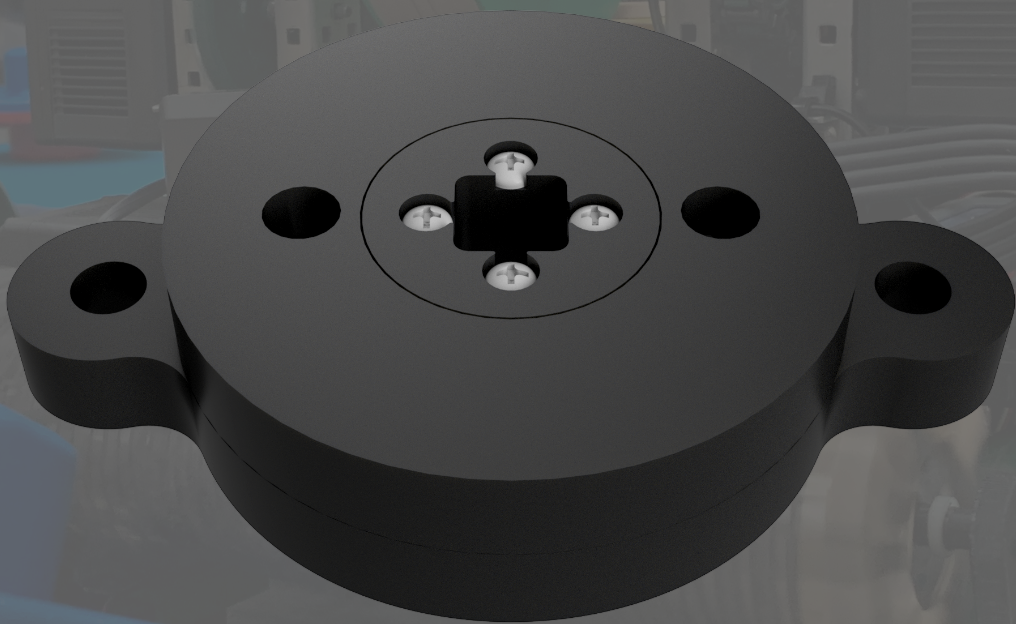
Low Profile Torsional Tensor

Final Report

2021 "Make It Real" CAD Engineering Challenge

Sponsored by Autodesk



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Context & Rationale

Insights into our development scope

Since its inauguration, the VEX Robotics community has been characterized for pushing the boundaries of robotic mechanisms to find creative solutions for complex problems. From a simple intaking system to an entire robot, teams have innovated approaches to mechanically expand various robot components to fulfill multiple tasks in an efficient manner. Most of these elements involve rotational motions that demand spring tension to facilitate their mobility and reduce stress in the motors. Historically, the use of rubber bands has become a standard material to provide the tension necessary for the expansion and functionality of such systems. The major disadvantage of this alternative is that rubber bands have a low fatigue limit after being subjected to long static loaded periods. Consequently, they minimize reliability since they require constant replacement and are known to snap during matches. To address this challenge, we proposed to design a light, simple and prospective substitution for the use of rubber bands in dynamic mechanisms. The addition of this part would maximize the consistency, reliability and ultimately the efficiency of a robot during any competition. Thus, this year, we engineered a Low-Profile Torsional Tensor that has the capability to employ spring tension in rotational movements and have excellent compatibility with current VEX Products.

Specifications & Platform Integration

Comprehensive technical description & VEX Applications

The part utilizes a torsional spring to apply a rotational force between two plates (Figure 1). Using #8-32 screws, each revolving plate can be attached to any structural components that rotate and require tension, as represented in Figure 2. If one of the rotating structures necessitates additional torque at its desired position, its corresponding plate can be wound to a maximum of 90 degrees. The axis of rotation contains a slot that can fit the High Strength Shaft and Insert Kits to yield a myriad of applications within the robot.

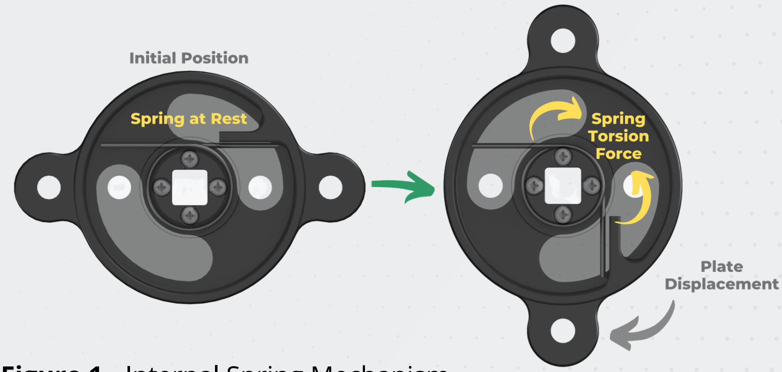

Figure 1 - Internal Spring Mechanism.

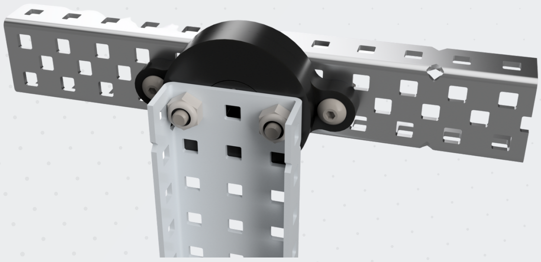

Figure 2 - Part attachment compatibility; requires four (4) #8-32 screws and nuts; two (2) for each plate.

The Low-Profile Torsional Tensor can not only be utilized for elements that commonly involve expansion at the beginning of the match such as intakes, trays, flywheel hoods and wheelie bars, it can also be applied in lifts and launching mechanisms that demand constant spring tension to lower stress in the motors.

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For systems that warrant large loads or displacements, multiple Torsional Tensors can be implemented in parallel or in series, as seen in Figure 3, to function accordingly.

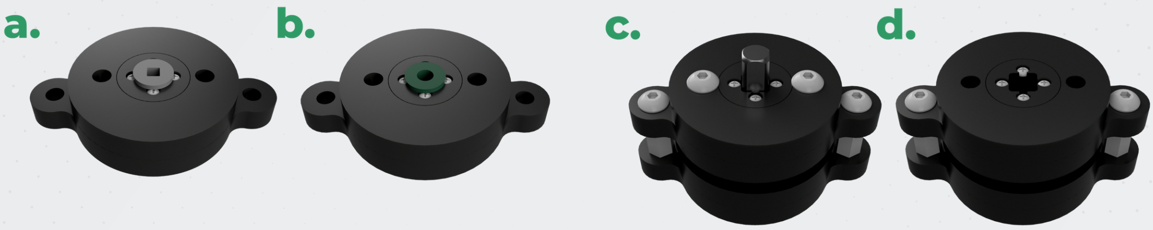

Figure 3 - Potential Setups. High Strength Shaft a) metal and b) plastic insert. c) Parallel setup for bolstered tension. d) Series setup for large displacements.

This elegant application presents an opportunity for students to learn basic principles of spring mechanisms. It is important to highlight that the Torsional Tensor requires external mechanical stops since it functions as a substitute for rubber bands and it is not designed to restrict the motion of heavy components. Refer to the Applications Guide for examples of potential uses of the product.

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Development Environment & Tools

Applied PMTs (Process-Method-Tools)

Autodesk Fusion 360

All the parts (Figure 4), assemblies and animations (Instructional Assembly Video) presented in this submission were designed with Fusion 360, version 2.0.9313. First, a two dimensional sketch was created with the desired geometry for each part and extruded to generate solid bodies. Similarly, sketches were drawn on the solids to remove or increase material in different areas to produce variations in depth and height. Outer part thicknesses are 0.5" and 0.25" as maximum and minimum respectively to simulate current nylon spacer thicknesses. Taking into consideration the VEX structural and hardware component measurements, specified holes were cut on the bodies to ensure seamless compatibility with current VEX products. The hole diameter corresponds to the standard #8-32 screw hole used for VEX Robotics flat bearings (0.168"). Center hole distances were designed considering the established space by the VEX Cortex and V5 platform (0.5" spacing per hole).

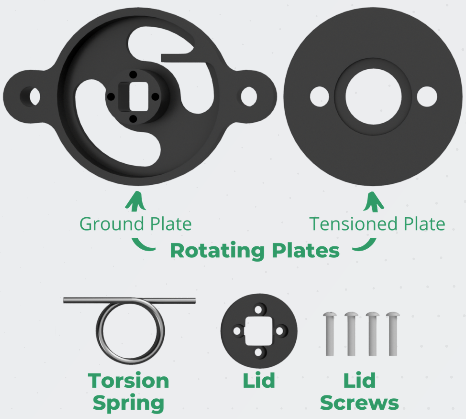

Figure 4 - Low-Profile Torsional Tensor Parts

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Applied PMTs (Process-Method-Tools)

Autodesk Fusion 360

The center axis slot (0.25” by 0.25” rectangle with 0.025” round edges) was deliberately designed to simulate the High Strength Gears slot to have the capability to insert High Strength Shafts or Insert Kits. The torsional spring was designed using the coil tool of the Fusion 360 software and specifications were defined based on standard commercial measurements. Both rotating plates contain a mechanical stop for each tip of the spring to ensure that tension is developed with torsion. The rotating plates are secured by a lid that is screwed onto the ground plate by four screws of equal diameter to the screws used to lock the V5 Motor Caps (0.7”). A schematic of the part assembly is seen in Figure 5 and technical drawings are presented in this submission as reference.

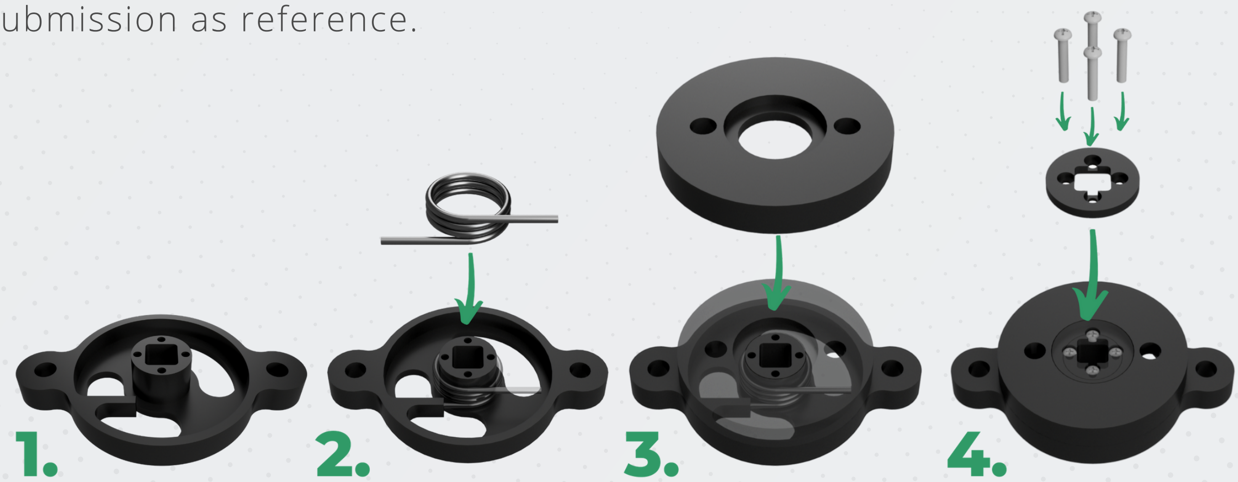

Figure 5 - Low-Profile Torsional Tensor Assembly. 1-2) Insert torsion spring. 2-3) Attach Tensioned Plate. 3-4) Screw lid onto Ground Plate with Lid Screws.

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Impact & Value

Component-driven and process-driven gains

Challenges like the “Make it Real” CAD Engineering Challenge helps us gain a deeper understanding of concepts like tolerances, compatibility, reliability and overall precision, which are necessary considerations when engineering new parts. This year, we are proud that we created a product that could be universally employed in robot components. Throughout our trajectory, AON Robotics has focused on designing and developing complete robot assemblies via 3D modelling before construction. Through this approach, we significantly reduce the time and cost of building the robots by preventing problems that occur during constructions and decreasing the amount of parts that we have to cut or modify. Furthermore, we can engineer custom parts with specific functionalities in our assemblies that can give us a competitive advantage by increasing the efficiency of our robots. As engineering students, learning to work with 3D design softwares allows us to attain pivotal quantitative skills that we can employ in personal and professional projects. From comprehending basic design limitations to optimizing part geometries through simulations, using Computer Aided Design programs like Fusion 360 helps us become better engineers capable of solving modern real-world problems.