

FIRST Robotics Team 1923: The MidKnight Inventors

West Windsor - Plainsboro Regional School District | www.FIRSTrobotics1923.org



Behind the Design
2016-17



Design Philosophy

At the kickoff of our 2017 build season, we committed to a new design philosophy focused on directly prioritizing FIRST Steamworks' major challenges. This commitment helped our team better allocate valuable resources, namely mentors' and students' time as well as our machining capabilities and budget. After reviewing the manual, we ranked point-generating actions, creating a priority list around which we designed our robot.

1. Drive
 - a. Robust
 - b. Agile
 - c. Easy to repair
2. Cycle gears
 - a. Retrieve gears from feeder station
 - b. Place on peg
3. Climb
 - a. Safe & reliable
 - b. Fast

Because we prioritized cycling gears from the feeder station we designed a robust and agile drivetrain to minimize cycle times. We designed a fast gear mechanism that would retrieve gears from the feeder station easily and place the gears on the peg. We wanted to minimize human error as well, so we designed a robot that makes it easy for the drive team to do well. To match our priorities of avoiding damage to the robot and being quick, we designed a robust and powerful climber. While our initial priority list guided all our major design decisions, it is still susceptible to change over the course of the season based on evolving game strategies: later in the season, we added a fuel shooter to our robot to continue to be competitive at Championship.

Easily serviceable, robust, and elegant, this is our most competitive robot yet.



Drivetrain

Features

*Eight 4" siped Colson Performa
Two 4" drop down Omni-wheels
CNC routed parallel plate chassis
Two 3 CIM Ball-shifting gearboxes: 9
fps in low and 19 fps in high
SRX Mag Encoders
BRECOflex pulleys and belts*

Functions

*Our shifting gearboxes, drop-down
Omni wheels, and siped Colsons
enable us to maneuver across the
field and cycle gears quickly, even
while being defended.*

Our parallel plate drivetrain exemplifies our objective of creating a serviceable and elegant robot. With the removal of just six bolts, our wheels, belts, pulleys and gearboxes can be serviced and replaced. Our new CNC router allowed us to manufacture accurate drive plates with triangular webbing to reduce weight while maintaining structural integrity. We cut sipes into eight 4" diameter Colson Performa wheels, which increases traction by almost 15%. This gives us great defensive ability (even at 95 pounds) and makes it much easier to get around opponents' defense. Drop-down omni wheels change the point of rotation to the front of the chassis, giving us the ability to slip out of a T-bone pin when necessary. Our generous sponsor BRECOflex provided us with belts and pulleys for our drivetrain, which are much more efficient than the chain we have used in the past.



Gear Mechanism

Features

Pneumatically-actuated two-part manipulator to release gears

Pneumatically-actuated slider to extend and retract mechanism into frame perimeter

Precision CNC routed aluminum funnel for rigidity and serviceability

Functions

Our sliding gear mechanism allows us to reliably retrieve gears from the feeder station and score them on the peg, even if other game pieces are in the way.

Two piston-actuated sliders mounted on the sides of our drivetrain allow our entire gear mechanism to move forward and backward. When fully extended, the mechanism lies flush with the end of our bumpers, but otherwise sits inside our frame perimeter. The slides allow the mechanism to extend over game pieces on the floor blocking the loading station or peg. The gear manipulator's VersaFrame structure maintains rigidity in a highly physical game. A carriage consisting of 1/2" Lexan bent into a 'U' shape secures the gear while driving and two pistons actuate to push the gear all the way to the back of the peg. The funnel is made out of 1/16" aluminum to provide just enough flex to account for differences from field to field. The funnel is wide, with sloped sides to center the gear in the active part of the mechanism: this lets the human player quickly feed gears without having to worry about accuracy.



Climber

Features

Two 30:1 VersaPlanetary gearboxes powered by mini-CIMs

CNC-routed ¼" aluminum plate

19" wide roller wrapped in hook Velcro

Reversible ratchet for anti-backdrive

Functions

Our pivoting arm, reversible ratchets, and wide roller give us the means to safely and reliably climb in around 5 seconds.

To mitigate the risk of our robot falling, we built a robust and reliable climber with built-in safety measures. Our CNC routed ¼" 6061 aluminum plates form a sturdy frame that can withstand a fall. We used two 30:1 VersaPlanetary gearboxes powered by mini CIMs, which have twice the necessary torque to lift the robot. We found that the plastic CIM adapters for VersaPlanetary gearboxes snap easily under high-torque load; as a result, we routed our own CIM adapters out of 3/16" 6061 aluminum plate. We wrapped our 19" wide roller with double-headed hook Velcro to catch onto our rope, which is made of 600 pound rated nylon strapping with loop side Velcro sewn on both sides. The climber assembly is attached to our robot through a pivoting arm, so the rope can begin wrapping around the roller with less load. A ratcheting wrench limits the climber to roll in only one direction, acting as an anti-backdrive system and taking the holding load off of the gearboxes and motors.



Shooter

Features

CNC-routed ¼" aluminum plate construction

775 Pro with VersaPlanetary v2

2" wide flywheel (60A durometer)

Functions

Our Lexan shooter hood, flywheel, and indexer allow us to score fuel.

In our first priority list at the beginning of the season, we listed interacting with fuel far under gear cycling because of its much lower point value. However, with the time we had in between Mid-Atlantic District Championship and World Championship, we decided that a shooter autonomous mode would be a great asset as a tiebreaker and make us a more valuable alliance partner. Our flywheel shooter design is fully customizable and allows for easy maintenance. The side plates, CNC routed from aluminum sheet, have slots for our ⅛" Lexan hood, which keeps the angle of each of our shots consistent. The tabs can be cut to change the angle at which the balls are released allowing for a more accurate shot. Our 2" wide flywheel, which spins at around 7000 RPM, is powered by a 775 Pro on a VersaPlanetary v2 gearbox with ¼" compression on the fuel. This combination of shooter speed and compression allows for rapid fire of fuel without the need for slave wheels to retain accuracy.