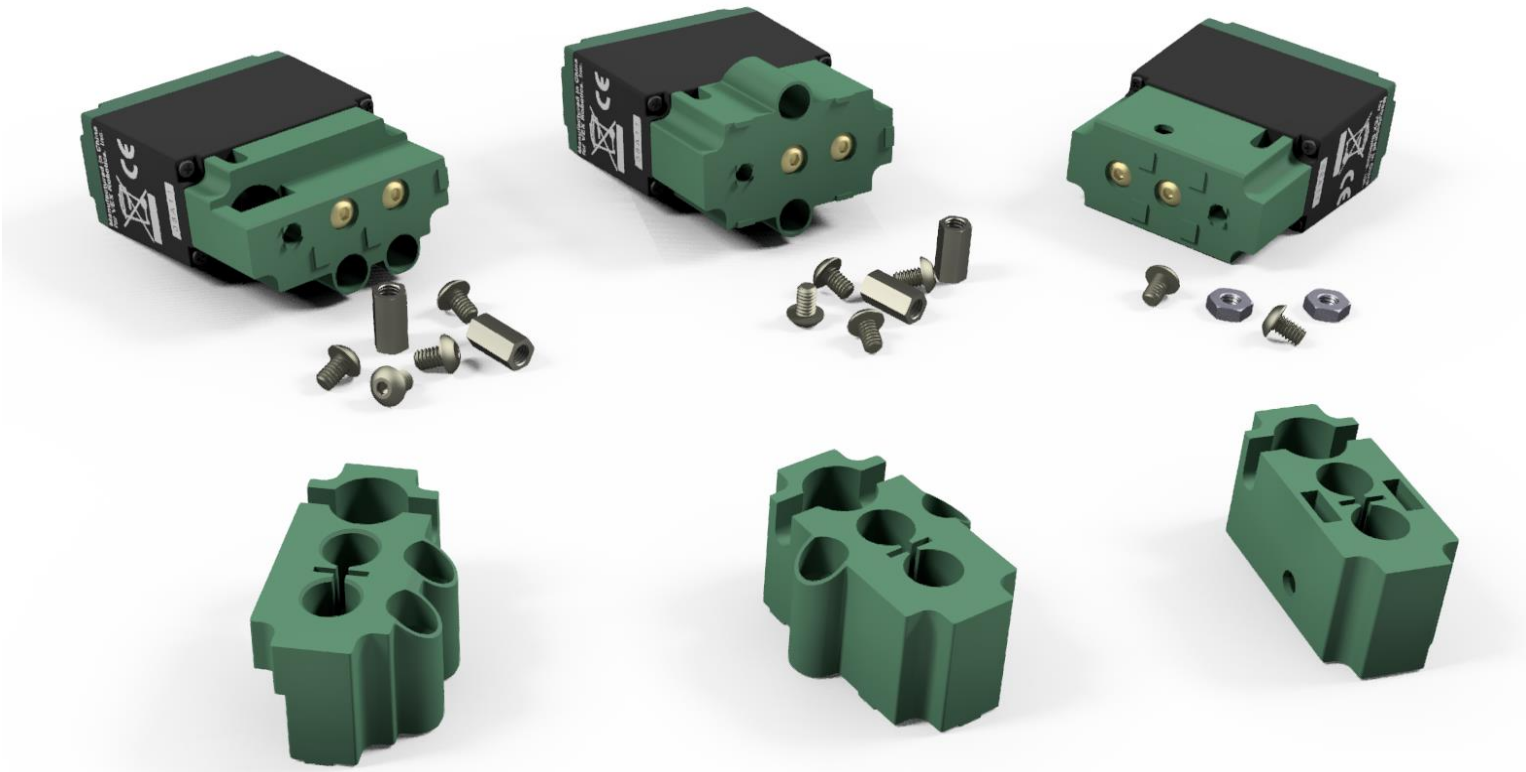
VEX Motor Attachment Blocks

Make It Real CAD Engineering Challenge, Sponsored by Autodesk®



AURA

Auckland University Robotics Association

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1. Introduction

The objective of this online challenge was to create a custom part for use in the VEX Robotics Design System. As per the challenge brief, the part should be **efficient, simple, elegant and useful**. Hence, instead of designing a complicated piece, AURA decided to use Autodesk Inventor Professional 2017 to tackle one of the most basic but frustrating issues talked about by teams when building VEX robots – attaching motors such that they can be easily removed without the hassle of dismantling other parts just to reach the motor. This way, instead of replacing some of the ingenuity seen in VEX robots, a complimentary part was designed. It was decided that the part should be basic but with unlimited possibilities and as compact as possible to minimise bulkiness and to allow fast 3D printing.

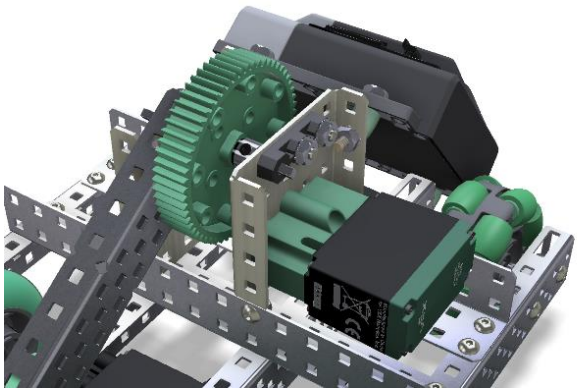

Figure 1.1: Standard Motor Block on Robot in CAD

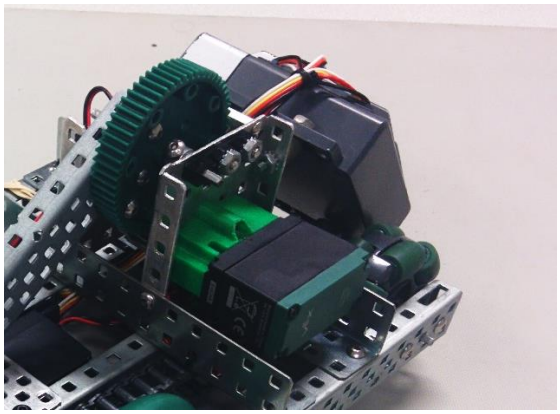

Figure 1.2: Standard Motor Block on Real Robot

2. Use

Four different Motor Attachment Blocks were designed (see Fig. 2.1) – a Standard Block, a Mid 2-wide C-Channel Block, and Left and Right Flange Blocks. Each block uses existing VEX hardware to be attached to the robot.

The Standard Block is designed to be used on a wider flat surface – e.g. a plate, or inside a 3-wide or 5-wide C-Channel. The Mid 2-wide C-Channel Block is designed to align a motor with the middle row of a 2-wide C-Channel. Finally, the Left and Right Flange Blocks are simply mirrored versions of each other, designed to allow a motor to fit adjacent to the flange of a C-Channel or Chassis Rail.

Figure 2.1: From Left to Right: Standard, Mid 2-wide C-Channel, Left Flange and Right Flange Motor Attachment Blocks

Since we designed multiple variants of the motor block for different placement types, the installation of a motor attachment block varies slightly. Most use standoff which fit in the cylinders on the sides of the blocks, however the Mid 2-wide C-Channel Block uses a hex nut which needs to be inserted through the top before the motor is screwed into the block. The motor is inserted and screwed into the block, forming a snug fit that is much more robust than a normal motor-metal connection, and finally the block is attached to the metal.

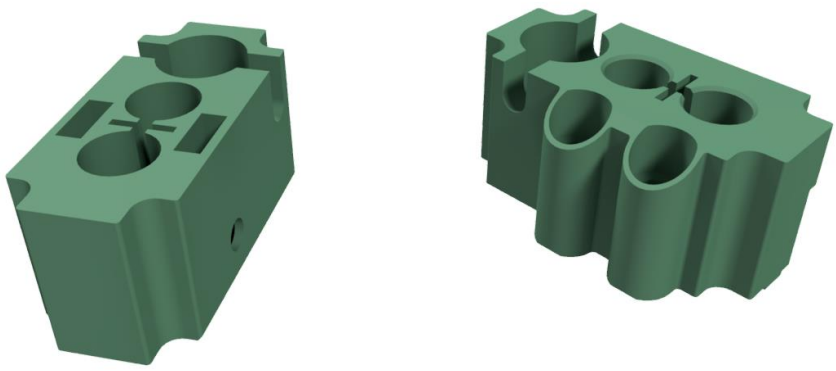

Figure 2.2: The Block on the Left Uses Hex Nuts, whereas the Block on the Right Uses Standoffs

Whilst seemingly complicated at first, when installing the Motor Attachment Block in practice the user will discover it's really quite fast and straightforward.

Slots are designed in the sides of the Motor Attachment Blocks to allow shaft collar access. If the builder wishes to install one inside the Motor Attachment Block, it should be placed before inserting the motor.

These Motor Attachment Blocks provide the ability to attach a motor in virtually any situation, and provide a very easy system to remove the motor without disassembling any complicated mechanism to gain access to the motor screws. Additionally, if the user only wises to access the internal gears of the motor (such as to change the internal gear ratio), once the Motor Attachment Block has been removed from the robot, the motor housing screws are easily accessible without the need to remove the motor from the Motor Attachment Block.

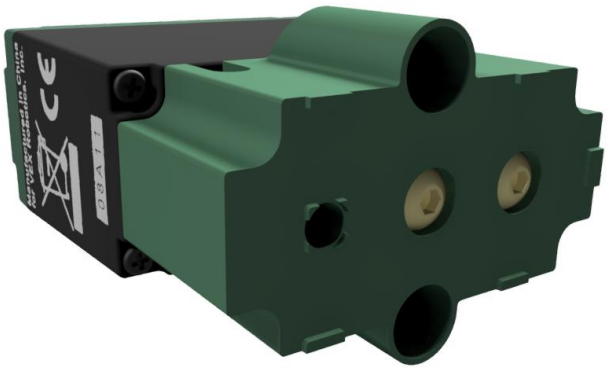

Figure 2.3: Access to the Motor Housing Screws is Preserved due to the Cut-out Corners

3. CAD Design

Autodesk Inventor Professional 2017 was used to create and render the Motor Attachment Blocks. A variety of tools were used, including Extrude, Loft, Fillet, Chamfer, Hole, and various Patterns.

Typically, the first step was to extrude a similar profile as on the VEX 393 Motors, and then create further extrudes to create or cut away material to make the final shape. On the base of the Motor Attachment Blocks are small studs designed to lock into the VEX metal to help hold the motor perfectly in place (see Fig. 3.1). Lofts were used to create these, with a slight slant to the sides such that they were easy to insert into the metal, but snug once in place. Due to the repeated arrangement, patterns were used to reproduce these perfectly across the base of the motor attachment blocks, where appropriate.

Materials were applied to all components used in rendering, and decals were added to the motors used in the renders for a more realistic finish.

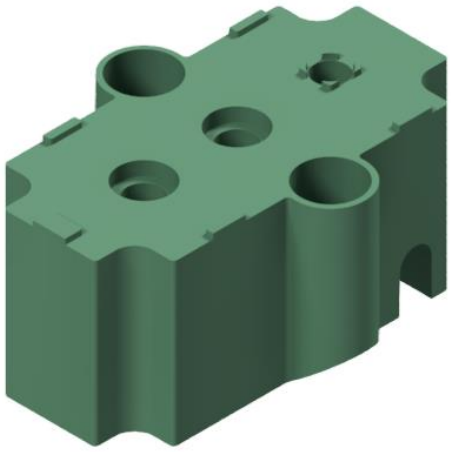

Figure 3.1: Short Studs for Easy and Perfect Alignment on the Bottom Surface

4. Design Process

Various iterations of the Motor Attachment Blocks were created. Fig 4.1 shows the first version of the Standard Motor Attachment Block, which was attached again with standoffs, but at the top and bottom instead of the sides. However, this wasn't an elegant solution, and due to the length of the block being increased significantly, was impractical for use. The attachment holes were in locations that were often otherwise occupied – such as for gears.

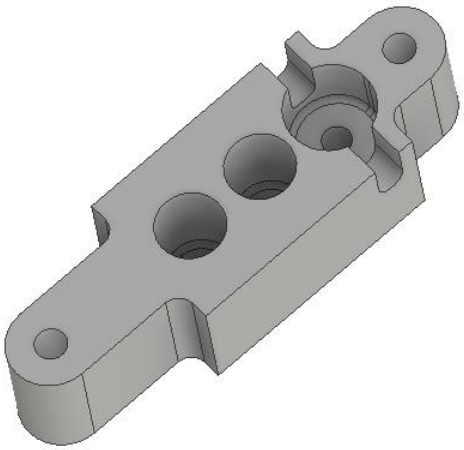

Figure 4.1: Original Version of Standard Motor Attachment Block

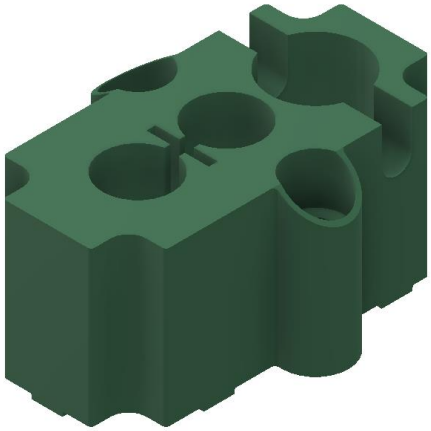

Figure 4.2: Final Version of Standard Motor Attachment Block

Once we were happy with the Standard Motor Attachment Block, we took this to a local VRC event to ask the opinions of High School students. Everyone we demonstrated our 3D printed example to was very impressed with how simple the part was, and more importantly how super useful it was. One student, whilst exaggerating, described the Motor Attachment Block as "life changing". Everyone we talked to wanted to use them on their robots.

Conclusion

AURA created Motor Attachment Blocks – a useful addition to the VEX Robotics Design System that compliments the builder's ingenious mechanisms. Simple and easy to use yet very effective, these have proved popular among the people we have shown them to, and are quick to produce from a 3D printer.

Autodesk Inventor Professional 2017 was used to design the Motor Attachment Blocks, which we also use to model our VEX U competition robots. Since most of us in AURA are engineering students, CAD will be a large part of our futures, and the skills learned through using Inventor are very valuable. Some of our students use CAD daily in their work placements. Whether they be mechanical, civil or from other engineering departments, most software used comes from Autodesk.