



Rolling Ball Maze

Completion time: 2-3 Lessons

Materials and Resources:

- Sheet MDF – 1cm thickness
- Pencil and ruler, wood glue, appropriate sawing tools, disc sander, sandpaper
- String, six 5mm ball bearings, double sided tape
- Pillar drill and 1.5mm and 5mm drill bits
- Formech vacuum forming machine
- Suitable plastic material (1.5mm HIPS recommended)
- Any clear plastic material
- <https://formech.com/case-studies/formech-at-big-monster-toys-chicago-il>

Skills at a glance:

Mathematics

Measurement

Language

Listening skills, following instructions

Thinking skills

Design, problem solving, applying own ideas to a given brief, independent thought, tool selection

Science

Heating plastics and effects, plastic/polymer material knowledge

Project Outline:

Students must design a very simple ball game, reminiscent of games we all played as children. It will entail a number of ball bearings contained inside a square vacuum formed area with a clear plastic window through which to view the action. Inside the game there will be a number of small holes, just big enough to roll the ball bearings into with a little skill. The playing surface will be flat, but for a few small obstacles and bumps to consider and negotiate by the player. The principal mould material will be MDF, with the addition of a few other simple materials and some very simple tooling to create the final mould to be vacuum formed. This is ideal for younger students, or for those new to the vacuum forming process.

Method:

With the game intended to be played holding it in the hands, it does not need to be too big. A 15cm square should be the approximate perfect size. Students should first cut a square of 1cm thick MDF to their desired size. This will make up the base of the mould.

On top of this base and along all four sides, there will need to be a frame added which will stop the ball leaving the playing bed, and provide a solid mount for the addition of the clear plastic window. Using strips of 1cm thick MDF material, students should cut this to size and fix this in place with wood glue, much like the border of a picture frame.

Let's assume for this project we are using six 0.5cm gauge ball bearings, although other sizes can be used. The flat MDF playing area will need six shallow holes to be drilled, into which these balls can be rolled to complete the game. Choosing six random but evenly spaced points around the playing area, these can be marked and drilled using the drill press with a 5mm drill bit.

These holes should not go through the material, rather they should create a shallow indentation to a depth of just 3 - 4mm. Holes will however require a 1.5mm venting hole drilled at their bottoms, through the MDF material.

With all six holes drilled, students can think about obstacles to put around the playing area to make the game a little more difficult. These can be added using very small pieces of MDF material or lengths of string, glued in place with wood glue. Blobs of wood glue itself might be put at random points around the playing area to give the surface an uneven feel, and to make the game more tricky. The mould must now be allowed to dry completely.

Homework Tasks:

The toy design and manufacturing industry utilises vacuum forming in a variety of different ways. Students have experienced just a small aspect of this, and can now think how else they might utilise it in the future producing a toy. Imagining they can make any toy of their choice, students must write a simple design brief which outlines what toy they will make, and how they will use vacuum forming within its making. The project does not need to be executed and so can be as far out and imaginative as the students choose, which will make it enjoyable for them, whilst also giving teachers a good idea as to their level of understanding.

Optional Extras:

This project can be easily adapted to use a wide range of mould making materials and the associated tools needed to shape them. Should a teacher wish to complete a quick and easy project whilst using other materials, then there is scope for this here. Working with foam rather than MDF would make for a different lesson focussing on different skills, which would involve students making varying design and production choices, and additional considerations with the heating and vacuum forming process.

Method: (Continued)

Once dried, each outer side of the mould will require draft angles to be applied using a disc sander. All other corners inside the game will require a rough sanding by hand to remove sharp corners.

Lastly, due to the playing area being one large recess, venting holes will need to be drilled around it to encourage the heated plastic material to form within it. Using a drill press and a 1.5mm drill bit these should be drilled through the mould, all the way around the outer edge of the playing bed, at 2cm intervals, and around any obstacles glued in place earlier.

The completed MDF mould is now ready to be vacuum formed using any suitable plastic material, although 1.5mm HIPS is recommended. Excess material will need to be trimmed off the completed vacuum formed piece.

With a sheet of clear plastic material, students can cut a square which will fit perfectly on top of their almost complete game. The six ball bearings can be placed inside the playing area, and the clear square window secured in place with strong double sided tape.

Students will now have their completed game, ready to be enjoyed and to swap with their friends to enjoy different challenges and obstacles.

Student Accomplishments:

- The production of a simple ball game
- Experience using MDF as a mould material
- Choosing appropriate tooling methods
- Applying independent design choices to a prescribed brief
- Experience using a range of sawing, cutting, drilling and sanding methods
- Practical hands on experience using a vacuum forming machine, and understanding its wider application

Teachers notes:

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