, spring constant	Moments, torque

ADDITIONAL INFORMATION

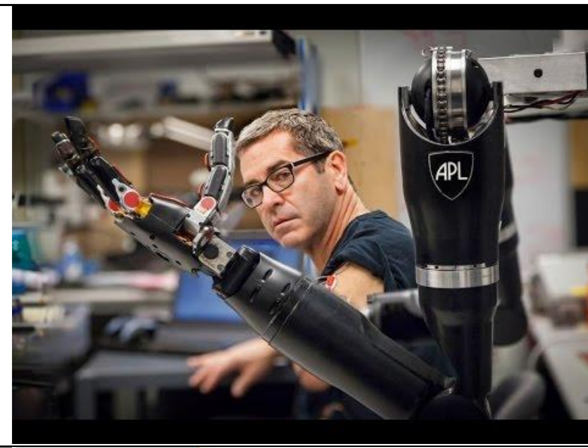
- Different styles of robotic cardboard hands that are applicable to the grade level
- Models of robotic hands seen on YouTube videos can further help teacher preparation

GENERAL SAMPLE LESSON PLAN (You can modify)

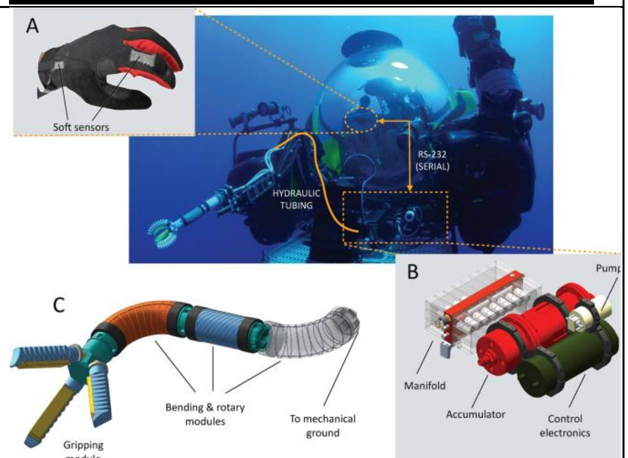
Lesson Plan: **Robotic Cardboard Hand**	**Teacher:**	**Date:**
Objective (s):	**Student(s) Should be able to:**	**Next Generation SSS Standard(s):**
Agenda: (sequence of class activities)	**Strategies:** _A/V Materials _Board work _Class Discussion _Demonstration _Group work_ ESOL_ ESE_EOC _Lecture _Library Assignment _Review_ DATA chat _Silent Reading _Student Presentation _FCAT _Individualized Instruction_ EOC_ CRISS/reading **Assessments:** _paper _observation _Class Work _Internet _Quiz _Test (exam)_Research Project __Lab _Student Presentation _Research Project _Board Builder Project_ Technology Software _Excel Printout _Research Project _Vernier Printout _Student Research Poster	**Daily Physics Strategies/ Routines:** **(pacing guides)** Modeling pedagogy Socratic dialogue white-boarding inquiry cooperative groups
Agenda: (sequence of class activities)	**Vocabulary:** Pressure Motion Force tension Pressure Extension Pull Push hold Spring force Energy Kinetic energy Potential energy Elastic potential energy Dexterity Spring constant (high levels)	**ESE / ESOL / SPED:** Log Journal Word Wall /under TV sharing VAKT Report Writing Concept Building Small Groups

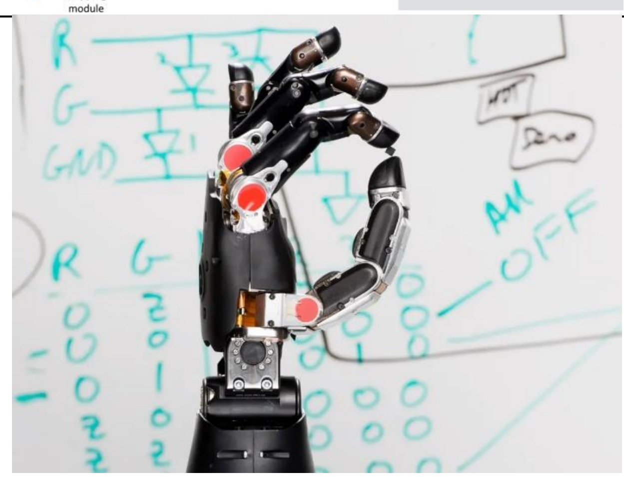
PICTURES

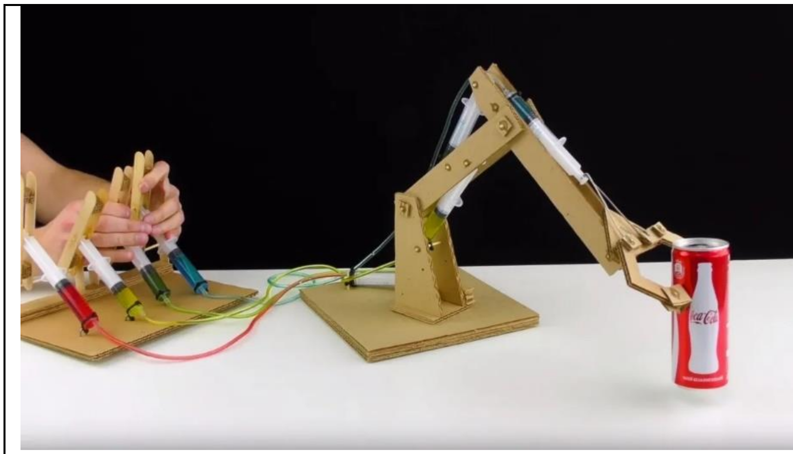

CANADARM2
SPACE STATION ROBOTIC ARM
Canada
HTV3


APL


RobotWorx


A
Soft sensors
RS-232
(SERIAL)
HYDRAULIC
TUBING
B
Manifold
Accumulator
Control
electronics
C
Bending & rotary
modules
To mechanical
ground
Gripping
module

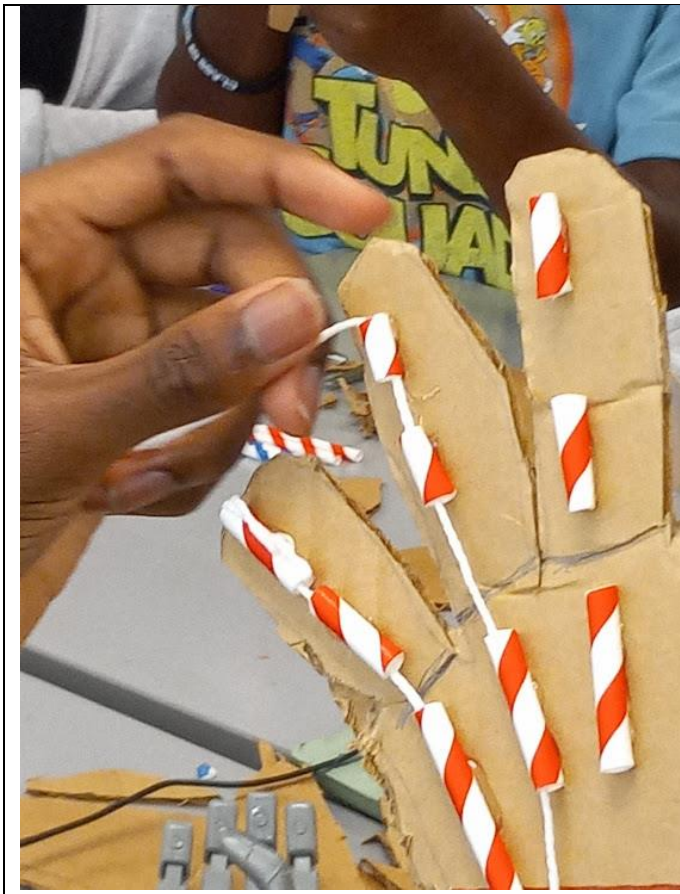





MDC STEM ACADEMY

Helping students at MDC create robotic cardboard hands

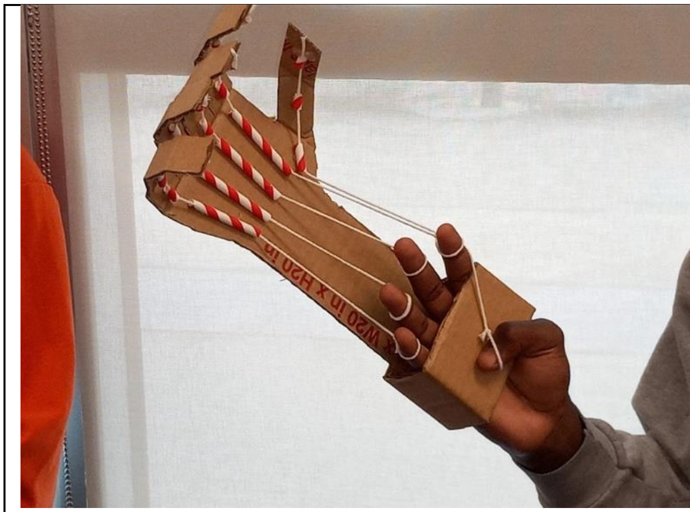
students measure & cut their cardboard hands



pulling string through straws in cardboard hand

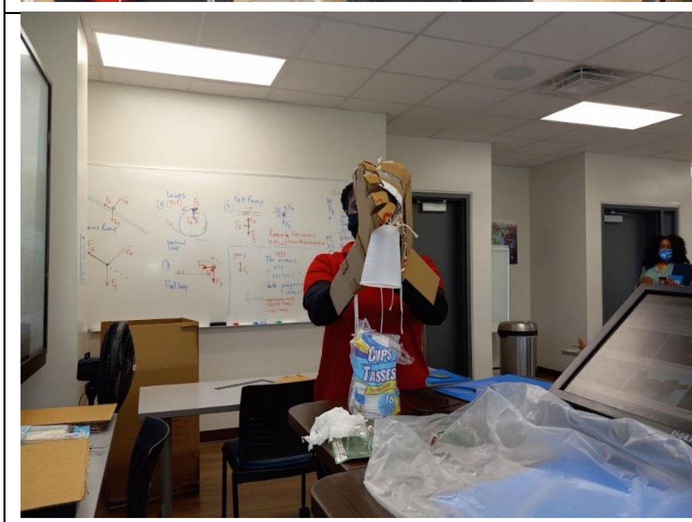

testing hand


testing hand



pulling strings to move fingers

practicing motion



practicing holding


holding plastic cup with 2 hands


all done and happy

GENERAL INFORMATION:

General Procedures: (for any level)

1	Obtain corrugated cardboard about 10" x 20"
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9	Make sure that the string, thread, or yarn is about 20", to give you plenty of "slack"
10	Place "wrist" section of cardboard onto main frame so that your hand can grab it as you pull the strings. The thickness and length of this box-like piece depends on the user's hand size.

Note: There are many variations to the thumb section, including one that has bending straws as part of the set up. Be careful to not have the string scrape too much onto the cut portion of the straws.

Note: Depending on the age group, different styles of scissors will be used and different levels of pre-preparations by the teacher will be needed.

Basic Dimensions:

The size of the robotic cardboard hand depends on the student creating it and is proportional to that person's hand.

Note: ignore the black box number! It dues NOT apply to your tunnel

Possibilities / Modifications

1. Different Materials: The robotic hand can be made from any alternate materials (cardstock sheet, paper, flannel, etc.).
2. Different Scales: Larger robotic hands can be made with larger budgets. Simply scale up all the given dimensions.

SITES

https://www.youtube.com/watch?v=rJmcfpTzv9A, Pro Robots, YouTube, "Robots like humans [TOP 10 androids that replace people] The robot era has com, June 2022.

Googles

note: email me if you need HELP!!! Or just text me at 786-775-1977.
Love_physics@dadescools.net
DO NOT HESITATE TO CONTACT ME IF YOU HAVE ANY PROBLEMS!