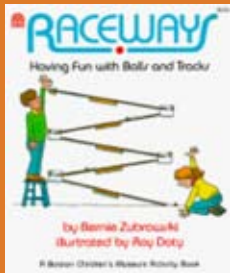


Marble Machines



Marble Machines was inspired by Bernie Zubrowski's book

Raceways: Having Fun with Balls and Tracks

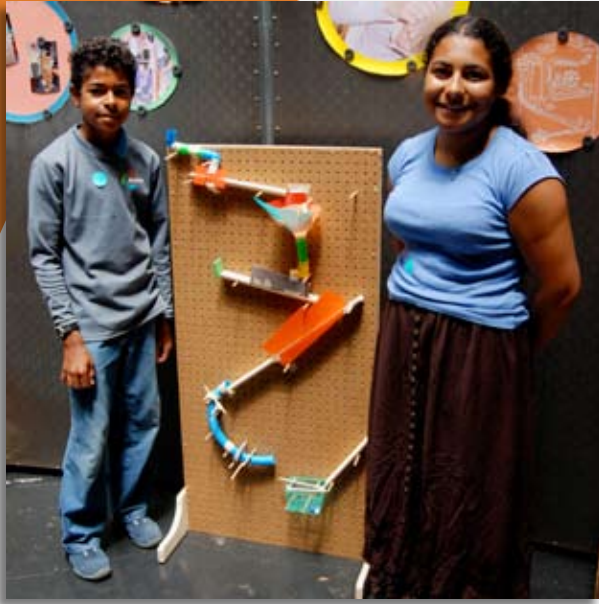


A Marble Machine is a creative ball-run contraption, made from familiar materials, designed to send a rolling marble through tubes and funnels, across tracks and bumpers, and into a catch at the end.



PIE Institute shares a playful and inventive approach to teaching science, art, and technology.





Collect & Make These Things

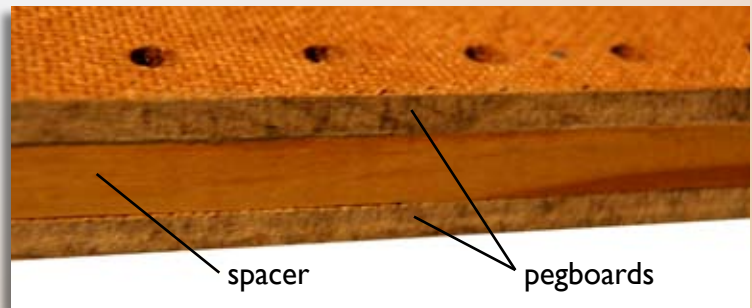
For the Board

(we use one board for every two participants)

- 2-foot x 4-foot (61 cm x 122 cm) sheets of pegboard with 1/4-inch (.6 cm) holes (two pegboards per board)
- 4-foot (122 cm) pieces of 1.5-inch x 1.5-inch pine (3.8 cm x 3.8 cm) (two long spacers per board)
- 21-inch (53 cm) pieces of 1.5-inch x 1.5-inch pine (3.8 cm x 3.8 cm) (two short spacers per board)
- wood glue, finishing nails, hammer
- 20-inch (51 cm) pieces of 1-inch x 6-inch (2.5 cm x 15.2 cm) pine, for the feet (two feet per board)
- 4 screws / screwdriver

Construction Notes

- Align both pieces of pegboard so the holes line up, separated on the edges by the pine spacers.
- Glue and tack the pegboard to the spacers.
- Connect the feet to the completed pegboard construction with screws. The feet can be rectangular or customized according to your preference.



For the pegs (about 20 per board)

Cut and sand 1/4-inch (.6 cm) dowels into 5-inch (13 cm) pieces

For the tracks (about 10 per board)

Cut 12-inch (30 cm) sections of cove molding
Cut 4-inch (10 cm) sections of cove molding

For the bumpers (about 10 per board)

Cut 3-inch (7.6 cm) pieces of pine





For the Tubes (5 per board)

Cut assorted lengths of copper pipe, plastic electrical conduit, or PVC (Polyvinyl Chloride) pipe for the marble to roll through.

Collect an assortment of fittings and connectors to fit the pipe.

Other things to collect

- Funnels (2 per board)
- Marbles (4 per board)
- Masking tape (1 roll per board)
- Clothespins (6 per board)
- Cans, cups, strawberry baskets, and other things to catch the marble at the end of the run (1 per board)



BUILD A MARBLE MACHINE



Using the collected parts and other things that you have on hand, build a Marble Machine so the marble travels from the top of the board to a target at the bottom as SLOWLY as possible.



Tip: Masking tape or clothespins can be used to keep some of the Marble Machine parts in place.

SHARE IT

Now share your Marble Machine with others.

Show your contraption to someone else and demonstrate the parts that were particularly tricky, then show your solution.





TAKING IT FURTHER

Add other challenges as the group becomes familiar with the materials.

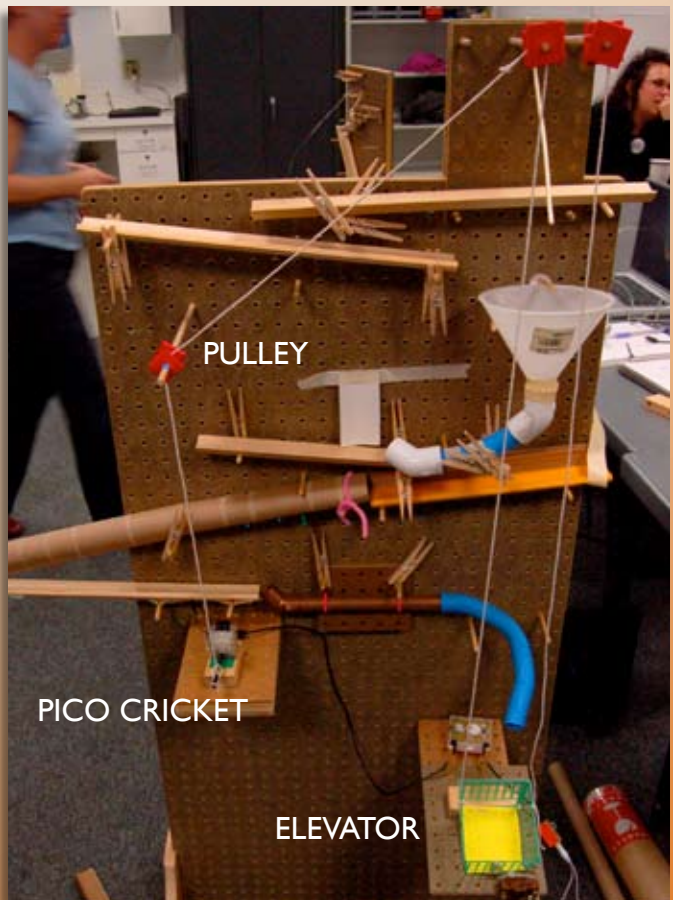
- Build a Marble Machine so the marble travels up and down, side to side, goes behind the board (right), or starts and stops.

- Add a simple circuit to the path of the marble to turn on a battery-powered motor, fan, or light!

- Try using strips of foil (left) as the switch, tripped by a metal marble that completes the circuit as it rolls down the channel.



- Program a PICO Cricket to respond to a simple switch (triggered by the rolling marble) and activate all sorts of interactive components including marble starters, elevators, trap doors, ball counters, and other inventive contraptions.



WHY IS THIS A PLAYFUL AND INVENTIVE EXPLORATION?

Reusable Materials and Components

This activity utilizes a set of materials that can be used again and again, by a variety of participants, in a variety of ways.



Creative Ways to Express Understanding

Thinking is made visible through the construction and adjustments made to the individual Marble Machines. New challenges and questions arise throughout this process.

Diverse Solutions to a Shared Theme

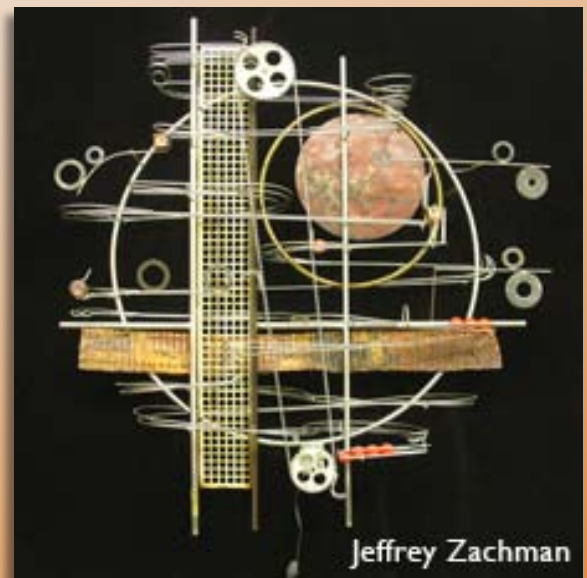
When this activity is part of a workshop, there are several different, individual solutions and creative designs.

Collaborative Opportunities

Sharing each completed Marble Machine at the end of the activity is a good way for participants to contribute to the group's understanding of the activity.

RELATED IDEAS

George Rhoads and Jeffrey Zachman are artists that build rolling ball sculptures out of steel and wood, often embedding musical and interactive elements.



This material is based on work supported by the National Science Foundation under Grant No. ESI-04-52567. Any opinions, findings, and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect those of the National Science Foundation.