VRC High School - CAD Engineering Challenge Sponsored by Autodesk

"Variable Tensioner" For Maintaining Chain Tension

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1 Introduction

In VEX, two fundamental ways of transferring power or altering the speed of rotary motion include gears and sprockets. While both have their advantages, sprockets (and chain) are able to transmit motion over a large distance between two points while maintaining the same direction of rotation. However, sprockets and chain bring the problem of having to keep the chain in tension to prevent slippage and inefficient power transfer. When both sprockets are in fixed positions, the distance between sprockets is constant and chain remains in tension. However, when one sprocket is allowed to move, the distance between sprockets may change, hence increasing or decreasing chain tension:

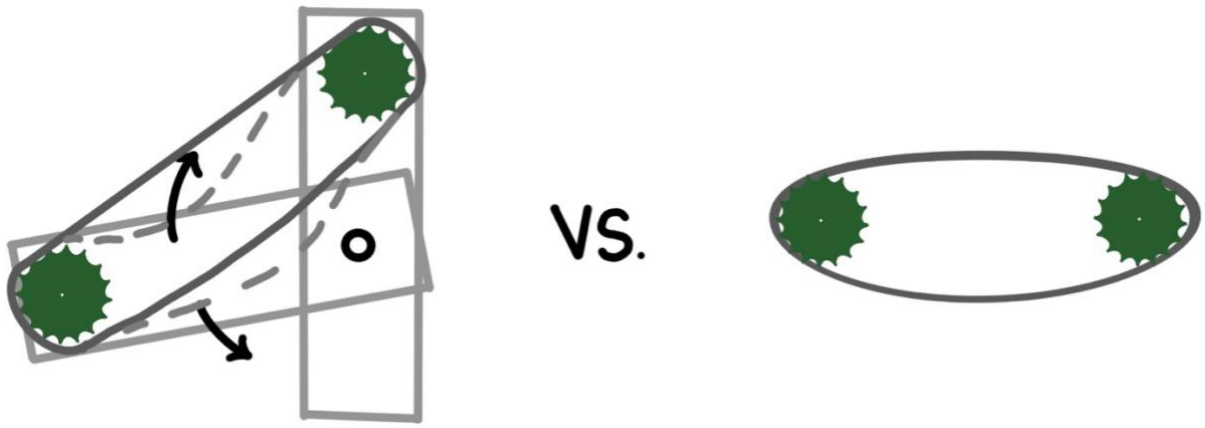
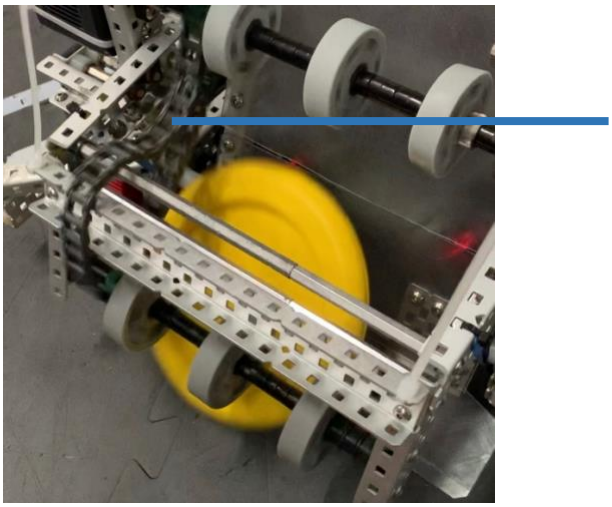


Figure 1.1 Loose chain on a set of sprockets on a hinge, vs fixed sprockets

This becomes an issue especially on intakes for Spin Up, where the sprockets cannot be fixed to more effectively intake discs:



Chain dipping downwards as distance between sprockets decreases

Figure 1.2 Loose chain when intaking a disc, after the sprocket moves

2 Conceptualization of variable tensioner:

Due to this, a simple solution would be a variable tensioner, a variation of a traditional tensioner able to consistently keep chain tight and in contact with the sprockets. A variable tensioner made with vex parts can be seen below:

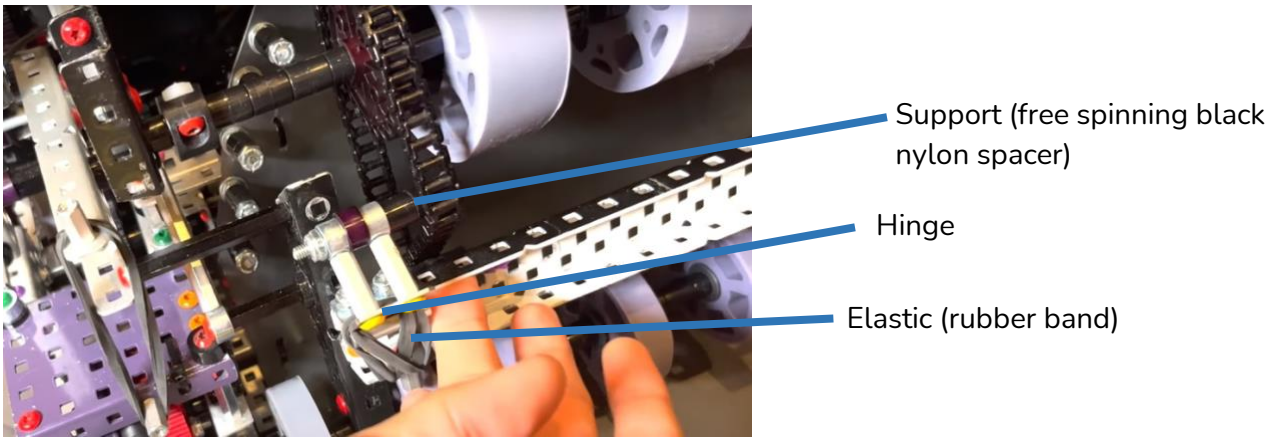


Figure 2.1 606X's original variable tensioner (cited below)

A variable tensioner consists of a hinge, a form of elastic to keep chain in tension, as well as a resting point for the chain. We wanted to adapt these parts of the tensioner to try and make it as simple and low-profile as possible.

3 Product

To aid the process of visualisation and design, we used Autodesk® Fusion 360™ software version V.2.0.14567 on Windows 64-bit, a potent 3D modelling piece of software that is implemented by designers and engineers.

Initially, the sketch function was used to illustrate the measurements and shapes of the product. The inspect function was used to find the dimensions of VEX square holes on aluminium channels and screw diameters. Shaping-forming features such as the cylinder and extrude from sketch make up individual components of our products, such as in the hinge's protrusions (see below), which will then be moved and attached together using the move and combine features. Lastly, the fillet tool was used to round off edges in the product, allowing it to distribute stress over a broader area and reduce material use. Below shows the dimensions of the variable tensioner:

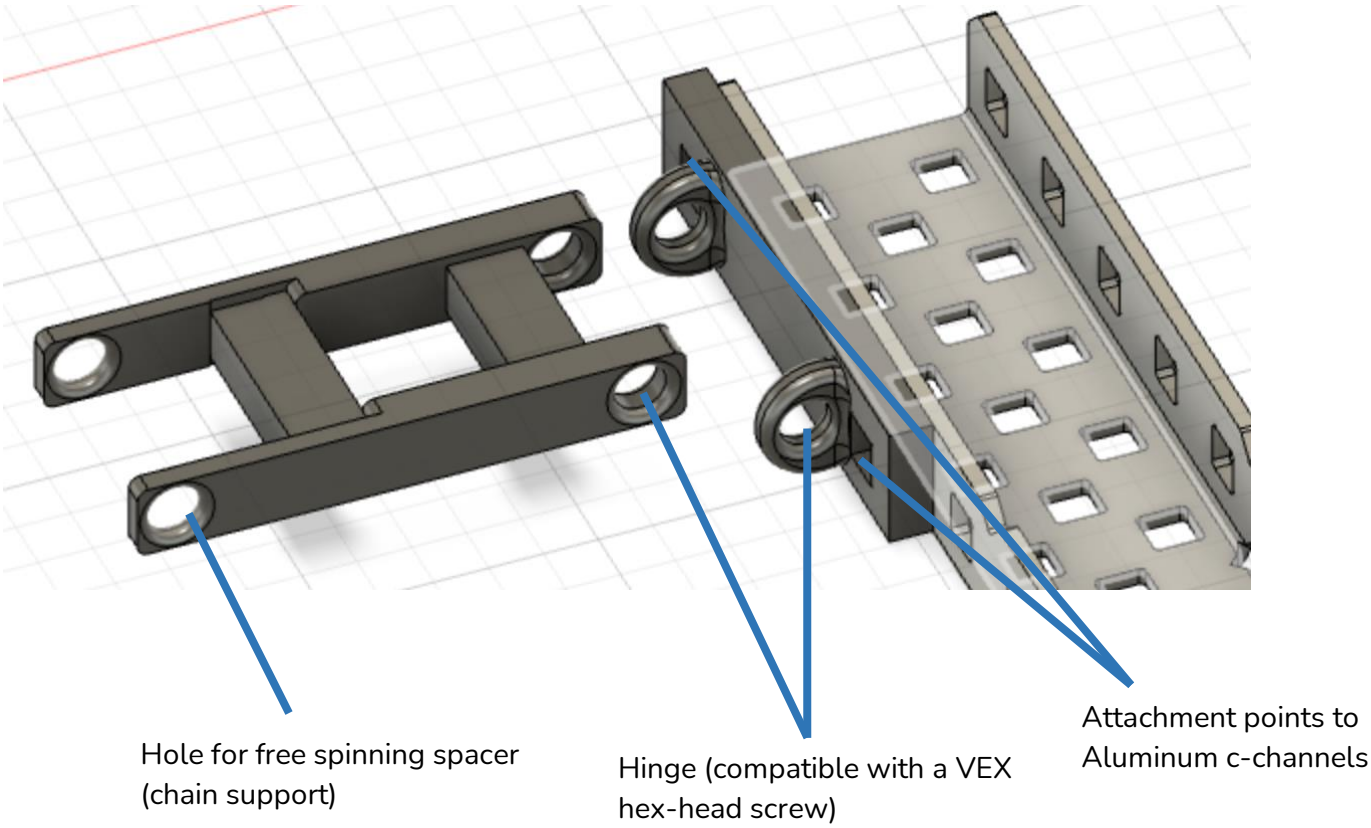


Figure 3.1 Overview of the variable tensioner (support on the left, hinge on the right)

Figure 3.2 Final printed hinge design

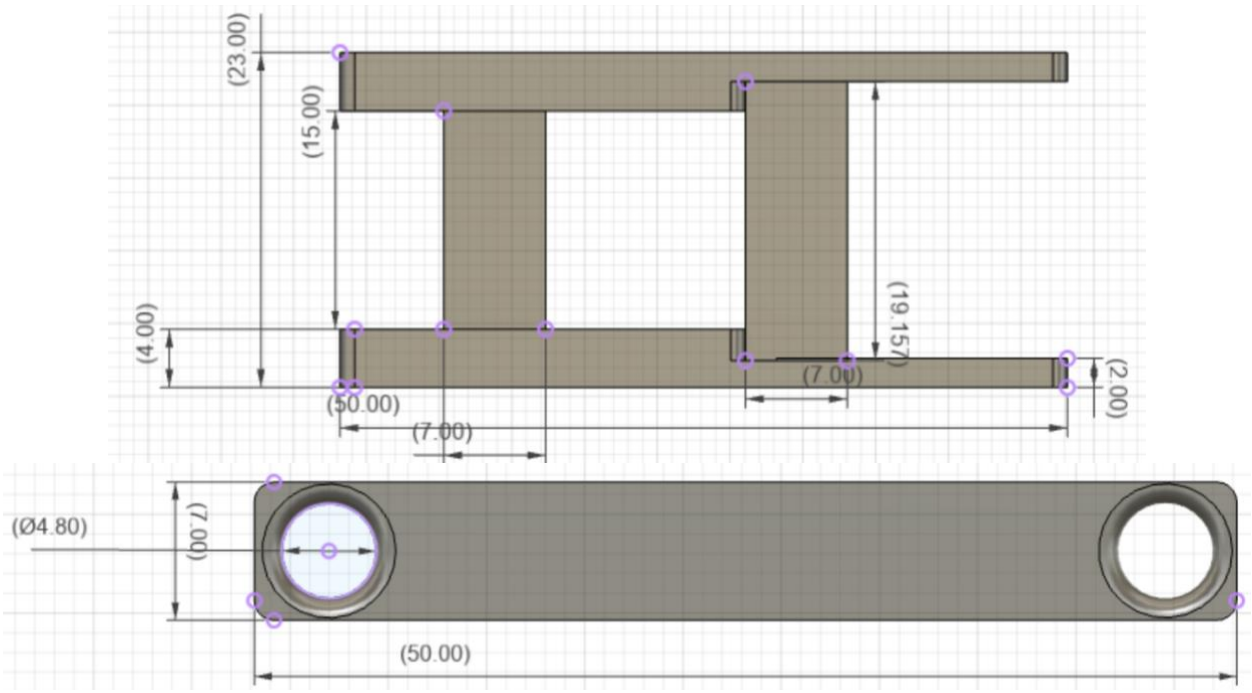


Figure 3.3 Dimensions of the support arm

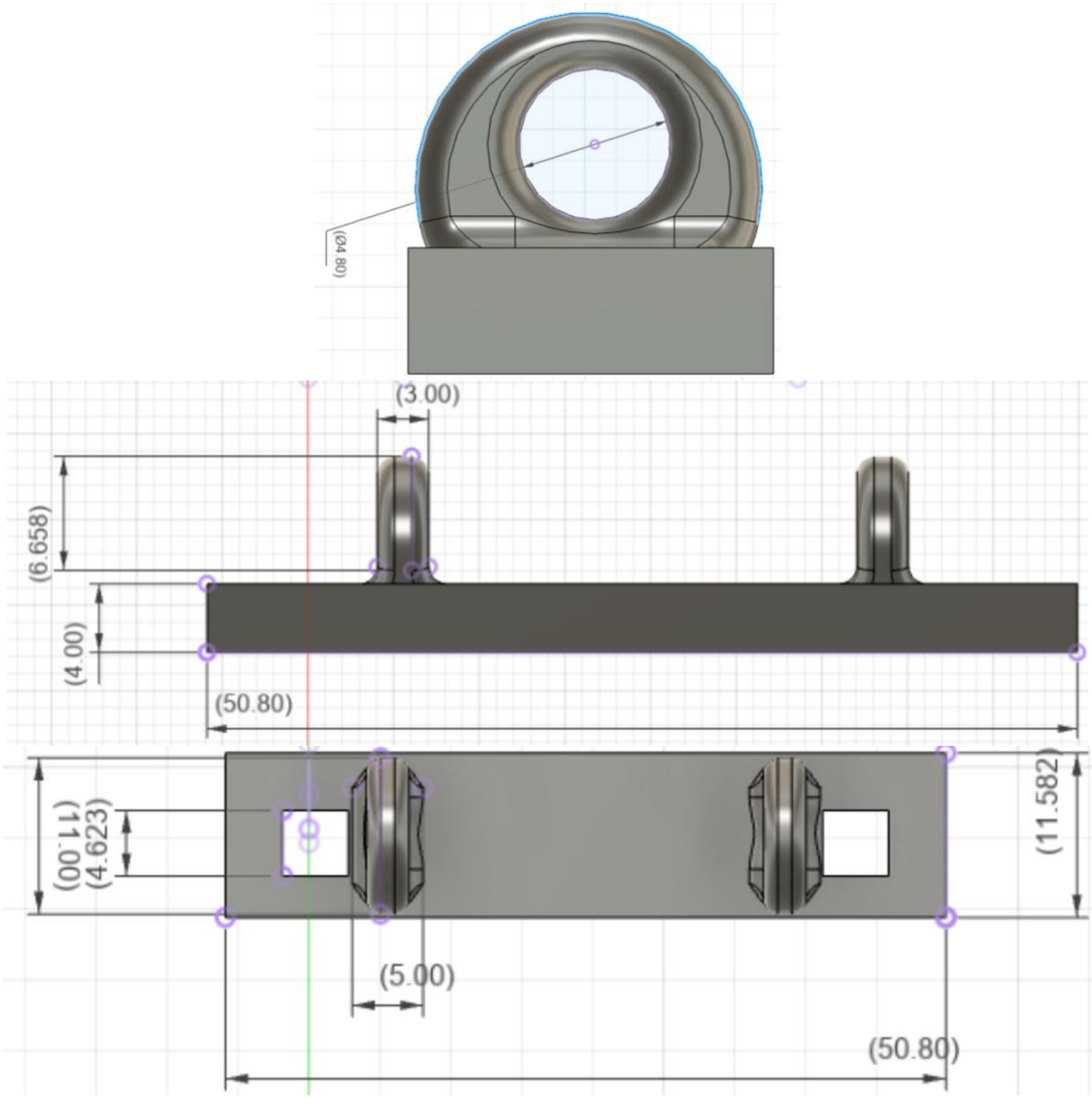


Figure 3.3 Dimensions of the hinge

Collectively, the tensioner has a length of around 61.582mm, with each of the circular holes measured to vex screws to ensure the an accurate diameter of approximately 4.800mm. The square holes on the hinge align to traditional VEX aluminium channels, with the hinge being 50.800mm wide or around 4 holes wide. The width of the arm is 23.000mm, able to fit between the protrusions on the hinge and able to more freely once attached together. Once printed, the holes on the arm will be compatible with vex screws. One end will be connected to the hinge while the other will have free spinning spacers to support the chain, reducing friction. Overall, a simple and space efficient design was achieved, drawing inspiration from VEX pillow block bearings as the hinge structure.

4 Application

Once placed on the robot, we tested how the tensioner would help support chain at different degrees of movement as seen below:

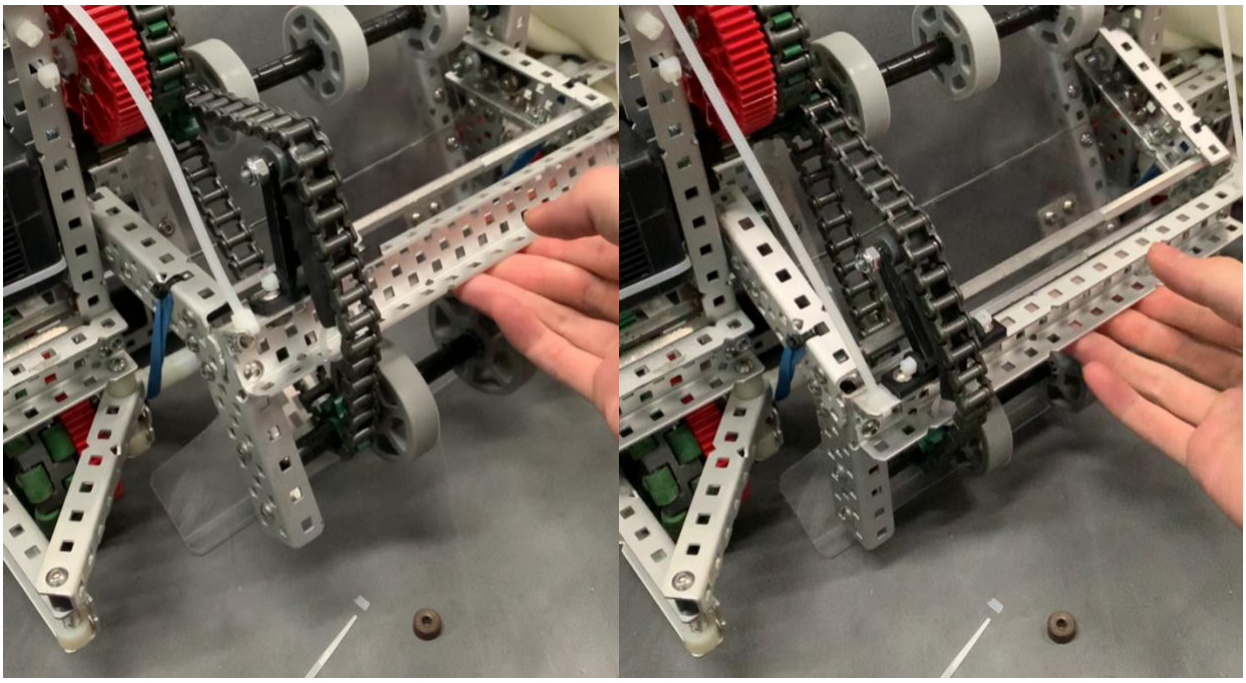


Figure 4.1 Chain getting looser as sprocket is lifted (left), chain at original height with no movement (right)

As seen from the picture, the tensioner is able to move to differing degrees based on the amount of excess chain due to movement. As the sprocket moves upwards, the chain gets looser as the distance between the sprockets decreases. This allows for the tensioner to be pulled by the elastic, ensuring the chain is stretched at kept in tension at all points:

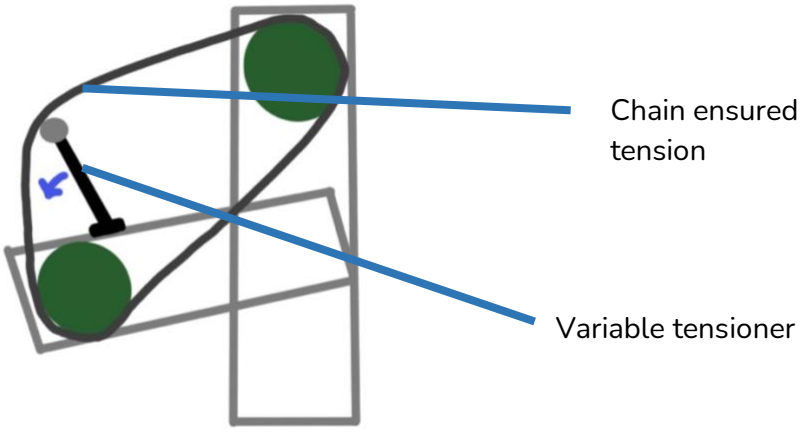


Figure 4.2 Chain getting looser as sprocket is lifted, allowing the tensioner to move and maintain chain tension

At its original and static position, the distance between the sprockets is greater and the chain gets tighter. The tensioner then moves backwards to compensate for the decreased distance, maintaining chain tension:

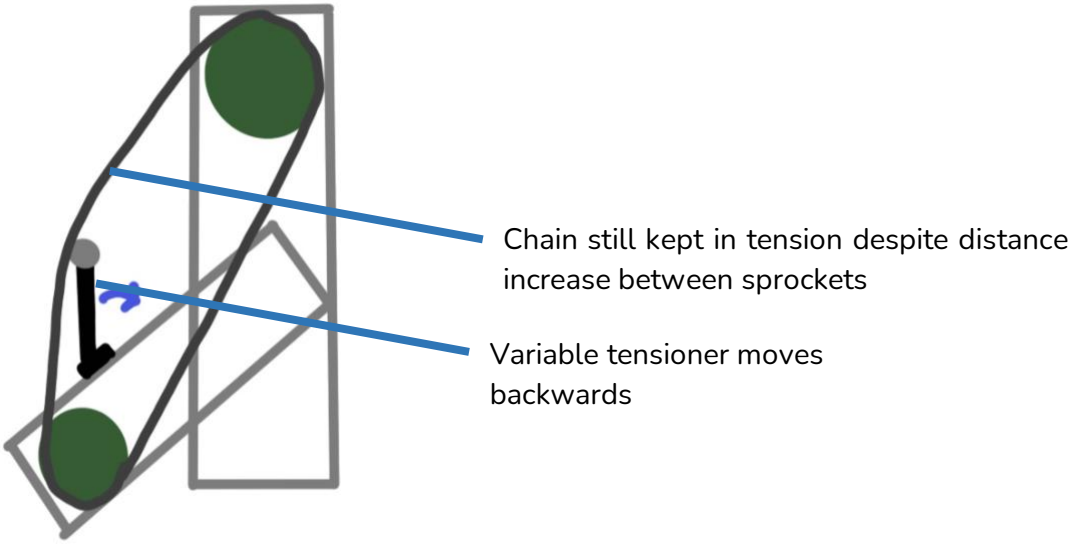


Figure 4.3 Chain getting tighter as sprocket moves back to its original position, allowing the tensioner to move back and maintain chain tension

Several pros over a tensioner made from VEX parts include simplicity, space and weight saving capabilities. Making the hinge a single part makes it lighter and require less tuning to achieve low friction. Usually, a simple hinge is made easiest by the VEX metal hinge, however, it may sometimes be too large or have too much friction for some applications. With the use of a single, cohesive part, friction and weight is reduced greatly, being printed with light-weight high strength PLA filament. This decreases the need to over-use elastics to compensate for friction in the hinge and the weight of metal components, ensuring only the minimum force required to support the chain is used. This makes for a simple-to-tune and more efficient design over typical tensioners, ensuring the force exerted by the tensioner on the chain is not so great as to generate unwanted friction, while maintaining even tension.

5 Conclusion

The project prompted us to use Autodesk® Fusion 360™ as a means of conceptualising and actualising our creative products. We have learnt the different steps in the design process, including idealizing, prototyping, and going through multiple iterations before reaching the final product. This project was also a good introduction to the multiple tools in Fusion 360, and we would like to expand our skillset in the software for future projects.

This project also has given us a chance to explore our creativity in attempting to make product of our own discretion, allowing us to gain greater interests in STEM and creative direction. This experience will help us grow in our creativity through experimentation and implementation, which will stay with us as engineers through our journey in education.

6 Acknowledgments

606X Variable Tensioner - https://www.youtube.com/watch?v=cGFqv_vy0PU
All images are taken from or by 8059Z
Diagrams drawn via Procreate on IPad OS