Acadiana 500 Annual Tricycle Race

Fast Pedal Engineers

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Acadiana 500 Tricycle Race
Metal Shark Boats

Organizational Structure

Fast Pedal Engineers

- **Andre Signoret**
  - **Team Leader & Computational Director**
    - **Oversee project timeline** and make sure deadlines and goals are met weekly.
      - Make sure weekly memos and reports have the right formatting and ensure document quality is present.
      - Connect with other team directors to make sure all tasks are being solved in the same manner.
    - **Design and analyze the mechanics** in the tricycle, this includes frame strength, stability, and performance.
      - Utilize computational tools (e.g. SolidWorks or MATLAB) to simulate the performance of the tricycle and create designs.
- **Matthew Dubea**
  - **Communications & Fabrication Director**
    - **Find a communication plan** for documentation progress and team inquiries.
      - Making sure external stakeholders in the project have clear communications with the FTE and solving questions the team might have.
    - **Oversee fabrication progress**, in this semester making sure that the material analysis is completed to ensure the best material is being used for the tricycle.
      - Management of any tools, equipment or components the team is gathering to use later in manufacturing
      - Conduct quality checks on parts designed ensuring compliance with the customer requirements and engineering specifications
- **Katie Kaliszeski**
  - **Finance & Testing Director**
    - Develop and **manage the budget** that will be used for the project.
      - Making sure all financial resources are organized efficiently in all parts of the design process.
      - Work with other team directors to find a potential sponsor for the project.
    - **Plan and execute testing protocol** to ensure the design for the parts is ideal for the tricycle.
      - Run an FEA on the tricycle parts to ensure that they will meet the standards to compete with smooth functionality and efficiently in the race.
      - Analyze testing or design data to find potential improvements in durability and maneuverability.

What is Acadiana 500 ?

- **Acadiana 500 Tricycle Race**
  - Annual race - New Iberia City Park
    - Founded in the 1980’s
    - 40 year hiatus – started back up 2024, 2025
  - Teams of 8 - design and build a tricycle
  - Teams then relay race in a circuit

Figure 1*:* Acadiana 500 Tricycle Race Flyer

Figure 2*:* 2025 Acadiana 500 Race

Requirements

Objective:

- Design and build a tricycle - safe, strong, fast, light weight, and that meets all dimensional limits
- Rules and penalties:
    - Maintain constant motion
    - Penalty - transition zones
    - Handicap (based on age)

#	Acadiana 500 Rule / Constraint	Dimensional Limit (in)
1	Seat-top height (ground → top, padded)	22–24 or ≤ 25 (padded)
2	Highest point on tricycle	≤ 32
3	Handlebar & rear-axle width	≤ 20 end-to-end
4	Crank-arm radius	≤ 4
5	Outside pedal-to-pedal span	≤ 24
6	Front-wheel center → outer pedal tip	≤ 12
7	Max pedal envelope (height × width)	≤ 6 × ≤ 6
8	Rear-axle track / overall trike width	17–20
9	Wheelbase	≤ 24
10	Front-wheel diameter	≤ 20
11	Propulsion method	No gears, motors, or chains
12	Braking	Foot-drag only in transitions

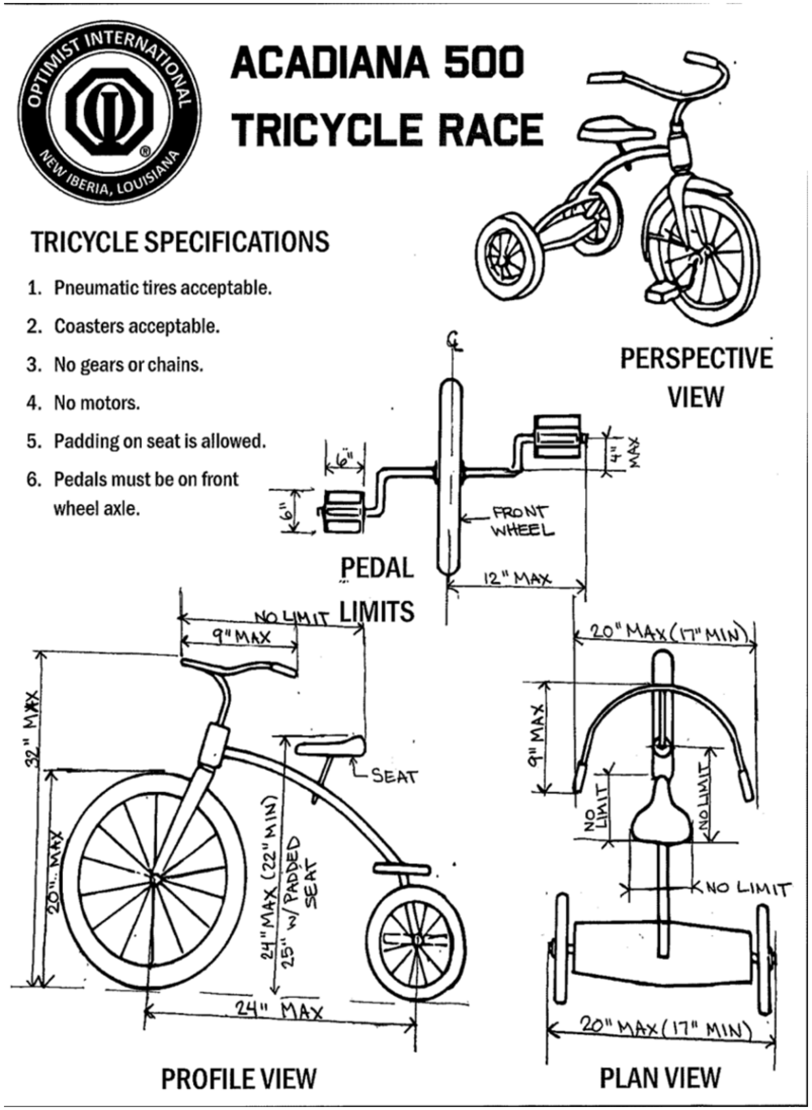


Figure 4: Acadiana 500 Tricycle Specifications

Concept Generation

Figure 5: Design Iteration 1

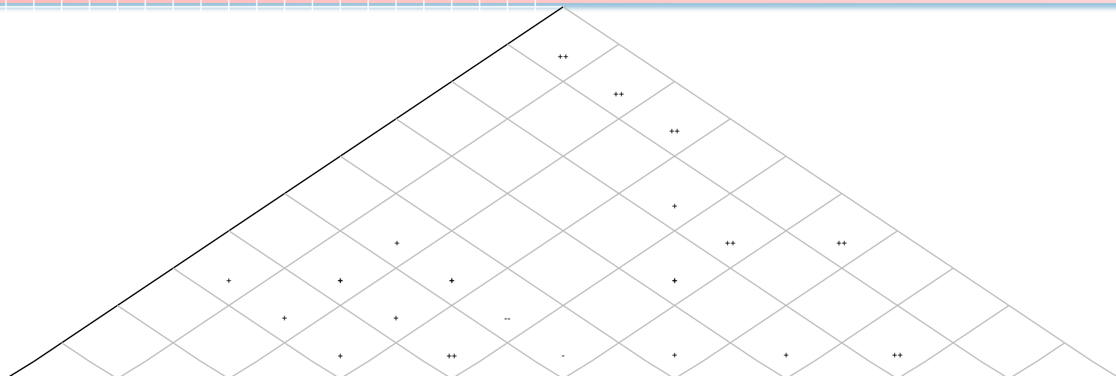
Figure 6: Design Iteration 2

Figure 7: Design Iteration 3

Figure 8: Actual Tricycle

Concept Selection

- House of Quality



Importance	Customer Requirements \ Engineering Characteristics	**Overall Width, Length, Height (in)**	Total Weight (lb)	Seat Height Adjustability (in)	**Frame Yield Strength (psi)**	Axle Stress at Max Load (psi)	**Factor of Safety (FoS)**	Assembly Time (hrs)	**Durability / Axle Stress at Max Load (psi)**	Rolling Resistance (lbf)	Total Manufacturing Cost ($)
10	**Ensure rider safety under all conditions**	▣	△	△	◉	▣	◉	◉	▣	▣	△
9	**Stable and responsive steering**		△			◉	◉	△	◉		
10	**Allow constant movement**					◉		▣	◉	▣	
8	Pneumatic tires for shock absorbance					◉	◉		◉	◉	△
8	**Coaster use in front assembly**						◉				
10	Front wheel pedal drive										△
10	No motors, chains, or gears										
10	Achieve constant high speeds and good acceleration		▣			▣			▣	◉	
9	Ergonomic seating and rider comfortability	△		◉			◉				
10	**Maintain dimensions: ≤20" wide, ≤24" long, ≤32" high**	◉						◉			
10	**Seat height ≤ 25" (W/ Padding)**	◉		◉				◉		△	▣
10	**Supporting variety of rider weights and sizes**	▣						◉			▣
8	Assembly time							◉			
10	Stress withstanding capability		△		◉	▣	◉		▣		
10	User friendly operation		◉				△				
8	Minimize design weight	△	◉					◉			△
7	Minimal cost							◉			
10	Meet intended functional and operational objectives	▣		▣	▣	△		◉	△	◉	▣

◉	Strong
▣	Medium
△	Weak

▲	Maximize
▼	Minimize
x	Target

++	Strong Positive
+	Positive
-	Negative
--	Strong Negative

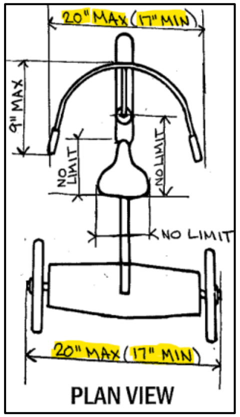
Concept Selection

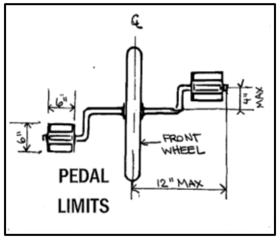
Evaluation matrix

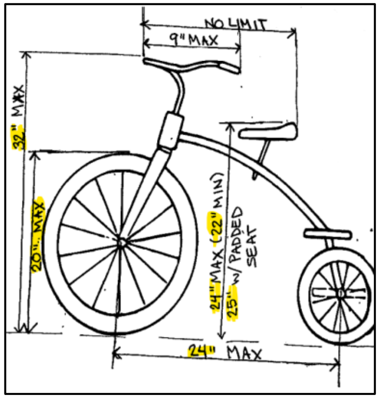
Importanace	Customer Requirements				
10	Ensure rider safety under all conditions	9	7	9	9
9	Stable and responsive steering	9	7	6	10
10	Allow constant movement	10	9	9	9
8	Pneumatic tires for shock absorbance	9	8	7	9
8	Coaster use in front assembly	8	3	7	9
10	Front wheel pedal drive	10	10	10	10
10	No motors, chains, or gears	10	10	10	10
10	Achieve constant high speeds and good acceleration	9	7	8	8
9	Ergonomic seating and rider comfortability	7	9	9	9
10	Maintain dimensins: ≤20" wide, ≤24" long, ≤32" high	8	7	7	10
10	Seat height ≤ 25" (W/ Padding)	9	8	7	10
10	Supporting variety of rider weights and sizes	8	6	8	9
8	Assembly time	8	9	7	7
10	Stress withstanding capability	9	6	9	9
10	User friendly operation	10	8	8	9
8	Minimize design weight	9	6	8	9
7	Minimal cost	5	7	7	8
10	Meet intended functional and operational objectives	9	7	8	10
	Total	1461	1251	13468	1529
	Relative Total = Total/Number of Criteria	0.81	0.70	0.75	0.85

Final Design

Figure 9: Final Tricycle Design Drawing







#	Acadiana 500 Rule / Constraint	Dimensional Specification (in)	FPE Design (in)
1	Seat-top height (ground → top, padded)	22–24 or ≤ 25 (padded)	**23–24.2 (pad)**
2	Highest point on tricycle	≤ 32	**31.5**
3	Handlebar & rear-axle width	≤ 20	**19.75**
4	Crank-arm radius	≤ 4	4
5	Outside pedal-to-pedal span	≤ 24	17.5
6	Front-wheel center → outer pedal tip	≤ 12	**8.75**
7	Max pedal envelope (height × width)	≤ 6 × ≤ 6	**4 × 5**
8	Rear-axle track / overall trike width	17–20	**19.7**
9	Wheelbase	≤ 24	**23.75**
10	Front-wheel diameter	≤ 20	**20**

Material Selection

Figure 10: SolidWorks of Reused Parts (post modification)

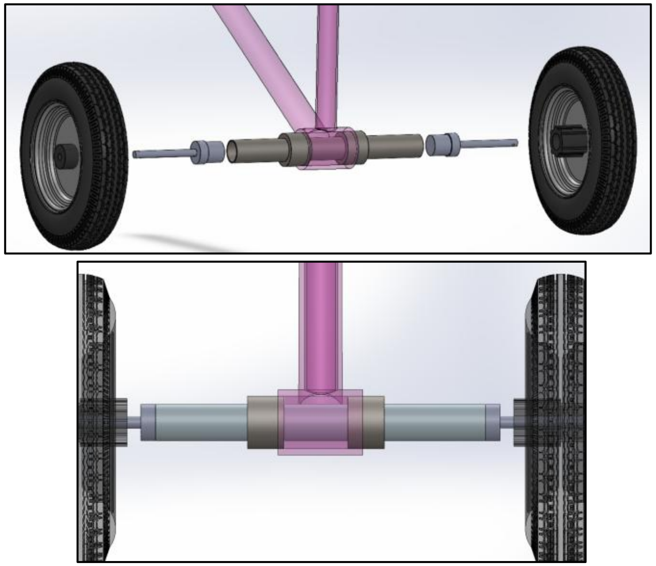


Figure 11: Rear Axle Sub Assembly

Component(s)	Material	Ultimate Tensile Strength (psi)	Yield Strength (psi)	Machinability	Weldability	Density (lb/in³)	Weight Ratio
Frame, Fork, Stem, Handlebars	AISI 1020 Steel	60900	50800	65%	Excellent	0.284	**37.14%**
Rear Axle Center Tube	AISI 4130 Steel	81200	66700	72%	Very good	0.284	8.57%
Rear Axle Center Bushings	AISI 1018 Steel	63800	53800	78%	**Excellent**	0.284	0.86%
Rear Axle Stub (Wheel Bushing)	AISI 4140 Steel (**Heat Treated**)	**148000**	95000	77%	Moderate	0.284	1.43%
Spacers	UNS C36000 **Brass**	55100	44200	**100%**	Not welded in design	0.307	0.46%
Fasteners, Bolts	SAE J429 Grade 5 Steel	120000	92000	65%	Not welded in design	0.284	0.71%

Analytical Calculations

1. To determine the angle at which the tricycle tips over, the following formula is used:

$$\theta_{tip} = \arctan\left(\frac{\text{Rear Width}}{\text{CoG Height}}\right) = \arctan\left(\frac{19.5}{23}\right) \approx \mathbf{22.98°}$$

The tricycle can lean up to **22.98°** before tipping occurs.

2. To calculate the total mass of the tricycle and rider combined, we use the formula:

$$\boldsymbol{m} = \frac{\boldsymbol{weight}}{\boldsymbol{gravity}} = \frac{204.5\text{ lbs}}{32.2\text{ ft/s}^2} = \mathbf{6.356\ slugs\ or\ 42.15\ kg}$$

Where:

- Total Weight = **204.5** lbs (Tricycle: 34–35 lbs, Rider: 170 lbs)
- Gravity = **32.2** ft/s²
- The combined mass of the tricycle and rider is 6.36 slugs (42.15 kg).

Cross-sectional **Area** = A= πr^2, with the **seat post** at a diameter of 2 cm (r=0.39in=1cm)

$$A = \pi(1^2) = 3.1416\ cm^2 = \mathbf{3.1416 \times 10 - 4m^2}$$

Now calculate the applied stress:

$$\boldsymbol{\sigma} = \frac{\boldsymbol{A}}{\boldsymbol{F}} = \frac{850}{3.1416 \times 10^{-4}} = 2.71 \times 10^6\ Pa = \mathbf{2.71\ MPa}$$

Assuming a uniaxial stress, the Von Mises stress will be the same:

$$\boldsymbol{\sigma_{VM} = 2.71MP}$$

3. **Max Stress (Von Mises)**: The Von Mises stress is used to predict the yielding of materials under loading conditions.

- Max Stress from FEA: **2.795e08 N/m²**
- The material used for the frame has a yield strength of **6.204e08 N/m².**

4. The **Factor of Safety (FoS)** is a measure of how much stronger the material is compared to the max expected load. The factor of safety is calculated using the following formula:

$$\textbf{FoS} = \frac{\sigma_{yield\ of\ material}}{\sigma_{VonMisesStress}} = \frac{6.204 * 10^8}{2.795 * 10^8} = \mathbf{2.22}$$

The **FoS = 2.22**; the frame can withstand 2.22 times the max stress calculated by the FEA. This confirms that the frame is structurally safe.

FEA & Stress Analysis

- **Input Forces (FEA):**
    1. Seat Post: 850 N
    2. Rear Axles (2): 450 N
    3. Handlebar: 150 N

- **Von Misses Stress (FEA):**
    - Maximum Stress: 2.795e08 Pa

- **Frame Failure?**
    - Maximum Stress Comparison: 6.204e08 Pa >>2.795e08 Pa

The maximum Von Mises stress is smaller than the yield strength, so **the frame will not fail under this loading condition.**

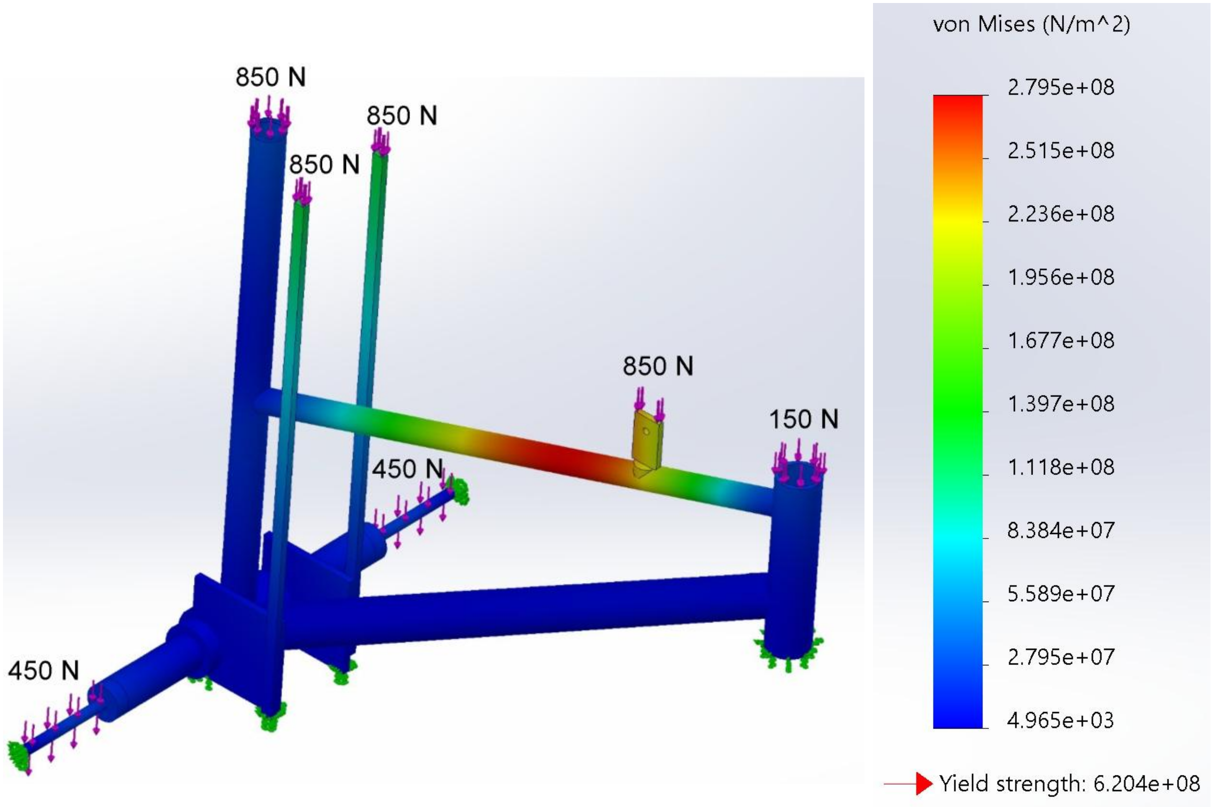


Figure 12: FEA Analysis on Frame

Manufacturing & Assembly

Processes used during manufacturing & assembly:

- **TIG Welding**:Used in **frame and seat support rails** for precision and strength.
- **CNC Machining**: Machined **rear axle sleeve, stem extension, and seat anchor points** to ensure tight tolerances and a precise fit.
- **Lathe & Press**:The **rear axle bushings and brass spacers** were fabricated on a lathe and press to ensure proper alignment and durability.

***Figure 13**: Final Design Exploded View*

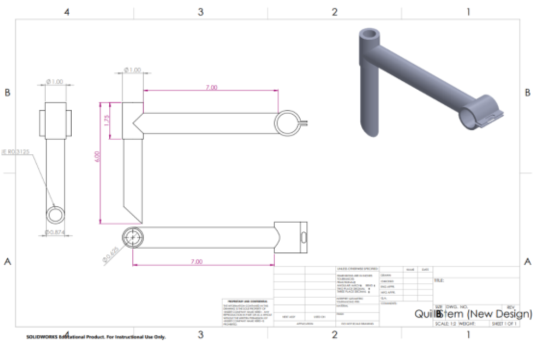


Figure 14: Quill Stem

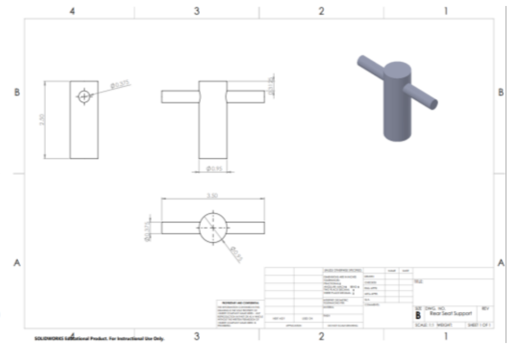


Figure 15: Rear Seat Support

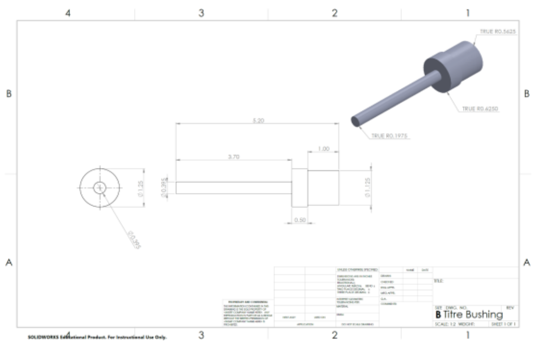


Figure 16: Rear Axle Tire Bushing

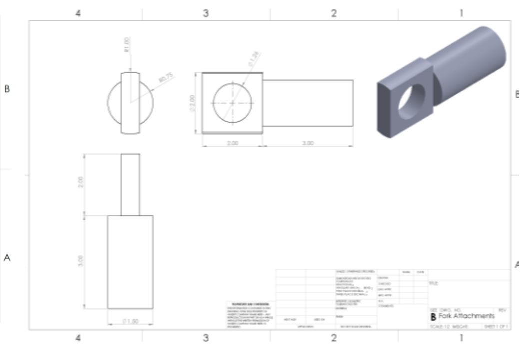


Figure 17: Front Fork Attachment

Testing

Track information:

- Length: 0.66 miles
- 8 Transition zones (30 ft)

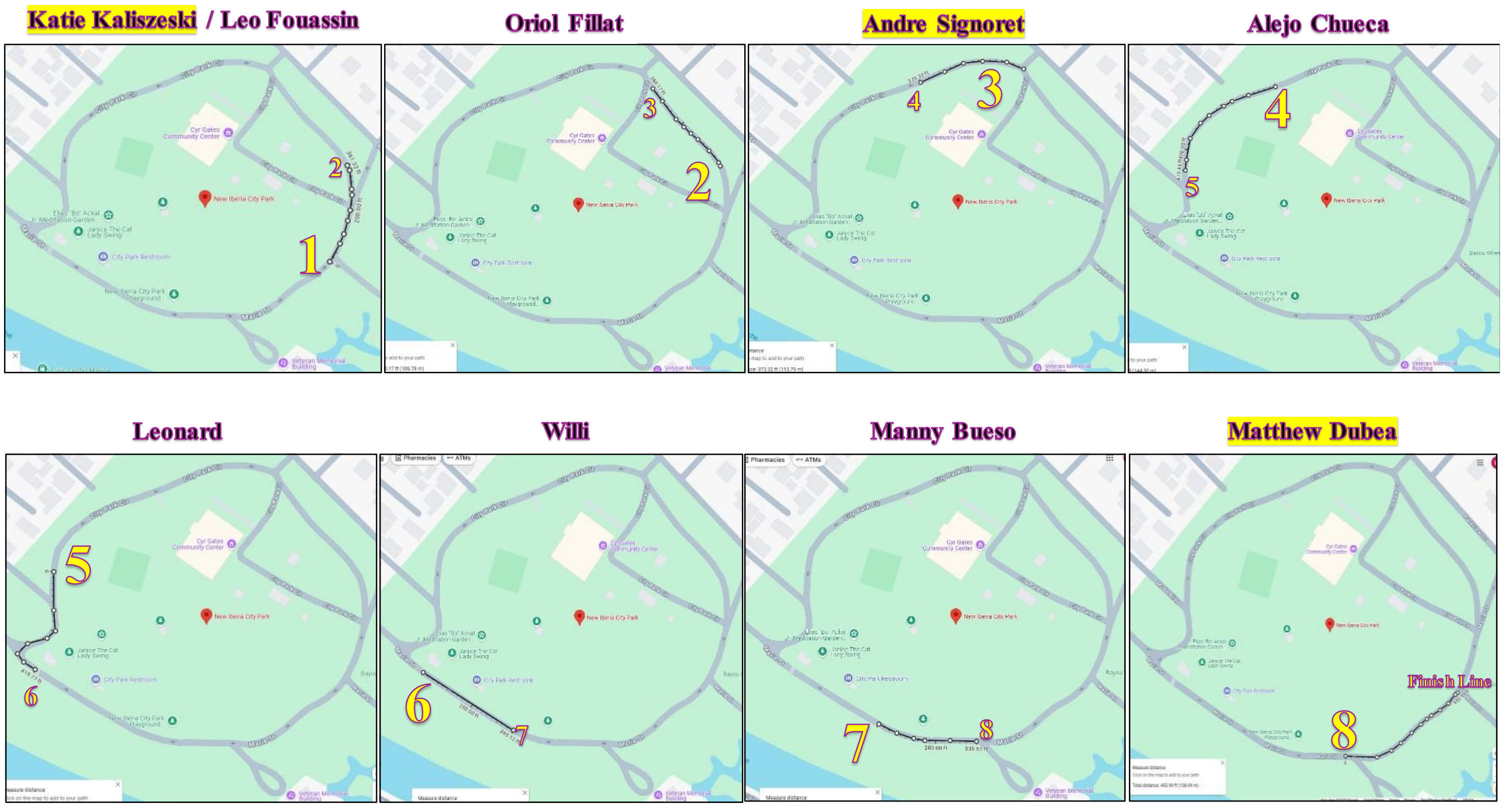


Figure 18: *Acadiana 500 Tricycle Track*

Gantt Chart

UNIVERSITY of LOUISIANA LAFAYETTE

Phase 1 (Fall 2024)

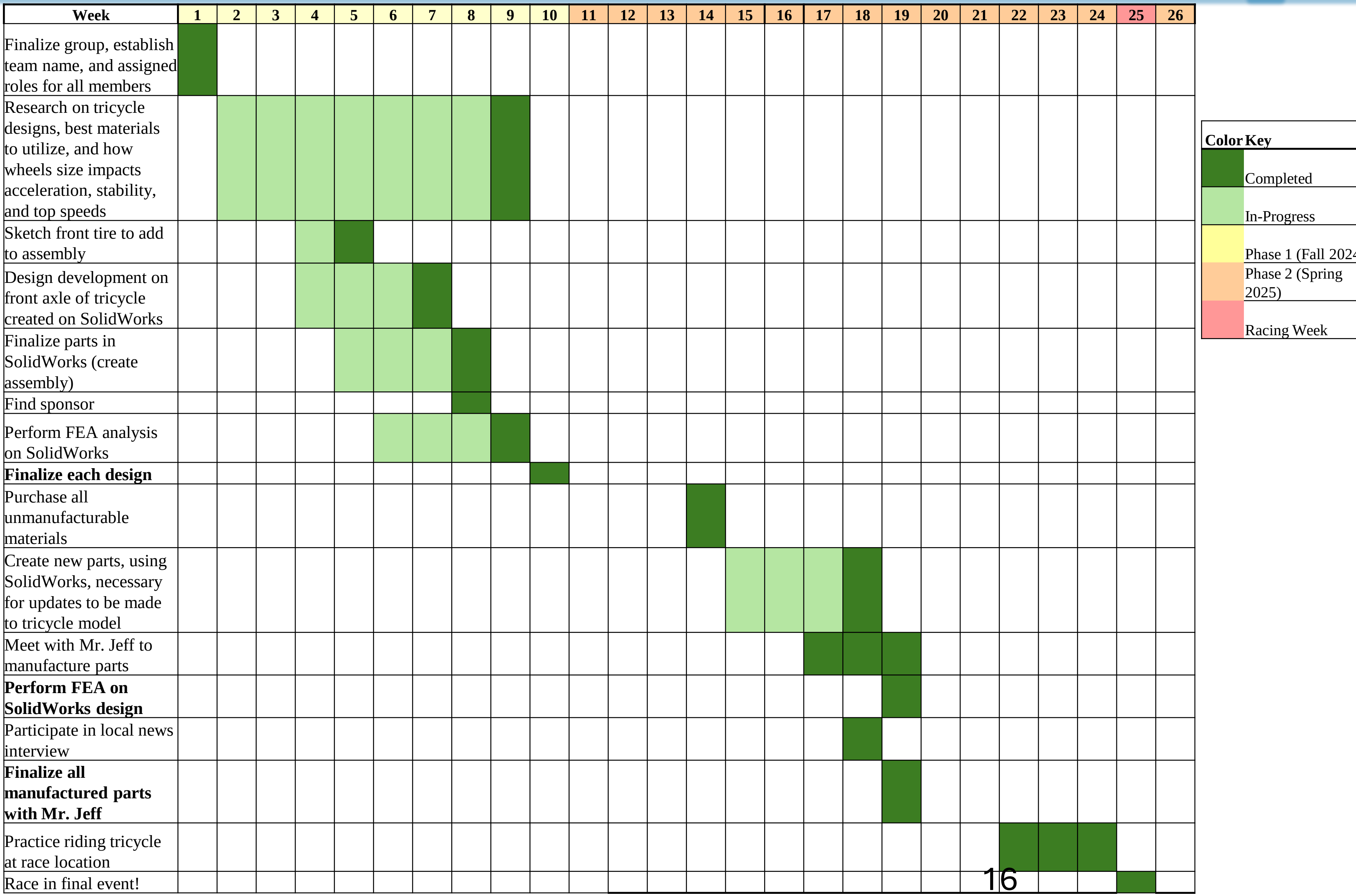
Week	1	2	3	4	5	6	7	8	9	10
Finalize group, established team name, and assigned roles for all members										
Establish means of communication										
Meet with Hanna Pellerin										
Research on tricycle designs, best materials to utilize, and how wheels size impacts acceleration, stability, and top speeds										
Rough draft for a parts list										
Team meeting										
Receive SolidWorks Weld course										
Sketch front tire to add to assembly										
Create table to show optimal dimensions for tricycle performance										
Design development on front axle of tricycle created on SolidWorks										
Finalize parts in SolidWorks (create assembly)										
Find sponsor										
Perform FEA analysis on SolidWorks										
Finalize each design										

Color Key	
	Completed
	In-Progress
	Phase 1 (Fall 2024)
	Phase 2 (Spring 2025)
	Racing Week

Phase 2 (Spring 2025)

Week	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Meet with Hanna Pellerin to discuss phase 2 plan																
Source all parts to order																
Verify all parts being ordered with Hanna Pellerin																
Purchase all unmanufacturable materials																
Meet with Mr. Jeff to discuss required manufactured parts and machining process																
Create new parts, using SolidWorks, necessary for updates to be made to tricycle model																
Create new SolidWorks drawing of edited tricycle design																
Meet with Mr. Jeff to manufacture parts																
Perform FEA on SolidWorks design																
Participate in local news interview																
Drive to New Iberia to visit location of race																
Finalize all manufactured parts with Mr. Jeff																
Work on final presentation, poster, & report																
Practice riding tricycle at race location																
Make any necessary adjustments before the event																
Final meeting with Hanna Pellerin to give final update																
Prepare for final race																
Race in final event!																

Gantt Chart Summarized by Major Achievements



Results

Round	Team	Time	Penalties	Final Time
Qualifier 1	**Fast Pedal ULL**	**3.41.87**	**0**	**3.41.87**
	Baby Sharks	3.35.17	.10	3.45.17
	Gym Class Heros	3.45.43	0	3.45.43
	The Loan Rangers	3.36.08	.10	3.46.08
	Baits Motel	3.46.63	.10	3.56.63
	Heavy Metal Sharks	3.50.38	.20	4.10.38
	Pedal Pushers	4.15.63	.20	4.35.63
	Amped Up	4.18.37	.30	4.48.37
	Pecan Peddlers	4.40.79	.50	5.30.79

Round	Team	Time	Penalties	Final Time
Qualifier 2	**Fast Pedal ULL**	**3.38.03**	**0**	**3.38.03**
	The Loan Rangers	3.35.25	.10	3.45.25
	Gym Class Heros	4.01.79	0	4.01.79
	Baby Sharks	3.40.87	.30	4.10.87
	Baits Motel	3.52.60	.20	4.12.60
	They see Me Rolling	3.58.15	.20	4.18.15
	Heavy Metal Sharks	3.49.58	.30	4.19.58
	Amped Up	4.07.83	.30	4.37.83
	Pedal Pushers	4.28.22	.30	4.58.22

Round	Team	Time	Penalties	Final Time
Semi-Final	**Fast Pedal ULL**	**3.33.00**	**.20**	**3.53.00**
	Baby Sharks	3.46.20	.10	3.56.20
	Heavy Metal Sharks	3.48.93	.10	3.58.93
	Baits Motel	3.51.69	.10	4.01.69
	The Loan Rangers	3.42.07	.20	4.02.07
	They see Me Rolling	3.53.15	.20	4.13.15

Round	Team	Time	Penalties	Final Time
Final	**Fast Pedal ULL**	**3.31.17**	**0**	**3.31.17**
	Heavy Metal Sharks	3.48.36	.20	4.08.36

- **1st place**
  - Winning time: 3 min 31 s (won all races)
  - Least amount of penalties received
  - Fastest track time of the day
  - Completed 4/5 races without any penalties
  - Average team speed: 11.3 mph

Figure 19: FPE Trophy Ceremony

Bill of Materials

Purchased Components — Cost and Source Summary

	Item / Sub-assembly	Qty	Material	Cost ($)	Source	Note
Re-used						
1	Bike Frame (triangular)	1	1018 Steel tube	0	Reused MTB	TIG welded
2	Handle-bars (straight)	1	1018 Steel tube	0	Reused MTB	Narrowed to 19 in
3	Stem (pre-extension)	1	1018 Steel	0	Reused MTB	Modified & Extended (TIG)
4	Rear tires	2	Steel and Rubber	0	Esport	Provided by business
Purchased						
4	20 in front-wheel assembly	1	Steel / 6061-T6	31.99	Razer DXT (razor.com)	(hub + cranks + coaster)
5	Titanium pedal extenders, 0.79 in	2	Titanium Alloy	35.99	Amazon	Increases pedal clearance
6	Aluminum flat pedals (pair)	2	6061-T6 / Steel	27.99	Amazon	½-20 thread
7	Handle-bar grips (pair)	2	ABS Plastic	6.98	Amazon	5.2 in length
8	Banana saddle w/ support rails	1	Polyurethane / Carbon Fiber / 1018 Steel	55.99	Amazon	18 x 4.5 in
9	"Full Petal Engineers" Team Jerseys	9	Cotton	52.91	Mrs. Kaliszeski	S, M, L
Machined						
10	Stem extension (+7 in)	1	1018 Steel	0	UL Shop - Mr. Jeff	1.5 h lathe + 0.5 h weld
11	T-anchor (Seat Security)	1	6061-T6	0	UL Shop - Mr. Jeff	1.5 h 3-axis mill
12	Center tube (rear axle sleeve)	1	4130 Steel	0	UL Shop - Mr. Jeff	0.75 h lathe
13	Rear-axle bushing set (stepped axle + brass)	2	4130 Steel / C360	0	UL Shop - Mr. Jeff	2.0 h lathe + press
14	Brass Spacers	2	C360	0	UL Shop - Mr. Jeff	0.5 h lathe
15	Bushing-to-frame collars	2	1018 Steel	0	UL Shop - Mr. Jeff	0.5 h lathe
16	Fork bearing blocks	2	1018 Steel	0	UL Shop - Mr. Jeff	5 h mill + drill/tap
17	Side stiffener plates	2	1018 Steel plate	0	UL Shop - Mr. Jeff	Included in 5 h weld total
18	Seat support railing	2	1018 Steel tube	0	UL Shop - Mr. Jeff	Braced with screws (Side Plate and Seat)
			Total Cost	211.94		

Potential Impacts

Figure 20: FPE Racer Katie

- All money raised during the event is **donated** to **boys' and girls' groups** in the New Iberia area
- The team gained further **experience** in:
  - SolidWorks design
  - Manufacturing and Assembly Process
  - Working with sponsors and meeting customer deadlines and requirements
  - FEA analysis
  - Utilizing kinematic equations to perform necessary calculations

Acknowledgments

- **Hanna Pellerin**: Event Organizer
  - Aided in answering all team inquiries
- **Capitol Cyclery**
  - Provided information on how tricycles are manufactured
- **Mr. Jeff**: MCHE Lab Professor
  - Guided the team in the Phase 2 process of assembly
  - Aided in manufacturing all necessary parts for the tricycle assembly
- **KATC News**
  - Covering the teams progress over a news segment/article
    - https://www.katc.com/lafayette-parish/mechanical-engineering-students-at-ul-build-tricycle-for-acadiana-500-race
- **Raising Canes**
  - Sponsored the team's registration fee: $250
- **E-Sport Guatemala**
  - Provided rear wheels for tricycle

Figure 21: FPE Team after Semi-Final Race

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Thank you for listening!

Questions?

Figure 22: FPE Team after winning Acadiana 500