

The 2010 ASME Student Design Competition (SDC)
EARTH SAVER: Autonomous Material Sorter



Overview:

Recycling is a global industry accounting for more than 1.5 million jobs and \$100 billion in annual revenue¹. As a whole, the industry currently processes more than 600 million metric tons of material annually, growing with the expansion of the global, green economy. This global expansion presents an increased need for new, efficient and cost-effective waste material sorters. The goal of the 2010 ASME Student Design Competition is to design, build, and test an autonomous system capable of accurately sorting common recyclable materials, namely ferrous and non-ferrous metals, plastics and glass into distinct waste containers.

Your job is to design, build, and test a system capable of rapidly and accurately sorting the four waste materials noted above into distinct waste containers. This system must operate autonomously and be capable of both material identification and waste handling. Points will be awarded based on the proper identification and handling of the waste materials, as well as the speed required to process the materials and the weight of the device.

Project Details:

Students will be provided with a semi-rigid waste container (a curbside recycling bin) containing twelve (12), randomly-distributed waste products, specifically:

1. Three (3) empty, irregularly-shaped plastic bottles, measuring approximately 75 mm (± 20 mm) in maximum diameter and 220 mm (± 20 mm) tall.
2. Three (3) empty, irregularly-shaped aluminum cans, measuring approximately 65 mm (± 20 mm) in maximum diameter and 120 mm (± 20 mm) tall.
3. Three (3) empty, irregularly-shaped tin-coated steel containers, measuring approximately 75 mm (± 20 mm) in maximum diameter and 110 mm (± 20 mm) tall.

¹ Statistics are taken from <http://www.recyclinginternational.com> - an independent publication of the international recycling community.

4. Three (3) empty, irregularly-shaped glass containers, measuring approximately 60 mm (\pm 20 mm) in maximum diameter and 95 mm (\pm 20 mm) tall.

At the start signal, these waste products will be poured by one (1) student, without direct student/waste product contact, from the semi-rigid waste container into a clearly-labeled, un-segmented/undivided hopper attached to the student's automated waste sorter (AWS). This student will then toggle a clearly-labeled master shut-off switch. Upon toggling, the AWS will need to autonomously sort the twelve waste products into five (5) distinct, clearly-labeled waste containers (transparent bins, boxes, or bags provided by the students) – one for each of the four (4) groups of waste products and a fifth container for unsorted/unclassified objects.

Device Requirements:

1. The AWS must autonomously identify, handle, and sort the aforementioned waste products.
2. The AWS must be powered by readily-available, over-the-counter, dry-cell, rechargeable batteries.
3. The AWS must have a readily-accessible and clearly-labeled master shut-off switch.
4. The AWS must be deemed by the judges to be safe. Any system deemed at the judges' discretion to be unsafe will be immediately disqualified and not allowed to participate in the competition.
5. To ensure ample space, the entirety of the AWS must fit within a container measuring, on the inside, 340 x 580 x 400 mm. The AWS must fit within this box fully assembled. Any expansion or extension of the AWS must be done autonomously by the system itself during the competition run.
6. The five (5) waste containers (bins, boxes, or bags provided by the competitors) – one for each of the four (4) groups of waste products and an additional (1) container for unsorted/unclassified objects – must be clearly labeled and transparent.

Contest Operation:

1. Each team will supply a full set of waste products to be sorted. Prior to the competition, judges will place all of the waste products from all of the teams in bins according to type. They will then randomly draw a set of waste products for each team's use during the competition. Therefore, teams will not be using identical sets of waste products.
2. Prior to a team competing, their device will be set-up in a 2 m x 2 m area. This area will be bordered by a 200 mm high wall. The entire area will be covered by thin plastic sheeting which will also cover the walls in order to entirely contain any spills, etc.

3. At the judges' start signal, one (1) student will pour the twelve (12) waste materials from the semi-rigid waste container into a clearly-labeled, un-segmented/undivided hopper attached to the student's automated waste sorter (AWS).
4. The student will then toggle a clearly-labeled master shut-off switch initiating autonomous material sorting.
5. Time stops when the AWS has deposited all twelve (12) waste materials into the five (5) waste containers and all waste materials have come to rest.
6. A maximum of five (5) minutes is allowed to complete the sorting and handling.
7. The AWS may not be touched or altered in any way during the run.
8. Any device not meeting the device requirements will be immediately disqualified.
9. If glass is properly sorted into the glass container but is broken, the team will receive a CS score of 1000 and a BG penalty of 4000. If broken glass is either put into an incorrect container or the unsorted container, the team will receive an IS penalty/US score and a BG penalty. If any broken glass is not completely contained within the waste containers the team will receive an IS and a BG penalty regardless of which container that the glass is partially in.
10. Distortion of waste containers in the sorting process is allowed.

Scoring:

- Points will be awarded on the following basis:

$$\text{Score} = (1000 \times CS) - (1500 \times IS) + (100 \times US) - (3 \times T) - (W/10) - (4000 \times BG)$$

where *CS* is the number of correctly sorted waste products, *IS* is the number of incorrectly sorted waste products, *US* is the number of unsorted waste products, *T* is the time required to sort the waste products in seconds (300 maximum), and *W* is the total weight of the empty device in grams, and *BG* is the number of glass containers broken.

- The team with the highest score at the competition's conclusion will be declared the winner.
- Any interaction with the device after the competition has begun will result in immediate disqualification.
- If an AWS is deemed, at any time, to be unsafe by the judges, it will be immediately disqualified.