

**SUPPLEMENTAL MATERIALS FOR:
REDUCING WASTE THROUGH INNOVATION:
ENGAGING THE MELBOURNE COMMUNITY VIA BOTTLE CAP
RECYCLING**



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Jesuit Social Services**



This report represents the work of one or more WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on the web without editorial or peer review.


Supplemental Materials A: Product Polls and Result


Supplemental Materials A.1: Product polls

1) Online product poll

Product Poll

The purpose of this poll is to determine the most favored potential product ideas to be made from recycled plastic material at the Ecological Justice Hub. The following ideas will include products intended for use within the Hub as well as products that could be sold outside of the Hub. The information collected from this poll will be used to select and then design, products which we will later make.

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* Indicates required question

Please indicate on a scale from 0-5 how useful the following products will be. 0 being something you have no interest in at all and 5 indicating something that you think would be very useful to the Hub or to others.

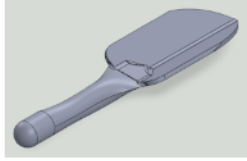
Products for Use Within the Ecological Justice Hub

Larger Plant Pot *



0 1 2 3 4 5

Garden Trowel *



- 0
- 1
- 2
- 3
- 4
- 5

Garden Stakes *



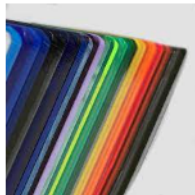
- 0
- 1
- 2
- 3
- 4
- 5

Plant Labels *



- 0
- 1
- 2
- 3
- 4
- 5

Plastic Sheets *



- 0
- 1
- 2
- 3
- 4
- 5

Clipboard *



- 0
- 1
- 2
- 3
- 4
- 5

Products for Use Outside the Ecological Justice Hub

Keychain *



0 1 2 3 4 5

Jenga/Lego Blocks *



0 1 2 3 4 5

Guitar Picks *



0 1 2 3 4 5

Cutting Board *



0 1 2 3 4 5

Coasters *



0 1 2 3 4 5

Office Supplies/Organizers *





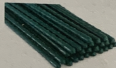




0 1 2 3 4 5

Coffee Plate *



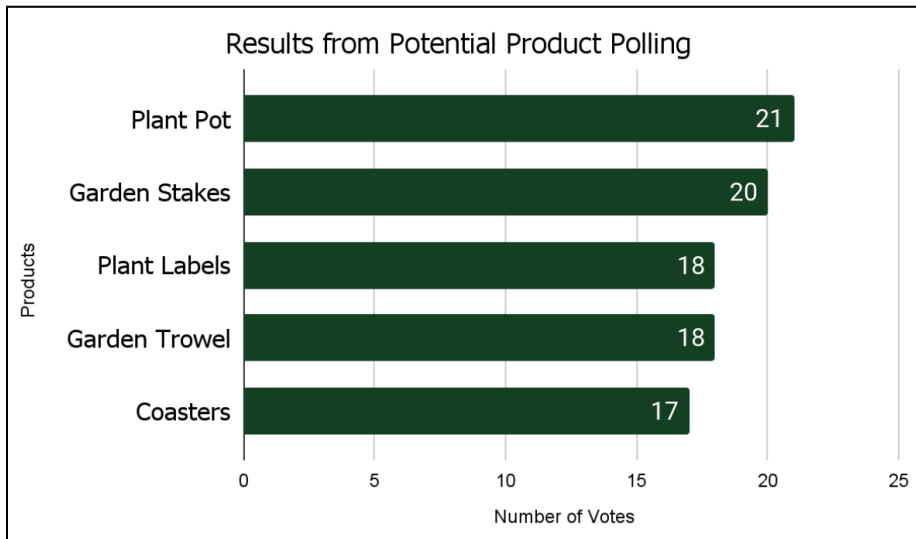
0 1 2 3 4 5

2) In-person product poll

| Product Name | Product Picture | Product Size | Associated Letter |
|--------------------|--|--------------------|-------------------|
| Plant Pot |  | 200 x 200 x 254 mm | A |
| Garden Trowel |  | 85 x 32 x 330 mm | B |
| Garden Stakes + |  | 405 mm | C |
| Plant Labels |  | 100 x 150 mm | D |
| Plastic Sheets |  | A4 sheet size | E |
| Clipboard + |  | A4 sheet size | F |
| Keychains |  | 75 x 50 mm | G |

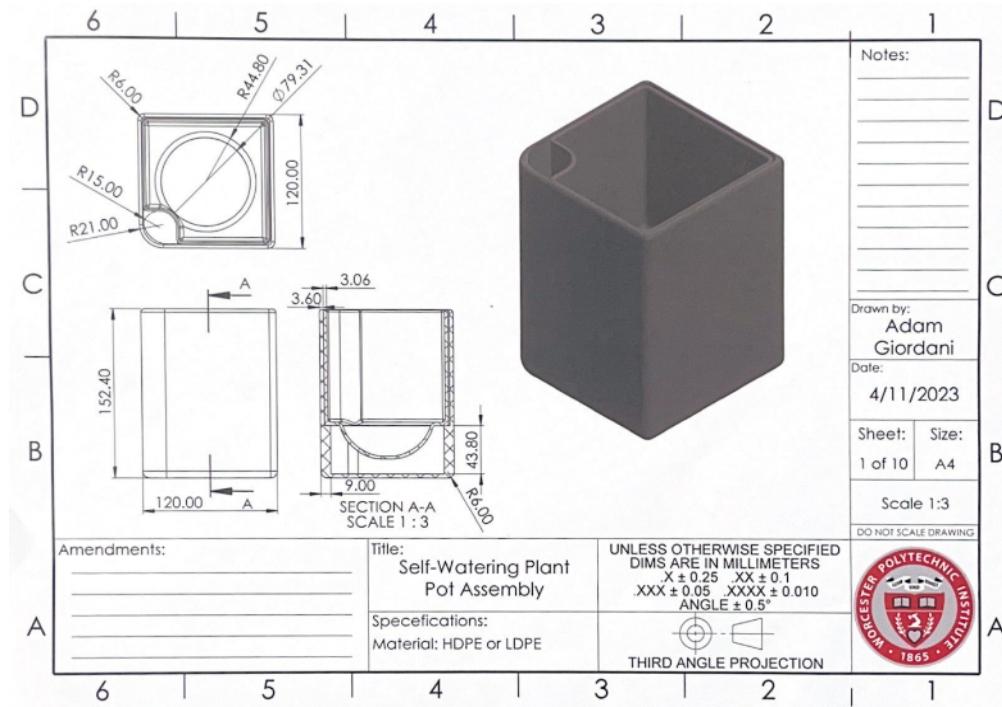
Supplemental Materials A.2: Poll Result

1) Top five product result

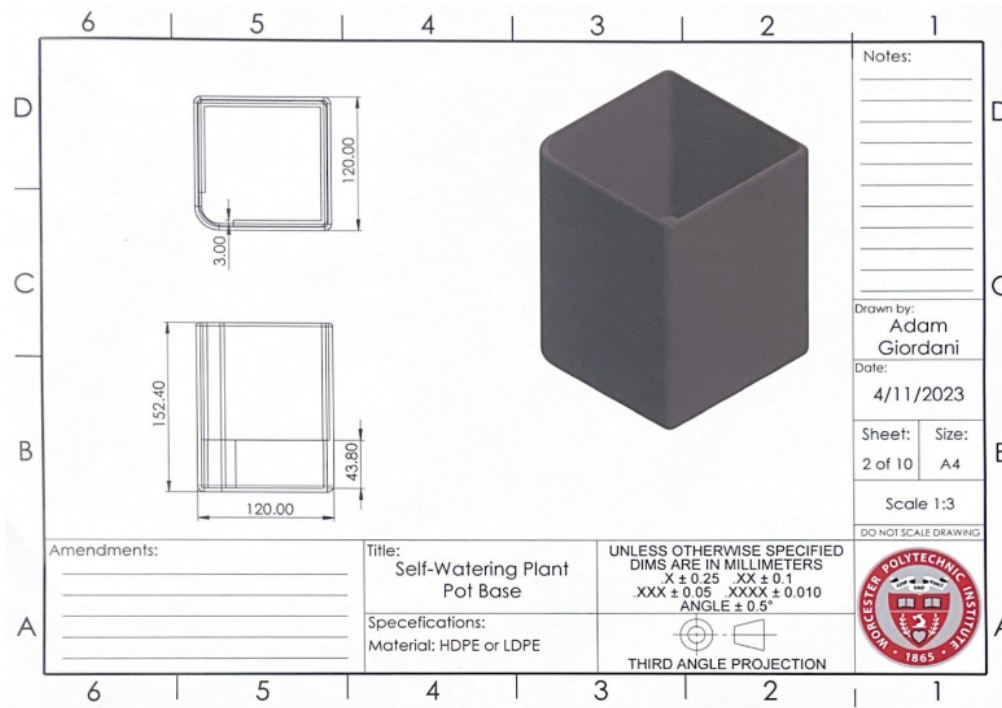


Supplemental Materials B: Designs and Technical Drawings

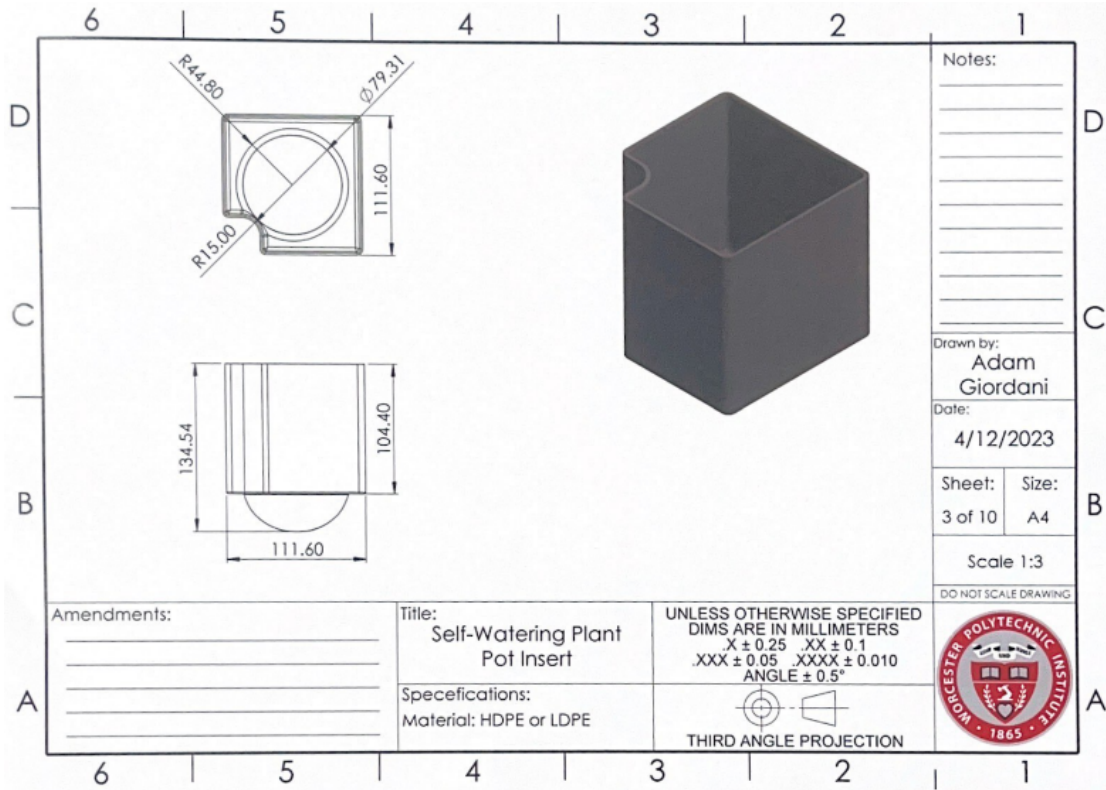
1) Plant Pot Design Drawings



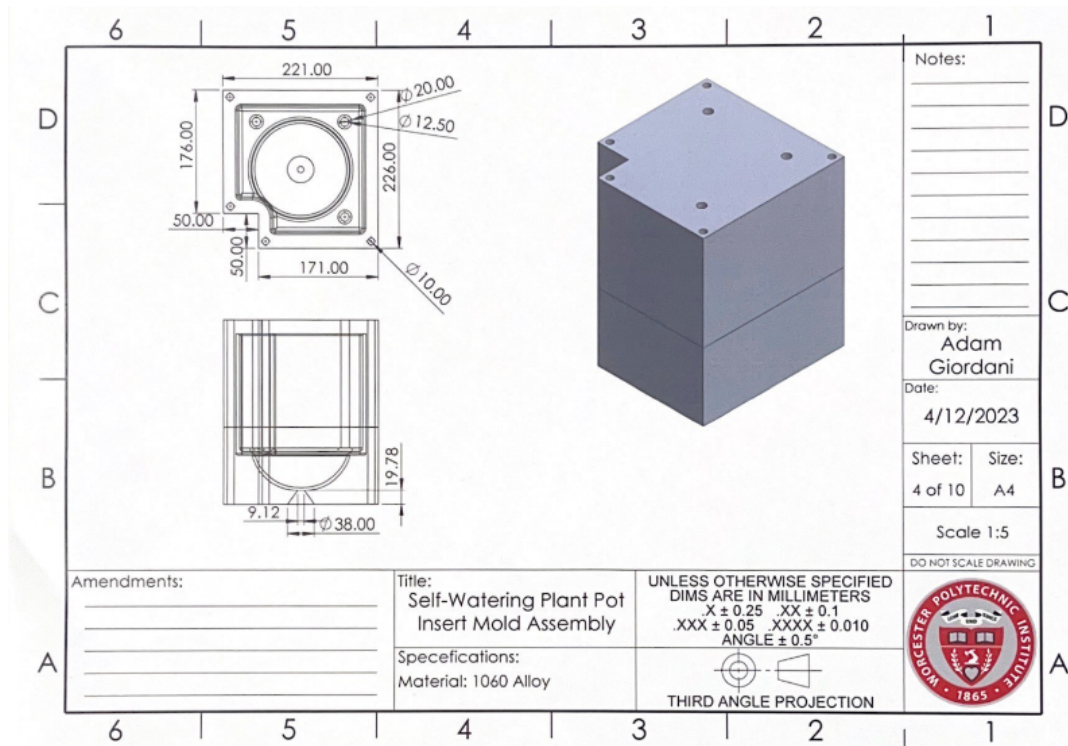
Self-Watering Plant Pot Assembly Drawing



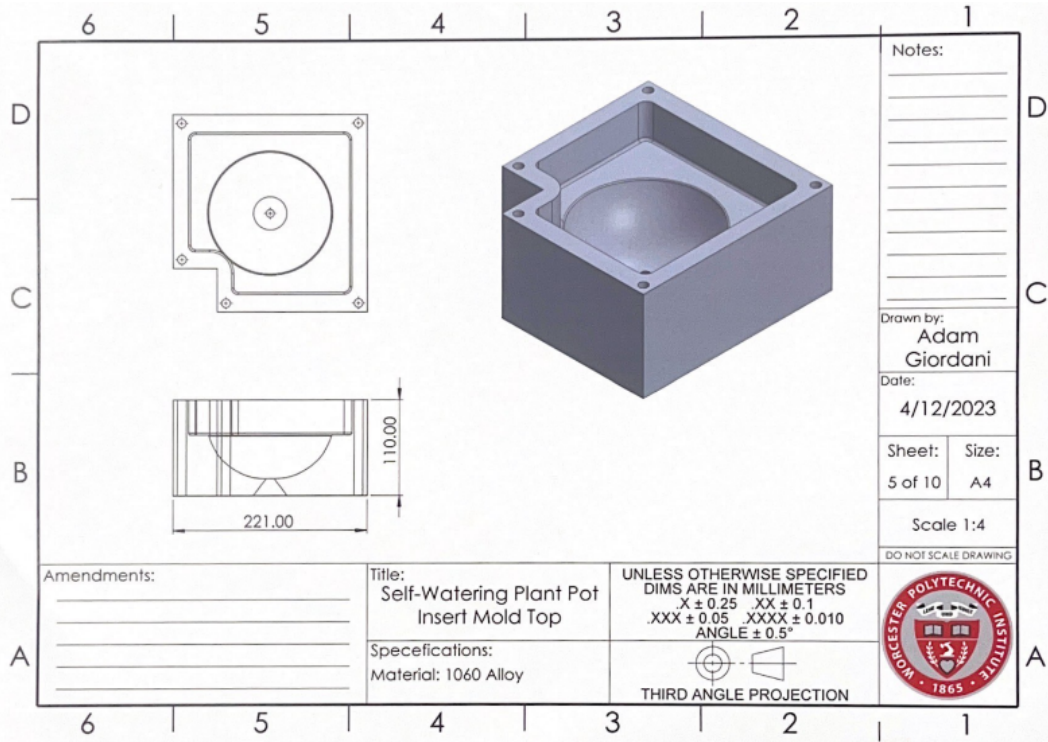
Self-Watering Plant Pot Base Drawing



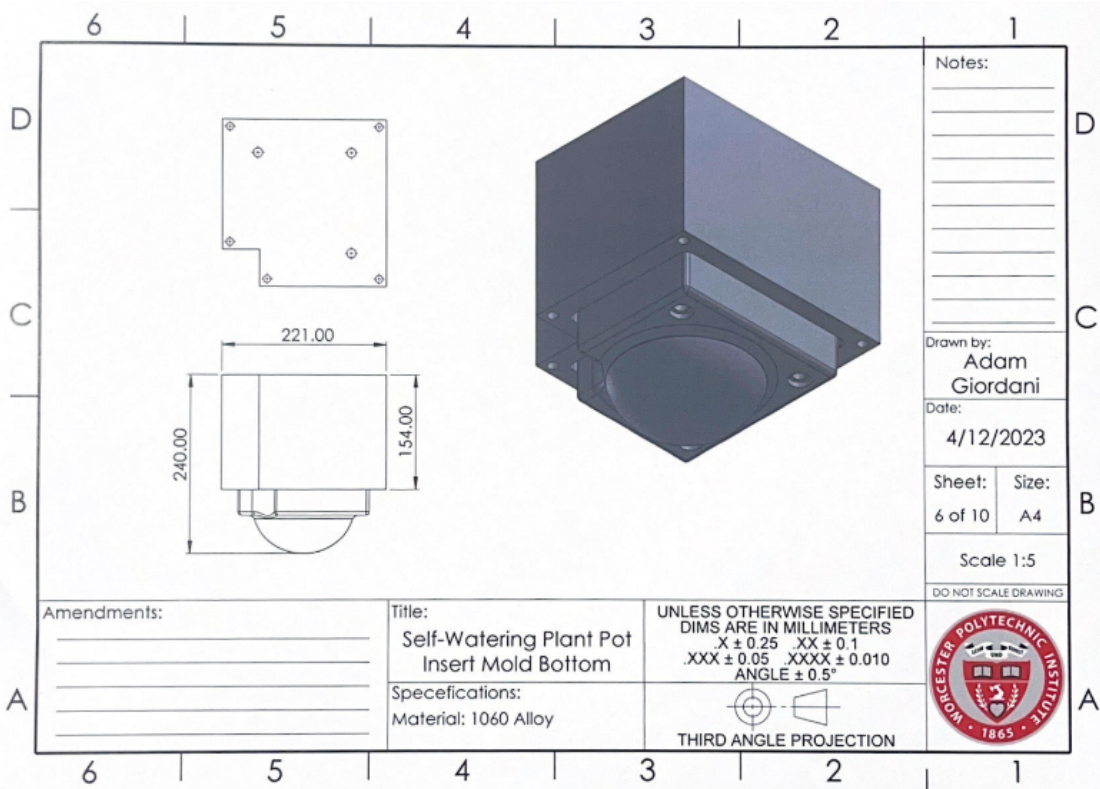
Self-Watering Plant Pot Insert Drawing



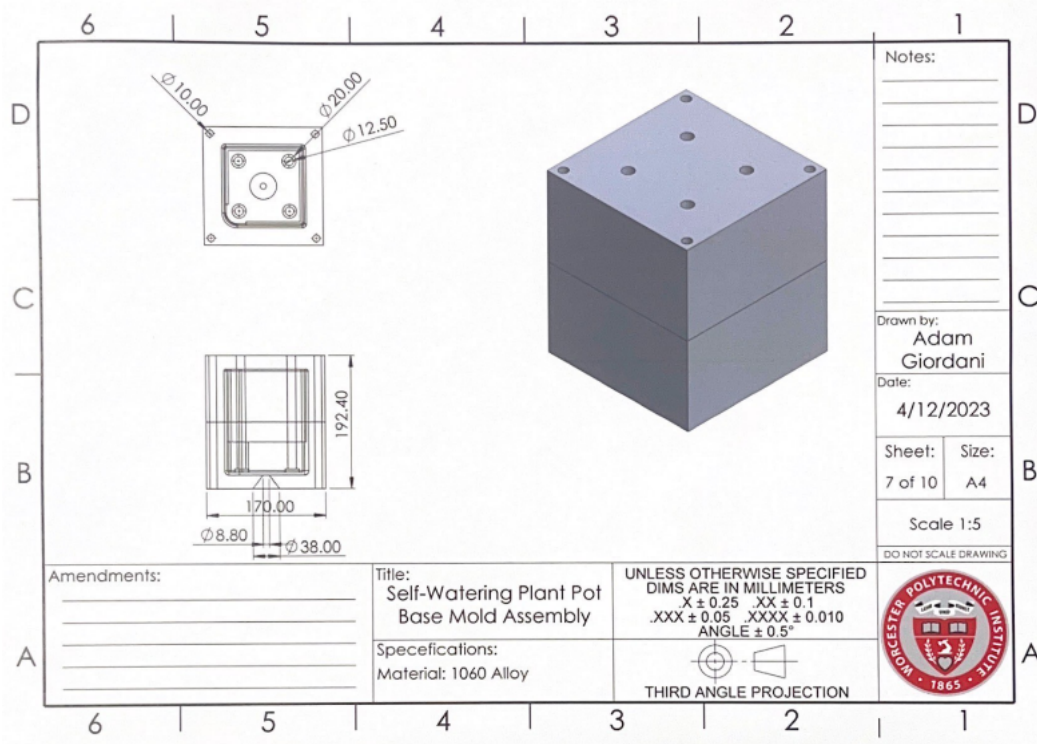
Self-Watering Plant Pot Insert Mold Assembly Drawing



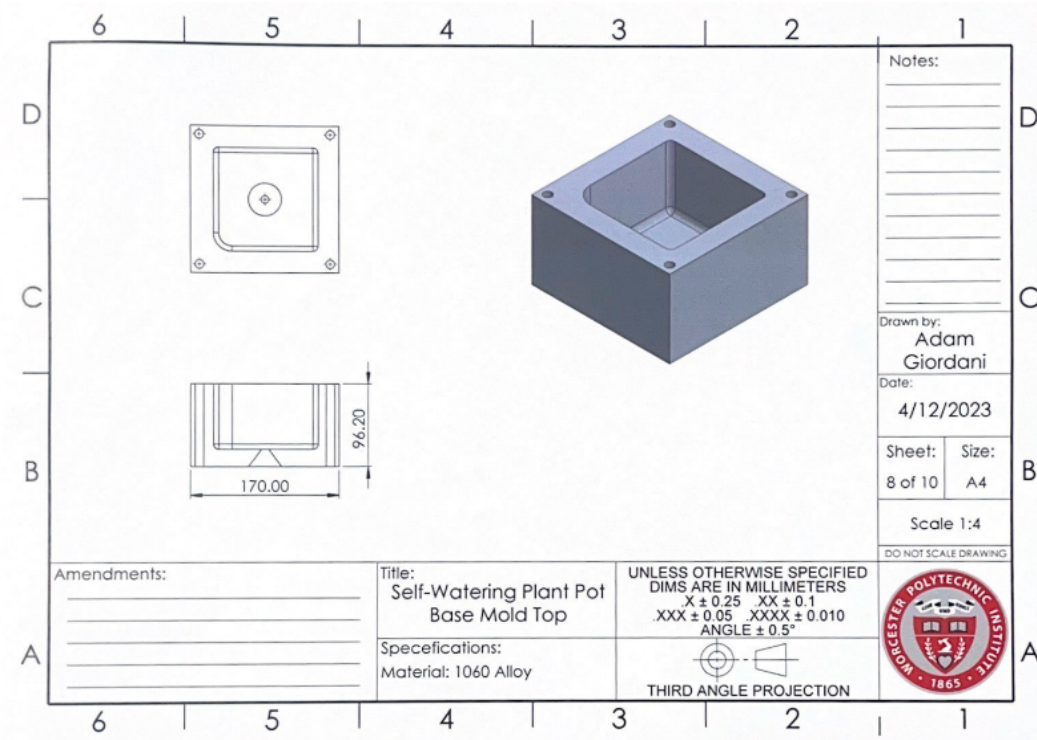
Self-Watering Plant Pot Insert Mold Top Half Drawing



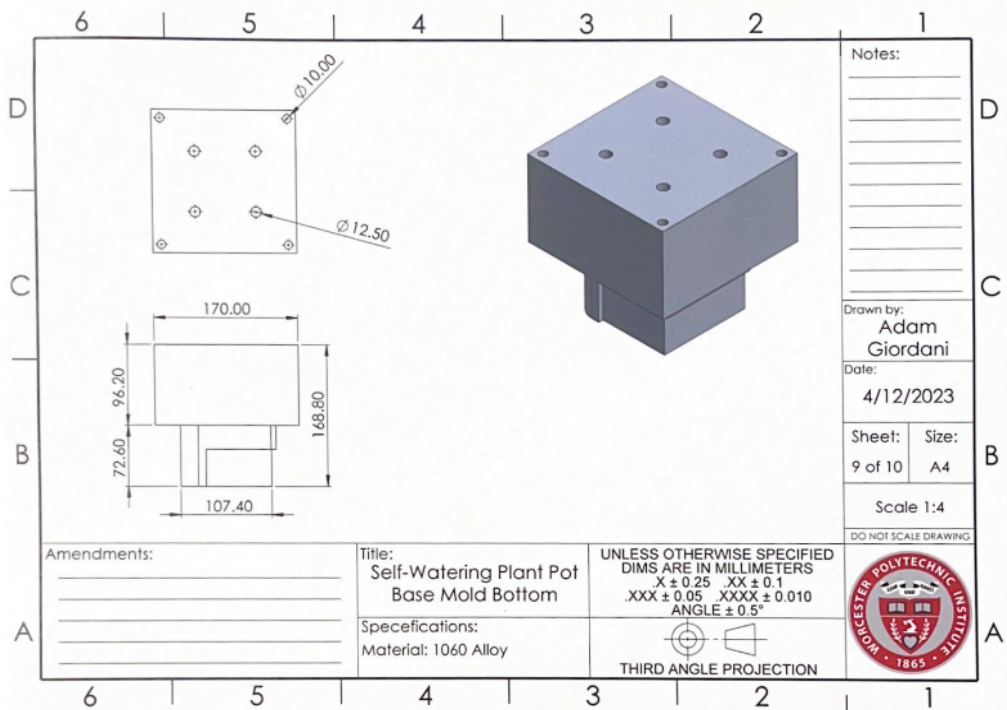
Self-Watering Plant Pot Insert Mold Bottom Half Drawing



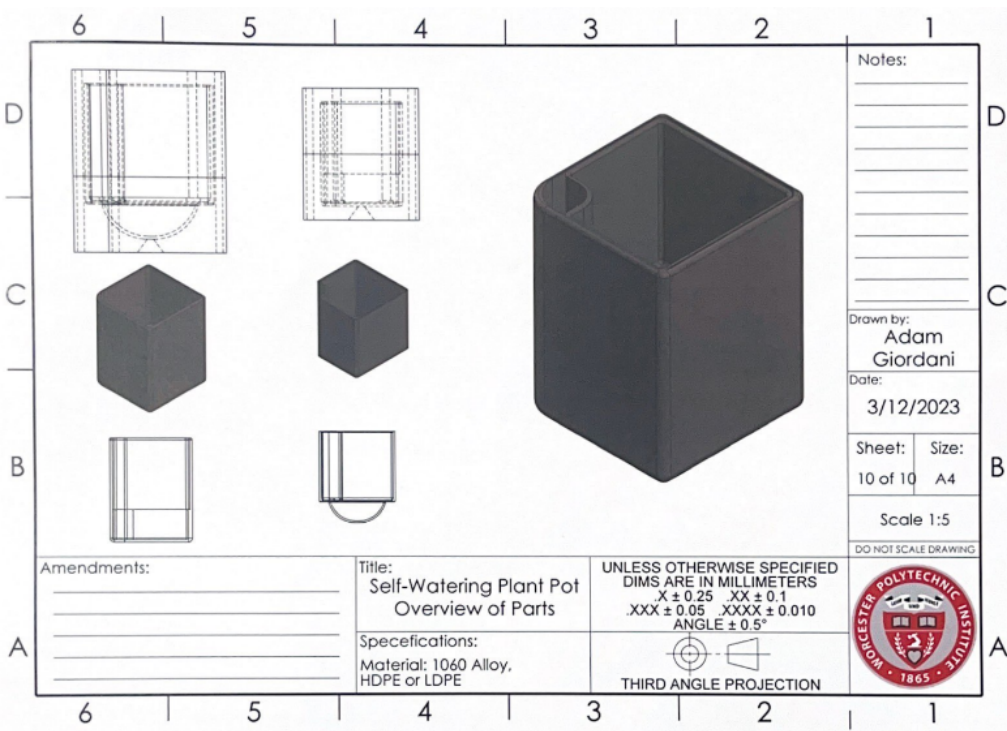
Self-Watering Plant Pot Base Mold Assembly Drawing



Self-Watering Plant Pot Base Mold Top Half Drawing

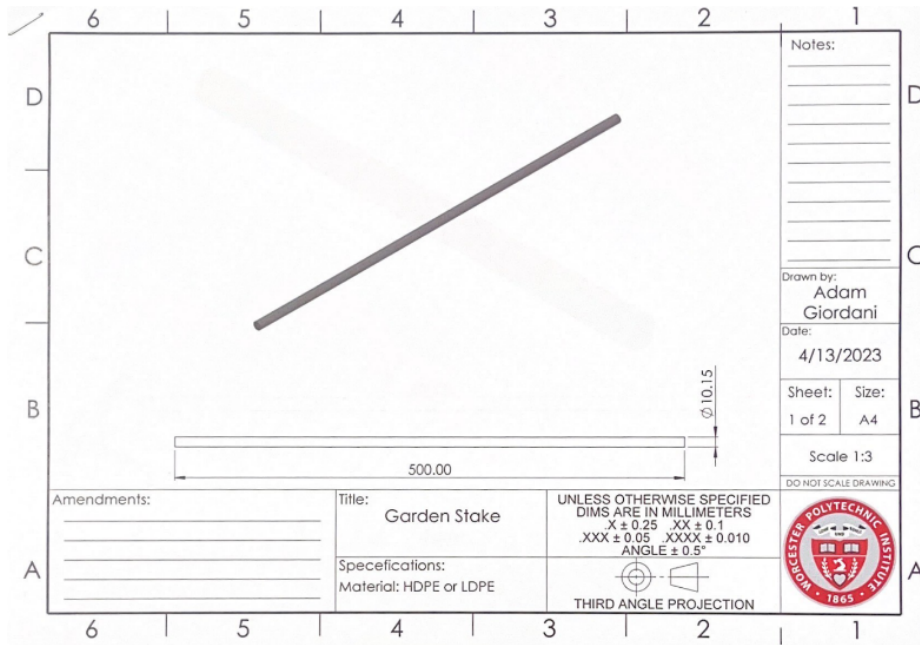


Self-Watering Plant Pot Base Mold Bottom Half Drawing

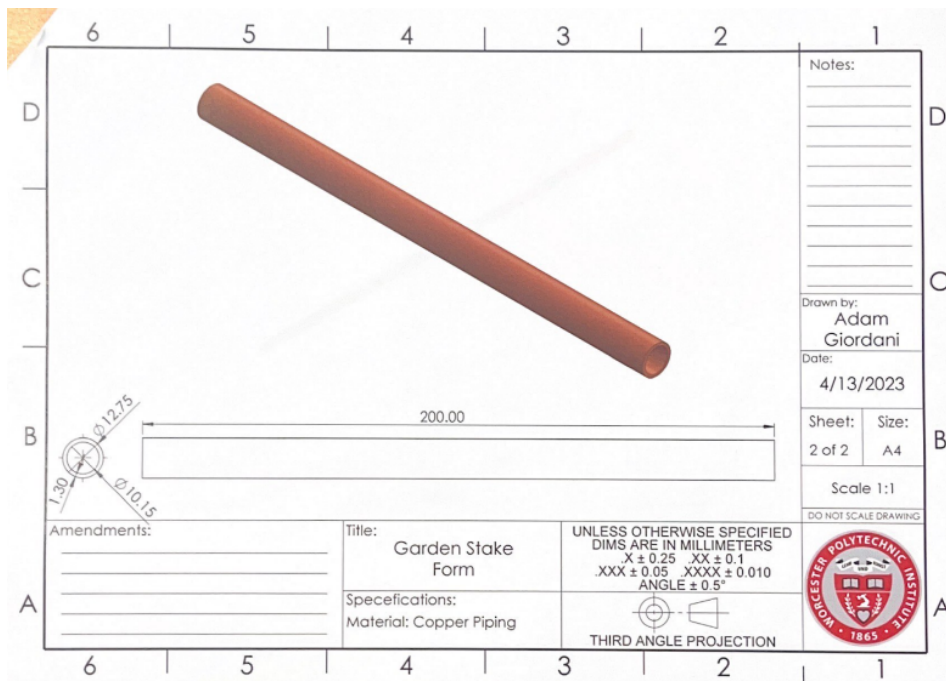


Self-Watering Plant Pot Overview of Parts Drawing

2) Garden Stake Design Drawings

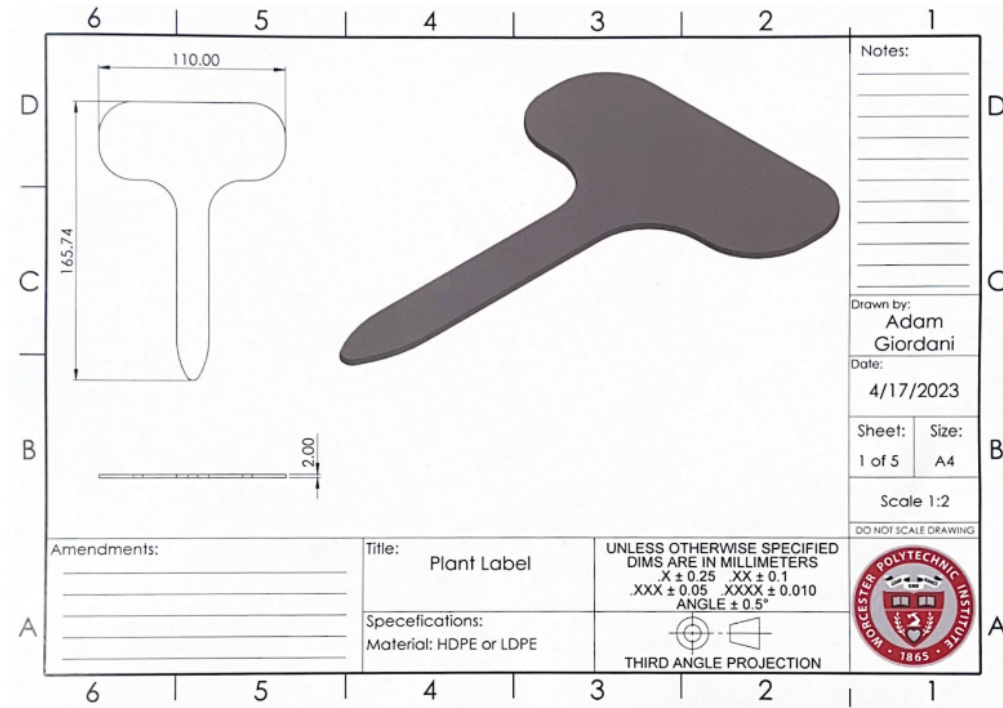


Garden Stake Drawing

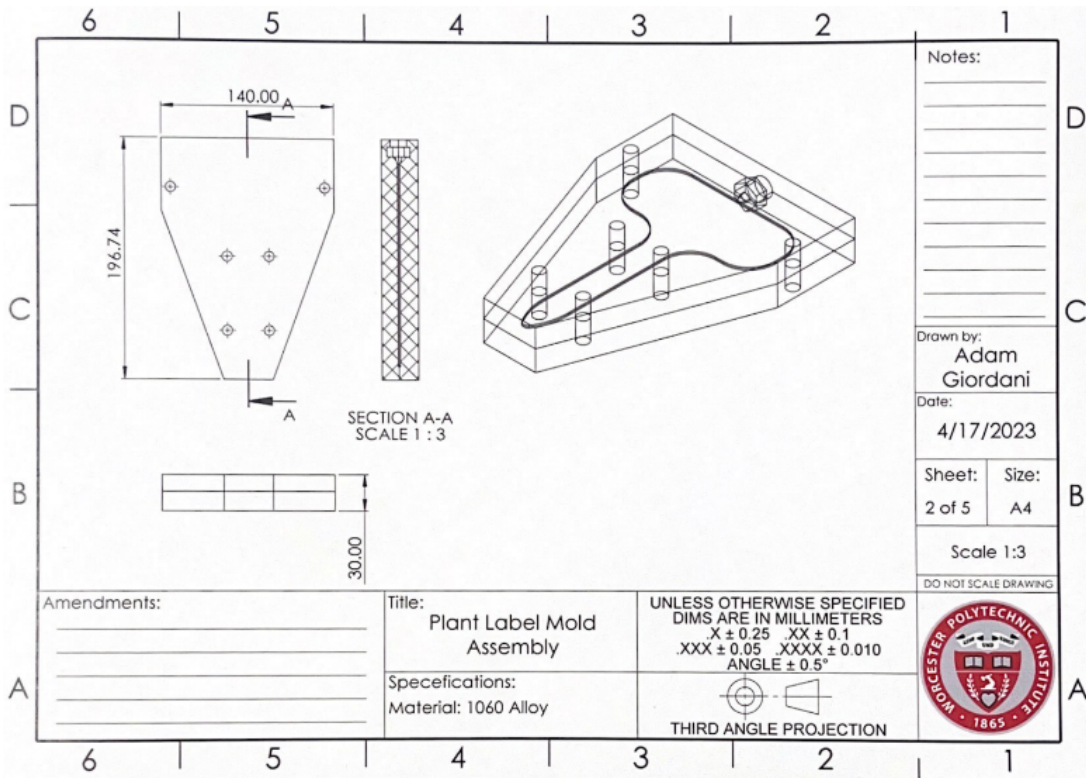


Garden Stake Form Drawing

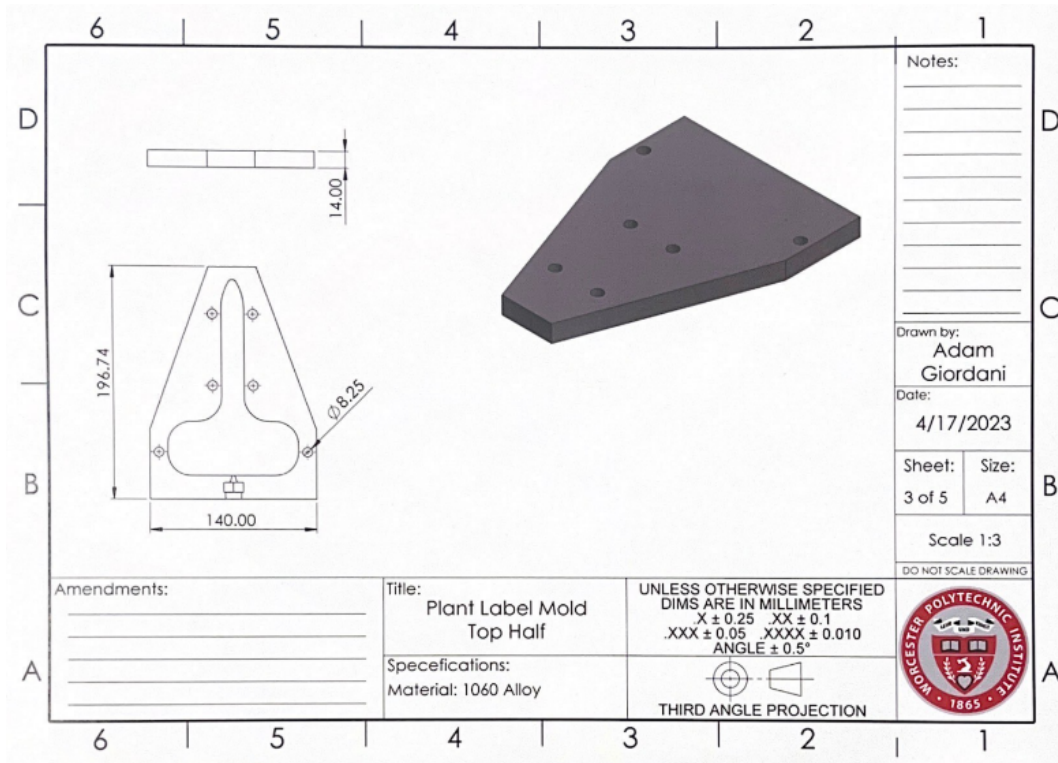
3) Plant Label Design Drawings



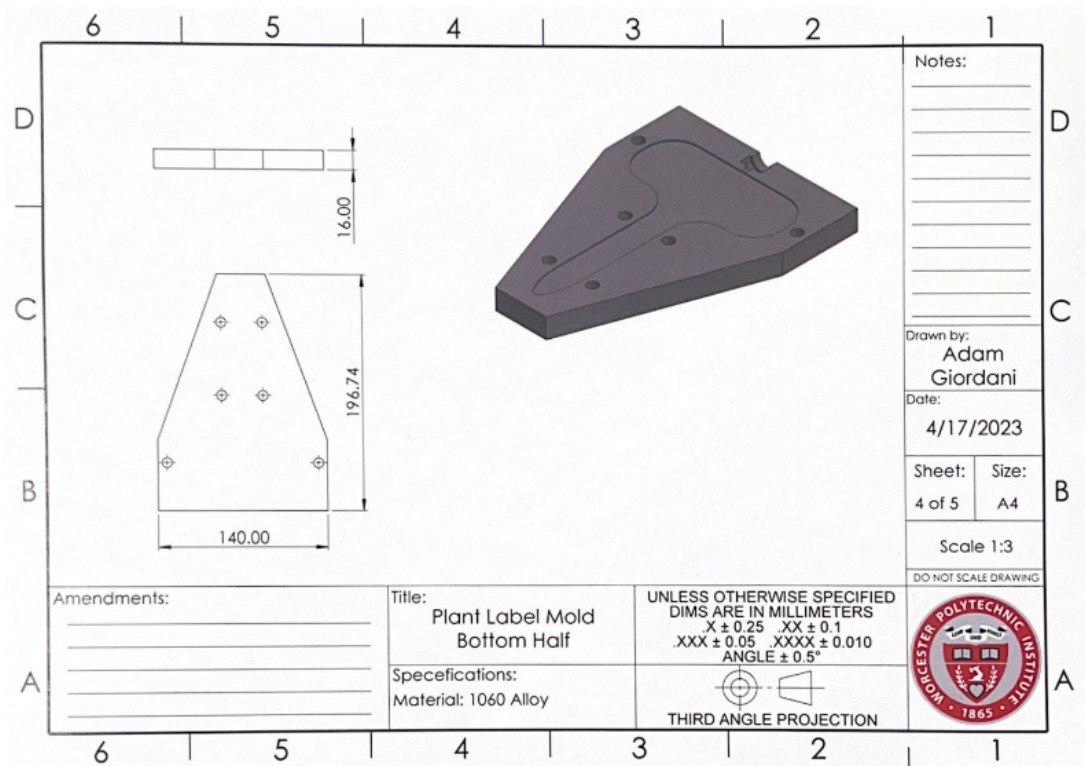
Plant Label Drawing



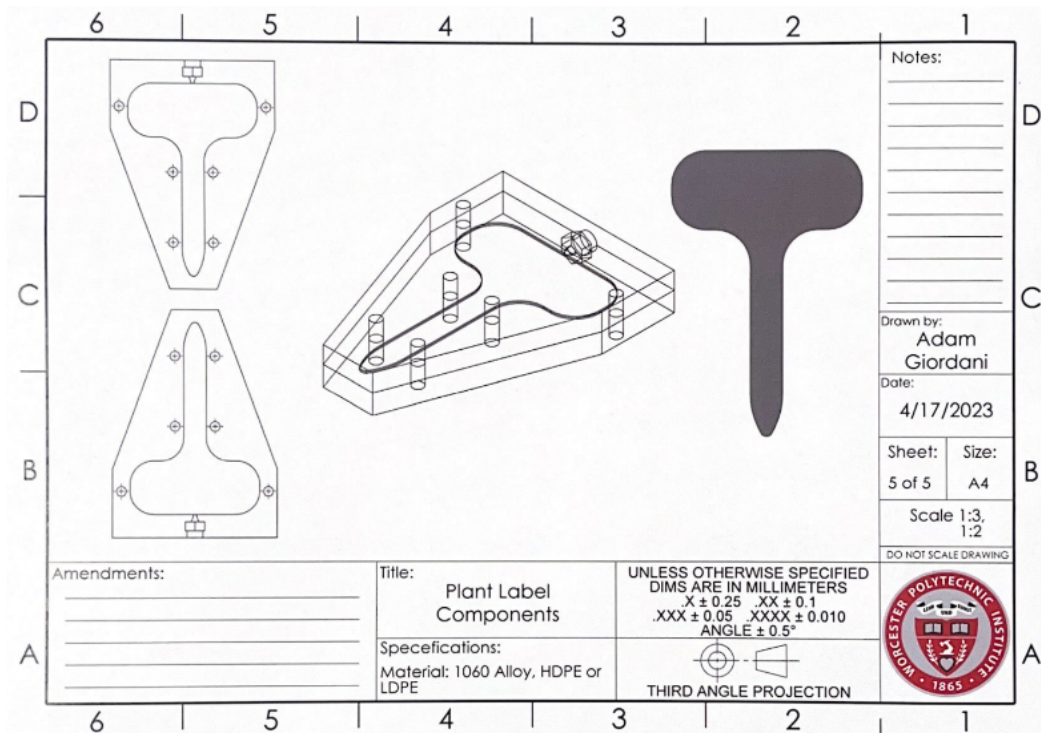
Plant Label Mold Assembly Drawing



Plant Label Mold Top Half Drawing

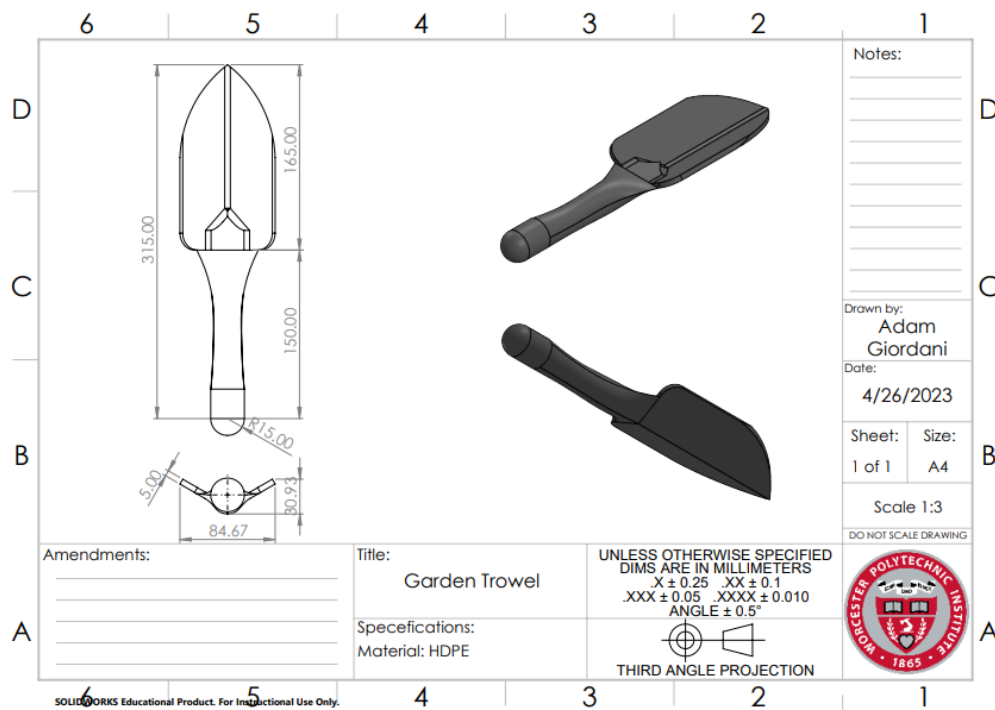


Plant Label Mold Bottom Half Drawing



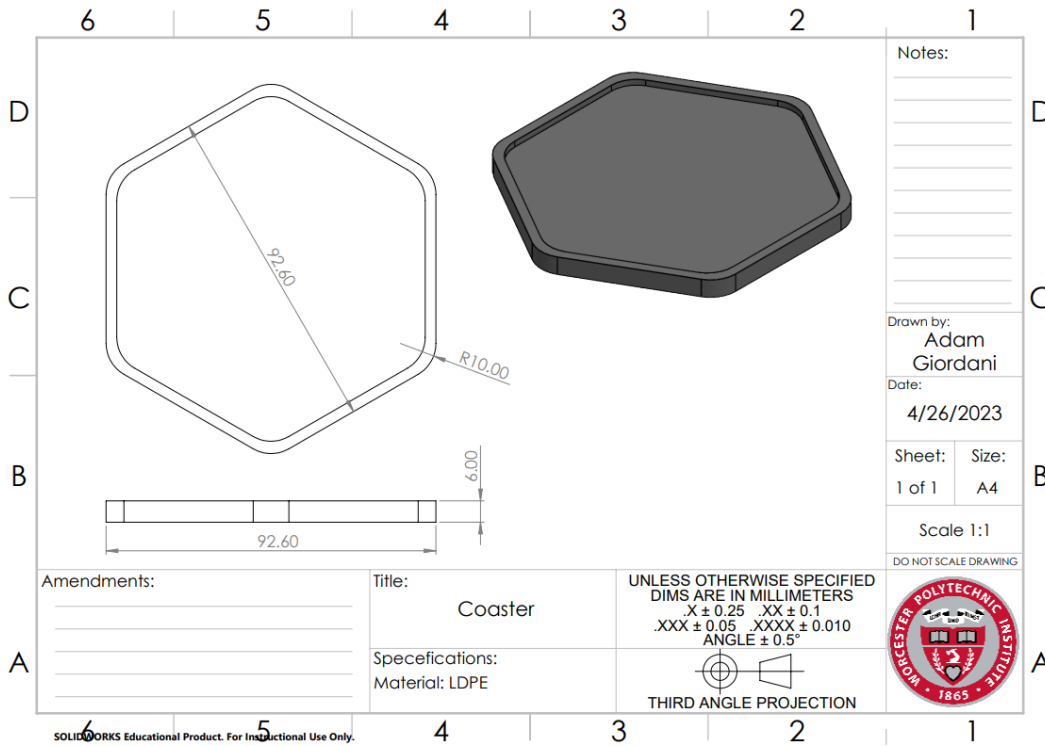
Plant Label Overview of Components Drawing

4) Garden Trowel Design Drawing



Garden Trowel Drawing

5) Coaster Design Drawing



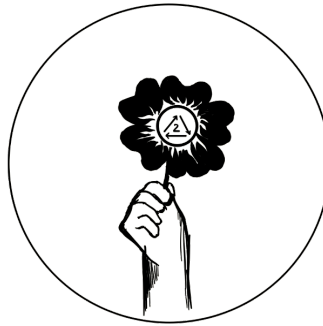
Coaster Drawing

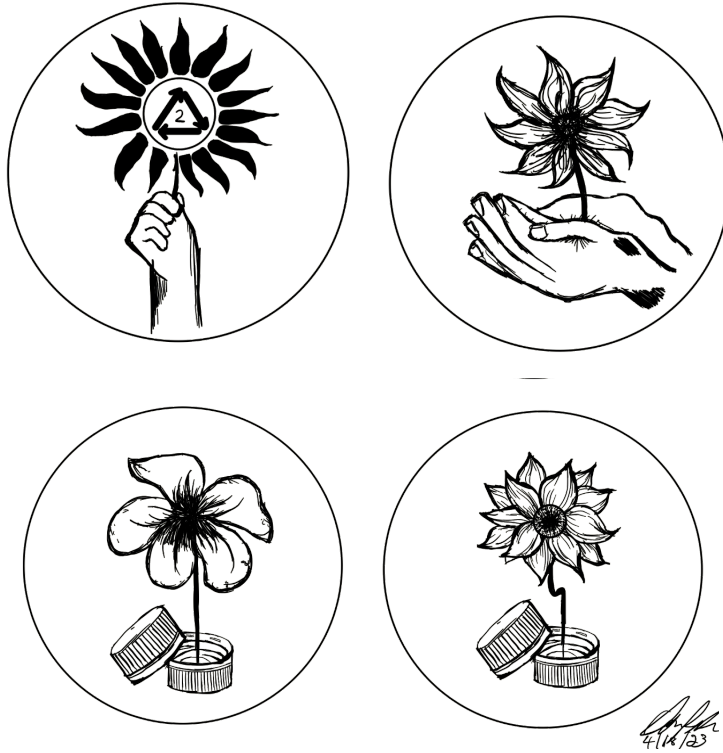
Supplemental Materials C: Plant Pot Packaging Design

1) Plant Pot Packaging Design



2) Plant Pot Logo Design Options





3) Packaging Sticker Design



Supplemental Materials D: Workshop Materials
Supplemental Materials D.1: Workshop Handouts

1) Pre-workshop survey flyer

TELL US HOW YOU SEPARATE PLASTIC CAPS



SCAN
HERE

Scan to help us study plastic cap recycling in Melbourne

Contact us at ecojusticehub@jss.org.au

2) Plastic pollution poster

PLASTICS ARE WITH US
FOREVER

EVERY PIECE OF PLASTIC
WE HAVE EVER USED
IS STILL ON THE PLANET TODAY

Plastic bottle caps are single-use plastic. They take approximately 450 years to break into small particles which are hard to detect and harm our environment.



ANNUAL GLOBAL REPORT OF PLASTIC POLLUTION

95%

Of plastic bottle caps end up in landfills

100K

Marine mammals die every year

400K

People die due to diseases linked to plastic pollution





IN AUSTRALIA 84% of plastic is sent to landfills and only 13% is recycled. Australians buy almost 15 billion plastic bottles every year, and 1.52 billion plastic bottles were sold in Australia in 2018-2019.



Bottled water consumption in Australia has increased over the past decade, with the average annual consumption increasing by 34%.

Scan to tell us how you recycle plastic caps



References: Australian national plan summary, 2021 // Sustainability Victoria, 2022

3) Plastic recycling poster

Have You Recycled Plastic Caps?

95%
of plastic bottle caps are ending up in landfills



100 K
marine mammals die every year due to plastic pollution



400 K
people die annually due to diseases linked to plastic pollution





DANGER WARNING!
When bottle caps are not recycled properly, they end up in landfills or waterways. As the time goes by, they will break into tiny plastic particles that are harmful to wildlife and humans and are hard to detect. Thus, they stay with us forever.

- ✦ Discarded recyclable bottle caps could be shredded, melted, and molded into new plastic products.
- ✦ Discarded non-recyclable bottle caps can be used as DIY tools or be used for decoration.

PROPER Way to Recycle Plastic Caps
Many Australian councils announced the recycling policy that plastic bottle caps must be separated from bottles before being placed in the recycling bin.



What can be done with these caps?



WHAT LIDS CAN WE USE?



UHT Milk
Water
Milk bottle
CLEAN LIDS ONLY Soft drink

Look for these signs on the bottle caps !





- ✦ Recyclable plastic lids are **grade 2, grade 4, and grade 5**
- ✦ **Acceptable lids:** Milk UHT bottle lids, water bottle lids, and soft-drink bottle lids

Examples of Plastic Recycling Organizations in Melbourne

- Lids4Kids program <https://www.lids4kids.org.au>
- Precious Plastic Melbourne <https://www.plastic.org.au>

Plastic lids should be washed, dried, and color sorted before sending to the organization

About
We are the Ecological Justice Hub of the Jesuit Social Services. We specialize in solving environmental issues and creating job opportunities to disadvantaged people in Melbourne community.

Mission
To create recycled plastic products from discarded plastic bottle caps and raise awareness about plastic recycling in the Melbourne community



Scan for more information



Contact us at: ecojusticehub@jss.org.au

4) Post-workshop poster

Now, what will you do with plastic bottle caps? The choice is yours :)



Scan to tell us
how you would recycle



Book the workshop here
Contact us at ecojusticehub@jss.org.au

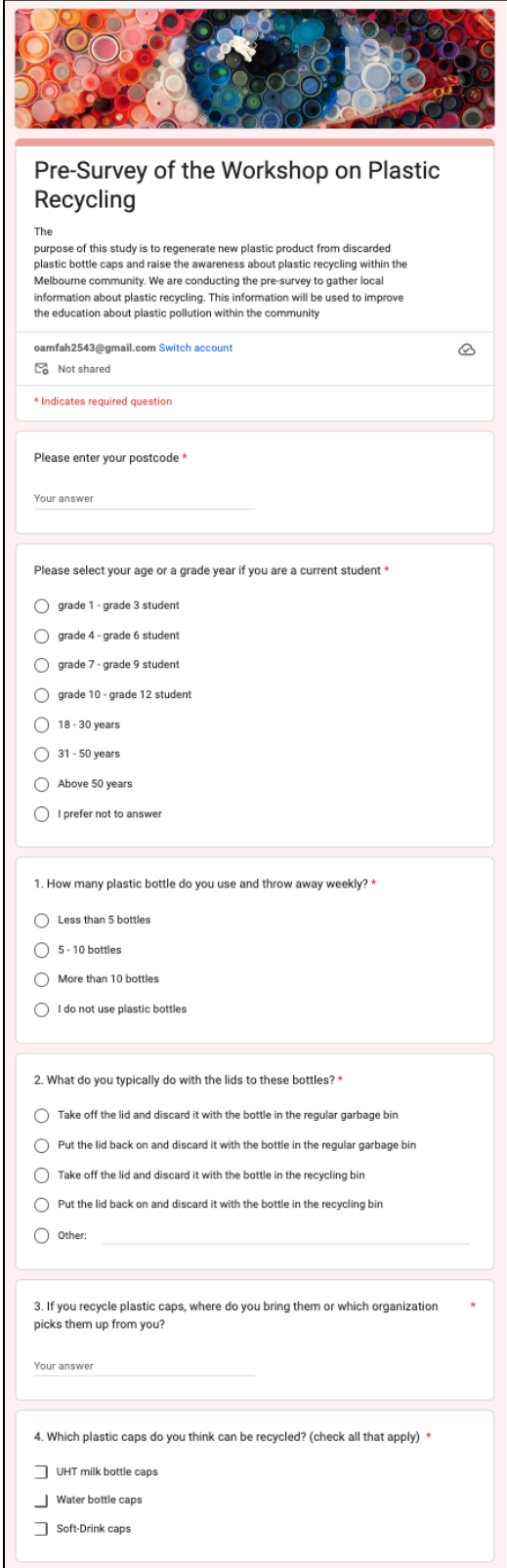
Turning a waste into
a community service
in Melbourne

100% RECYCLED PLAS




Supplemental Materials D.2: Workshop surveys


1) Pre-workshop survey



Pre-Survey of the Workshop on Plastic Recycling

The purpose of this study is to regenerate new plastic product from discarded plastic bottle caps and raise the awareness about plastic recycling within the Melbourne community. We are conducting the pre-survey to gather local information about plastic recycling. This information will be used to improve the education about plastic pollution within the community

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 Not shared

* Indicates required question

Please enter your postcode *

Your answer _____

Please select your age or a grade year if you are a current student *

grade 1 - grade 3 student

grade 4 - grade 6 student

grade 7 - grade 9 student

grade 10 - grade 12 student

18 - 30 years

31 - 50 years

Above 50 years

I prefer not to answer

1. How many plastic bottle do you use and throw away weekly? *

Less than 5 bottles

5 - 10 bottles

More than 10 bottles

I do not use plastic bottles

2. What do you typically do with the lids to these bottles? *

Take off the lid and discard it with the bottle in the regular garbage bin

Put the lid back on and discard it with the bottle in the regular garbage bin

Take off the lid and discard it with the bottle in the recycling bin

Put the lid back on and discard it with the bottle in the recycling bin

Other: _____

3. If you recycle plastic caps, where do you bring them or which organization picks them up from you? *

Your answer _____


4. Which plastic caps do you think can be recycled? (check all that apply) *

UHT milk bottle caps

Water bottle caps


Soft-Drink caps


2) Post-workshop survey



Post-Survey of the Workshop on Plastic Recycling

The purpose of this study is to generate new plastic products from discarded plastic bottle caps and to raise awareness about plastic recycling within the Melbourne community. This information will be used to improve the workshop. The results given from the workshop would be published in the report.

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 Not shared

* Indicates required question

Please enter your postcode *

Your answer

Please select your age or if you are a student please select your grade year *

year 1 - year 3 student

year 4 - year 6 student

year 7 - year 9 student

year 10 - year 12 student

18 - 30 years

31 - 50 years

Above 50 years

I prefer not to answer

1. How many plastic bottle do you plan to use and throw away weekly?

Less than 5 bottles

5 - 10 bottles

More than 10 bottles

I do not plan to use plastic bottles

2. What would you do with the lids to the plastic bottles?

Take off the lid and discard it with the bottle in the regular garbage bin

Put the lid back on and discard it with the bottle in the regular garbage bin

Take off the lid and discard it with the bottle in the recycling bin

Put the lid back on and discard it with the bottle in the recycling bin

3. If you will recycle plastic caps, where will you bring them or which organization will pick them up from you?

Your answer

4. Which plastic caps do you think can be recycled? (check all that apply) *

Soft-Drink caps

Water bottle caps

UHT milk bottle caps

5. General Impressions *

| | 1 (Very poor) | 2 | 3 | 4 | 5 (Excellent) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| My overall rating of the quality of this workshop is | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The usefulness and clarity of content on the poster are | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The safety protection during the workshop activities is | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The time management in each activity during the workshop is | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

6. To what extent are the following topics from the workshop useful to you?

| | 1 (not useful) | 2 | 3 | 4 | 5 (very useful) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Cause, effect, and the importance of plastic pollution | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| How to help the community recycle plastic bottle caps | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Types of plastic bottle caps that can be recycled | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| How to make recycled plastic product from discarded plastic bottle caps | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

7. What problems do you see in preventing the recycling process in Melbourne community?

Your answer _____

8. Do you have suggestions for how to improve the plastic recycling system within the Melbourne community? *

- Community projects
- School education
- Creating recycling initiatives
- Business engagement
- Policy Reform
- All of the above
- None of the above
- Other: _____

9. Do you have suggestions for how to improve this workshop? *

Option 1 _____

10. How much more likely are you to recycle plastic caps and other plastics after this demonstration? *

| | 1 | 2 | 3 | 4 | 5 | |
|----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--|
| I will not likely to do so | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | I will very likely to do so than before the workshop |

11. Are you likely to recommend and discuss this workshop with your friends or family? *

| | 1 | 2 | 3 | 4 | 5 | |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------|
| Unlikely | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very likely |

Supplemental Materials E: Instructional Materials

- 1) Complete instructional manual

INSTRUCTION MANUAL

For instructions on how to use and operate an injection mold, extruder, and
3D printer

TABLE OF CONTENTS

| | |
|-----------------------|----------|
| INJECTION MOLD | 1 |
| EXTRUDER | 3 |
| 3D PRINTER | 5 |

INJECTION MOLD

- 1) Sanitize
 - a) Fill a laundry bag half full with bottle caps
 - b) Place them in the washing machine
 - c) Turn on a slow cycle with cold water on the washing machine
 - d) Once the washing machine cycle has completed, remove lids from the machine
 - e) Lay the lids out individually to dry
- 2) Sort by grade
 - a) On the inside of each bottle cap is a small number, this number indicates the grade of plastic
 - b) Sort the lids by grade (typically 2, 4, or 5)
- 3) Sort by color
 - a) Once all of the lids are sorted by grade, sort the lids by color
- 4) Shred the plastic
 - a) **SAFETY PRECAUTIONS FOR BENCHTOP SHREDDER**
 - i) Wear safety glasses or goggles when operating this machine as plastic bits can fly out of the hopper
 - ii) Do not operate with any loose articles of clothing
 - iii) Always keep long hair tied back and away from the machine
 - iv) Never put hands, fingers, or other objects down into the hopper
 - b) Place bucket under the shredder
 - c) Cut bottle caps in half
 - d) Power on the machine in the forwards position
 - i) Make sure that the emergency stop button is pulled up
 - e) Place a lid in shredder every 5-7 seconds
 - f) If lids get stuck, flip power switch to reverse
 - g) Then after a few seconds flip switch back to forwards
 - h) Once done shredding, turn shredder off and remove bucket with shredded lids
- 5) Preheat the mold in the oven for ~30 minutes until mold is at 120° C
 - a) Wear heat resistant gloves when handling the mold
- 6) Preheat the injection molder to desired temperature based on grade of plastic
 - a) See sheet with temperatures on the injection mold
- 7) Assemble the mold
 - a) Align top piece and middle pieces together
 - i) Use an allen key to tighten the screws
 - b) Align the bottom and middle pieces together
 - i) Line the washers up with the mold
 - ii) Use an allen key to tighten the screws
- 8) Once injection molder is preheated
 - a) **SAFETY PRECAUTIONS FOR THE INJECTION MOLD**
 - i) Wear heat resistant gloves at all times when using the machine and handling the mold

- ii) Do not operate with any loose articles of clothing
- iii) Always keep long hair tied back and away from the machine
- iv) Never put hands, fingers, or other objects down the funnel
- b) Place mold under the injection mold
 - i) Make sure it's lined up with the nozzle
- c) Turn the handles all the way so that the piston is out of the barrel
- d) Place shredded plastic into the funnel
- e) Turn handles to lower the piston and push plastic into barrel
 - i) Turn handles slowly
- f) Repeat turning the handles to raise and lower the piston until it cannot be lowered anymore
- 9) At this point mold is full
 - a) Remove the mold from injection
 - i) Unscrew the bottom of the mold
 - b) Remove product from the mold
 - i) Push the pot out of the mold using the pin
- 10) Either turn off machine OR repeat steps 7-9

EXTRUDER

- 1) Sanitize
 - a) Fill a laundry bag half full with bottle caps
 - b) Place them in the washing machine
 - c) Turn on a slow cycle with cold water on the washing machine
 - d) Once the washing machine cycle has completed, remove lids from the machine
 - e) Lay the lids out individually to dry
- 2) Sort by grade
 - a) On the inside of each bottle cap is a small number, this number indicates the grade of plastic
 - b) Sort the lids by grade (typically 2, 4, or 5)
- 3) Sort by color
 - a) Once all of the lids are sorted by grade, sort the lids by color
- 4) Shred the plastic
 - a) **SAFETY PRECAUTIONS FOR BENCHTOP SHREDDER**
 - i) Wear safety glasses or goggles when operating this machine as plastic bits can fly out of the hopper
 - ii) Do not operate with any loose articles of clothing
 - iii) Always keep long hair tied back and away from the machine
 - iv) Never put hands, fingers, or other objects down into the hopper
 - b) Place bucket under the shredder
 - c) Cut bottle caps in half
 - d) Power on the machine in the forwards position
 - i) Make sure that the emergency stop button is pulled up
 - e) Place a lid in shredder every 5-7 seconds
 - f) If lids get stuck, flip power switch to reverse
 - g) Then after a few seconds flip switch back to forwards
 - h) Once done shredding, turn shredder off and remove bucket with shredded lids
- 5) Preheat the extruder to desired temperature based on grade of plastic
 - a) See sheet with temperatures on the extruder
- 6) Assemble the mold
 - a) Align top and bottom pieces together
 - i) Use an allen key to tighten the screws
 - ii) Use two clamps to keep mold tight and secure
- 7) Once the extruder is preheated
 - a) **SAFETY PRECAUTIONS FOR THE EXTRUDER**
 - i) Wear heat resistant gloves at all times when using the machine and handling the mold
 - ii) Do not touch any heated nozzles or surfaces
 - iii) Never put hands, fingers, or other objects down the funnel
 - b) Connect mold to the extruder with the ¼" nozzle
 - c) Fill machine hopper with the shredded lids

- d) Turn the handle counter clockwise to feed the shredded plastic through the machine
- e) Continue turning the handle until there is enough resistance so that it cannot be turned anymore
- 8) At this point mold is full
 - a) Remove the mold from injection
 - i) Unscrew the bottom of the mold
 - b) Remove product from the mold
- 9) Either turn off machine OR repeat steps 6-8


3D PRINTER


- 1) Turn on the printer using the switch on the side of the machine
- 2) Preheat the printer
 - a) To preheat the printer, select the "ready" option on the screen. The printer will automatically put itself in the auto home position. Once that is completed, select the "manual" option on the screen, and then select the preheat setting for the desired plastic (PLA or ABS).
- 3) Load file onto SD card
 - a) To load a 3D printing file to the printer, it needs to be uploaded to the printer's SD card. Connect the SD card to the flashdrive and plug it into your computer. When in the slicing software, there will be an option to save the file to the SD card. Once the file is uploaded to the card, remove the flashdrive and the SD card and place the SD card back into the printer.
- 4) Level the printer
 - a) Before starting a print, always make sure that the bed is level. Take a piece of paper and place it over the bed. The bed is leveled in 5 places, the center and the four corners. At each spot twist the gears under the bed to raise and lower the bed. A good indication of the bed being leveled is having a slight resistance on the paper when moving it back and forth from the nozzle. The bed is completely leveled when there is that slight resistance in all 5 places.
- 5) Start the print
- 6) Remove print from bed once completed

2) User-Testing Feedback Form

Feedback Form

The purpose of this study is to regenerate new plastic products from discarded plastic bottle caps and raise the awareness about plastic recycling within the Melbourne community. The information you provide will be used to help improve the instructional materials (instruction manual and video) used in the user-testing activity.

melissa.kelly1350@gmail.com [Switch account](#) 

 Not shared

* Indicates required question

Were there any aspects of the instructions you found difficult? If so, which parts? *

Your answer

Were you confused at any point while using the machinery? If so, explain where you were confused. *

Your answer

Do you have any suggestions on how we can make the instruction manual and video easier to follow? *

Your answer

[Submit](#) [Clear form](#)