MESA Mathematics Engineering Science Achievement
JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY

# R³

REDUCE REUSE RECYCLE


**School**: Patapsco Middle School
**Grade**: Middle School (6th)
**State**: Maryland
**Team Name**: The RoboKnights
**Team Members:**
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## Problem Statement

- As per a 2013 Environmental Protection Agency study, an average American wastes about 4.4 lbs of materials per person every day. Majority of the recyclable items are filled in landfills.
- Based on our research, there is no distinct product that can identify all types of recyclable items with appropriate prompts to avoid intermix of trash and recyclable items.

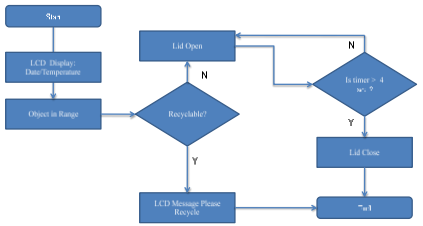
## Objective

- Efficiently segregate recyclable items from trash to save energy and the environment

## User Requirements (Goals/Constraints)

- Need a device to identify recyclable items and restrict recyclable items to be intermixed with trash.
- Needs to be weather proof and avoid damage from trash inside the container
- Needs to have display panel for friendly usability and buzzer prompting.
- Efficient proximity sensing of recyclable items.
- Scope is limited for home usage- needs further improvements for commercial usage.
- Recyclables should be fed individually to container.

## Process Flow Diagram




## Engineering Design Process

**Ask**:
- Durability of the device, condition of recyclables.
- Too many recyclable items in landfills can lead to pollution.
- Recycling can save a lot of energy.

**Imagine**:
- We considered 3 solution approaches and shortlisted one option - Designed a device to identify recyclable items thrown in trash bin with lid

**Plan**:
- Design and development work is split into 3 modules - Metal Detector, Motion detector and Display Panel.

**Create**:
- Implement above 3 modules.

**Test and Evaluate:**
- Performed the unit test for each module separately and captured the test results for the relevant scenarios.

**Improve:**
- In future, the prototype will be enhanced for plastic, cardboard, paper and glass.

**Share Solution:**
- The key strength of the current prototype model is uniqueness of the product to deliver various capabilities like metal detection, LCD display and auto lid open/close.

**Input Devices:**

Ultrasonic Sensor

Inductive Proximity Sensor

RTC/Temperature Sensor

**Output Devices:**

LCD

Piezo Buzzer

DC-Servo

## R³ Prototype

Arduino Mega 2560

BUDGET

Front View

Top View

Open View

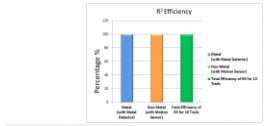
Integrated Device Box

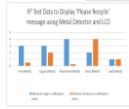

**Reduce landfills, use R3 device, to save the environment**

## FACTS

- Recycling 1 ton of plastic can save an equivalent of 2 peoples energy for 1 year.
- Manufacturing products for recycled paper and plastic reduces water pollution by **35**% and **air** pollution by **73**%.
- One plastic bottle can save enough energy to power a 60 watts light bulb for 6 hours.
- It takes about 25 recycled bottles to make a fleece jacket.

## Graphs



## Conclusion

The device has foundational framework with focused capabilities but has potential to be fully extendable to meet broader diversified needs

Key Advantages
- Minimizes intermixing of recyclable with trash in turn helps
  - Reduction of chemical toxic gases generation from Landfills
  - Increased Opportunity on recycling and saves energy

Key Strengths
- Supports metal detection to avoid intermixing with trash and provides recycle opportunity
- The device is very user friendly - displays a LCD message and buzzer to prompt user to recycle the item
- If the item is recyclable, the lid does not automatically open

## Recommendations

Consider below capabilities for future enhancements for multi iteration releases for full blown product
- Plastic, cardboard, paper and glass sensing are must have capabilities
- Notification to user's phone with recycled material data would be a valuable addition in the future.
- Extend product capabilities from residential to commercial usage.