AEST Department Student Training for Sorting and Preparation of Recycled Plastics

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Table of Contents

Section 2: Demonstrate Proper Equipment Use and Processes for Plastic Sorting, Shredding, and Washing

A. Sorting Plastics

1. Collect plastics
2. Sort by plastic type
3. Sort types by color
4. Correctly identify and sort 10 pieces of plastic using given information provided in section 1, and sorting charts

B. Shredding Plastics

1. Demonstrate the steps for shredding plastics using a WB Granutec 110

C. Washing Plastics

1. Demonstrate how to correctly load plastics
2. Operate the Washing Machine with correct cycle settings
3. Show how to dry the plastics

Section 3: Value and Impact of Recycling

A. Describe the impact on the environment with regards to plastic recycling

1. Share the benefits of the three R’s of recycling

2. Fill out a trainee survey to assess the extent to which the training will be implemented as a student in the AEST Department

Summary

Thanks to the effort of independent clubs, i.e. the Society of Manufacturing Engineers (SME) and the Environmental Sustainability Club (ESC), Millersville's Applied Engineering and Safety Department (AEST) has developed a plastic recycling program that will turn used plastic goods on campus back into useful products. These new products will be sold through the campus bookstore or online via ETSY. Currently, there is little recycling taking place on campus through waste management streams, and no internal recycling of used goods in any form. Osborn Hall, the building that houses the AEST Department is a pioneer in recycling efforts on campus thanks to the help of the Society of Manufacturing Engineers Club (SME) and the Environmental Sustainability Club (ESC). These groups are seeking to increase student participation and educate the students at Millersville University in this newly created plastic recycling effort to create a more environmentally conscious campus.

Trainees are needed to help increase recycling awareness among peers on campus as well as helping to sort, wash, and shred received plastics to decrease overall plastic waste on campus. Due to a number of reasons most of the single use plastic on campus is thrown away rather than recycled. Two of these main reasons are recent restrictions in Chinese imports of plastic as well as a lack of recycling locations easily accessible for students on campus — The only plastic that Millersville can recycle is " Plastic bottles, jars, jugs, and anything else with a neck. — [but] [a]ll other plastics should be thrown in the waste bins" https://www.millersville.edu/sustainability/sustainable-campus/recycling.php. However, when plastics are brought to Osburn Hall, instead of ending up in a landfill, they are used to create new goods that will be valued far longer than their previous life span. According to the President of SME, "We need students to help with every part of the plastics recycling program, collection,

sorting, and even shredding" (Blizzard). As trainees and students, it will be your job to participate in this recycling initiative and learn about the necessary steps to successfully recycle these materials.

By the end of this training manual the trainee will:

1. Describe the differences between industrial recycling and recycling in the AEST Department as measured by a written exam.

2. Correctly sort, wash, and shred recycled plastics under supervision of your instructor using the training manual and provided equipment as shown in the demonstration.

3. Describe the importance of implementing the three R's and fill out an end of training survey upon completing the training manual.

Overview

This training manual is designed to be completed independently by each trainee. As you progress through and complete each section, you will be required to complete an examination before moving on. The first section will address knowledge regarding industrial plastic recycling systems, as well as best practices for the AEST Department recycling program, and will end with a five question written examination. The second section will cover the steps required to operate each machine necessary for recycling plastic in the AEST Department. After the completion of section 2, you will participate in a live demonstration on machine operation and be required to demonstrate proper machine usage to your instructor before moving on to the final section.

Finally, Section 3 will cover the importance of the three R's and incorporating them into your daily routine and will end with a brief quiz concerning the three R's as well as several questions regarding your experience with the training manual. Following the completion of this training manual, you will be asked to complete a brief survey that will be handed in to your instructor.

Section 1: Information Regarding Industrial Plastics Recycling and the Applied Engineering and Safety Department (AEST)

Recycling In Industry

Sorting in Industry

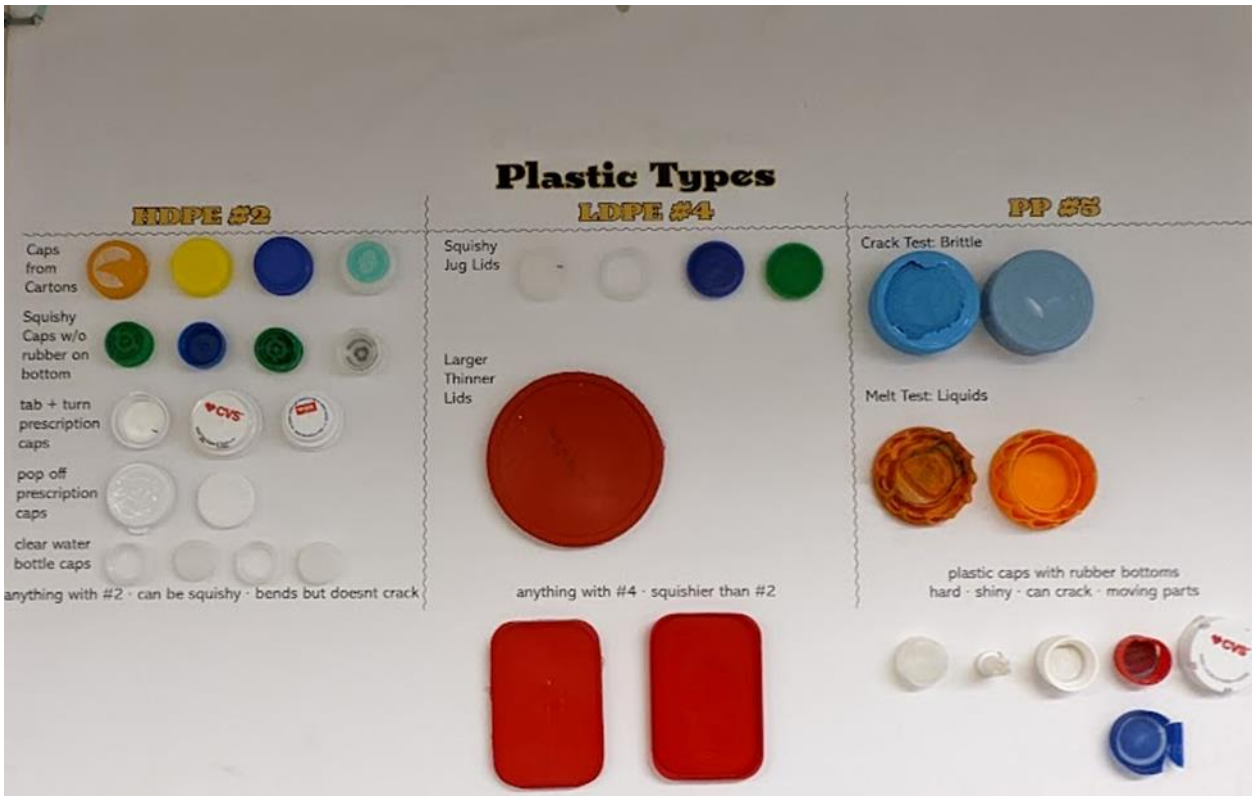
Sorting plastic is the first and most important step of recycling plastics. Without sorting, plastic would be impossible to recycle due to the specific polymer properties of each plastic type. There are three types of waste streams used for domestic waste. The first is multi-stream recycling, which is dependent on the user to sort recyclables into four different groups: paper and fiber, plastic, glass, and metals. The second type of waste stream is dual stream. Dual stream recycling is when waste is sorted into two groups. Although this can vary, an example is one bin for paper products and a separate bin for plastic, glass, and metal. The final type of waste stream is single stream waste where all recyclables are mixed in one bin. Although this is very convenient for the home or student recycler, it is challenging to sort and separate these different items later. These domestic recyclables will either get picked up by trucks, or they will be delivered by the user to a drop off station. These plastics will then be processed either automatically or manually. After processing, the plastic is sold in bales to recyclers who will use it to produce new recycled plastic.

The characteristics of plastics also aid in the identification of their plastic types. Plastic characteristics vary from one plastic type to another and are influenced by the wide variety of polymer compositions. However, there are certain features that are innate to each given plastic, and these can help us to not only identify the type of plastic for the recycling process, but also

the best plastic for a given application after it gets recycled. The characteristics of these plastics can be seen in Figure 1.

Figure 1. Poster of plastic types and identifying characteristics. (Severn)

Many plastics are recyclable, even if they are not accepted with curbside pickup or through other recycling streams. However, items like plastic bags can clog machines if they are not separated



out before recycling (What Plastics Can and Cannot Be Recycled?, 2020). This often leads to these plastics being tossed out. The benefits of a small-scale system include being able to recycle plastics that are often rejected within mainstream or large-scale recycling systems due to their difficulty or inconvenience, like plastic bags. This will simply require a slightly different set of steps or increased manpower needed to recycle these items.

Unfortunately, there are some plastics that are not recyclable, also known as thermoset plastics. These plastics undergo a fundamental change of their polymer structure once exposed to heat. There are some methods of reprocessing thermoset plastics into usable materials, however they are rarely cost effective and are very challenging to complete successfully. However, the more common thermoplastics do not undergo polymerization when exposed to heat. Rather, their polymer chain relaxes allowing them to be formed into a variety of shapes and sizes. In the AEST department for example, plastic water bottles are frequently shredded, melted, and reformed into commemorative keychains. This ability to relax their polymer chain when heated is the same characteristic that allows them to be recycled through the process of shredding, melting, and reshaping.

Shredding in Industry

Shredding on an industrial scale is frequently done prior to washing. Plastic is obtained in bulk already sorted and broken into smaller pieces using any number of shredding machines. These machines each produce a different sized plastic flake or shredded plastic based on the needs of the recycling plant. There are countless methods of shredding plastic, however almost all of them use a mechanical shearing process to cut the plastic into bits that are easier to process. Some of the machines that can be used to shred plastics are granulators, shredders, impact devices and more. (Mantia, 2002)

Washing In Industry

Once the plastics are fully shredded, it will then be sent to be washed which removes labels, adhesives, and grime. Recycled plastic often arrives at a recycling facility unsorted and unclean.

This contamination can come from multiple substances such as foods, chemicals, labels, or anything else the plastic may have come into contact with during its lifespan.Washing helps prevent contamination in the plastic shred process and ensures that the finished plastic is both clean and of high quality. In the recycling industry, there are several common washing methods to prepare plastic for its next step in the recycling process.

The goal of washing is to remove impurities. The most common among these are dirt, food, and plastic labels. Industrial grade washers use a combination of several machines or methods to remove grime and labels. Friction washing is a common method of cleaning plastic items. It uses high pressure water and a rotating drum in order to completely remove items like labels and any dirt or grime that is present. In addition to aggressive washing, it is common for chemicals to be added to the wash to improve the cleaning process. One common chemical or “wash additive” used is caustic soda. This will make the washing process more aggressive in order to help remove contaminants.

Recycling in the AEST Department

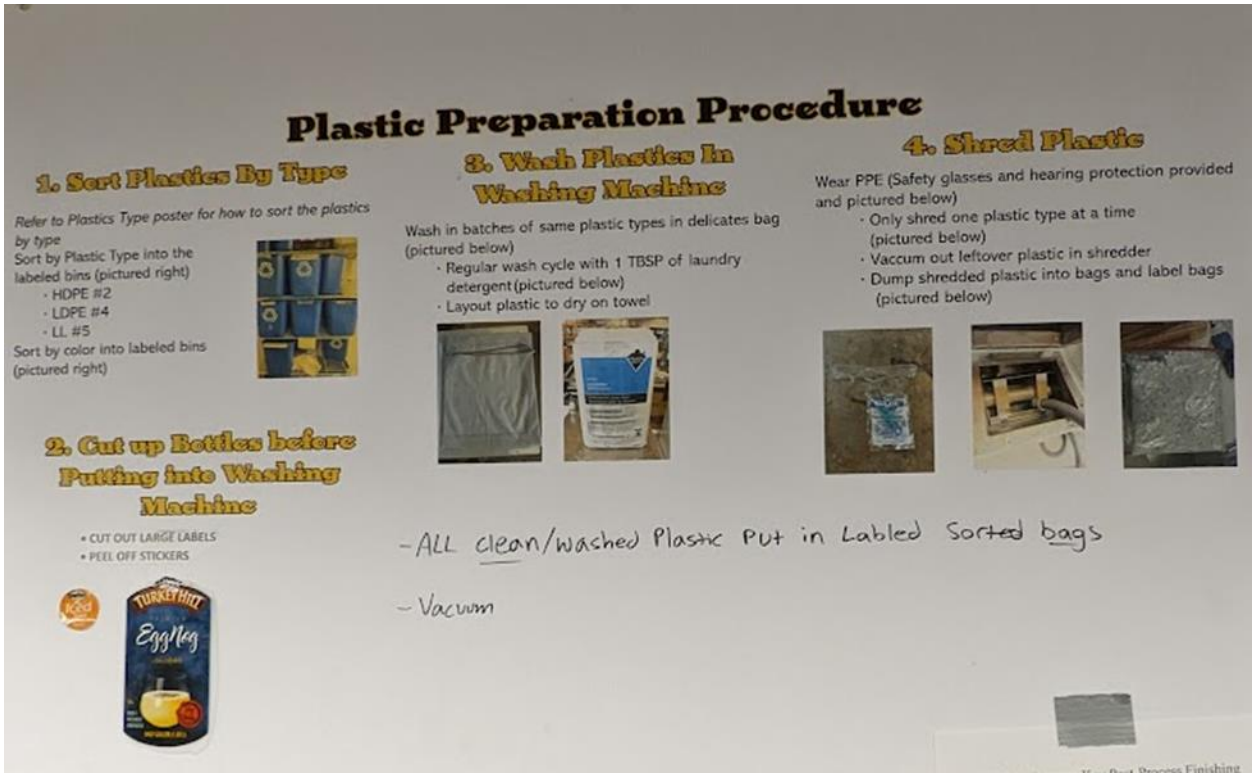


Figure 2. Poster showing steps for plastic recycling (Severn)

Sorting in the AEST Department

Sorting in the AEST Department varies quite a bit from the sorting system of industry. First, plastic is dropped off at the AEST Department by students and faculty all over campus. Usually, as plastics are received, it has already been rinsed and is ready to be sorted and moved into storage. However, sometimes it is necessary to perform a pre-wash to remove grime or food particles that would become rotten or odorous if they were immediately stowed. If no pre-wash is necessary, or after it has been completed, the plastic recycling in the AEST Department is simple. First, the plastic that is to be sorted will be gathered from storage and brought out into the polymer lab. Then the plastic is sorted by plastic type and then sorted once again into each

color. This is typically done by members of SME, or by other members of the AEST Department.

The Recycling Number System

Most people are familiar with the small symbol used to designate the type of and recyclability of a given plastic. It has the appearance of a small triangle with arrows and in the center there is a number which designates the type of plastic that the item is made from. This symbol is known as the Resin Identification Code system (RIC) and is a method of identifying plastics that was "developed by the Society of the Plastics Industry at the urging of recyclers in the 1980s" during a rise in awareness of the need for plastic recycling (Modernizing the Resin Identification Code | ASTM Standardization News, n.d.). There is often a misconception that this symbol designates whether a plastic item is recyclable, when in fact, its true purpose is to help recyclers and consumers determine the type of plastic during the sorting process.

The different recycling symbol number designations are:

1. Polyethylene terephthalate (PETE)
2. High density polyethylene (HDPE)
3. Polyvinyl chloride (PVC)
4. Low density polyethylene (LDPE)
5. Polypropylene (PP)
6. Polystyrene (PS)
7. Others, including materials made with more than one plastic from categories 1-6

(American Society for Testing and Materials, 2014)

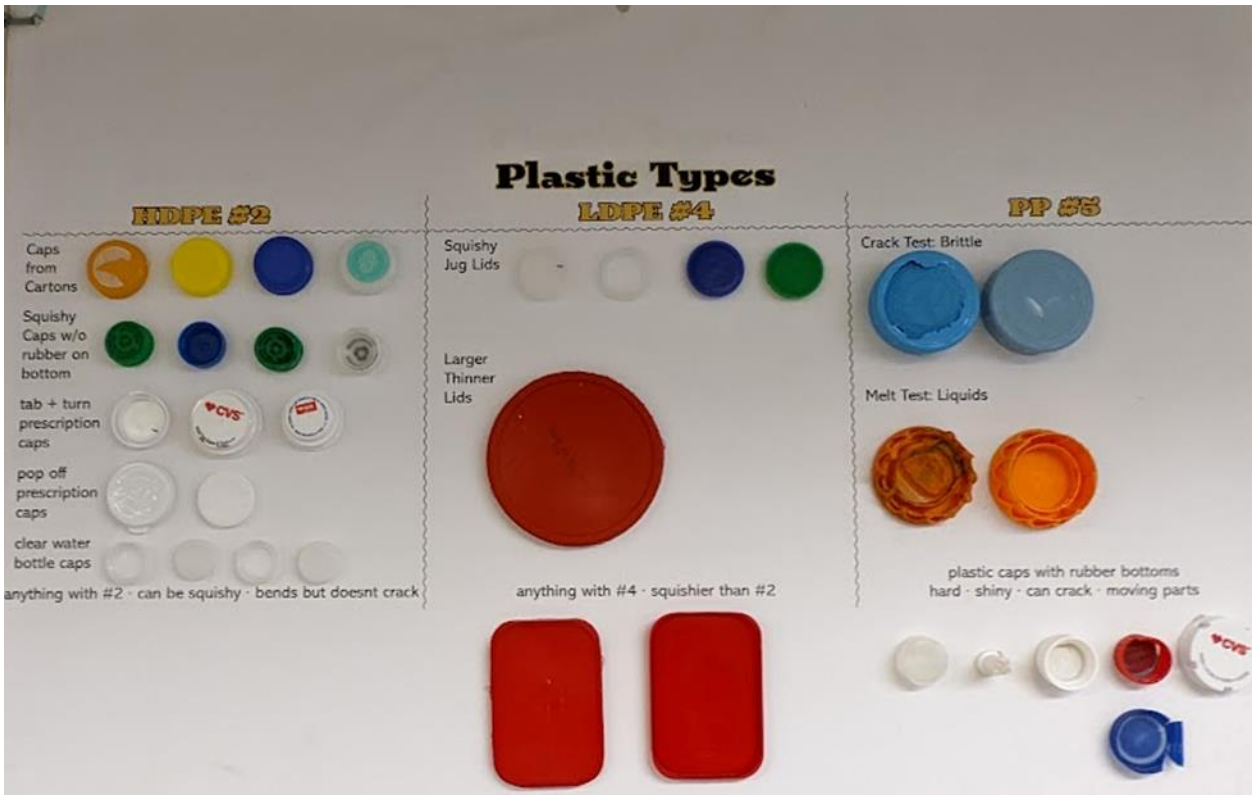


Figure 1

Washing in the AEST Department

The AEST Department's washing is done on a much smaller scale, and it is not necessary to process the plastic in high volumes. As such there will be a higher proportion of manpower, and fewer high complexity high efficiency machines used for the AEST department's plastic recycling program. However, the plastics that the AEST Department obtains from campus recycling efforts from clubs such as SME and ESC will still have the standard contaminants such as food, chemicals, and labels that will need to be addressed for health purposes and quality plastic regrind.--- source —-

Our washing process utilizes a few simple steps: Rinsing (prior to sorting/storage), label removal, resizing, bagging, washing, and drying

Plastic is rinsed prior to storage to maintain cleanliness, and reduce rot and mold that would occur if the plastic was left uncleaned. Unlike in industry, the AEST Department's washing is completed in a pre-existing household washing machine. Since this machine is not designed for washing plastics, several steps are a bit different from that of traditional washing. First, labels must be removed by hand prior to washing and shredding. The second is that the AEST Department does not shred their plastics before washing them, or else they may clog the washing machine with plastic particles; however, some of the larger plastic items like gallon milk jugs or large detergent bottles need to be cut in to smaller pieces using scissors so they can fit in the washing machine. Next, the AEST Department bags their plastics so that they stay together and do not get trapped in the washing machine, in order to make them easier to remove after they have finished washing. Finally, the plastic is laid out to dry on the tables so there will not be any moisture in the plastic flakes. Once drying is complete the washing process is finished and it is time to proceed to the next stage of plastic recycling: shredding.

PICTURES (FIGURE 3a and 3b)

Our Shredding Machine

In order to better understand the AEST department's recycling operation, they will need to address and identify several key parts of a granulator in order to better understand how their own shredder operates. They will use a shredding machine known as a plastic granulator (model 110 Granutec) made by Whitaker Brothers. Granulators are a specific type of machine designed to produce fine plastic shred, which is ideal for these uses especially when being used in the relatively small processing machines (injection molders, ovens, etc.) that they have in the department

Figure 4. Model 110 Whitaker brothers Granutec Granulator

Cutting chamber

- screen
- knives
- rotor

· **Belt**

· **Motor**

· **Electrical component controls**

· **Hopper**

· **Feed opening**

· **Flap**

· **Discharge metal bin or vacuum/air separator**

Section 2: Demonstrating Proper Equipment Use and Processes for Plastic Sorting, Shredding, and Washing (FIGURE 5)

Sorting

Plastic is sorted in two sections: first by plastic type, then by plastic color. You may use the following sorting guide, and list of steps during your end of section 2 performance exam, as well as any time it is needed in the future.

Steps For Sorting

1. Gather plastic from AEST Department either from storage or from the plastic recycling deposit locations around the building

2. Perform a pre-wash and allow plastics to dry

3. Store dry plastics in “catch-all” large trash cans

4. Select a large catch all bin to begin sorting

5. Choose plastic sorting bins for plastic types

6. Sort plastic from collection barrel into plastic types

7. Choose color bins for each plastic type

8. Sort each plastic type into the color bins specifically for that type

Washing

Plastic washing is completed using a domestic washing machine and perforated laundry bags to hold the plastic. Prior to beginning washings, labels must be removed by hand and containers must be resized to be successfully washed. Containers that are closed or have small openings, as well as oversized items like gallon milk jugs must be cut down to expose the inside for complete washing. Before being placed in the washing machine, the plastics must be bagged so they will all stay together and not get trapped in the washing machine. Bagging also makes the plastic much easier to remove after washing. Finally, the plastic is laid out to dry on the tables so that there will not be any moisture in the plastic flakes, or final molded objects.

Rinsing

Storage

Plastic prep

Bagging

Washing

Drying

1. Cut any closed bottles or oversized items into relatively thin strips, roughly one inch wide using scissors or a hook knife

2. Place the strips and small plastic parts like bottle caps into the mesh bags, stored above the washing machine, and then place them into the washing machine

3. Set the machine for a normal wash cycle and allow to run

4. Remove bags from washing machine

5. Roll paper out from the holders located at the ends of the table and then lay out the wet plastic on them for drying

6. Once the plastic is dry, place plastics in the respective bins located on the shelf near the shredder

Shredding

Plastic shredding is completed using a granulator. There are several key parts of a granulator and a basic understanding of them is required to operate the Whitaker Brothers 110 Granulator correctly:

- Estop
- Start button
- Hopper
- Feed
- Screen
- Discharge

Operating the granulator is a straightforward process with several basic safety steps. When operating, first press the start button and place the plastics into the hopper located at the top of the shredder. A rubber flap is there to prevent bits of plastic from flying out at the user. When the shredder is in use, it is important to know what the E-stop is and where it is. The E-stop, or Emergency Stop, is used to stop the machine in the event of an accident or unexpected event or just to stop the machine during normal operation. The E-stop is located at the top right of the machine, just next to the start button. fig– Always make sure you have your hand near it at all times in case of an emergency. For example, if metal or glass got into the granulator during use or if an injury occurs. Once plastic is placed into the granulator it falls down the feed and into the cutting chamber where it is processed into small bits by the rotor knives. The size of the plastic pieces is determined by the size of the holes in the screen which allow plastic particulates to fall into the discharge. The discharge is where the plastic is separated using an air separator. This separates the plastic by shred size ensuring the separator produces an even sized flake.

PICTURE (FIGURE 6)

Section 3: Value and Impact of Recycling

The impact of recycling cannot be understated. Currently, there is very little recycling carried out on campus and we know that the vast majority of all recyclable materials will never make it to a recycling plant. Instead, recyclable materials end up in a landfill or are put towards a non-renewable resource like being burned for electricity. Or worse yet, in our oceans. Herein lies the importance of recycling. As you likely know, there are three aspects to recycling: Reduce, Reuse, Recycle. These three categories are critical to decreasing the plastic waste that people create every day, and in reality, recycling is actually the least beneficial. "In the order of decreasing environmental desirability—reduce, reuse, recycle (materials) and recover (energy)" (Hopewell et al., 2009).

All three of these are changes that can easily be implemented in one's daily life. The first goal should always be to reduce your plastic usage as this prevents waste from ever being made. Second, reuse those things that can be reused - like water bottles, Tupperware, or find uses for those items that are meant to be thrown away. And finally, whatever plastic waste you create either on campus or at home, recycle it. That way groups like the AEST Department can repurpose that waste back into a product that will be valued, used for a much longer duration, and kept out of landfills.

Please take a moment to take the test and fill out the information box regarding how you feel this training manual will impact your future choices about plastic usage and recycling. And whether you will participate in the campus effort to recycle.

Conclusion

Thank you for completing the recycling training program for sorting and preparation of campus recycled plastics in the AEST Department. During this training, you have learned the key differences between industrial recycling and the AEST Department's recycling program as well as passing the training requirements necessary to participate in the campus program. You have learned about the processes and machines required to sort, wash, and shred plastics; and how to successfully operate these machines to produce plastic flake for creating new recycling. Most importantly, you have learned about the value of participating and engaging in recycling as a way of life, and the importance of participating in recycling efforts here on campus to help the AEST Department make Millersville University a more environmentally sustainable campus.

If you are interested in donating plastics for recycling to the AEST department, please rinse and deliver your plastic in trash bags to the Polymer and Ceramics lab in Osburn Hall. (Main level, Room 205).

For questions or considerations, please feel free to reach out to us at:

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