VEX Magnetic Plate

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The magnetic plate was initially designed to replace mechanical locks, which have added excess weight to robots during the VEX 2017 Starstruck competition season. When robots unfold from the initial 18"x18"x18" square, the components of the robot often need to lock in place once they are unfolded into their new positions. Magnetic plates can be used to hold these parts in place, replacing more unreliable rubber band based locking mechanisms. The applications are not limited to this function, as they can also be used to move parts without the the use of a motor or pneumatics. This can be done by flipping one of the clamps to match up like charges, generating a repulsive force. This allows the magnetic clamps to be useful in a variety of situations, being able to both move components, and to hold them in place.

Robots that make use of a claw that unfolds at the end of a rotating arm can benefit from these magnetic plates. By attaching the clamps to opposite sides of a hinge joint, when the joint swings open, the attractive force between the two plates pull the claw into place. Once the magnets have pulled the base of the claw and the end of the arm together, they hold it in place, keeping the claw's position locked. The repulsive forces of the magnetic plates can also be applied through a similar robot design. After the arm of the robot is used to throw scoring objects, it has to return to its initial position. When the motors are used to move the robot arm back down, the arm's descent is assisted by gravity. This leads to the arm colliding with the base of the robot at a high velocity, damaging the arm and parts of the drive train. By placing a magnetic plate on the drive train and placing a magnetic plate on the arm with the similarly

charged side facing the first magnet, the arm will be slowed as the two magnets approach each other, decreasing the force of the impact.

To create the magnetic plate, I used the student version of Autodesk Inventor Professional 2015. The magnetic plate was built in three part files, the magnet holder, the magnet holder cap, and the neodymium magnet, then combined through an assembly. The magnet holder is a 1.02"x1.40"x0.18" (2x3x1/3 block) plastic component that holds the neodymium magnet in place, and into which the cap is inserted to enclose the magnet. The piece has two channels on opposite sides of the magnet into which screws can be inserted to attach it to the robot. The neodymium magnet is placed into the slot of the magnet holder, then the magnet holder slot is covered by the magnet holder cap, sealing the magnet inside of the magnet holder to create a completed magnetic plate.

To create the magnet holder in Inventor, a 2-dimensional drawing of the component was created, starting from a 1.02"x1.40" rectangle. Two rectangles were created 0.11" in from the sides and from the top of the 1.02"x1.40" rectangle, with dimensions of 0.8"x).18". Then the corners of each rectangle were replaced with arcs using the center point arc tool. To create the slot for the neodymium magnet, the diameter of one of the magnets was measured (0.5"), then a 180 degree arc with a diameter of 0.51" was created around the center of the 1.02"x1.40" rectangle. This arc was connected to the edge of the rectangle, leaving a slot for the magnet. Extruding this drawing 0.18" created the base of the magnet holder, then the edges of the slot were extruded inwards 0.02" on both sides, to cover the magnet slot. The edges of the screw channels were chamfered by 0.01" to complete the channels. Finally, a rectangular indentation into the magnet holder was made on either side of the slot, to fit the cap on to the magnet holder.

The magnet holder cap was created using a 2-dimensional drawing, beginning by completing the circle begun by the 180 degree arc with a diameter of 0.51". This is done to enclose the circular neodymium magnet in a circular pocket when the cap is placed into the holder. The cap drawing is then made to fit inside of the 0.51' slot inside the magnet holder, with two prongs that stick out of the side of the cap, to fit inside the rectangular indentations made on either side of the magnet holder slot. The magnet holder cap was complete once it was extruded 0.14". The neodymium magnet was created to the specifications of a 0.5" diameter storebought magnet, with a height of 0.125". The edges of the magnet were chamfered by 0.005" to add the magnet's rounded edges. The components were put together in an assembly file, with a pin constraint and mate being used to place the magnet inside the magnet holder, and two mates and a flush being used to place the cap in the magnet holder.

Through this project I have gained more experience in using 2-dimensional drawings effectively, and in transitioning from 2-dimensional views to a 3-dimensional model. I plan to use Inventor in the future, to model my robots for VEX competitions, and to design parts to create 3-dimensional prints for other projects. Inventor is useful in robotics because it can be used to simulate the forces a robot will experience while running, and can be used to design a robot quickly and efficiently, without having to physically rebuild the robot. Learning 3-dimensional modeling will help in my future plans to work in physics and engineering, as simulations of forces and mechanical systems are used in both to avoid expensive physical tests.