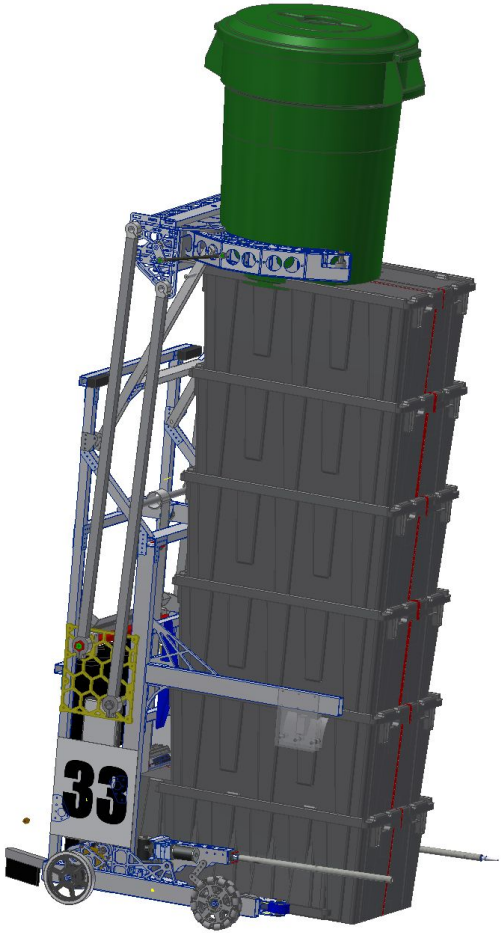
2015 BEHIND THE DESIGN BUZZ XX

NOTRE DAME PREP
FIRST
KILLER BEES
33

BUZZ XX



INITIAL DESIGN PROCESS

After Kickoff, we immediately began the design process by reviewing the game rules with the entire team. During this step, 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. We also created a scoring matrix to evaluate which actions provided the most return.

# of Times Done	1 Tote	2 Tote	3 Tote	4 Tote	5 Tote	6 Tote	1Tote&Can	2Tote&Can	3Tote&Can	4Tote&Can	5Tote&Can	6Tote&Can	1 TC&L	2 TC&L	3 TC&L	4 TC&L	5 TC&L	6 TC&L	Litter in Landfill	Litter in Opp Auto	Herd Totes
1	2	4	6	8	10	12	3	6	9	12	15	18	6	12	18	24	30	36	1*	3	1
2	4	8	12	16	20	24	6*	12	18	24	30	36	12	24	36	48	60	72	2*	6	2
3	6	12	18	24	30	36	9*	18	27	36	45	54	18	36	54	72	90	108	3*	12	3
4	8	16	24	32	40	48	12*	24	36	48	60	72	24	48	72	96	120	144	4*	18	4
5	10	20	30	40	50	60	15*	30	45	60	75	90	30	60	90	120	150	180	5*	20	5
6	12	24	36	48	60	72	18*	36	54	72	90	108	36	72	108	144	180	216	6*	24	6
7	14	28	42	56	70	84	21*	42	63	84	105	126	42	84	126	168	210	252	7*	28	7
8	16	32	48	64	80	96	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8*	32	8
9	18	36	54	72	90	108	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	9*	36	9
10	20	40	60	80	100	120	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10*	40	10
11	22	44	66	88	110	132	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	11
12	24	48	72	96	120	144	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	12
13	26	52	78	104	130	156	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	13
14	28	56	84	112	140	168	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	14
15	30	60	90	120	150	180	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15
16	32	64	96	128	160	192	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	16
17	34	68	102	136	170	204	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	17
18	36	72	108	144	180	216	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18
19	38	76	114	152	190	228	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	19
20	40	80	120	160	200	240	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20

Functional Requirements:

Need- Low center of gravity
Need- Fast
Need- Acceleration
Need- Nimble
Need- Rigid/Robust
Need- Repeatable/Accurate
Need- Create stack of 6 w/ container
Need- Fast floor collect out of pile
Need- Grab garbage can off step
Need- Drive over ramp
Need- Straddle ramp

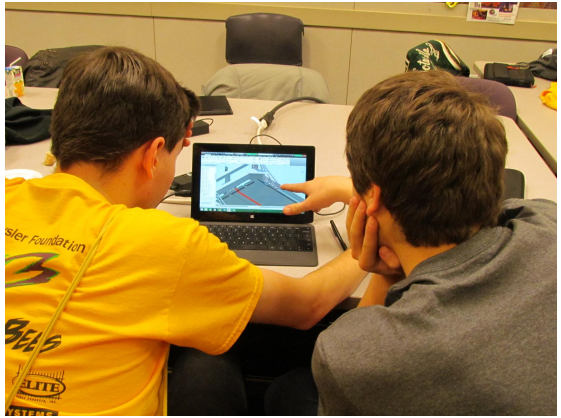
Need- Don't let litter slow you down
Need- Don't get stuck on ramp

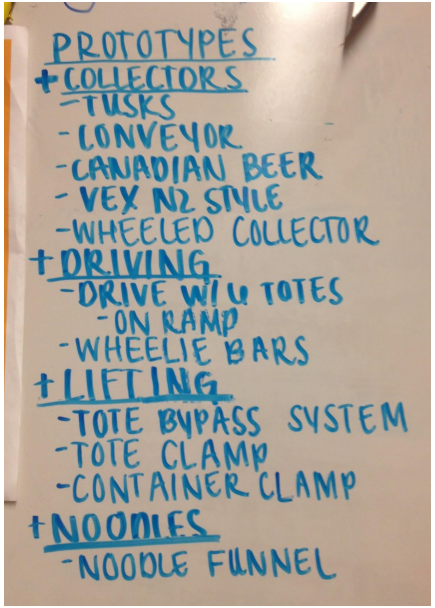
Want- Create stack of 3 in auto
Want- Make stacks of stacks
Want- Move litter into Landfill

Wish- Stack ~3 and take container from step

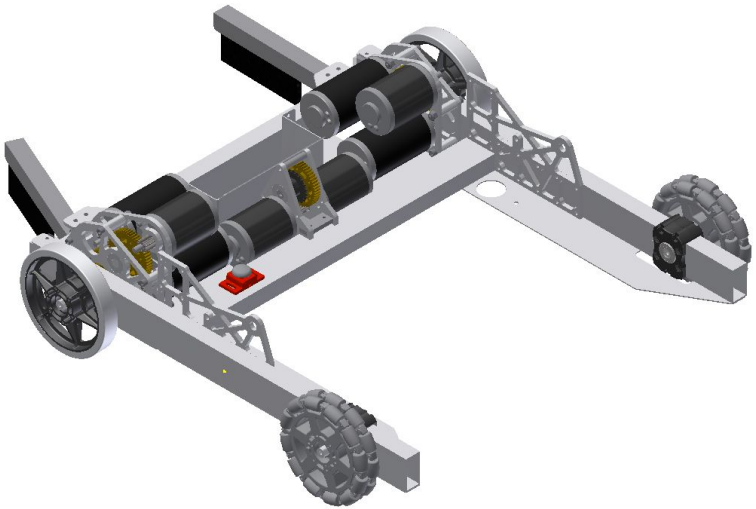
DEVELOPMENT OF DESIGN

During week one, we held brainstorming sessions where students and mentors to conveyed their design concepts and ideas to the entire team. At this time, a list of functional objectives was compiled for the machine. The CAD process began during this time, allowing younger students and mentors to easily collaborate on the design process. The team began the prototyping process in various groups, focusing on ways to separate, lift, and stack the cans and totes.



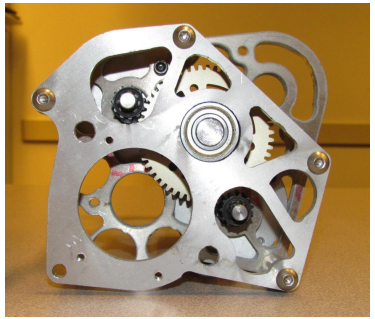


DRIVETRAIN



The chassis is a key part of the design of our robot. A prototype chassis was designed and built during the offseason to test the wheels, gear ratios, and overall design concept. This prototype chassis also provided vital driver training. After Kickoff, we decided that a lighter, 4 wheeled version of this concept was feasible to accomplish our primary functional objectives.

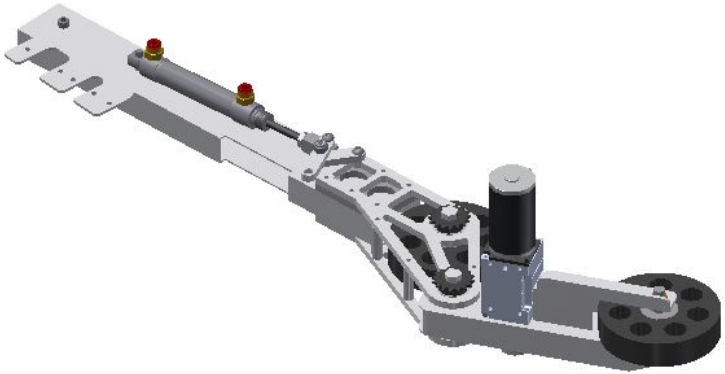
- 4 6” Omni wheels
- C-base frame allows for internal tote collection.
- Custom gearbox accommodates up to 3 CiMs. Each side of the drivetrain has 2 Mini CiMs.
    - Geared for 8 feet/second.
- 25 pitch chain runs through the chassis base.
- Spring-loaded wheelie bars support the robot.

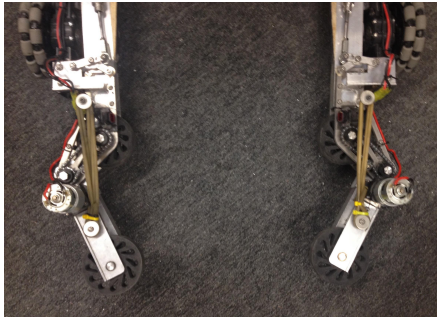


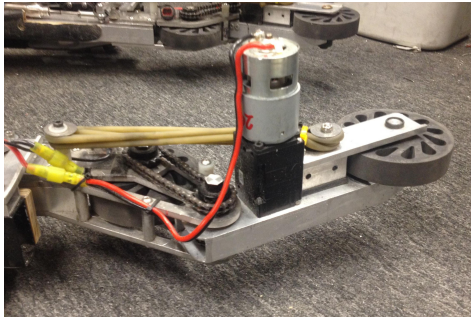
Transverse Wheel Intake

Originally, we used a combination of actuating transverse wheels and spinning rubber “tusks” to orient and collect totes. After Week One competition, we redesigned our intake to be faster and more efficient when collecting from the landfill. Our initial prototyping looked to determine the best material for these wheels and the optimal amount of pinch on the totes.

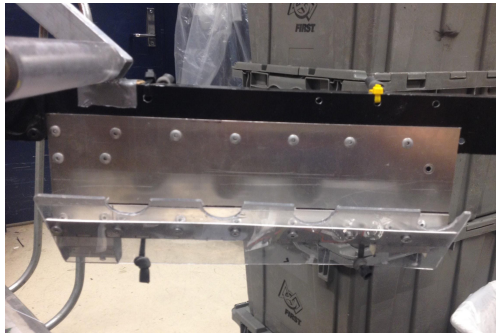
- 2 BaneBots 775 Motors with VersaPlanetary gearboxes
- Rubber wheels provide the best grip when removing totes from the landfill.
- SICK Optical sensors control the actuation of transverse wheel assemblies.





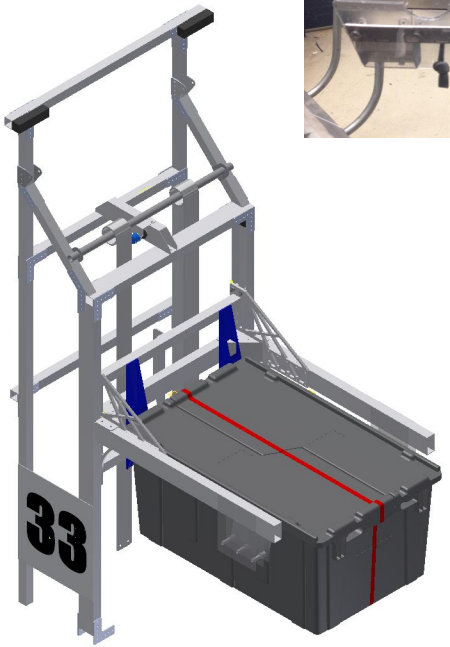


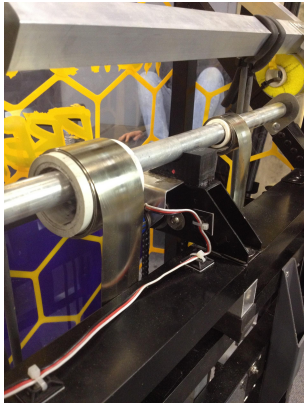
ELEVATOR & STACKER



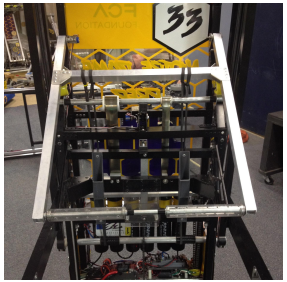
Having built elevator lifts in years past, we were confident that we could design an elevator and stacker that would meet all of our primary functional requirements. The frame of the robot incorporates the elevator, stacker, and other features such as the electronics board.

- Gearbox accommodates 2 CIM-type motors. To save weight, our elevator uses 1.
- 25 pitch chain drives the stacking mechanism.
- Adjuster nuts in the elevator slides allow for fine-tuning of the mechanism.
- Lightweight polycarbonate “fingers” are a bypass mechanism that hold the stack of totes.
- Closed-loop controller monitors the stacker’s position.





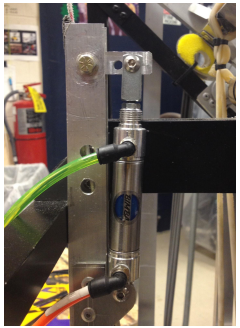
STACK CLAMP



The lightweight stack clamp steadies the stack of totes within the robot. The stack clamp also inputs the number of totes carried into the overall state machine for Buzz XX.

- Rotary potentiometer measures number of totes held in stacker.
- 1.25” polycarbonate tubing on bearings reduces friction between the container and the totes.
    - When scoring, the stack clamp slides out from underneath the container without upsetting the stack.

STACK CLAMP BRAKE



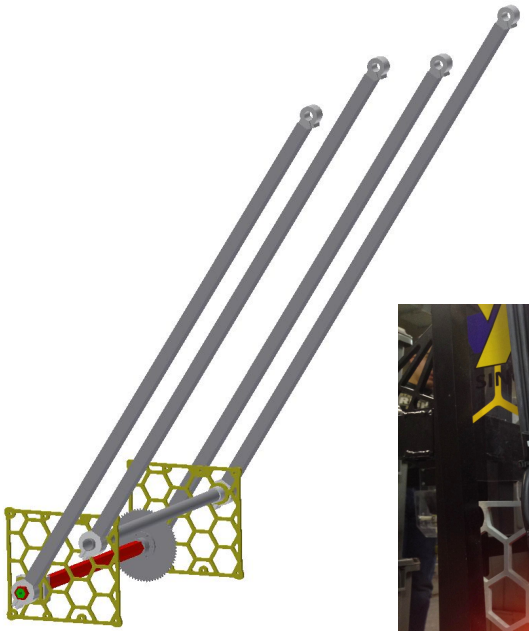
During Week One competition, we found that when scoring stacks of six, our stack clamp could occasionally unnest the top totes and disrupt the stack. To prevent this, we designed a stack clamp brake, similar to a rope jammer used in climbing. The brake arrests the stack clamp in the “up” position, preventing it from slamming down as a stack is being scored.

- 2” piston

FOUR BAR LIFT

Manipulating the containers from auton and from the step was a primary functional objective. Because the four bar manipulates the container separately from the rest of the stack, Buzz XX is able to cap stacks within the robot and those made by alliance partners. Originally designed for 25 pitch chain, the four bar is now powered with 35 pitch chain.

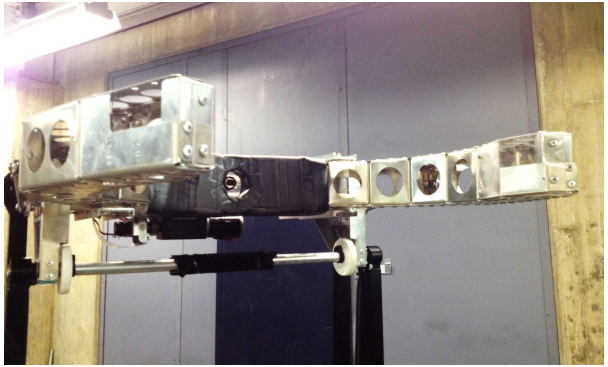
- Mini CiM motor with a VersaPlanetary gearbox, 40:1 gear ratio
- 35 pitch chain drives the four-bar.



CONTAINER CLAW

During the prototyping phase, we explored several options for a container claw and found that a pinching-style claw worked best. It was designed to be able to accommodate two transverse roller wheels at the edge of the claw. If needed, these modular wheel assemblies can be added later.

- BAG motor with Versaplanetary gearbox - 125:1 gear ratio.
    - Potentiometer on the motor allows for preset claw positions. In addition to a manual override, the operator has options for open, partly open, closed, and “tote collect” positions.
- Overcenter locking linkage to prevent backdriving.



ELECTRONICS

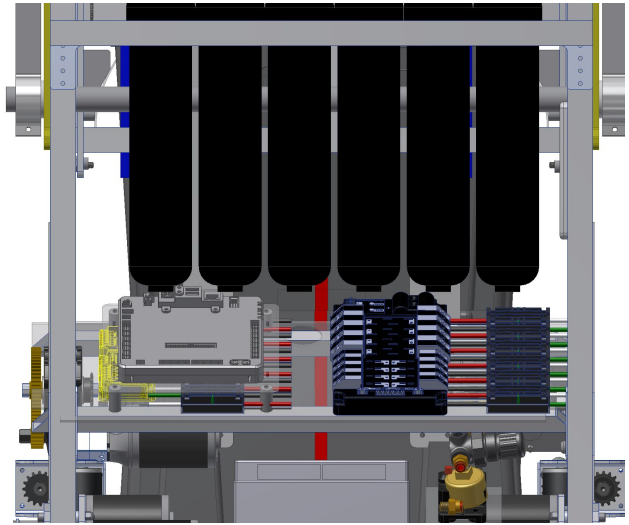
The placement of the electronics panel was rendered in CAD prior to the assembly of the robot. The board was built up with main electrical components outside of the robot in order to expedite the wiring process.

Motors & Motor Controllers

- 9 Victor SP Motor Controllers
- 1 CiM (elevator)
- 5 Mini CiMs (4 - drivetrain, 1 - four-bar)
- 1 Bag Motor (claw)
- 2 BaneBots 775 Motors (intake)

Sensors & Encoders

- 1 VEX Yaw Rate Gyroscope Sensor V1.0
- 4 Potentiometers (four-bar, stacker, stack capper, and claw)
- 2 VEX Bumper Switches (tote intake)
- 2 Absolute Encoders (drivetrain)
- 3 Sick Optical Sensors (2 - transverse wheels, 1 - claw)

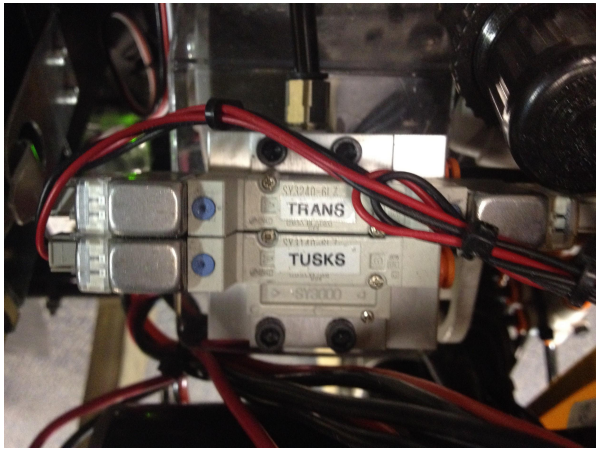


PNEUMATICS

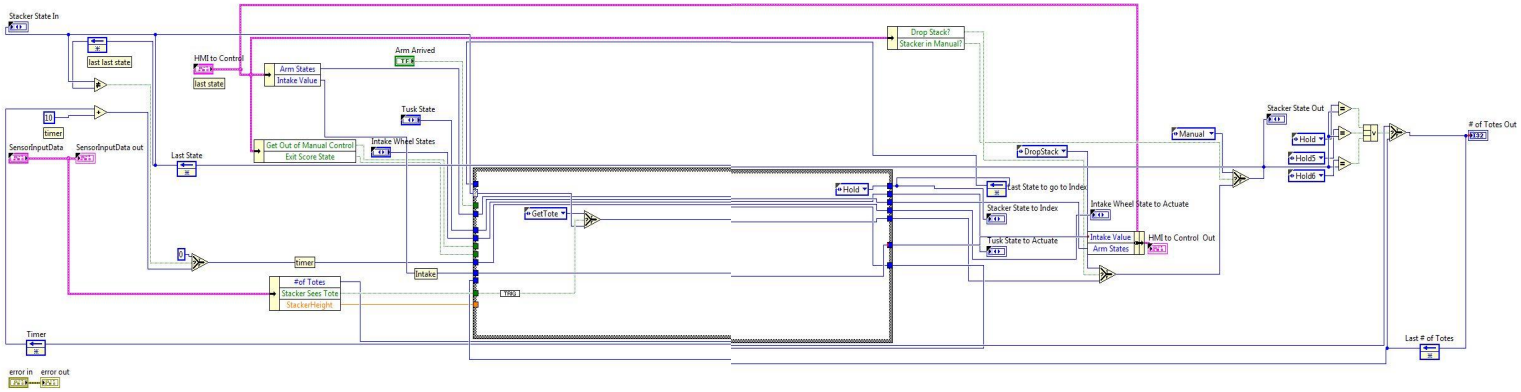
Pneumatics are integral to our design. They are optimized for all mechanisms on the robot to provide quick actuation for aligning and collecting totes.

An offboard compressor saves weight. The pistons for Buzz XX are smaller than previous years and are cycled less, so an onboard compressor was unnecessary.

- 3 2” pistons (2- intake, 1- stack clamp brake)
- 5 Clippard 574 ml air tanks



PROGRAMMING AND LOGIC

Buzz XX was programmed with LabView. 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.

- Closed-loop controllers on the stacker, claw and four-bar.
- Arcade drive interface on the drivetrain.
- Input from sensors on the stacker, elevator lift, four-bar, and claw feed values into the state machine.