MINI BAJA MEMORANDUM

to:	**Dr. John tester**
from:	**Drivetrain design team**
subject:	**Final report**
date:	**May 2, 2014**
cc:	**n/a**

The following memorandum pertains to the final design, the prototype and testing of the drivetrain and drivetrain components of the Mini Baja that performed in El Paso, April 24th through the 27th.

The final drivetrain design consisted of a continuously variable transmission (CVT) paired with a locking differential complete with forward, neutral and reverse. These two main components were ordered specifically to meet our design requirements. Thus the diameters of the CVT and differential were pre-designed to be cohesive within our system.

Within this main system there are six main subsections of the overall system: a gas catch system, CVT cover, shifting system, throttle system, engine mounts and half shaft were all fabricated to support the main system. Each have secondary analysis to support the theory of their design with the exception of the half shafts. These were precisely milled to fit our specifications and therefore did not require analysis on a secondary level.

The attached report will examine the drivetrain components in more detail and all analysis that contributed to the final design of drivetrain.

Respectfully,

Team 2

SAE Mini Baja Drivetrain

By:

Abdulrahman Almuflih, Andrew Perryman,

Caizhi Ming, Zan Zhu, Ruoheng Pan

Team 02

Final Report

Submitted towards partial fulfillment of the requirements for

Mechanical Engineering Design II – spring 2014

Department of Mechanical Engineering

Northern Arizona University

Flagstaff, AZ 86011

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Nomenclature

- Wheel diameter(D)
- Total weight (W)
- Slope of the hill (∂)
- Efficiency of CVT(N_{cvt})
- CVT High speed ratio (r_{cvt-h})
- CVT Low speed ratio (r_{cvt-l})
- Differential Forward ratio (r_{d-f})
- Differential Reverse ratio (r_{d-r})
- Engine rotation per minute (rpm)

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Abstract

SAE Baja competition is a international competition in which student teams from many universities compete in a series of events designed to test the Baja vehicle to its limits. Student teams must engineer and build a single seat off-road vehicle. It must be able to traverse rugged terrain like rough roads or steep hills while offering the upmost level of safety for the occupant. A group of 15 students from NAU is participating in this competition at University of Texas, El Paso in late April. Three five person teams have designed the frame, drivetrain, and suspension. Our team is responsible to design the drive-train with the engine provided by SAE. The drive-train must meet the expectations in the acceleration, traction, maneuverability, and endurance events. Our final design employs a continuously variable transmission (CVT) and a differential for reverse. It can provide high torques and fast acceleration while maintaining durability.

1. Introduction

The Baja Vehicle Design is a competition sponsored by the Society of Automotive Engineering (SAE) and hosted in different locations across the country. Teams of students from different universities will design and build a Baja vehicle to compete against each other. All teams will use the 10 hp OHV Intek provided by Briggs & Stratton Corporation. The teams will have to build the vehicle to fit that engine and maximize their designs to meet the design objectives and win the competition. For the capstone senior design project, the Baja vehicle was assigned to three teams each with a separate task. All teams must collaborate together to design the vehicle. The tasks assigned to the teams are the frame design, suspensions design, and drive-train design. In this report, problem formulation, proposed design, prototype fabrication, testing and result and cost analysis will be identified and explained.

2. Problem Formulation

2.1. Objectives

The main objective of this project is to design and build a Baja vehicle that meets the client and stakeholders requirements and needs. Our client is the Society of Automotive Engineering (SAE) and they are the sponsor of the competition who sets the rules and regulations. The stakeholder is Dr. John Tester who will oversee the project progress to make sure that our teams design will win the competition. To win the competition, the Baja vehicle will be run through a series of events to see if it finishes them successfully. These events include acceleration, traction, maneuverability, specialty, and endurance events. Our team will design and build a drive-train with all these objectives in mind to ensure winning the competition. Based on the information obtained from the stakeholder and provided by the SAE, specific objectives are set by our team to maximize the drive-train design. Objectives include choosing a transmission that can have reverse so that the Baja vehicle can succeed in the maneuverability event. Moreover, the gear ration has to be maximized so that the resulted torque will win the acceleration and traction events. Finally, the sprocket materials will have to be chosen carefully so that the drive-train will have better endurance. This will result in low maintenance to be needed and will successfully complete the endurance and specialty events.

2.2. Needs Identification

2.2.1. Customer Needs and Engineering Requirement

Customer Needs described by Engineering Requirements. These are the needs that the team has discussed and established as what the customer wants to see in this product. Requirements are needs that are nonnegotiable and in this case describe the engineering properties we use to measure the established needs. The Engineering requirements for our design are Safety, Desirable acceleration, Ability to climb the hill, Ability to pull an excess load, Durability, Long maintenance period, large max velocity, Ability to reverse, and Inexpensive.

For safety, no matter how well the system works, if it's not safe than it can't be used. Safety is of large importance. The related specification is material strength (Kpa). Any number of tests can be done to make sure that the product is durable. It would not make sense to do long term test so some equivalent short term stress test would measure what kind of stresses the system could potentially handle.

For desirable acceleration, in order to success our Baja vehicle project, the vehicle must reach the peak acceleration of the engine provided. It is a key point to win the acceleration competition. The related specification is power efficiency. The efficiency will be measured by calculating the amount of power transferred from the motor to the wheels.

For ability to climb the hill, in order to complete all the events in the competition, the vehicle must be able to climb a hill with the highest velocity that it can. The vehicle also needs to complete the whole hill course to even place no matter how great the velocity is. The related specification is torque (N.m). To measure the transferred torque, the team will calculate it by using gear ratio from the CVT transmission and secondary gear box.

For ability to pull an excess load, the traction event will be provided, if local terrain does not support a significant hill climb. Therefore, for our project to be successful, the vehicle must be able to pull an excess load on a flat surface as fast as it can. The related specification is torque (N.m). To measure the transferred torque, the team will calculate it by using gear ratio from the CVT transmission and secondary gear box.

For durability, since the Baja vehicle needs to complete multiple events in the competition, it must be able to uphold peak performance during the tests as well as competition events. The related specification is cost ($). To measure the cost, a breakdown of each material used on one product will be calculated. It will be measured in dollars per unit.

For long maintenance period, since the Baja vehicle will go through many tests and competition events, a longer maintenance period will save much of our time. It will also make the whole system more reliable. The related specification is cost ($). To measure the cost, a breakdown of each material used on one product will be calculated. It will be measured in dollars per unit.

For large max velocity, in order to win the competition, it must go as fast as possible. The related specification is velocity (m/s). To measure the velocity, the team will time how long it takes to go through a significant distance.

For ability to reverse, in order to handle all the different competition events, the vehicle must be able to reverse and adjust its position. Optimally this will save time the case of a misjudged obstacle or is the vehicle gets stuck. The related specification is torque (N.m). To measure the transferred torque, the team will calculate it by using gear ratio from the CVT transmission and secondary gear box.

For Inexpensive, because of our limited budget, the team must consider the cost of all the materials used. Making it performs the best under the limited budget is the largest point we should focus on. The related specification is cost ($). To measure the cost, a breakdown of each material used on one product will be calculated. It will be measured in dollars per unit.

2.2.2. Quality Function Deployment

The QFD is a chart that takes the weighted importance of all customer needs and plots them against engineering properties required to compute the required analysis of those needs. It can be useful to define the needs but more importantly it makes for a great communication tool. For instance you would draw up a QFD and display the weighted importance of each need. Then you would present this to your customer. If the customer believes that the weights are sufficient and accurate then you may move as planned in you project.

Table 1: The Quality Function Deployment (QFD)

	Engineering Requirements for Drive-train							
Customer Needs	**Customer Weights**	Cost	Size	Torque	Weight	Velocity	Material strength	Power efficiency
Safety	7	3			3	1	9	
Accelarate fast	8	1	3	9	3	3		9
Able to climb the hill	10	1		9	3	3		3
Able to pull an excess load	10	1		9	3	1		3
Durability	9	3					9	
Long maintenance period	5	3	3				9	
Drive fast	10	1		3	3	9		3
Able to reverse	8			9				
Inexpensive	7	9	1		1		3	
	Raw score	164	46	354	142	161	210	162
	Relative Weight	13%	4%	29%	11%	13%	17%	13%
	Unit of Measure	Dollors	m^3	N.m	kg	m/s	Kpa	ul
	***ul--> Unitless by method**							

2.3.Goal

2.3.1. Torque Goal

In the hill climb event, the Baja vehicle will be expected climb an incline of significant difficulty. The team assumed the incline to be approximately 40 degrees. Through the inspection of previous courses, as a group we felt this would be the maximum angle in any hill climb we might encounter. In order to complete the incline, the force on two wheels will need to be greater than the component force of gravity along the incline, which is G1 in the figure below:

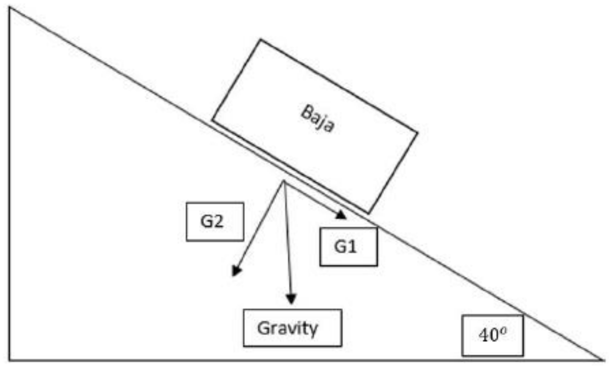

Figure 1: Free Body Diagram of Baja for Hill Climb Event

- G1 = G × sin ∂ = 600lb × sin 30 = 300 lb
- Force on each wheel = 150 lb.
- Torque on each wheel = 150lb × $\frac{D}{2}$ = 150lb ×11.5/12 = 143.75 lb
- Total force on the wheels = 287.5lb
- Total torque $(T_t) = 287.5lb \times \frac{D}{2} = 287.5\ lb \times \frac{11.5}{12} = 275.5\ lb - ft$

From the equations above we can assume that the minimum torque that needs to be transferred to the wheels is 300lb-ft.

2.3.2. Speed Goal

Table 2: Tennessee 2013 Acceleration Event

Rank	Car No	School	Team	Time Run 1	Time Run 2	Best Time	Acceleration Score (75)
1	1	Cornell Univ	Big Red Racing	3.870	3.861	3.861	75.00
2	52	Michigan Tech Univ	Blizzard Baja	3.950	3.872	3.872	74.70
3	6	Univ of Maryland - Baltimore County	UMBC Racing	3.902	3.957	3.902	73.86
4	78	Univ of Maryland - College Park	Terps Racing	3.906	3.974	3.906	73.75
5	73	LeTourneau Univ	Renegade Racing	3.935	3.916	3.916	73.48
6	3	Rochester Institute of Technology	RIOT Racing	3.999	3.924	3.924	73.26
7	44	Ohio Northern Univ	Polar Bear Racing	3.945	3.955	3.945	72.67
8	36	Universite de Sherbrooke	Sherbrooke Racing Team	4.011	3.992	3.992	71.37
9	57	Univ of Wisconsin - Madison	UW Baja	4.129	4.037	4.037	70.13
10	45	Univ of Arkansas - Fayetteville	Racing Razorbacks	4.043		4.043	69.96

From the table we can see the top team have an average time of 4 seconds to finish a 100 foot course. Assuming that the Baja keeps accelerating with the average acceleration during that time. We can calculate the maximum velocity

- Distance = Max Velocity × time ÷ 2
- Max velocity = Distance × 2 ÷ time
  = 100 × 2 × 0.68 ÷ 4
  = 34 mph

Based on the result, 30 mph is the goal for max speed that the team has set out to obtain.

3. Proposed Design

3.1. Analysis for CVT system

3.1.1. Assumptions and variables

- Wheel diameter(D): 23 inch
- Total weight (W): 600 lb (including the driver)
- Slope of the hill (∂): 30 degree
- Efficiency of CVT(N_{cvt}): 88%
- CVT: PULLEY SERIES 0600-0021 AND DRIVEN PULLEY SERIES 5600-0171 from CVTech-AAB Inc.
  High speed ratio (r_{cvt-h}): 0.43 Low speed ratio (r_{cvt-l}): 3
- Differential: Dana Spicer, H-12 FNR
  Forward ratio (r_{d-f}): 13.25 Reverse ratio (r_{d-r}): 14.36

3.1.2. Calculation

- CVT ratio = $3 - \frac{2.57*(rpm-800)}{2800}$ for 800<rpm<3600
- Total ratio = $r_{cvt} \times r_{d-f} \times N_{cvt} = r_{cvt} * 12 * 0.88$
- Torque on the wheel = Torque output * Total ratio * N_{cvt}
- Speed = $\frac{D \times RPM \times \pi}{total\,ratio * 12 * 60} * 0.68 = \frac{23\,in \times RPM \times \pi}{total\,ratio * 12 * 60} * 0.68$

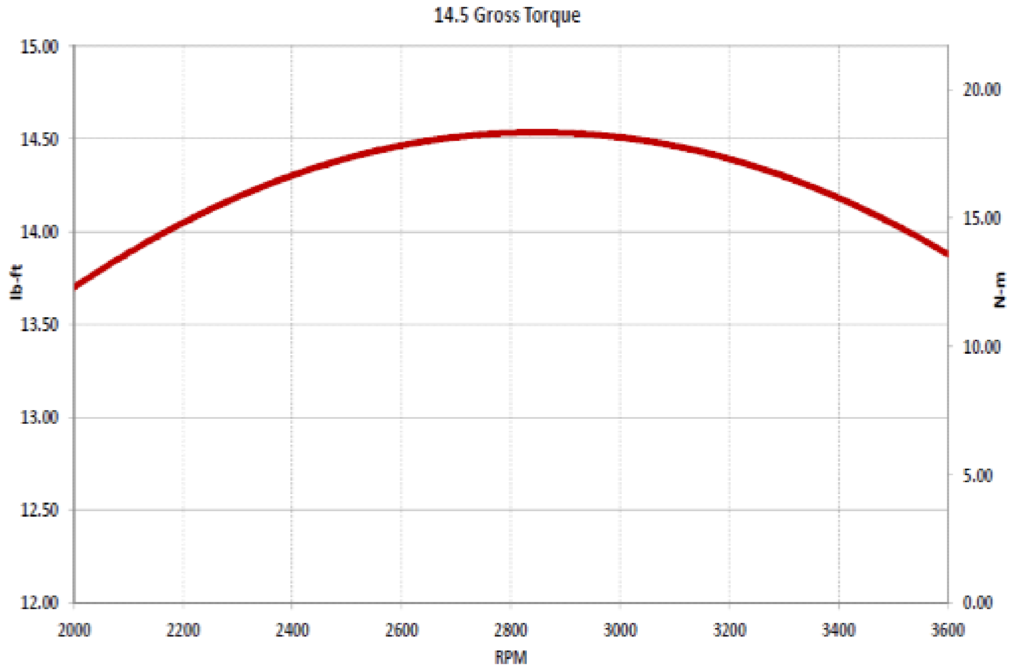

Figure 2: Motor Torque Curve

With the equation and graph above we made the table below:

Table 3: Speed and Torque Calculation

Engine rpm	Torque output (lb-ft)	CVT ratio	Total ratio	Torque on wheel (lb-ft)	Speed (mph)
1800	13.20	2.082	24.278	320.467	5.06
2000	13.70	1.899	22.137	303.282	6.17
2200	14.10	1.715	19.997	281.956	7.51
2400	14.30	1.531	17.856	255.347	9.17
2600	14.45	1.348	15.716	227.096	11.29
2800	14.52	1.164	13.576	197.117	14.08
3000	14.50	0.981	11.435	165.809	17.90
3200	14.40	0.797	9.295	133.843	23.49
3400	14.20	0.614	7.154	101.590	32.43

From this table we can see the max torque is 320.467 lb-ft and the max speed is 32.43 mph which satisfy the team's intended goals.

3.2.Final design

3.2.1. Overall Description

The Baja will still operate using the Briggs and Stratton ten horse power engine in connection with CVTech-AAB's CVT. The CVT will still have a low ratio of 0.43:1 and a high ratio of 3:1. Following this assembly is where the system has been altered. The Dana Spicer H-12 FNR differential will provides the cart with a forward ration of 13.25:1 and a reverse ratio of 14.36:1. This improved system will provide a direct connection from the power source to the output shafts reducing the loss of efficiency. These alterations have also made the system more compact and easily removable in the case of swapping broken parts.

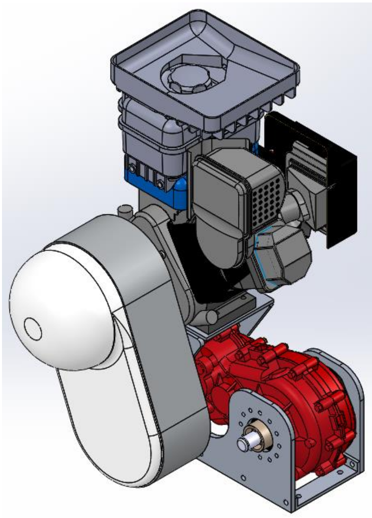

Figure 3: Overall drive train CAD

3.2.2. Engine Mount Design

<u>Description</u>

To make the maintenance of drive-train system easier, the team designed an engine mount during winter break, which will assemble engine, differential and CVT. If the team need to take out the drive-train system for maintenance or test, the whole system can be taken out when the engine mount is taken out.

<u>3D model</u>

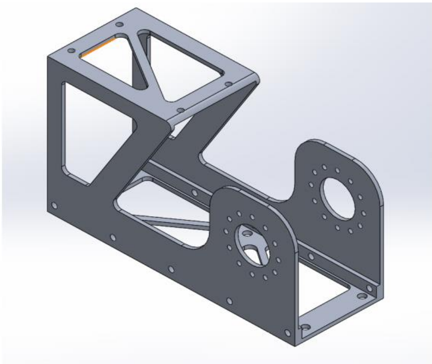

Figure 4: Engine Mount Solidworks

Finite Element Analysis

When the team designed the engine mount, a FEA test has been done to make sure the mount can hold the stress that will be added on the mount. 800 lbf load has been added on the top of the mount, and 40 lbf load has been added on each threaded hole on both two sides of the mount. The test showed that the maximum deflection will be on the bar at the top of the mount, and the stress will be 0.288 mm. The safety factor of this mount is 10.97 maximum.

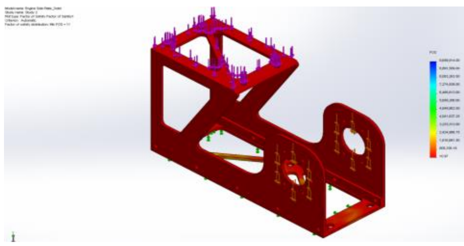

Figure 5: Safety Factor Test

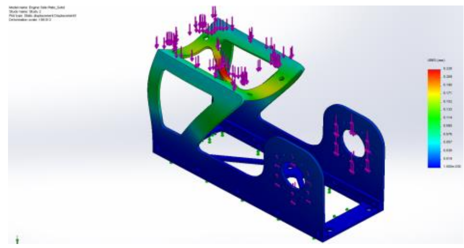

Figure 6: Deflection Test

3.2.3. Drip Pan Design

Description

Following the SAE mini Baja rules, a drip pan will be necessary for every team to prevent the gas leak. The drip pan the team designed will be on the top of the gas tank with a drip pan drain. The gas that spill out of the gas tank when refilling will be lead to the ground through the drip pan drain.

3D model

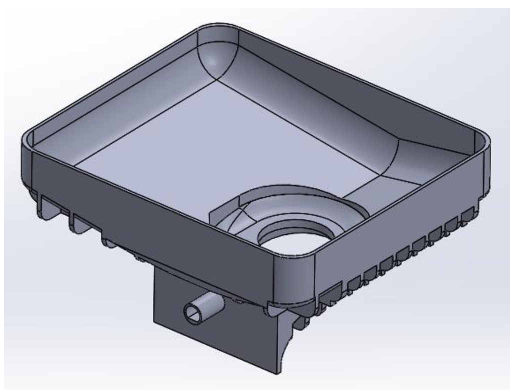

Figure 7: Drip Pan Solidworks

3.2.4. CVT guard

Description

The CVT guard is designed to cover all the rotation part of CVT. The side wall will be made with sheet mental and the cover will be made of plastic sheet. It will be bolded somewhere to the engine mount, but that is something we will decide last, because it is so close to the frame, we want to make sure it fit our dimensions.

3D model

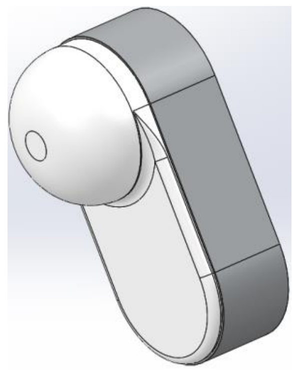

Figure 8: CVT Guard Solidworks

3.2.5. Shifting system

Description

The shifter box includes a shifter housing and a shifter bar. There are slots on the top side of the shifter housing, and these slots can make the shifter bar stock into the right positions. The shifter bar is connected with the housing by a spring, which can make the bar locked into the slot easily. On the right side, the bar is connected to the housing by a ball bearing, which can let the bar move around. On the shifter bar shown in Figure XX, there is a small piece connected both bar and a clevis, and the clevis is connected the shifter cable. The shifter cable was ordered and the length of the cable is three feet. The cable has two heads connect with the clevis on the shifter bar and differential. There is a small part (Figure XX) connected both differential and head of the shifter cable. When the driver pull or push the shifter bar the small part on the differential can be rotated and the gears can be shifted.

3D model

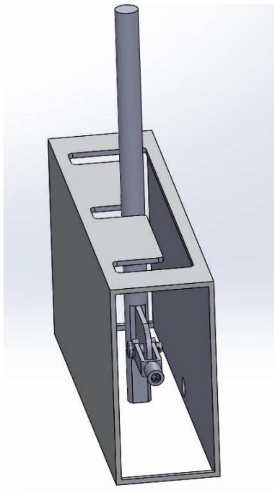

Figure 9: Shifting box Solidworks

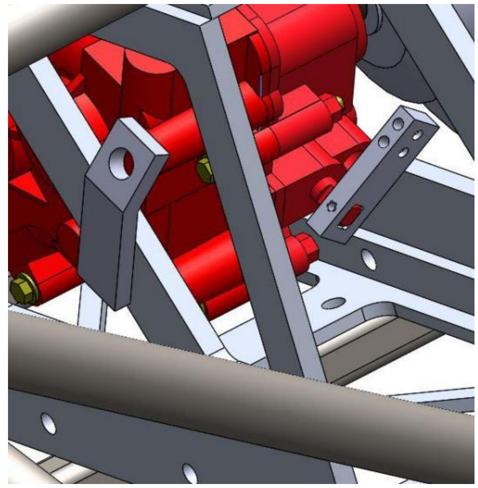

Figure 10: Shifting Cable Lock and Shifting Lever Solidworks

4. Prototype Fabrication

When constructing the drivetrain there were six main fabrications. As the drivetrain team, we were responsible for fabricating a; CVT cover, Gas Catch, throttle pedal, shift lever, half shafts and engine mount. Each of these builds came with their own challenges to overcome and solutions to be solved. The simplest of the six was the Gas Catch system. This part was simply designed to specification provided by SAE and 3-D printed to these desired characteristics. Unfortunately upon arrival to competition, there were small modification made to the catch per request of the tech inspectors at the event. Following the print of the catch, we immediately began the process of designing the CVT guard from the same material as the catch. The attachment to a sheet metal rim was simple enough using rivets, but issued occurred when mounting the rim to the engine. Luckily, the Engine had existing taps that we were able to mount to but because the CVT belt was had so much tension there were difficulties attaching an removing the cover. However none of these restriction created catastrophic failures. .

The most tedious of concepts that the drivetrain took on was the design of the throttle and shifting mechanism. Both of these task were not overly difficult, but took time to manipulate and adjust, tensions, and maneuverability of the systems. The throttle system as well as the shifting system used store bought cables, but custom fabricated housings. The difficulties came with calculating how much translation the mechanism needed and give this translation where would the stop/hold need to be mounted to ensure this translation was achieved. This was mapped out in Solidworks, then when the team was satisfied, print outs would be used to mock up the materials and finally cut to description.

As we moved on we realized we saved the parts that were most likely to see failures for last. Because we knew the terrain would be rough and rocky, we knew that we had to error on the side of caution when fabricating the half shafts and engine mount. These task again were not overly complicated but fairly tedious due to the requirements that these members needed to be reliable. When constructing the half shaft it was imperative that these pieces be milled exactly to specification and welded together using a properly gauged steel sleeve. The engine mount was slightly less difficult because we were able to program the dimensions into a CNC machine to precisely cut the cross members to our design. These members were first design in Solidworks and then evaluated using the Finite Element Analysis within this system. Though the mount was built sufficiently, it did suffer a catastrophic failure at one of the welds of the cross members. This member was repaired on site at the competition but unfortunately failed again with insufficient time to repair.

Based on the competition rules, the vehicle needs a CVT guard to cover all the rotation parts of the CVT. Our CVT guard includes a top cover and the side wall. The top cover of the CVT guard was modeled in solid works and printed by a 3D printer, and the side wall of the guard was made from sheet metals. The printing process of the top cover is more than 30 hours. Because of some unknown problems, the 3D printer will be shut down before the cover was finished. So the team decided to cut the top surface into two pieces, and print them separately. Because the CVT guard is barely larger that the CVT, another difficulty the team had with the CVT guard was how to put it to the right position, to avoid the guard touching any rotation part of CVT. Since the top cover of the CVT guard was 3D printed, and material was not transparent, the team spent a lot of time try to find the right position to set up the CVT guard.

Talking about the drip pan, the team used the 3-D printer to print it out. Because the team measure all the dimensions of the gas tank by hand, there is some human errors. That turned out to be that the printed drip pan cannot fit above the gas tank. It took the team about half days to sand the drip pan, in order to make it fit.

The shifting system on the vehicle includes a shifting box, a shifting cable, a shifting cable lock, and a shifting lever. The shifting box was made from two welded together aluminum tubing. An aluminum bar was put into the shifting box as the shifting bar. The team ordered the shifting cable online and it was connected with both shifting bar and shifting lever on the differential. The shifting cable lock was bolted on the left side of the engine mount to locate the shifting cable on the right shifting position.

The team had some troubles when we were trying to find a right position to bolt the shifting cable lock on the engine mount. Since the shifting angle the differential needed was very small, a little bit error with the cable's position can make the vehicle cannot be shifted. The team spent a lot of time on it and finally found a perfect position for the lock.

Fabrication photos

Figure 11: Assembled Drivetrain system

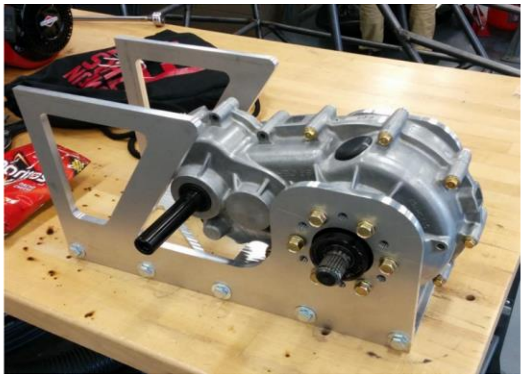

Figure 12: Engine Mount

Figure 13: Drip Pan

Figure 14: CVT Guard

Figure 15: Shfting Box

Figure 16: Assembled Shifting Cable Lock and Shifting Lever

5. Competition Results

116 teams had participated the SAE mini baja competition at UTEP. As a new team, the NAU mini baja team past the technical check and participated all the sub-events in the competition, including endurance, suspension, hill climb, land maneuverability, acceleration, sale presentation and design presentation. All the results is showing below:

Events	Ranking (out of 116 teams)
Endurance	46th
Suspension & Traction	56th
Hill Climb	58th
Land Maneuverability	27th
Acceleration	64th
Sale Presentation	17th
Design Presentation	45th
Cost	69th
Overall	**51th**

Our baja was not been able to finish the last event which is 4 hours endurance race. The shifter had a small issue after 8 laps and was fixed quickly. The most serious failure happened after 17 laps, the welding that connecting top piece and side wall of engine mount broke. The baja then lost power because the CVT belt is not tight enough to transfer the power. Although the team welded it again and got the baja back to race, it only last half lap and then been towed out.

6. Cost Analysis

For the SAE Mini Baja competition as a competing team we are required to create and present a Sales Presentation to a hypothetical manufacturing company. This imaginary company is prospecting to produce a Mini Baja at four thousand units per year. Thus, this will set the base criteria for our calculations and tables. Our team also assumed that out of 365 days this company would only be producing units for approximately 261 days of the year. With these two criteria established we were able to; create a Bill of Materials, estimate the manufacturing costs, cost of man power, and the total cost of production.

Since the final presentation in December of 2013 there have been a few changes made to the SAE Baja drive-train system. This had some effects on the cost analysis of the project, some positive and some negative. Below in Table 7 you will notice that because the system now incorporates a differential, the manufacturing hours required per day were reduced by more than thirteen hours. This equates to approximate savings of $350 per day jus in labor. Fallowing this, the budget for the system was hardly reduced. Because the new system uses a Dana differential, the price rose significantly. Luckily this product was donated to the SAE team, thus or budget rose but the system was actually more cost effective. A similar rise in cost can be seen in the systems bill of materials. Since the system has become more compact and efficient, you can see the cost increase for these desirable attributes. Though there were slight increases in these two areas, the decrease in cost in all other areas still outweighs the increase in parts cost. Thus, our system has not only become more efficient and simplistic, but is cost effective as well.

Table 4: Manufactory Hours

Part	Half Shaft	Keys	Hours per Unit	Hours per Day
Individual	.65 Hours	.25 Hours		
Drive Shaft	1.3 Hours	.75 Hours	2.05 Hours	30.75 Hours

Table 5: Budget for Drivetrain

	Price($)	Quantity	Comments	Total
Engine	200	1	Ship fee	200
Differential	1000	1	Dana	1000
CVT	250	1	CV-Tech	100
Key	5	4		20
Half-shaft	260	2	Polaris	520
Shipping	200		Fed Ex	200
Total Price				2040

Table 6: Bill of Materails

Half shafts	Engine	CVT	Differential	Key	Total
1,040,000	979,980	500,000	2,000,000	5836	4,525,816

Table 7: Total Estimated Man Hours

Total work units	Complete units per day	Total hours per person	Number of labors	Hrs per person per day	Hourly Wage ($)	Total cost of labors ($)
4000	15	2086	8	8	26	433,888

7. Conclusions

Our team along with the Frame team worked throughout the winter break and have come up with an optimized design where a gear box and secondary reduction system are replaced by a single differential. This was a step off the board from our original design but prevailed well. The updated concept not only simplified our design but reduced the weight drastically while still achieving our intended goals. As a result, the team was able to order many parts and move on to more simplistic but important tasks such as a throttle design and shifting mechanism. These strides allowed us to make up some lost ground and produce our design on schedule and perform at the competition in El Paso Texas. End up with 51th place out of 116 teams.

References

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[2] Richard Budynas, and J Keith Nisbett. *Mechanical Engineering Design*. 9th ed. 1021. New York: McGraw-Hill, 2011. Print.

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[4] 2014 Collegiate Design Series: Baja SAE®Rules
http://www.sae.org/students/2014_baja_rules_8-2103.pdf

[5]Continuously variable transmission(CVT)
https://d2t1xqejof9utc.cloudfront.net/files/19153/eti19CVTransmission.pdf?1363999370

[6] CVT Transmission
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[7] A Short Course on Automatic Transmissions
http://www.carparts.com/transmission.htm

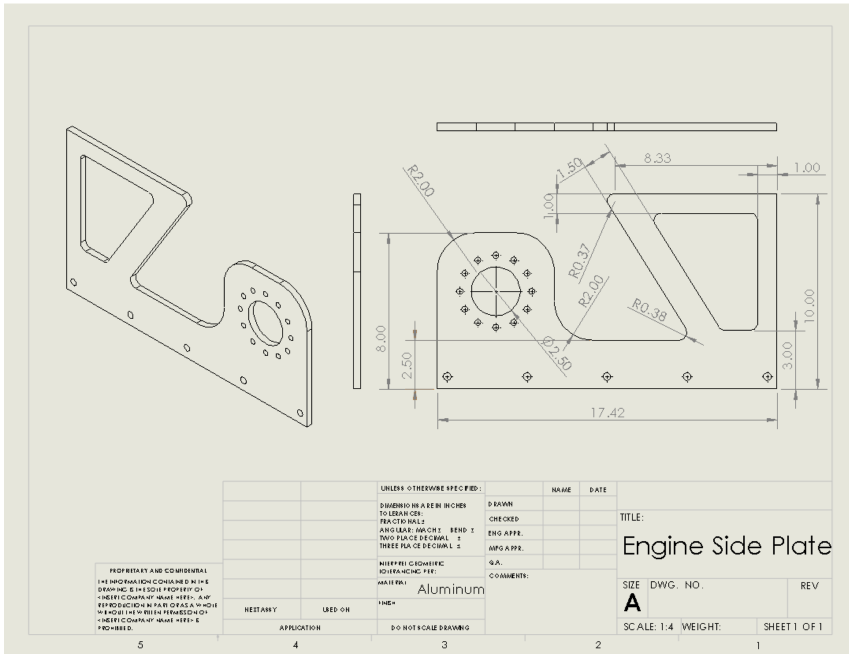
[8] CVTech-AAB
http://issuu.com/cvtech_aab/docs/cvtech-aab-catalog-us-2013?e=3611395/2594502

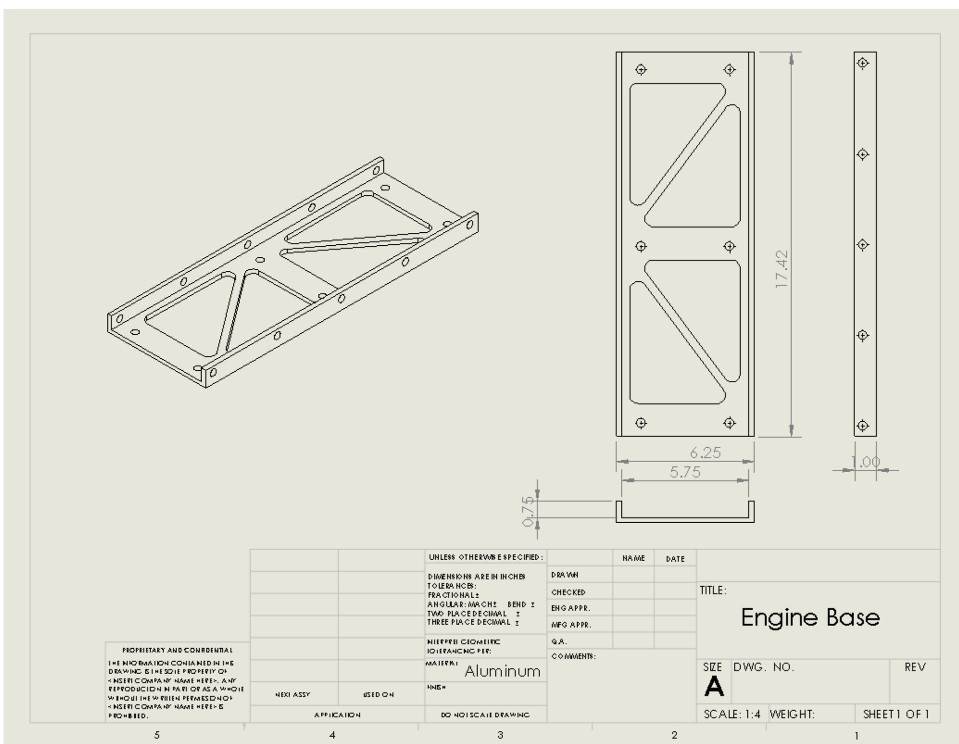
[9].Seamless AMT offers efficient alternative to CVT
http://www.zeroshift.com/pdf/Seamless%20AMT%20Offers%20Efficient%20Alterntive%20To%20CVT.pdf

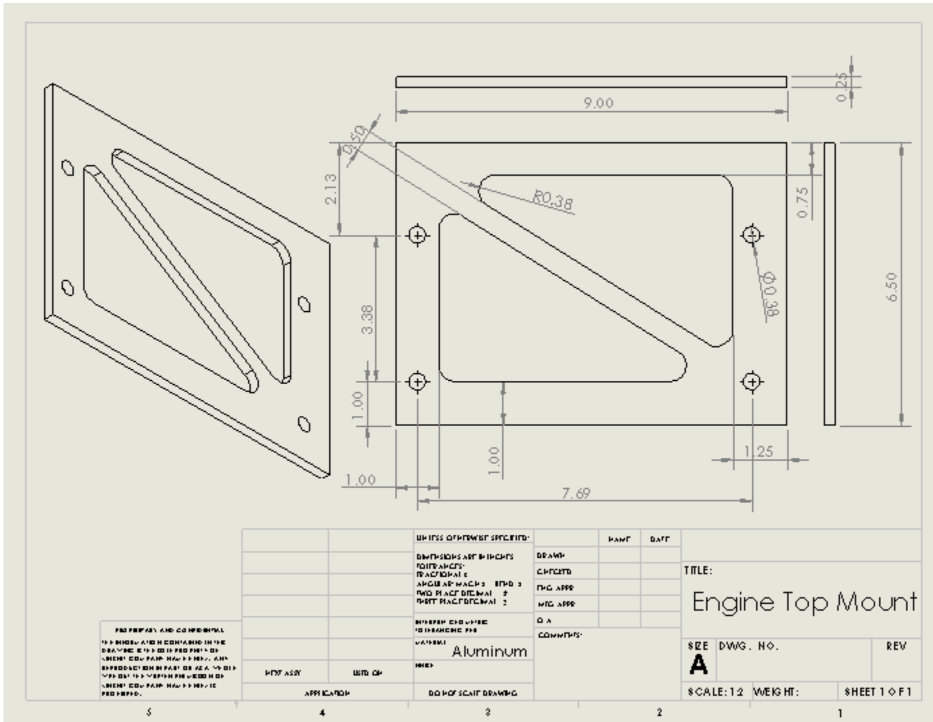
[10] Baja SAE Result
http://students.sae.org/competitions/bajasae/results/

Appendix

Engineering Drawing







9.00
0.25
0.50
2.13
R0.38
0.75
Ø0.38
6.50
3.38
1.00
1.00
1.25
1.00
7.69
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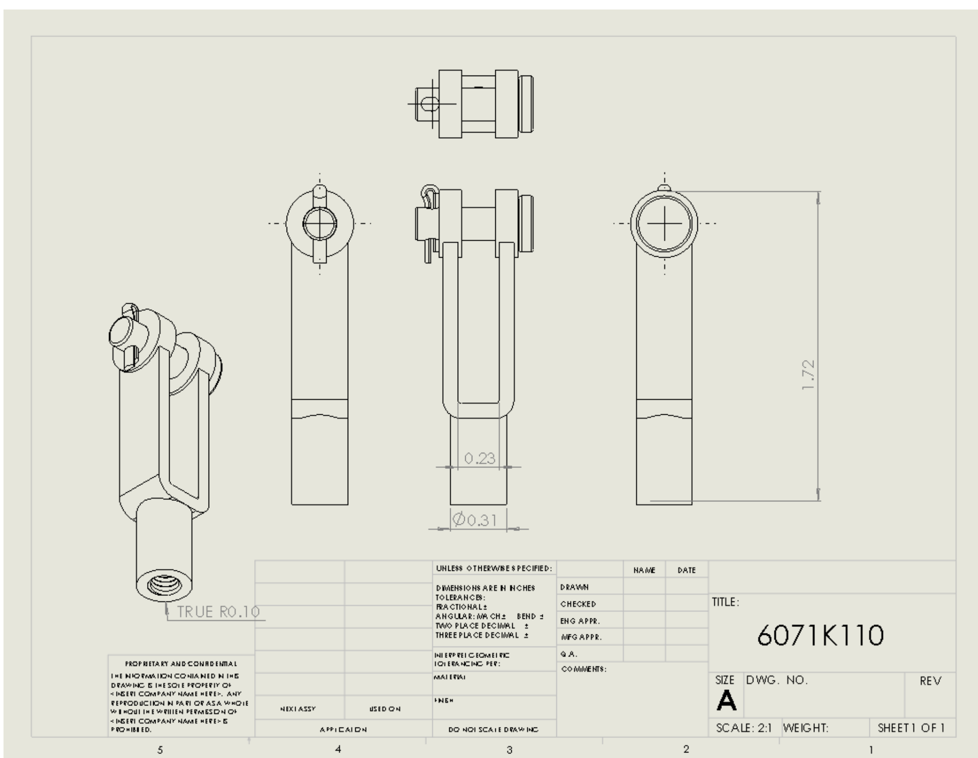
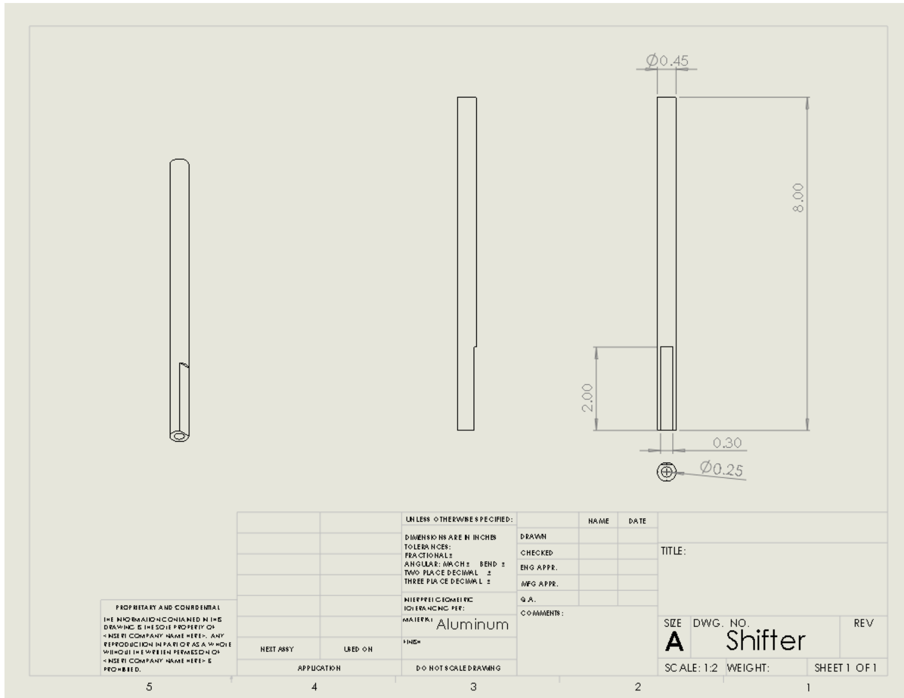
Engine Top Mount
Aluminum
SIZE DWG. NO.
A
REV
SCALE: 1:2 WEIGHT:
SHEET 1 OF 1



1.72
0.23
Ø0.31
TRUE R0.10
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
6071K110
SIZE DWG. NO.
A
REV
SCALE: 2:1 WEIGHT:
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL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8.00
2.00
0.30
Ø0.25
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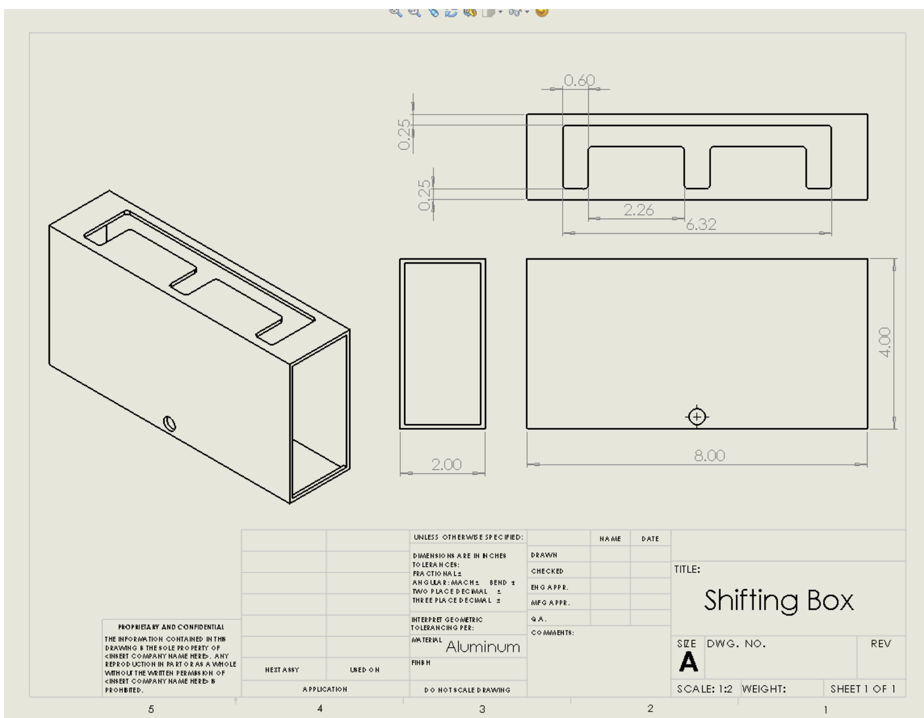
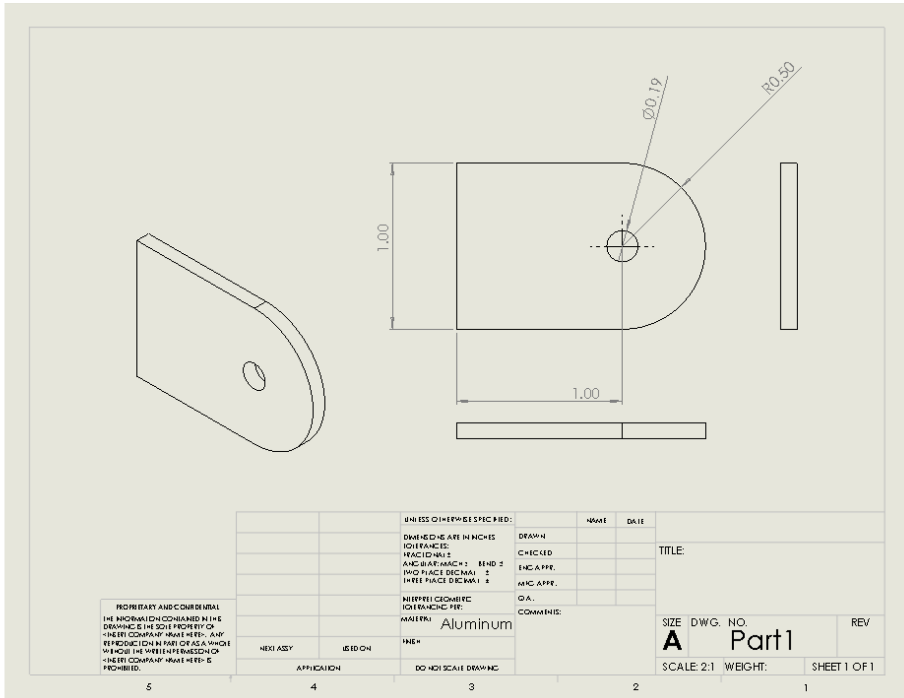
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Aluminum
SIZE
A
DWG. NO.
Shifter
REV
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL


0.60
0.25
0.25
2.26
6.32
4.00
2.00
8.00
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Shifting Box
Aluminum
SIZE
A
DWG. NO.
REV
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL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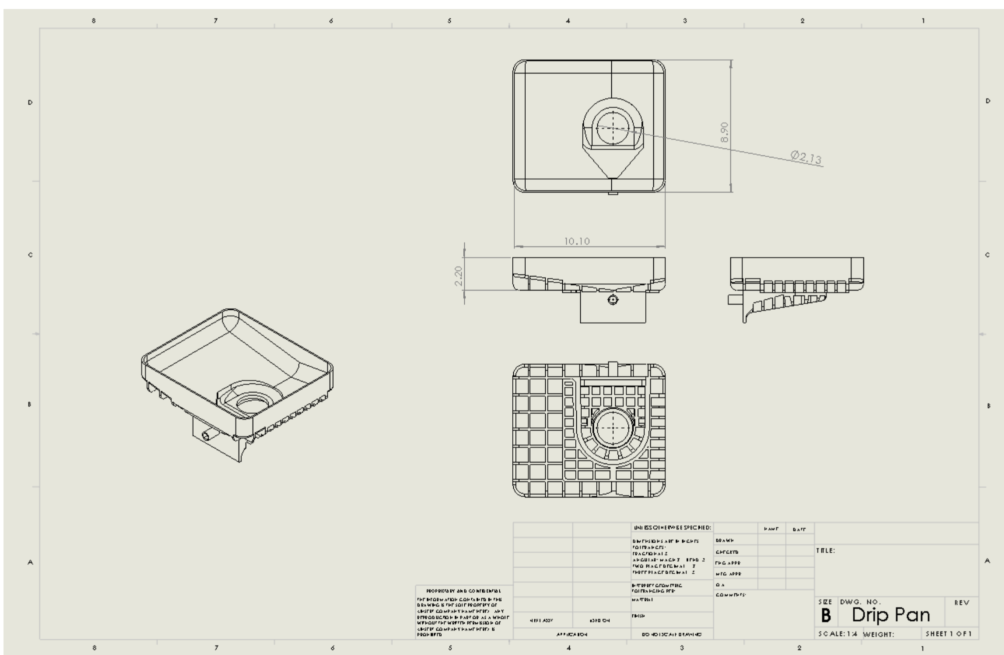
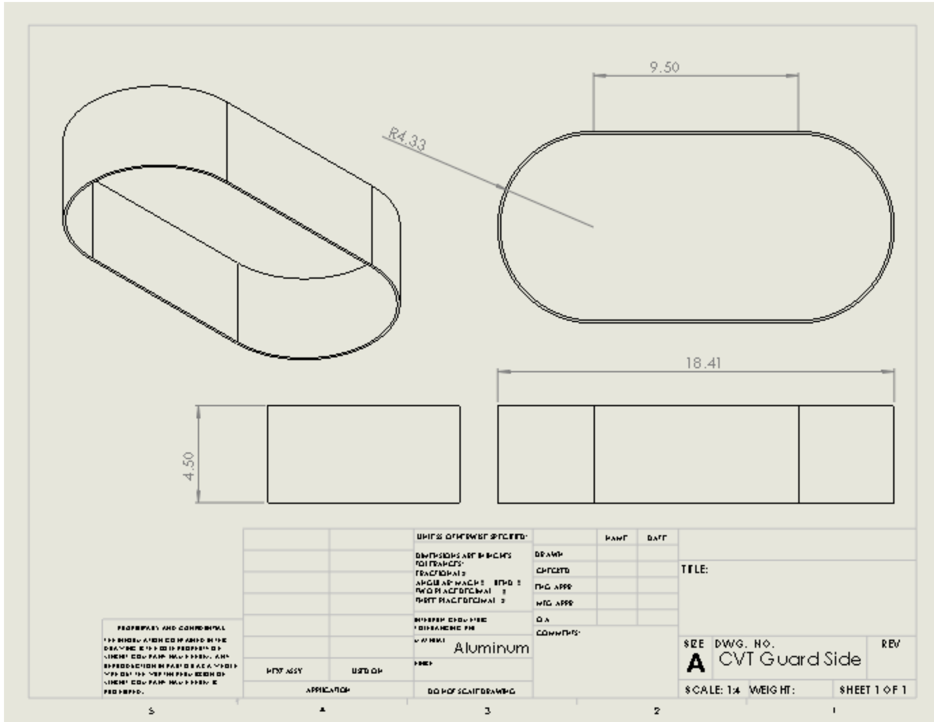
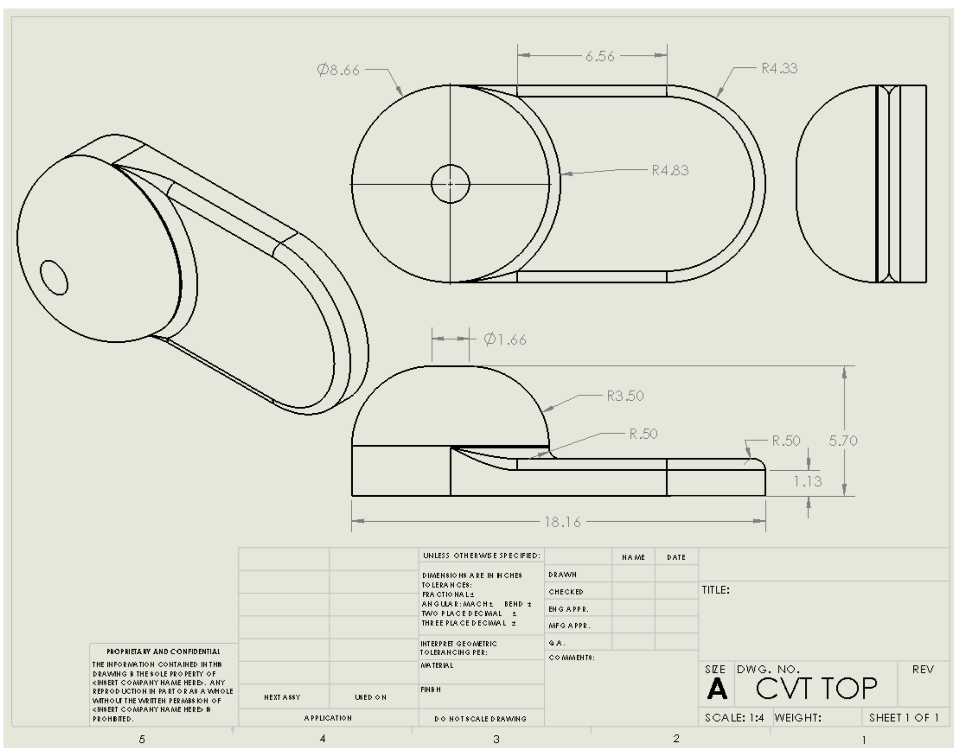
R0.50
1.00
1.00
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
MATERIAL
Aluminum
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
TITLE:
SIZE DWG. NO.
A
Part1
REV
SCALE: 2:1 WEIGHT:
SHEET 1 OF 1


8.90
Ø2.13
10.10
2.20
TITLE:
SIZE DWG. NO.
B
Drip Pan
REV
SCALE: 1:4 WEIGHT:
SHEET 1 OF 1


9.50
R4.33
18.41
4.50
TITLE:
SIZE
A
DWG. NO.
CVT Guard Side
REV
Aluminum
SCALE: 1:4
WEIGHT:
SHEET 1 OF 1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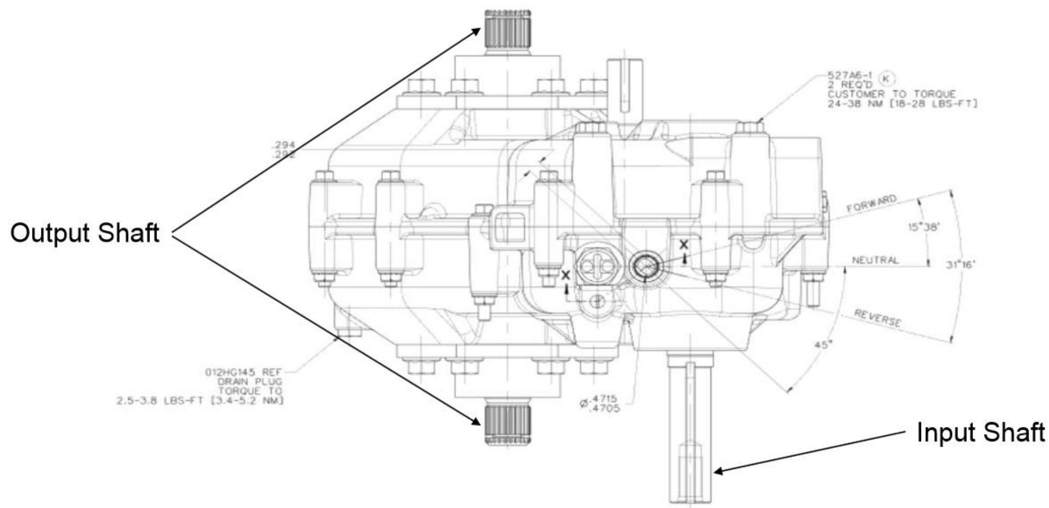
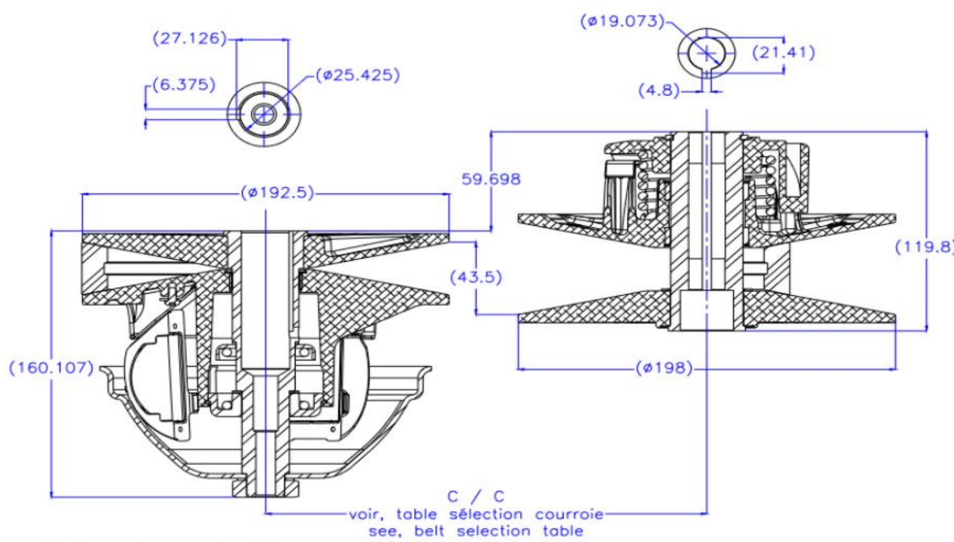
6.56
R4.33
R4.83
Ø1.66
R3.50
R.50
R.50
5.70
1.13
18.16
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
TITLE:
SIZE
A
DWG. NO.
CVT TOP
REV
SCALE: 1:4
WEIGHT:
SHEET 1 OF 1



Mini Baja geometry



Note: All dimensions are in millimetres (mm)

Acknowledgment

ACEFNS, ASNAU, Babbitt Ford Lincoln, Bill G. Bennett, Copper State Nut and Bolt, CVTech, Imo Fab 316 Motor Works, Industrial Metal Supply, KC Hilites, Northland Motorsports, Page Steel, Polaris, Sabic, Schafer Gear Works Inc.