SPARTAN ROBOTICS

FRC 971

Technical Documentation 2016

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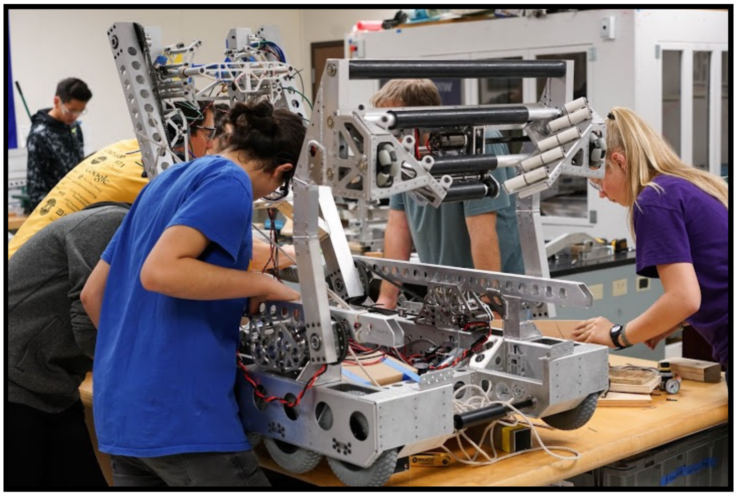
971 on Design

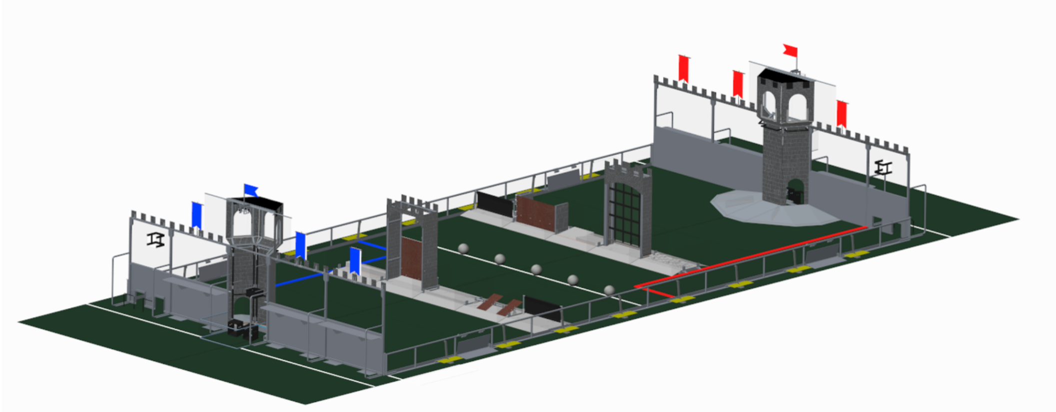
On Spartan Robotics, we believe that engineering is the process of optimizing a solution to perform its task as efficiently as the laws of physics allow. Our goal is to develop the highest quality robot possible and relentlessly chase perfection.

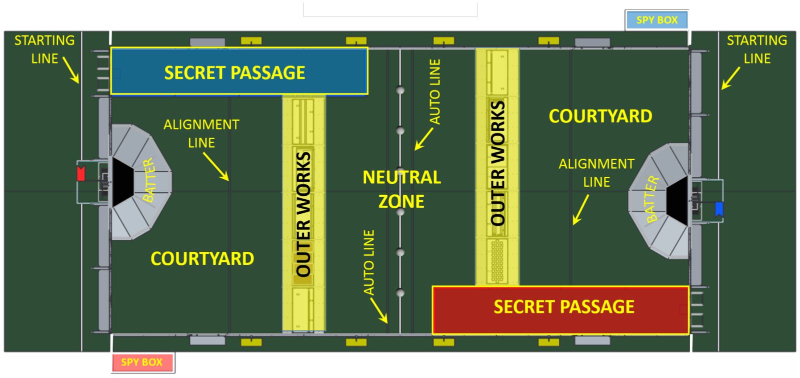


Design Process

1. Identify necessary functions.
2. Determine assemblies and allocate the necessary functions
    - Prototype subassemblies
    - Use CAD to determine geometry and prototype to confirm feasible geometry
3. Use CAD to design the robot and produce drawings for manufacturing
4. Integrate subsystems with code. Use state feedback control to make the robot run reliably and consistently

Robot Function Objectives





- Be able to cross four of the five defenses
- Fit under the low bar so we would have a reliable crossable defense
- Unblockable high release shot and fender shot capability
- Fast scoring cycles
- Sturdy drivebase to enable efficient transversing of defenses
- Climber as a low priority because shooting has a higher point yield

Prototyping

Shooter

Single wheel shooter prototype

Linear shooter prototype

Single Wheel	Linear
Pros:	
- Consistent power due to greater wheel contact - Successfully implemented by many teams in 2012	- Consistent Shot - Packages well
Cons:	
- Bulky packaging	- Little experience with this shooter type beyond prototyping - Less wheel contact

Fingers

Wooden prototype of pneumatically actuated fingers

We iterated upon our design by adjusting finger positions to optimize ball control. Through prototyping the fingers we learned that bearings were necessary on the ends of the fingers to smoothly transition the ball into the shooter. We also found that our CADed ball size was incorrect, we then had to modify shooter dimensions to fit the correct ball size.

Pros:

- Controls balls well
- Consistent load to shooter via pneumatics
- Low profile

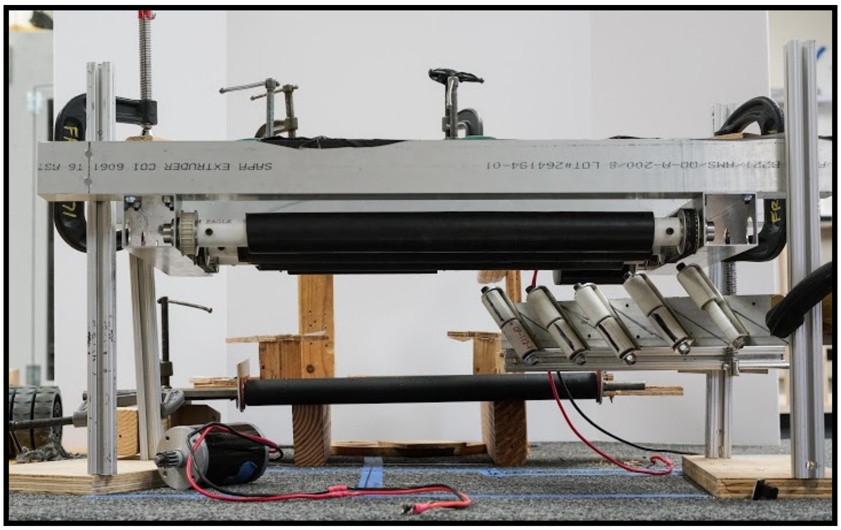
Cons:

- High complexity

Intake

Original Design

Our original design had four horizontal rollers that decreased in size as they approached the bumper. It also included angled passive rollers to funnel the ball over the bumper and into the shooter. We came to this design after prototyping the mechanism and adjusting to find the optimal roller positions.



Pros:

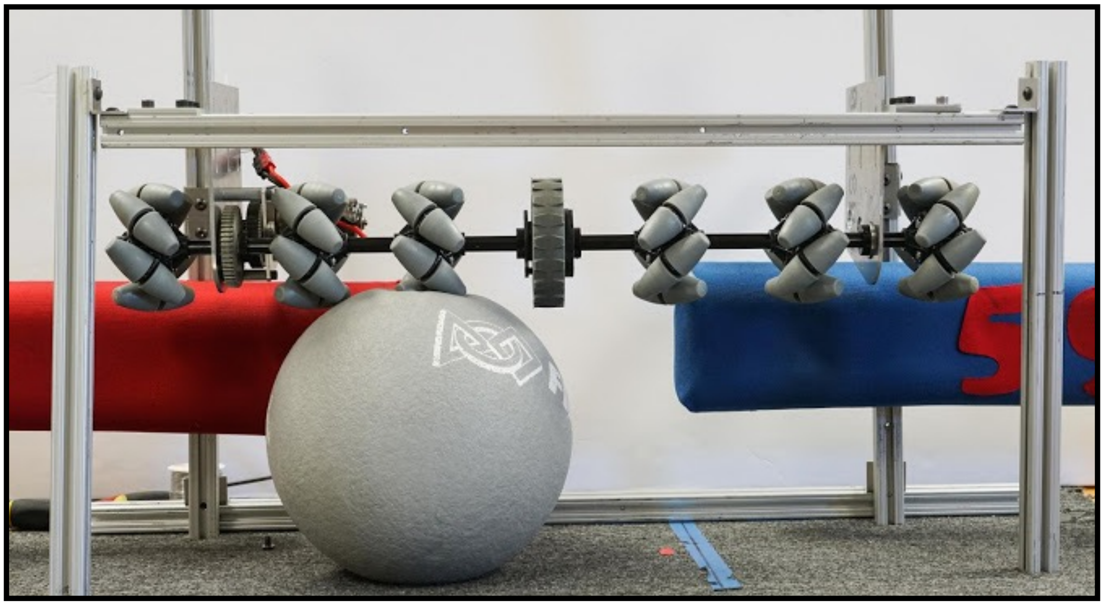
- Centers the ball outside of the bumper
- Only requires a single motor

Cons:

- Heavy and Bulky
- Sensitive to ball compression

Improved Intake Design

After practicing with our original design, our chain began stretching due to the weight of the intake; additionally, it did not intake balls as efficiently as we had predicted. After the aforementioned difficulties, we re-designed our intake to contain a singular row of mecanum wheels with a center omni wheel.



Pros:

- Centers ball faster
- Good ball control at different angles
- Controls ball while driving backwards
- Lighter than previous design
- Effectively pulls the ball from corners

Cons:

- Corner centering is not as fast as it could be

Wheel Placement

We tested different wheel quantities and placements. Through iterations of prototyping we found that eight wheels with a dropped center worked best for overcoming defenses.

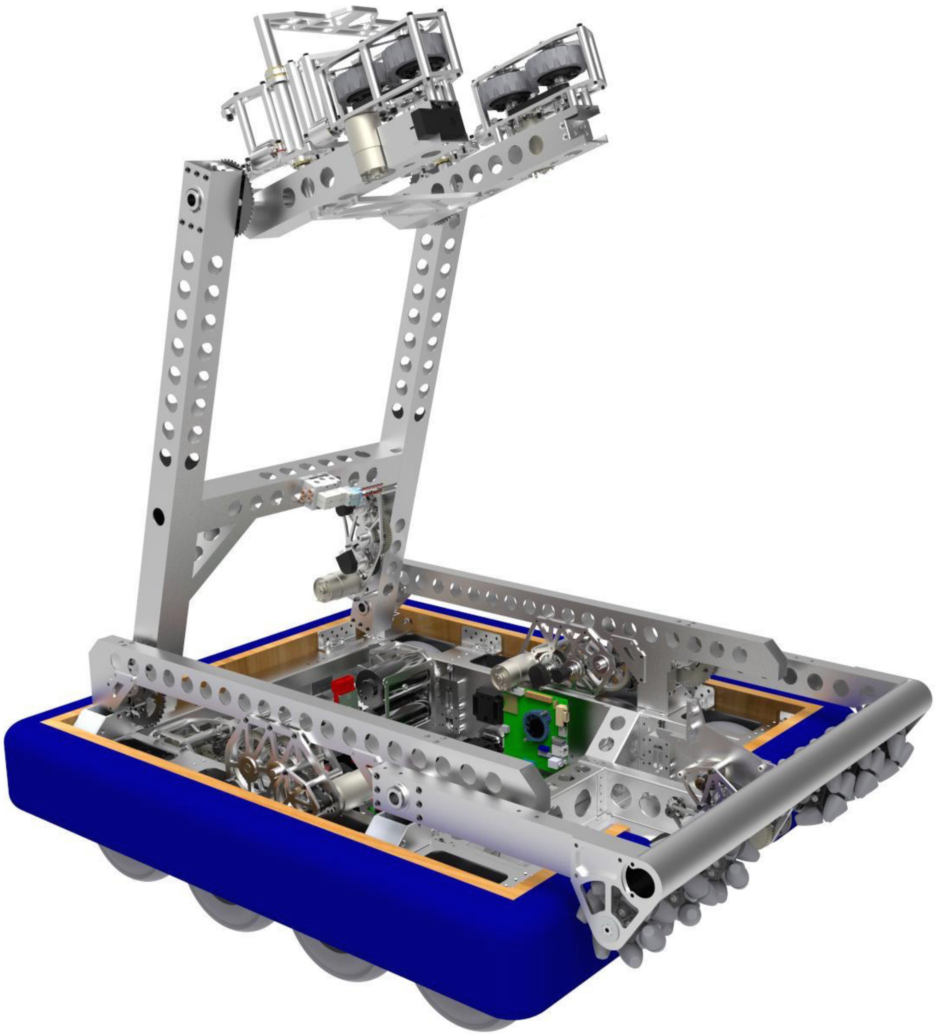
Pros:

- Does not get caught on defenses
- Enough robot clearance over the defenses

Cons:

- Wheel cadence is bad for moat at low speeds

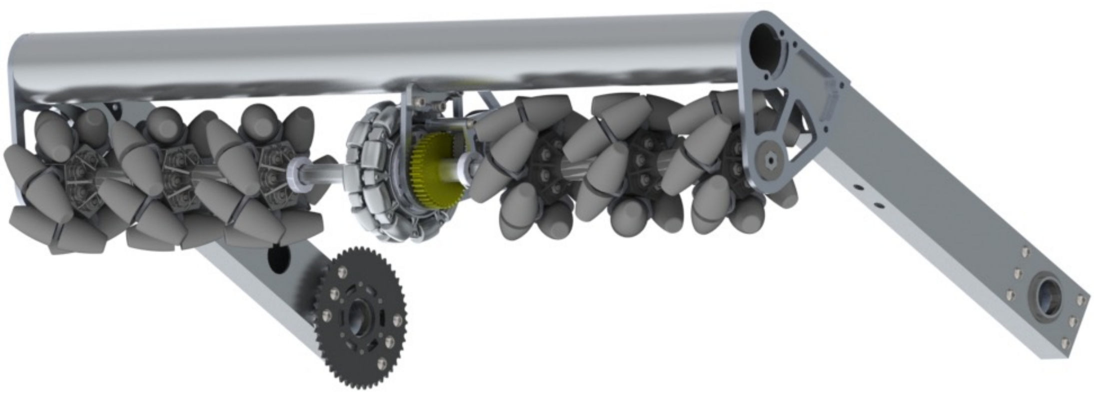
The Final Design



Drivebase

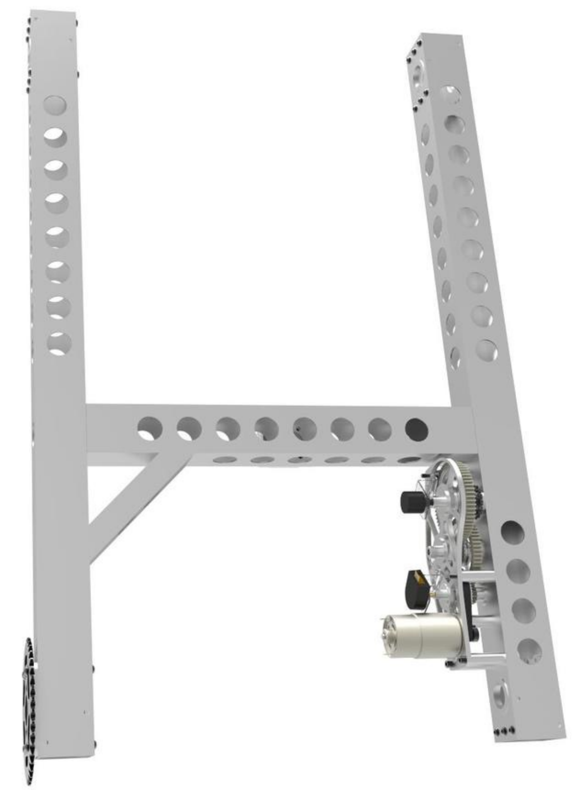
- Rectangular frame 27” x 32.75”
- 971 sheet metal drivetrain
- Compact electronics layout due to low-profile design
- Clamshell design for stiffness
- 8” pneumatic wheels that we could get in order to go over defenses
- Powered bottom kick roller to assist the ball’s travel into the robot

Intake



- Single row of 6 mecanum wheels
- Mecanum wheels funnel balls into the shooter
- Middle omni wheel to assist funneling
- Intaking wheels as close as possible to bumper to decrease profile and increase maneuverability

Arm

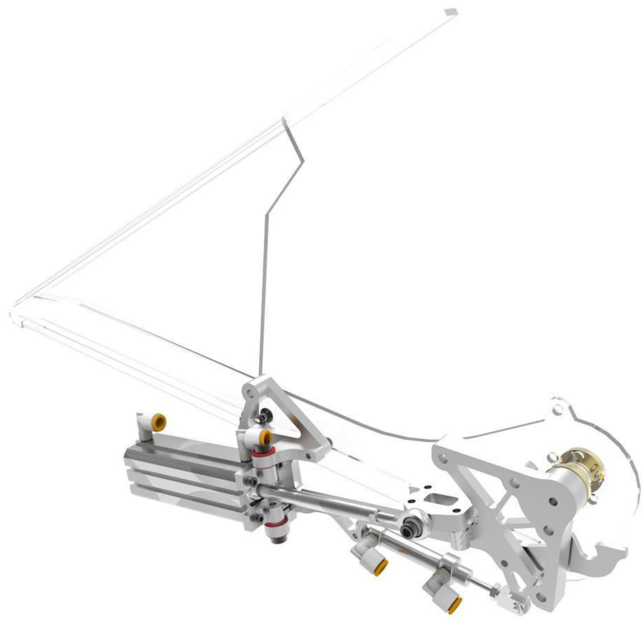


- Two joints to move shooter from tucked position to high shooting position
- Multiple gearboxes along tube to make more compact

Shooter

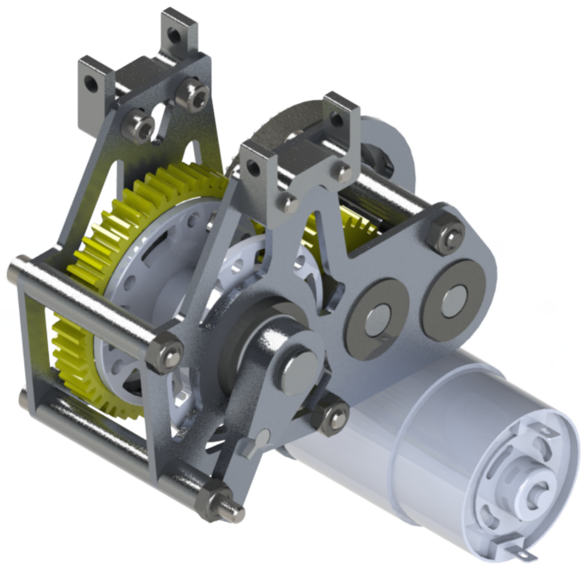
- Two wheels on either side compress and shoot ball
- Plates on top and bottom provide alignment
- Pneumatic actuated “fingers” for consistent loading and push it into shooter

Wedges



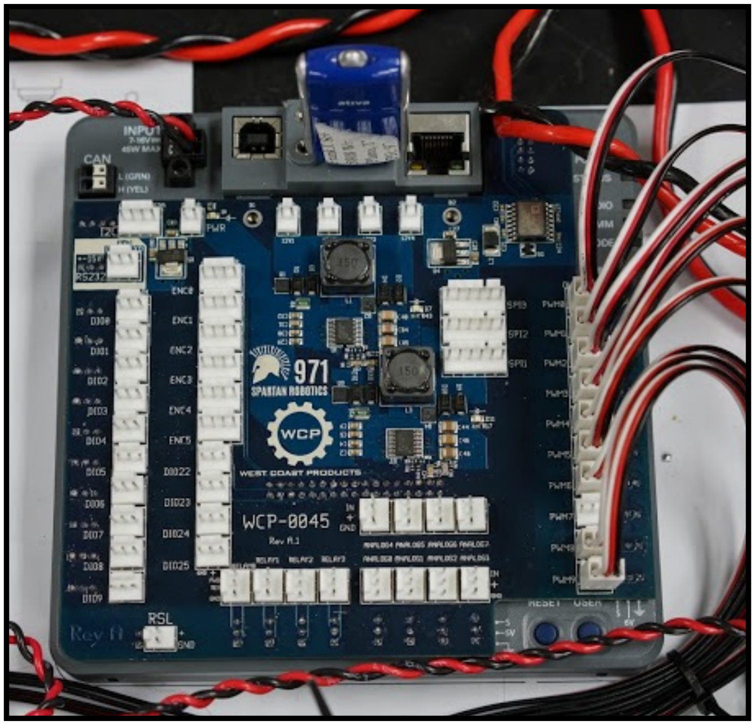
- Lexan wedges used to manipulate the Chival-de-frise and Portcullis defenses
- Achieves a large range of motion with piston actuated chain rotation in order to package when not in use
- Contains an optional latch for maintaining wedge position in high speed traversal

Hanger



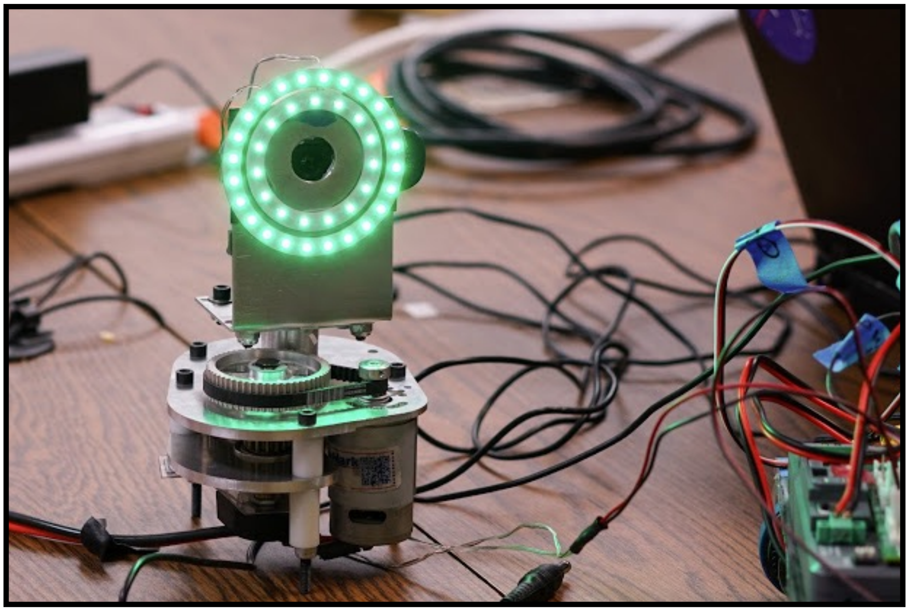
- Hanger arm deployed off of main robot arm
- Hanger arm deployed using pneumatic latches and extended by gas springs surgical tubing. The hook linear extension is restrained by a pin on the arm
- Once the hook is latched onto the bar, the winch mechanism lifts the robot using a pulley system, which enables locating the winch on the side of the robot
- Design optimized to fit within remaining weight and space budget

Spartan Board



- Iterated on custom design from last year and worked with West Coast Products to sell it
- Contains quick release connectors that ensure wires stay connected
- Has 12V and 5V regulators to prevent sensor and encoder brownout
- Gyro for measuring heading

Custom Light Rings



Prototype vision lights

- Custom light rings for vision. Allows for packaging in the shooter tube
- Hall-effect sensor boards for sensing position of shifter piston. Outputs an analog signal from two digital sensors using resistor voltage divide. Has 12V and 5V regulators to prevent sensor and encoder brownout