# PowerBin

## Constructing an Electric Powertrain to Motorize Trash Barrels

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Documentation

## Background

**Problem Statement:**

- Many people struggle to easily transport their trash barrels to the curb.
  - Age-Induced Loss of Muscle Strength (Keller & Engelhardt, 2014)
  - Medical conditions: Arthritis, ALS, CIDP, etc. (Neuromuscular Disorders, n.d.)
  - Heavy Trash Barrels! (National Overview, n.d.)
  - Long, Hilly, or otherwise difficult to maneuver driveways

**Engineering Goal**

- Create an electric-powered trash barrel that helps users maneuver it while keeping them involved in the process.
  - Benefits of exercise & independence (Klietz, 2022)

## Requirements


**Level 1: (Top Priority)**

- Propellable w/o strenuous amount of user force.
- Safe for user operation.
- Electrical components are waterproof
- Electrical components are inside the barrel.
- The user controls the trash barrel's speed.
- The system is to powered by electricity or other renewable energy sources.
- Adaptable to all standard trash/recycling barrel sizes.

**Level 2:**

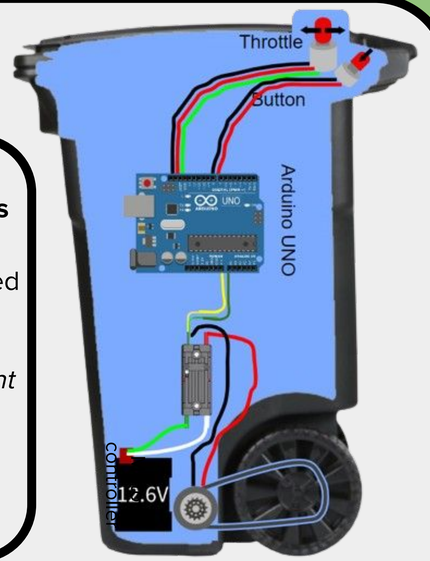
- Operable in different weather conditions
- Operable in different terrains
- Apparatus will weigh <= 60 lbs.
- Remain intact when damaged

**Figures 1, 2:** 3D printed trash can with two servo motors controlled by an Arduino UNO. The system features a knob to change the rotational velocity.

**Figures 3, 4:** 3D printed barrel and a 3D printed tug cart with lever. The lever latches onto the trash can's bar, and can then drag it.

## Results

### The PowerBin:




### Design Study #1
**Sprocket Ratio Fitness**

Purpose: Verify gear ratio to ensure intended gear operation

Statistically *insignificant* difference ($p = 0.49$) indicates proper gear function (123.75° vs. 121.65°)

### Design Study #2
**Potentiometer-Regulated Velocity**

Purpose: Assess the correlation between the Arduino setting and the velocity generated.

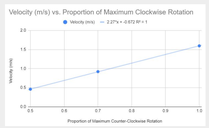


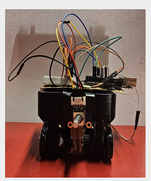

**Figure 7**: Linear Velocity vs. Dial Position

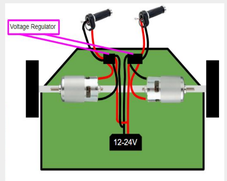
### Design Study #3
**Barrel Velocity**

Purpose: To analyze the performance of the final iteration.

The device was able to provide sufficient power assist to the user. It achieved a velocity of 0.668 m/s with relative ease.

**Design 1**: Button/throttle hybrid control

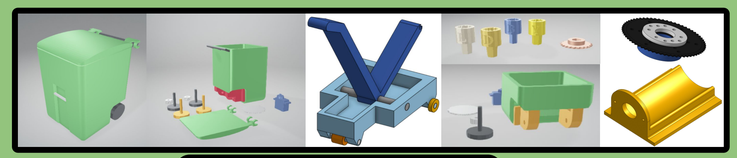





**Figures 5, 6:** 3D printed trash can with two servo motors controlled by Arduino. The system features a button which, when engaged, rotates the servo motors.

## Methodology

- A standard 64 gallon Toter trash can was donated by Casella (Garbage, N.D.)
- Two CIM motors with 22 tooth sprockets were connected to 64 tooth sprockets on the wheels using a chain.
- An Arduino was connected to a potentiometer and two Talon SRX motor controllers to allow for the user to control speed
- Buttons were attached to the arduino system to manage power delivery the motor (on or off)



Creating the PowerBin

## Conclusion

- The *PowerBin* offers a unique assist to those who struggle to transport their trash to the curb.
- With a combination of non-active throttles and on/off buttons, the *PowerBin* has been optimized for safe, effective, and simple use.

Future Work:

- Add all level 3 and 4 (nice to have) criteria.
- Adapt the design to use fewer 3D printed components and more metal/injection molded components for durability/longevity.

References

*Garbage Pickup from Casella*. (n.d.). Casella. Retrieved March 26, 2024, from https://local.casella.com/Garbage-Pickup

Keller, K., & Engelhardt, M. (2014). Strength and muscle mass loss with aging process. Age and strength loss. Muscles Ligaments Tendons Journal, 3(4), 346–350. https://doi.org/10.32098/mltj.04.2013.17

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*Neuromuscular Disorders*. (n.d.). Penn Medicine. Retrieved March 26, 2024, from https://www.pennmedicine.org/for-patients-and-visitors/find-a-program-or-service/neurology/neuromuscular-disorders