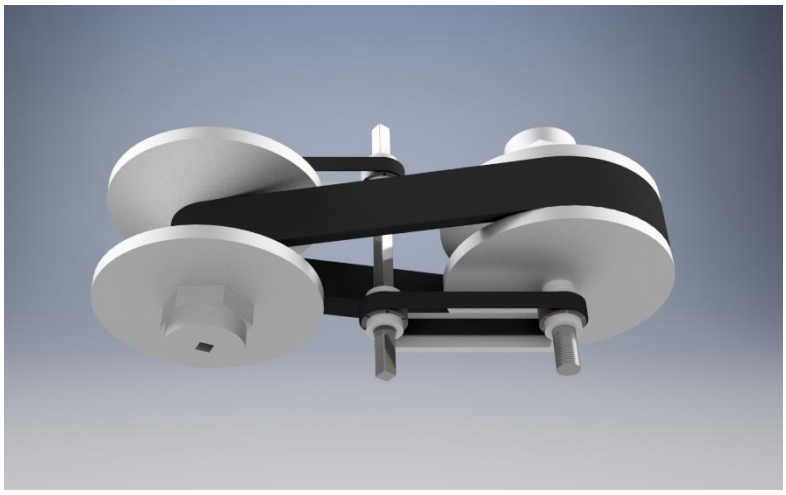
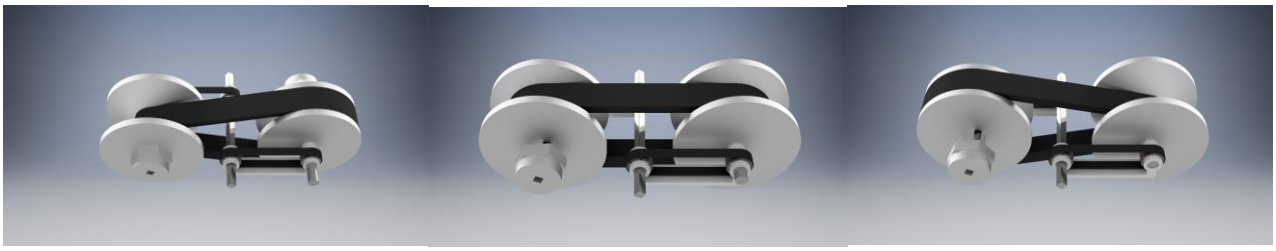
Talking the Torque

Whenever we go to VEX EDR competitions, the general consensus is that a functioning, single-unit gearbox would be a useful addition to most robot designs. Whilst it is plausible that you can create your own makeshift gearbox out of existing VEX parts, getting it to work consistently is challenging due to the fact that the parts will not fit together properly in this way. For this reason, I decided to design a contained unit that functions like a gearbox using Autodesk Inventor Professional 2017.

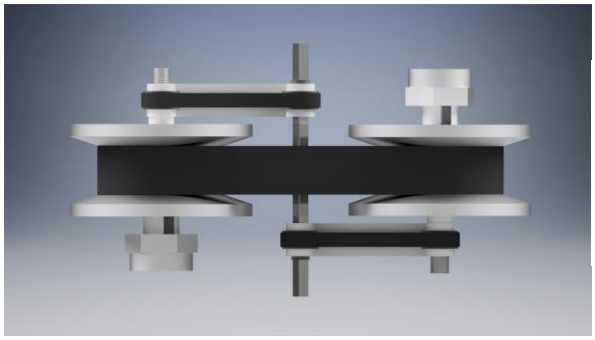


The new part that I have designed is a belt-driven Continuously Variable Transmission (CVT). Effectively, this means that the unit can smoothly alter the gear ratio from 1:4 to 4:1, and every possible ratio in between. The transmission works by changing the distance between two pairs of two conical discs, therefore changing the diameter of the belt at each end. It is important to note that only one of the discs in each pair actually moves, and the moving discs are diagonally opposite to each other. The discs change distance by driving two threaded rods that move the discs forwards and backwards. One of these rods is a left hand thread, whereas the other one is a right hand thread. This is deliberately designed so that both of the rods can be turned in the same direction, but the discs move in opposite directions relative to their respective belts. These two rods are belt-driven by one central shaft that controls the gear ratios.



Change in gear ratios due to moving positions of discs

Due to the unit's diagonal symmetry, the input and output ends of the CVT are interchangeable, which ultimately improves the usability of the unit.



Top view of the internal assembly showing the diagonal symmetry of the unit.

Gear ratio set to 1:1

Some examples of how the CVT would be used on a VEX EDR robot are as follows:

- A drive-train that can change between high speed and high torque. This allows for fast movement around the field, but then a quick gear change to resist shoving. This will also free up the number of motors that you have at your disposal
- Accelerating a flywheel. This means that you will achieve a nice and smooth acceleration curve, putting less strain on the motors
- Lifting game objects with different weights. This allows you to have extra speed with lighter objects and extra strength with heavier ones, making the lift mechanism more efficient

To design the CVT, I used Autodesk Inventor Professional 2017. I thoroughly enjoyed designing with this software, and I utilised a variety of techniques, including:

- Constraint Limits. This enables moving the discs only the distance that they are allowed to move
- Mirror Pattern. This sped up the design process, as I only had to design half of a symmetrical part
- Measuring Tool. This ensured that the CVT was compatible with standard VEX parts
- Parameters. These were used to link multiple dimensions with a Maths equation
- Sweep Tool. This extrudes a 2D sketch along a path

From this project, I learned how a CVT actually operates so that I could accurately design one for a VEX EDR scenario. After having done extensive research on the topic, I discovered that a CVT is superior to a standard gearbox in many contexts due to its smoothness and increased torque. As I plan to enter an engineering and design profession, I find using Inventor very useful, because it has given me the basic skills necessary for the software that are not taught in schools.

At our club, we believe in always designing before you build. Whilst this may take more time than building from scratch as you go, ultimately, it means that the robot gets built once, and built correctly. This saves a lot of time in the long run, as we do not have to go back and fix problems that would not have occurred had the robot been designed first. Due to this structure, using Inventor is extremely useful, as we have detailed designs that can be assembled relatively quickly to present to the builders. Also, in terms of documentation, Inventor allows access to previous CAD models, so that earlier ideas can be revisited and developed.

In the future, I plan to continue using Autodesk Inventor Professional in a career context, and also to complete passion projects.