

SAE Baja Design

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Team 02

CONCEPT GENERATION AND SELECTION REPORT

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I. Introduction

This report will explain and depict the concept generation and selection of the SAE Baja Team's drivetrain. The contents should describe our three concepts in depth, depict them so that you might be able to visualize the concept and outline the advantages and disadvantages of each possible selection. Furthermore, our decision matrix will plot the three choices against each other to visually confirm which choices is the best for our particular problem. The criteria that the matrix is based on will be clearly displayed below with explanations of the criteria and why this stands out as a criteria. The report will wrap up with a clarification of our teams status and where we need to be in the near future.

II. Concept 1 - Continuously Variable Transmission

Introduction

A Continuously Variable Transmission (CVT) is one kind of automatic transmission that can transfer the range of power and torque from the engine to the drivetrain continuously.

Explanation

There are three different types CVT. Friction drive is the first type of CVT that we want to introduce. There are two different discs in this system, the driving disc is connected with the engine and the driven disc is connected to the drive axle. These discs are connected perpendicularly as shown in **Figure1** .The main concept of this type is using friction between two discs to change the gear ratio.

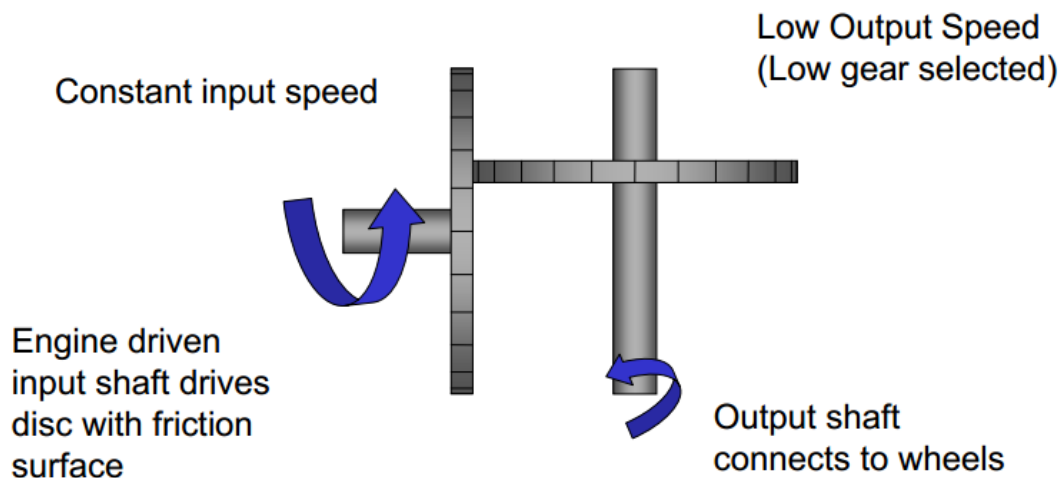


Figure 1: Friction Drive CVT Basic Concept (Source: cloudfront.net)

The second type of CVT is a pulley drive. This type of CVT changes gear ratio by moving two sheaves of one pulley closer together and moving two sheaves of another

pulley farther apart while the two pulley are connected by a V-belt. There are many different pulley drive CVT since the belts are built out of different materials. We desire to use a rubber V-belt, which can be used for low torque and engine power, since the rubber belt cannot handle high amounts of torque and power. Another option could be a metal V-belt, which is used by Nissan, Toyota, Audi and Subaru's CVT designs. These belts are designed to handle more torque than the metal V-belt we would consider in our CVT.

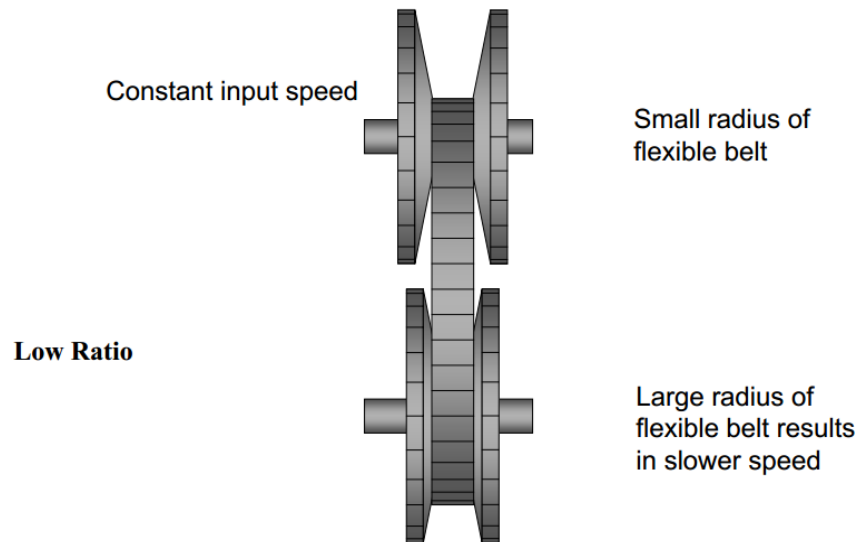


Figure 2: Pulley Drive CVT Basic Concept (Source: cloudfront.net)



Figure 3: Rubber V-belt CVT (Source: atvriders.com)

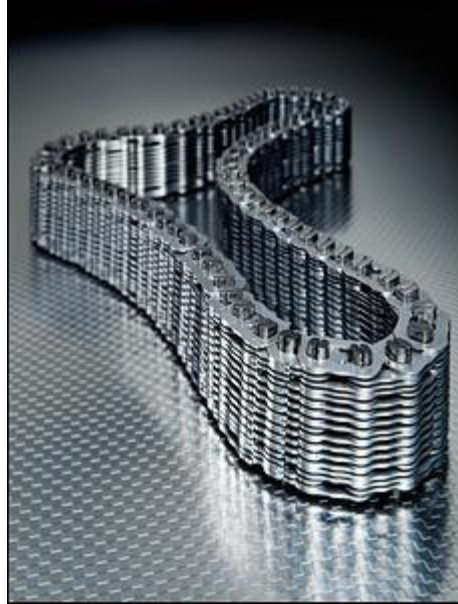


Figure 4: Chain V-belt CVT (Source: autospeed.com)

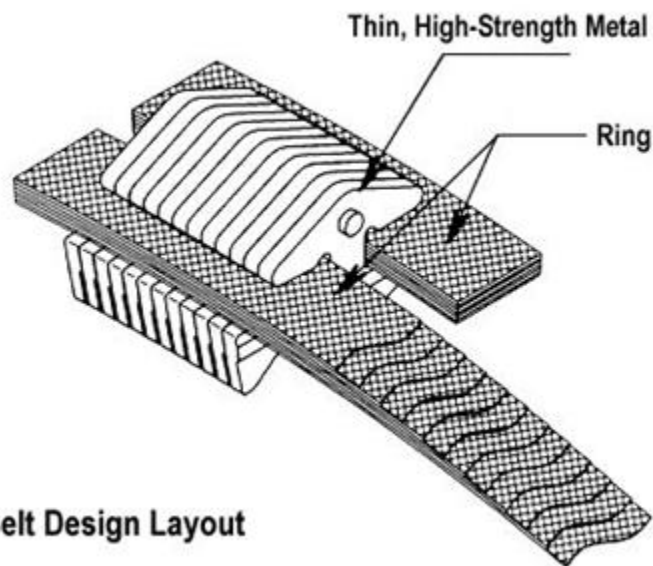


Figure 5: Metal V-belt CVT (Source: insightcentral.net)

The last type of CVT is Toroidal CVT. By using one pair of rollers between the input disc and output disc, the transmission can change the gear ratio to allow the vehicle to have enough torque at low speed but at the same time have a power full high end speed.

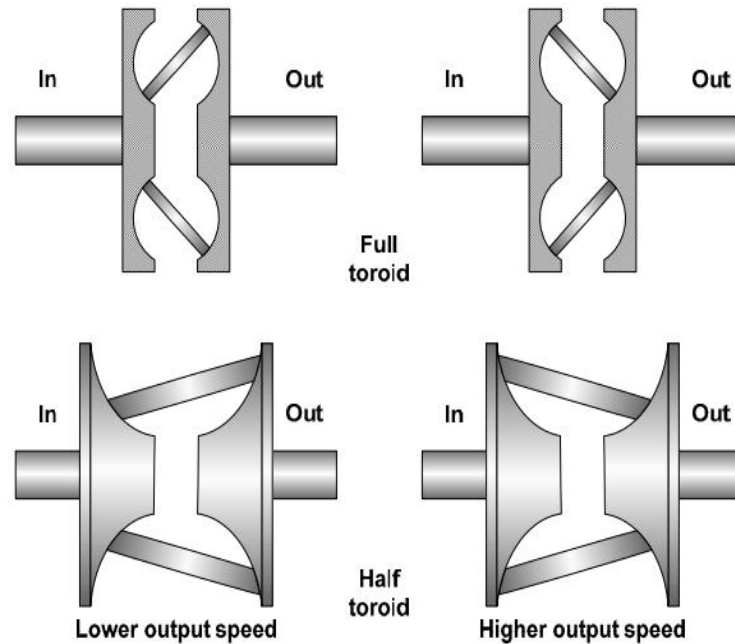


Figure 6: Toroidal CVT Basic Concept (Source: cloudfront.net)

Advantages:

- Does not require you to shift gears.
- Allows power to be transferred continually.
- Good fuel efficiency.
- Has a wide range of gear ratio.

Disadvantages:

- The system cannot handle too much torque.
- Does not naturally incorporate a reverse

III. Concept 2 – Automatic Transmission

Introduction:

The automatic transmission is one of the possible concepts for the Baja drive train design. This transmission system is a type of motor vehicle transmission that can automatically change gear ratios as the vehicle cycles from low rpms to high rpms.

Explanation:

A Planetary Gear System is the basic construction for an automatic transmission system. It contains a ring gear, more than two planet gears, and a sun gear. The sun gear is connected to the drum, while the planet gears are connected to the carrier. For our Baja vehicle drivetrain this

concept would provide; a high speed shift, low speed shift, reverse shift and a free release neutral. For the low speed shift, the ring gear is connected to the input shaft from the engine, the planet gears are connected to output shaft, and the sun gear is locked in place. For the high speed shift, a ring gear is connected to the input shaft from the engine, the planet gears are connected to output shaft and locked into a fixed position, and the sun gear is unlocked. For the reverse shift, the ring gear is connected to the input shaft from the engine, the sun gear is connected to the output shaft, and the planet gears are fixed in position. The clutch pack locks the drum in place as well as the carrier, thus allowing the transmission to move between gears. For the free release neutral, this system releases both clutch and band simultaneously. The construction of the planetary system is shown by the followed **Figure 7** and **Figure 8**.

Advantages:

- Good performance on rough road. The gears in automatic transmission are never physically moved and are always engaged to the same gears. While the vehicle passing through rough road, there is no power loss due to shifting gear.
- Easy to drive. Automatic transmissions don't need the driver to shift gear while driving. Thus, the driver can focus more on the road.
- Low failure rate. Automatic transmission avoid many abrasions from shifting gear.

Disadvantages:

- Lower fuel efficiency. The shifting process in automatic transmissions are completed by hydromantic system. This process causes power loss.
- Higher price. Due to the complex construction of automatic transmission, the price of it is higher than the other transmission systems.
- Higher maintenance cost. This system requires more frequent maintenance than the other systems we are considering.

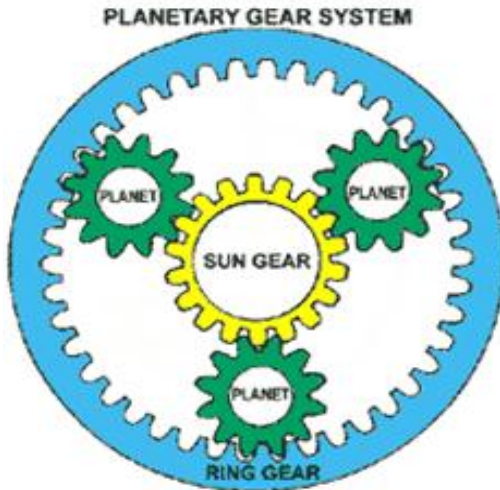


Figure 7: Planetary Gear System

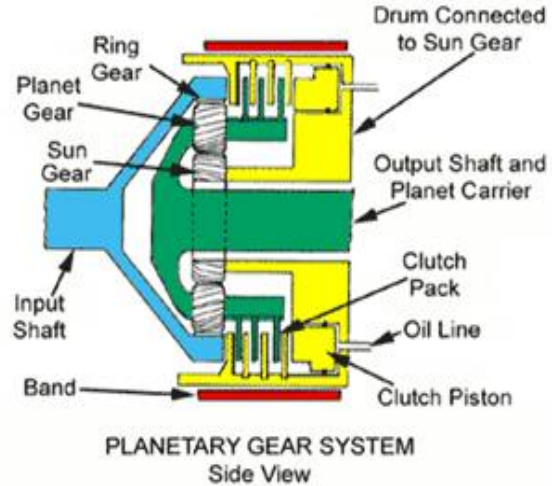


Figure 8: Planetary Gear System

(Source: carparts.com)

IV. Concept 3 – Manual Transmission

Introduction

A manual transmission is composed of two main set of gears. The first set of gears is the one connected to the engine to transfer the power. The second set of gears is the one with the gear selector fork, which switches between the different gear ratios. The ratios are set from low gear ratio to higher gear ratio. The first gear has the lowest gear ratio which provides higher torque but lower speed. As the driver switches from low gears to higher gears, the gear ratio will increase and thus provides a higher speed but lower torque.

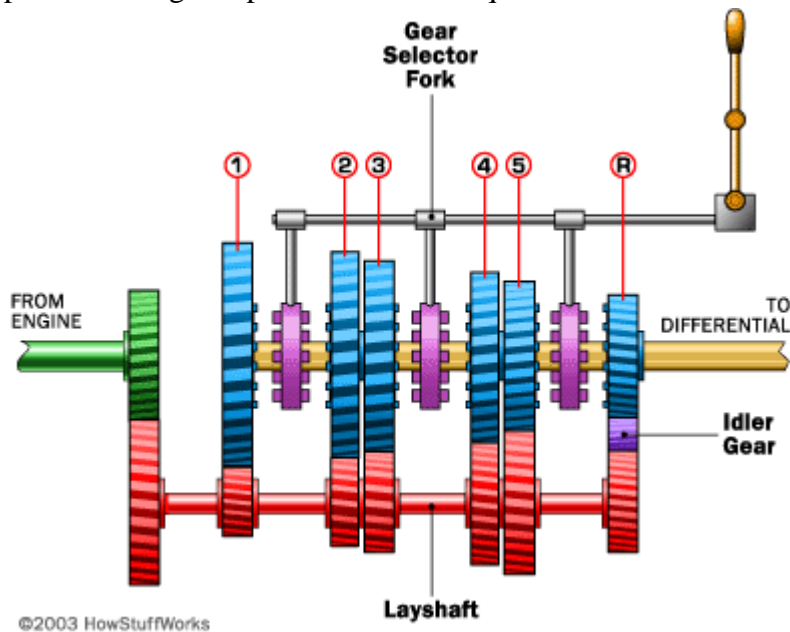
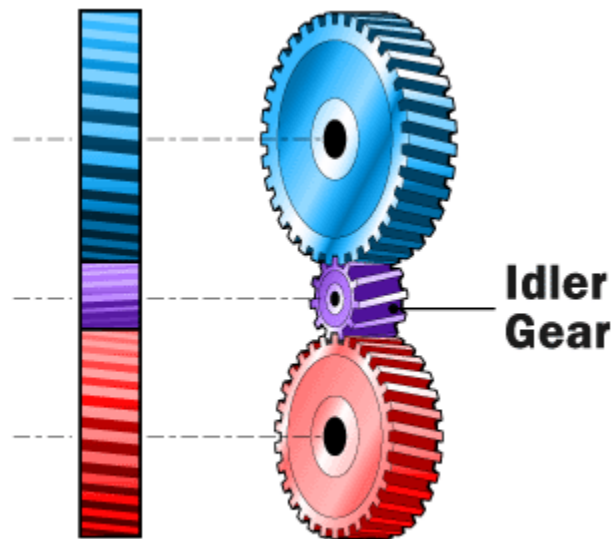


Figure 9: Manual Transmission (Source: howstuffworks.com)

Explanation

To further explain how manual transmission works, a five speed manual transmission, commonly used in cars, is used as an example. In a five speed manual transmission, there are three forks controlled by three rods that are engaged by the shift lever as shown in Figure (X). It can also be seen that the shift lever has a rotation point in the middle. When moving the gear shifter right and left, it engages different forks. When moving the gear shifter forward and backward, it engages one of the gears within the gear selected fork, (Figure (X)). In manual transmission, the reverse option can be added easily. In Figure (X), it can be seen that by simply adding the Idler gear, the gear output gear will start spinning in the opposite directions to the other gears providing a reverse option.



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Figure 10: Idler Gear (Source: howstuffworks.com)

Advantages:

- In manual transmissions, the driver has the ability to lower the gear to achieve higher rpms, which will allow the vehicle to complete a hill climb obstacle.
- A manual transmission allows for a better acceleration as the driver chooses to switch gear at the appropriate time to maximize the acceleration.

Disadvantages:

- Low drivability; the complexity of how a manual transmission functions makes it harder for most people to use.
- The weight of the manual transmission is heavier compared to the CVT and automatic transmissions.

V. Concept Selection

Table 1: Decision Matrix

Concepts	CVT	AT	MT	WEIGHT
Durability	1	2	3	10%
Maintenance	2	1	3	5%
cost	1	2	3	15%
Reversibility	2	3	1	10%
Drivability	3	2	1	25%
Acceleration	3	1	2	15%
Energy Efficiency	2	1	3	10%
Weight	3	2	1	10%
Weighted Total	2.25	1.8	1.95	100%

Due to the result of our decision matrix, CVT is the concept we choose finally.

Description of all criteria:

- Durability: The ability for the transmission to withstand wear, force or pressure. How well the transmission works in different situations.
- Maintenance: The time period for the transmission to be maintained, like changing transmission oil. The distance of the transmission that can be used before being maintained.
- Cost: Money needed to spend to purchase the transmission.
- Reversibility: Whether the transmission has reverse function or not.
- Drivability: The quality of being easy or pleasant to drive.
- Acceleration: The increase rate of speed. How fast can the Baja with this transmission accelerate to a certain speed.
- Energy Efficiency: The ratio between the energy output to axle and the input energy from the engine.
- Weight: The mass or quantity of matter contained by the object in consideration.

VI. Project Plan

Progress Update

Currently our team is behind in our current project plan. There are multiple outstanding events that must take place before we can progress as planned. Firstly, we were behind on our calculations because the team had prior obligations that we were all more concerned with. Thus, we have dedicated the week of October 29th to finish the calculation without fail. Secondly, we

need money. The Baja Team has put together a proposal to be distributed to local and related businesses as well as family members to fundraise the appropriate budget. Until we have reached this budget the physical ordering of our parts has been put on hold. This is reflected in the project plan, so hopefully we will be able to order by the end of November.

Gantt chart

The figure below (**Figure 11**) is the outline of our current project plan which is followed by the visual representation of this outline.

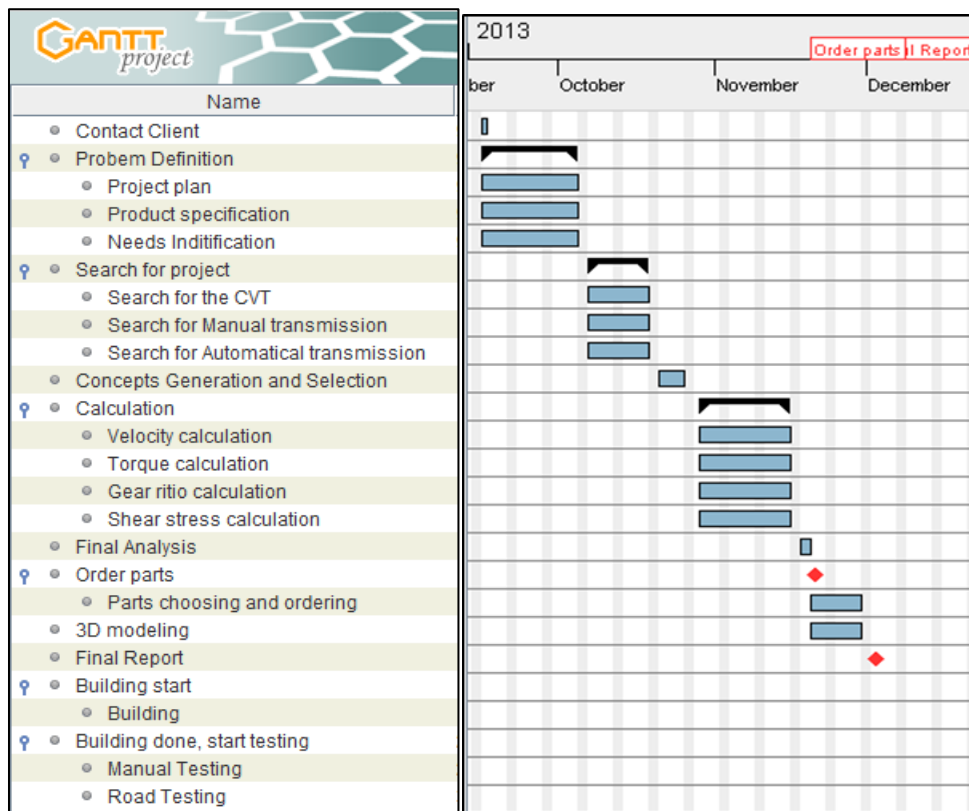


Figure11: Gantt Chart Outline

VII. Conclusion

In conclusion Concept 1 – Continuously Variable Transmission is the best possible solution to our particular problem. Our criteria were based on both what the team identified as desirable traits as well as our customer’s needs. **Table 1** above clearly depicts how our team came to the decision on Concept 1. We had a preconceived notion that this is the concept we wanted to go with because not only did the Drivetrain Team want to use this system, but the Baja Team as a whole want to as well. We came to this conclusion first because the top competing teams at this event use CVT drivetrains. Then, secondly our decision matrix confirmed that this would be our best possible solution. Moving Forward all of our calculations and design will be based on the assumption that we will be using a CVT or torque converter to perform in the SAE Baja competition.

VIII. References

- Continuously variable transmission (CVT)

Available:

d2t1xqejof9utc.cloudfront.net/files/19153/eti_19_CVTransmission.pdf?1363999370

- CVT Transmission

Available: www.insightcentral.net/encyclopedia/encvt.html

- How Manual Transmissions Work

Available: www.howstuffworks.com/transmission4.htm

- A Short Course on Automatic Transmissions

Available: www.carparts.com/transmission.htm