

# Paper Mechatronics: Paper Pals

*Recycle. Reimagine. Reinvent.*

Prototyping innovative movement and ambulation concepts with cardboard

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## Customer & User Needs

- The kit should be easy to assemble (ages 8-18).
- The kit should be low-cost.
- The kit should be educational.
- The kit should encourage creative design.

## Market Hypothesis & Business Model

We believe our prototypes will be popular because of their integration of papercrafts with mechatronics and creative forms of energy. Users will be inspired by these representative ideas as means to make animal robots move with easy-to-use materials.

## Triple Bottom Line Analysis

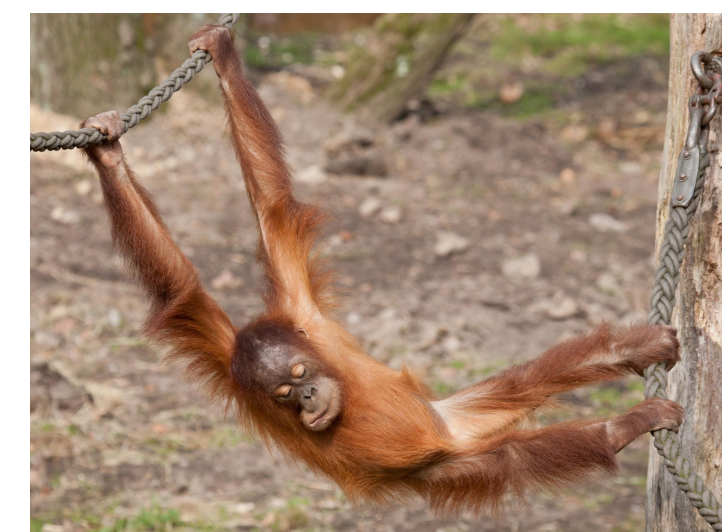
- **Social**
  - Makes educational resources accessible to lower-income, underserved communities, e.g. urban public schools
- **Environmental**
  - Recycled/reusable materials
- **Financial**
  - Affordable by the general public
  - “Employers” contained to researchers e.g. Concord Consortium
  - Simple assembly means room for design growth, scalability

## Lessons Learned

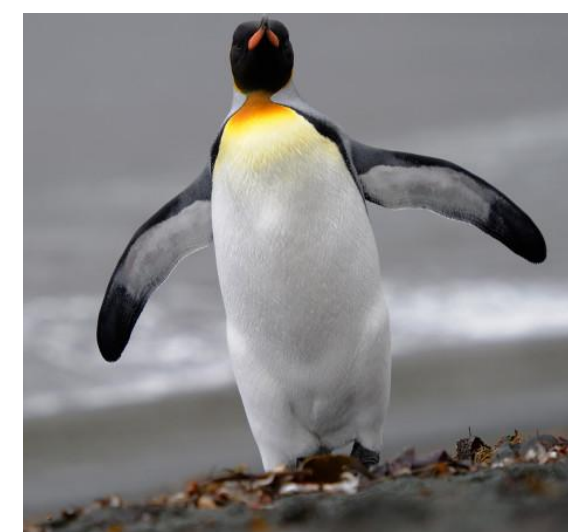
- Providing the right amount of guidance to the user to enable accomplishment while still allowing creativity is a tricky balance
- Kids struggle with unfamiliar materials and tools
- It’s important not to dismiss an idea too quickly
- Customers and users may be different and it’s important to distinguish early on
- It’s important to satisfy needs of customers, users, and sponsors.
- Mechanisms must be fine tuned when created with less robust materials.

## Imitating animal movement with paper

EASY



Swinging



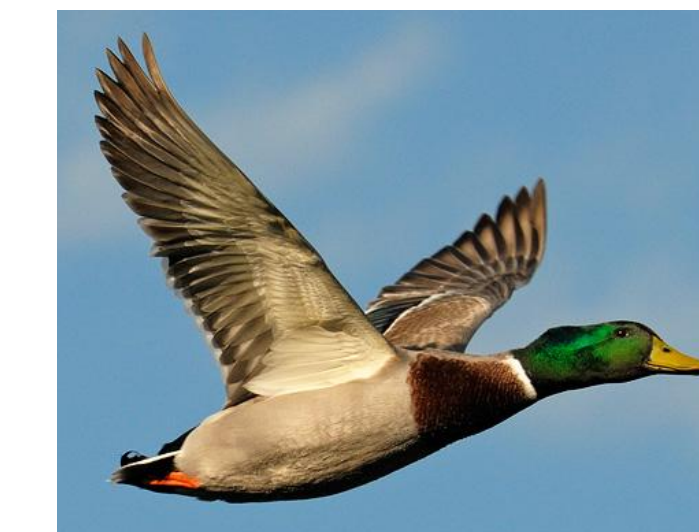
Waddling



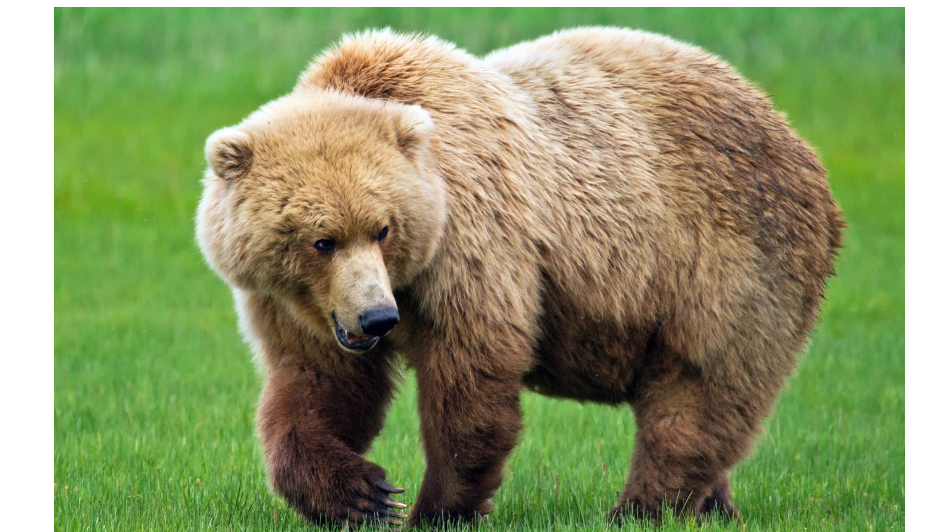
Hopping



Bipedal Hopping



Flying



Quadrupedal walking

DIFFICULT

### Concept Selection

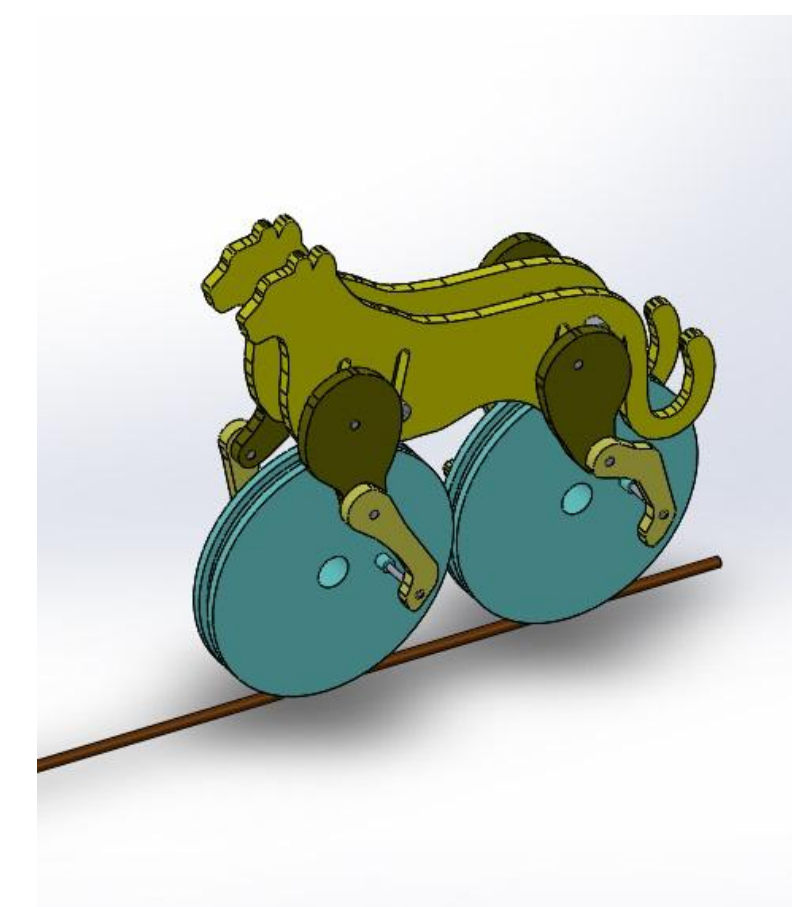
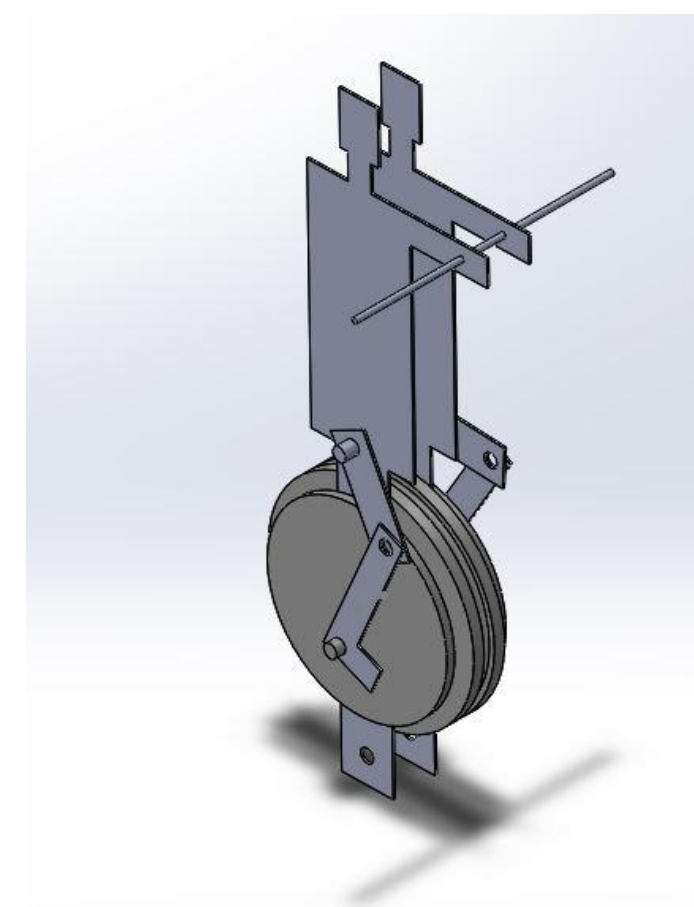
- Relatively easy to assemble
- Clearly identified as an animal
- No special tools required
- Use a mix of laser-cut parts and self-cut parts
  - Laser cut for precision
  - Self-cut for creativity

### Materials

- Cardboard
- Wooden dowels
- String & wire
- Washers
- Glue/tape

### Gravity as a driving force

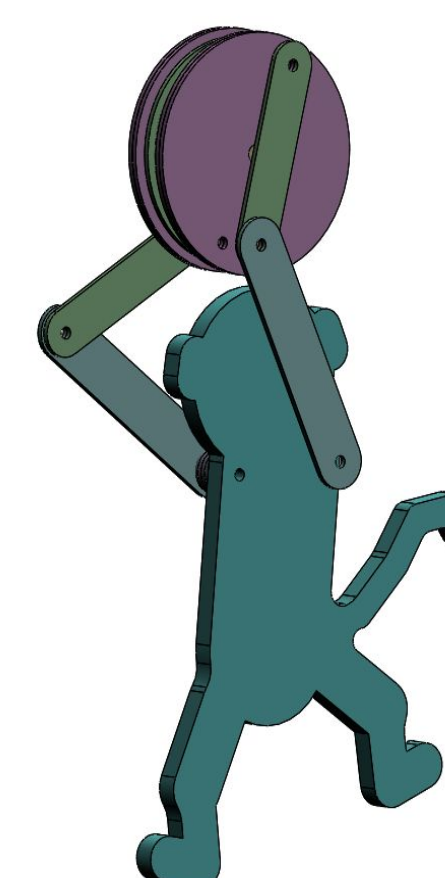
We wanted to make the kits as accessible as possible so we use gravity to drive the motion of the animals. Simple electronics, such as motors and LEDs can be added to both improve performance and widen the scope of education.



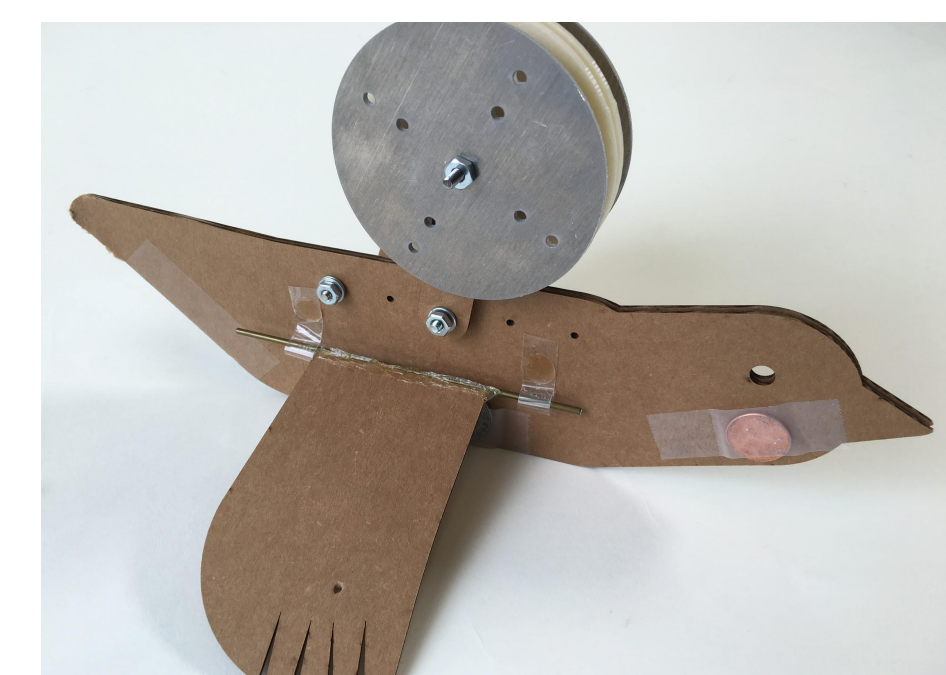
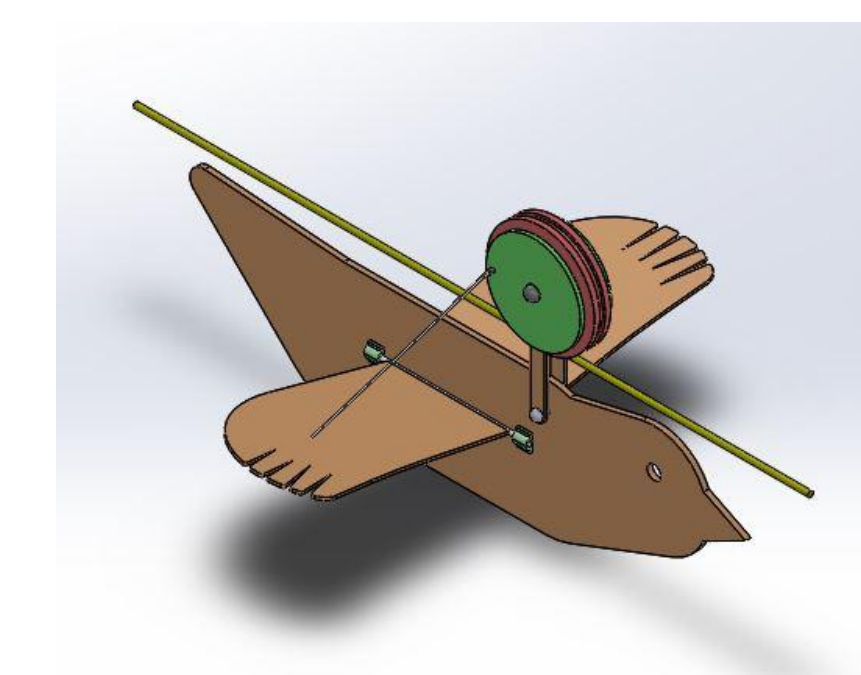
### Pulley system

Using a pulley and wire, we can achieve different kinds of motion as the pulley rolls down the string:

- Flapping wings
- Single and multi-joint limbs
- Hanging/swinging
- Walking (multiple pulleys)



Note: original Kangaroo template found on Instructables

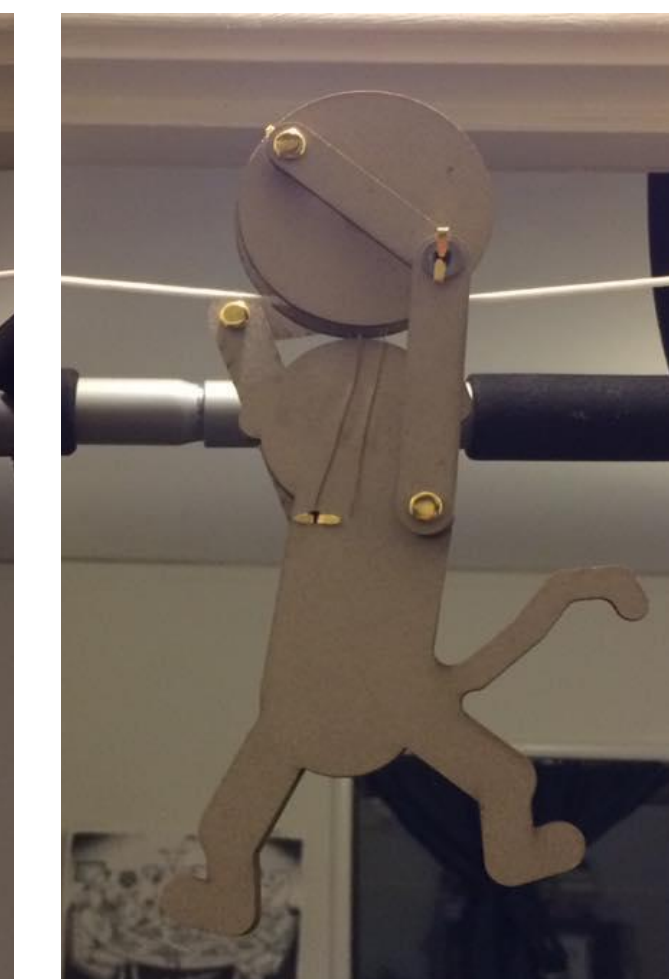
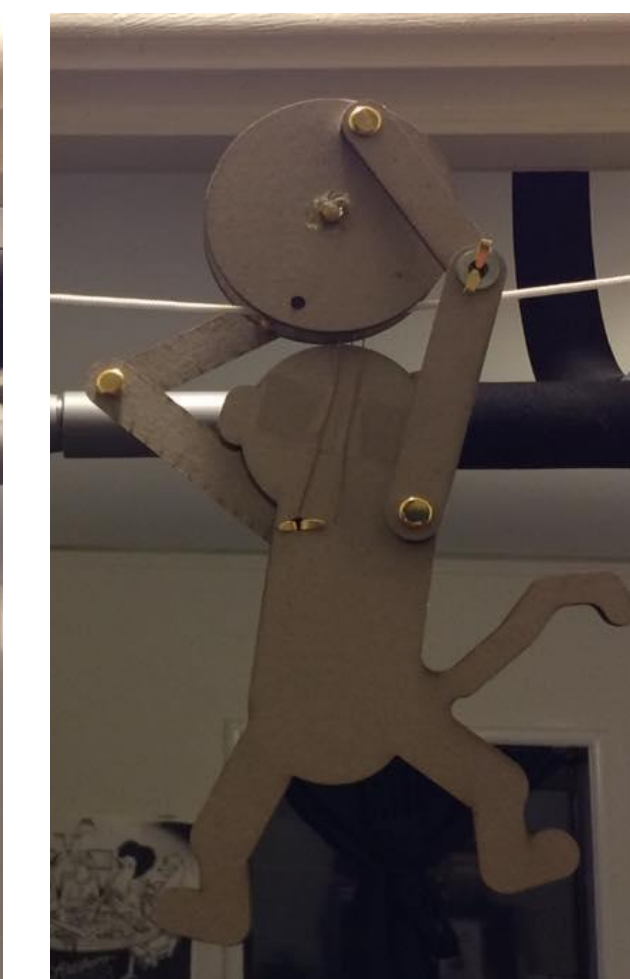


### Whats in a kit?

- Several precision laser-cut parts for linkages/joints
- Some pre-cut or perforated animals to start with
- Instruction/inspiration booklet

### Hopping system

- Rear legs of animal move back and forth as the animal “hops” down an incline.
- Simple on the outside, but needs precise balance to be effective.
- Variation with puzzle piece and perforation concepts



### Swinging chimpanzee design

- Only 6 unique cardboard parts
- Could add another pulley to this design to make an animal which hangs on all four limbs (sloth)