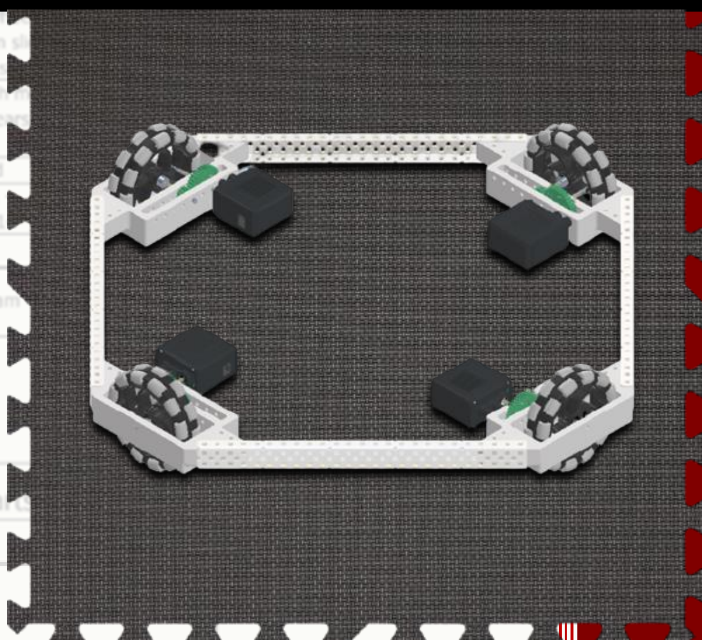
VEX Online CAD Challenge



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2 INTRODUCTION

An X-Drive [Figure. 2] is as easy to build as the more common Tank Drive [Figure. 6] but provides significant additional agility because of its angled wheels and ability to drive sideways. Normally, wheels need to turn for the robot to turn. However, since the X-Drive restricts the wheels from turning, the robot is forced to strafe, effectively increasing the travel distance per rotation in comparison to other VEX Drivetrains. This ability also improves performance during the autonomous competitions.

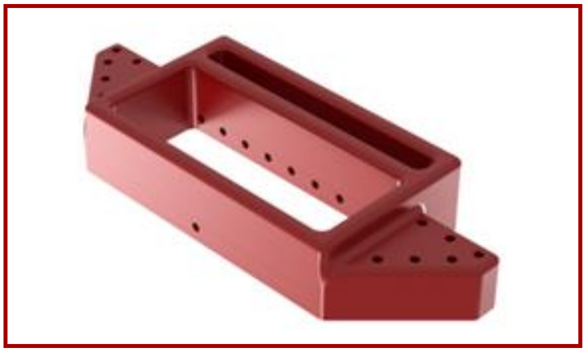
As the most agile type of VEX Drivetrain, maximizing the X-Drive's overall efficiency will greatly improve its chances of game success. The wheel bay being presented is a device that allows for significant reduction of the amount of substructure components needed to assemble the X-Drive. Being that the sub-assembly dedicated to the intake is the most critical in this year's competition, it is imperative that the robot is designed to maximize all possible spacing for the intake system.

3 STRUCTURE

3.1 BACKGROUND

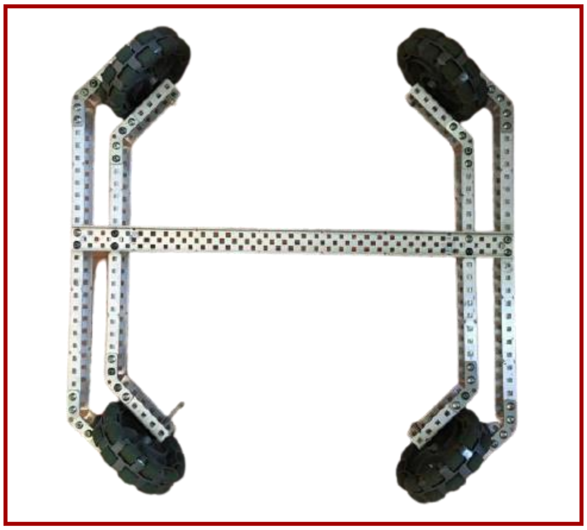
With the wheel bay [Figure. 1], the implementation of an X-drive into a robot is made easier while remaining space conscious.

FIGURE 1: WHEEL BAY



In VEX robotics, most components in the structure subsystem come in a variety of shapes and sizes to allow for other VEX parts to be connected. While the standardization of these parts is useful, it also confines builders to the set measurements of VEX parts. For example, the following figure (Figure 2) is an example of a common x-drive design.

FIGURE 2: BASIC X-DRIVE



To maintain the sturdiness of the structure, a series of c channels wrap around the outside of the wheels to hold them in place. While this does address the problem of providing stability to the wheels, this also takes away space from the intake system and makes the robot heavier due to the extra parts.

3.2 FUNCTIONALITY

The wheel bay offers an upgrade for a standard x-drive chassis, reducing the size and weight of a robot [Table I.]. The reduction in weight may reduce the load on the drive motors, potentially increasing the speed of the robot. The reduction in size of the chassis also offers more space within the size limits to dedicate to other subsystems such as the intake.

Furthermore, while the wheel bay was designed to function with VEX 4” omni-directional wheel, it is also compatible with the 2.75” and 3.25” omni-directional wheels as well.

FIGURE 3: X-DRIVE WITH WHEEL BAY

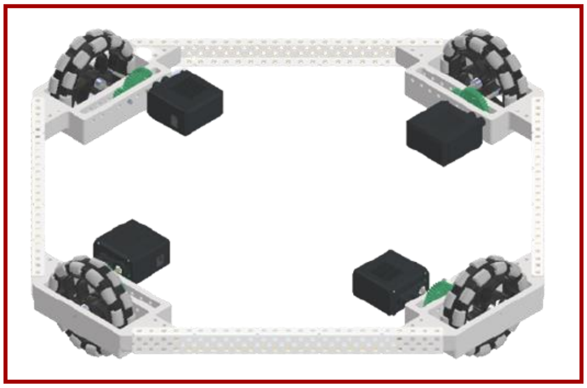
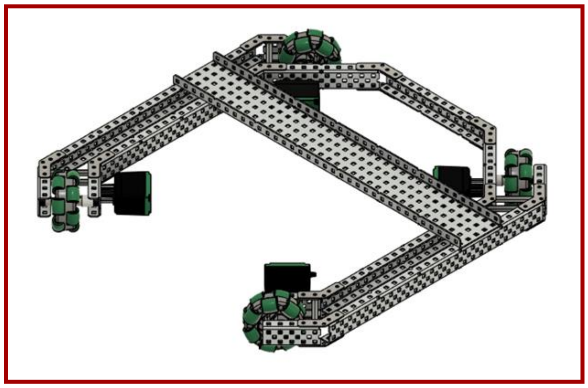


FIGURE 4: X-DRIVE WITHOUT WHEEL BAY

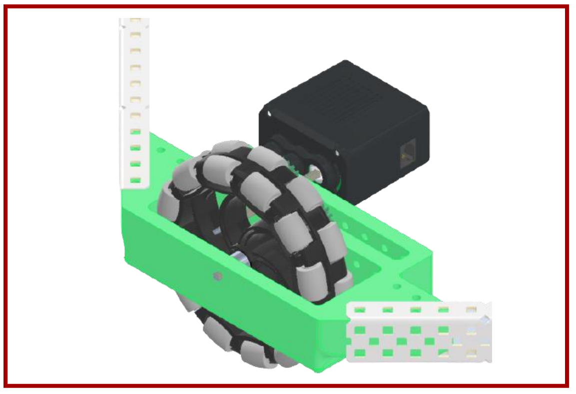


To make an X-Drive without the wheel bay requires almost double the substructure components, consequentially doubling the weight of the robot structure as well. There is also a significant size reduction of at least 2” (may be more depending on the wheels used).

Being that the wheel bay is made of plastic and permits an X-Drive to be built with less components considerably reduces the weight of the structure. Since one major objective of this year’s game is to “own” a row of goals, it is imperative that the robot be fast enough to go on the offensive and be able to quickly switch to the defensive since descoring a goal is relatively simple. The lighter a robot is, the faster and more agile it becomes. Not to mention the extra space allows for a more intricate intake and output design.

Furthermore, the wheel bay provides ample space for a wheel and gears and allows for effortless part replacement since the wheel bay is only component directly connected to any c-channels.

FIGURE 5: CLOSE UP VIEW OF WHEEL BAY



4 DATA

4.1 WEIGHT COMPARISON

TABLE I.

With Wheel Bay	Without Wheel Bay
1518 g	1590 g

The table demonstrates the weight difference between figures 2 and 8. Overall, there is a 5% weight difference. Any cutdown in weight has a chance to significantly increase speed and agility. It also increases motor efficiency as motor productivity decreases with additional load.

5 METHODS

5.1 AUTODESK APPLICATION

All parts were created using Autodesk Inventor including,

- The wheel bay
- Assembly X-Drive with the wheel bay
- Assembly X-Drive without the wheel bay
- Drawing files

Fusion 360 was utilized to create the stress analysis and shape optimization files.

6 CONCLUSION

The idea of the wheel bay stemmed from the desire to create an x-drive design that minimized space and maximized fabrication ease and functionality. This was to be achieved by creating a chassis around the wheel and by utilizing Inventor, many designs were created and refined before the final product was 3D printed.

Along developing time management and task allocation skills, a deeper understanding of the importance of continuously rectifying one's designs was established. The wheel bay presented will save valuable time and energy and will be adopted in our future robot designs.

7 Appendix

FIGURE 6: STANDARD TANK DRIVETRAIN

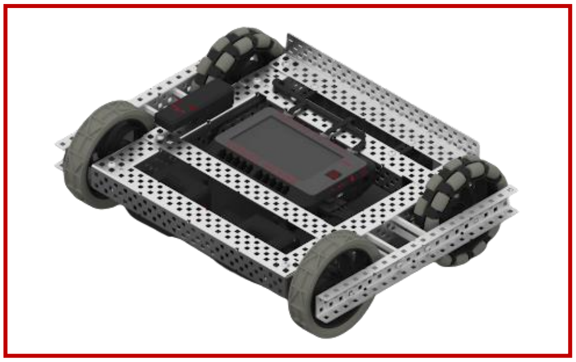


Fig. 6. The figure above is a demonstration of a common tank drivetrain design used in VEX Robotics. The rendering was taken from the VEX wiki page.

FIGURE 7: TANK DRIVETRAIN WITH WHEEL BAY ATTACHMENT

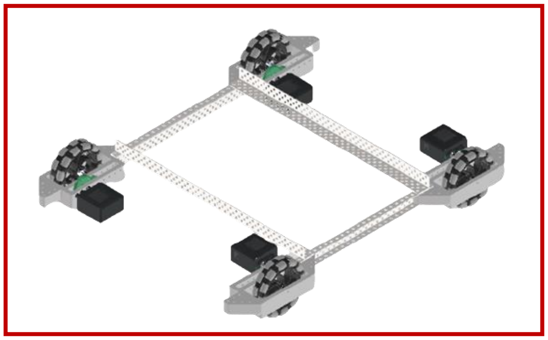


Fig. 7. The figure above is a rendering of what a tank drivetrain would look like with the wheel bay.

https://wiki.purduesigbots.com/hardware/vex-drivetrains

FIGURE 8. X-DRIVE WITH WHEEL BAY

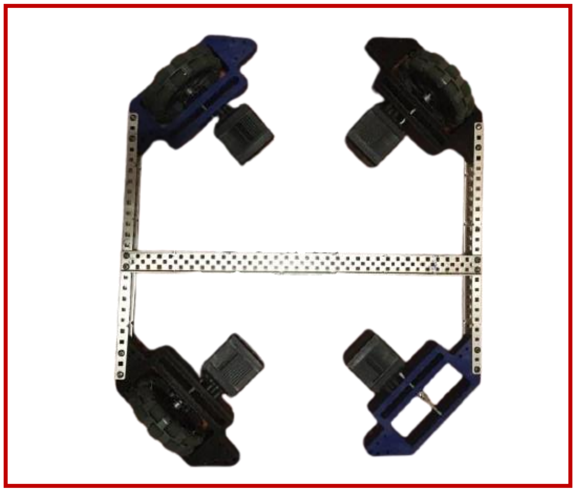


FIGURE 9: 3D PRINTED WHEEL BAY

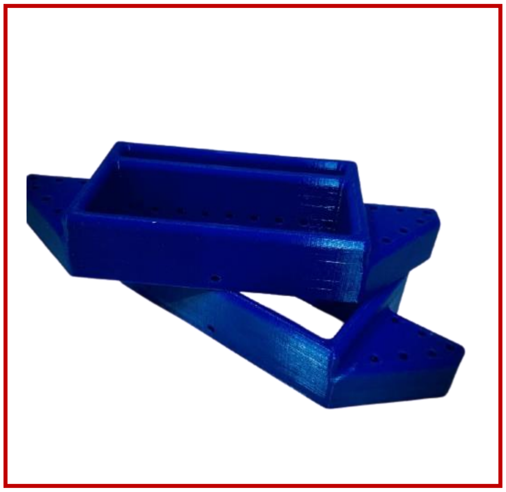


FIGURE 10: DISPLACEMENT SIMULATION

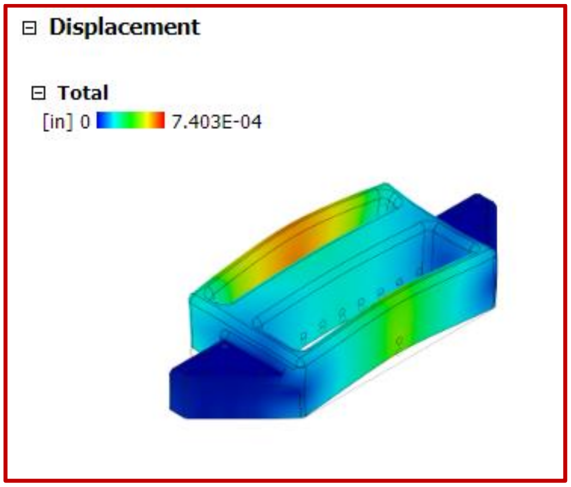


Fig 10. Deformation shows how much the modular wheel bay will deform under load.

FIGURE 11: STRESS ANALYSIS SIMULATION

Fig 11. Static stress demonstrates how the modular wheel bay will deform under load.

FIGURE 12: SHAPE OPTIMIZATION

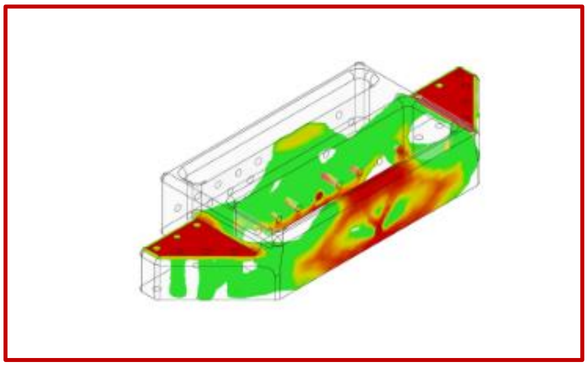
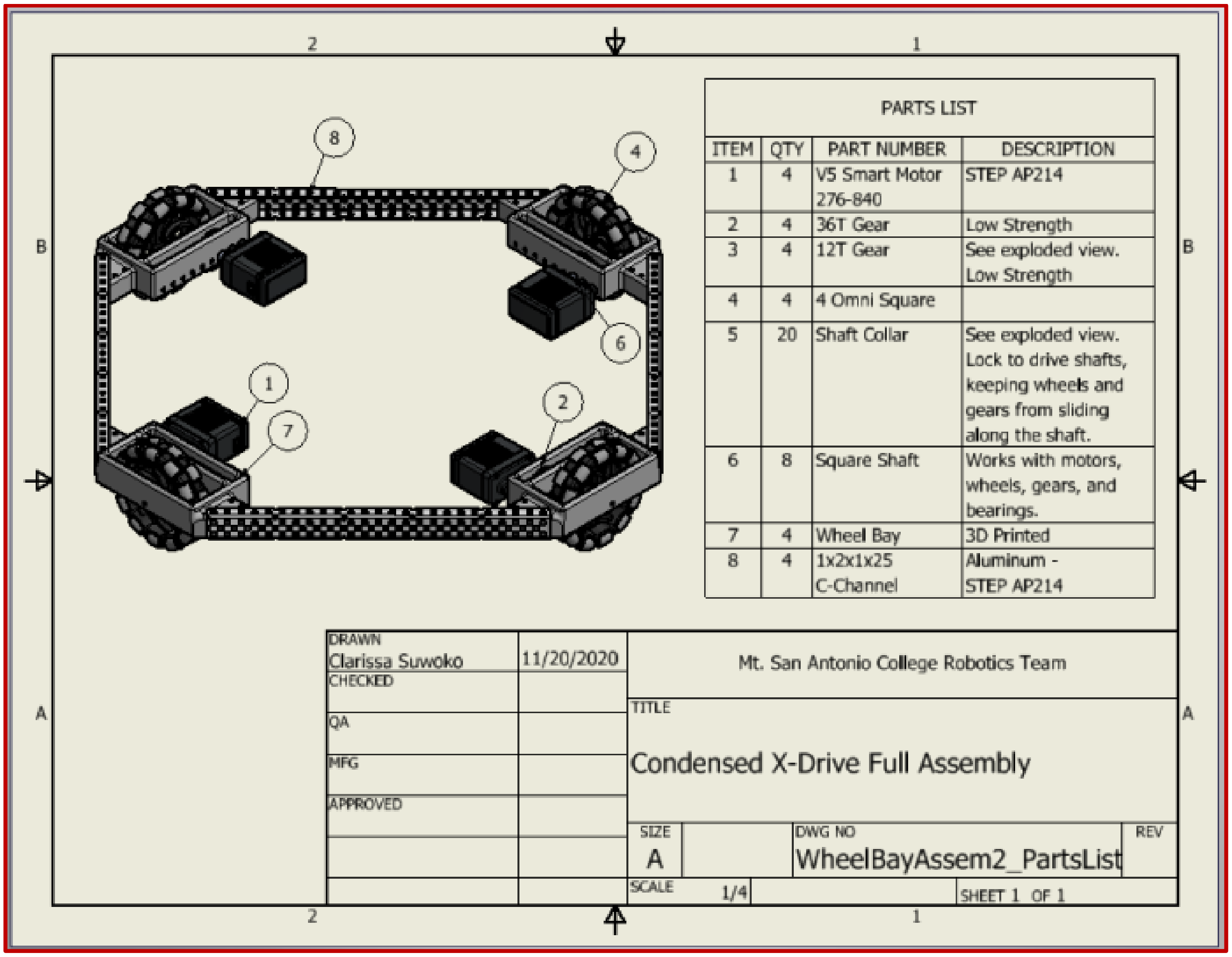


Fig. 12. Shape optimization allows for a display of possible methods to reduce the weight of the part while keeping a specified level of rigidity. Showcases the most important parts of the part.

FIGURE13: ***CONDENSED X-DRIVE FULL ASSEMBLY***



ITEM	QTY	PART NUMBER	DESCRIPTION
1	4	V5 Smart Motor 276-840	STEP AP214
2	4	36T Gear	Low Strength
3	4	12T Gear	See exploded view. Low Strength
4	4	4 Omni Square	
5	20	Shaft Collar	See exploded view. Lock to drive shafts, keeping wheels and gears from sliding along the shaft.
6	8	Square Shaft	Works with motors, wheels, gears, and bearings.
7	4	Wheel Bay	3D Printed
8	4	1x2x1x25 C-Channel	Aluminum - STEP AP214

Fig. 13. The figure above is a drawing file illustration which displays the top-down view of the wheel bay being utilized in a standard x-drive drivetrain.

FIGURE 14: *WHEEL BAY SUBASSEMBLY*

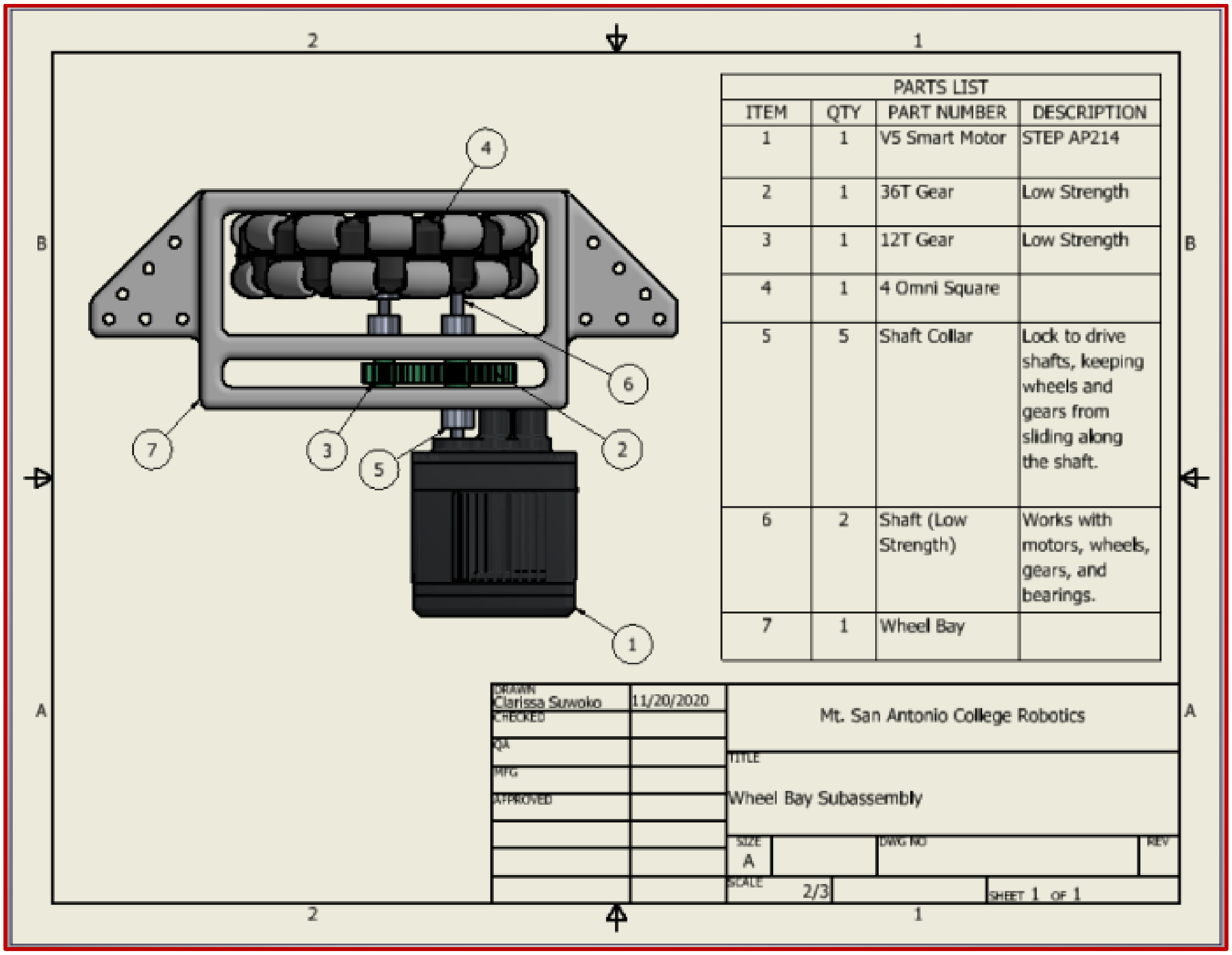


Fig. 14. The figure above is a drawing file illustration which displays the top-down view of one-wheel bay module. The assembly includes the wheel bay, an omni wheel, a simple gear train, a V6 Smart Motor, and the appropriate hardware.

FIGURE 15: DRAWING FILE

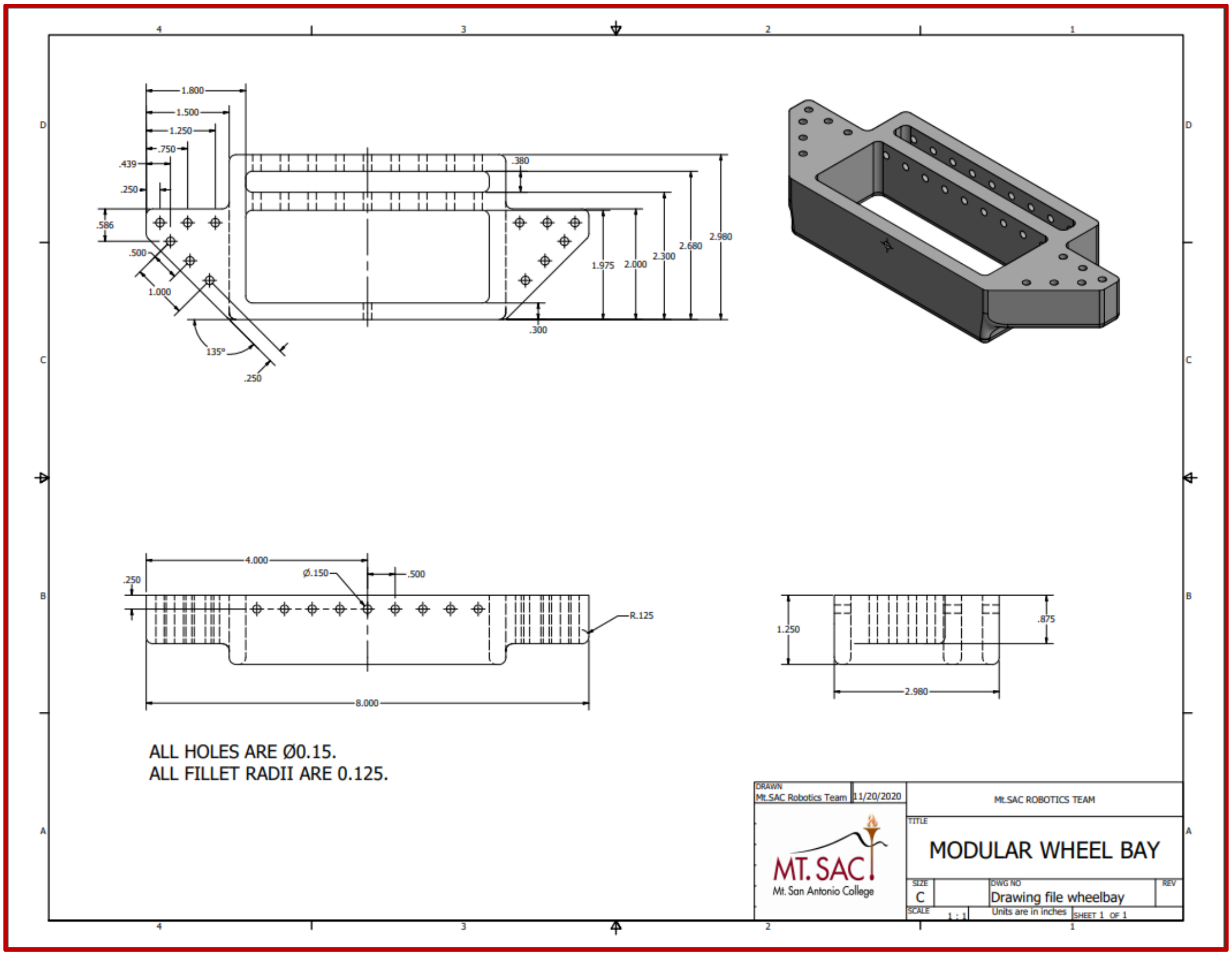


Fig. 15. Drawing file of the modular wheel bay.