Team Information

Project Name

A New Dimension in the Laboratory Supply Chain

Team Lead

Adam Perkins, Department of Health and Senior Services, State Public Health Laboratory , 573-751-1075

Team Members

Minimum: 3; Maximum:10

	Name	Department/Division	Email address
1	**Adam Perkins**	DHSS/SPHL	Adam.Perkins@health.mo.gov
2	Richard Sapp	DHSS/SPHL	Richard.Sapp@health.mo.gov
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Your Pitch

What problem are you addressing? (No more than 200 words)

Plastics are a key consumable in the testing that is conducted at the Missouri State Public Health Laboratory. We have struggled to obtain plastics, namely those made with laboratory grade plastic or polypropylene (PP), since March of 2020. Over the last 18 months of the pandemic, the laboratory has frequently encountered delays of up to six months in receiving or in certain cases the complete unavailability of the plastic supplies needed throughout the laboratory for testing. This has made it necessary for the laboratory to prioritize and sometimes postpone specific testing to adjust to the uncertainty in our ability to obtain these key testing supplies.

What is the root cause of the problem? (No more than 200 words)

The pandemic has had a huge impact on many areas of the plastic comsumables supply chain. First, the increase in testing for the virus has resulted in a much larger demand for those consumables which are needed to conduct the testing in all areas of the laboratory. Additionally, the supplies of the plastics have been affected by the closing of factories, difficulties in shipping and adjustments by manufacturers to meet market demand for products specific to the pandemic. This has led to an inconsistent supply of key plastic consumables which leads to uncertainty when it comes to planning ahead for testing needs.

What is your proposed solution? (No more than 200 words)

The laboratory should move towards the mass production of key plastic consumables by recycling laboratory grade plastic waste and using that material to 3D print the plastic supplies that are needed. On a small scale, the laboratory has already successfully produced a number of plastic products using the 3D printer; additionally, there is nearly 1500lbs of plastic waste currently being discarded that could be recycled. By investing in several pieces of specialized equipment, a workflow would be established to transform this plastic waste into the material used by the 3D printer for the production of plastic supplies. The overall goal is to make the laboratory more self-sufficent when it comes to our supply of plastic consumables.

Which area of impact is your primary focus? (No more than 10 words)

Reduce total plastic waste and protect against supply shortages.

What is your primary measure for impact?

Primary measure	Current Status	Target
#5 Plastic Waste Recycled	0%	25% by Dec 31, 2022.
Sharps Containers Produced In-House w/ Recycled Materials	0	500 by Dec 31, 2022.

** Measures should follow SMART principle: Specific-Measurable-Actionable-Relevant-Time bound.*

OA's guidance on performance metrics

Project Plan

What are the major activities and milestones to deliver your solution? (Additional steps may be added)

	Activity	Milestone or deliverable	Due date
1	Design prototype sharps container using polypropylene filament using 3d printer.	Completed sharps container which can the undergo QC.	**28-Aug-21**
2	Develop SOP for quality control on 3d-printed sharps containers using industry standards.	Locate industry source for quality control standards. Adapt standards to in-house SOP.	**30-Sep-21**
3	Test prototype sharps containers using quality control SOP.	Sharps container approved for use in the laboratory for biohazard waste disposal by Safety Officer.	**15-Oct-21**
4	Complete workflow for entire process from accumulation of plastic waste all the way through 3D printing of new sharps containers.	SOP for process approved by EMT at MSPHL.	**15-Nov-21**
5	Purchase equipment necessary to recycle plastic waste (pipette tip boxes) into filament used for 3d printing.	Select the three pieces of equipment necessary for the three steps to turn plastic waste into new filament for 3d printing.	**1-Mar-22**
6	Produce prototype sharps container using filament from recycled plastic.	Completed sharps container made from recycled filament that passes QC standards.	**4-Apr-22**
7	Develop SOP for production and training materials - train one additional person to increase efficiency	Manual for operation of all equipment that can assist with training additional staff.	**2-May-22**
	Begin regular process of recycling plastic waste and producing sharps containers.	Recycling 30 lbs of plastic a week and producing 10 sharps containers a week.	**9-May-22**
8	Staff training on entire workflow to produce sharps containers	At least one additional staff member to serve as a backup to maintain production of sharps container at all times.	**1-Jun-22**

Required Resources and Support

What is the expected project duration? Choose one from the list below.

Long term (> 6 months)

How many people will be required to finish the project in the given duration? Choose one from the list below.

Small (<4 people)

Does your project require any specialized skills to complete? If so, explain. (No more than 100 words)

This project requires skills in operating the design software to make the prototype as well as the experience to operate the 3D printer.

Does your project require any statutory change to complete? If so, explain. (No more than 100 words)

No

Can you implement your project with your current resources? If not, explain. (No more than 50 words)

Strongly recommended: Provide a cost breakdown in your additional materials.

Yes we have the funding to make the necessary equipment purchases that are detailed in the presentation and supplemental materials. .

Are there other factors critical to design and implement your project? (No more than 50 words)

Getting through the bid process for purchasing the equipment as quickly as possible, finding appropriate space to house the new equipment

Additional Materials

Please list any additional materials you have provided.

1	
2	
3	

A NEW DIMENSION IN LABORATORY SUPPLIES

EXECUTIVE SUMMARY

PROBLEM STATEMENT – The Missouri State Public Health Laboratory (MSPHL) will avoid future testing interruptions due to plastic consumable supply shortages by recycling plastic waste generated by the laboratory into plastic filament that can be used by our 3D printer to produce plastic consumables internally instead of purchasing them from external sources.

ROOT CAUSE - The pandemic has had a major effect on our testing workflow over the past 18 months, specifically with regards to our ability to obtain plastic testing consumables that used to be readily available. The pandemic has also caused issues with the supply chain that is responsible for producing these plastic consumables. Some manufacturing facilities are closed or are working below maximum capacity while others have shifted their production to produce items that are more directly connected to meeting specific market demands. If this problem is not addressed, it may require the prioritization of some testing methods over others and may even cause interruptions to testing that would delay results for critical screening methods.

SOLUTION - Our team would like to expand our small scale production of plastic products using our 3D printer to produce plastic consumables on a larger scale and become more self-sufficient in meeting the laboratory's needs. Additionally, our team plans to support this new workflow by recycling plastic waste that is created by routine laboratory testing and would otherwise be discarded. Investment in specialized equipment will allow us to transform plastic waste into recycled plastic filament. This filament will then be used to produce laboratory plastic consumables using our 3D printing process. Our goal is to begin with a pilot project where we will focus on recycling a specific type of plastic waste (#5 or polypropylene) that will meet laboratory and industry standards for producing a sharps biohazard waste container and negate our current need to purchase these products.

KEY MILESTONES – Our first milestone was the production of a prototype sharps container. Our next major step is to purchase the remaining equipment necessary to complete the workflow including a shredder, a granulator and an extruder. In the selection of this equipment, we have focused on models with small footprints and those that are easy to use so that we can have the necessary space to house the equipment and reduce training on the use of this equipment. Our next major step will be to put the entire workflow to the test by recycling accumulated plastic waste, turning it into plastic filament and then printing sharps containers using this material. Once a workflow is established, the last step of the pilot project is to build the workflow into the daily routine for all the team members.

PERFORMANCE MEASURES - Within the first year of the pilot project being launched our goal is to recycle at least 25% of the polypropylene that is currently discarded which is enough to produce 500 sharps biohazard containers (25% of the current amount used) to replace what we would normally purchase. This represents 375lbs of plastic waste from being put into a landfill as well as a cost savings to the laboratory of nearly $2,600. Beyond the first year, the objective is to recycle all of the polypropylene discarded by the laboratory and to expand production to replace all purchased sharps containers. The yearly impact moving forward will be 1500lbs of plastic removed from the waste cycle and a cost savings to the laboratory of $8,900.

NEXT STEPS – Following the completion of this pilot project, we would like to share this workflow with laboratories across state government who are likely facing similar issues with obtaining plastic consumables for testing methods. We believe there is also an opportunity for Missouri Vocational Enterprises to expand their manufacturing capacity, and perhaps our existing recycling programs across state government could be adapted to providing the necessary plastic material to allow for 3D printing capacity in that area.

FEASIBILITY

The MSPHL has eight distinct testing units responsible for monitoring the health of Missourians through various testing methodologies, but we focused on the three units that we viewed as being the largest suppliers of the plastic waste. There is the potential for more plastic waste to be collected from the rest of the laboratory following the pilot project.

Overall supply of waste polypropylene (PP) from first floor laboratories FY21:

Molecular Unit	598 kg polypropylene
Virology Unit	37.4 kg polypropylene
Microbiology Unit	23.2 kg polypropylene
Total	658.6 kg (PP)

Approximately 660kg of plastic waste from FY21 from these three sources represents enough material to 3D print over 2,000 one-gallon sharps containers. This will allow the laboratory to cease purchasing these containers commercially and realize the full cost savings laid out below.

TIME INVESTMENT

Reclamation time:
- Shredding: Up to 300Lbs/Hour
- Granulation: Up to 33Lbs/Hour
- Extrusion: Up to 4.5Lbs/hour

3D print duration for 1-gallon sharps container: 5 hours 45 minutes (two containers per day)
- Expanding production with second 3D printer: 6 sharps containers per day

DESIGN CONSIDERATIONS

During the design phase of our pilot project of producing sharps containers, considerations were given to the following characteristics as stipulated in the *International Standard for sharps injury protection – requirements and test methods* ISO 23907-1:2019(E)

- Resistance to Sharps Penetration
- Resistance to Fall Damage
- Resistance to Toppling
- Impermeability to Liquid Egress
- Permanent Closure
- Biohazardous Warning Label

All 3D printed products will be subject to the same level of scrutiny and undergo rigorous testing equivalent to the aforementioned methodologies. We will guarantee quality and ensure that personnel safety and competitive function are paramount.

GOAL & PERFORMANCE MEASURES

We will begin by 3D printing 500 one-gallon sharps containers from recycled plastic in the first year (replacing 78% of total 1-gal. sharps container requirements) for a savings of $2,600. Our goal is to expand to 3D printing operation to meet all of the MSPHL's sharps container needs in 2022 (opportunity to save $8,900/year on sharps containers alone). Our second measure involves the amount of plastic waste that is recycled at the laboratory with a goal of recycling 25% of the current waste that we are collecting from the three sources mentioned above. That will be enough material to produce the 500 one-gallon sharps containers in year 1 and then that output would be increased throughout year 2 to recycle all of the plastic waste produced.

SCALABILITY: PRODUCTION

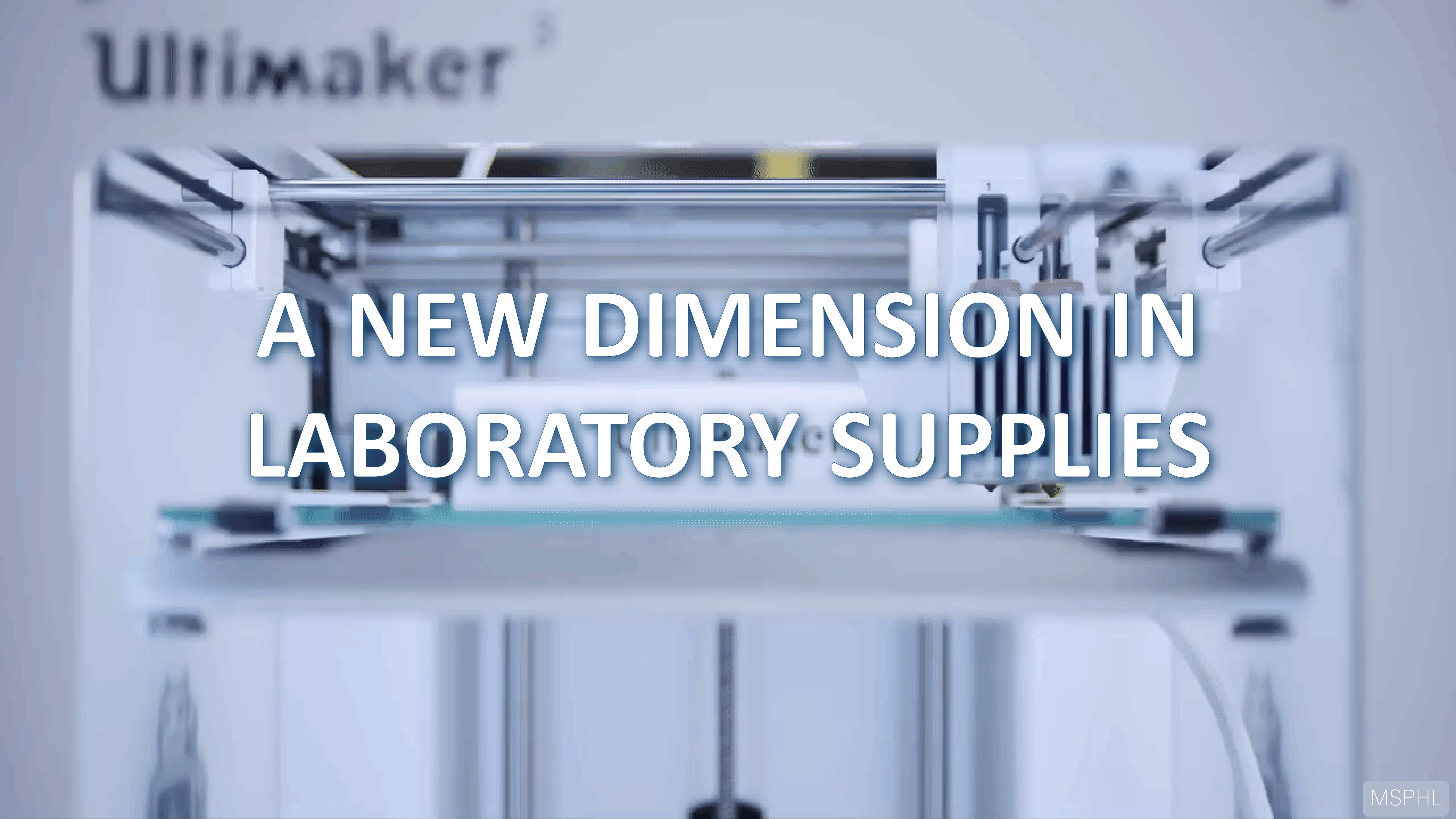
With the addition of a large format 3D printer employing IDEX technology it would be possible to more than double productivity through concurrent 3D printing. Recent advancement in IDEX (Independent Dual Extrusion) systems has made it feasible to simultaneously produce two or more prints for the same time expenditure; all with one machine, and maintaining the same footprint. The compact nature of this system and performance characteristics make it an ideal choice for moderate volumes of in-house fabrication. If multiple machines of this variety were employed the benefits would compound, and are easily scalable to meet demand.

An additional benefit of this system is the adaptability of the recycled plastic product. While our pilot project focuses on production using 3D printing processes, the recycled plastic waste produced through our workflow can be adjusted so that other benchtop manufacturing equipment could be utilized. After we have optimized our production of sharps containers, we would like to create designs for replacing additional plastic consumables that are needed at the laboratory. Specifically, the use of automated benchtop micro-molding machinery would allow for the production of cryogenic vials, micro-centrifuge tubes, specimen collection devices and potentially even pipette tips. This machinery can produce industry grade injection molded parts while being compact enough for benchtop operation. Each item that could be produced internally would result in additional cost savings to the laboratory by reducing the amount of supplies that had to be purchased commercially. An preliminary estimate for the replacement of each item through in-house production would be nearly $1,000 for cryovials, $1,090 for sample collection devices and over $12,500 by replacing large volume pipette tips.

SCALABILITY: APPLICATION

For the scope of this pilot project, we have focused only on the recycling of laboratory grade plastic (#5 or polypropylene) because the plastic consumables that are produced at the laboratory must be able to be autoclaved. However, this workflow could easily be adapted to the recycling of additional plastics including (PET/PETE, LDPE, and HDPE) that may already be recycled through the State Recycling Program. Expansion of this program could allow for collection of these plastics to be recycled here at the laboratory or to develop more sites where the processing of the plastic waste could be handled. Our group has also considered that Missouri Vocational Enterprises could be an area where this workflow could be expanded to allow for production of plastic components that did not need to be laboratory grade but could range from construction of specific plastic parts for repairs on a small scale to taking on mass production of common plastic goods for all of state government.

Our team also recognizes the potential in collaborating with the Office of Administration's State Recycling Program to tap into additional funding opportunities as well as their connections with manufactures in the private sector. As our program expands to other manufacturing methods having contacts with more experience will help us to improve our processes. It would also allow for the training opportunities beyond state government to invest in the development of more people who can utilize these processes statewide.


Ultimaker
A NEW DIMENSION IN
LABORATORY SUPPLIES
MSPHL

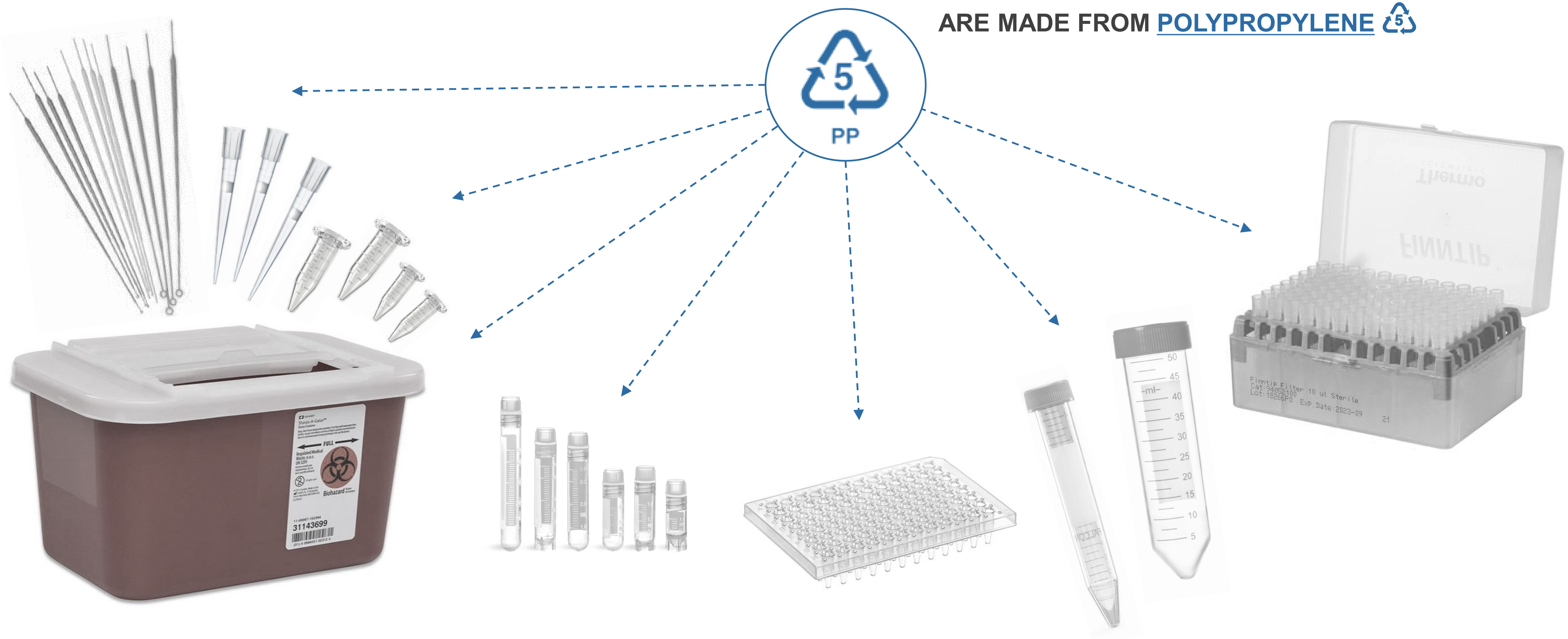
Plastic consumables have emerged as a weak point in our testing workflow

The pandemic has amplified demand for plastic consumables.

Essential testing supplies have become subject to indefinite backorder.

Delays or stoppage of key testing could result if left unchecked.

NEARLY ALL CRITICAL CONSUMABLES ARE MADE FROM POLYPROPYLENE



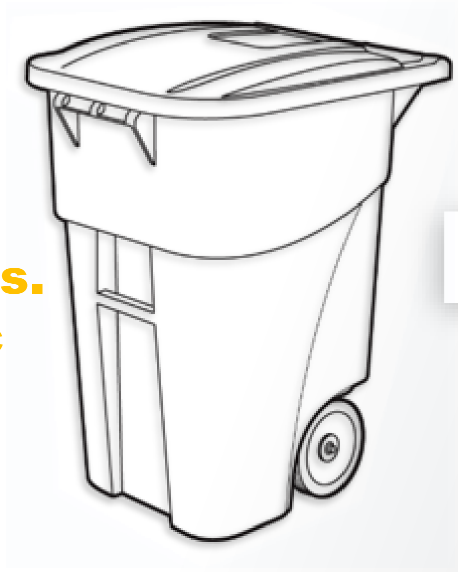
MSPHL Can Become Self-Sufficient by Reclaiming Our Own Plastic Waste

We produced over 1500lbs of laboratory grade plastic waste in FY 2021.

We have already prototyped and 3D printed laboratory devices to improve testing

We can avoid shortages by shifting to in house production.

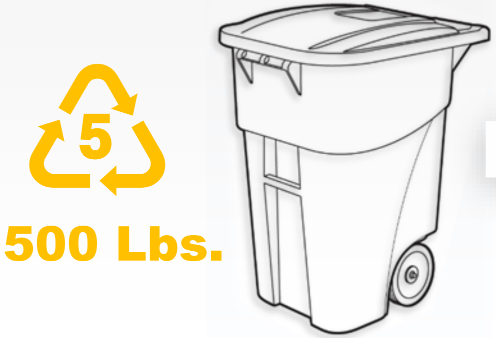
1500 Lbs. Plastic Waste




thermo scientific
INTEGRA

The reclamation process produces benefits beyond self-sufficiency

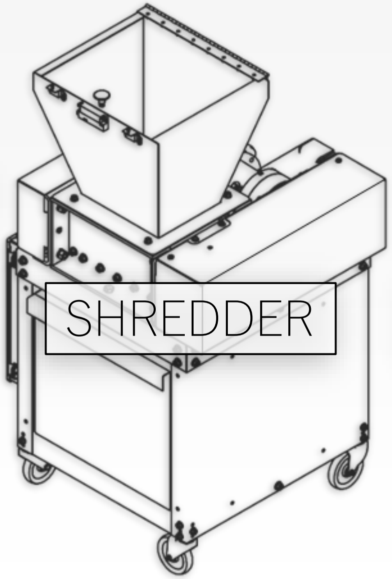
LABORATORY PLASTIC WASTE

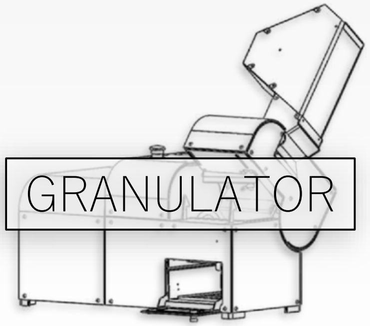


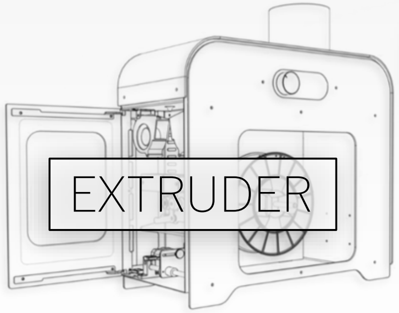
1500 Lbs.

PROCESS

REQUIRED EQIPMENT



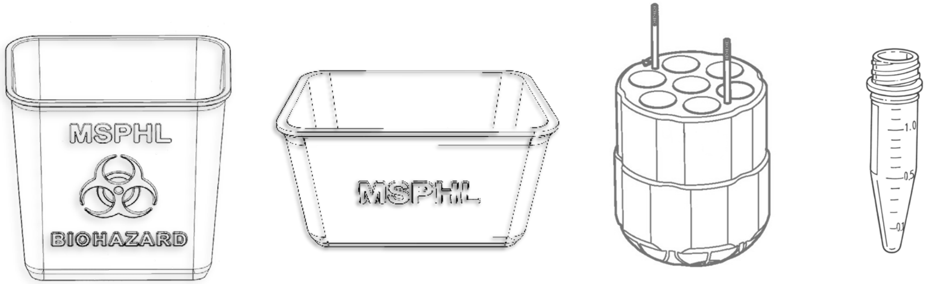




TOTAL EQUIPMENT EXPENSES	$ 37,470.00

RECYLCED FILAMNET

3D PRINT REPLACEMENT SUPPLIES IN-HOUSE



COST RECOVERY

ANNUAL RETURN

2022	2023	2024	2025	2026
$2,600	$8,900	$8,900	$8,900	$,8900

COST RECOVERY	$ 38,200.00

The process can expand beyond the MSPHL

- Connect with other laboratories in state government (DNR, Highway Patrol, Agriculture)
- Connect with Missouri Vocational Enterprises on manufacturing opportunities
- Connect with State Recycling Program for additional funding and expertise

MSPHL Team

Adam Perkins

Section Manager

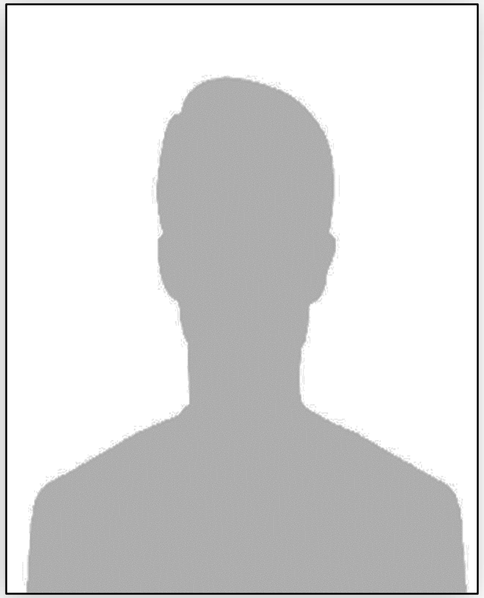
Lean Six Sigma Green Belt

Member of Show-Me Excellence Team

Mary Barrioz

Quality Systems Officer

Lean Six Sigma Green Belt



Richard Sapp

Laboratory Scientist

Over Ten Years of Experience AutoCAD drafting & 3D design

Seven years of Experience in Fused Deposition Modeling