Quick Starting Your Injection Molding Process

A Rough Guide to a Challenging Process

Leia Chang, Jinny Kang

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Introduction

Manual Purpose:

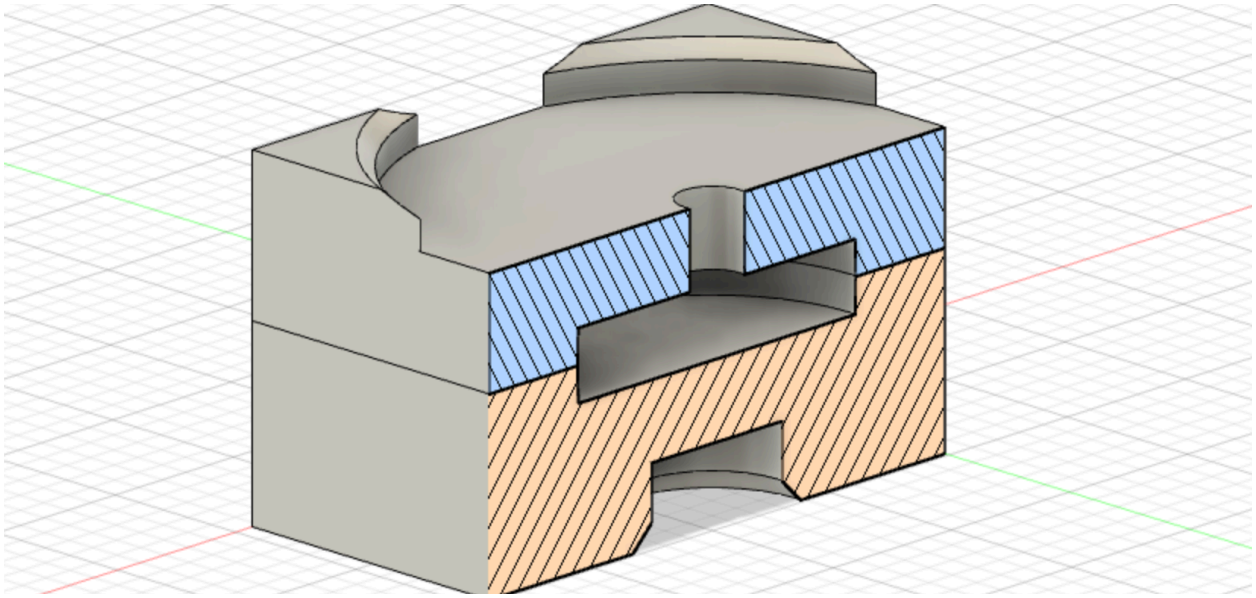
This crash course is to go hand-in-hand with the Morgan-Press Injection Molder Standard Operating Procedure Manual to give a detailed overview of designing and creating an injection mold. This guide is intended to be a starting place for audiences who are generally unfamiliar with the injection molding process. The guide includes common tips and lessons from our experience.

Background:

The original goal for this project was to find solutions to an excess of 3D print material—specifically, PLA waste made at the Makerspace. The aim was to be able to mass produce modular prototyping blocks for both students within and outside of NYU.

Why Injection Mold:

- Creating mass stock of a particular item with precision and speed



Designing an Injection Mold

💫 **Design Program:** Fusion 360

I. Figure out your interfaces.

Questions to Consider:
Where does the machine touch the mold?
Do you need spacers?
How do you mount your mold to the spacer?
Is there anything else that needs to be done here?

✏️ **Keep In Mind:** For the NYU Makerspace's Injection mold, your mold will need to interface with the available spacers as well as a disk for where the nozzle sits. For nozzle, riser, and other dimensions, see the Makerspace's page for this machine. The NYU Makerspace also has an aluminum housing made to house a mold created from high-temp plastic, also available on that page.

II. Figure out your sizes.

Questions to Consider:
How big or small can your mold be?
What's the size of your object?
Can your molding machine inject that much plastic?
What size stock material can you get?

III. Design your object, and design it with molding in mind.

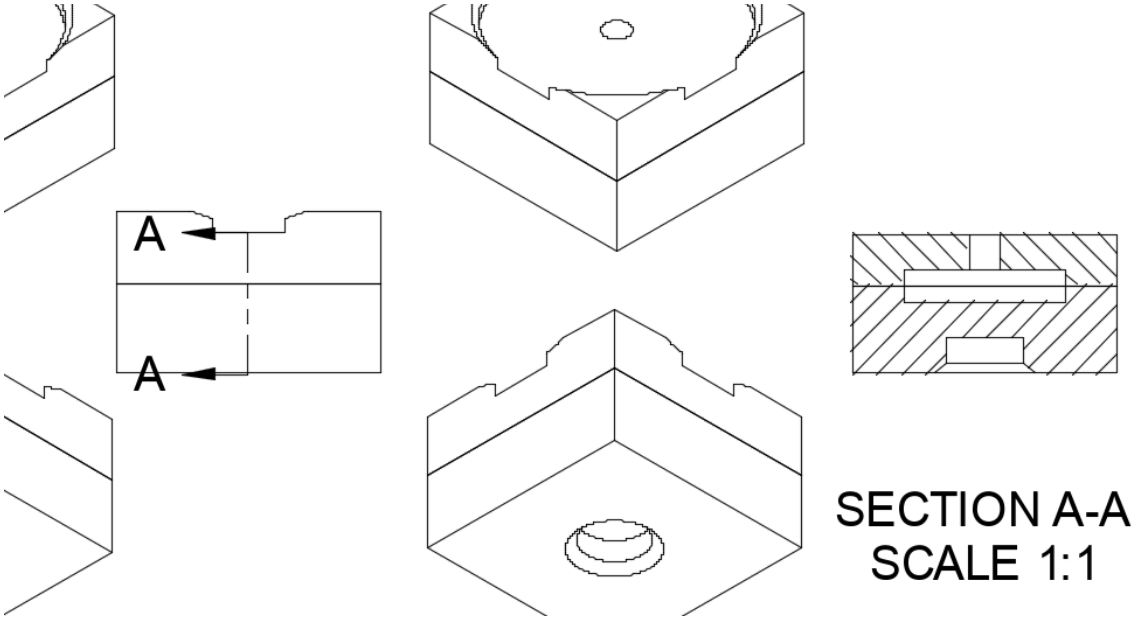
a. Many seemingly simple objects actually have very complex molds in many parts. You'll probably want to start with a **simple two-part mold**, but that means your object needs to be able to fit into and be removed from those two halves.
b. **Parting lines** are left where the molds meet. Where should they appear on your object? Where can you place them such that they won't affect the object's function?
c. Removal from the molds can be difficult where vertical walls are placed. Many parts of your object may need to be drafted (adding an angle to assist in removal).
d. **Buckling** happens when one part of your object cools before other parts, and the plastic can warp or pull apart. In order to prevent buckling, all walls on your object should be a uniform thickness.

IV. Design your mold.

a. You have all your parts. It's time to model it! Design the outside and injection hole your mold, and ensure that it interfaces with the machine you'll be using.
b. Consider how much extra material you want your mold to have outside the part. The more extra material, the longer it will take to cool.
c. Combine your object and the mold, subtracting the object from the mold to get your final parts.

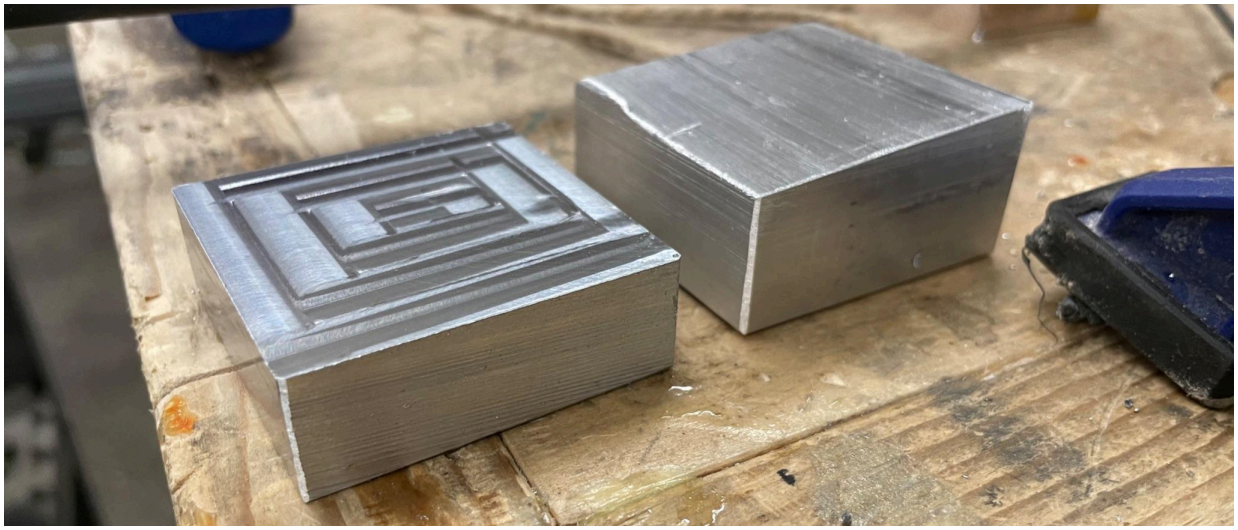
✏️ **Keep In Mind:** When aligning your object in the mold, consider where you want the plastic to be injected. You'll have spurs left behind at these injection points.

Once your mold is designed in CAD, you can mill it out of **aluminum** or, depending on what your injection machine supports, print it in **high-temperature plastic**.



✏️ Considerations and Tips

- **GO TALK TO AN INDUSTRIAL ENGINEER OR DESIGNER**. There are a lot of considerations in the design, and in industry there are many other things considered that I didn't bother with (flow rate, breaking points, actual material properties, etc).
- Be ready to do a few iterations. This is a difficult process to get right.
- Leverage your CAD software the right way, and your life gets a lot easier. By designing the object first, and then subtracting it from the mold, you can tweak the part and get your changed mold downstream.



Cutting Aluminum

Cutting aluminum can be intimidating at first, especially if you've never done it before. A couple of tips: ✏️💡🔦🕯️✨

- The Makerspace sells aluminum stock in 2x2x2 inch and 4x4x4 inch sizes. This is a great starting point for smaller molds. Other sizes of aluminum can be found on McMaster-Carr or even on Ebay.
- While you *can* cut aluminum on a band saw, the waterjet or a specialized metal saw will be much easier.
- Get up to snuff on the Tormach CNC Mill. This will be your best friend for a while.

While cutting your stock for the mold, keep a few things in mind:

- You'll have to cut down the faces of your stock anyway, so a little roughness is fine.
- Try to cut your stock so that it's just a tiny bit bigger than your mold's final size. This lets you use the mill to bring it down to the right size, and keep your precision and alignment between the two halves of the mold.

Alternatives

3D Printing

While you'll probably use 3D printing to test your intended objects anyway, you may consider using it to produce all your objects. 3D printing is quick to set up and has a fairly straightforward process that allows for quick iteration. However, its production rate is much slower per-piece, and generally will have much lower resolution than you might want.

For a high-resolution printer that's good for precision pieces (or even printing mold inserts), take a look at the Form 3.

Milling

You'll likely be milling to create your mold anyway. Milling is great for if you need your piece to have delicate or precise parts, but don't want the print lines of a 3D printer. The setup is more complicated than 3D printing, but works well if you're only making a few copies of your object.

Check what materials your milling machines can work with.

Outsourcing

Honestly, if you're making anything for production or with any desire for performance, you'll probably just outsource this design and creation. A quick google search for "custom injection molding" should get you what you want.

Future Exploration

- Recycled PLA temperatures & best practices
- Printing an injection mold on the Form3 in high-temp plastics

Resources

MakerSpace NYU Link

MakerSpace Plastic Injection Molder Link

Makerspace Tormach PCNC440 Link

Morgan Industries Plastic Injection Molding Machines Link

3Space Injection Molding Design Guide Link

Protolabs' Design Guidelines for Plastic Injection Molding Link