Blackstone Valley Regional Vocational Technical High School
Student Portfolio- Project Reflection

Date	5-12-23
Student Name	Om Patel
Subject	CIM (10^{th})
Instructor's Name	Mr. Oliveira
Instructor's Signature	Mr. Oliveira

In this project, my partner and I were challenged to create a robot that could pick up discs, shoot them, expand over a 12-foot by 12-foot field, and spin rollers. This robot would have to be able to be controlled by a controller for the driver section of the game and be programmed to do an autonomous section. This may sound easy but there were many constraints to this project. We were only allowed to build in an 18-inch by 18-inch by 18-inch square and only could expand horizontally in the last ten seconds of the game. We were also only limited to VEX parts and 8 motors. One other quirk is that we are only allowed to hold 3 discs at once. With this challenge, we were forced to use the engineering design process to create a product that could complete all the tasks assigned.

With a deep understanding of the problem my partner and I started brainstorming and prototyping one of the most important features of a robot, its drive train. With many different drive train ideas out there we had to think of which design would best suit our needs. We need it to drive precise, fast, mobile, and stable. Due to this, we decided to use a tank drive. Our robot consists of a powerful and nimble drive train, featuring two motors and four wheels. The front wheels are equipped with omnidirectional rollers for maximum agility, while the back wheels provide traction and stability.

After creating the drive train my partner and I started the creation of the intake. The intake had many prototypes with one being a larger triangle shaped ramp and one being a solid sheet of metal as a ramp. One thing we noticed from these failures was that none of the ramps could slide under a disc. To solve this we used individual strands of metal that could bend and be filed down instead of a wide single sheet of metal. On these ramps, we tried making and using many different intake wheels, such as small Omni wheels and custom 3-D printed wheels. However, after many trials and errors, the final intake wheels became rubber bands stretched across 2 sprockets. This allows for the disc to compress against the rubber bands and attach to them making it easy to transport them across the metal rails. We used multiple of these to transport the disc into our flywheel.

With the drive train and intake systems completed we then started to build the flywheel. The flywheel is the main component in how we shoot our disc into the goal. When designing the flywheel we had to make sure the wheel spun fast enough but still had enough torque to move the disc. Normally a motor would spin at 200 rpm but with a 6:1 gear cartridge, a motor can speed at 600 rpm. If that motor is connected to a 60-tooth gear that is driving a 12-tooth gear it creates a gear ratio of 5:1 which outputs a total of 3,000 rpm when combined with the 6:1 motor. To create more torque and speed we also connected a second motor that has the same 6:1 cartridge. With this setup, we could shoot our disc from one side of a field to the other, 12 feet. Some other adjustments that had to be made to the flywheel are the wheels. We made sure to use the biggest wheel as it would provide the most surface area on the disc and added rubber bands to make it grippier and more flexible. On the wheel, we added another wheel and a gear that had screws attached to it to add more weight to the flywheel. Adding more weight allows for a smoother and more consistent shot. This is due to the weight adding more rotational inertia.

With the flywheel constructed, we needed a way to push the disc into the flywheel. To do this my partner and I created an indexer. Rather than just attaching the intake to the flywheel itself we created a place for the discs to rest on the flywheel and attached an indexer so we can choose when we shoot the discs. The indexer had to fit in a small space between the flywheel and intake track, which required careful sizing and design considerations. Our original design consisted of a snail cam attached to a motor but when we attached it to the robot itself we encountered issues. The angle at which the flywheel was at counteracted the force being applied to the disc. We could not move the flywheel due to size restrictions and decided to create a better design. In our final design, we used a 36-tooth gear driving a rack gear on a linear slide. When the gear spins the slide would either drive backward or forwards propelling into the disc and pushing it into the flywheel.

With the main purpose of the game finished the side tasks were left to be done. To start the endgame or expansion section of the game we tried creating a catapult that would launch a gear with a string attached across the field. With this design, we noticed that the catapult was inconsistent, large, and used too many rubber bands. With this design being a failure we had to think of a new way to solve this problem. One day while trying to fix issues on the robot one of our peers shot I me with a rubber band, this made me realize we could use this mechanic to shoot a rubber band with string across the field and cover tiles. Using a plate attached to a dual-acting cylinder we could extend the actuator and push the rubber band off one end of a shaft, which would mimic the act of shooting a rubber band - a person extending a rubber band between two hands and releasing the back end. With this design working I could then use the same cylinder to shoot three rubber bands in one extension. I then mirrored this triple rubber band shooter onto the other side of our robot and in total could shoot 6 strands of sting across the field.

The final part of the construction of this robot was the roller. The roller is used to spin the dual-colored rollers that are attached to the field. It is a simple design that consisted of two traction wheels with rubber bands on a shaft. This shaft would then be connected to the intake motor as we did not have enough space to connect a motor directly to the shaft.

To start the autonomous section I created multiple functions that I could call to repeat certain tasks. Using a distance sensor I created a function that checks that there are 3 discs stacked on the flywheel. If those three discs are there it will then shoot them and if they are not there it will spin the intake as the most likely reason for there not being a third disc is it is stuck in the intake. I then used a Vision Camera that can detect the colors red or blue to make a command that spins the roller until the field attached roller is spun to our assigned team's color. I created two of these commands one for the color blue and one for red. I then create 4 more functions that can align the flywheel of the robot to the assigned team goal. If we were assigned the red team we could either use the turn left or turn right alignment commands and if assigned blue we could then use the blue commands. To make this I had to use a Vision Camera that was mounted center to the flywheel. I then used the camera to take a screenshot of what it is seeing whilst it is spinning until we see a red or blue goal that is the same height and is aligned to the center of the camera frame. Once these standards are met the robot will stop and continue the rest of the code. Overall, the function portion of the code tested my abilities to problem-solve, program using variables, sensors, if-else statements, and loops, and provided me with a wide knowledge of how to code with VexV5. For the rest of the autonomous section, I used the directional commands given in the code. Things such as moving forward, turning right, etc. These commands allowed for a quick and easy way for me to test and try out different paths. After brainstorming my partner and I had created a path that could shoot 5 discs, spin 2 rollers, and expand over the field. While creating this path I made sure to consider the one-minute time limit we had and our robot's ability to turn and drive. While creating this robot I also modeled every single variation and prototype of our robot in Fusion 360 as it provided a great way to document our thought process and evolution while designing this robot. As my partner and I were not always together, I could sometimes model an idea I thought of or create a part in Fusion so we could reference it to build in real life later. 3D modeling can provide so many benefits and was a very important part of this project.

Blackstone Valley Regional Vocational Technical High School
Student Portfolio- Project Reflection

Technical competencies and academic skills demonstrated by completing this assignment.

Framework Standard	**Description**
2.E.03.02	Build a working model of a robot or automated system.
2.B.05.01	Define requirements for a project or product.
2.D.02.07	Combine model parts into working assembly, manipulate and animate assembly using a 3-D modeling program.
2.B.04.02	Maintain engineering logs/notebooks/journals and portfolios for projects.
Embedded Academics	**Description**
2.B.01.1.1	Identify and explain the steps of the engineering design process: identify the problem, research the problem, develop possible solutions, select the best possible solution(s), construct prototypes and/or models, test and evaluate, communicate the solutions, and redesign.
2.B.01.02.11-12.b	Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
2.C.02.14.6-8	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
2.B.01.1.3	Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques.