Project Portfolio

Leiam Gaudin

PURDUE UNIVERSITY | School of Mechanical Engineering

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February 2025

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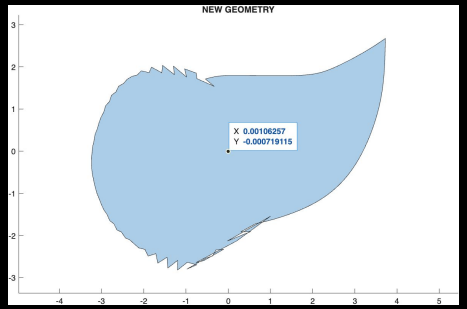
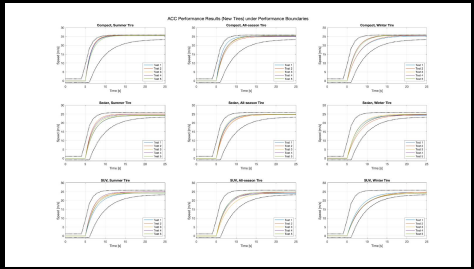


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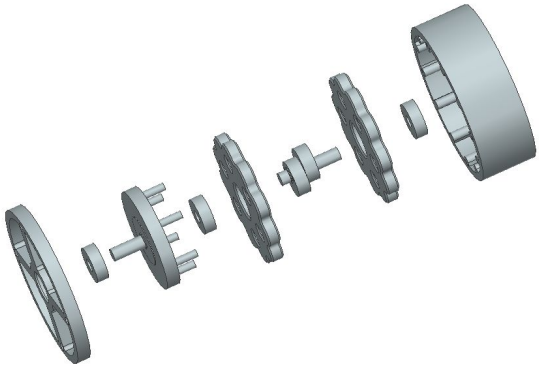
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CAD Freelancing Webpage	abcd	abcd
April, 2026	date	date

Cycloidal Drive

February 2025





- Design and assembly in **Siemens NX**
- Fully parametric cycloidal drive gearbox with dual counter-balancing cycloidal disks
- **11:1 reduction ratio**, optimized for 3D printing

Cycloidal Drive

February 2025

	Name	Formula
1	Default Group	
2		
3	disk_center_hole_dia	22.2
4	disk_chamfer	1
5	disk_output_hole_center_dist	25
6	disk_output_hole_dia	10
7	disk_thickness	0.3in
8	E	0.1in
9	N	11
10	num_output_holes	6
11	R	1
12	Rr	0.
13	theta	t*

Value	Units	Dimensionality	Type
	mm	Length	Number
22.2	mm	Length	Number
1	mm	Length	Number
25	mm	Length	Number
10	mm	Length	Number
7.62	mm	Length	Number
2.54	mm	Length	Number
12		Unitless	Number
6	mm	Length	Number
40.64	mm	Length	Number
3.048	mm	Length	Number
360	mm	Length	Number

All parts were modeled using parametric expressions within NX. Expressions were linked together so that the entire assembly will update accordingly when an expression is changed

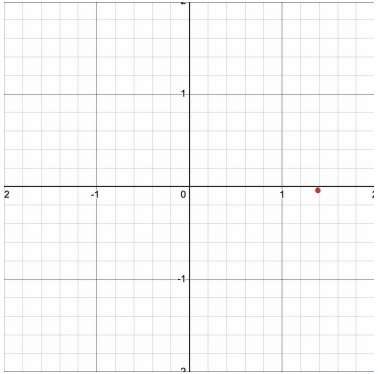
$$X = Rcos(\theta) - R_r\, cos(\theta - \psi) - Ecos(N\theta)$$

$$Y = -Rsin(\theta) + R_r\, sin(\theta - \psi) + Esin(N\theta)$$

$$\psi = -tan^{-1}\frac{sin((1-N)\theta)}{(R/EN) - cos((1-N)\theta)}$$

$$0^\circ \leq \theta \leq 360^\circ$$

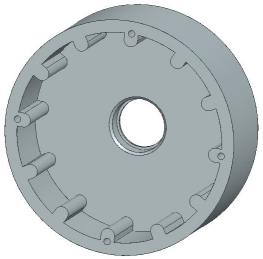
The shape of the cycloidal disks was generated using a law curve and the equations above



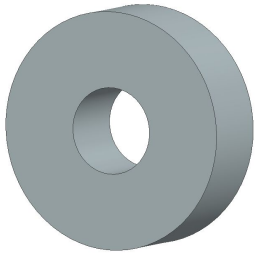
The equations above draw a curve that looks like this. Geometrically this is what allows the gearbox to function properly

Cycloidal Drive

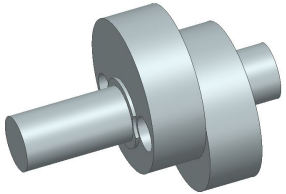
February 2025



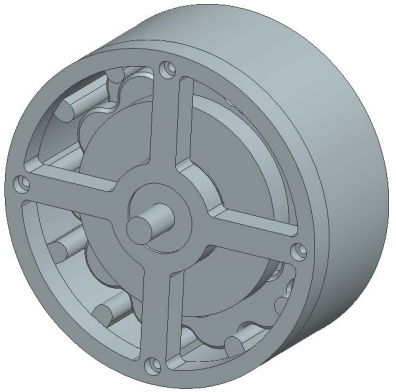
Cycloid Housing



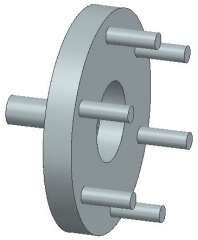
Ball Bearing x3



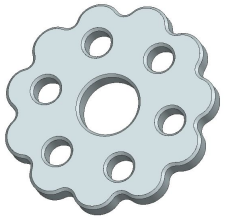
Eccentric Shaft



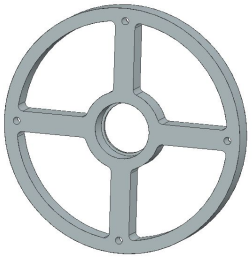
Assembly



Output Disk



Cycloidal Disk x2



Housing Top Plate

Battlebot

October 2025, Purdue Railside Robotics



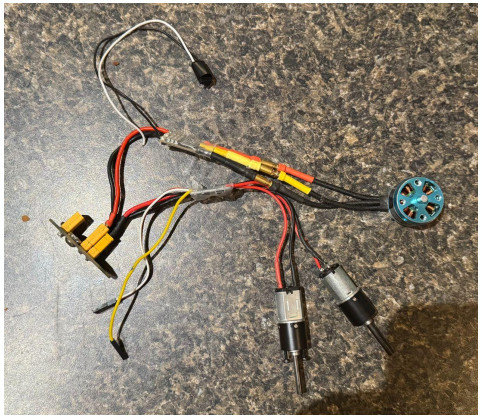
- Weight class rules: “Plastic Antweight” means 1 lb total weight limitation, PLA 3D printed parts only
- Custom asymmetric weapon geometry to maximize damage
- BLDC weapon motor, DC drive motors
- 3s LiPo battery
- Belt driven drivetrain

Battlebot

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All parts were modeled and optimized for 3D Printing with minimal support on Bambu Labs A1 in PLA.



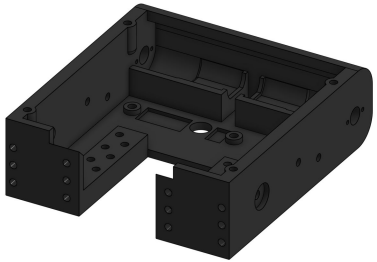
Electronics were soldered together and plugged into a power distribution board



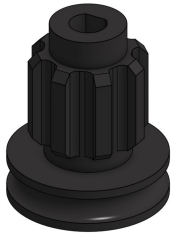
Electronics tightly fit into the robot's housing

Battlebot

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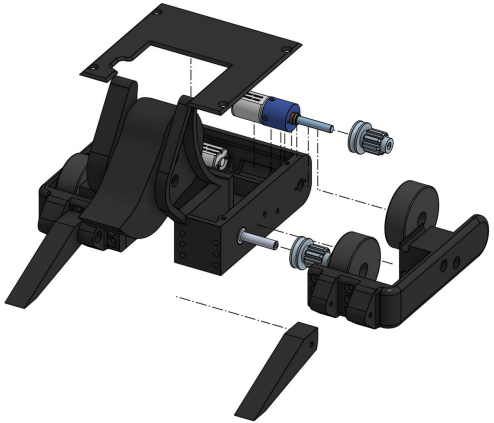
Housing



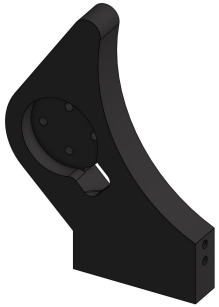
Drive Hub



Fork



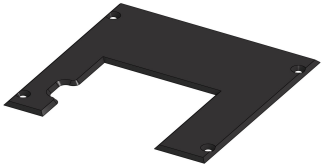
Assembly



Right Upright



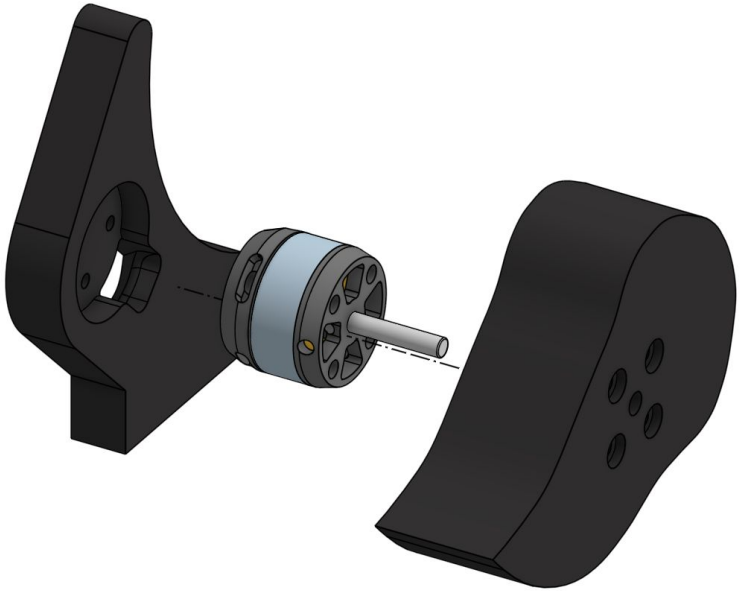
Weapon



Housing Top Plate

Battlebot

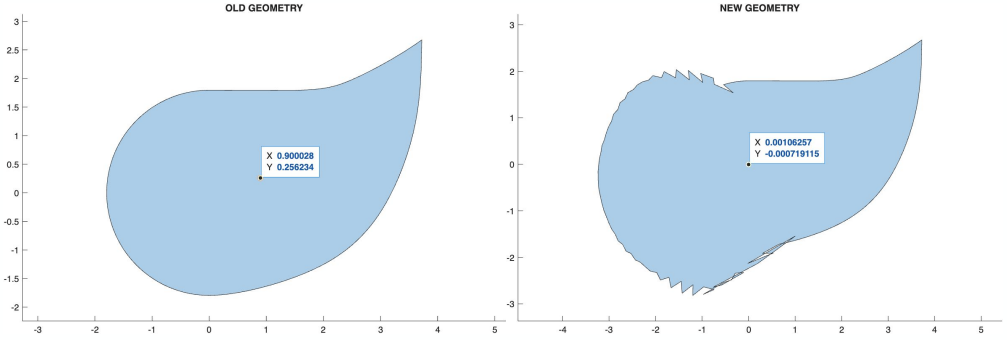
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The weapon is cantilevered on a BLDC motor for simplicity of design

Battlebot

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Custom MATLAB center of mass balancing script used to alter blade geometry resulting in the following center of mass:

Center of mass ☐ Override

X ↘	-0.003 mm
Y ↗	-1 mm
Z ↑	0.005 mm



Final Design

Battlebot

October 2025, Purdue Railside Robotics



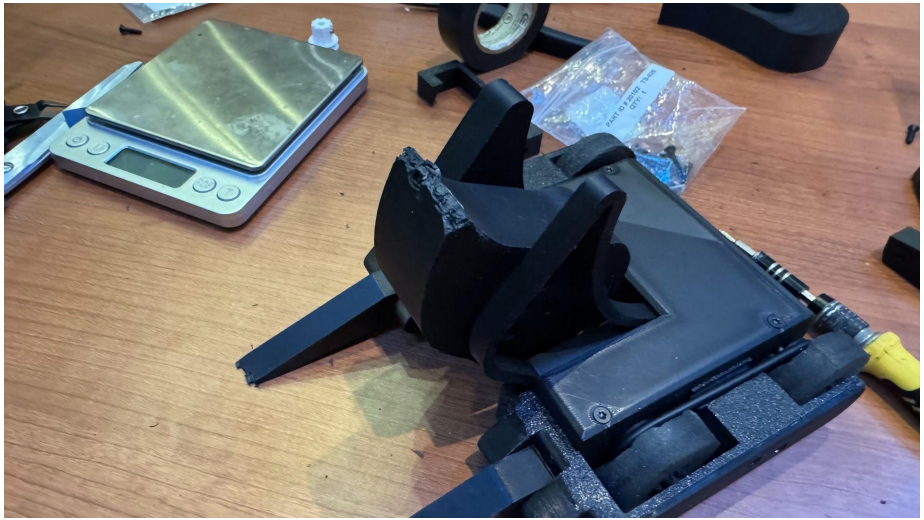
Damage of opponent after Match 2

Results:

1) Onboarding tournament winner
2) Rated best aesthetics
3) Extremely high damage to weight ratio

Battlebot

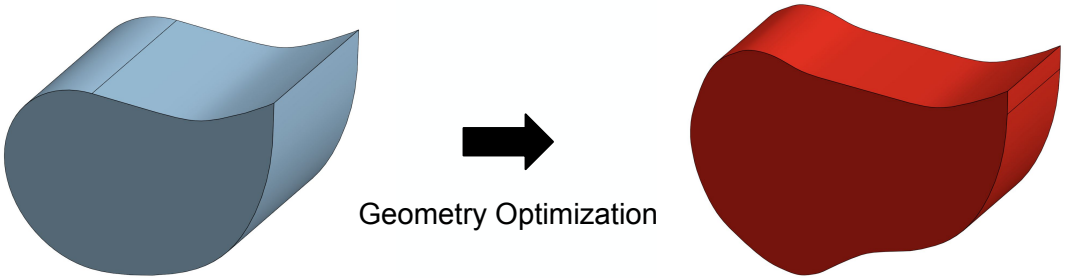
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Post-tournament weapon tip wear (no fractures of the weapon)

COM Optimizer

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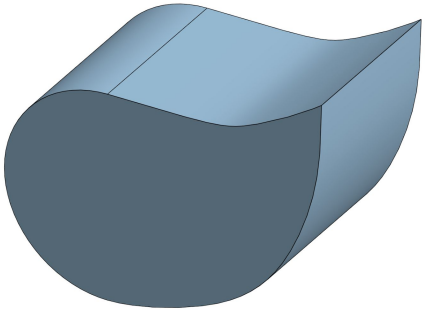
Use of MATLAB to optimize the mass distribution of a BattleBot weapon blade

Benefits of balancing center of mass:

- Improved drive handling (reduced vibration)
- Improved rotational stability
- Increased weapon efficiency
- Lower energy consumption

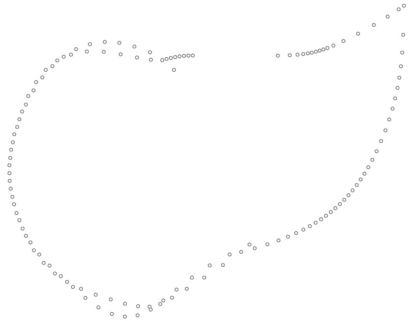
COM Optimizer

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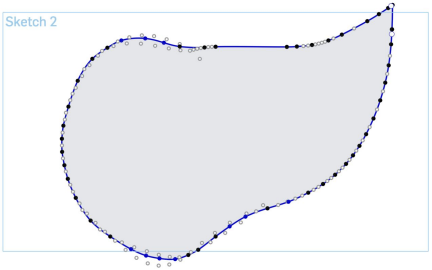
Input Geometry

(stl file)

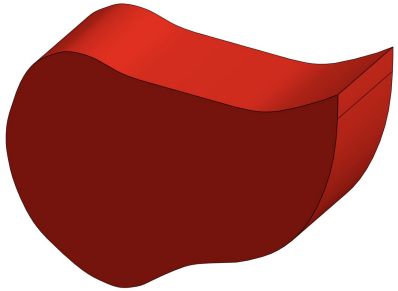


Output Points

(csv file)



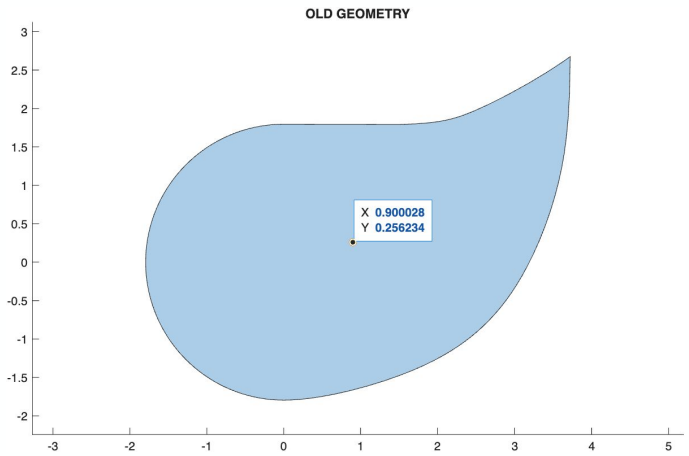
Sketch Spline

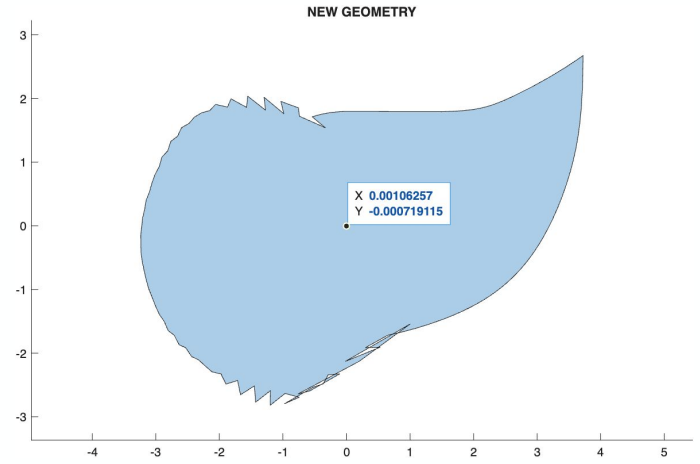


Extrude Profile

COM Optimizer

October 2025, Purdue Railside Robotics



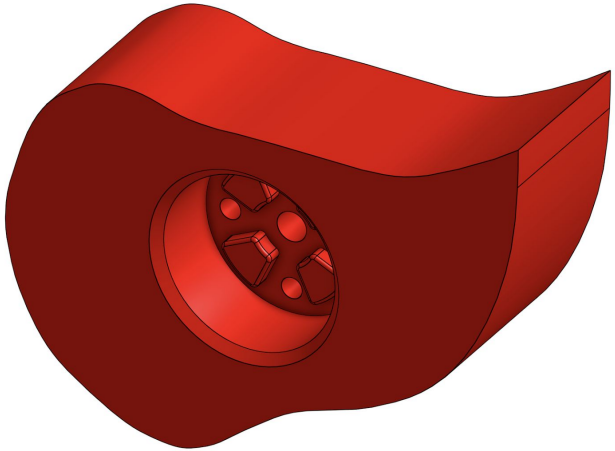


Center of mass ☐ Override

X ↘	-0.003 mm
Y ↗	-1 mm
Z ↑	0.005 mm

COM Optimizer

October 2025, Purdue Railside Robotics

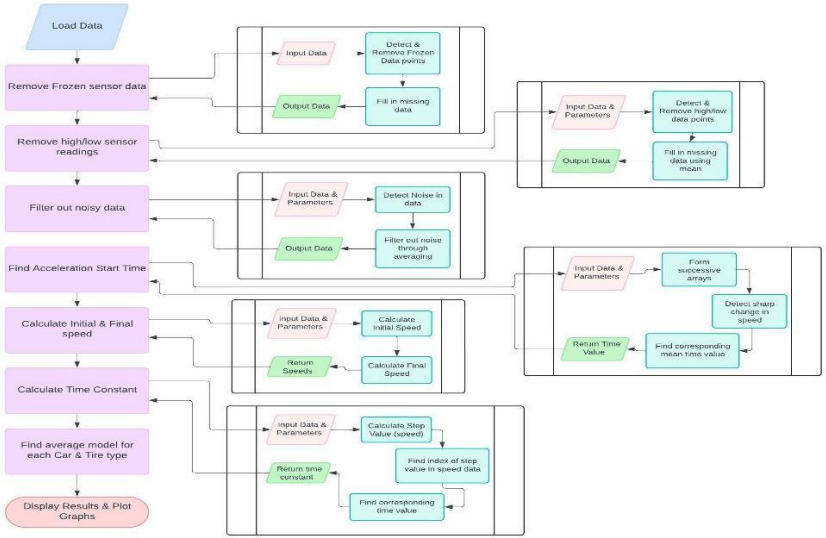


Final Blade Design

- Cutout for BLDC motor
- Motor housed inside so its weight contributes to overall inertia
- Chamfer for easier press fit installation

ACC Analysis

October 2025, Purdue University



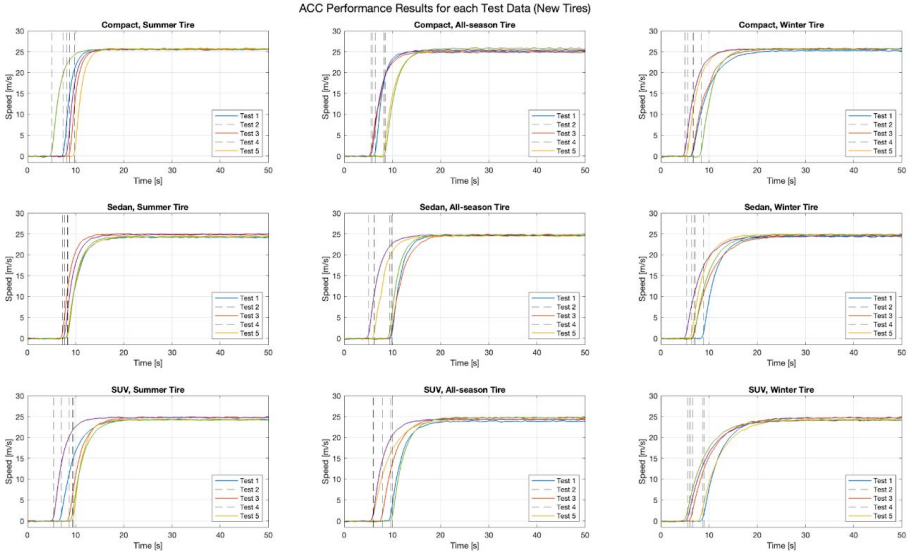
MATLAB Functions

Block Diagram

- Analyze automated cruise control system (ACC) response
- Custom noisy sensor data filtering
- First order system modeling
- Evaluate cruise control performance across different tire and vehicle types

ACC Analysis

October 2025, Purdue University

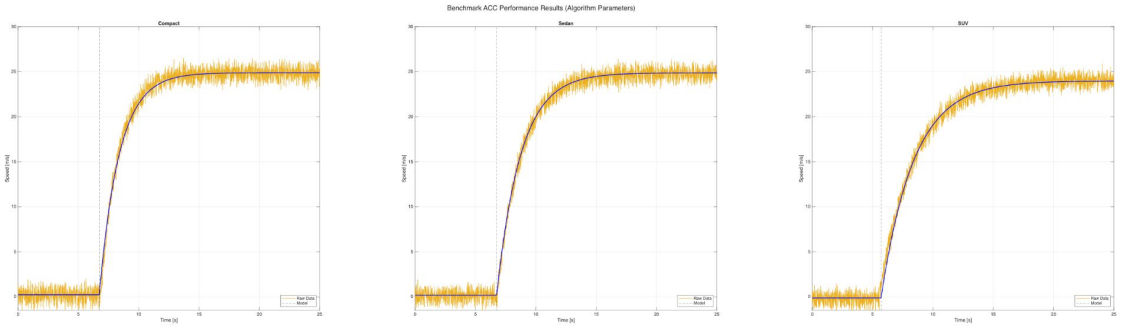


Filtered Data

- Data filtering using custom averaging algorithm: “moving average” approach
- Preserves trend of data and data spikes (important for identifying first order parameters)
- Faster performance than built in MATLAB smoothing functions for processing large amounts of data

ACC Analysis

October 2025, Purdue University

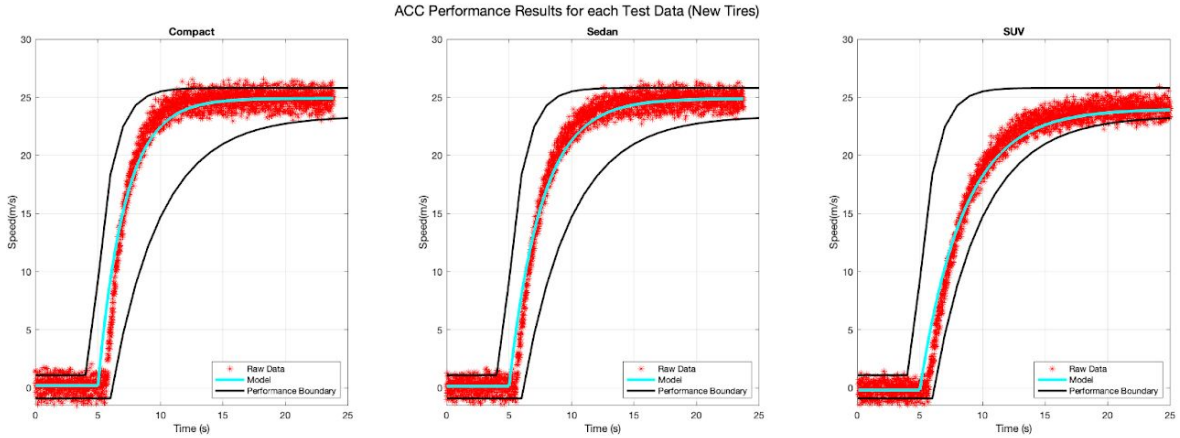


Model and Raw Data

- Consistent data trends
- Accurate acceleration start time identification
- Proves that model is an accurate simulation of real life conditions

ACC Analysis

October 2025, Purdue University



Model and Raw Data, Performance Boundaries

- Models all fall within these upper and lower boundaries, showing that the tire performance is in the required margins
- This shows that the company can implement the new tires on its vehicles without safety concerns

ACC Analysis

October 2025, Purdue University

Vehicle	Tire Type	M3 Algorithm Parameters				M4 Algorithm Parameters			
		Start time [s]	Time constant [s]	Initial speed [m/s]	Final speed [m/s]	Start time [s]	Time constant [s]	Initial speed [m/s]	Final speed [m/s]
Hatchback	Summer	7.3	2.01	-0.1	25.61	7.83	1.48	-0.07	25.61
Hatchback	All-season	6.32	2.53	-0.1	25.22	6.93	1.9	-0.05	25.22
Hatchback	Winter	4.64	4.31	-0.14	25.62	6.44	2.52	-0.06	25.62
Sedan	Summer	7.44	2.49	-0.09	24.47	7.99	1.95	-0.06	24.47
Sedan	All-season	7.48	2.63	-0.1	24.7	8.07	2.03	-0.06	24.7
Sedan	Winter	6.11	3.61	-0.1	24.63	6.92	2.81	-0.03	24.64
SUV	Summer	6.2	3.93	-0.12	24.45	8.0	2.14	-0.05	24.45
SUV	All-season	7.28	3.1	-0.11	24.37	7.94	2.48	-0.06	24.37
SUV	Winter	6.17	4.35	-0.12	24.41	7.14	3.4	0.01	24.41

Calculated Parameters

Benchmark Data SSE_mod:

1. Compact: *0.500*
2. Sedan: *0.449*
3. SUV: *0.399*

Algorithm Benchmark SSE_mod:

1. Compact: *0.037*
2. Sedan: *0.025*
3. SUV: *0.065*

Algorithm Performance Parameters

- As you can see, the SSE_mod values are extremely low
- It is safe to assume that our algorithm will accurately reflect the true performance of the system in the experimental data on new tires

ACC Analysis

October 2025, Purdue University

Code Link (Google Drive):
https://drive.google.com/drive/folders/1ioz_0BCPQoV3D9xtlhWJ5x1n8icNe5-m?usp=drive_link

Purdue Assignment Dashboard

April 2026, Purdue University

Problem:

- Purdue uses too many websites for managing assignments; it takes 10+ clicks and 60 seconds of time to view an assignment
- Duo SSO login is annoying

Solution:

- I built my own assignment dashboard (html frontend, python backend)
- The python script scrapes Gradescope and Brightspace (course websites) and records all assignments in one place
- Clean UI for readability
- Less time clicking and more time working

Purdue Assignment Dashboard

April 2026, Purdue University

- Clicking an assignment in the dashboard takes you directly to it
- When assignment is submitted it disappears from the dashboard

Purdue Assignment Dashboard

April 2026, Purdue University

The dashboard features a calendar to visualize what day assignments are due

CAD Freelancing Webpage

April 2025, Purdue University

I designed a simplistic webpage designed to market my freelancing skills in manufacturing drawings, CAD part and assembly design, and 3d printing to make more money remotely over the summer.

CAD Freelancing Webpage

April 2025, Purdue University

The web ui allows me to see customer jobs and approve/change quotes for various different requests

Reach Out to Me



www.linkedin.com/in/leiam-gaudin



leiamgaudin@gmail.com

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