NORTHERN ARIZONA UNIVERSITY

To: David Willy, Husain Sodawalla

From: SAE Baja 24

Date: 12/08/2023

Re: Project Management for ME486C

1 Reflection

With the fall semester ending, it is important to look back at the past 16 weeks of work produced by the team and analyze it within the scope of engineering teamwork strategies and optimized workflow.

1.1 Project Management – Successes

The team had a generally productive semester that yielded satisfactory results on all assignments for ME476C. The list below highlights some of the behaviors exhibited by team members that lead to this success.

- Weekly Meetings in the Shop
- Excellent Communication Within Sub-teams
- Willingness to Produce Once Targets Were Identified
- High-Quality Documentation on PowerPoints

1.2 Project Management – Room for Improvements & Action Items

Despite overall performance being excellent, the team did have some areas to improve upon if ME486C is to go smoothly. These opportunities for improvement are in the list below and are paired with appropriate action items to ensure these issues are properly addressed.

- **Lack of Communication Between Sub-Teams**
  1. **Host round-table discussions during weekly shop meetings to make sure the whole team is on the same page with design progress, manufacturing updates, etc.**
     - This will help the team by increasing team-wide awareness and allowing collective input on issues.
  2. **Increase communication on Teams**
     - This will further increase team-wide awareness which will be crucial to meet competition deadlines.
  3. **Ask for feedback and help early to make sure tasks are carried out efficiently**
     - By doing so, teams can avoid poor work quality and manufacturing holdups.
- **Time-Crunches on Major Assignments**
  1. **Establishing more strict deadlines for assignment progress**
     - This will leave more leeway for the team to edit/optimize assignments and their content without rushing.
  2. **Hold teammates accountable and help when needed**
     - This is a tight-knit team with members that are willing to help wherever needed. Making sure to utilize this feature will be a major time-saver during the latter stages of ME486C.

3. **Start assignments early**
    - Assignment deadlines on CANVAS are unlikely to be moved by the instructor, so the team must ensure that the work we deliver is started early enough to allow for revisions and proof-reading before submission.

- **Increased Need for Initiative**
    1. **Proactive purchasing of materials for ME486C**
        - Lead-times can be lengthy for material/purchase orders, so making sure to order ASAP will help the team stick to manufacturing plans.
    2. **Establish aggressive deadlines for manufacturing**
        - Making sure to get things done with speed will allow the team to front-load the semester, leaving more time for testing and optimization before competition.
    3. **Stick to manufacturing plan and Gantt chart progress markers**
        - The scheduling performed by team leaders is a valuable resource and making sure to reference this timeline will ensure team-wide consistency. Deadlines that are hit early will further allow stress to be taken off the backs of all team members.

1.3 Remaining Design Efforts

The team has performed solid, intelligent work over the past semester making sure to satisfy all capstone and competition requirements. As such, the list of remaining design efforts is sparse. None the less, these outstanding design efforts can be seen below.

- **Front End**
    1. Brake Pedal Validation
    2. Tie Rod Threaded Insert Redesign
    3. Brake Bias Shaft Design & Validation
- **Rear End**
    1. Trailing Link Weight Savings
    2. Camber Link Length Adjustments
    3. Shock Mount Reinforcement
- **Drivetrain**
    1. Individual Part FEA Analysis
    2. Individual Part Optimization (Weight Reduction)
    3. Include Brass Fitting into Driving Clutch
    4. Rear Gearbox Expansion Chamber
    5. Belt Shielding from Rear to Front
    6. Front Pulley Shield
- **Frame**
    1. Frame panel design
    2. Drivetrain integration
    3. Driver safety integration
    4. Seat design
    5. Battery mount and location
    6. Brake light integration
    7. Pedal and master cylinder mounts and location

2 Gantt Chart

To aid in the success of this project, the team's Gantt chart has been updated to include all necessary capstone and competition deliverables. The chart shown below highlights the deadlines established from week 1 of the spring semester to the first hardware status check (33%).

Table 1: ME486C Gantt Chart - Week 1 to 33% Hardware Check

PROJECT: SAE Baja 24

NAU A.Y. 2023-2024

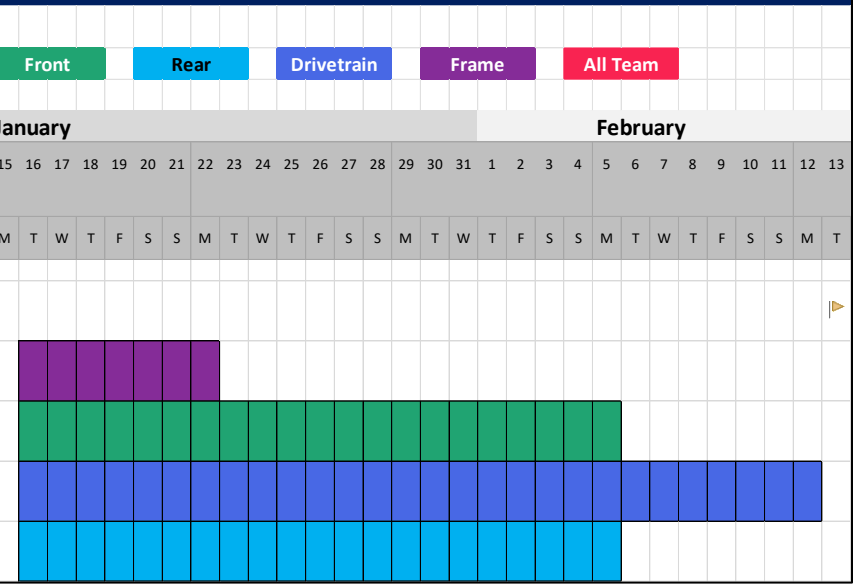
Project Manager: Abe Plis

Project start date: 9/12/2023

Scrolling increment: 125

Legend: Front | Rear | Drivetrain | Frame | All Team

Milestone description	Responsible Sub-Team	Assigned To	Progress	Start	Days
Hardware - 33%	Milestone	All Team	**0%**	2/13/2024	1
Frame Welded with Tabs	Frame	Cooper Lead	**0%**	1/16/2024	7
UCA,LCA, Steering & Begin Knuckle	Front	Bryce Lead	**0%**	1/16/2024	21
Start CVT Housing, Gears, and Pully	Drivetrain	Henry Lead	**0%**	1/16/2024	28
Camber Links & Hub	Rear	Seth Lead	**0%**	1/16/2024	21



The Baja team is split up into four distinct sub-teams with separate manufacturing responsibilities that are outlined in the chart above.

By the first hardware check, the front-end team should have a decent start on the upper control arm and lower control arm manufacturing with 4130 tubing purchasing and welding jig creation occurring prior to the start of the semester. In addition, the front end should have begun the manufacturing of the custom steering rack, facilitating racking housing mounting on the frame, and cam-pathing of the knuckle.

The rear end team has already begun machining the rear hubs which will be completed before the end of the Fall semester. The camber link rod end inserts will be machined out of steel and aluminum starting in January using stock that the baja team already possesses. The rear end team is also hoping to reach out to the laser cut sponsor before the end of the Fall semester and communicate our needs before making an order in January next

year. With these goals in mind the rear end team should have the hubs, camber links, and trailing link material ready to go before the first hardware check.

By the first hardware check, the drivetrain team will have all material purchased so that parts can start to be machined. These parts include the CVT, housing, gears, shafts, and pulley. The drivetrain team is planning on sending machined parts to a heat treatment place before final installation of front and rear gearboxes. The team will also start to purchase required bearings and pulleys.

By the first hardware check, the frame team should have the whole frame fully welded. This includes all suspension component mounts. The seat holder members should be in place and the seat should be close to being in the car for the final time. The team should have started paneling and mounting for components like the battery, fire extinguisher, rear light etc. The engine and drivetrain components should be mostly hard locked in place within the frame.

3 Purchasing Plan

There is a large variety of aftermarket support for traditional off roading vehicles that can be utilized in the construction of the team's SAE Baja vehicle. The purchasing plans for each sub-team utilizing aftermarket items are featured below.

3.1 Front End

The purchasing plan for front end can be seen below in Table 2. The rough outline for the beginning of the semester follows the outline in section 2 with the knuckle, hub, and control arms being the focus out of the gate for purchasing. Then, attention will be shifted to buying components for the steering system in mid-February and finished out with the brake/throttle assembly purchasing targeted to be completed by the beginning of March. This will allow the car to be driven by mid-March for testing and performance optimization before the SAE competition in late April.

Table 2: Front Purchasing Plan

Part Name	Quantity	Cost	Total Cost	Material	Purchase/Made	Vender	Vender Part Number	Manufacturer (if not vender)	Lead Time	Purchase By
CV Axle/Nut	2	108	216	Steel	Purchased	Amazon	N/A	Yamaha	1 week	1/16/2024
CV Spline	2	40	80	Steel	Purchased	Amazon	N/A	Yamaha	1 week	1/16/2024
CV Bearing	4	72.92	291.68	Steel	Purchased	SKF	6006-2RS1	same as vender	1 week	1/16/2024
Upper Control Arm Knuckle Bolt	2	14.76	29.52	Alloy Steel	Purchased	MMC	90044A124	same as vender	2 days	1/16/2024
Lower Control Arm Knuckle Bolt	2	14.89	29.78	Alloy Steel	Purchased	MMC	90044A125	same as vender	2 days	1/16/2024
Tie Rod Knuckle Bolt	2	11.99	23.98	Alloy Steel	Purchased	MMC	91251A542	same as vender	2 days	2/1/2024
Control Arm Frame Bolt	4	18.22	72.88	Alloy Steel	Purchased	MMC	N/A	same as vender	2 days	1/16/2024
Master Cylinder	2	220	440	N/A	Purchased	Tilton	78-625	same as vender	1 week	2/14/2024
Brake Hose	2	18.4	36.8	Steel	Purchased	Amazon	N/A	Racewill	1 week	2/14/2024
Pedal Sensor	1	5	5	N/A	Purchased	Amazon	N/A	WQSING	1 week	2/14/2024
Throttle Pedal Sensor	1	5	5	N/A	Purchased	Digikey	N/A	Digikey	1 week	2/14/2024
Rack End	2	10	20	Aluminum	Purchased	Joes Racing Products	N/A	same as vender	1 days	2/14/2024
Rack End Screws	2	5	10	Aluminum	Purchased	Joes Racing Products	N/A	same as vender	1 days	2/14/2024
Pinion Housing	1	100	100	Aluminum	Purchased	Joes Racing Products	N/A	same as vender	1 days	1/16/2024
Pinion Gear	1	100	100	Steel	Purchased	Joes Racing Products	N/A	same as vender	1 days	1/16/2024
Pinion Bearing	2	10	20	N/A	Purchased	Joes Racing Products	N/A	same as vender	1 days	1/16/2024
3/8 Rod End for Tie Rod	4	10	40	Steel	Purchased	McMaster Carr	60645K14	same as vender	2 days	1/16/2024
Tie Rod	2	15	30	Carbon	Purchased	Amazon	N/A	CN Carbon Fiber	1 week	1/16/2024
Steering Column	3	15	45	Carbon	Purchased	Amazon	N/A	CN Carbon Fiber	1 week	2/14/2024
U Joint	2	40	80	Steel	Purchased	McMaster Carr	6443K106	same as vender	1 day	2/14/2024
Pinion Face Plate	1	5	5	Plastic	Purchased	Joes Racing Products	N/A	same as vender	1 day	1/16/2024
1/4"-20 Bolts for Steering Column	3	11.58	34.74	Titanium	Purchased	McMaster Carr	94081A112	same as vender	2 days	2/1/2024
1/4"-20 Nut for Steering Column	3	10.8	32.4	Titanium	Purchased	McMaster Carr	94528A117	same as vender	2 days	2/1/2024
1/2"-13 Bolt for Rack to Tie Rod	2	20.83	41.66	Titanium	Purchased	McMaster Carr	94081A749	same as vender	2 days	2/1/2024
1/2"-13 Nut for Rack to Tie Rod	2	10.32	20.64	Titanium	Purchased	McMaster Carr	90545A034	same as vender	2 days	2/1/2024
Control Arm Swivel Joint	4	68.21	272.84	Steel	Purchased	McMaster Carr	63195K36	same as vender	2 days	1/16/2024

3.2 Rear End

The purchasing plan for the rear end team can be seen below in Table 3. Prior to the winter hiatus, the team plans to purchase the CV axle and bearings. First priorities moving into semester 2 are going to be purchasing all fasteners and hardware for the links, wheels, and axle assembly. Having these parts ordered as early as possible will ensure that production of parts begins as soon as the semester begins, with all testing and tuning completed prior to the SAE Baja competition in April.

Table 3: Rear End Purchasing Plan

Part Name	Quantity	Cost	Total Cost	Material	Purchase/Made	Vender	Vender Part Number	Manufacturer (if not vender)	Lead Time	Purchase By
Ball Joint Rod End with Nut	2	14.78	29.56	Zinc-Plated Carbon Steel	Purchase	McMaster-Carr	4237N107	same as vender	1 day	1/16/2024
5/16"-18 Shoulder Screw	4	2.44	9.76	Alloy Steel	Purchase	McMaster-Carr	91259A626	same as vender	1 day	1/16/2024
1/2"-13 Shoulder Screw	2	5.81	11.62	Alloy Steel	Purchase	McMaster-Carr	91259A794	same as vender	1 day	1/16/2024
5/16"-18 Nylon-Insert Flange Locknut	4	0.17	0.68	Medium-Strength Steel	Purchase	McMaster-Carr	93298A204	same as vender	1 day	1/16/2024
1/2"-13 Nylon-Insert Flange Locknut	2	0.52	1.04	Medium-Strength Steel	Purchase	McMaster-Carr	93298A206	same as vender	1 day	1/16/2024
Yamaha Grizzly 350 CV	2	115	230	Steel	Purchase	Ebay	YFM350FGI	Yamaha	1 week	12/15/2023
SKF Deep Groove Ball Bearing	4	6.93	27.72	Steel	Purchase	Bearing Basement	6006 2RS1	SKF	1 week	12/15/2023
Hex Nut-Grade 5	8	0.16	1.28	Medium-Strength Steel	Purchase	McMaster-Carr	95462A031	same as vender	1 day	1/16/2024
Low-Profile Socket Head Screw	8	0.56	4.48	Alloy Steel	Purchase	McMaster-Carr	92220A253	same as vender	1 day	1/16/2024
Super-Swivel Ball Joint Rod End	4	13.74	54.96	Zinc-Plated Carbon Steel	Purchase	McMaster-Carr	6960T23	same as vender	1 day	1/16/2024
Ball Joint Rod End	4	6.6	26.4	Zinc-Plated Carbon Steel	Purchase	McMaster-Carr	60645K14	same as vender	1 day	1/16/2024
Nylon-Insert Locknuts-Grade 8	8	0.35	2.8	High-Strength Steel	Purchase	McMaster-Carr	97135A419	same as vender	1 day	1/16/2024
Carbon Fiber Camber Link	2	15.99	31.98	3K Carbon Fiber	Purchase	Amazon	B0791XDV7W	Abester Composite Materials	2 days	1/16/2024
Hex Head Screw	8	0.38	3.04	High-Strength Steel	Purchase	McMaster-Carr	91257A628	same as vender	1 day	1/16/2024
		Total Cost:	535.32							

3.3 Drivetrain

The purchasing plan for the drivetrain team is seen in Table 4. The team plans on purchasing all raw materials by the end of the semester so that the team can account for the lead time and delays that may arise. Once spring semester starts in January, the team will start machining the necessary parts listed in the table below. In addition, bearings and belts will need to be purchased by the end of the year so that test fitting machined gears and shafts can be done before actual testing occurs.

Table 4: Drivetrain Purchasing Plan

Part Name	Quantity	Cost	Total Cost	Material	Purchase/Made	Vender	Vender Part Number	Manufacturer	Lead Time	Purchase By
60355K178 Ball Bearing	4	7.55	30.2	Steel	Purchase	McMaster-Carr	60355K178	Same As Vendor	3 Weeks	12/14/2023
6656K151 Ultra-Thin Ball Bearing	3	79.81	239.43	Steel	Purchase	McMaster-Carr	6656K151	Same As Vendor	3 Weeks	12/14/2023
GMN FK6205-2RS Sprag	2	N/A	N/A	Steel	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
Circlip CV Cup	2	N/A	N/A	Aluminum	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
Front Input Gear	1	50	50	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Front Output Gear	1	100	100	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Front Input Shaft	1	75	75	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Front Output Shaft	1	75	75	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
CV Cup	2	100	200	Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Front Drive Side Housing	1	50	50	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Front Passenger Side Housing	1	50	50	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
SKF 65X80X8 CRW1 R Seal	3	38.75	116.25	Fluoro Rubber	Purchase	Motion Industries	85311155601	Same As Vendor	3 Weeks	12/14/2023
SKF_80X100X10 CRW1 R Seal	1	22.48	22.48	Nitrile Rubber	Purchase	Motion Industries	85311030847	Same As Vendor	3 Weeks	12/14/2023
SKF 7438 Seal	3	12.82	38.46	Nitrile Rubber	Purchase	Motion Industries	85311005562	Same As Vendor	3 Weeks	12/14/2023
Socket Head Cap Screw	8	N/A	N/A	Aluminum	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
Socket Head Shoulder Screw	2	N/A	N/A	Aluminum	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
60355K185 Ball Bearing	3	8.99	26.97	Steel	Purchase	McMaster-Carr	60355K185	Same As Vendor	3 Weeks	12/14/2023
6656K245 Ball Bearing	1	128.92	128.92	Steel	Purchase	McMaster-Carr	6656K245	Same As Vendor	3 Weeks	12/14/2023
Rear Gearbox Input Shaft	1	35	35	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Rear Gearbox Intermediate Shaft	1	40	40	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Rear Gear 2	1	15	15	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Rear Gear 3	1	15	15	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Rear Gear 4	1	50	50	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Rear Gear 5	1	400	400	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Rear Gearbox Driverside Case	1	125	125	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Rear Gearbox Passengerside Case	1	125	125	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Driving Side Clutch	1	59	59	4140 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Driven Side Clutch + Pulley	1	59	59	4140 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Front End Pulley	1	10.92	10.92	4140 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
Shifter Lever	1	25.24	25.24	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Shifter Lever Housing	1	75	75	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Shifter Fork	1	21.49	21.49	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Swivel Joint	1	8.21	8.21	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Gear Box Pulley Shield	1	19.67	19.67	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Shift Fork Mount Guard	1	19.67	19.67	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Dog Clutch Cap	1	19.67	19.67	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Engagement Cable Mount	1	5.35	5.35	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Idler Pulleys	11	52.25	574.75	Aluminum	Made	N/A	N/A	Henry	5 Weeks	N/A
60355K733 Ball Bearings	2	10.65	21.3	Aluminum	Purchase	McMaster-Carr	60355K733	Same As Vendor	3 Weeks	12/14/2023
Idler Pulley Bearings	11	0.78	8.57	Aluminum	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
Linkage Cable	1	78.74	78.74	Steel, etc.	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
60T Threaded Black-Oxide Steel Track Roll	1	34	34	Steel	Purchase	McMaster-Carr	N/A	Same As Vendor	3 Weeks	12/14/2023
Circlips	2	2	4	Copper	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
4WD belt	1	76	76	Rubber	Purchase	Bolton	3280-8M-20 Optibelt OMEGA HTD Timing Belt	Same As Vendor	3 Weeks	12/14/2023
CVT control belt	1	6	6	Rubber	Purchase	Beidlers Belts	160xl037	Same As Vendor	3 Weeks	12/14/2023
CVT power belt	1	50	50	Rubber	Purchase	Xcaliber Motorsports	21g3353	Same As Vendor	3 Weeks	12/14/2023
Cam followers	8	4	32	Steel	Purchase	Amazon	CF4 cam follower	Same As Vendor	3 Weeks	12/14/2023
Oil-Embedded Bronze Sleeve Bearing	3	6.56	19.68	Bronze	Purchase	McMaster-Carr	6391K768	Same As Vendor	3 Weeks	12/14/2023
One-Piece Thrust Ball Bearing	1	48.72	48.72	Steel	Purchase	McMaster-Carr	60715K111	Same As Vendor	3 Weeks	12/14/2023
Ultra-Thin Ball Bearing	1	63.69	63.69	Steel	Purchase	McMaster-Carr	6656K236	Same As Vendor	3 Weeks	12/14/2023
Ball Bearing	1	7.72	7.72	Steel	Purchase	McMaster-Carr	60355K336	Same As Vendor	3 Weeks	12/14/2023
Ball Bearing	1	12.62	12.62	Steel	Purchase	McMaster-Carr	60355K983	Same As Vendor	3 Weeks	12/14/2023
Cast Iron Acme Round Nut	1	39.91	39.91	Cast Iron	Purchase	McMaster-Carr	97014A595	Same As Vendor	3 Weeks	12/14/2023
316 Stainless Steel Acme Lead Screw	1	33.52	33.52	Steel	Purchase	McMaster-Carr	95080A103	Same As Vendor	3 Weeks	12/14/2023
Limit switch	1	5	5	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
Hall effect	1	13	13	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
Magnet	2	0.25	0.5	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
Hudson 343x	1	500	500	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
Odrive pro	1	300	300	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
Arduino portena h7 lite	1	80	80	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
Primary mobile sheave	1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Primary fixed sheave	1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Secondary mobile sheave	1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Secondary fixed sheave	1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
CVT standoffs	2	15	30	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
CVT outside partial standoff	2	7	14	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
CVT inside partial standoff	2	7	14	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Control motor pulley	2	20	40	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Primary shaft	1	20	20	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Secondary shaft	1	20	20	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Secondary cam	1	40	40	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Secondary cam mount plate	1	10	10	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Backplate	1	50	50	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Frontplate	1	25	25	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Motor mount plate	1	10	10	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Square bush	1	15	15	Bronze	Purchase	McMaster-Carr	N/A	Same As Vendor	3 Weeks	12/14/2023
Gearbox shaft support	1	10	10	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Anti-rotation forks	3	2	6	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Lead screw nut flange	1	45	45	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
Motor	1	900	900	N/A	Purchase	Kholer	N/A	Same As Vendor	3 Weeks	12/14/2023

3.4 Frame

The purchasing plan for the frame is somewhat unique compared to other sub-teams. Other than the frame itself, there are very few components that need to be manufactured. Of those components there are many that the BAJA team is already in possession of. Driver safety equipment is already in possession, but components like the seat, side paneling, the suspension tabs, and the engine mount all must be manufactured. There are also a few components that need be purchased like the gas tank and the gas tank mount washers. Moving forward, the plan is to acquire as many components as possible, if the budget permits, so that the team is not waiting on components to move forward with manufacturing.

Table 5: Frame Purchasing Plan

SAE Baja Frame BOM											
Part	**Description**	**Manufacturer/Vender**	**Qty**	**Units**	**Make/Buy**	**Part Status**	**Lead Time**	**Purchase/Manufacture By**	**Unit Cost**	**Cost**	**Obtained**
Primary Members	4130 1.25x.065" tubing	IMS	45	ft	Buy	Being Manufactured	0	11/1/2023	0.00	0.00	Y
Secondary Members	4130 1x.035"tubing	BFS	45	ft	Buy	Awaiting Part	5 Days	12/11/2023	8.00	360.00	Y
Tabs	4130 0.1"sheet	VROOM Engineering	100	in^2	Make	Awaiting Part	1 Week	1/29/2024	0.28	27.78	N
Side Panneling	Carbon Weave	Novakinetics	20	ft^2	Make	Design	1 Week	2/5/2024	0.00	0.00	N
Seat	Carbon Weave	Novakinetics	4	ft^2	Make	Design	1 Week	1/29/2024	0.00	0.00	N
Epoxy	Carbon resin epoxy	Novakinetics	1	gallon	Buy	In House	0	N/A	0.00	0.00	N
Harness	Standardized	RaceQuip	1	unit	Buy	In House	0	N/A	0.00	0.00	Y
Submarine Straps	Standardized	TBD	2	unit	Buy	In House	0	N/A	0.00	0.00	y
Fire Extinguisher	5BC Standard	TBD	1	unit	Buy	In House	0	N/A	0.00	0.00	Y
Extinguisher Mount Bracket	Drake FIREX-MNT-DAG	Drake	1	unit	Buy	In House	0	N/A	0.00	0.00	Y
Fuel Tank Mounting Washers	McMaster Carr 94733A723	McMaster	8	50	Buy	To Be Ordered	1 Week	2/5/2024	0.00	0.00	Y
Mounting Hardware	Misc. nuts, bolts, washers needed	TMS Titanium	1	unit	Buy	To Be Ordered	1 Week	2/5/2024	0.00	0.00	N
Skid Plate	.06"HDPE	TBD	6	ft^2	Make	To Be Manufactured	2 Week	2/12/2024	5.00	30.00	N
Firewall	.02" sheet metal	TBD	9.5	ft^2	Make	To Be Manufactured	1 Week	2/13/2024	7.75	73.63	N
									Total Cost	**491.40**	

4 Manufactured Items

With the team being based out of the NAU machine shop, a large majority of manufactured components will be made in-house to save money and time. The manufacturing plans of each sub-team are outlined below.

4.1 Front End

The manufacturing plan for the front end can be seen in Table 6. Again, the rough outline for the beginning of the semester follows the outline in section 2 with the knuckle, hub, and control arms being the manufacturing focus out of the gate. Then, manufacturing attention will be shifted to the steering system in mid-February and finished out with the brake/throttle assemblies being manufactured by the beginning of March. This will allow the car to be driven by mid-March for testing and performance optimization before the SAE competition in late April.

Table 6: Front Manufacturing Plan

Quantity	Cost	Total Cost	Material	Purchase/Made	Vender	Vender Part Number	Who Manufactures	Manufacture Time	Manufacture Deadline	Raw Material	Manufacture Location
3	8.8	105.6	4130, 4'	Made	IMS	N/A	Abe	1 week	2/1/2024	4130	Shop
3	8.8	105.6	4130, 4'	Made	IMS	N/A	Abe	1 week	2/1/2024	4130	Shop
2	450	900	6061-T6	Made	IMS	N/A	Bryce	2 weeks	2/1/2024	6061	Shop
2	190	380	6061-T6	Made	IMA	N/A	Bryce	2 weeks	2/1/2024	6061	Shop
4	4	16	6061-T6	Made	IMS	N/A	Bryce	1 day	2/1/2024	6061	Shop
4	4	16	6061-T6	Made	IMS	N/A	Bryce	1 day	2/1/2024	6061	Shop
2	4	8	6061-T6	Made	IMS	N/A	Bryce	1 day	2/1/2024	6061	Shop
4	4	16	6061-T6	Made	IMS	N/A	Evan	1 day	2/1/2024	6061	Shop
12	1.5	18	Delrin	Made	MMC	7521T16	Abe	1 day	2/1/2024	Delrin	Shop
4	N/A	N/A	Steel	Made	IMS	N/A	Abe	2 week	2/14/2024	1020	Shop
1	95	95	6061-T6	Made	IMS	N/A	Evan	2 week	2/14/2024	6061	Shop
1	30	30	Carbon	Made	N/A	N/A	Abe	1 day	3/1/2024	Hockey Stick	Shop
1	20	20	Steel	Made	N/A	N/A	Evan	2 week	3/1/2024	1020	Shop
4	5	20	Aluminum	Made	N/A	N/A	Evan	1 day	3/1/2024	6061	Shop
6	2	12	Aluminum	Made	N/A	N/A	Evan	1 day	3/1/2024	6061	Shop

4.2 Rear End

The manufacturing plan for the rear end team can be seen in Table 7. This outlines the plan moving forward in the semester once all hardware and materials have been sourced. The team plans to estimate costs for all raw material prior to the start of the manufacturing to ensure cost stays within budget with recent design changes. Since each part will be manufactured in-house, part production will begin at the start of the semester to ensure all parts are produced by mid-February. With this plan, we as well as the other sub teams will have all parts produced to begin testing by mid-March.

Table 7: Rear End Manufacturing Plan

Part Name	Quantity	Cost	Total Cost	Material	Purchase/Made	Vender	Vender Part Number	Who Manufactures	Manufacture Time	Manufacture Deadline	Raw Material	Manufacture Location
Trailing Link	2	134.34	268.67	1/8" 4130 Steel Plate	Made	OnlineMetals	9668	Lars	3 weeks	2/13/2024	4130	Workshop
Trailing Link Rod End Insert	2	N/A	N/A	A36 Steel	Made	NAU SAE Baja	N/A	Lars	2 days	2/13/2024	A36	Workshop
Shock Spacer	8	N/A	N/A	A36 Steel	Made	NAU SAE Baja	N/A	Lars	1 day	2/13/2024	A36	Workshop
Wheel Hub	2	N/A	N/A	6061-T6 Aluminum	Made	NAU SAE Baja	N/A	Seth	2 days	2/13/2024	6061-T6	Workshop
Wheel Hub Spacer	2	N/A	N/A	6061-T6 Aluminum	Made	NAU SAE Baja	N/A	Seth	1 day	2/13/2024	6061-T6	Workshop
Knuckle	2	N/A	N/A	A36 Steel	Made	NAU SAE Baja	N/A	Joey	1 week	2/13/2024	A36	Workshop
Carbon Fiber Camber Link Insert	4	N/A	N/A	6061-T6 Aluminum	Made	NAU SAE Baja	N/A	Joey	1 day	2/13/2024	6061-T6	Workshop
Steel Camber Link Insert	4	N/A	N/A	A36 Steel	Made	NAU SAE Baja	N/A	Joey	1 day	2/13/2024	A36	Workshop
Steel Camber Link	2	N/A	N/A	1" 4130 Steel Pipe	Made	NAU SAE Baja	N/A	Seth	1 day	2/13/2024	4130	Workshop

4.3 Drivetrain

The manufacturing plan for the drivetrain team is listed in Table 8. The outline depicts that a majority of parts will be manufactured in house. The team plans on sending all machined gears and shafts to be heat treated and so it important to manufacture these items first because of the heat treatment lead time and to reach the testing deadline in March. For both front and rear gearbox housings, the team plans on manufacturing it in late January to early February so that all gears and shafts can be test fitted.

Table 8: Drive Manufacturing Plan

Quantity	Cost	Total Cost	Material	Purchase/Made	Vender	Vender Part Number	Manufacturer	Lead Time	Purchase By
4	7.55	30.2	Steel	Purchase	McMaster-Carr	60355K178	Same As Vendor	3 Weeks	12/14/2023
3	79.81	239.43	Steel	Purchase	McMaster-Carr	6656K151	Same As Vendor	3 Weeks	12/14/2023
2	N/A	N/A	Steel	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
2	N/A	N/A	Aluminum	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
1	50	50	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	100	100	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	75	75	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	75	75	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
2	100	200	Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	50	50	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	50	50	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
3	38.75	116.25	Fluoro Rubber	Purchase	Motion Industries	85311155601	Same As Vendor	3 Weeks	12/14/2023
1	22.48	22.48	Nitrile Rubber	Purchase	Motion Industries	85311030847	Same As Vendor	3 Weeks	12/14/2023
3	12.82	38.46	Nitrile Rubber	Purchase	Motion Industries	85311005562	Same As Vendor	3 Weeks	12/14/2023
8	N/A	N/A	Aluminum	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
2	N/A	N/A	Aluminum	Own	NAU SAE Baja	N/A	Same As Vendor	N/A	N/A
3	8.99	26.97	Steel	Purchase	McMaster-Carr	60355K185	Same As Vendor	3 Weeks	12/14/2023
1	128.92	128.92	Steel	Purchase	McMaster-Carr	6656K245	Same As Vendor	3 Weeks	12/14/2023
1	35	35	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	40	40	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	15	15	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	15	15	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	50	50	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	400	400	4340 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	125	125	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	125	125	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	59	59	4140 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	59	59	4140 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	10.92	10.92	4140 Steel	Made	Metal Supermarkets Phoenix	N/A	Henry	5 Weeks	N/A
1	25.24	25.24	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	75	75	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	21.49	21.49	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	8.21	8.21	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	19.67	19.67	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	19.67	19.67	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	19.67	19.67	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	5.35	5.35	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
11	52.25	574.75	Aluminum	Made	N/A	N/A	Henry	5 Weeks	N/A
2	10.65	21.3	Aluminum	Purchase	McMaster-Carr	60355K733	Same As Vendor	3 Weeks	12/14/2023
11	0.78	8.57	Aluminum	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	78.74	78.74	Steel, etc.	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	34	34	Steel	Purchase	McMaster-Carr	N/A	Same As Vendor	3 Weeks	12/14/2023
2	2	4	Copper	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	76	76	Rubber	Purchase	Bolton	3280-8M-20 Optibelt OMEGA HTD Timing Belt	Same As Vendor	3 Weeks	12/14/2023
1	6	6	Rubber	Purchase	Beidlers Belts	160xl037	Same As Vendor	3 Weeks	12/14/2023
1	50	50	Rubber	Purchase	Xcaliber Motorsports	21g3353	Same As Vendor	3 Weeks	12/14/2023
8	4	32	Steel	Purchase	Amazon	CF4 cam follower	Same As Vendor	3 Weeks	12/14/2023
3	6.56	19.68	Bronze	Purchase	McMaster-Carr	6391K768	Same As Vendor	3 Weeks	12/14/2023
1	48.72	48.72	Steel	Purchase	McMaster-Carr	60715K111	Same As Vendor	3 Weeks	12/14/2023
1	63.69	63.69	Steel	Purchase	McMaster-Carr	6656K236	Same As Vendor	3 Weeks	12/14/2023
1	7.72	7.72	Steel	Purchase	McMaster-Carr	60355K336	Same As Vendor	3 Weeks	12/14/2023
1	12.62	12.62	Steel	Purchase	McMaster-Carr	60355K983	Same As Vendor	3 Weeks	12/14/2023
1	39.91	39.91	Cast Iron	Purchase	McMaster-Carr	97014A595	Same As Vendor	3 Weeks	12/14/2023
1	33.52	33.52	Steel	Purchase	McMaster-Carr	95080A103	Same As Vendor	3 Weeks	12/14/2023
1	5	5	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	13	13	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
2	0.25	0.5	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	500	500	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	300	300	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	80	80	N/A	Purchase	N/A	N/A	Same As Vendor	3 Weeks	12/14/2023
1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	N/A	N/A	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
2	15	30	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
2	7	14	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
2	7	14	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
2	20	40	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	20	20	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	20	20	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	40	40	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	10	10	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	50	50	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	25	25	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	10	10	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	15	15	Bronze	Purchase	McMaster-Carr	N/A	Same As Vendor	3 Weeks	12/14/2023
1	10	10	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
3	2	6	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	45	45	Aluminum	Made	Ryan Kedrowskis aluminum vendor	N/A	Henry	5 Weeks	N/A
1	900	900	N/A	Purchase	Kholer	N/A	Same As Vendor	3 Weeks	12/14/2023
	Overall Total	$5,589.65							

4.4 Frame

Regarding the frame, the main manufacturing focus is the frame. Fitting the processed primary members and coping and mitering the secondary members will enable the team to weld the frame in a timely manner. Most materials are provided by sponsors and will be acquired by early February. Having a welded and functioning frame by the end of January allows the other sub teams to integrate their components earlier and fine tune the vehicle.

Table 9: Frame Manufacturing Plan

Part	Description	Vender	Vender Part Numbe	nufacturer/V	Qty	Units	Make/Buy	Part Status	Material	Lead Tim	ase/Manufa	Unit Cos	Cost	Obtain
Primary Members	4130 1.25x.065" tubing	IMS		IMS	45	ft	Buy	Being Manufactured	Steel	0	11/1/2023	0.00	0.00	Y
Secondary Members	4130 1x.035"tubing	BFS		BFS	45	ft	Buy	Awaiting Part	Steel	5 Days	12/11/2023	8.00	360.00	Y
Tabs	4130 0.1"sheet	VROOM Engineering		VROOM Engine	100	in^2	Make	Awaiting Part	Steel	1 Week	1/29/2024	0.28	27.78	N
Side Panneling	Carbon Weave	Novakinetics		Novakinetics	20	ft^2	Make	Design	Carbon Fiber	1 Week	2/5/2024	0.00	0.00	N
Seat	Carbon Weave	Novakinetics		Novakinetics	4	ft^2	Make	Design	Carbon Fiber	1 Week	1/29/2024	0.00	0.00	N
Epoxy	Carbon resin epoxy	Novakinetics		Novakinetics	1	gallon	Buy	In House	Resin	0	N/A	0.00	0.00	N
Harness	Standardized	RaceQuip		RaceQuip	1	unit	Buy	In House	Nylon/Fabric	0	N/A	0.00	0.00	Y
Submarine Straps	Standardized	TBD		TBD	2	unit	Buy	In House	Nylon/Fabric	0	N/A	0.00	0.00	y
Fire Extinguisher	5BC Standard	TBD		TBD	1	unit	Buy	In House	N/A	0	N/A	0.00	0.00	Y
Extinguisher Mount Bracket	Drake FIREX-MNT-DAG	Scott Drake	842110165558	Scott Drake	1	unit	Buy	In House	Aluminum	0	N/A	0.00	0.00	Y
Fuel Tank Mounting Washers	McMaster Carr 94733A723	McMaster	94733A723	McMaster	8	50	Buy	To Be Ordered	Rubber	1 Week	2/5/2024	0.00	0.00	Y
Mounting Hardware	Misc. nuts, bolts, washers needed	TMS Titanium		TMS Titanium	1	unit	Buy	To Be Ordered	Titanium	1 Week	2/5/2024	0.00	0.00	N
Skid Plate	.06"HDPE	TBD		TBD	6	ft^2	Make	To Be Manufactured	HDPE	2 Week	2/12/2024	5.00	30.00	N
Firewall	.02" sheet metal	TBD		TBD	9.5	ft^2	Make	To Be Manufactured	Steel	1 Week	2/13/2024	7.75	73.63	N
												Total Cost	491.40	

5 Competition Deliverables

The SAE Baja organization requires each team to complete a “Design Review Breifing” that is essentially a final report in the format of a PowerPoint. This deliverable is due on the 25th of March which should roughly coincide with the due date of the final capstone report. The team would like to propose that the Design Review Briefing that is prepared for the SAE Baja board of judges substitute the formal final report requirement for ME486C.

6 Conclusion

Upon completion of this memo, the 2023-2024 SAE Baja capstone team has a solid foundational understating of the tasks that must be considered and manufacturing challenges that must be handled to be successful. With this information in mind, the team will enter the spring semester with directed initiative and work hard to assemble the full vehicle by mid-March, allowing for thorough testing before the SAE Baja competition in Gorman, CA.