MANUAL FOR BUILDING THE

5327E Robot

Team 5327E

2019-2020 Tower Takeover

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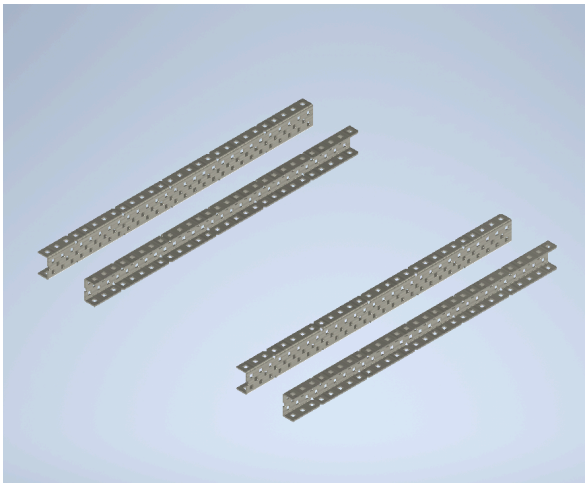
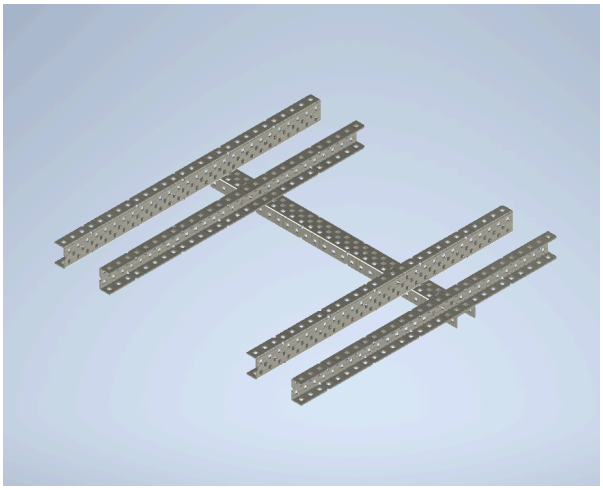
BASE

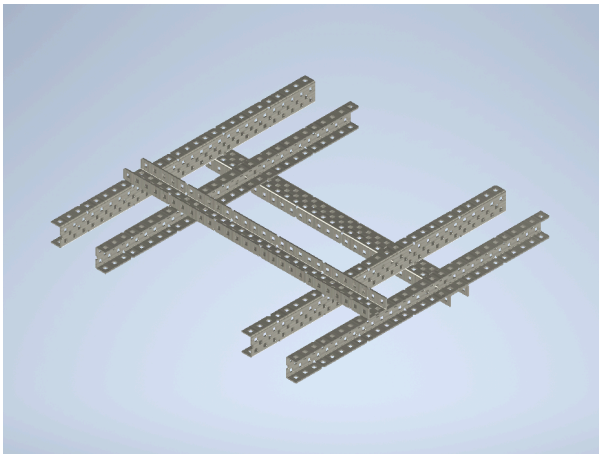
The 2019 - 2020 Tower Takeover game has a field with many cubes that make it hard for robots to move around the field. In order to have a competitive edge, our robot needs to be able to maneuver around these cubes when needed. One feature of our robot that helps us do this is that the robot's base is a lot smaller compared to other competing robots. We used aluminum C-channels on our robot because it contributes to our lightweight robot. It is important to avoid having a heavy robot because the heavier the robot is, the slower it will be. In this year's game, speed is an important factor as we need to collect as many cubes as we can before our opponent obtains them.



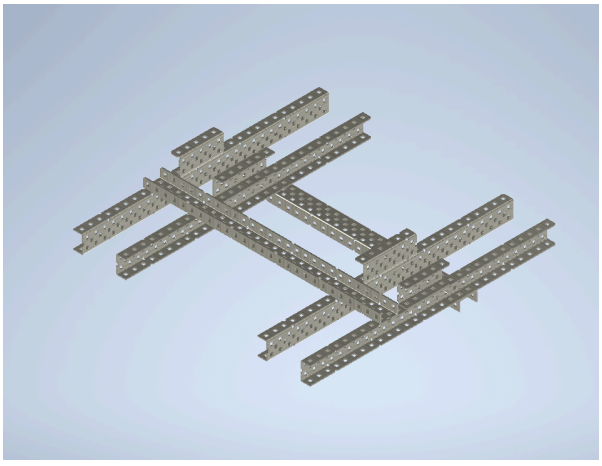
1. We start off building the base with four C-channels that are twenty-eight holes. Twenty-eight holed C-channels are necessary because we need our base to be relatively small in order to move around the field without being hindered by the vast amount of cubes that are on the field.



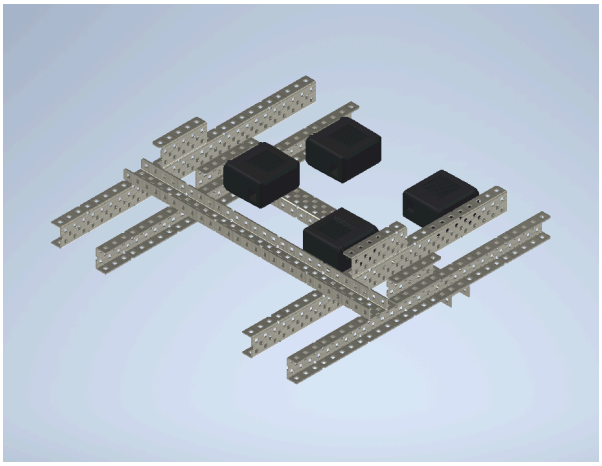
2. After orienting the four C-channels as shown on the left, we add another C-channel that is attached to all four C-channels. The purpose of this C-channel is to connect both sides of the base.



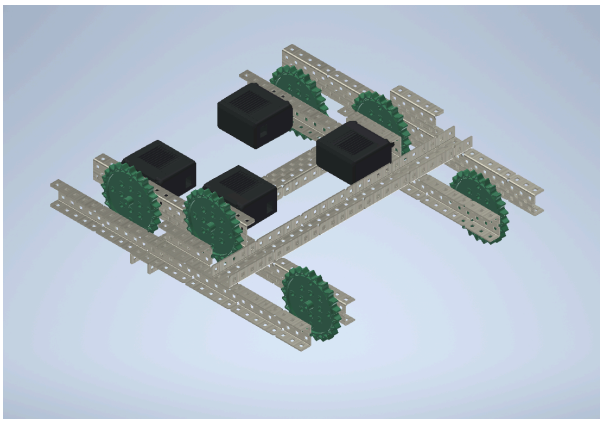
3. Similar to the crossbar C-channel attached below the base, there is also another C-channel of the same length that acts as a crossbar attached above the base.



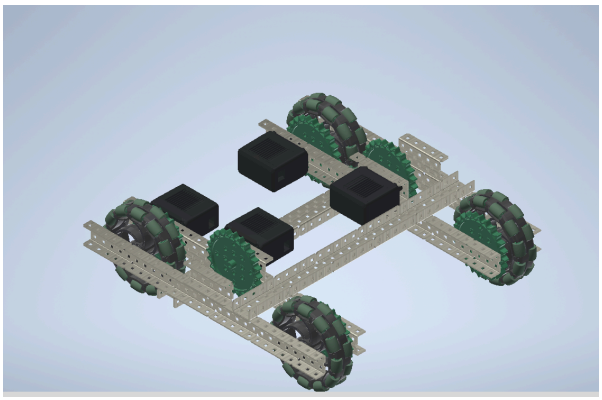
4. Obtain four C-channels that are six holes long. These should be placed in the same orientation as the C-channels that they are attached to. These C-channels are here in order to hold up the motors.



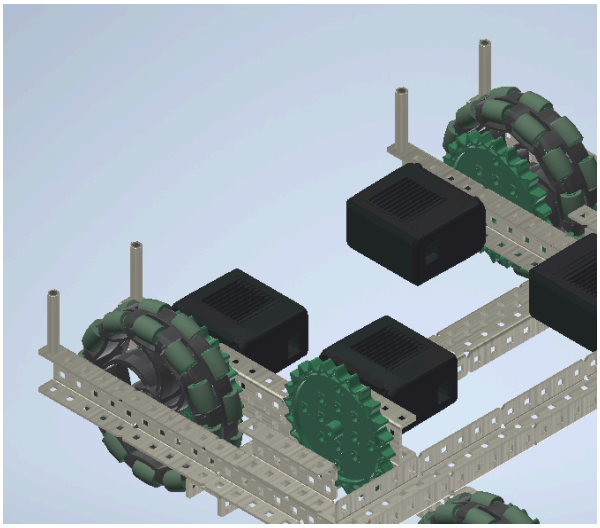
5. Attach four 200 RPM motors to the base. Two of the motors should be attached to the two inner initial C-channels, while the other two should be attached to the small six-hole-long C-channels.



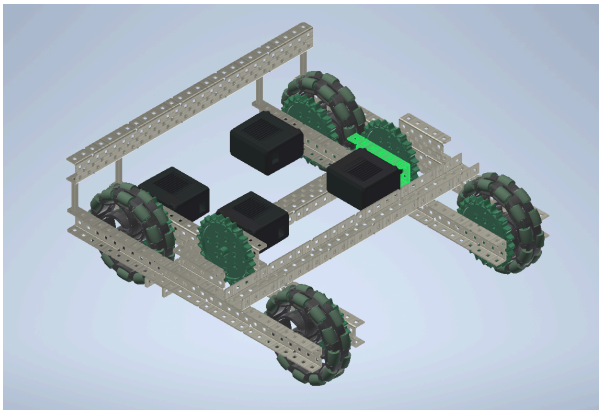
6. Attach two sprockets to the motors on each side using an axle. At the front, attach one sprocket on each side to the inner C-channels also using an axle. Make sure to apply bearings to stabilize the rotation of the axle.



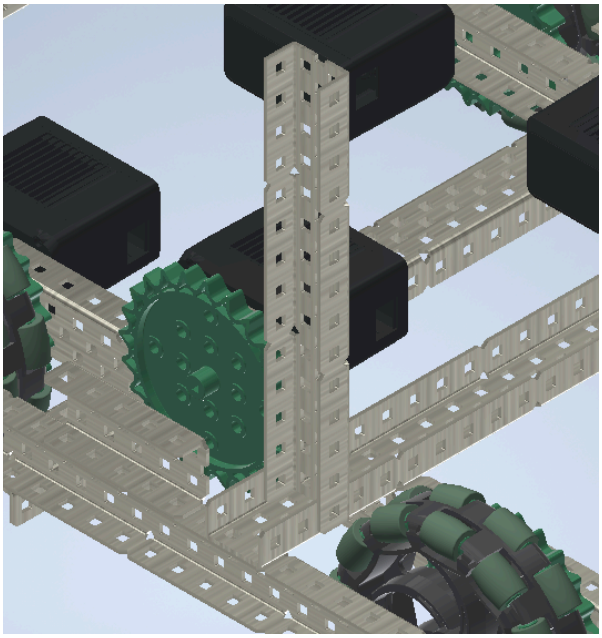
7. On the same axle as the outer sprockets (not the middle one), attach a 4-inch omni wheel to each axle. Make sure to link all the sprockets together by connecting chain links on the sprockets (not shown in image)



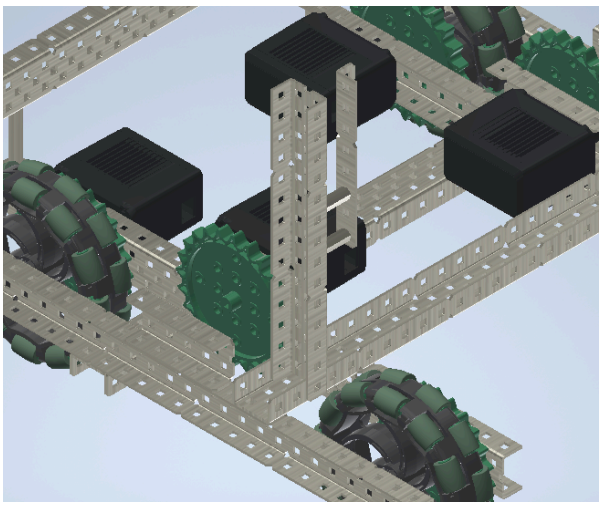
8. Get four standoffs that are two inches. We also need four three eight crews in order to attach these standoffs. Make sure that these standoffs are study and won't unscrew by themselves because these standoffs will hold up the crossbar for the lift towers.



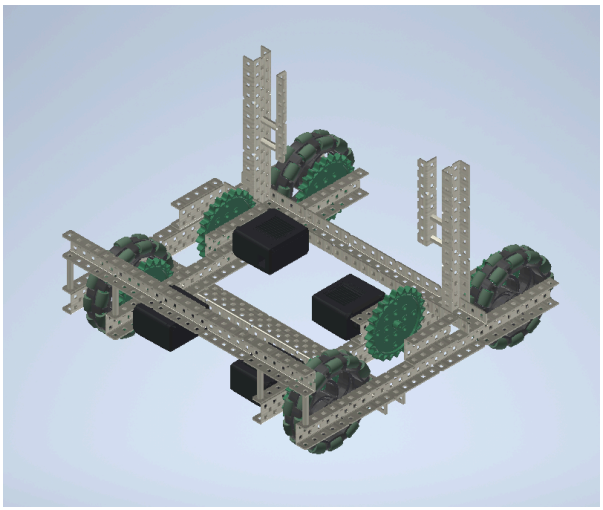
9. Add a C-channel that is attached atop the four standoffs in the back of the base.



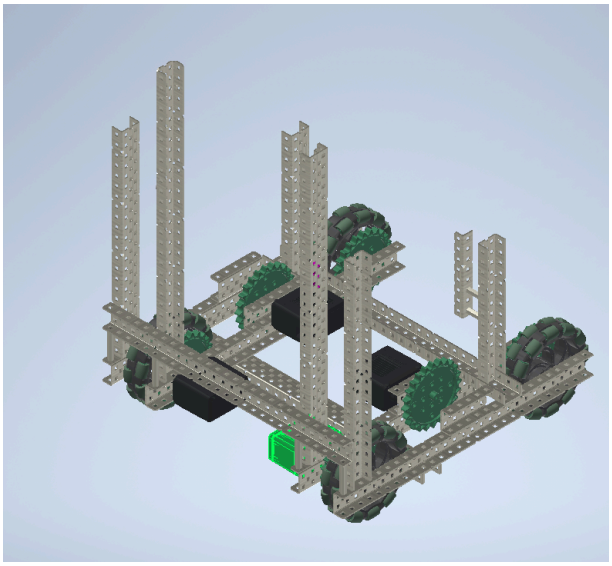
10. In order to prepare for building the actual lifts, we will be building vertical bars. These are made from C-channels that were fourteen holes long. These vertical bars will be used to align the lift.



11. Attach an 8-hole half-channel to the vertical bar using two standoffs on the sixth and eighth hole.



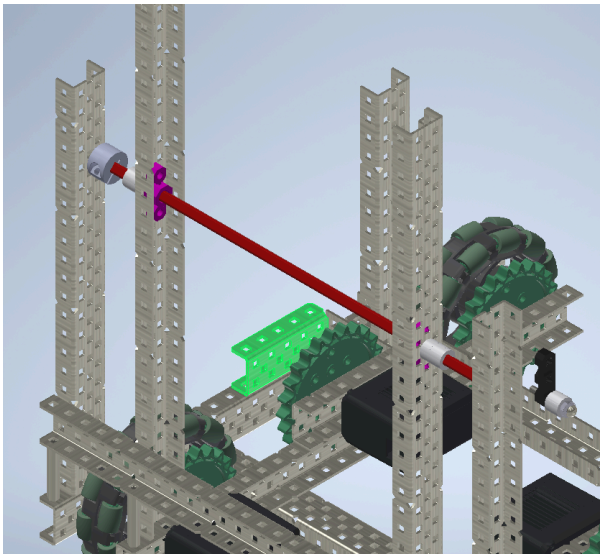
12. Mirror the vertical bar and half-channel on the other side of the base.



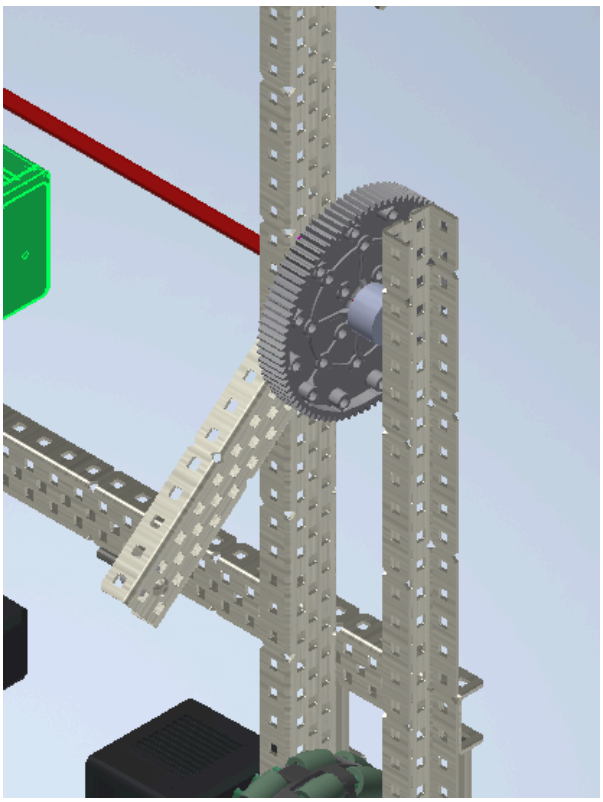
13. Next, we build the lift towers that hold up the lift. Two C-channels that are 22 holes long are added to the ends of the base. These C-channels should be oriented in a way that they are facing outside. Two other C-channels that are 35 holes long will be placed on the inside of the base. All four C-channels are going to have one of their sides attached to the horizontal crossbar. This will contribute to the lift's sturdiness.

LIFT

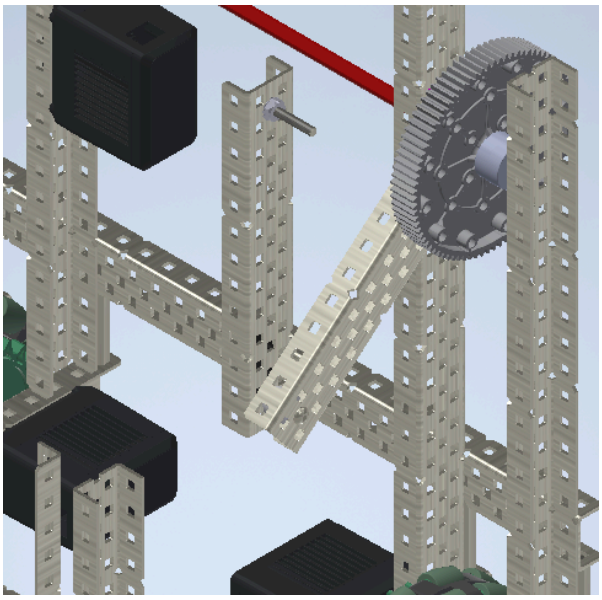
In this year's game, we need to be able to lift up cubes and place them in the towers to increase the value of our stacks of cubes. Something unique about the way we built our lift is that it uses one high strength axle which provides a lot of stability to our lift. We also have two vertical bars that help align the lift so that the C-channels do not bend when picking up the cubes.



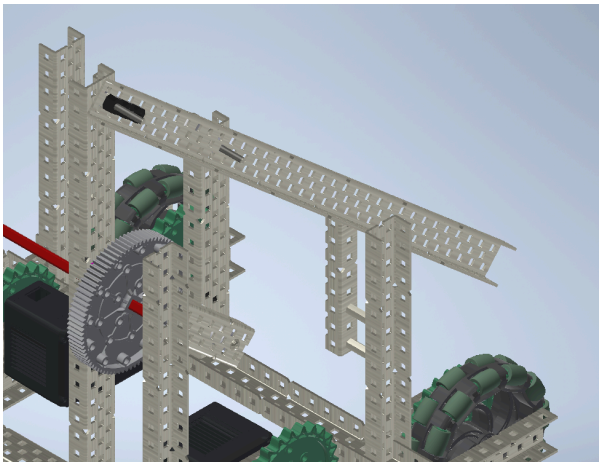
14. Run a high-strength axle through the four vertical bars. Also attach high-strength collars and high-strength bearings where needed. We will need a high strength axle in order to give the maximum support to the lift.



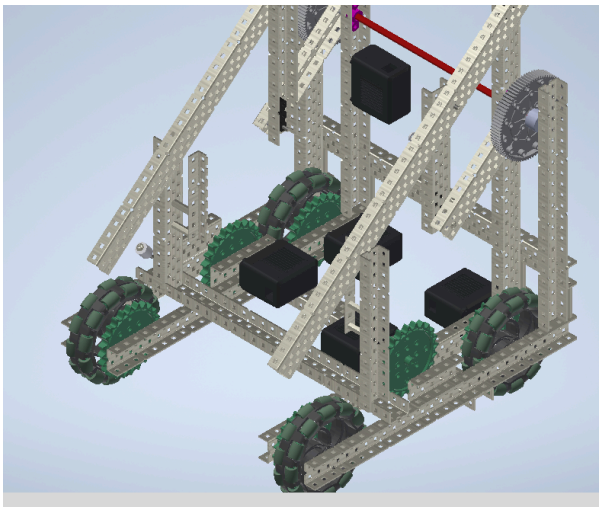
15. Attach a high-strength gear to the high-strength axle. Screw a C-channel onto the high-strength gear.



16. We need two C-channels that are each 13 holes long. These C-channels should have the flat side facing the gear so that they take up less space when they are attached to the wheel.



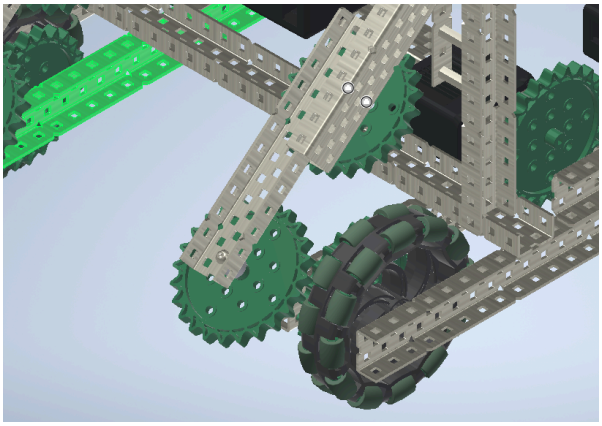
17. Attach a C-channel to the inner vertical bar via screw joint and attach it to the medium-sized C-channel extruding from the C-channel that is attached to the high-strength gear



18. Mirror the high-strength gear and various crossbars on the other side of the robot.

ROLLERS

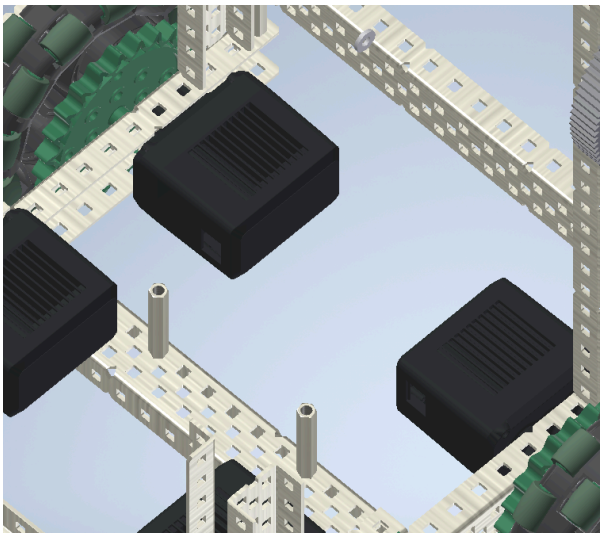
Another mechanism that is included on our robot is rollers. This mechanism helps us intake cubes and push them on our tray. To build these rollers, we have 24 tooth sprockets that are connected to the chain. This allows us to grip the cubes through the use of friction and intake them on our tray.



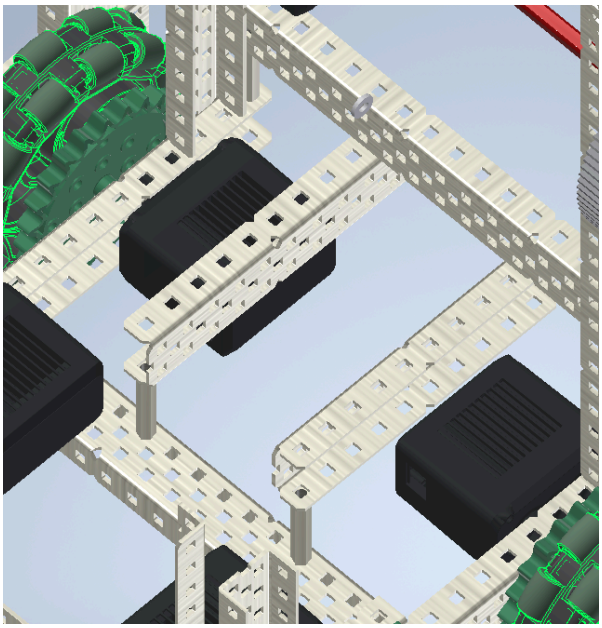
19. Attach a C-channel to the lift arm. Then, on the bottom of the C-channel, attach one sprocket via screw joint near the bottom of the C-channel. Attach a motor on the upper part of the C-channel (not shown in image) and attach another sprocket to the motor using an axle. Mirror the rollers on the other lift arm.

ANGLER

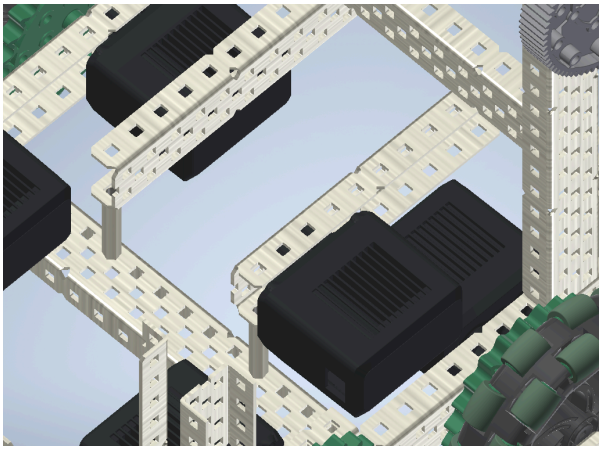
Attached to the tray, we have the angler. This mechanism helps move the tray which gives the robot the ability to outtake the stacks of cubes. Since each cube is around 285 grams which results in the stack of cubes being very heavy. Currently, our maximum cube stack contains nine cubes which means that our highest cube stack is 2,565 grams. In order to move this heavy mass, the angler has to be very powerful. This means that the motor has to have a high torque because more torque means more power.



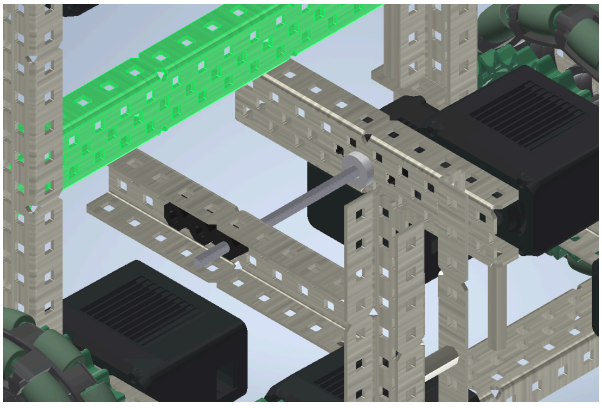
20. In order to build the angler, we first need two standoffs that are each 1.5 inches. These will use a midget to connect to the lower crossbar of the base. It is important that they are screwed on tight because they will be holding up the angler, which deal with a lot of weight that comes from the cubes.



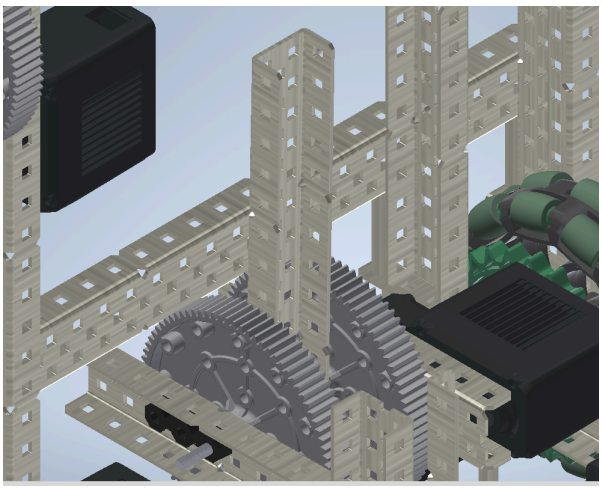
21. Attach a C-channel that is 10 holes long to each standoff. These C-channels will be oriented with the flat parts facing each other.



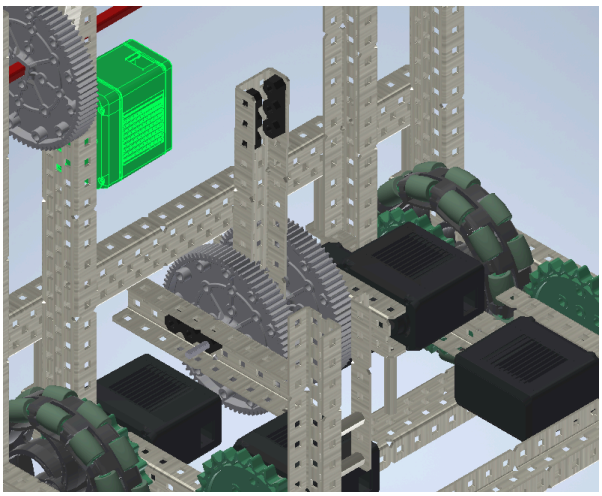
22. Attach a motor to the C-channel on the right.



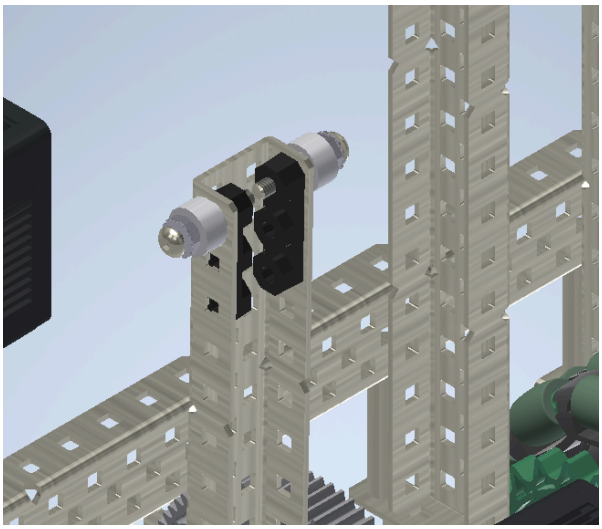
23. Attach an axle to the motor and add a bearing to the C-channel on the left. Secure this C-channel with a collar in order to ensure that the axle doesn't accidently fall out of the motor.



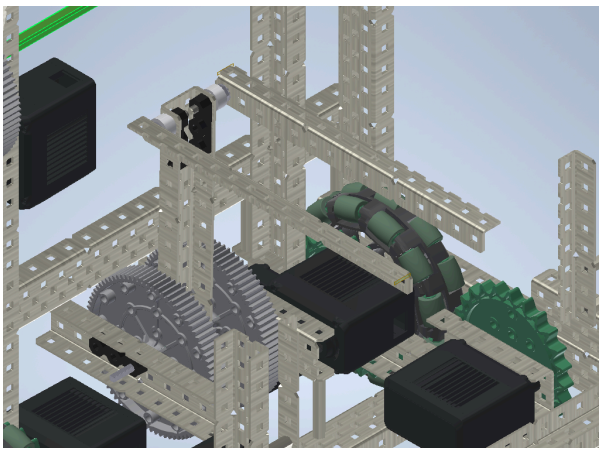
24. Put a high-strength gear, a C-channel, then another high-strength gear on the axle attached to the motor.



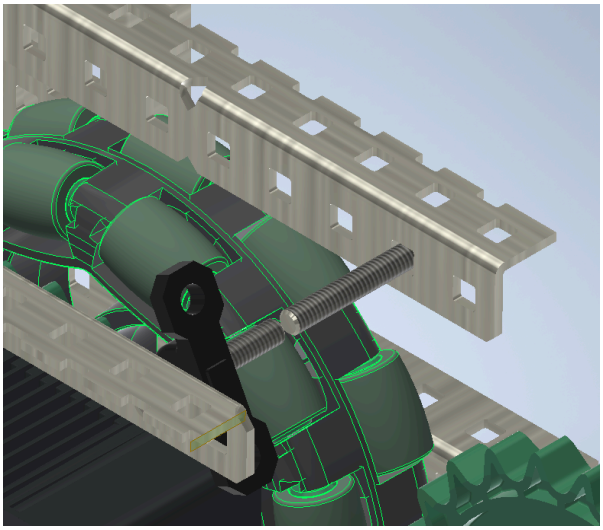
25. Attach two bearings, each on either side of the C-channel that is attached to the gears.



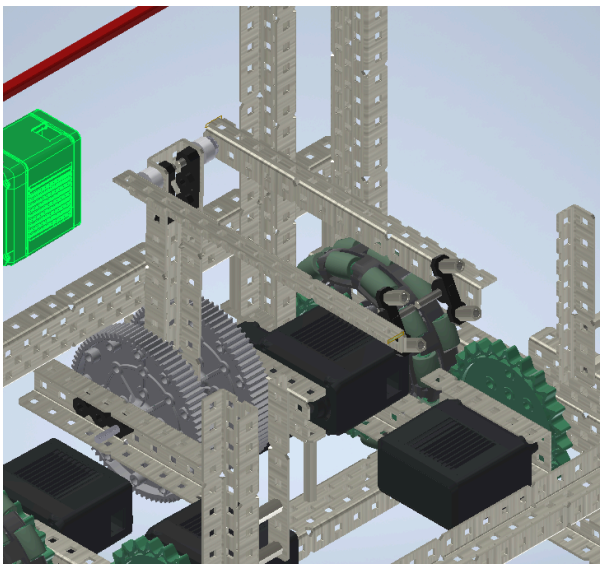
26. Put two screws through the top hole of the bearings that has a Keps nut, then a collar.



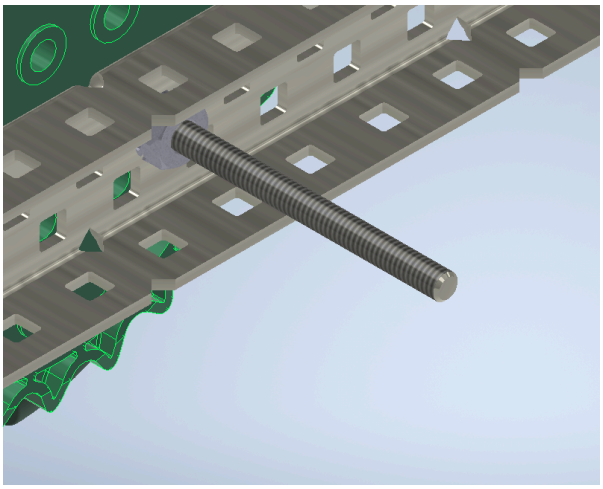
27. Obtain two half C-channels that are each fifteen holes long. Make sure that the flat part is facing inwards and the edges that are cut are facing outward.



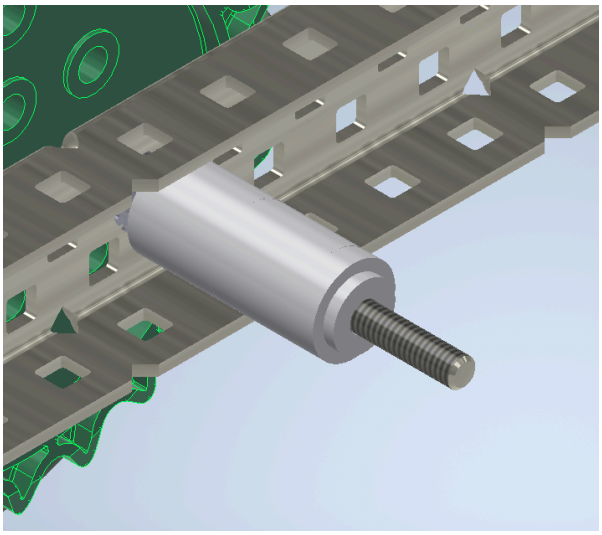
28. Put a screw through each half-channel one hole away from the edge.



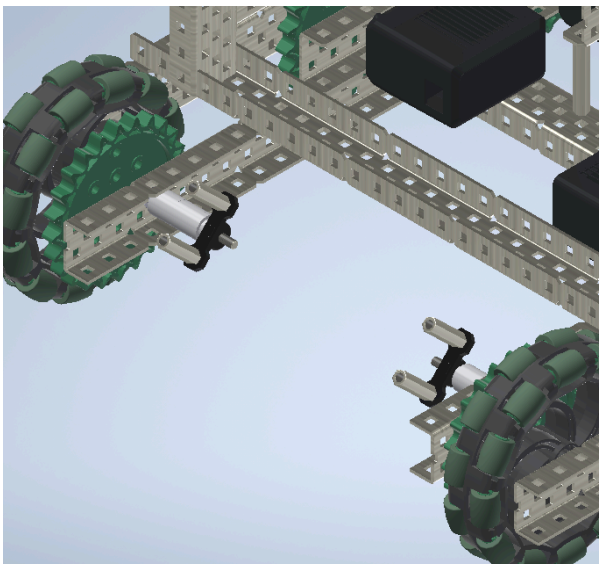
29. Attach pillow blocks to each of the screws extruding from the half-channel. Add two standoffs to each pillow block.



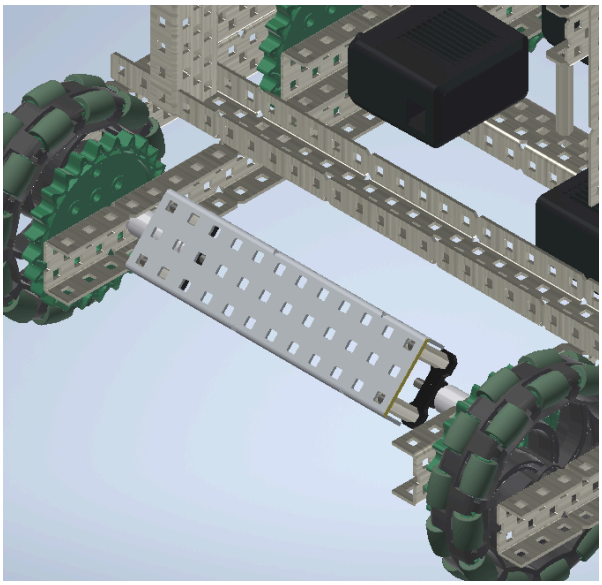
30. Attach a 1.5 inch screw on the inner C-channel. Secure it with a Keps nut.



31. On the screw that has just been attached, add one inch of spacing and a one sixteenth spacer.



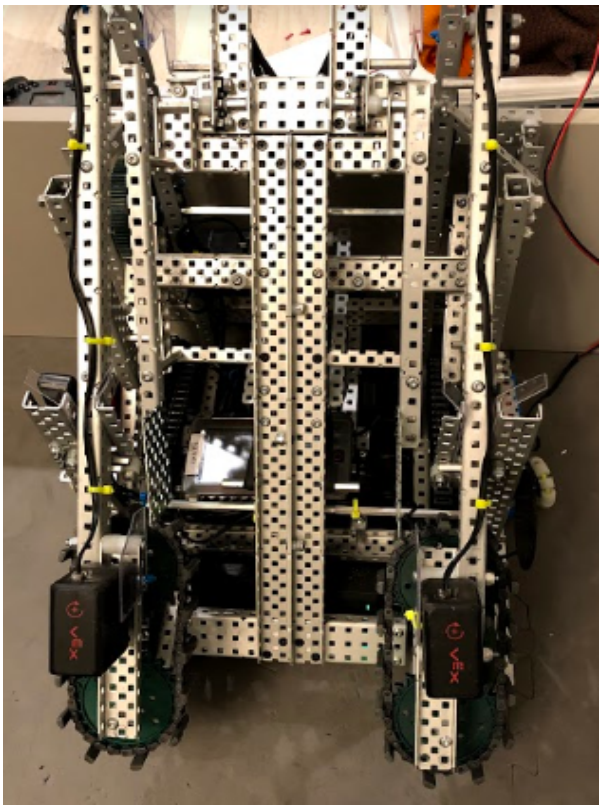
32. Mirror the screw on the other side of the base. Attach a pillow block to each of the screws. Attach two standoffs to each pillow block.



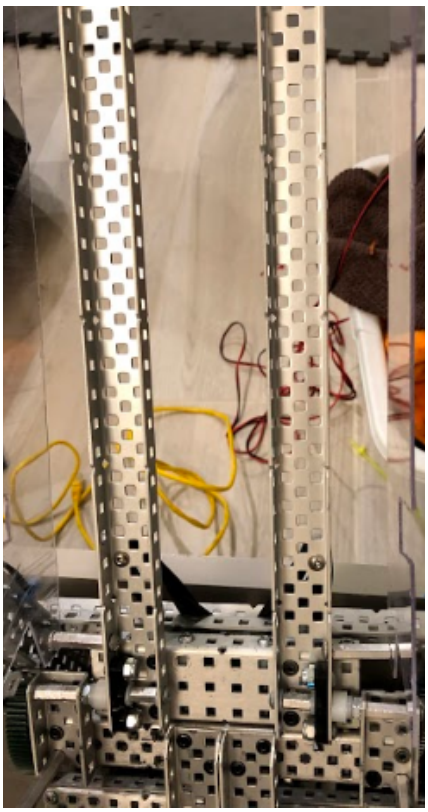
33. Attach a 3-hole-wide C-channel to the standoffs from the pillow blocks.

TRAY

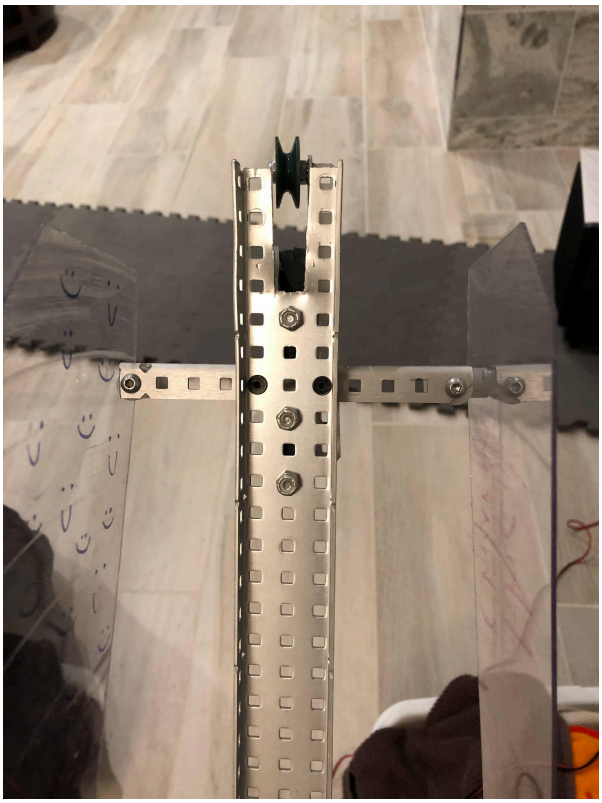
Our robot has a three-stage lift which is how we store our cubes before placing them in our protected zones. Along with two C-channels per each stage, we also use rectangular pieces of polycarbonate to align the cubes on the tray and make sure that they don't fall off. Through intensive fine-tuning, we have made this tray sturdy and stable.



34. Attach two C-channels that are 35 holes long to the 3-hole-wide C-channel. These two C-channels should be attached to each other and the crossbar on top of the lift towers.



35. For our second level of the tray. This is made up of two C-channels that are 35 holes long. To attach this level with the first level, use two bearings and attach two standoffs on each side to a 3 hole side C-channel.



36. Attach two polycarbonate panels on each side of the tray using a perpendicular screw joint. To make the screw joint, use one screw that goes through a collar, then have a screw extruding from the horizontal hole of the collar. Make sure to secure the screw initially with a nut.

WIRING

In order to program the motors, we will have to use wires to connect the motors to the brain, where the code is uploaded. When we are attaching the wires, we try to use shorter wires whenever possible because it reduces the amount of time it takes for the signal to reach the motors. This is why it is important to connect the wires to the ports that are closer to the motors. We have included a port schematic that lists which port is connected to each motor. We also included an explanation of the different types of motors we used on our robot. The color of each cartridge is also included in this summary. We also include where our battery and radio module are plugged into the brain.

Motor	Corresponding Port
Base Left Front	Port 14
Base Left Rear	Port 1
Base Right Front	Port 17
Base Right Rear	Port 10
Lift Right	Port 7
Lift Left	Port 8
Angular	Port 2

Mechanism	Cartridge RPM	Color
Lift	100 rpm	
Angler	100 rpm	
Base Motors	200 rpm	
Roller Motors	200 rpm