



KILLER BEES 33



2014 BEHIND THE DESIGN BLZZ XIX

INITIAL DESIGN PROCESS

After Kickoff, we immediately began the design process by reviewing the game rules with the entire team. We also looked over the field specifications. We continued development by determining primary functional objectives for the machine. These were determined by analyzing cost and benefits of game tasks relative to point value. Simulated matches, with students as the robots, provided valuable insight into timing and potential gameplay.

Some of the primary functional objectives derived from these discussions included:

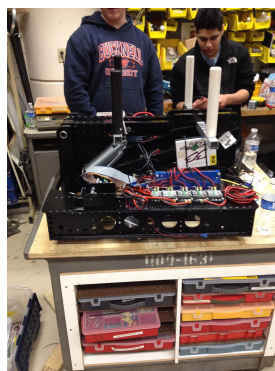
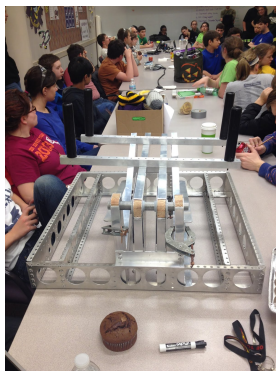
- Throw into high goal
- Catch the ball
- Shoot at multiple spots
- Pass to other teams
- Collect from the floor
- Throw over the truss
- Robust
- Drive fast
- Quick processing
- Score in the low point goal
- Spit the ball out
- Play good defense
- Quick shot turnover
- Reliable Shot
- Low center of gravity
- Be agile
- Score extra balls quickly
- Score extra balls quickly
- Simple
- Multiple auton programs
- Align to the wall for shooting
- Collect ball while driving full speed
- Shoot while moving
- Catch own throw

CHASSIS

The chassis is a key part of the design of our robot. Our chassis is designed for optimal acceleration and quick field maneuverability. We chose a 4 wheel omnidirectional drive train, inspired by FRC Team 148 (2013) and Build Blitz's Team JVN. The omnidrive is lighter, more efficient, has little turning scrub, and is difficult to play defense on.

Specs:

- 28" x 28" chassis frame
- x4 direct drive CIMs
- x4 VEXpro 4" omni wheels
- Gear Ratio: 12:72
- Speed: 14 ft/sec



CATCHING

In order to develop an effective catching mechanism, we built a kit bot chassis with a large catcher that funnelled the ball into a spot as low on the robot as possible. We came to the conclusion that in order to catch the ball more accurately and securely, we would need pivoting “wings”. In addition, we recognized the need to stabilize the ball as it sat in the catapult cradle, especially when the collector was down. A hoop of fiberglass rod, activated by two pistons, clamps the ball and secures it in the cradle.

Specs:

- Height: 59”
- Deploys quickly to catch balls and minimize bounce-outs
- String pulley system slaves side and back panels together
- x4 4” pistons open/close wings
- Bungee attached to the collector assists pneumatics.
- x2 5/8 fiberglass rods help contain the ball before it settles.

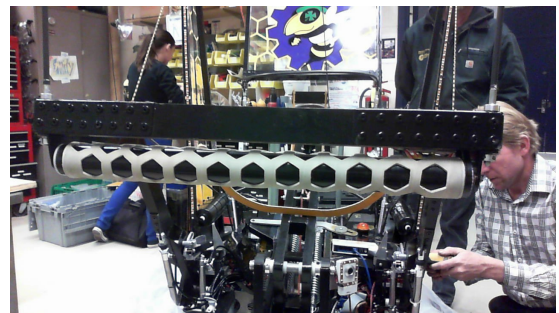


COLLECTOR

Functional objectives for the collector included the ability to collect while moving, gently “pass” the ball to another robot, collect balls that approach the robot at angles, and serve as part of our catching apparatus. Initial prototypes experimented with both straight and bent-arm models. The bent-arm model proved to be most effective for collecting balls approaching from the sides. The team worked to find the optimal roller height for collecting from both sides and front of the robot and the optimal angle for the bend in the arm. In addition to arm structure, prototypes tested various roller and wheel surfaces. Both 4” and 2” wheels had difficulty collecting balls from the side. A continuous PVC roller with anti-abrasion gum rubber covering was most effective.

Specs:

- x2 AndyMark 9015 motors
 - Simulator gearbox
 - Belt & pulley reduction leads to 9:1 final drive
- Abrasion-Resistant Gum Rubber Tubing covers front PVC roller
- x2 5” pneumatic pistons
- Welded, angled collector arm aids ball pickup from multiple directions



SHORT SHOT MECHANISM

Being able to make a short shot is imperative to the game play and robot versatility. In order to accomplish the task, we brainstormed ideas such as adjusting the shot angle with the upstop and adjusting spring tension. However, we concluded that we can do a “pop shot” by

deflecting the ball off of the collector. After making sure our collector could withstand the force of the ball, we tested different heights of the collector to see which would produce the optimal deflection. In addition, striking the collector adds topspin to ball, allowing it to more easily score if it contacts the goal in any way.

Specs:

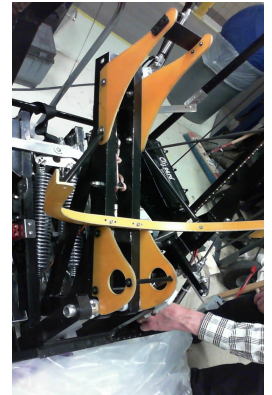
- x2 2" pistons
- custom polycarbonate hooks to lock collector into place

CATAPULT

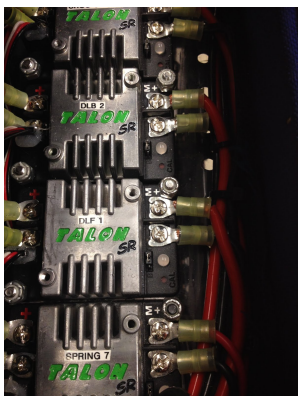
At the beginning of the season, we established multiple objectives for the catapult, such as being able to make a short shot and a full court pass. Throughout the prototyping process, it became apparent that we needed more spring force than we had immediately available. In order to achieve the spring forces we needed, we used extension springs, surgical tubing, and even a large compression spring. We discovered that cradling the ball to its circumference provided the most consistent flight path. We also found that a seatbelt would not stretch over time and would be a reliable upstop.

Specs:

- Spring tensioner: CIM with VEXpro Versa Planetary Gearbox
 - Gear Ratio: 60:1
- x6 springs, total of approx. 900 lbs of spring force
 - x2 18 lbs/in large springs
 - x4 9 lbs/in medium springs
- Rollover "choo-choo" cam w/ interlocking flail/hub design
 - final drive: 160:1 ratio
 - CIM with Dewalt transmission: bi-directional roller clutch prevents backdriving
 - Custom bearing from flail to crank, maximizes torsional rigidity
 - Optimization of thrust faces (gearbox face for crank, crank for flail)
- Dyneema cord: 8000 lb load



ELECTRONICS AND PNEUMATICS



- Placement of cRIO, PD board, and Talons rendered in CAD prior to assembly.
 - x8 Talons
 - x1 release motor, x1 tensioner motor, x4 drivetrain motors, x2 collector motors
 - x1 Spike (On-board compressor)
- Pneumatics are integral to our design. They are optimized for all mechanisms on the robot to provide quick actuation for catching, collecting, and shot selection.
 - x2 5" Pistons (Collector)

- x4 4" Pistons (Ball clamp, catching)
- x2 2" Pistons (Short shot mechanism)

PROGRAMMING AND LOGIC

- Absolute encoder used to detect angular position of rollover cam (choo choo)
- Optical sensor mounted on the front of the catapult z-frame used for ball detection
- Spring potentiometer used to calibrate spring tension
- Limit switch to detect collector state
- x2 VEX Optical Shaft Encoders mounted on 2" VEX omni wheels used as follower wheels for encoders
- The state machine manages all robot operations, aside from the drive train. This allows for complex interactions between the various subsystems to be easily coordinated within the programming.