

Automata with PVC Pipe Base

Shared by: Edgerton Center K-12 Maker Team

Specialized tools and materials used:	Experience level required:
Drill	Beginner/intermediate
Craft materials (card stock, foam sheets, markers, hot glue, craft tape, hole punch, scissors or cutting tool)	Beginner/intermediate
Wood dowels, 1/4" diameter	Beginner
PVC pipe and joints, size 1/2"	Beginner
Clear PVC tubing (1/4" ID, 3/8" OD)	Beginner

Grade Level and Subject (of this example): 9th Grade Literature

Topic/Content Standards (for this example): Mechanical design, abstract modeling



Macbeth, Act IV scene i



Common automata motions

Summary of Project:

Students will design and create machines with moving objects/characters that symbolize abstract concepts and represent dynamic situations. These machines, called *automata* or *cam toys*, use hand-powered mechanisms to create cyclical motions that animate a scene (see [simple](#) and [complex](#) examples). Cams are rotating shapes that push on or rub against

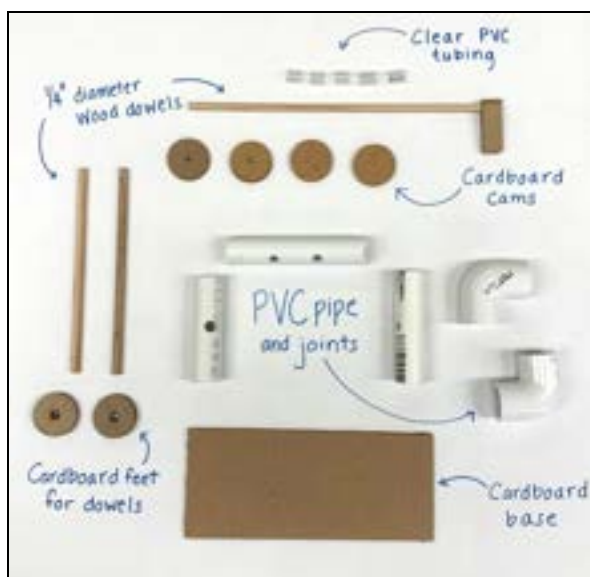
mechanical elements to create other motions. One rotating *drive shaft* can power many cams, and each cam can create a different motion in its associated mechanical element.

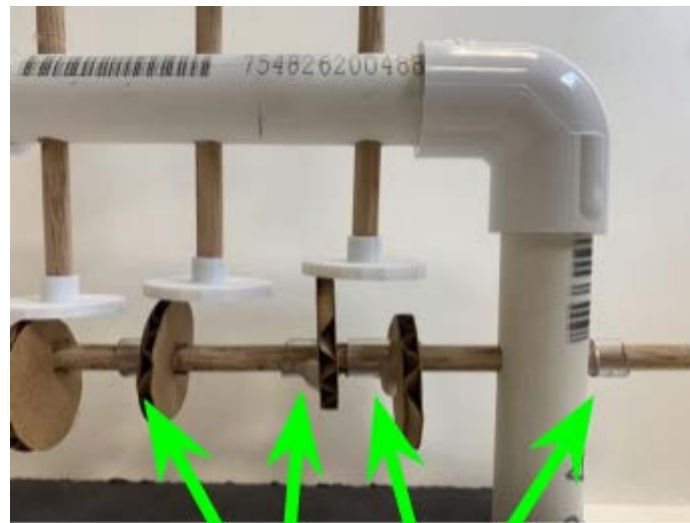
This design uses inexpensive PVC pipe and fittings and is a modern take on a classic craft machine. Traditional automata bases are made with wood pieces or cardboard, both of which require clean cuts and 90° corners. The use of PVC pipes and 90° angle fittings eliminates the need for clean perpendicular cuts, the use of wood cutting tools, and the production of sawdust. Ratcheting PVC pipe cutters are inexpensive, do not require much strength, and create clean cuts. The cut ends will not be exactly perpendicular, but the ones that go in the fittings don't matter, and the ones that get glued to the base can be adjusted with hot glue. The PVC pipe, fittings, and cutters are all easy to get at a hardware store such as Home Depot.

Automata models can show academic content, such as a depiction of a sound wave, or could represent abstract concepts, like a balance of power, ecological interactions, or societal changes. Students investigate the motions and mechanisms that are possible, match motions to the concepts or characters they are depicting, then fabricate with a combination of craft materials and PVC pipes.

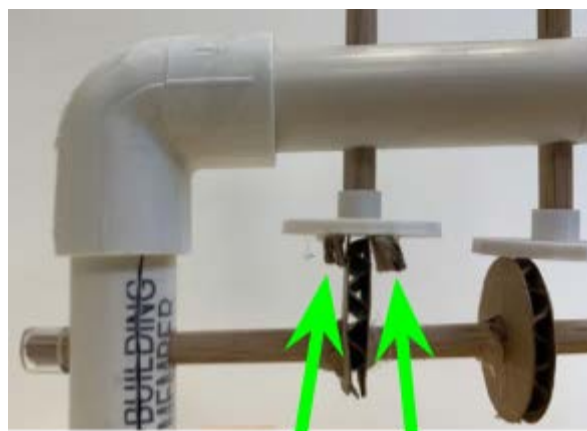
Instructors may want to create a series of requirements and parameters for students to meet, such as creating multiple characters or objects, including more than one form of motion (spin, side-to-side, up-down), and varying the range of motion (speed, height, frequency). This project may be completed individually or in groups of 2-3 students. Depending on students' experience with mechanical design and fabrication, this project should take approximately 2-3 hours.

Encourage students to test each other's automata, and see if they can figure out what they mean before the concept is explained.





clear PVC tubing keeps the dowel and cams in place



cardboard guard rails keep the up/down cam steady



Suggested resources

- Example automata in action: [Sample 1](#), [Sample 2](#)
- Step by step [guide](#) with photos
- Mechanical cam toys [Instructable](#)

Possible Content explorations

- **Science:** Chemical reactions, phases of matter, pollination/plant growth, cell processes, effects of climate change/rising sea level
- **Social Studies:** Change in power balance before/after conflict/event, social structures, reactions to social stresses like taxes/cultural oppression/work conditions, stewardship examples
- **ELA:** Scenes or animated characters from a story/novel/play/history
- **World Languages:** Cultural norms in world cultures, myths and legends