Helical (Screw) Gear Final Report

2019 Make It Real CAD Engineering Challenge

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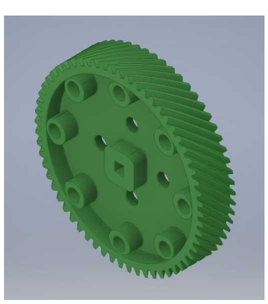
23 December 2019

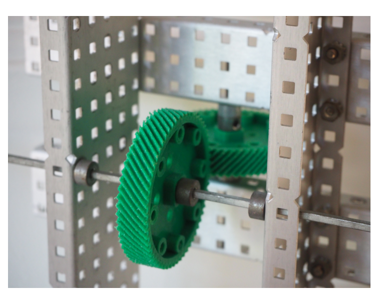
I. Problem Introduction

One of the least developed areas in current VEX robotics is nonlinear power transfer. Many new opportunities and mechanisms would be possible with updated and modern solutions to transfer power between axes. Currently, products exist such as the worm gear and bevel gears; however, these are often unreliable and difficult to utilize. From experience with bevel gears, one shaft is often left under supported due to the size of the gears and the inability to intersect axles and they are difficult to keep meshed correctly. As for worm gears, there is not much design freedom, as it is often a very slow gear ratio and power can only be transmitted efficiently from one direction.

II. Screw Gear Introduction

As a solution to these issues, I have designed for VEX an efficient and elegant real world solution: helical gears (also known as screw gears). These types of gears are used in car transmissions and machinery due to their unique properties. Not only do they allow for seamless 90 degree power transfer, but they can also be used as a quieter and smoother alternative to standard gears. These gears are identical to current VEX high strength gears, and are therefore compatible with current VEX shafts, metal and hardware. However, the teeth of the gears, rather than being straight, are set at a 45 degree helix angle and twisted around the gear. As previously mentioned, this allows for reliable nonlinear power transfer and a smoother alternative to standard gearing.





III. Perpendicular Power Transfer

The angled teeth allow for the axles of the gears to be placed perpendicular to each other and still function as normal gears. They efficiently transfer power between non-parallel and non-intersecting axles. Furthermore, because the axles do not intersect each other, the gears can be supported much better than with other methods such as bevel gears. Also, it is possible to create many more gear ratios on a perpendicular orientation than it is with other mechanisms. This is due to the fact that any of the sizes of gears are compatible with each other and are not constrained by size as with bevel gears, or limited due to the mechanism like a worm gear.

IV. Smoother Standard Operation

The angled teeth of the helical gear allow for smoother meshing and greater contact between the gears. Instead of the teeth contacting each other at once as in straight cut gears, helical gears are designed to distribute pressure gradually along the whole tooth. When the teeth engage on a helical gear, the contact starts at one end and slides to the other, effectively spreading out the contact forces and creating a smoother mesh. This result is proven by many real world mechanisms that use gears such as car transmissions/gearboxes, machinery, and complex equipment.

V. Design Statement

This gear design is to create a better alternative to bevel or worm gears with many more applications and improved reliability. The new design also can be used as an alternative to the current straight cut high strength gears for a smoother and quieter operation. The gear is compatible with current VEX Robotics design system components and modeled to the exact specifications of current gears.

VI. CAD Program and Method

To model the gears, I used the program Autodesk Inventor Professional 2017. By precisely measuring distances using calipers, I was able to accurately copy a tooth of an existing high-strength 60 tooth gear into Inventor. From this point I used the helical coil command to extrude the tooth upwards with rotation. By using the radius (r) of the gear to find the angle (θ) between the start and end of the arc (s) needed to put the teeth at the correct angle ($\theta = s/r$), I was able to use a proportion to find the exact number of rotations needed on the extrude to produce teeth with a 45 degree helix angle. I then arrayed the teeth around the centerpoint of the gear to create 60 teeth. Then, creating a series of cylinders, I was able to intersect the teeth with the solid surface of the gear and model the face to the proper dimensions.

VII. Project Conclusion

This project has had a positive affect on my ability to design, create and test 3D parts. I learned additional aspects of CAD through all of the trial and error that I experienced attempting to achieve the final product. My knowledge of the program is average but this competition has made me much more comfortable with specifically Inventor and similar programs. It was enjoyable to design a real world component that was useful, as opposed to the typical exercises that are required in a CAD course. Because of the experience I gained, I am likely to design more objects in the future. Now that I have a more in depth knowledge of the program, I can see more potential problems that can be solved or objects that can be designed through CAD programs. My goal is to be part of a VEXU team in the future, and this skill that I am developing will be invaluable when 3D printed components are legal. Likewise, the ability to model certain elements in CAD programs will help me on my current team as I can design ideas virtually and have a better representation of what the robot should look like. All of these skills will be very helpful in my future career path, as I plan to major and then work in engineering and engineering related fields. In all of these jobs, CAD skills are very important and used daily to design and create components for any given project. Therefore, this competition has not only furthered my skills in CAD programs, but will also improve my team's robotics performance and prove to be invaluable for my future career.