VEX Robotics Competition "Make it Real" CAD Engineering Challenge

Team 6546B

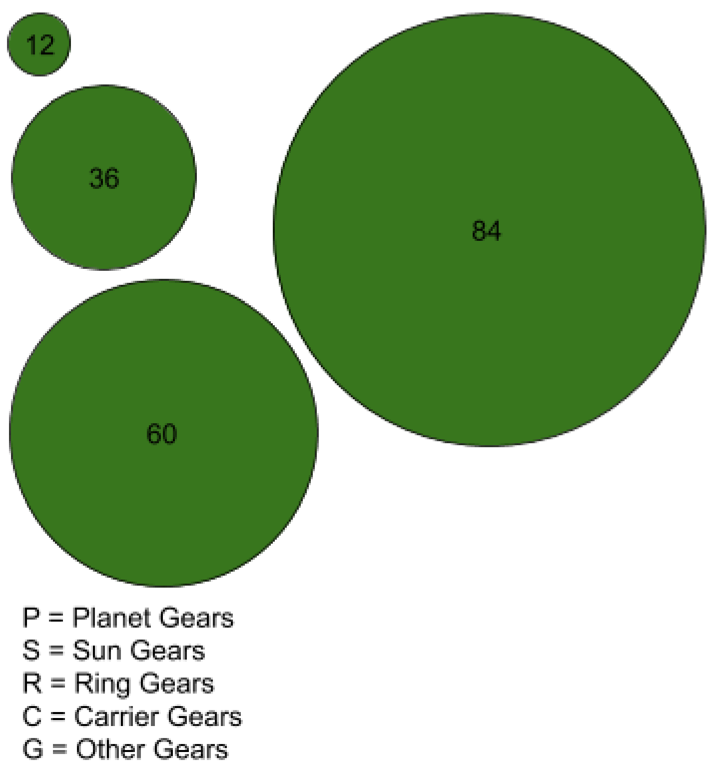
Introduction:

During our robot's construction, we faced numerous challenges with the functionality of motors and the systems of mechanism we attempted to employ. We tried implementing solutions such as ratchets, transmissions, or other techniques, but most were unreliable, and produced inconsistent results.With the chance to design and create a new part in VEX, we knew exactly what we were going to work on: the **Planetary Gearing System**

Explanation of the Part:

For our project, we implemented existing VEX gears and the 3D parts we created to assemble the planetary gearing system. We used VEX gears for the sun and planet gears, as shown below, and we custom-made the ring and carrier gears. In our implementation, the part allows for three different gear ratios and one mechanism, although you could add more mechanisms and ratios.

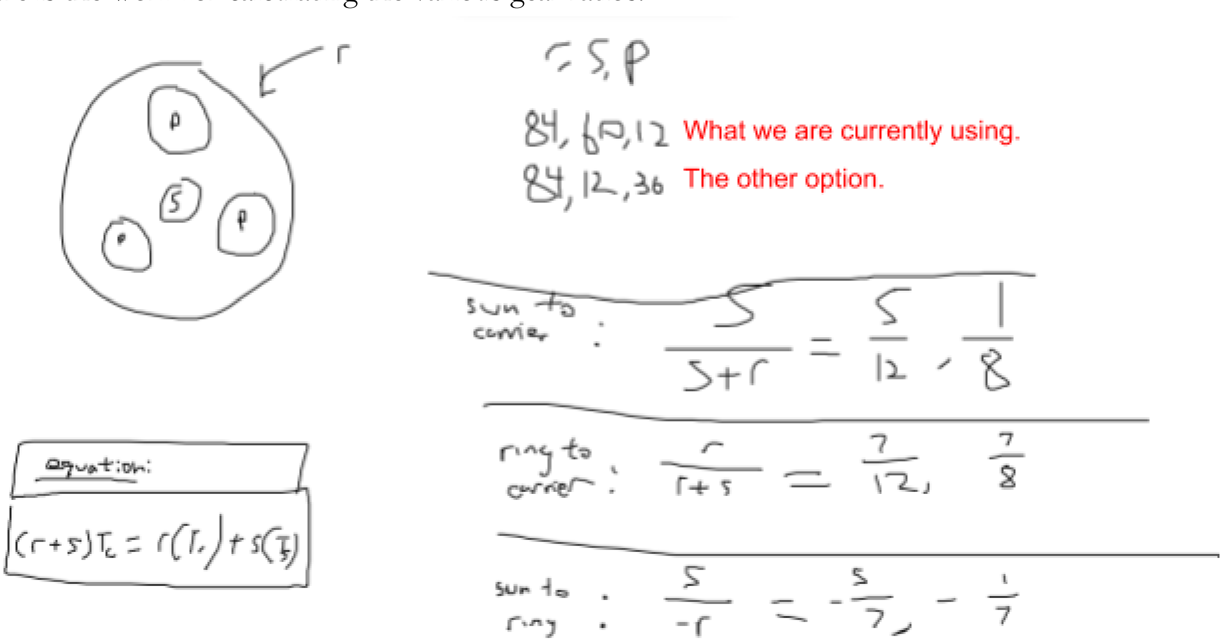
Key:



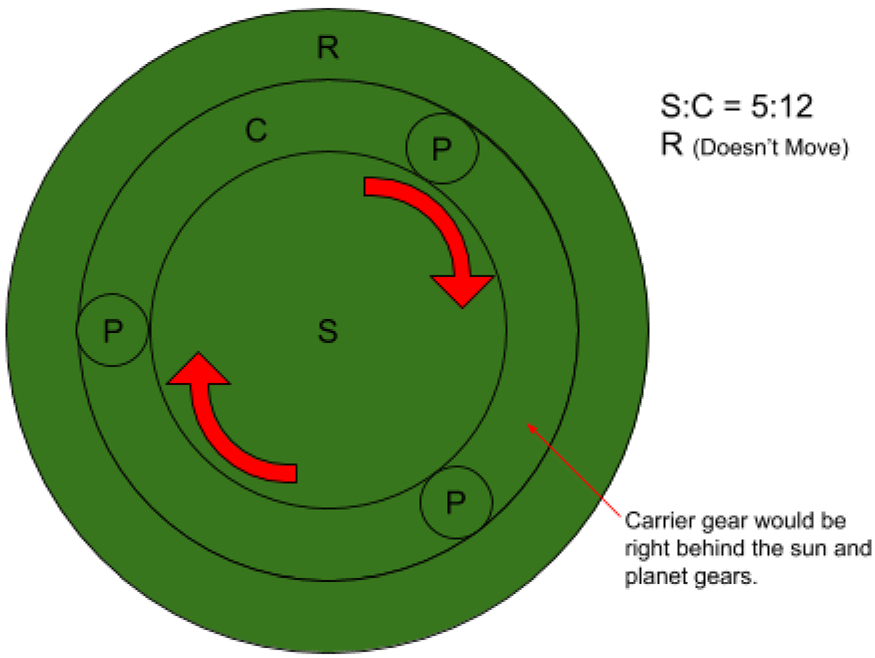
In a conventional planetary system, you would have a ring gear, where there are teeth on the inside of it, and a sun gear in the middle, and planet gears that spin around. Contrasting, these planet gears have shafts that go into the carrier gear.

Our planetary gearbox is customizable. We can change the sun gear to a 12 tooth gear, and the planets to 36 tooth gears.

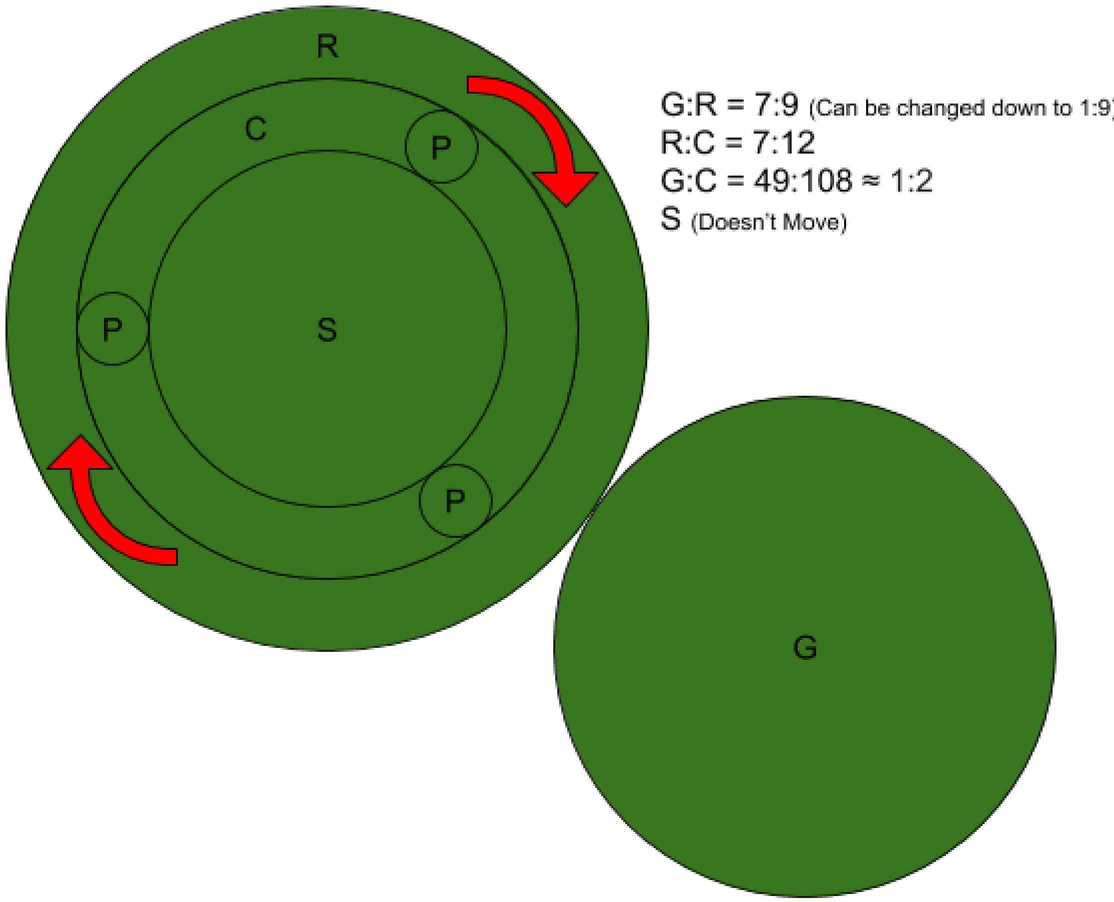
Here is the work for calculating the various gear ratios.



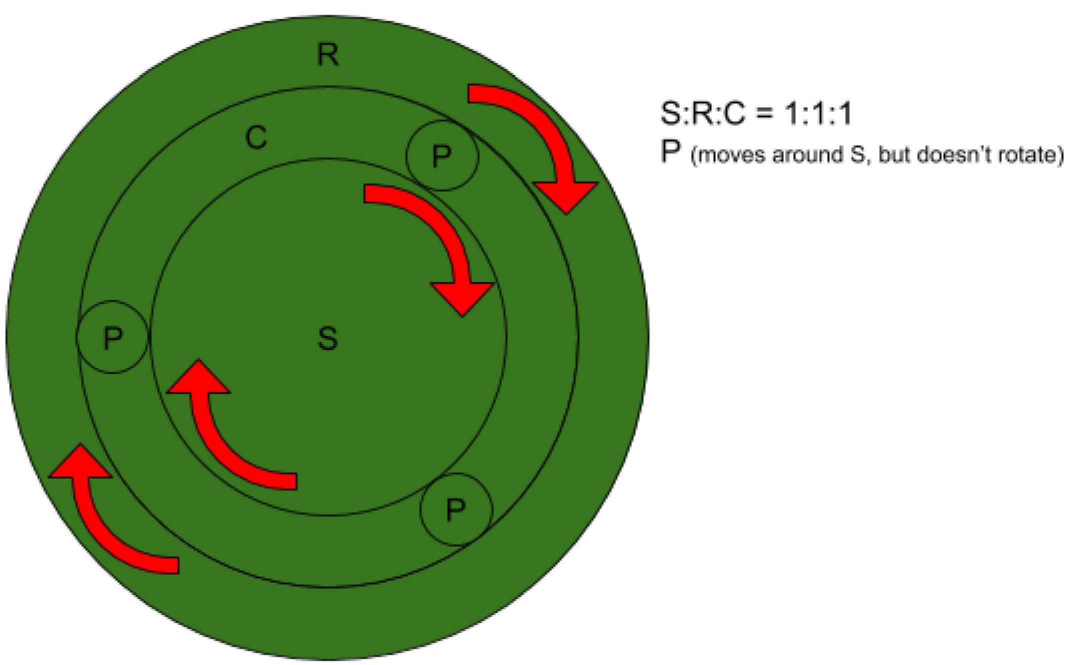
Here is a model of the planetary gearbox we built.

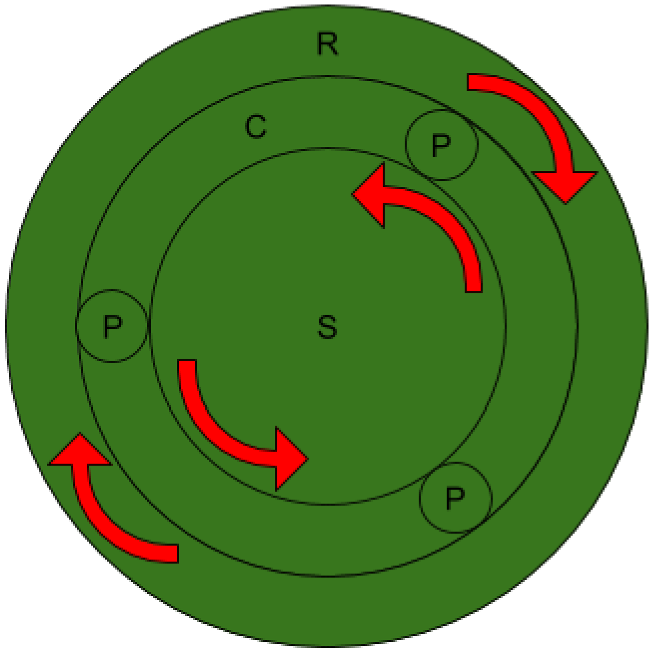


Powering the ring gear with another gear opens up many options.



In order to have a 1:1:1 gear ratio, the gear driving the ring gear would need to be an 84 teeth gear (creating a 7:9 gear ratio), and the sun gear's motor would have to be spun at 7/9 speed.





Possible Uses for a Planetary Gearbox:

Many advanced mechanisms could be built. A three-speed drive base could be built. (The drive base would be driven off of the carrier gear) When the sun gear is turning on its own, the drive base would have a 5:12 gear ratio. When the ring gear is turning on its own the drive base would have an approximately 1:2 gear ratio. When the ring gear and sun gear turn simultaneously, the drive base gear ratio would be a 1:1 gear ratio, but with torque from both motors. When the sun gear and planetary gear are spinning in opposite directions, the ring gear can spin by itself without interfering with the drive base.

Another option is to build a differential. This can be done by powering the sun gear with one motor and the carrier gear with another motor. When the sun gear and carrier gear are powered in the same direction, both systems are fully powered, but spin in the same direction. When the sun gear and carrier gear are spun in opposite directions, the carrier gear's system is powered, and the ring gear turns in the direction of the carrier gear. If only the sun gear is spun, the carrier gear stays in place, but the ring gear can be run. If only the carrier gear is spun, the sun gear stays in place, but the ring gear can be spun. This allows you to have 4 different speeds for the ring gear, while also powering another mechanism from the carrier gear.

Software and Design Process:

Upon the creation of our part, we implemented the design process to ensure we created a good piece.

We had achieved the ‘empathize’ step through our own personal experience. After our struggles to couple multiple mechanisms with motors, we understood that there were problems with the reliability and functionality of current motor solutions.

Then, we needed to define the problem. When looking at our robot performance and possible improvements, we were able to identify a problem: we wanted a better solution to improve the functionality of motors, specifically with speed transmissions and split transmission.

The longest step for us was ideation, as we needed to think of a solution to the problem as well as attempt to design it using Fusion 360. To begin, we researched possible solutions, but we found our solution in our very own robotics lab. We discovered a compact gearbox called a planetary gearbox. Upon further exploration, we discovered that it was the ideal solution to our issue.

We continued ideation on paper, designing possible prototypes, and we found multiple solutions. However, in order to implement actual VEX gears in our solution, our most efficient solution involved a ring gear that wrapped around the planet gears and a carrier gear that would be attached to the planet gears with axles. We modeled our design in Fusion 360. After multiple troubleshoots, we were able to successfully model the planetary gearing system.

The next step was to prototype and test. We utilised Markforged 3D Printers to print a prototype..

We now have a functional planetary gearbox. The planets can move around the sun, and the gearbox could be applied to all of the aforementioned concepts.

Conclusion:

Our team got to create a piece that could possibly be used in a real-world situation, and we learned more skills regarding design process, determination, 3D modeling, and more.

In our opinion, the most useful skill learned was the design process. The prototyping and creation process was exciting as well as surprisingly insightful. We learned how to ideate, solve problems, and persevere, which is definitely going to be crucial in the future.

Furthermore, learning advanced skills with Fusion 360 is something that was extremely useful. Upon creating a working part, we could understand and appreciate the usefulness and applicability of using Fusion 360 to make custom parts or even just ideate. Not only would this be extremely useful for more advanced robotics applications, but 3D modeling and printing has great potential for applications in fields ranging from engineering to biotechnology,