



Lighthouse Community Public Schools

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LINKAGES

A Guide from the Creativity Lab

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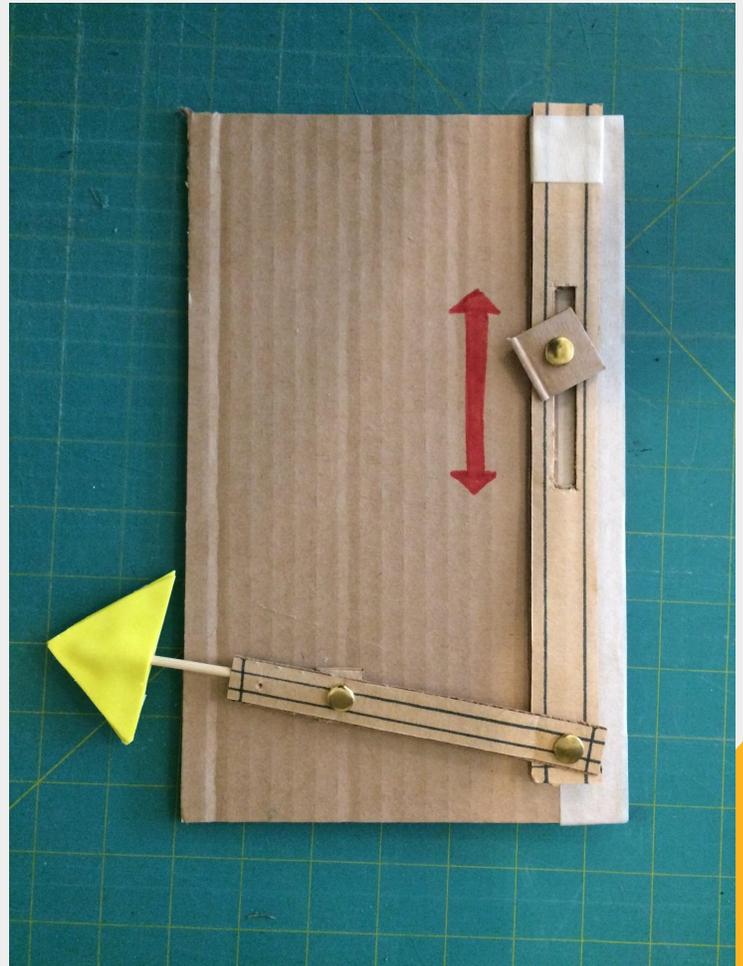
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Based on

A Look @ Linkages from the Tinkering Studio



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About This Project

Linkages are an introduction to mechanical motion and are a fun way to connect to STEM learning.

The project is versatile as it can be created from different accessible materials, from cardboard and popsicle sticks to wood and LEGOs. The complexity also varies, from simple back-and-forth linear motions to complete cams with rotary motion. Introducing linkages leads to experimentation in types and combinations of mechanics used, and what the final product is (A moving hand? A flapping butterfly? A bicycle?)

Linkages are connected to physics, geometry and to concepts of transmission of motion mechanics. A good first step would be to introduce students to different kinds of motion transmission and have them replicate them.

Our Story

Our linkage project is based on our experience at the Tinkering Studio at the Exploratorium, where Amy Dobras spent time creating examples for the Creativity Lab. She encouraged us to create a Linkage activity for the East Bay Mini Maker Faire 2017. The results were good, but we think defining a theme for the project is best: e.g. "Let's create moving animals" or "let's create a drawing-machine". We conducted this activity with the Middle School Robotics class and with High School students. In Middle School the activity was done in two sessions: the students were given a more creative prompt, and, after seeing some examples, created very different linkages with inventive characters and storylines.

In High School, the linkage activity was connected to Yoga and human anatomy. Students were asked to think about motion and mechanics in the body and replicate them through a linkage.

Materials & Tools

MATERIALS

- Cardboard bases 6"x10"
- Cardboard strips $\frac{3}{4}$ "x $5\frac{1}{2}$ "
- Cardboard strips 1"x 10"
- Brads
- Bamboo skewer
- Foam sheets
- Hot glue
- Rubber bands
- Plastic cups
- Cardboard tubes (toilet or paper towel rolls)
- Other craft materials

TOOLS

- Awls (for hole punching)
- Cardboard cutters or knife
- Markers
- Hot glue gun

Learning Targets

- I can explore complexity.
- I can explore playfully without a preconceived plan.
- I can learn from mistakes and follow unintended paths.
- I can create a working linkage that conveys ideas, feelings, and/or personal meaning.

TIME: 60+ mins



Context: Before we make...

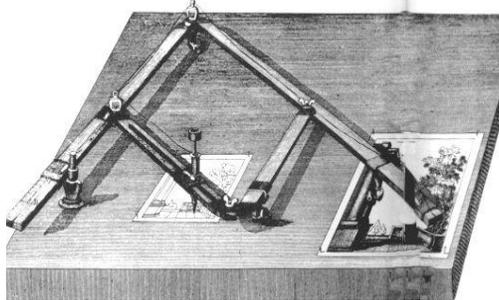
A mechanical linkage is an assembly of bodies connected to manage forces and movement. Perhaps the simplest linkage is the lever, which is a link that pivots around a fulcrum attached to ground, or a fixed point. Linkages have real-life applications such as scissor-lifts, pantographs, and bicycles. Linkages are also present in the human body (joints).

[Making Linkages](#)

[Linkages and Scribble Bots](#)



[Linkages @ Tinkering Studio](#)



[Creating a Pantograph](#)



[Types Of Linkages](#)

Material Management

- Pre-cut cardboard sticks and bases to size. Other materials can be cut and assembled by the students. If anything runs out during the class have the students prepare them.
- Consider separating materials and tools in the classroom, and think about what can be directly accessible to students, and what should be distributed or supervised by a teacher.
- Consider using alternatives to cardboard. Popsicle sticks look good but are time-consuming to prep. Toilet and paper towel rolls are good, as are cups and straws.
- Spare ten minutes towards the end of the class to have students clean up and organize the tools. .
- Save student work in a bin (have them label it) so they can work on their project later

How to Introduce New Tools & Tech SAFELY

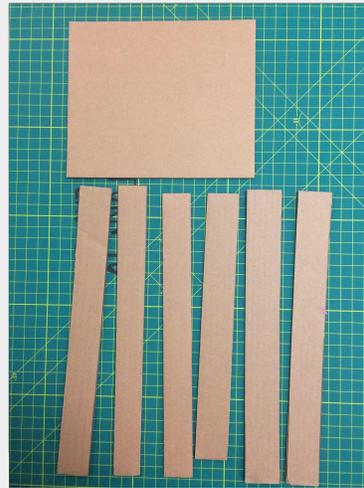
Certain tools used in Linkages could potentially be dangerous. Pay particular attention to the use of:

- **Awls:** they are sharp and shouldn't be carried around. Students should use them with a foam board underneath as to not damage any surfaces.
- **Box cutters and x-acto knives:** remind students to use cutting mats
- **Hot glue gun:** low-heat glue guns are suitable for this activity.

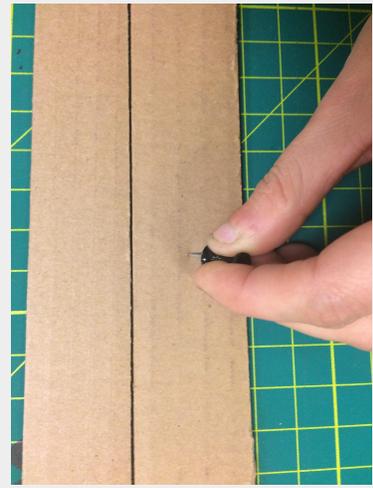
Step-By-Step Guide

This step-by-step guide illustrates how to make a specific type of linkage, a **scissor lift**. This is a basic tutorial that shows more the techniques of creating a linkage. Don't feel limited by the final product, and feel free to take any techniques and materials shown here to recreate different kinds of linkages.

1. Cut cardboard to size
 - a. **Base** (optional)
 - b. **Strips**. You will need at least six equal-sized pieces.
2. Use a push pin or awl to poke through the center of two strips.
3. Join them with a brad to form an "X"
4. Do this with the other cardboard strips
5. Join the top of one "X" to the bottom of another "X".
6. Continue joining however many "X"s you have.



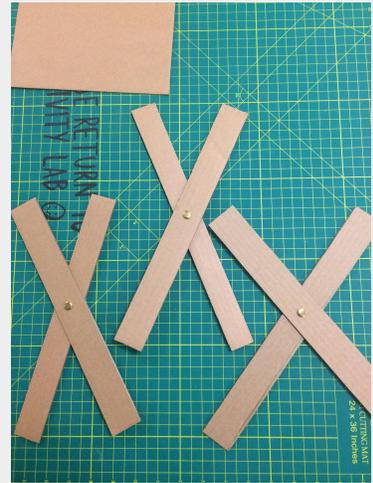
1.



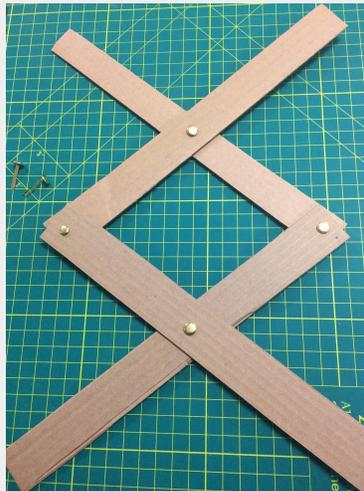
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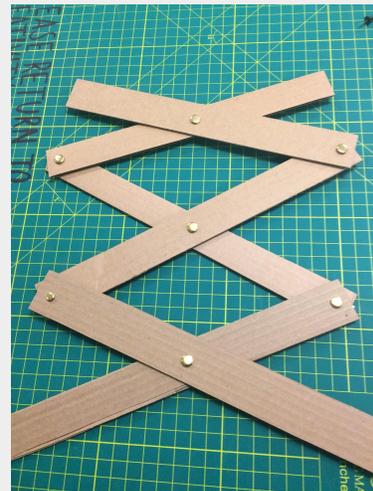
3.



4.



5.



6.

Linkages with Older Students

Linkages is a motion activity that invites students to focus on movement, forces, interactions between parts etc.. For our Yoga and Fitness module, High School students were shown parts of the skeletal system, how joints work, and other anatomical notions, and were asked to replicate specific parts of the body. Providing a prompt often helps with the design process, but can limit creativity; try to find a balance between direction and freedom for the students. For High School the "theme" was the body; for other grades it can vary from animals, invented characters and storylines, etc.

Other online examples of linkages:

[Make Magazine](#)

[Youtube Directory For Linkages](#)

[507 Mechanical Movements](#)

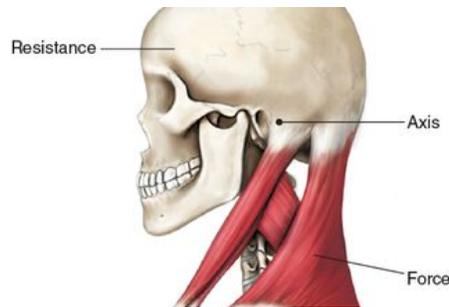
[Definition of a Mechanical Linkage](#)

[Notions of Mechanical Movement](#)

[Examples of Linkages](#)



[Linkages @ the Exploratorium](#)



[Levers in the Human Body](#)



[Linkages and Robotics](#)

Examples of Linkages based on human anatomy created in 9th and 10th grade with the Fitness class. Bones, muscles, ligaments and joints were recreated with different materials.



Standards Assessed in Linkages

For the Middle School, the Standards assessed were:

- Complexity of linkage
- How well the linkage fit into your design to create a realistic motion + feeling
- Visual appearance of linkage

For High School, the Standards assessed were:

- Complexity of linkage
- Understanding of human mechanics (bones, joints, muscles, tendons etc...)
- Visual appearance of linkage