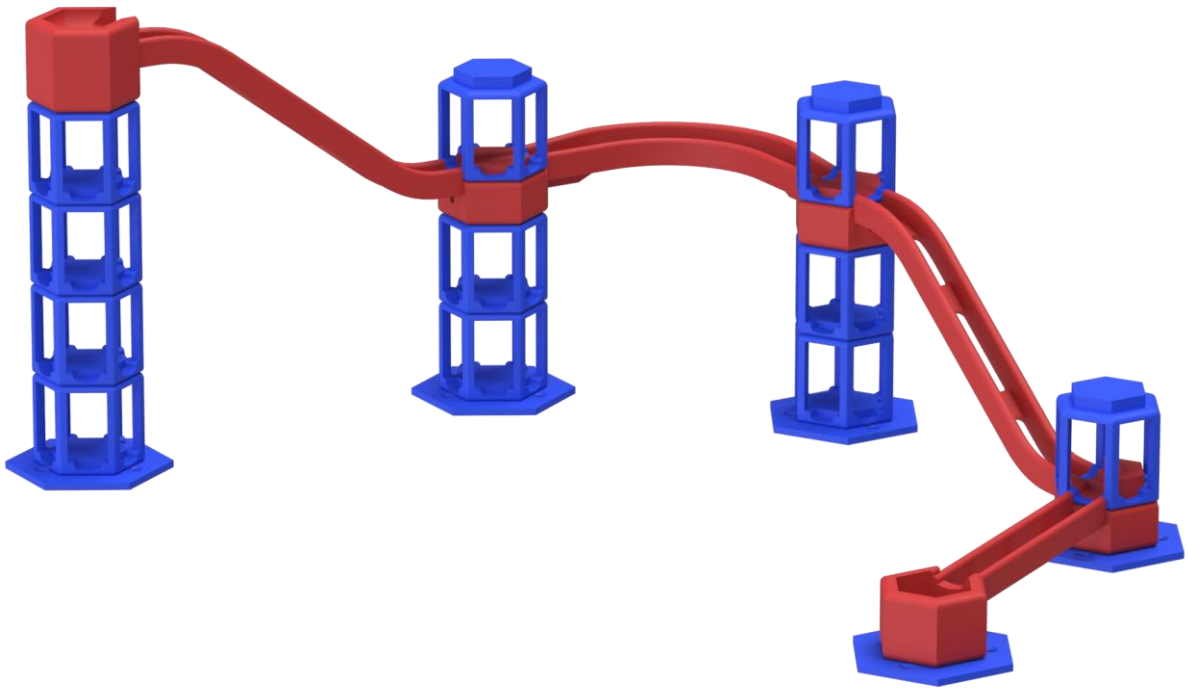
SOLIDWORKS

DESIGN PROJECTS

STUDENT GUIDE

3DEXPERIENCE



MARBLE RUN

DASSAULT SYSTEMES

DESCRIPTION

Welcome to the Design Projects Student Guide for Marble Runs! The focus of this project is a modular marble run design. Marble runs have a long history and modular designs provide ample room for creativity even after fabrication.

This guide contains information regarding Design Intent, DFAM (Design for Additive Manufacturing) and Design Tips to keep in mind for each part.

You will use CAD to design each part, print the parts on a 3D printer and assemble them to complete the marble run.

For a video demonstrating the design approach, detailed dimensions and step by step instructions, see the links in the **Additional Resources** section below.

PROJECT TASKS

1. Create the following marble run components in CAD:
    - Straight Track
    - Sloped Track
    - Curved Track and Strut
    - Support and Half Support
    - Straight Connector
    - Turn Connector
    - Start and End Baskets
    - Base
2. Create an assembly of the marble run in CAD.
3. Print the physical components on a 3D printer.
4. Assemble the marble run.

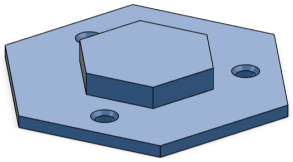
ADDITIONAL RESOURCES

LINK TO DOCUMENTS

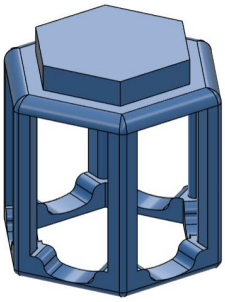
LINK TO YOUTUBE VIDEO

LINK TO STEP-BY-STEP

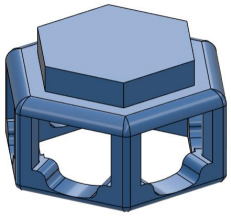
MARBLE RUN COMPONENTS



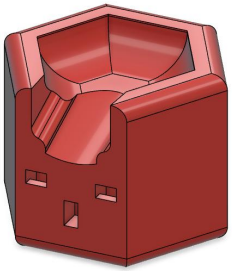
Base Plate



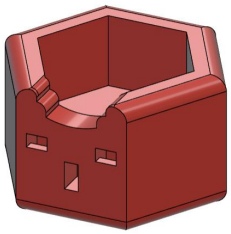
Support



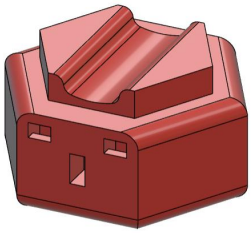
Half Support



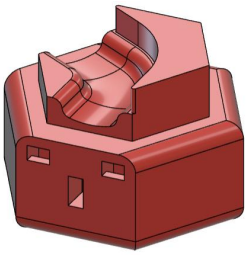
Start Basket



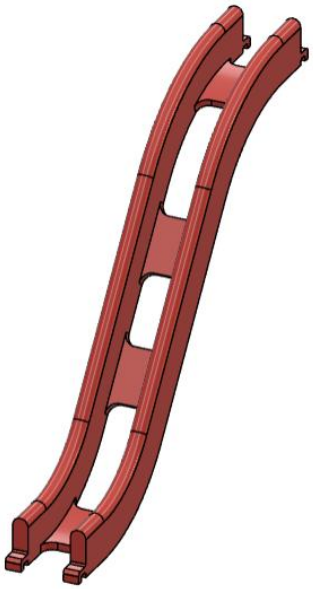
End Basket



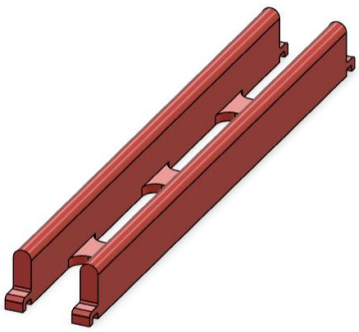
Straight Connector



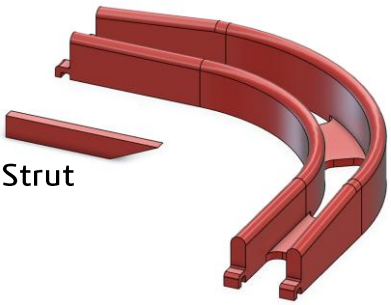
Curved Connector



Sloped Track



Straight Track



Strut

Curved Track

STRAIGHT TRACK

DESIGN INTENT

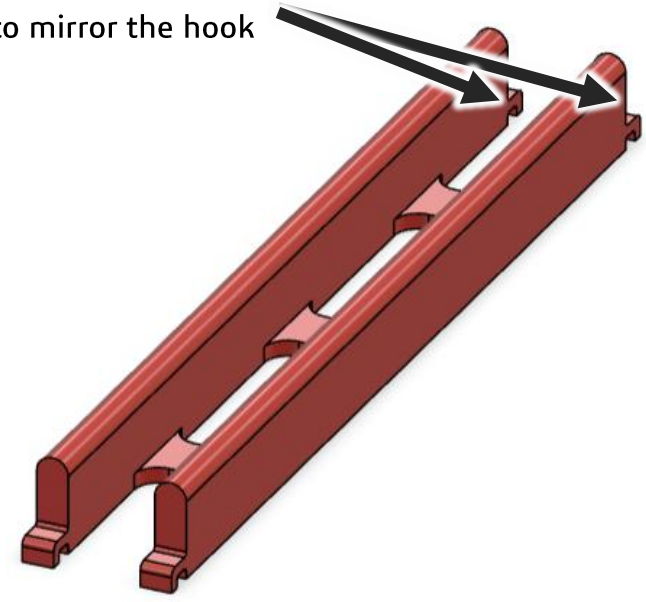
- Guides forward marble movement.
- Marble rolls smoothly and stays on track.
- Can easily and securely attach and detach from connectors.

DFAM

- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- Sketch the bottom of the track and use 2 extrudes, one for the rails and one for the rail ties.
- The distance between the rails should be less than the diameter of the marble.
- Sketch a hook on the side face of one rail and extrude up to a vertex on the other side of the rail.
- Take advantage of existing planes to mirror the hook features.



SLOPED TRACK

DESIGN INTENT

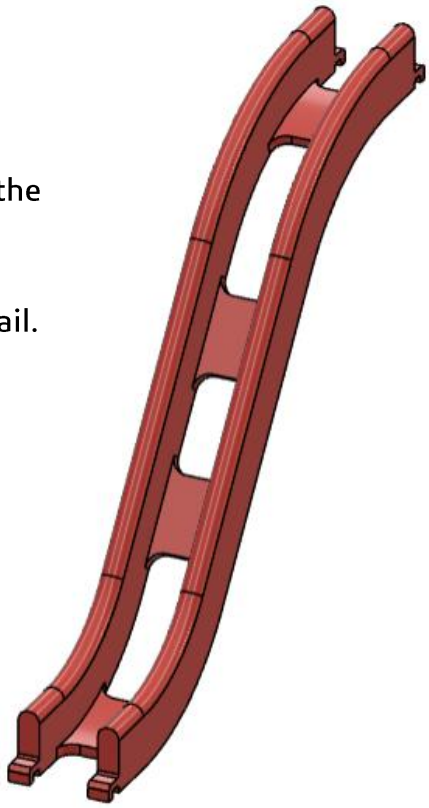
- Guides vertical marble movement.
- Marble rolls smoothly and stays on track.
- Can easily and securely attach and detach from connectors.
- Has an overall height equal to two stacked supports.

DFAM

- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- Use a sweep to create one rail.
- Sketch the hooks on the side face of the rail and extrude up to a vertex on the other side of the rail.
- Create the rail ties on a new sketch by converting the slope to construction lines, sketching the desired profiles, and extruding.
- Take advantage of existing planes and mirror the rail.



CURVED TRACK

DESIGN INTENT

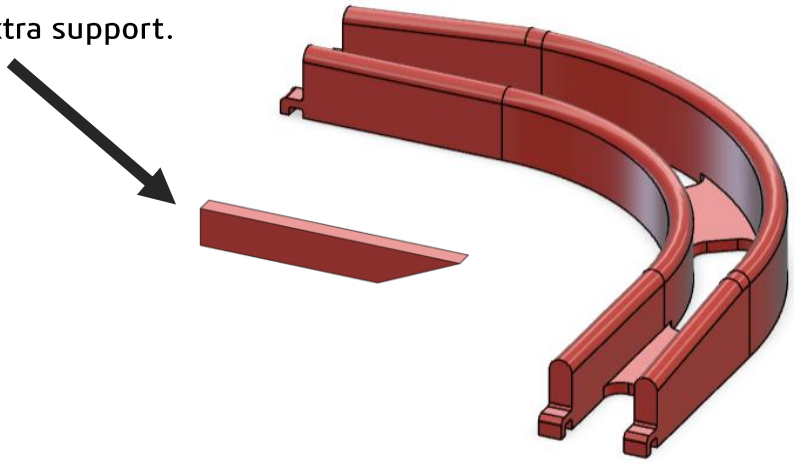
- Guides marble turning.
- Marble rolls smoothly and stays on track.
- Can easily and securely attach and detach from connectors.
- Is supported by struts to ensure stability.

DFAM

- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- Sketch the bottom of the track and use 3 extrudes, one for the inner rail, one for the outer rail, and one for the rail ties.
- Make the extrude of the outer rail taller than the inner rail.
- Use a chamfer on the outer rail before adding the track fillets to make the height increase gradual.
- Use pre-existing planes to mirror one set of hooks and create a reference plane for the other set.
- Create a small strut for extra support.



SUPPORT

DESIGN INTENT

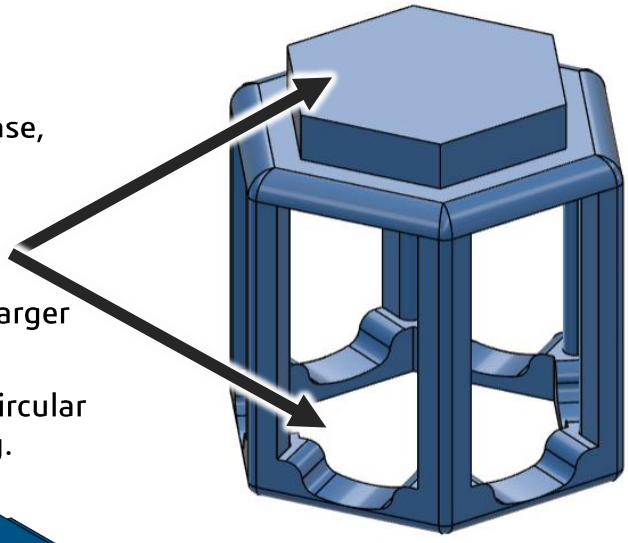
- Supports connector pieces.
- Is able to stack on top of other supports.
- Allows marbles to pass through with little to no resistance.
- Has cutouts that match track profile.

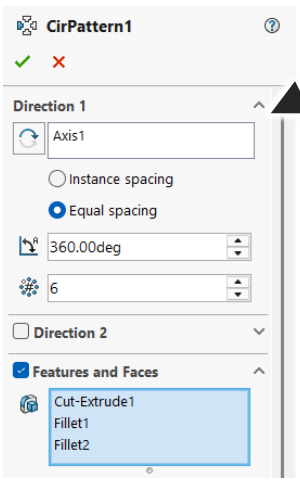
DFAM

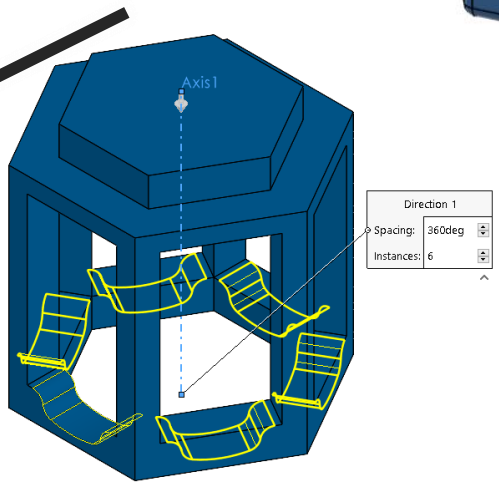
- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- Use 4 extrusion features, one for the base, one for the posts, and two for top.
- Make sure the hole at the base and the extrusion on top are both 5.5mm tall.
- Be sure the distance between posts is larger than the diameter of the marble.
- Make the track cutouts last and use a circular pattern to take advantage of symmetry.







Note: the height of the entire component should be 5.5mm taller than the intended height of the support to account for overlap when assembled.

HALF SUPPORT

DESIGN INTENT

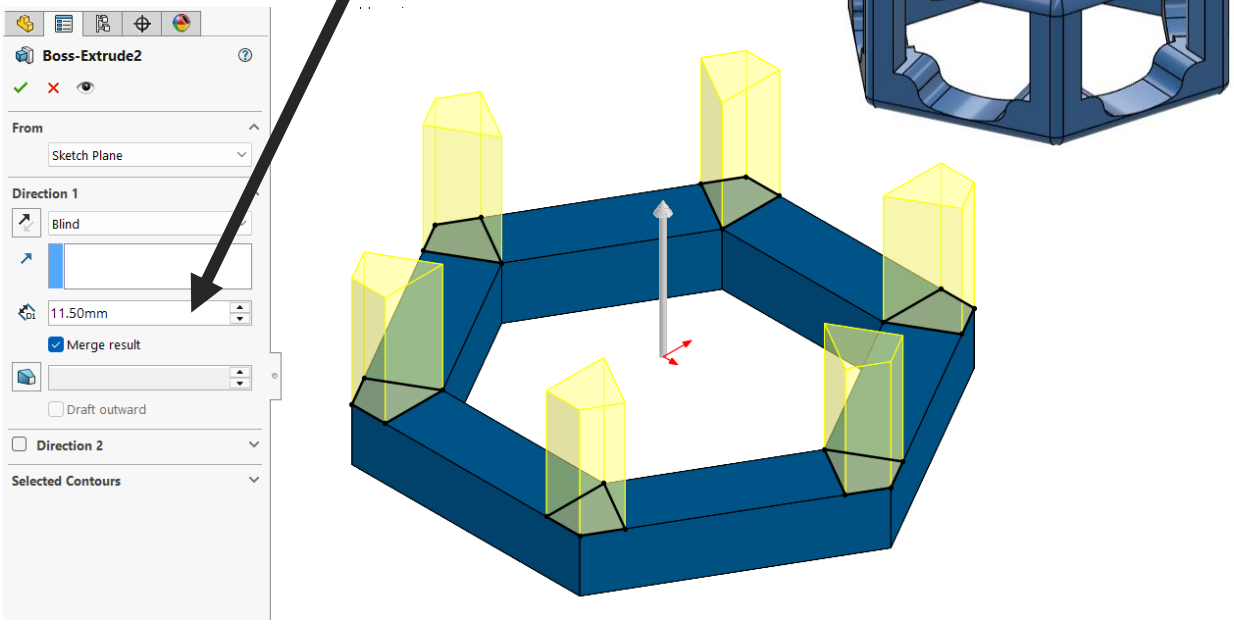
- Is able to stack on top of other supports.
- Is half the height of typical support to increase arrangement options.

DFAM

- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- Use the Save as New tool while in the full-height support part to reuse the geometry and change the post extrusion height.



STRAIGHT CONNECTOR

DESIGN INTENT

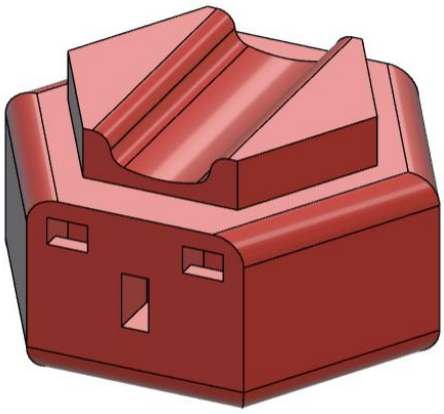
- Provides straight path between two tracks.
- Matches track profile – marble stays on track.
- Has secure connection points for tracks and struts.
- Can stack on top of supports and allow supports to stack on top of it.
- Same height as half supports for easy arrangement.

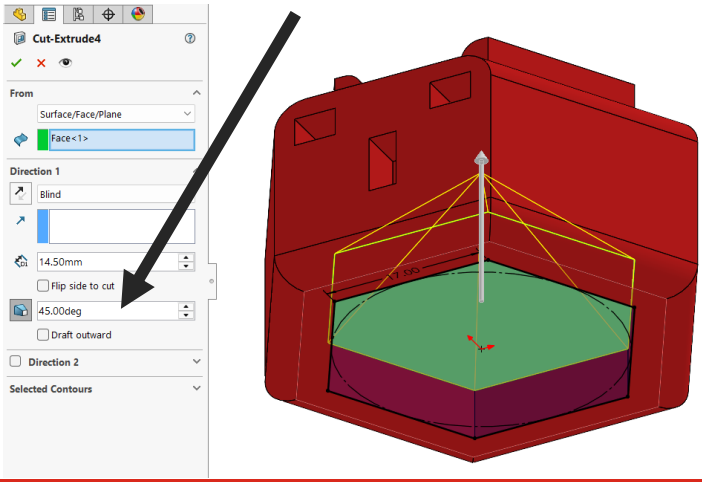
DFAM

- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- Ensure the top extrude and bottom extruded cut are 5.5mm.
- Mirror the track connection points to the other side of the connector.
- Add an extruded cut to the bottom and toggle draft on to reduce supports and material use.





CURVED CONNECTOR

DESIGN INTENT

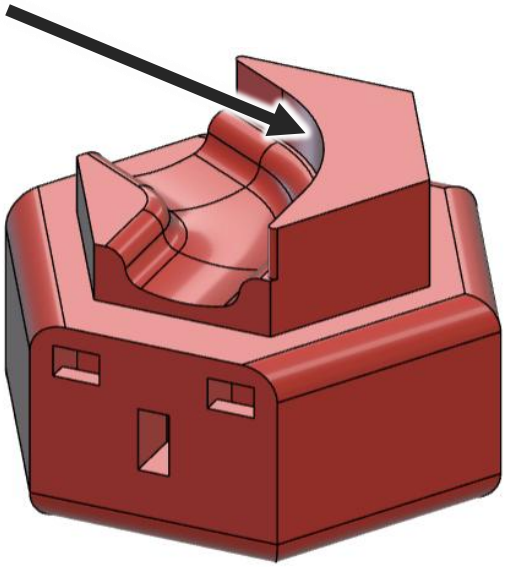
- Provides curved path between two tracks.
- Matches track profile – marble stays on track.
- Has secure connection points for tracks and struts.
- Can stack on top of supports and allow supports to stack on top of it.
- Same height as half supports for easy arrangement.

DFAM

- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- Ensure the initial top extrude and bottom extruded cut are 5.5mm.
- Use a swept cut to create the track cut.
- Use a offset entities to create the banked side. Ensure the offset is far enough from the track so the marble has three points of contact.
- Use a circular pattern and toggle Geometry pattern on to duplicate the track connection points on the other side of the connector.
- Add an extruded cut to the bottom and toggle draft on to reduce supports and material use.



START AND END BASKETS

DESIGN INTENT

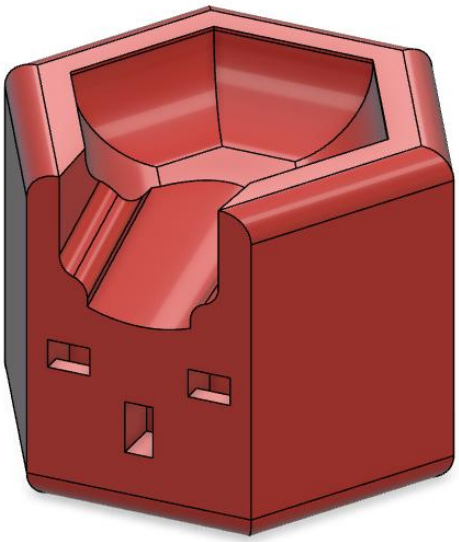
- Provides controlled start/end of marble run.
- Can stack on top of supports.
- Has secure connection points for tracks and struts.

DFAM

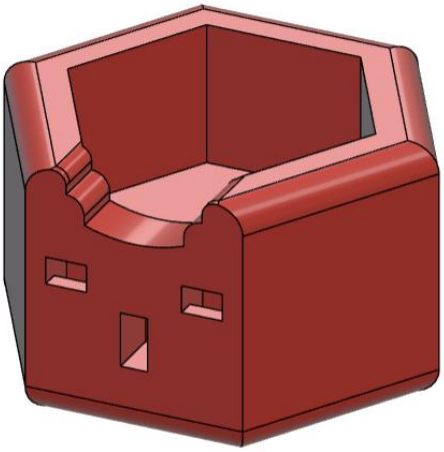
- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

DESIGN TIPS:

- On the start basket, use a lofted cut to create the sloped track.
- Add an extruded cut to the bottom and toggle draft on to reduce supports and material use.



Start Basket



End Basket

BASE

DESIGN INTENT

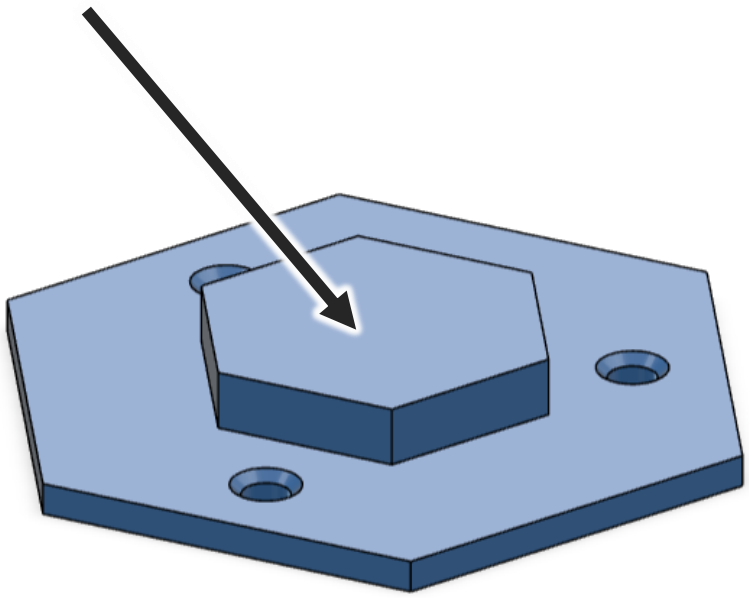
- Provides a wider base profile for added stability.
- Allows supports, connectors, and baskets to stack on top of it.
- Has holes for mounting (optional).

DFAM

- Follows modular design principles for easier testing and to reduce material waste when reprinting.
- Designed to minimize support material.
- Incorporates nesting to print several components at one time.

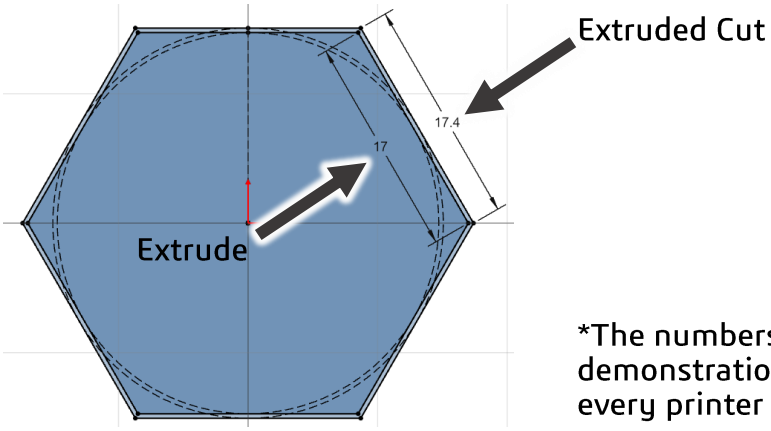
DESIGN TIPS:

- Use a circular sketch pattern to position the screw holes.
- Use a chamfers on the edge of the screw holes to easily countersink them.
- Make sure the inner extrusion is 5.5mm from the face of the first extrusion.



3D PRINTING - TOLERANCING

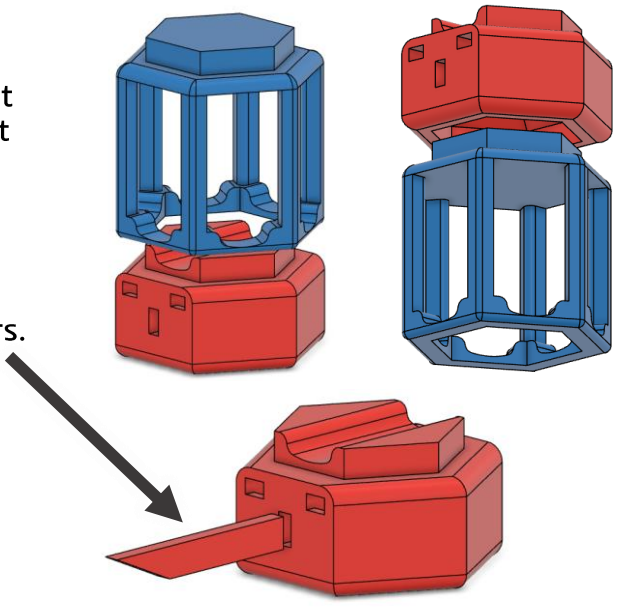
- Designs with perfect fits in CAD do not always fit together perfectly when 3D printing because every printer has a different resolution.
- Any component interacting with each other will likely need to be adjusted – this process is called tolerancing.
- Holes and cuts are typically made larger than extrudes to account for error.



*The numbers displayed are just for demonstration. Tolerancing required for every printer varies.

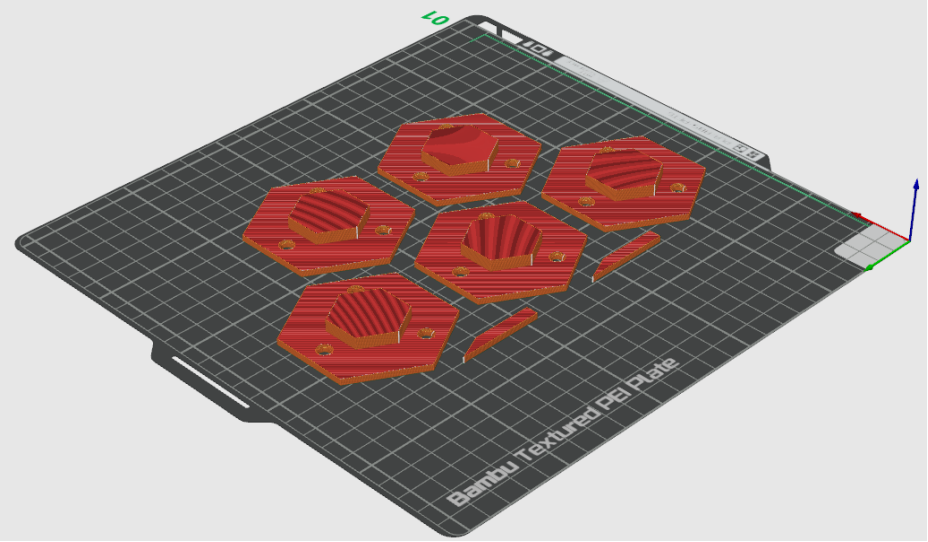
MARBLE RUN TOLERANCING

- It is recommended that the bottom cut of each support, connector, and basket is made slightly wider than the top extrudes on connectors, supports, and bases.
- The strut may need to be designed smaller than the slot on the connectors.
- The hooks and connection points for tracks are designed with extra space, but may need extra tolerancing.

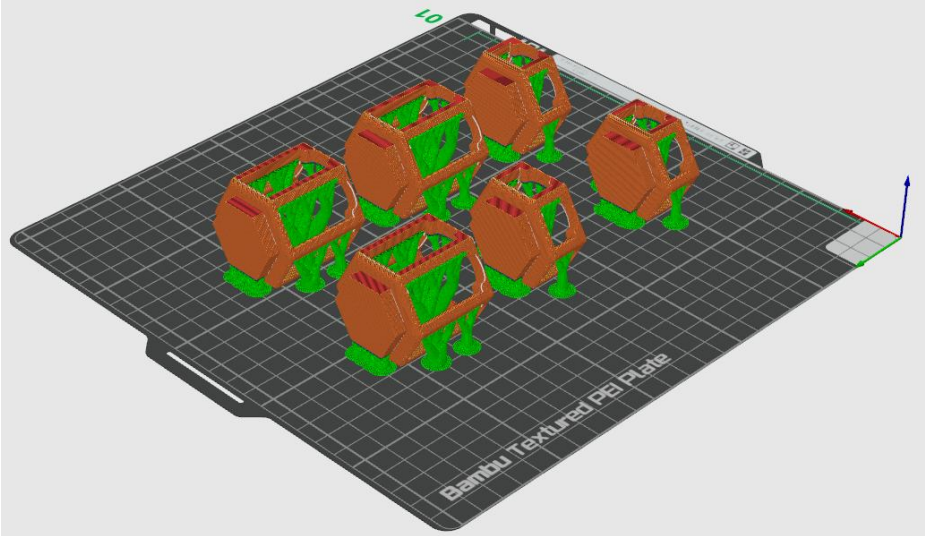


3D PRINTING

- Save your parts as STL files.
- Nest your parts to print many at one time.
- Orient the parts to minimize the use of support material, (see images below).



NESTING



ORGANIC/TREE SUPPORT STRUCTURES