ADJUSTABLE 45 DEGREE GUSSET

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INTRODUCTION

The four wheel holonomic drivetrain known as an X-Drive consists of four omnidirectional wheels arranged in a square with each wheel pointing inwards at an angle of 45 degrees [Fig 1]. Due to the unique placement of the wheels on an X-Drive, omnidirectional movement can be achieved [2]. Teams looking to increase the maneuverability of their robots often use the X-Drive for this reason [3].

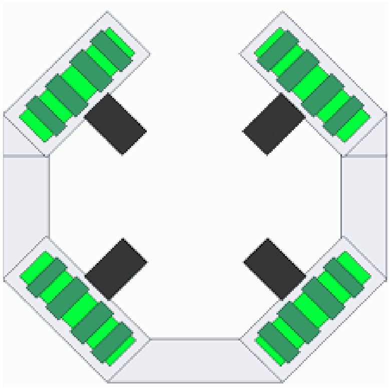

Fig 1. Simplified diagram of an X-Drive [1]

VRC teams creating the X-Drive using VEX C-Channel have run into the issue of maintaining consistent alignment with the rest of their drivetrain structure [4]. This is due to the fixed mounting positions found on VEX 45 degree gussets. Teams have circumvented this issue by creating custom plastic plates for their X-Drives [Fig 2]. Creating an X-Drive with proper alignment requires fabricating custom plates which is an option that not many teams have access to.

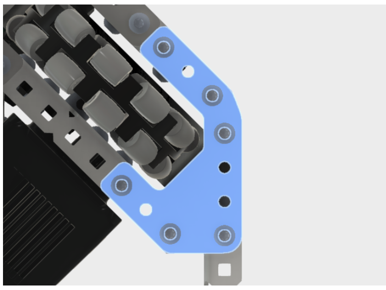

Fig 2. Bottom-facing render of an X-Drive used by team 5225A for the VRC 2019 Tower Takeover competition [5]. Custom Lexan plate is highlighted.

DESIGN PROPOSAL

In order to simplify the process of creating an X-Drive for VRC teams, we propose an adjustable 45 degree gusset be made. Our gusset would allow for the same degree of customization offered with traditional custom gussets while also reducing the requirements needed for teams to get started with creating an X-Drive. Our 45 degree gusset would consist of two 1” x 0.16” slots in place of the traditional two 0.16” holes spaced 0.5” apart [Fig 3]. Using a slot allows for variable mounting of c-channel on the gusset as the screws can slide within the slot. Through trial and error, the correct mounting of the gusset can be found that maintains proper alignment with the structure.

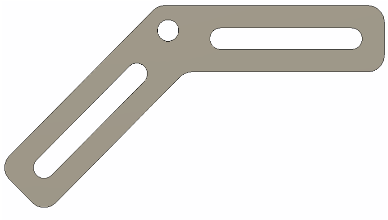

Fig 3. Top down view of adjustable 45 degree gusset compatible with VEX C-Channel structural beams.

DESIGN PROCESS

For our design we used Fusion 360 v.2.0.11894, the latest version available at the time of writing. We began the process of creating the gusset by first creating a sketch along the XZ plane. We then entered the sketch workspace and created 2D representations of the short side of a 2x1 C-Channel and a #8 standoff using construction lines. Although the #8 standoff is hexagonal, we simplified it to a circle and set it to be coincident with the sketch origin and tangent to the left side of the 2x1 C-Channel. A #8 screw hole was added concentric to the #8 standoff [Fig 4].

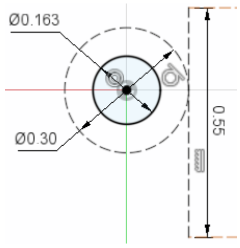

Fig 4. Fusion 360 sketch containing a rectangle with a height of 0.55” and a tangent circle measuring 0.3”.

A slot measuring 0.163” by 1” was then created 0.25” from the top and left side of the 2x1 C-Channel [Fig 5].

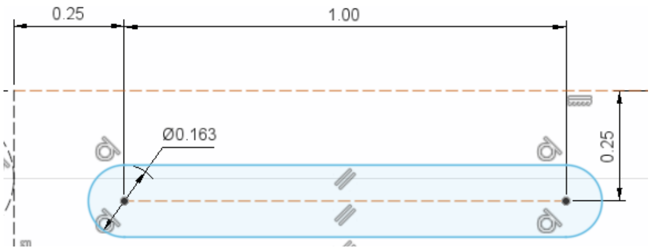

Fig 5. 0.163” x 1” slot spaced 0.25” from the top and left of the C-Channel.

Three lines spaced 0.25” from the slot were then created, along with a construction line coincident to the #8 standoff and the bottom right corner of the C-Channel [Fig 6].

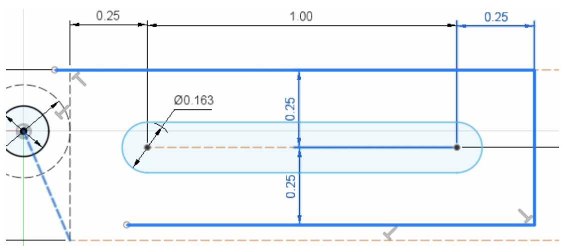

Fig 6. 0.25” perimeter around slot and construction line coincident to the bottom left of C-Channel and #8 standoff. Highlighted in blue.

The construction line created earlier was then angled at 22.5 degrees from the left side of the C-Channel. The slot and perimeter were then mirrored over this line [Fig 7].

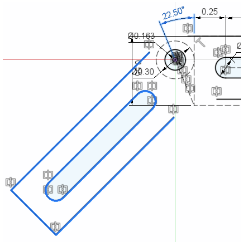

Fig 7. 22.5 degree constraint and mirrored features highlighted in blue.

The open ends of the perimeter were then set to be coincident with each other, creating a sketch profile [Fig 8].

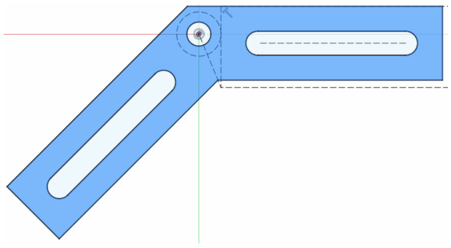

Fig 8. Profile created after constraining open ends of perimeter to be coincident.

The profile was then extruded 0.063”, the same thickness as existing VEX gussets [Fig 9].

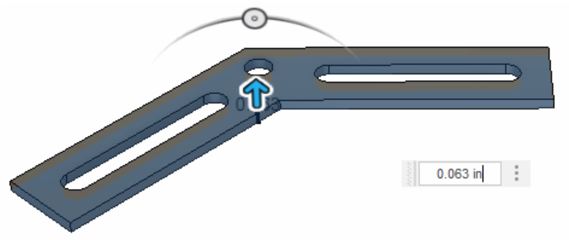

Fig 9. Body created after extruding profile by 0.063”.

Round corners in the body were smoothed out using the fillet tool. Fillets were set to have a radius of 0.125”.

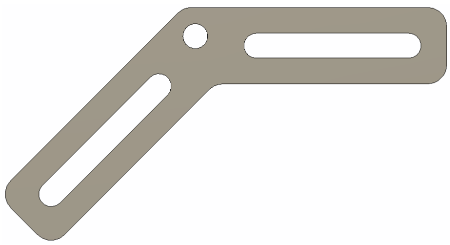

Fig 10. Finished gusset after 0.125” fillets are applied.

DESIGN APPLICATION

Since VEX C-Channel has a hole spacing of 0.5”, by creating a slot that is 1” long we are able to accommodate any screw placement on the gusset. To demonstrate this, we created an X-Drive and overlaid a 0.5” grid to demonstrate that both ends of the drivetrain remain aligned [Fig 11]. We have also attached an animation to our submission that was created in Fusion 360 v.2.0.11894 using the animation workspace that showcases the variable screw positions [6].

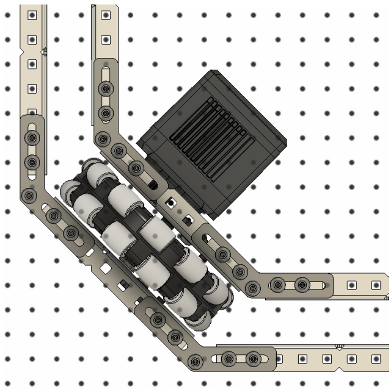

Fig 11. Example X-Drive using adjustable 45 degree gussets with 0.5” grid.

CONCLUSION

We hope that one day VEX will be able to manufacture and sell a gusset similar to the one that we created. Adjustable gussets not only allow easy fabrication of X-Drives but also make designing robots with angled structural components (eg. tilted conveyor belt) easier as trigonometry is not needed to ensure that all pieces of the structure are aligned.

Throughout this process we used a variety of tools to create our final submission. The mirror tool was used to create the gusset and the symmetrical rectangular pattern tool was used to create the 0.5” grid that we overlaid on [Fig 11]. We also created a basic animation using the Fusion 360 animation workspace [6] using the transform components tool.

Learning how to use CAD was an important step of our design process as a team. Using Fusion 360, we created a 3D model of our robot before we built it. This allowed us to analyze the functionality of our robot without having to spend the resources building one. Without this step in our design process, we would not have been able to quickly test the validity of our robot idea.

We also recognize that learning how to use CAD software is also an important part of becoming an engineer. One of our team members has applied their Fusion 360 skills in a partnership project with a local vending machine company. This highlights the importance of learning how to use CAD software such as Fusion 360 on the journey to become an engineer.

REFERENCES

[1] www.drivenrobotics.com/node/114

[2] blog.elliotjb.com/2013/10/holonomic-x-drive-tutorial-theory-of.html

[3] https://www.vexforum.com/t/what-is-the-best-tower-takeover-advanced-drive-chassis/63862/2

[4] https://www.vexforum.com/t/x-drive-spacing-help/80763

[5] https://purdue3033.autodesk360.com/g/shares/SH9285eQTcf875d3c539e182acb3c1248f78

[6] https://youtu.be/3x7plLf2ZxM