College of Engineering
Department of Mechanical & Industrial Engineering

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ME, ECE Capstone Design Programs

Project #23: 30-lb Combat Robot—TOBY

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VALERO

Background

Robot Battles are sumo-style competitions where robots use weapons, drivetrains, and durable frame & armor to outperform opponents by immobilizing them or pushing them off of the combat arena.

Objective

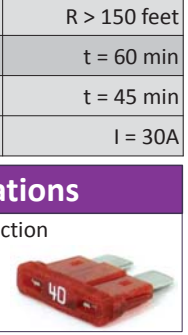
- Design and manufacture a robust & effective 30-lb combat robot to **win the Bengal Bot Brawl**
- Immobilize opponents and/or push them off of the combat arena
- Abide by the **Robot Battles™ Rules & Guidelines**
- Entertain!

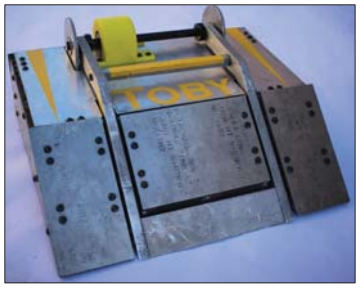
Engineering Specifications

Specifications	Target values	Measured values
Robot weight	W ≤ 30.75 lbs	W = 29.7 lbs
Top speed	v ≈ 8-10 ft/s	v = 7.55 ft/s
Lifting & pushing	F > 30.75 lbf	F = 40 lbf
Weld efficiency	ε ≥ 80%	ε = 81%
Wheel coefficient of friction	C.O.F. = 1.0	C.O.F. = 1.03
Transmitter range	R > 50 feet	R > 150 feet
Drivetrain run time	t =17 min	t = 60 min
Weapon run time	t = 18 min	t = 45 min
Max current draw	I < 38A	I = 30A

Safety Considerations

- **40A fuses** for over-current protection
- Easy-access **weapon kill switch**
- **Loctite** on all fasteners
- **Safe handling** of LiPo batteries





Weapon System

- ½" 6061-T6 Aluminum weapon arms
- 37° titanium wedge
- 775pro motor w/ spur gears (pictured)
- VersaPlanetary gearbox (525:1 GR)
- ½" hex shaft, clamps, & ball bearings

Drivetrain

- Two RWD 775pro motors (pictured)
- VersaPlanetary gearboxes (25:1 GR)
- Colson Performa 4" wheels
- Front idler ball transfers

Frame

- Water-jet cut **5052-H34 Aluminum** plates
- **TIG welded** (pictured)
- **Slots and tabs** for precision & durability
- #10-24 **nutstrip** fasteners (x19)

Armor

- **Outer:** 1/16" titanium plates
- **Inner:** 1/4" shock absorbing visco-elastic polymer
- #10-24 hardened alloy steel bolts with lock nuts
- 3D printed weapon spur gear guard
- 7075-T6 Al / glassfiber pre-preg composite top plate

Electronics

- Three Talon SRX ESC's (pictured)
- 4,000 mAh LiPo battery (x2)
- 2,200 mAh LiPo battery
- 10 gauge wires w/ connectors

Control System

- Wireless transmitter (pictured)
- Receiver w/ antennas
- Signal mixer for drivetrain
- AAA battery pack

Competition Results

Bengal Bot Brawl Champion!

- Toby knocked all of the opponents off of the stage in the free-for-all brawl
- **No failures** of any sub-systems
- **No repairs needed** in between battles
- Batteries lasted the duration of the brawl

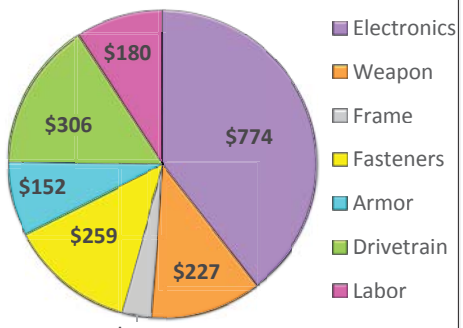
Testing Overview

- **Assembled robot impact & drop tests**
- Flaw detector scanner & liquid dye penetration tests of welds—**no defects**
- **Gearbox & electronics testing**
- Mixer malfunctioned during drop tests, so an enclosure was modeled & 3D printed
- **Practice driving & battery duration** testing
- Transmitter & receiver **signal testing**

Improvements

- ***Slightly*** larger robot for easier access to internals and quicker assembly/disassembly
- Change forward/backward speed from 65% to 55% for increased robot control
- Exponential throttle curve instead of linear

Budget ($2,000 allotted)



Total cost: $1,958

Research/Concept Generation (September-November) → Engineering Analysis & Design (October- November) → Redesign & Purchasing (December-February) → Manufacture & Assemble (January –April) → Testing & Driving (February- April) → Bengal Bot Brawl April 10th, 2018

Sponsor: Mr. Jack Rettig, Valero

Adviser: Dr. Marcio de Queiroz