VEX Planetary Differential

Team ETC

Elgin Community College

Elgin, IL

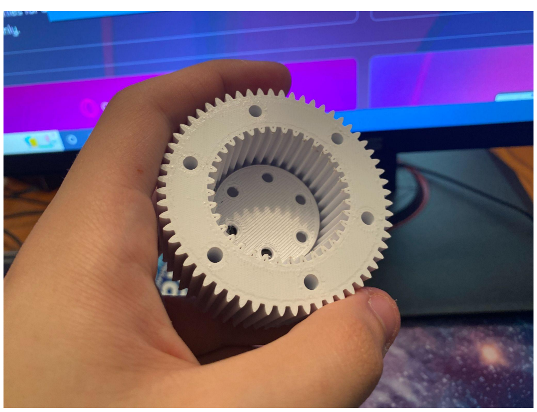
01/13/2023

Abstract

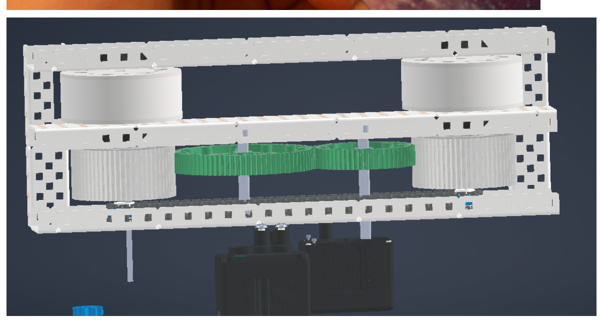
The VEX Planetary Differential gearbox is a third-generation design submitted for the VEXU CAD Engineering Challenge sponsored by Autodesk. By offering a small, effective, and stylish solution for power transmission, the design seeks to enhance the functionality of robots. This report will go through the third-generation gearbox design, including its compact size and effective power transmission, as well as the design process, including the use of Autodesk Inventor and the difficulties addressed. The challenge submission for the design includes a video showing the gearbox in use.

Introduction

My name is Brandon Lis, I am a student at Elgin Community Challenge, and this year, our team sought to design a low profile planetary gearbox. The VEX Planetary Differential gearbox is the third version of the design, each version aimed to improve upon the previous one. The first version of the design had issues with the tooth profile and screw fits, which were improved in the second version. The third version of the design was compacted further, and the original 608 bearing was replaced with a VRC legal bearing, suitable for High Strength axles. The second version of the design was produced using white PLA and tested on a dual set of prototype disc flywheels, capable of dynamically adjusting the two flywheel's speeds while sharing torque equally. It featured two motors, one which remained in one direction while shooting, and one which could adjust the curve of disc using the flywheel speeds, adding velocity to one flywheel and taking from the other. The maximum speeds ranged from 4200rpm on one flywheel and -600rpm on the other, to 1800rpm on both flywheels.

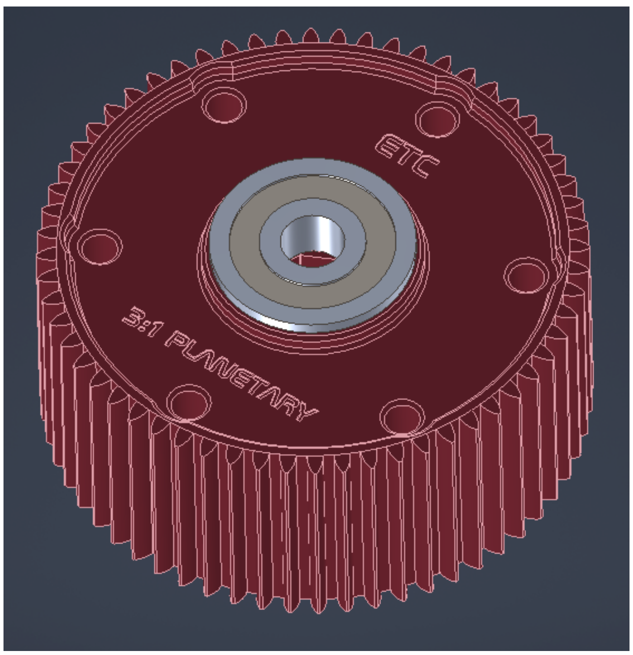


This prototype uses the older version of our planetary gearbox design.



Design

The gearbox is a two-part system, with a height of 1.27 inches and diameter of 2.58 inches, which is the same side profile as a 60-tooth gear. The gear ratio between the sun gear and ring gear is 3:1 relative to the planet carrier, and between the carrier and ring gear is 3:4 relative to the sun gear. The three stages of rotation allow for differential addition of velocity, and can be used to split power from one motor into two elements. A suitable formula for the speed of the ring gear is: "R = (4C - S)/3", where R is the ring gear, S is the sun gear, and P is the planet carrier.



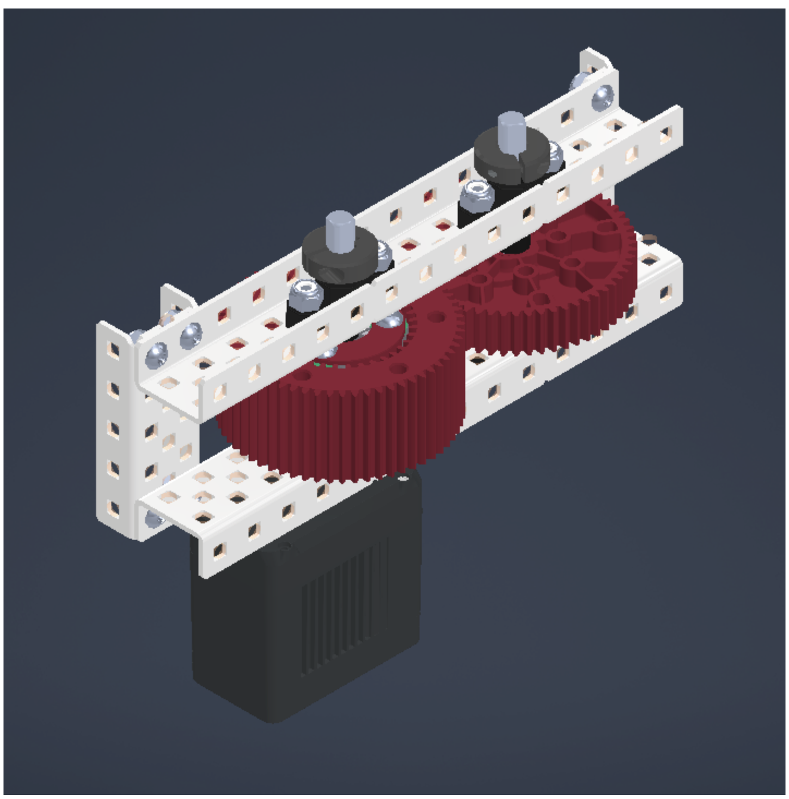
The third iteration of the planetary gearbox.

Efficiency

The planetary gearbox is efficient due to the lack of 90-degree power transmissions. Additionally, the VRC legal bearing used in the third version of the design is suitable for high-strength axles and improves the overall efficiency of the gearbox.

Design Work

The design work was done using Autodesk Inventor, our team's most familiar CAD software, with a combined experience of 4 years and approximately 400 custom-designed parts. Even with such experience, the design still required many full cycles of the engineering process, and challenged our team at first. The design process also included varied use of assemblies, drawings, and presentation files with Autodesk Inventor. The software version used for the design is Autodesk Inventor Professional 2023.1, and the testing included PLA plastic parts, graphite dry lubricant, and were measured for concentricity using a dial gauge and a manual lathe.

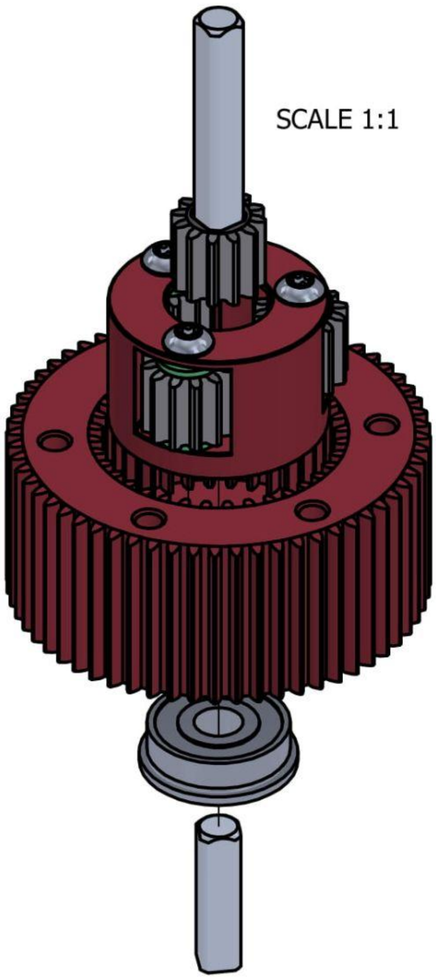


An example of a motor splitting power between two outputs.

VEX Planetary Differential

Conclusion

Designing the VEX Planetary Differential gearbox has been a challenging but rewarding experience for our team. The third version of the design improves upon the previous versions by incorporating a VRC legal bearing suitable for high-strength axles, and compacting the design further. A compact, effective, and aesthetic method of power transfer is provided by the gearbox design, which opens up more accessible complex gearings for teams which may have been hesitant to do so before. I believe the skills and knowledge gained from this project will be helpful in our future designs. I also invite the readers to watch the included video in the submission to see the gearbox in action.



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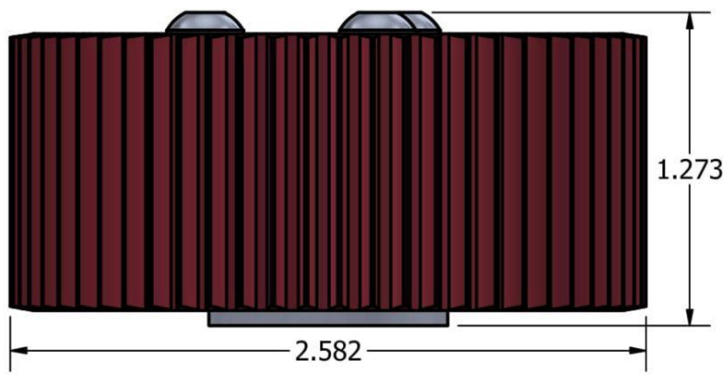
PARTS LIST		
ITEM	QTY	PART NUMBER
.302" (1/4" ThunderSquare) ID x 0.875" OD x 0.280" WD (Flanged Bearing)	1	217-5830
12T High Strength Metal Pinion	4	276-2251
Metal Shaft Insert	6	276-3881-002
#8-32 x 7/8" Star Drive Screw	3	276-4995
2" High Strength Shaft	1	276-7465
1" High Strength Shaft	2	276-7465
Planetary Gear Carrier	1	ETC-3471
Planetary Gear Ring	1	ETC-3472



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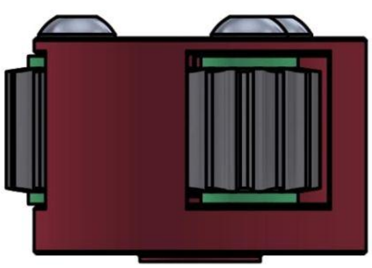

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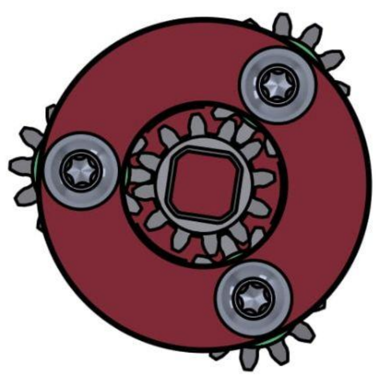

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DRAWN Brandon Lis	1/13/2023	ETC ROBOTICS	
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APPROVED			
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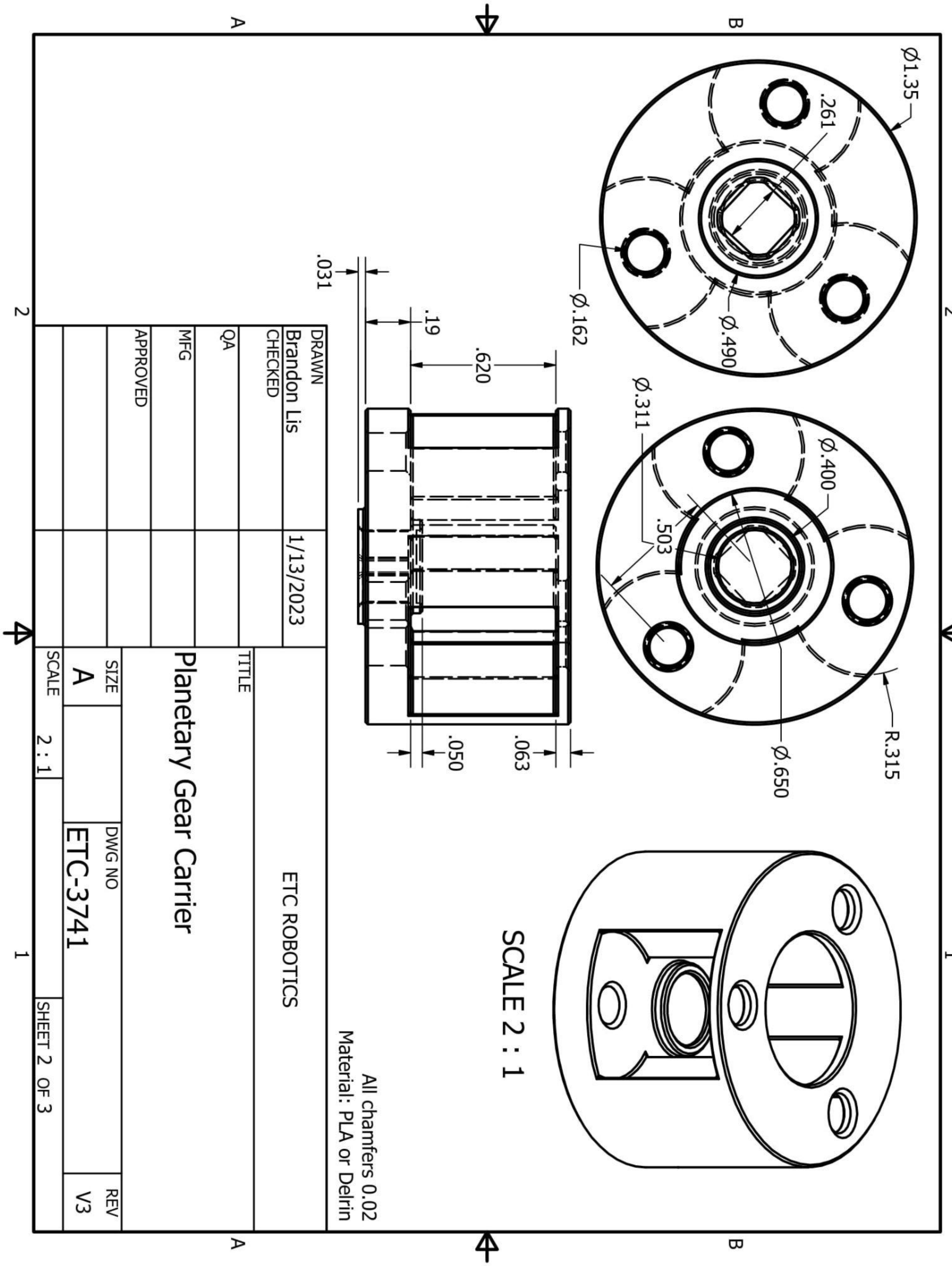
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Brandon Lis
1/13/2023
CHECKED
QA
MFG
APPROVED
ETC ROBOTICS
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ETC-3741
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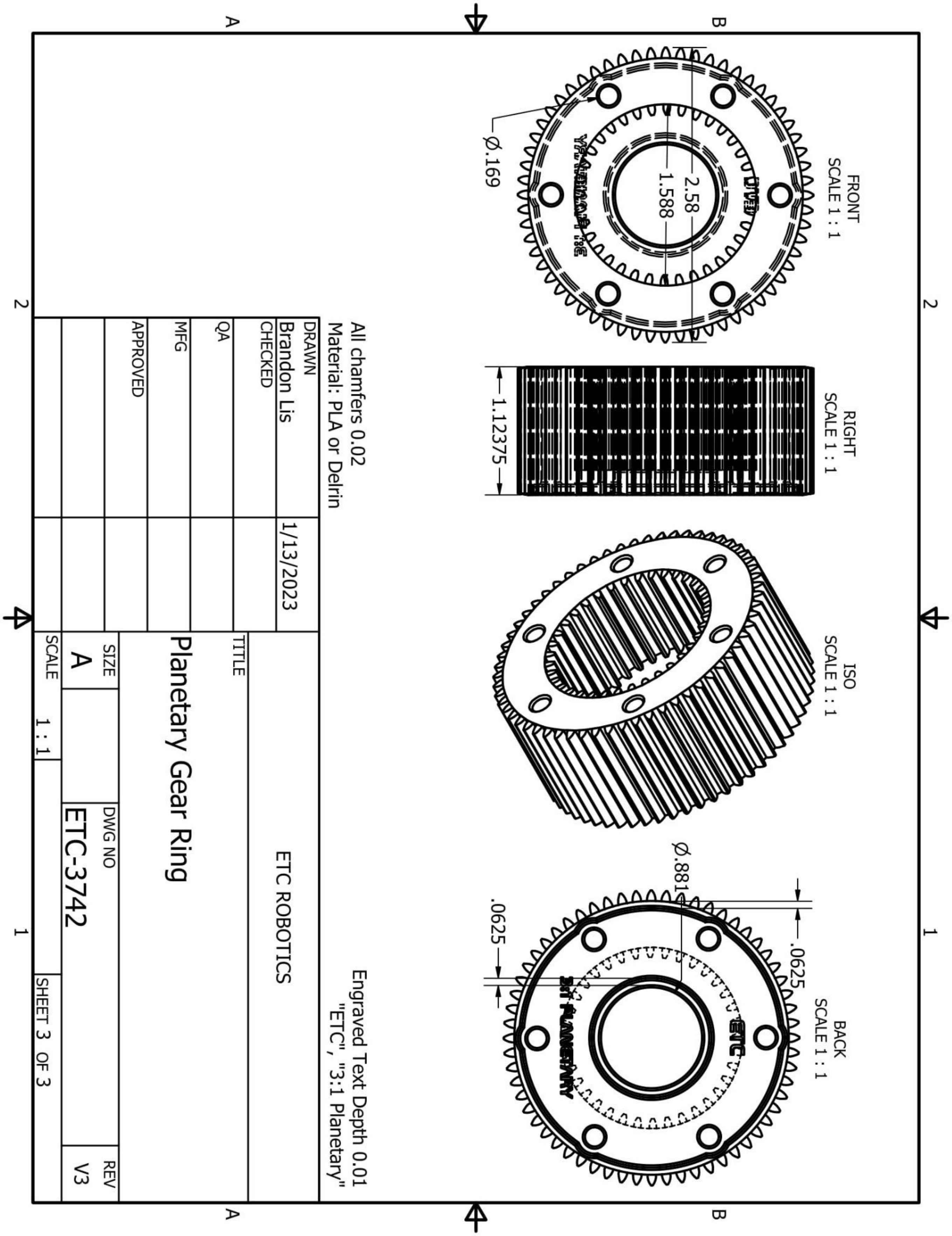
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Brandon Lis
1/13/2023
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APPROVED
ETC ROBOTICS
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SIZE
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DWG NO
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REV
V3
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SHEET 3 OF 3