To: Dr. David Trevas

From: Kaleb Brunmeier, Tye Jorgensen, Jacob Najmy, Riley Karg, Jacob Kelley, Will Preston, Jesse Summers, Jacob Grudynski, Michael Edirmannasinghe, Jacob Ruiz, Aaron King, Lucas Cramer

Date: 02/28/20

Subject: Implementation Memo

The SAE Baja capstone project tasks students with building a single person, off-road vehicle. During a collegiate competition, the buggy will be put through a series of inspection and driving tests. Last semester, the team broke down into four different sub-teams consisting of a frame team, drivetrain team, front end team, and rear end team. This memo will detail the manufacturing processes used by the whole team, design changes that have occurred within each respective sub-team, and a breakdown of the remaining manufacturing timeline.

1 Implementation

For the NAU Baja team, the first semester of capstone could be summarized as the design phase, while the second semester is the manufacturing phase. The design phase of this project was quite extensive as the project was split into four different sub-teams to design the components of the buggy. Detailed in this section are the design changes seen by each sub-team. Additionally, manufacturing processes used by the entire team are listed and discussed in more detail.

1.1 Manufacturing

The manufacturing processes used to build the NAU Baja vehicle can be seen listed here. This list details processes used by the entire team.

- Manual Mill (NAU Machine Shop/ K&M Machine Tool Inc)
- Manual Lathe (NAU Machine Shop/ K&M Machine Tool Inc)
- Rotary Tube and Pipe Bending
- Tube Coping
- Threading
- Grinding (Angle Grinder, Grinding Wheel, Sanding Wheel)
- Cut-Off Saw, Horizontal Band Saw
- TIG/MIG/Stick Welding
- Plasma Cutter (Tye’s Friend’s Company, NAU Art Studio)
- Wire EDM (AZ Wire Specialists)
- Heat Treatment (Phoenix Heat Treating Inc)
- CNC Mill (NAU Fab shop)
- Hack Saw (NAU Fab Shop)
- Hydraulic press fit bearings
- Drilling
- Boring

One of the primary tools/processes being used for the whole team are the mills and lathes. These manufacturing methods have been critical in creating many different brackets, mounting hardware, and drivetrain components. Similarly, tube bending and tube coping have been used extensively throughout the vehicle. The frame itself was pre-bent but all other steel tube components have been bent and coped by the Baja team. Welding has also been a critical manufacturing process for the team, as the entire frame and all other components are welded in-house at the NAU Machine Shop. While most of the manufacturing is being completed by the NAU Baja team, some processes had to be outsourced. The Wire EDM process needed to manufacture the gears was outsourced to AZ Wire Specialists. Additionally, the heat treatment of the gears was also outsourced to Phoenix Heat Treating, Inc.

1.2 Design Changes

1.2.1 Drivetrain Design Changes

1.2.1.1 Design Iteration 1: Change in Rear Differential Output Flange

The original design of the rear differential output flange consisted of 6 different mounting holes, a female splined insert that protrudes 0.75" off the flange, and a little over 0.5" face width for the mounting tabs. This design was made specifically for a Yamaha Rhino 700, which its engine produces about 40 hp compared to the 10 hp motor that the NAU Baja Team uses. The photo shown in the figure below depicts the output flange before any modifications were made:

Figure 1. Rear Differential Output Flange (unmodified)

The driveshaft boss pictured above is made of a hardened steel and is much stronger than what is needed for the 10hp motor in the buggy. Therefore, we cut off three out of the six mounting tabs, leaving three mounting tabs in a triangular pattern. We also cut off the female splined insert and surfaced the entire flange down to 0.30". The modified part as described above is shown in the figure below:

Figure 2. Modified Rear Differential Output Flange

These modifications that were made not only reduce the amount of weight of the part, but also helps with spatial constraints between the gear reducer and the rear differential. To ensure that this modified part is sufficient of strength, the team benchmarked the modified output flange against the flanges that were used on last year's number 44 buggy. Last year's flanges were only 0.25" thick and consisted of 1018 CD steel with 3 bolt holes, therefore, the modified flange is strong enough. A triangular flange with an identical bolt pattern was then cut out and will be used to bolt directly from the gear reducer to the differential. The 2D drawing of the opposing flange is shown below for reference:

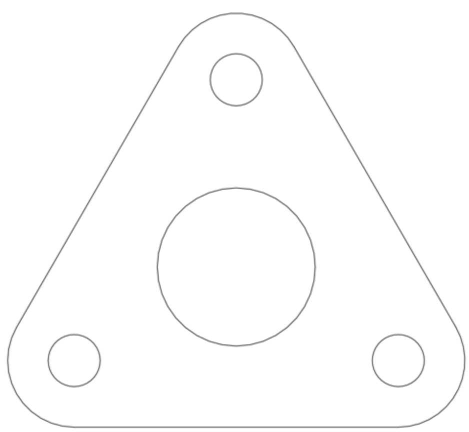

Figure 3. Gear Reducer to Rear Differential Flange

1.2.2 Frame Design Changes

1.2.2.1 Design Iteration 1: Change in Frame Iterations discussion

The frame saw numerous and frequent iterations in its design, approximately 30 iterations in the frame's design was made from the start of the project to its current state. The frame design started in appearance very close to #44 (last year's Baja), but as the project continued the frame needed constant adjustments to fix missed errors and to accommodate the challenge of implementing a 4WD system. The resulting frame geometry transformed from V1.0 to the current physical frame V3.1. The frame additionally needed slight modifications in the bend radii of the geometry to match the fabrication capabilities of the outsourcing facility. The figures below show the drastic difference between the first and last iterations of the frame.

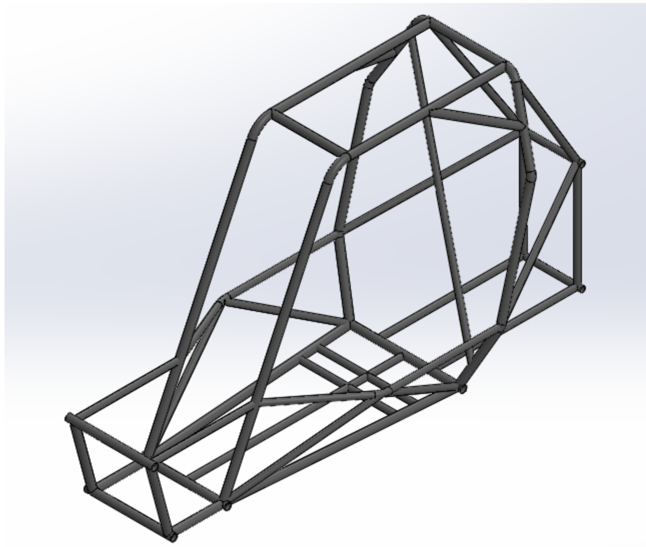

Figure 4. Frame Iteration V1.1

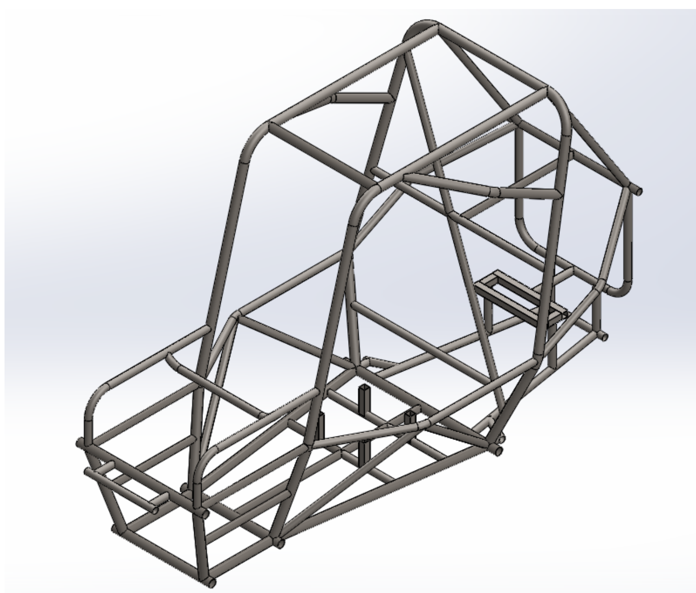

Figure 5. Frame Iteration V3.0

Figure 6. Physical Fabricated Frame in Current State (V3.1)

The physical frame and now updated CAD model are now referred to as V3.1. A mistake in placement when welding the frame members of V3.0 together caused the mounting points for the base of the roll hoop to be a 1.25” wider than initially intended. This caused some moderate issues later in fabrication of the frame.

Front End Design Changes

1.2.2.2 Design Iteration 1: Change in Brake Rotor discussion

The original brake rotors intended for use on car #31 utilized a cross-drilled design and measured to be 1/8” thick, with a 7” OD and 4.5” ID. This was done to accommodate the entire area of the pad and avoid use of excess material to save weight. However, the inner diameter was later decreased by 1/8” to ensure safe contact with the rotor surface and pad. In addition, the front hubs featured extended rotor mounting studs that must be shaved and cut to allow for ample spacing between the steering knuckle and hub. The Pitch Circle Diameter (PCD) of the original rotor design was also required to be changed to match that of the front hub. This required the inner radius of the rotor to be enlarged to 4.75” because the holes extended into the rotor contact surface in the SolidWorks model. This subsequently required the OD of the brake rotor to be enlarged to 7.5” to allow for ample area for the brake pad to contact and provide clearance for M8 x 1.25 button head hex bolts. With this change implemented, a rotor measuring 7.1875” OD from car #44 and a Wilwood GP200 caliper were placed inside a 10” wheel to verify caliper clearance. Angled slots were implemented alongside the cross-drilled holes to further reduce the unsprung weight of the vehicle. A larger outer and inner diameter will increase the effective rotor radius, which yields a higher braking torque. Figure 7 represents the original rotor configuration, and Figure 8 represents the current rotor design.

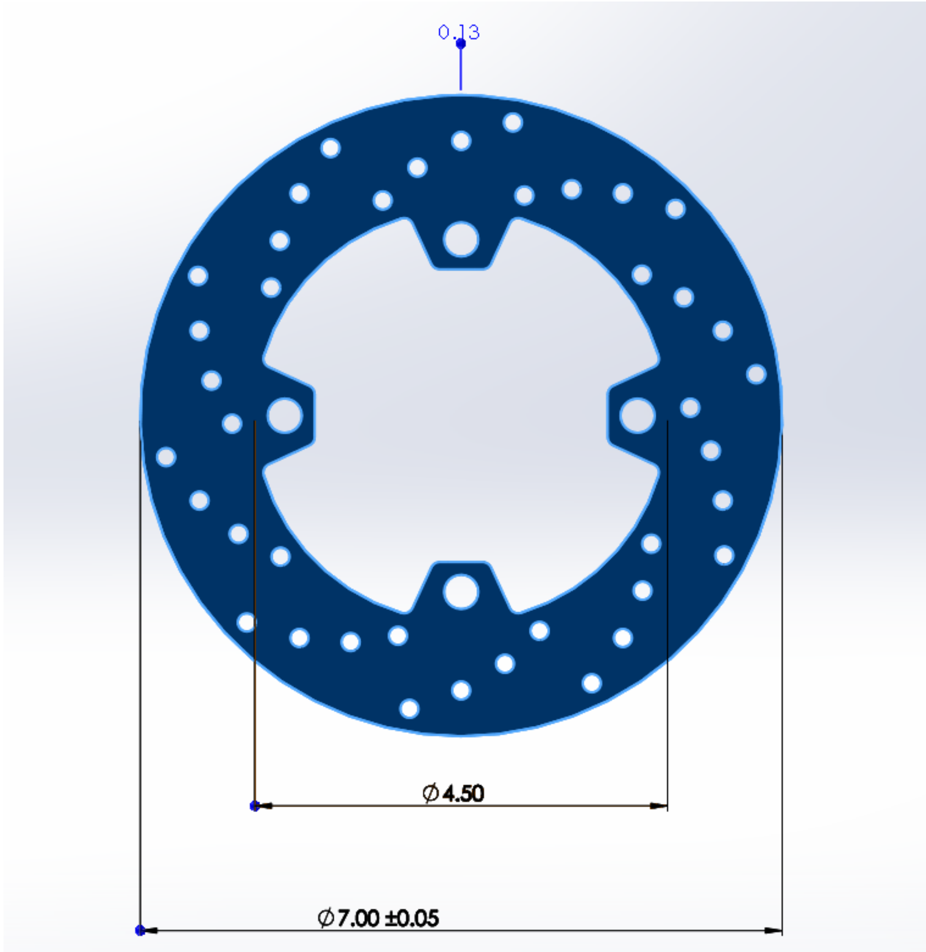

Figure 7. Initial front brake rotor design

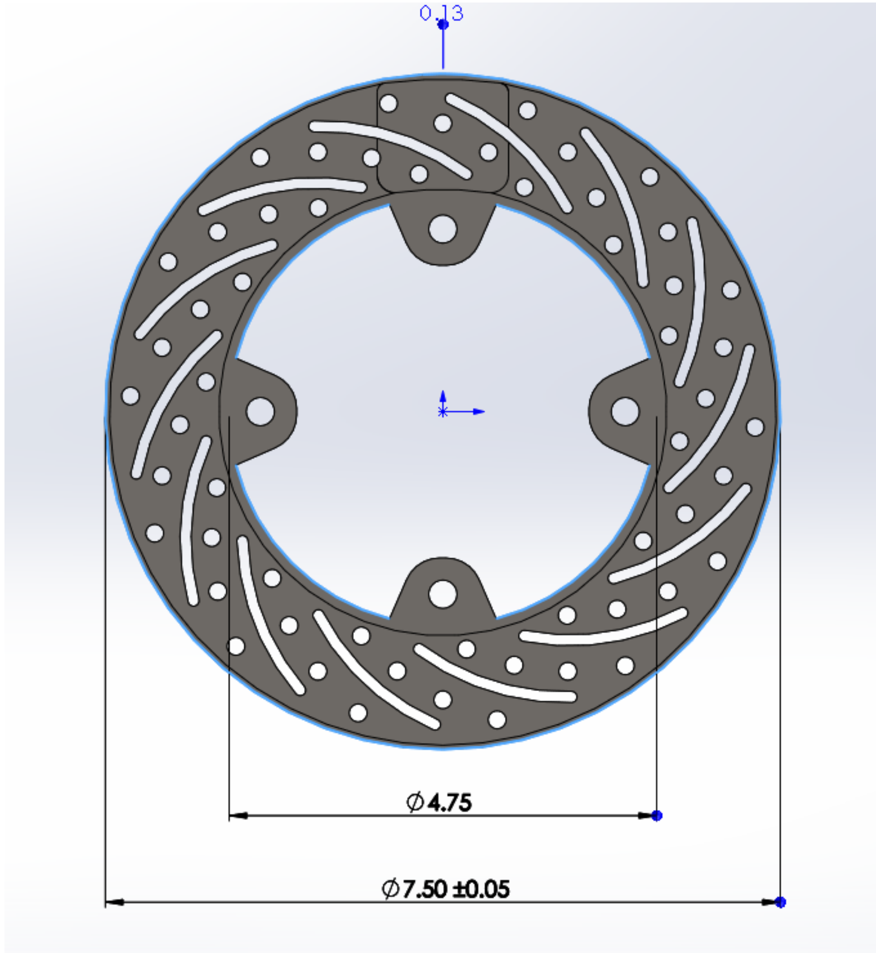

Figure 8. Current front brake rotor design

According to the Baja SAE competition rulebook, the rear brakes of the vehicle must be operated through the final drive of the drivetrain system. This means that the rear brakes must be placed in a location where there are no remaining gear reductions. In the beginning of the design phase, the rotor and caliper were to be mounted on the unmodified rear differential output flange displayed in Figure 9. This would provide braking through the driveshaft, which was later determined to violate the final drive requirement. Instead, the rear brake rotor will be mounted on the rear CV axle with small tabs welded to the collar of the axle. The brake caliper will utilize custom mounting brackets welded to the frame. Figure 9 represents the initial rear rotor design, while figure 10 displays the expected rear rotor and caliper position for car #31.

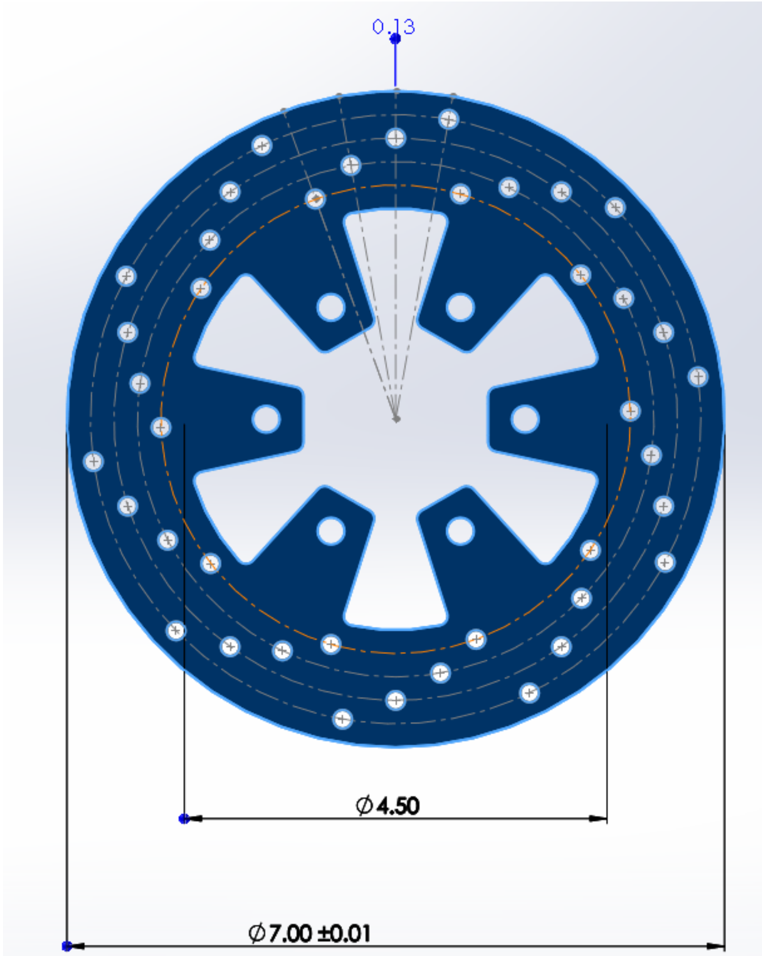

Figure 9. Rear differential mounted brake rotor

Figure 10. Expected rear brake setup and position

1.2.2.3 Design Iteration 2: Change in Steering Rack

The initial idea was to facilitate a small steering rack that could be used effectively with the 4WD set up of the SAE Baja vehicle. The rack anticipated indicated that the rack travel would be 3.5 in. Due to insufficient information, the rack was found to be unsuitable for a linear travel of 5in lock to lock and reasonable shaft diameter to support the pressure of the suspension and steering torque.

Figure 11. Initial steering rack

Following the reference dimensions of the above seen steering rack, it was determined that in order to accomplish the Ackermann angles without over steering taking place, a linear travel of 5in was needed. With this information, the decided to apply a 14-inch steering racking design for small off-road vehicles. This rack consists of a steering shaft of 5/8 in and a rack shaft diameter of 7/8 in which can support the stress exerted on the steering system. The 5/8 steel steering shaft supports the input torque and the rack shaft can handle the stress on steering the vehicle.

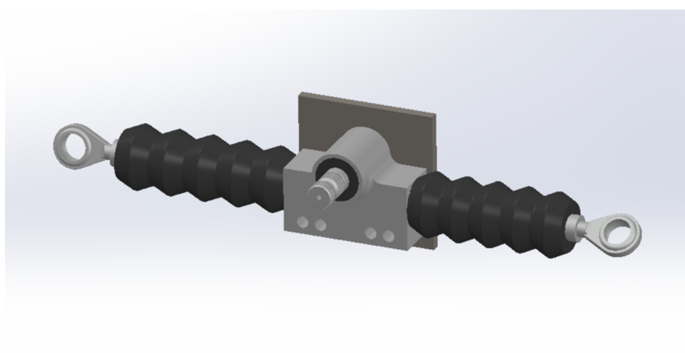

Figure 12. New and Final Steering Rack

The final steering rack is currently being mounted after testing procedures were done to assure the efficient functionality of the steering system. The mounting plate attached to the steering rack as shown in the figure above, is welded onto the cross member on the frame and centered to the middle of the nose.

Design Iteration 3: Control Arms

The initial design on the upper and lower control arms were meant to fix a 6” long tube bushing for the frame side of the arm to combat the torque on the arms. This made the mounting tabs on the frame wider and a much longer fastener would need to be acquired to reach through the bushing and mounting tabs. This design was altered for simplicity and functional purposes. The current design features a chassis tube insert of solid steel welded directly into the end of the tube arm on the frame side. This is then drilled and threaded to screw a heim joint into it. This made the frame mounting tabs closer together, leaving more room for the front differential to be fitted and a small amount of fluctuation in the arms to account for turning and hard landings. The rod end fitting design can be seen in Figure 10 below.

Figure 13. The rod end fitting design for the front end control arms

The second modification to the front control arms was the angle of the upper arms. The bend of the arms in the original design spaced the rod ends of the arms at the frame 6" apart. Due to newfound knowledge, the upper arms were bent at more of an angle so that the frame side spacing moved out to 8.75". This change was to strengthen the upper arms from breaking due to a frontal impact. The now wider arms have more of a resistance to bending and torsion from an impact. The new upper arm angle can also be viewed in Figure 13 above.

1.2.3 Rear End Design Changes

1.2.3.1 Design Iteration 1: Change in Lateral Link Connection discussion

The original trailing arm had four tabs welded to the back end of the trailing arm for the rear lateral links to connect to with bolts, nuts, and rod end heim joints. Creating these tabs was going to cause the team to purchase more flat aluminum plates and create CNC code to manufacture these tabs. The team therefore decided to make a change to the design in order to reduce the cost of the trailing arm and the manufacturing time needed to make the trailing arm. The new design is a one-inch diameter plug that will be welded into the ends of the trailing arm tubing. These plugs will be tapped with threads so the bolts can screw directly into the trailing arm without the use of nuts and the mounting tabs. The plugs require less time to manufacture and cost less than the mounting tabs did. In addition, this change reduced the total amount of parts in the rear trailing arm, reduced assembly time, and reduced the risk of failure. The mounting tabs before the change would have endured large amounts of stress along their welded joints, while the new plug design distributes the force along the entire plug and portions of the arm itself. This eliminates the chance of the connections breaking off the trailing arm. Overall, this design change will benefit the rear-end system.

Figure 14. Original Design

Figure 15. Weld Plugs on Prototype (Final Design)

After testing the protype with the new design implementations, the team is confident in the current design and concluded that no further changes were needed for the design.

2 Future Implementation

The remainder of the manufacturing plan has been outlined by sub-team's individual tasks. As soon as one team finishes their manufacturing process including the spares needed, that team will help any team still requiring help with their manufacturing process. If the schedule is followed as seen in the manufacturing burn list, the team fully anticipates finishing the Baja in a timely manner before the competition in April.

2.1 Further Manufacturing and Design

As was stated, the remainder of the manufacturing process is detailed by each sub-team’s individual tasks. A breakdown of these tasks for the Front and Rear End, and Frame and Drivetrain teams can be seen below in Figures 16 and 17, respectively.

Front			Rear	
will	manufacture brake pedal mount	DONE	jacob	Trailing arm tubing (x4)
jake	A arms	DONE	aaron	order rear heim plug material (1" x 2' 6061 AL)
jake	shock mounts	DONE	luke	Rear heim plugs (x8)
summers	order hubs	DONE	aaron	Tubing by firewall
	knuckles	DONE	aaron	order front ball joints bearing
summers	wheels	End 6	jacob	Front ball joint bearing (x4)
summers	tires	DONE	luke	Arm shock mount (x4)
michael	steering rack brackets	End 7	jacob	shock mount -frame (x2)
michael	find a steering rack	End 7	aaron	Trailing arm face plate (x8)
michael	tie rods figure it out	End 7	aaron	bearing carrier (x4)
will	caliper mounts, full brake system	End 7	aaron	press fit bearings (x4)
jake	steal 52 shocks	DONE	done	order CVs (x2)
will	manufacture rotors	End 8	aaron	CV extension/contraction (x2)
michael	linear travel clearance, column mour	End 8	luke	Machine down hubs (x2)
all	hardware	DONE	summers	order rims
all	Build something awesome	DONE	summers	order tires
		DONE	aaron	order lateral link material
		End 7	luke	manufacture lateral links
		DONE	luke	lateral link frame mounts (x4)
		DONE	luke	nuts and bolts
		DONE	done	order shocks or take shocks

Figure 16. Manufacturing Burn List

drive train				frame		
Week Due	Status	POC	Event	In progress	jacob	finish welding frame
	In progress	tye	Fabricate TC	6	jacob	aquire/build all tabs for miscelaneous stu
	in progress	kaleb	CV Axle Fitment	In progress	riley	fire wall
	In progress	Kaleb	Front diff mounted	DONE	jacob	body pannels
				In progress	riley	seat and mounts
7	In progress	Najmy	ECVT Computer mounting location and bracket	8	riley	driveshaft guard and mounts
7	Not Started	Najmy	ECVT Testing	8	kaleb	drivetrain guards
7	Not Started	Najmy	3D print encoder mounts	eh	riley	car numbers
7	Not Started	Najmy	3D print limit switch mounts	6	mixed	all the avocados
7	Not Started	Najmy	3D print Battery Cases	9	najmy	kill switches
7		Kaleb	ECVT Hall effect sensor brackets	In progress	riley	floor pan
7		Tye	TC Shafts	10	jacob	paint
7		Tye	ECVT Pulleys	7	done	seat belts
7		Tye	ECVT Shaft	7	jacob	foot pan/diff cover
7		Tye	ECVT final weld together	10	ruiz	sponsor stickers
7		Tye	ECVT Bearing Housing built and bearing pressed	9	riley	gas tank splash guard
7		Tye	Ball screw modification	as needed	riley	mounting hardware for everything
7		Tye	ECVT Hardware Done	5	riley	gear case protection
7		Riley	Driveshaft	DONE	jacob	fire extinguisher
8	Not Started	Najmy	Sprocket welded to shaft collar	OVER DUE	Riley	Sleeve and Slot Engine Mounts
8		Kaleb	ECVT guards	always	yes	be cool
8		Kaleb	Bearing Block Mounts - Driveshaft, CV Fitment			
9	Not Started	Najmy	ECVT Wiring harness			
9	in progress	arduino boys	ECVT wrap up coding			
9		Tye	TC Mounts			
4	OVER DUE	Tye	Steering wheel print and wire			
4	OVER DUE	Najmy	order new sprockets			
5	OVER DUE	Najmy	Finish ECVT Wiring Harness (Just on actual ECVT)			
	DONE	Tye	Rear diff mounted			
	DONE	kaleb	Dzus Tabs			
	DONE	riley	Engine Mounts			
	DONE	Michael	Print encoder Mount			
	DONE	Najmy	Finish Non-ECVT Code			
	DONE	Najmy	Finish Battery Build			
	DONE	Michael	Limit Switch Covers			
	DONE	Najmy	Start ECVT Computer 2.0 Build			
	DONE	Kaleb	Mount Side Nose members			
	DONE	Kaleb	GCode Brake Mount			
	DONE	Kaleb	Order RE bearings			
	DONE	Kaleb	gear material sent out			
	DONE	Kaleb	order FE Uniballs			
	DONE	kaleb	Finish ECVT Brackets			
	DONE	najmy	ECVT Main Assembly manufacture			
	DONE	najmy	ECVT computer final build			
	DONE	kaleb	Gear fabrication/heat treat - need order			
	DONE	kaleb	TC Bearings - need order			

Figure 17. Manufacturing Burn List

As can be seen from the figures above, many tasks have already been completed. As for the remaining tasks, most of these are on schedule to be completed by the given week in the figure. One area where the team is behind on progress is with the ECVT coding and construction. However, with some collaboration, this area of the project will be able to be caught up.

2.2 Schedule Breakdown

At this point in the semester, the team is overall on track to finish the buggy before competition. On a sub-team basis, however, some teams are slightly behind schedule in some areas. The Rear and Front end teams are still on schedule and should be finishing up their respective systems within the next week. As was discussed in the previous section, the Drivetrain team is slightly behind schedule due to issues met when the gears were initially trying to be manufactured. These issues have now been solved and this portion of the project is getting back on track with schedule. Furthermore, the team is now in the last stages of the build process and should be nearing completion of the build in the time frame set out by the team.

2.3 Budget breakdown

In regards to budget, the team is doing well. With our current donations and fundraising up to this point, the team had a total budget of $11,030.89. Of this budget, the team has an estimated total cost of $10,181.50. With this estimated total cost, the team is left with a surplus of $849.39. This is very beneficial for the team as this allows for any unexpected costs that may occur before the completion of the buggy. Individual breakdowns of each sub-team's BOM can be found below in Figures 19-22. Additionally, the only costs left for the team to worry about are travel costs for the competition. The team may have to host more fundraising events in order to fund those costs upfront.

Team	Cost
DR-FR (CtD)	$4,155.72
FE-RE (CtD)	$3,137.09
Total (CtD)	$ 7,292.81
Total Cost	$ 7,292.81
Current Budget	$ 11,030.89
Working Budget	$ 3,738.08
Total Est. Cost	$10,181.50
Current Deficit	$ 849.39

Team Income	
Description	Amount
Gore (Capstone)	$ 6,000.00
GoFundMe	$ 3,042.33
Registration	$(1,350.00)
Panda Express	$ 93.56
Family Donations	$ 3,000.00
Cafe Rio	$ 75.00
Chipotle	$ -
Drive Day	$ 170.00
Total	$11,030.89

Figure 18. Total budget breakdown

FRAME						
Part #	Part Name	Qty	Vendor	Estimated Unit Cost	Estimated Total Cost	Links
FR.1	Frame Material/Fabrication	0	VR3 Engineering	$ 2,000.00	$ 2,000.00	VR3 Engineering
FR.2	4310 Steel Tubing 1.25"x0.065"x56ft	1	Advanced Metals Sales	$ -	$ 660.00	N/A
FR.3	4310 Steel Tubing 1.00"x0.058"x30ft	1	Advanced Metals Sales	$ -	$ 300.00	N/A
FR.4	4310 Steel Tubing 1.00"x0.035"x40ft	1	Advanced Metals Sales	$ -	$ 416.00	N/A
FR.5	4310 Steel Square Tubing 1.00"x0.035"x10ft	1	Advanced Metals Sales	$ -	$ 128.00	N/A
FR.6	4310 Steel Plate 0.125" 3ft^2	1	Advanced Metals Sales	$ 75.00	$ 75.00	N/A
FR.7	4310 Steel Plate 0.250" 2ft^2	1	Advanced Metals Sales	$ 125.00	$ 125.00	N/A
FR.8	Dzus Fasteners	100	Southwest Fasteners	$ 87.00	$ 87.00	
FR.9	Carbon Fiber Panels	N/A	Vroom	$ -	$ -	
FR.10	Carbon Fiber Seat	1	Novakinetics	$ -	$ -	
FR.11	Brake Lights	1	Walmart	$ 36.18	$ -	Brake Light
FR.12	5-point Harness	1	Summit Racing			Safety Harness
FR.13	Steering Wheel Material (Ultem)	1	Inventor Lab	$ -	$ -	N/A
FR.14	Transponder Subscription	1	MyLaps	$ 173.99	$ 173.99	MyLaps X2-MX Transponder
FRAME TOTAL:					$ 3,964.99	

Figure 19. Frame BOM

DRIVETRAIN						
Part #	Part Name	Qty	Vendor	Estimated Unit Cost	Estimated Total Cost	Links
DT.1	B&S 10 HP Vanguard Engine	1	Briggs & Stratton	$ 546.30	$ 546.30	Briggs & Stratton
DT.2	Fuel Tank	1	Pyrotect	$ 225.00	$ 225.00	Fuel Tank
DT.3	Fuel Line	1	Napa Auto	$ -	$ -	1.5 ft of Fuel Line
DT.4	Kill Switches	2	Parker SportsCenter	$ 52.00	$ 52.00	Ski-Doo
DT.5	Gaged Secondary CVT Pulley	1	Gaged Engineering	$ -	$ -	Gaged CVT Specifications
DT.6	3/4" Ball Bearing	2	SKF	$ -	$ -	3/4" Bearing
DT.7	1" Ball Bearing	2	SKF	$ -	$ -	1" Bearing
DT.8	3/4" Bearing Seal	1	SKF	$ -	$ -	3/4" Bearing Seal
DT.9	1" Bearing Seal	2	SKF	$ -	$ -	1" Bearing Seal
DT.10	6061 Aluminum Flat Stock	1	Speedy Metals	$ 322.06	$ 322.06	Aluminum Stock
DT.11	1" 8620 Steel Plate	1	Speedy Metals	$ 125.91	$ 125.91	Steel Stock
DT.12	48 Tooth Gear Fabrication	2	PING	$ -	$ -	Not Applicable
DT.13	24 Tooth Gear Fabrication	2	PING	$ -	$ -	Not Applicable
DT.14	5/8 Hollow Steel Tube	1	SpeedyMetals	$ 27.36	$ 27.36	5/8 OD Steel Tube
DT.15	Safety Covers	2	SpeedyMetals	$ 54.32	$ 54.32	1/8 in. Aluminum Sheets
DT.16	Misc. Hardware	0	Copper State	$ -	$ 150.00	Copper State Bolt & Nut
DT.17	ECVT Components	0	N/A	$ 513.66	$ 567.96	
DT.18	Rear Differential	1	maXpeedingrods	$ 240.00	$ 240.00	
DT.19	Front Differential	1	maXpeedingrods	$ 266.00	$ 266.00	
DT.20	Contingency Fund	0	Any	$ -	$ 300.00	N/A
DRIVETRAIN TOTAL:					$2,876.91	

Figure 20. Drivetrain BOM

Front End						
Part #	Part Name	Qty	Description	Estimated Unit Cost	Estimated Total Cost	Links
1	A- Arms	4	Material	$ 50.00	$ 200.00	1" Tubing
2	Hubs	2	Yamaha Grizzly 350	$ 102.00	$ 204.00	Hubs
3	Left Knuckle	1	Yamaha Gizzly 350 Left Knuckle	$ 61.95	$ 61.95	Left Knuckle
3	Right Knuckle	1	Yamaha Grizzly 350 Right Knuckle	$ 164.00	$ 328.00	Right Knuckle
4	Shocks	2	King Shocks UTV Performance Series Coilover Shocks	$ -	$ -	King 20001-111 Coilovers
5	Wheels	2	Remington UTV Buckshot	$ 78.97	$ 157.94	Remington UTV Buckshot
6	Brake Rotors	2	Fabricated in campus shop	$ 20.00	$ 40.00	Manufactured in house
7	Brake lines	2	Honda TRX250R & ATC250R	$ -	$ -	Brake Lines
8	Brake Caliper	3	Wilwood 120-12178 Black 2 Piston Gp200 Brake Caliper	$ 69.99	$ 209.97	Wilwood Brake Calipers
9	Brake Fluid	2	DOT 3 Fluid	$ 2.99	$ 5.98	Brake Fluid
10	Master Cylinder	2	Wilwood Aluminum Master Cylinder .625" Bore	$ 58.10	$ 116.20	Wilwood Master Cylinder
11	Brake pedal	1	WILWOOD BRAKE PEDAL SWING MOUNT DUAL M/C FRONT MOUNT	$ -	$ -	Wilwood Brake Pedal
12	Brake pad (Set of 2)	2	Wilwood Purple Compound Brake Pads Calipers: GP200	$ 44.39	$ 88.78	Brake Pads
13	Steering rack and pinion	1	Polaris RZR XP 1000 RackBoss Heavy Duty Rack And Pinion	$ 299.95	$ 299.95	Polaris Steering Rack
14	Steering Column	1	PSC XR Series Intermediate Steering Columns CL01AH	$ 220.00	$ 220.00	PSC XR Steering Column
15	Tie Rods	2	Empi Ball Joint Tie Rod, Left, Dune Buggy Baja Bug	$ 34.95	$ 69.90	Tie Rod
16	Ball joints	4	BALL JOINT 1	$ -	$ -	Ball joints
17	Nuts & Bolts	20	Miscellaneous Hardware	$ -	$ -	Copper State Nut and Bolt
18	Tires (Set of 2)	1	SUNF 22x7-10 ATV Tires 22x7x10 at Race Tubeless 6 PR A027 Set of 2	$ 96.98	$ 96.98	Rubber Tires
19	CV Axle	2	Polaris RZR 800 S Axles - ADR Brand	$ 74.95	$ 149.90	CV Axles
Total Cost Estimate:				$ 1,379.22	$ 2,249.55	

Figure 21. Front End BOM

Rear End						
Part #	Part Name	Qty	Description	Cost	Total Cost	Link to Cost estimate
6960T6	Ball Joint Rod Ends	6	Super-Swivel Ball Joint Rod Ends	$ 10.68	$ 64.08	Heim Joints (Large)
1388K452	Tube Mounting tabs	1	Steel Sheet	$ 47.53	$ 47.53	1/8" Flat Stock
6547K37	Mounting Tabs	1	Steel Bar Stock	$ 57.94	$ 57.94	1.5" Square Stock
5KM-25311-10-00	Rear Hub	2	2010 Yamaha 350 Grizzly IRS hub	$ 68.25	$ 136.50	Yamaha Hubs
89955K646	Trailing arm Tubing	4	Steel Tubing	$ 36.46	$ 145.84	1" Chromoly Tubing
89955K629	Rear Links	2	Steel Rod	$ 44.06	$ 88.12	3/4" Tubing
20001-118A	Rear Shocks	2	King Shocks UTV Performance Series Coilover Shocks	$ -	$ -	King 20001-111 Coilovers
60645K14	Rod Ends	6	3/8" Ball Joint Rod Ends	$ 4.07	$ 24.42	Heim Joints (Small)
DAC30550032-2RS	Bearings	2	Bearings	$ 27.77	$ 55.54	Hub Bearing
YFM450FGW	CV Axle	2	Cv axle	$ 69.99	$ 139.98	Grizzly 350 CV Axle
D12R511	Rims	2	Connect hub to tire	$ 42.63	$ 85.26	Wheel
SunF A041	Tires	2	Tires	$ 64.99	$ 129.98	SunF Tires
NA	Nuts and Bolts	0	Nuts and bolts for connecting members	$ -	$ -	Copper State Nut and Bolt
YPB12T	Ball Bearing	2	For misalignment at the joint	$ 23.88	$ 47.76	Misalignment Bearings
YPB7T	Ball Bearing	4	For shock misalignment	$ 16.78	$ 67.10	
Total Cost Estimate:					$ 1,090.05	

Figure 22. Rear End BOM