REC 2019 Online Challenge:
Make it Real CAD Engineering Challenge – Sponsored by Autodesk
by Team 2019F

Last year, our team decided to make heavy use of pneumatics while competing in the VEX “In The Zone” competition. While this decision was largely positive, having to frequently monitor our air pressure (PSI) proved incredibly tedious. Because we had no internal method of verifying how much air we had in the tank, we would frequently perform unnecessary testing with either a tire gauge or an air pump. As a result, the nozzle degraded to the point that it caused air to leak constantly, requiring us to replace the expensive tank. Because of this experience, we decided to design a new VEX sensor to alleviate these issues.

Able to track the tank pressure in real time, this sensor would not only allow for teams to verify their PSI before the start of the match but also would permit them to make in the moment programming decisions as needed based on the remaining air pressure in the tank. This would have been incredibly useful for our team, particularly with regard to skills competitions. We had developed several skills strategies to implement at varying pressure levels to accommodate for the ambiguous and inconsistent amount of air used by each function. Unfortunately, this created significant driver uncertainty about this valuable resource, as we often had limited direct evidence to support our decisions and operated more out of gut inclination. With this new sensor, teams could more accurately assess their functions and efficiently employ their resources. In addition, this sensor would allow for more driver accountability, as referees could quickly ensure that a team had not exceeded the upper air limit.

After doing some brief research, we decided to model our sensor after typical air pressure gauges. These gauges work by allowing air into a piston which causes a spring to compress, emulating the force or pressure of the air. After incorporating the piston and spring mechanism into our sensor, we brainstormed methods for measuring the force of the compressed spring. We initially considered placing sensors (such as light sensors or limit switches) along the roof of the casing, as this would allow one to observe the degree of the spring’s compression. However, we realized this would require installing an inordinate number of sensors to attain an accurate reading, a fact that would likely increase the manufacturing price of the sensor dramatically. Returning to the drawing board, we eventually realized that we could include a simple pressure sensor at the end of the casing that would read the force exerted on it by the compressed spring. According to Newton’s third law or motion, this force would equal and directly oppose the force of the air, allowing us to precisely determine and quantify the air pressure of the tubing. This reading could then be transmitted to the brain, where it could be received and used by a team's program. As the robot expended air throughout the match, the spring would decompress and expand, exerting less force on the sensor and creating a lower pressure reading.

Using Autodesk Inventor Professional 2017, we began to transform our preliminary ideas into reality, incorporating existing official VEX components with parts of our own design and patterning our own parts to align with the appearance of VEX parts as much as possible. After some trial and error, we assembled the sensor we envisioned in a simple and elegant way. This project taught us about many of Inventor's useful tools. From double checking our measurements with the distance tool to re-coloring each part, adjusting and fine-tuning it until it matched the unique shade of the VEX sensors, this project taught us about some of the many ways that Inventor facilitates the brainstorming, design, and, ultimately, construction process, as it provides for clear communication about the specification of products to be manufactured.

As seniors, most of our team members have spent the last several months working diligently on college applications, hoping for acceptance letters to our desired engineering programs. This challenge also served to highlight Autodesk's utility in our future careers, allowing us to test novel solutions in a low-cost and low-risk environment before investing heavily into a real-world assignment. Instead of exorbitantly investing on costly and intricate prototypes, we could devise a realistic mock-up of our intended product effortlessly and efficiently. In addition to our future careers, this program provided crucial support both to our team's ability to brainstorm and concoct preliminary robot designs and to better assess their feasibility. While VEX competitions currently prohibit 3D-printed parts, Inventor serves as a useful tool to ensure the viability of a particular design without needing to build a physical model. It also allowed us to simulate the intricate movement of key robot features, enabling us to visualize the solution in a new light. Inventor has been principally useful in its ability to let us test our ideas and solutions without the fear of failure, empowering us to succeed by opening our eyes to a world of realistic possibilities.