Studica

worldskills
Mobile Robotics Competition

Hardware Tips and Techniques

- Basic construction.
- Useful tools and techniques.

- Get some practice building hardware.

WSR Collection Components

- Hardware Pack
- National Instruments myRIO
- Sensor Pack
- Motors and Motor Controllers
- Software (LabVIEW for myRIO)
- Studica WSR Toolkit

World Skills Robotics Hardware

- Various Structural Elements, Sensors, Controls, etc…
- Developed by Studica and its partners to World Skills requirements
- The robots maximum dimension for entry passageway is 600 mm x 600mm and 500 mm tall

Structure – Construction Tips

- Advantages of the Hardware
  - Versatile hole pattern and mounting hardware
  - Multiple Options
  - Machined Gears
  - Aircraft Grade Aluminum
- Tools
- Extras that you may need ??
  - Teams cannot purchase delivered pre assembled items
  - Structural Elements? Not included in additional $ value
  - Best bet is to design and manufacture

Criterion C

Economy of the Robot Design relative to the Potential End User Client's Cost Factor		The Competitors have designed their Robots in the context of meeting the needs of an 'End User Client'. Clients are interested in both performance and product cost. This aspect focusses on the degree of cost beyond the provided component collection.	
The value of Performance Related Additional Components	The Robot Design involves a substantial to excessive additional cost to the client factor.		0 or 1.75
The value of Performance Related Additional Components	The Robot Design involves a moderate additional cost to the client factor.		0 or 1.75
The value of Performance Related Additional Components	The Robot Design involves a minimal additional cost to the client factor.		0 or 1.75
The value of Performance Related Additional Components	The Robot Design involves no additional cost to the client factor		0 or 1.75

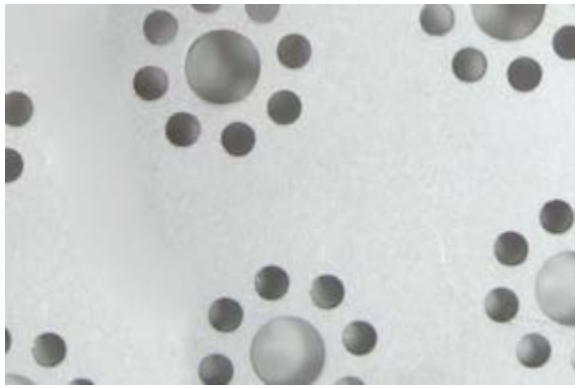
Criterion D – Fabrication and Assembly

The Fabrication and Assembly evaluation process will involve the direct inspection of the competitor's robot and object management systems by an Expert Jury Panel with the focus being on the physical status of all elements.

- Wiring Standards
- Frame Standard
- Object Management System
- Safety Light

Structure – Hole Alignment

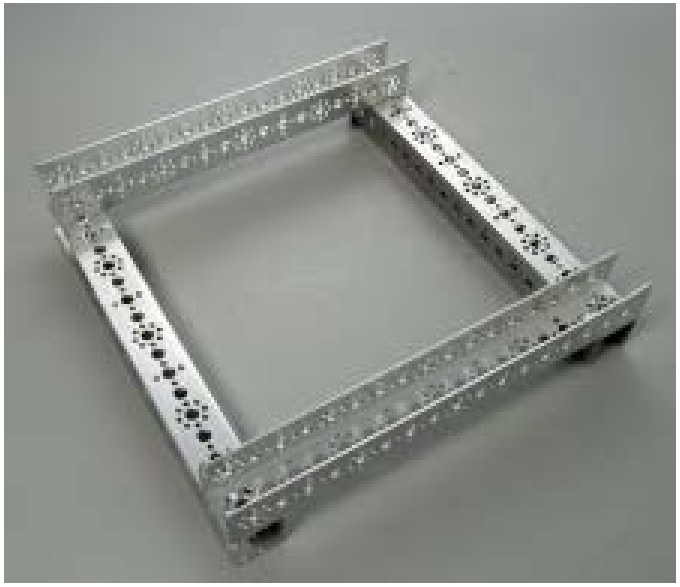
The hole pattern found on all structural pieces enables construction using several different angles.



Align the holes of the top channels to the holes of the bottom channels where you'd like them to be.
At each corner, drop four SHCSs down through the four small holes on either side of the large hole.

Structure - Constructing a Chassis

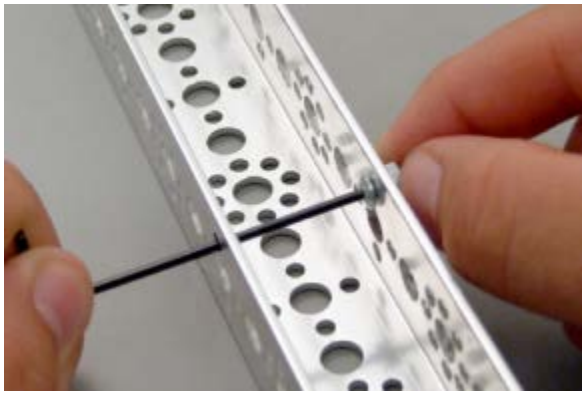
The most straight forward use of the hardware is construction of the frame which serves as the robot's chassis. 32mm channel functions well to connect inside corners. Or, as shown, turn the channel pieces face-to-face and bolt them together into a rectangle.



Use channel pieces side by side with the open end of the U-shape facing down. Set two more channel pieces across the first two, but with the open ends of each 'U' facing up.

Structure – Screws and Nuts

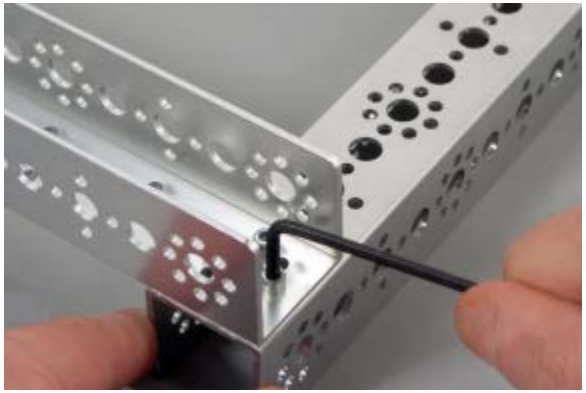
Tightening Screws The screws in the system are fastened with kep nuts, which feature a toothed side. The toothed side should face toward the screw head so the teeth can ‘grab’ onto the metal.

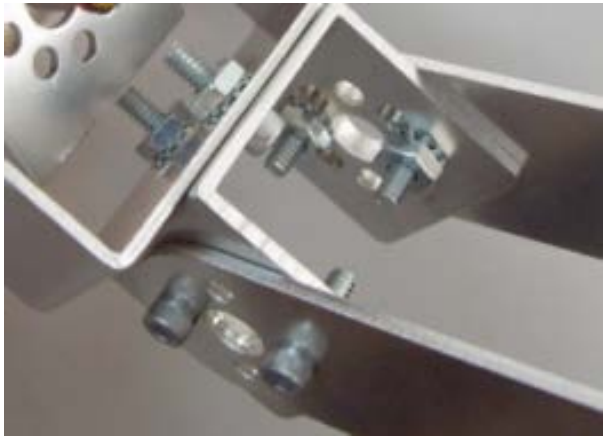


The hole pattern allows an Allen wrench to pass through pieces of channel to tighten screws on the opposite side.

Structure – Screws and Nuts

When building with the system, it's best to wait until all structural pieces are in place to completely tighten the screws. This will help prevent any contortion in your design.





When building, choose the placement of screws and nuts based on ease of access. Avoid placing screws in concealed areas, and remember to position them in a way that allows access to screw heads with an Allen wrench.

Structure – Screws and Nuts

Selecting screws

The base collection includes 100 each of 1/2” and 5/16” Socket Head Cap Screws (SHCS), 50 each 3/8” Button Head Cap Screws (BHCS). and 100 Kep nuts. (1 1/4” screws are also included as part of the gear to hub spacer assembly components.)

The 1/2 inch SHCS’s are recommended for fastening two metal pieces together.

Structure – Screws and Nuts

The 3/8” BHCS’s should be used for attaching servos, as the socket head cap screws can damage the servo’s plastic tabs. Both 3/8” BHCS and 5/16” SHCS are appropriate for use on tube clamps and when there is limited space inside the structure.

The 5/16” SHCS’s work well with the servo horn – they won’t strip as easily. The BHCS’s are appropriate for use in situations where the SHCS’s may protrude and interfere with other parts.

Tightening Hubs & Tube Clamps

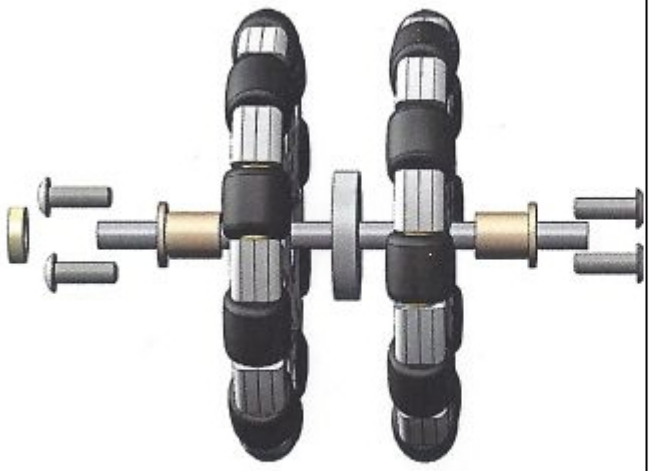
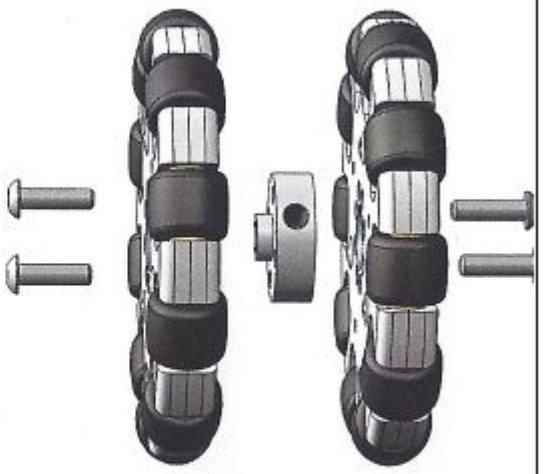
For maximum clamping grip, tighten the clamp screws in stages. First, snug the set screw on the clamp or hub.

Then attach the hub or clamp to the structural element with 4 screws and partially tighten them.

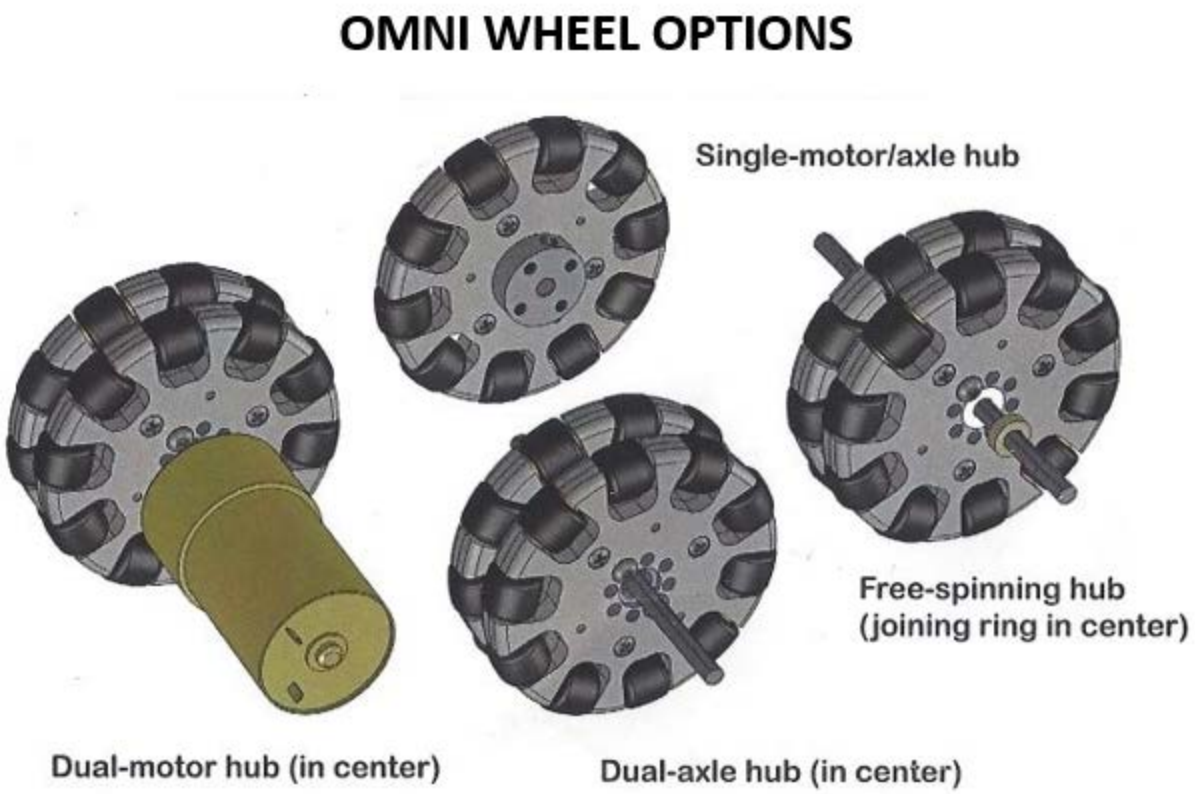
Finish tightening the set screw.

Then finish tightening the four other screws. This procedure maintains the clamp's shape in preparation for attachment to structural elements while ensuring proper grip on axles and tubes.

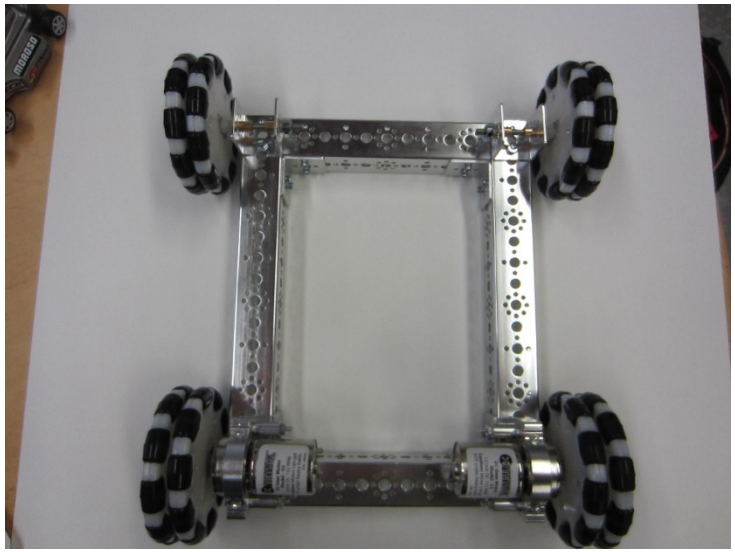
Structure – Omni Wheel

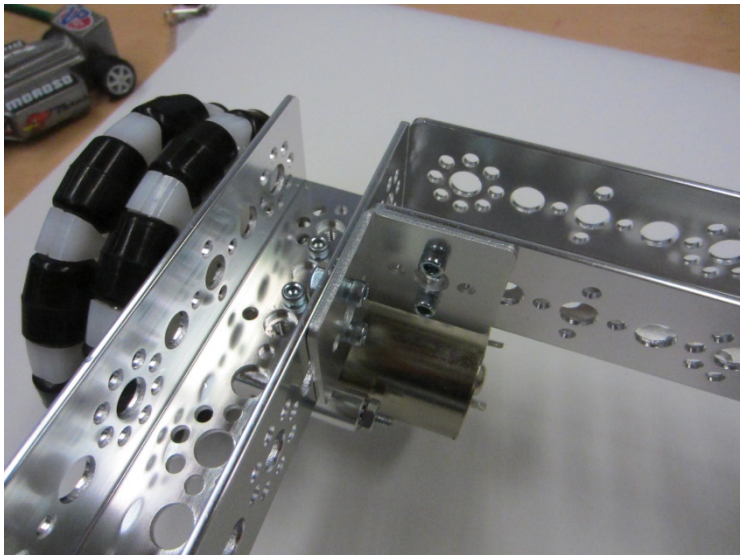
	
Free-spinning, dual offset roller assembly, Uses two bronze bushings, one axle and two nylon spacers.	Dual-driven wheel assembly. Uses axle or motor hub to fasten together.

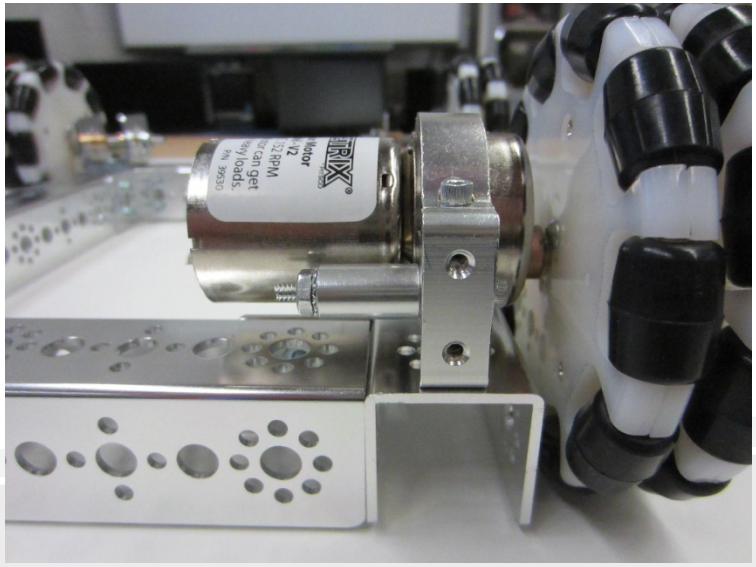
Structure – Omni Wheel



Structure – Omni Wheel






TETRIX
Motor
12
132 RPM
can get
heavy loads.
P/N 39530

Structure – Other Wheel and Drive Options

Plaction Wheels

4" Plaction Wheel with Blue Nitrile Tread

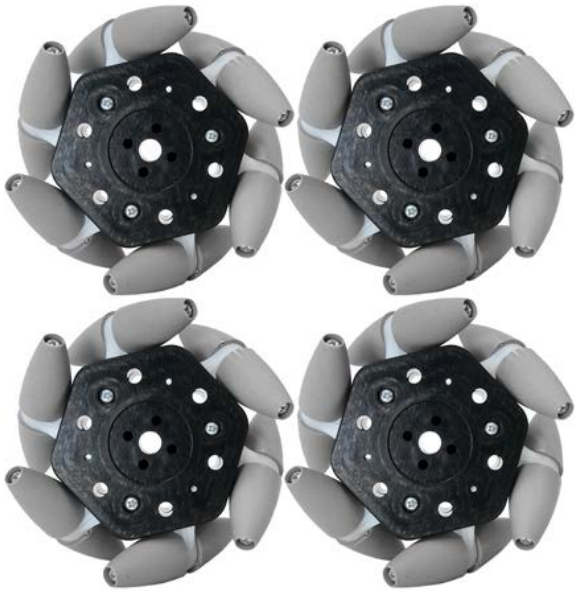
4" Plaction Wheel with WedgetopTread

Structure – Other Wheel and Drive Options

Stealth Wheels

Structure – Other Wheel and Drive Options

Mecanum Wheels – 4” (100mm) Standard and Deluxe

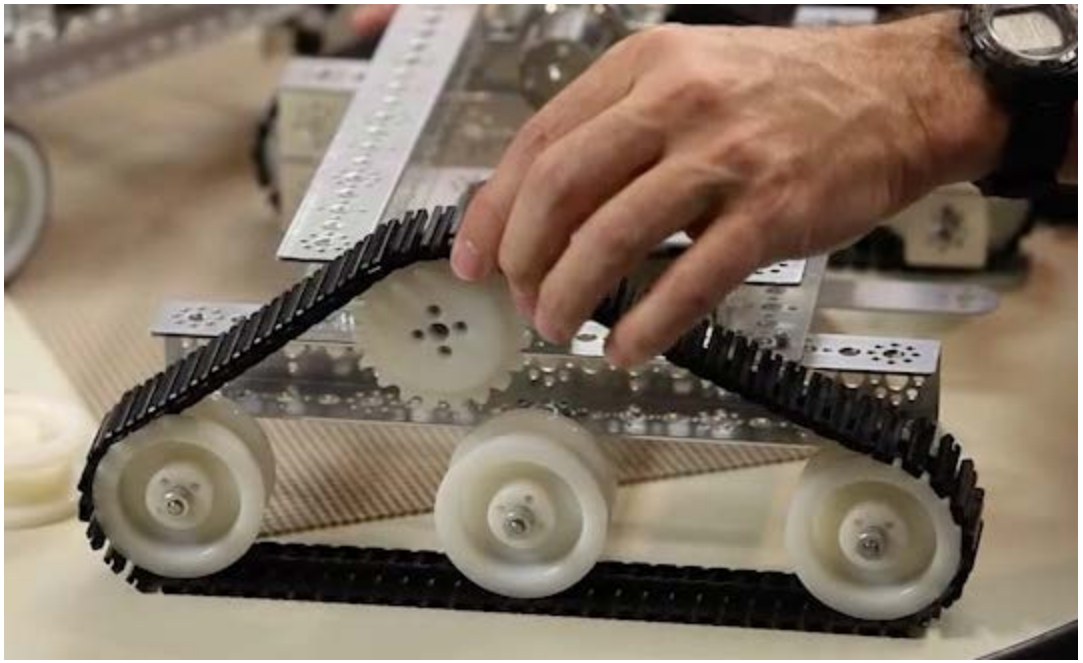


Structure – Other Wheel and Drive Options

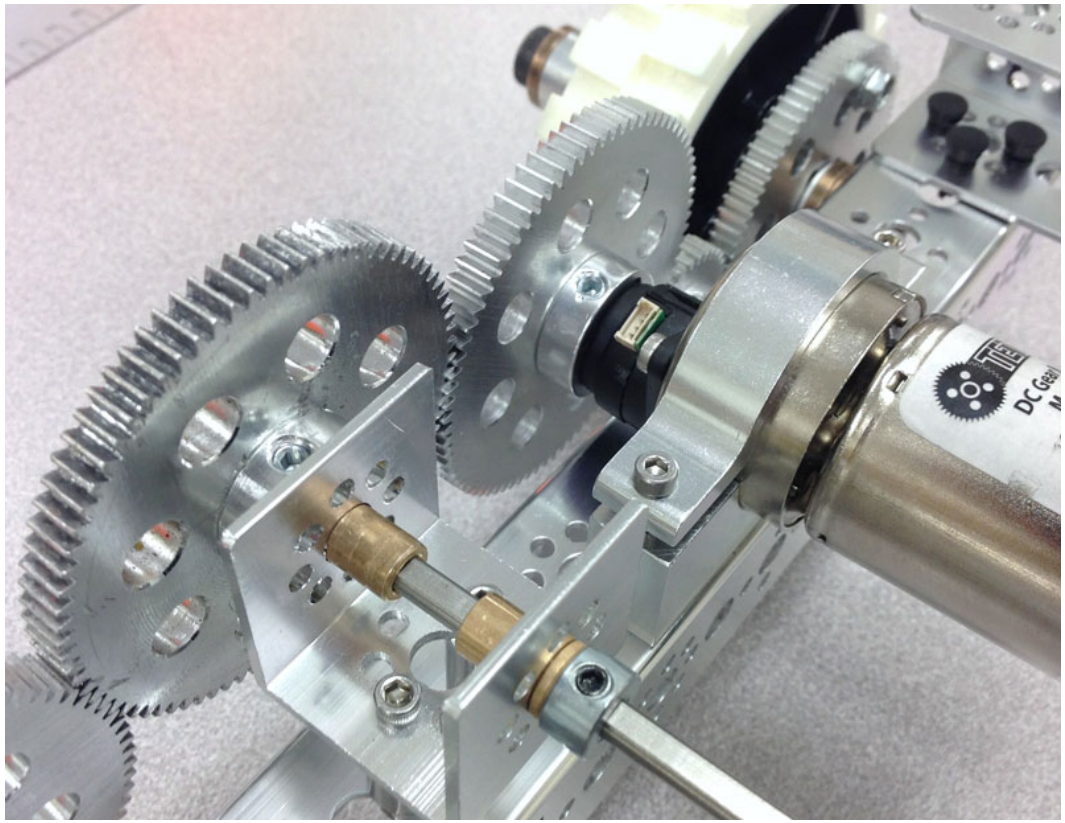
Rubber Tread Wheels

Structure – Other Wheel and Drive Options

Track Drive



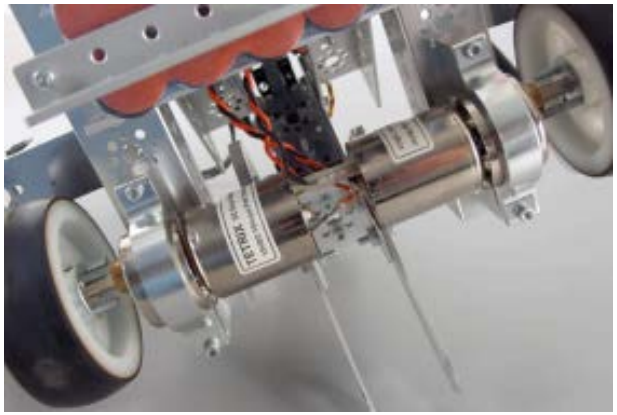
Structure - Drive Train



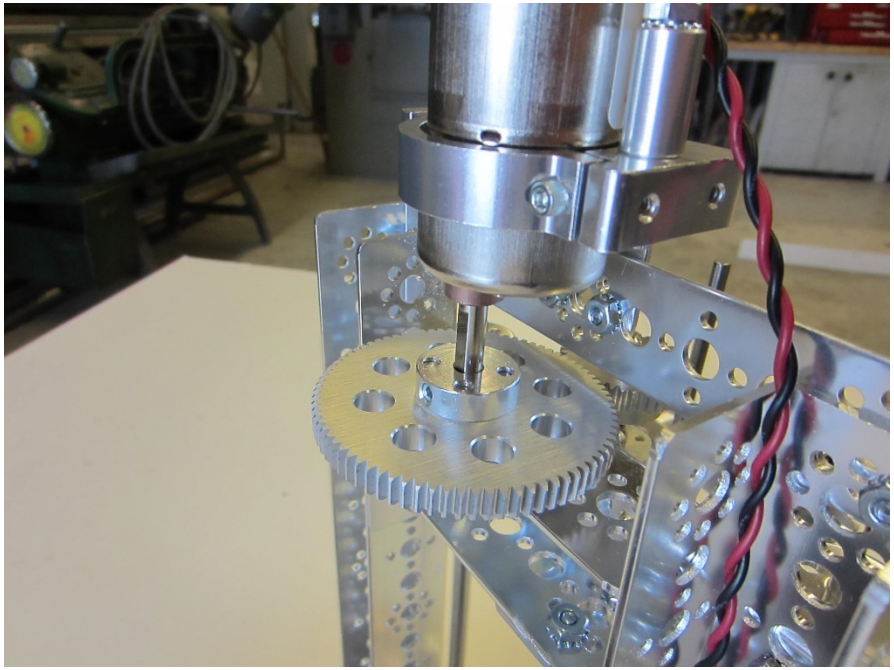
Structure – DC Motors

DC motors provide strong, continuous rotation and are well suited for moving the heavy structure pieces. The DC motors are commonly used in the robot's drivetrain.

- More Torque then Servo
- Encoders for speed/position control
- Mounting Hardware

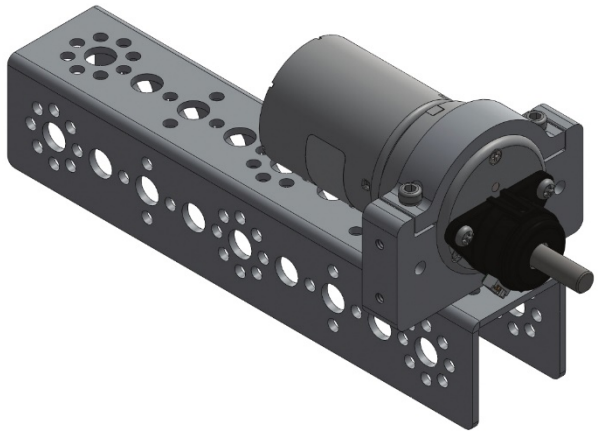


Structure – Motor Mounting

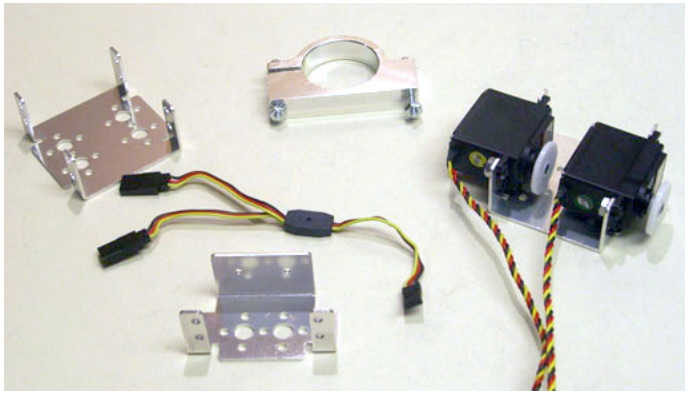


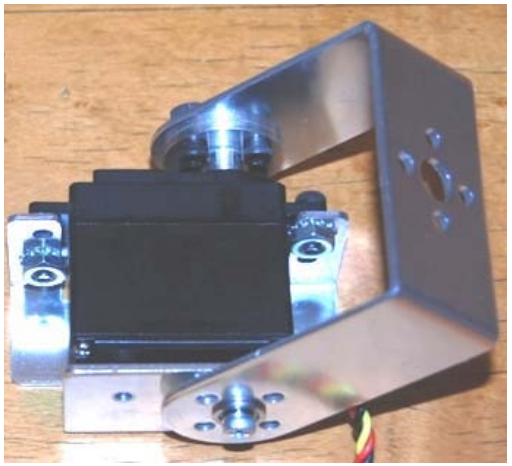

Motor
152 RPM
can get
heavy loads.
P/N 39530

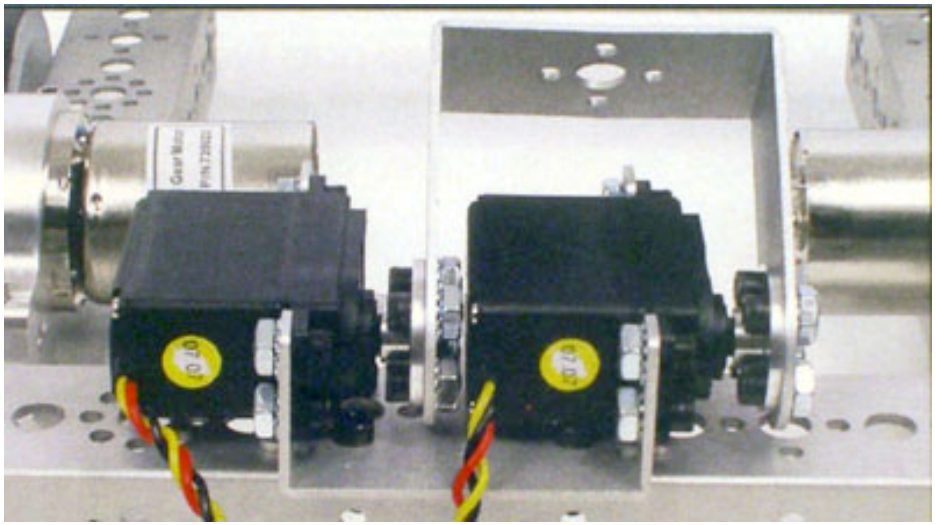
Structure – Motor Mounting



Structure – Servo Motors







Servos can be used in many different ways, such as with robot parts that pivot.

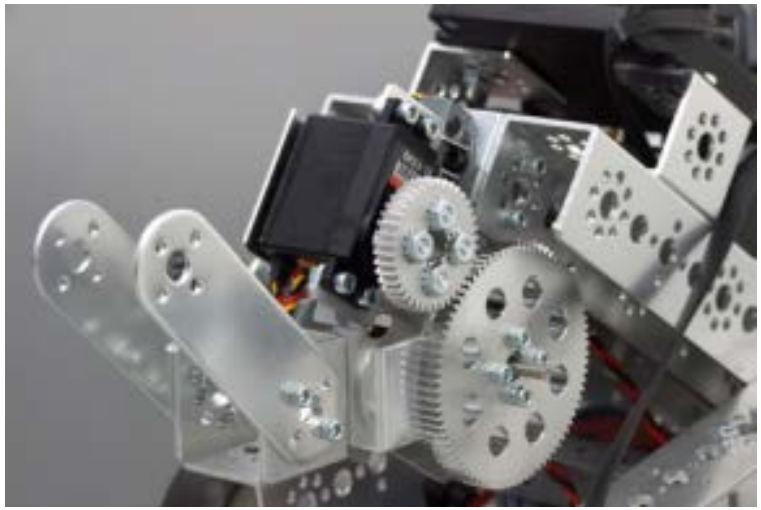
Structure – Servo Motors

Ways to use servos

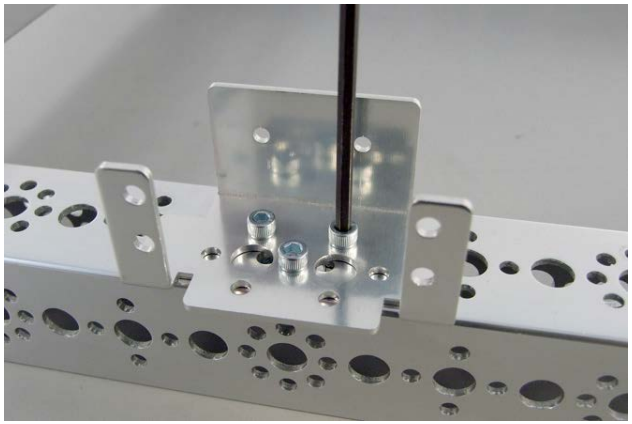
- Single or double brackets for mounting
- Horn connected to gears, wheels, structural pieces
- Connect to end of pipe
- Be careful of order of assembly –think first, build second

Structure – Servo Motors

Standard Servos rotate to a specified position between 0° and 180°, and then hold that position. This ability makes servos a good choice for controlling an arm. The range of motion provided by a servo can be increased or decreased through the use of gears.

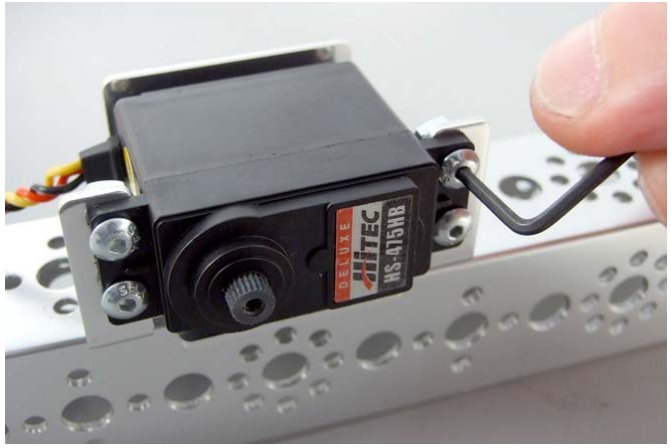


Structure – Servo Motors



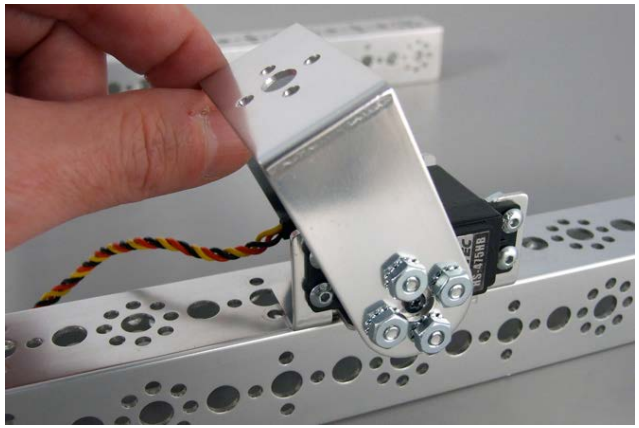
Determine where on the chassis you want to place the
servo. Using 1/2” SHCSs and kep nuts, attach the single servo motor bracket to the chassis.

Note that the back of the servo will be positioned against the bracket’s larger, single, upright panel.



Slide the servo into the bracket. The flanged sides on the front of the servo should go on the outside of the two prongs of the bracket. Using 5/16” SHCSs and kep nuts, attach the servo to the mount.

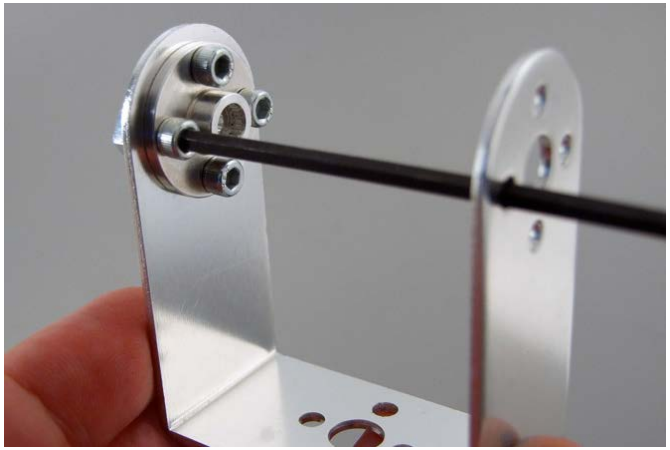
Structure – Servo Motors



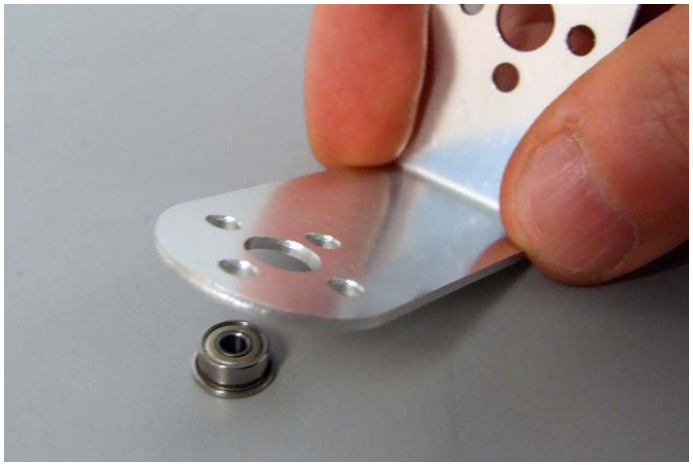
At this point, it is possible to attach other pieces – such as
channels, angles, and flat bars – directly to the servo horn.
However, using a pivot bracket will create a stronger pivot.

Note: All the servos come with a plastic servo horn on them. Remove these plastic horns and replace them with the metal horns that come with the collection.

Structure – Single-Servo Mounts with Pivots



Remove the servo horn. Place the horn's flat side to the inside of one end of a joint pivot bracket. Using four 5/16" SHCSs, attach the horn to the pivot bracket and secure it with kep nuts. The kep nuts should be on the outside of the bracket. Set aside the servo horn screw.



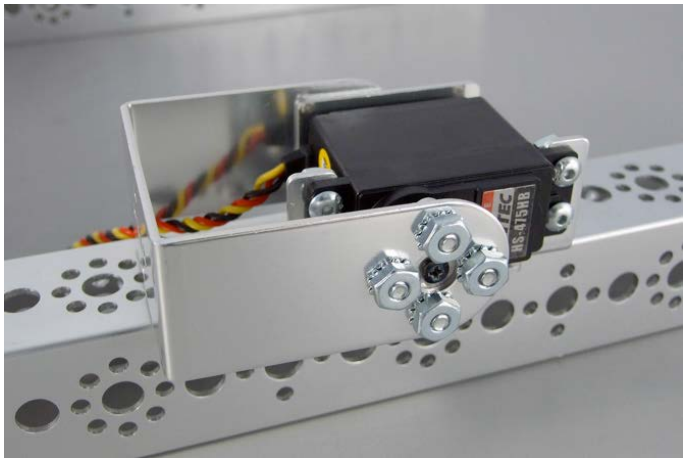
Find the pivot bearing, screw, nut, and washer. Place the bearing flange-side down on a flat surface. Place the side of the pivot bracket opposite the horn over the bearing and align the bracket hole to it. Press down firmly to pop the bearing into the bracket hole.

Structure – Single-Servo Mounts with Pivots

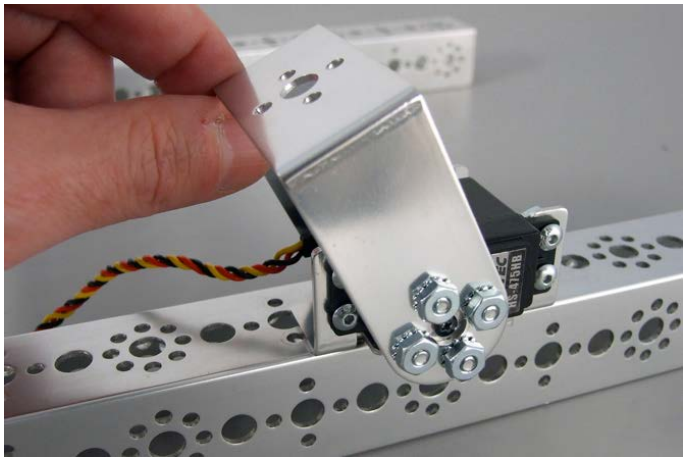
Place the bearing screw through the bearing from the outside of the pivot bracket. Insert the screw into the back of the motor bracket. Secure the pieces together with the washer and nut – but do not overtighten.

Place the servo into the motor bracket, stretching the unattached side of the pivot bracket so the horn fits into the servo's motor shaft. Secure the servo to the motor bracket with 1/2" or 5/16" SHCSs.

Structure – Single-Servo Mounts with Pivots

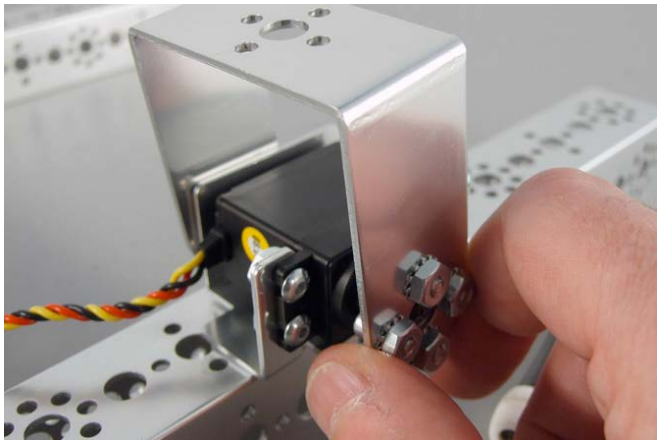


Adjust the servo's range of motion as needed. (To adjust a servo's range of motion, you must first find its mechanical stop.)



Push the bracket or structural element attached to the servo until it won't move any further (this is the mechanical stop).

Structure – Single-Servo Mounts with Pivots

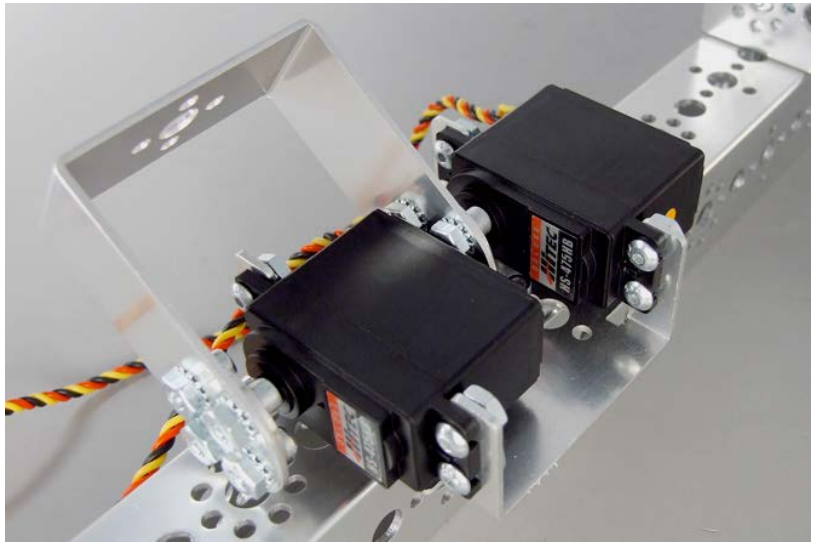


Without moving the servo motor shaft, detach the bracket or element and position it where you want it to stop.

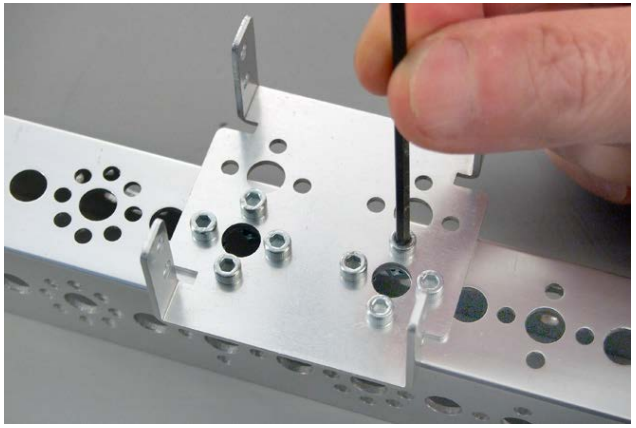
Re-attach it to the servo, taking care not to move the servo motor shaft. Secure the bracket or element to the servo with the servo horn screw.

Structure – Double -Servo Mounts

In situations where one servo is not powerful enough, and the range of motion cannot be decreased through gearing to increase torque, a second servo can be used. If you are using two servos, be sure they are synchronized.



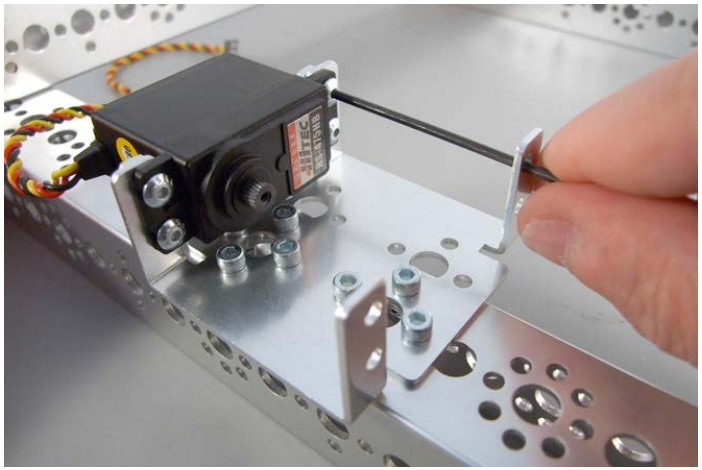
Structure – Double -Servo Mounts with Pivots



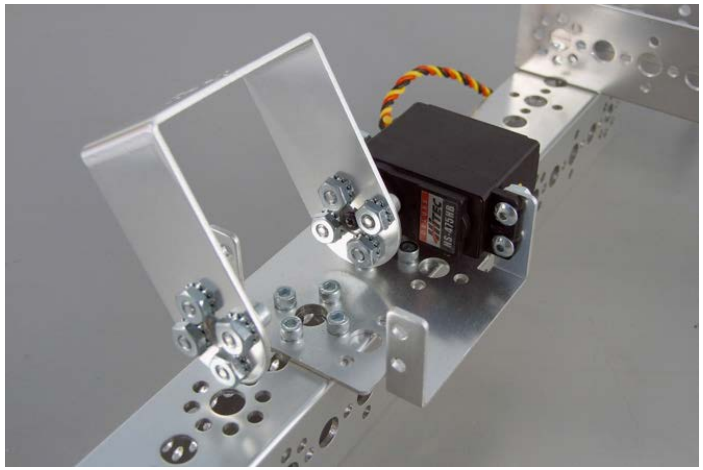
Determine where on the chassis you want to place the servos. Using 1/2” SHCSs and kep nuts, attach the double-servo motor bracket to the chassis.

Remove servo horns from two servos. Attach these to a joint pivot bracket, each with two 5/16” SHCSs and kep nuts, so one is on the inside of the bracket and the other is on the outside and at the opposite end.

Structure – Double -Servo Mounts with Pivots



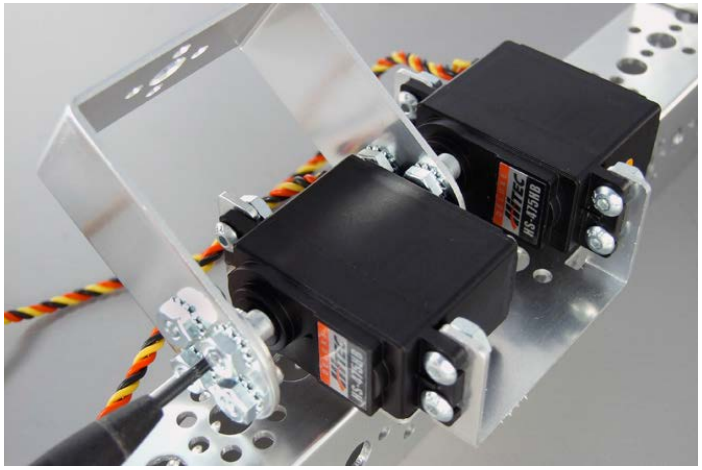
Place one servo into the double servo motor bracket so it faces into the bracket. Secure the servo in the bracket with four 5/16” SHCSs and kep nuts.



Place the pivot bracket so the horn on the outside of the pivot bracket connects with the servo on the motor bracket. Secure the servo horn to the servo with the servo horn screw.

Structure – Double -Servo Mounts with Pivots

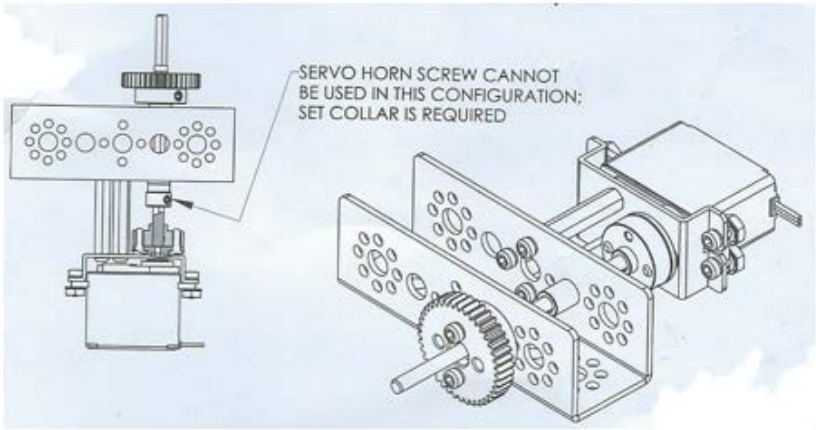
Set the servos' range of motion and center them together. This step ensures that the servos will not work against each other.



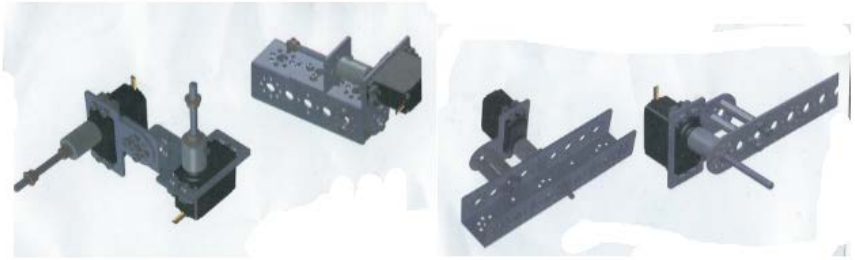
Place the second servo so it faces out of the motor bracket and is parallel to the other servo. Use four 5/16" SHCSs and kep nuts to secure the second servo to the bracket. Using the other servo horn screw, secure the second servo to the other side of the bracket.

Structure – Servo Motors

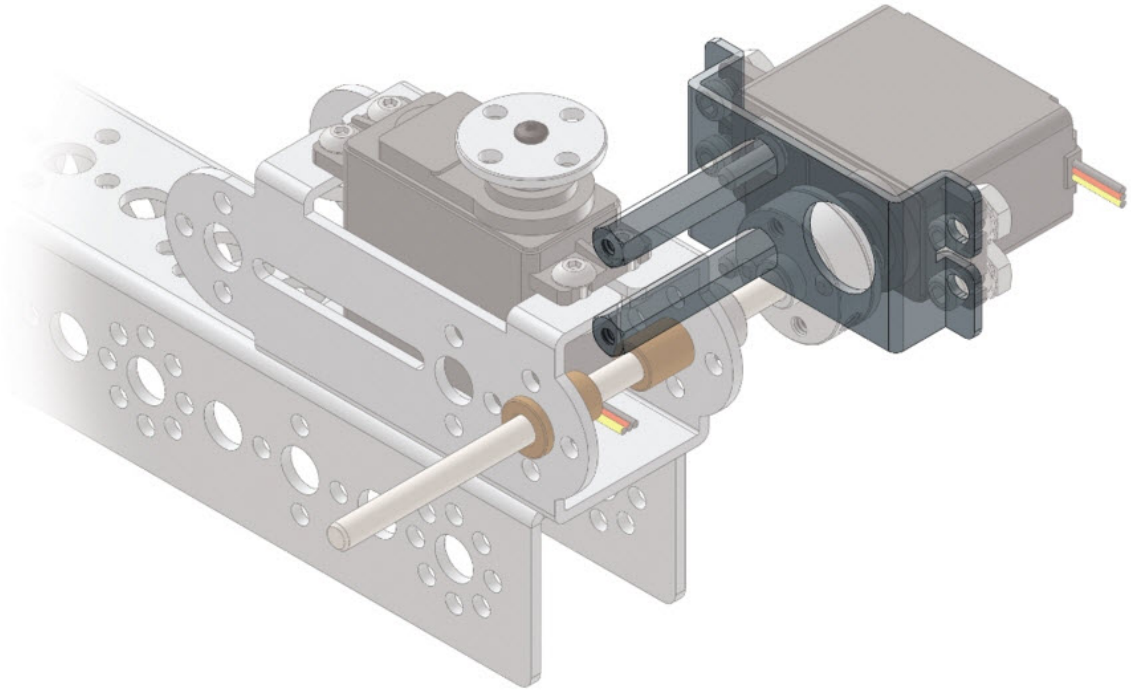
Standard Scale Servo Front Mount



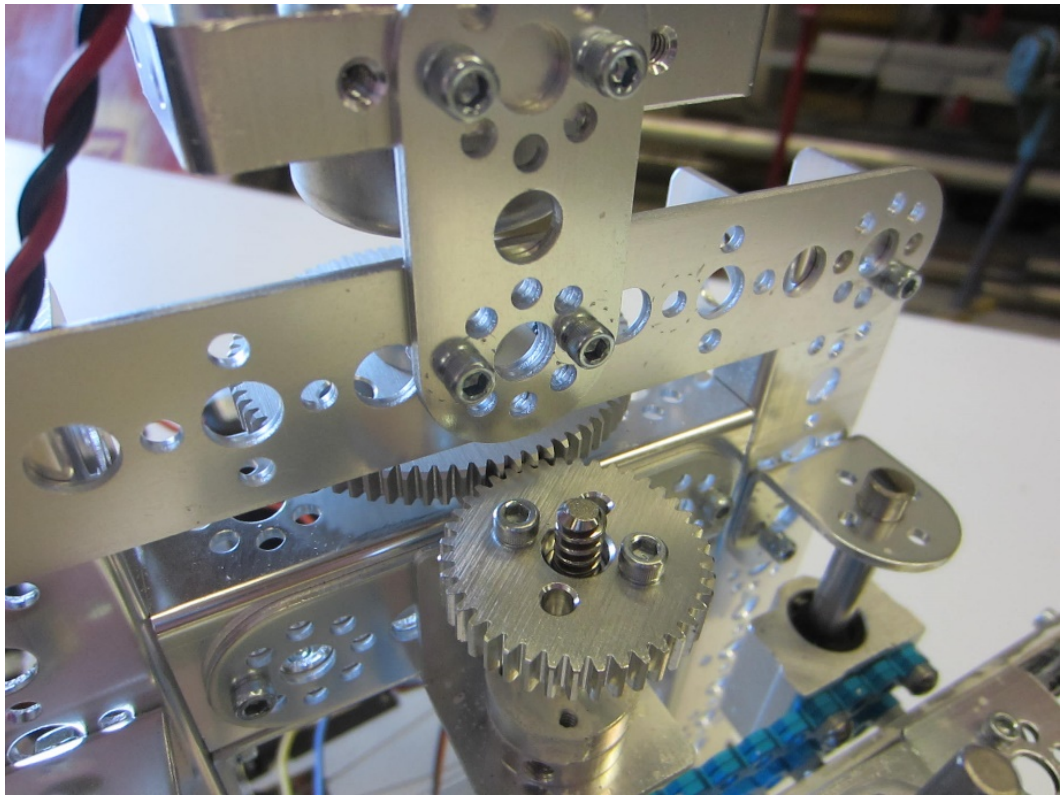
Standard Servo Mounting Kit Assembly Examples



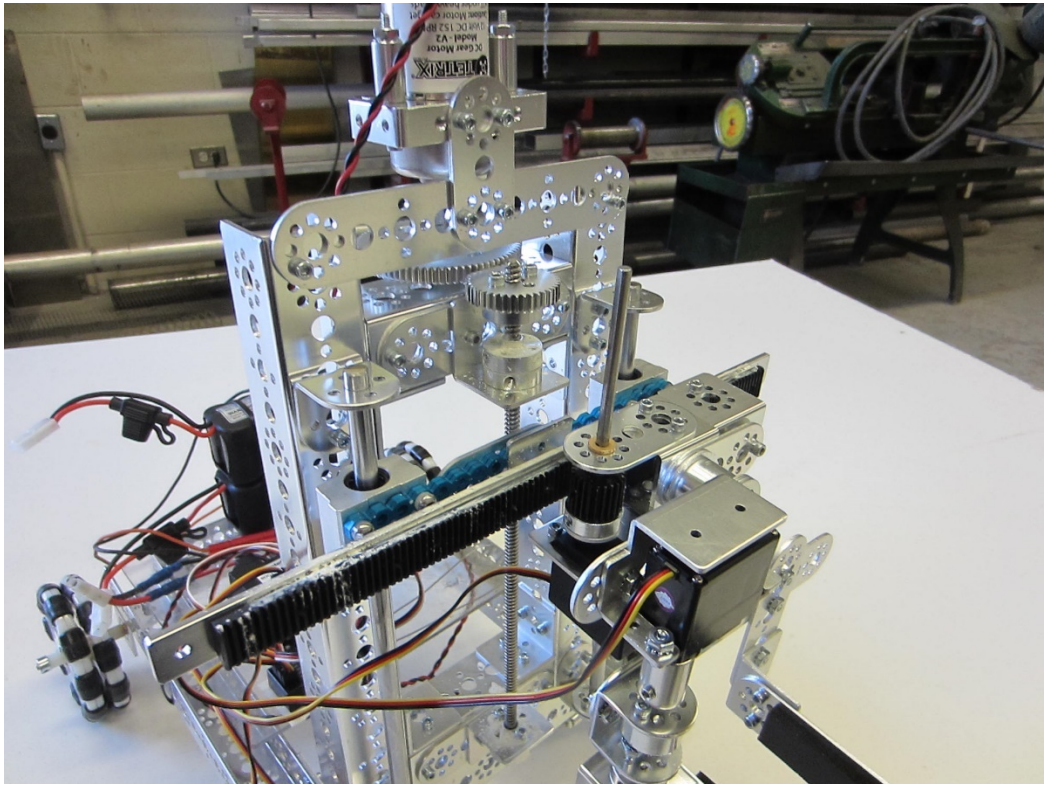
Structure – Servo Motors



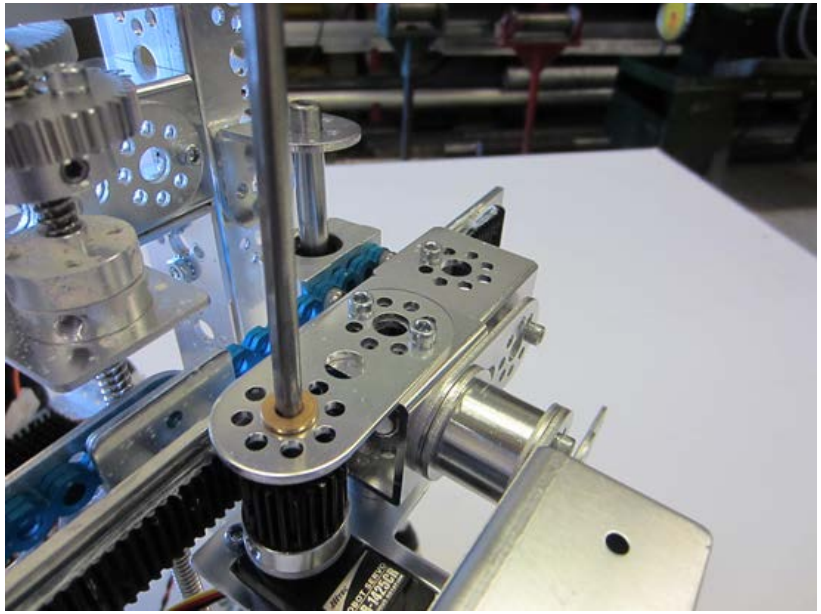
Structure - Gears

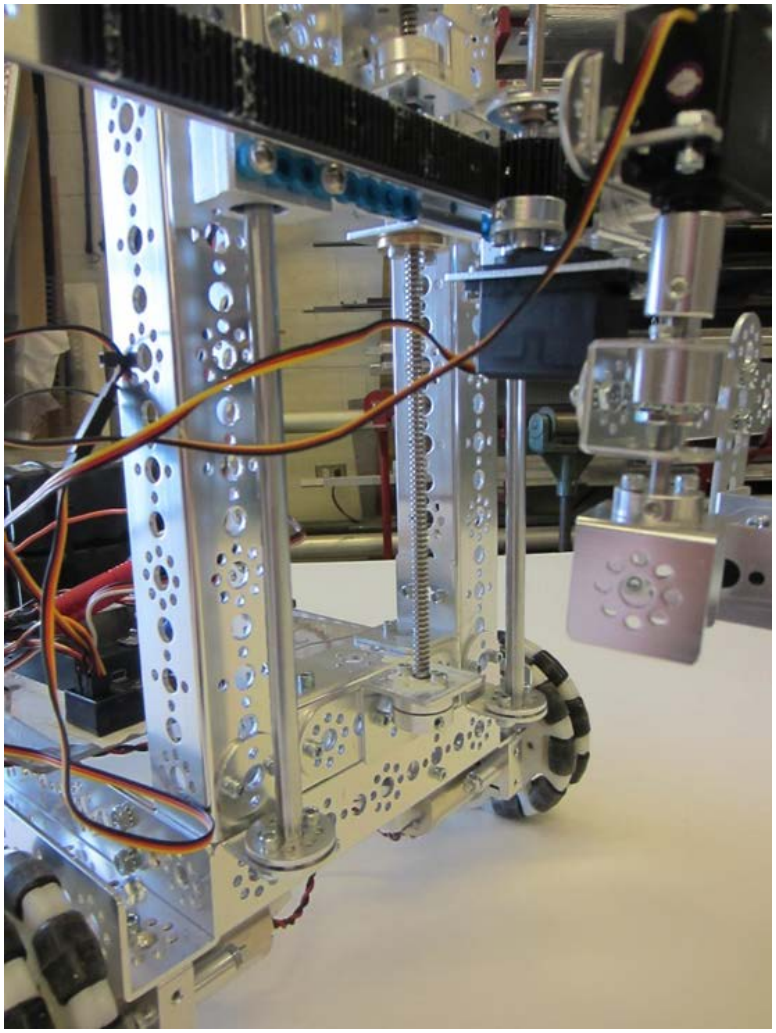


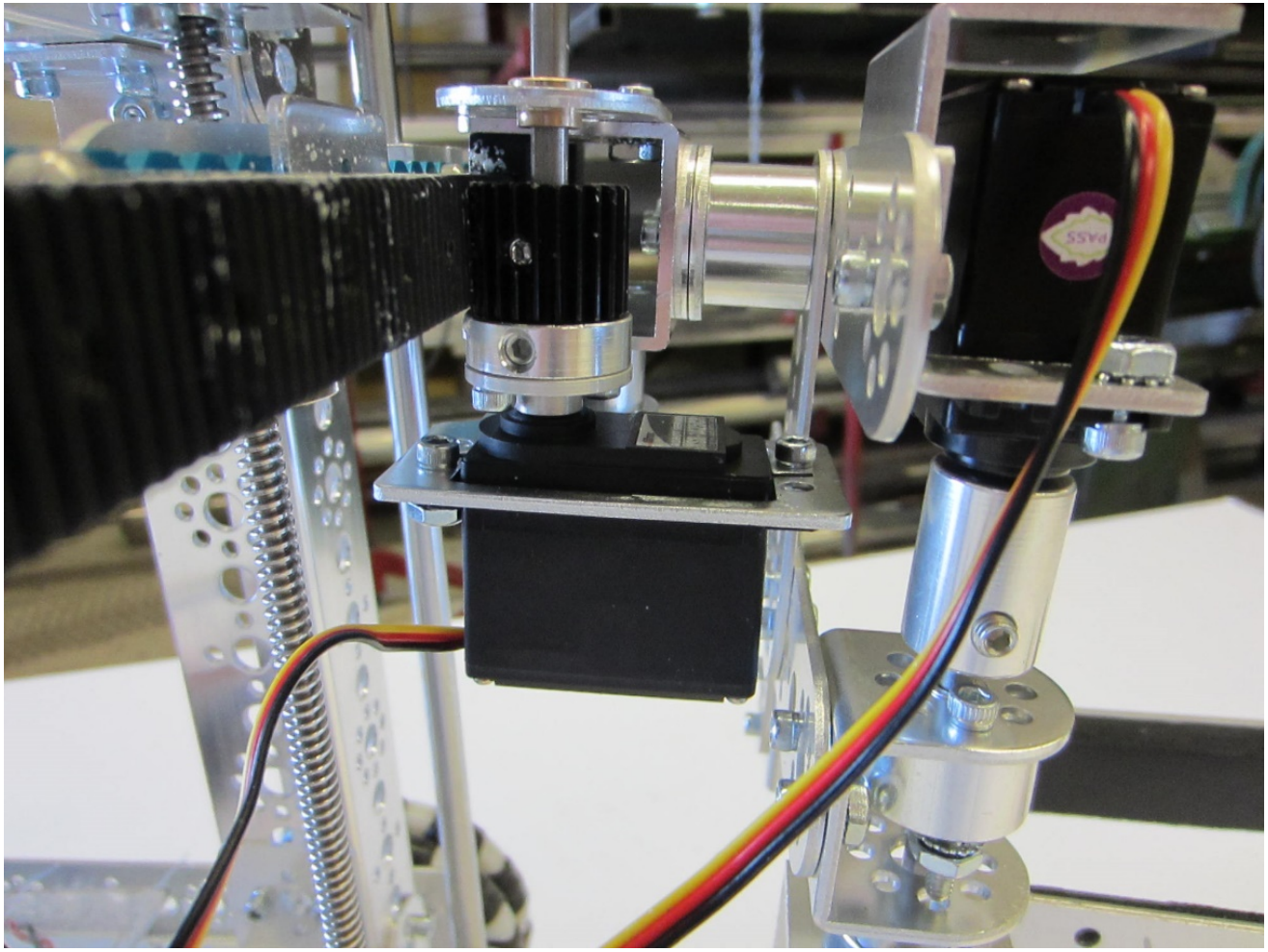
Structure - Mechanisms



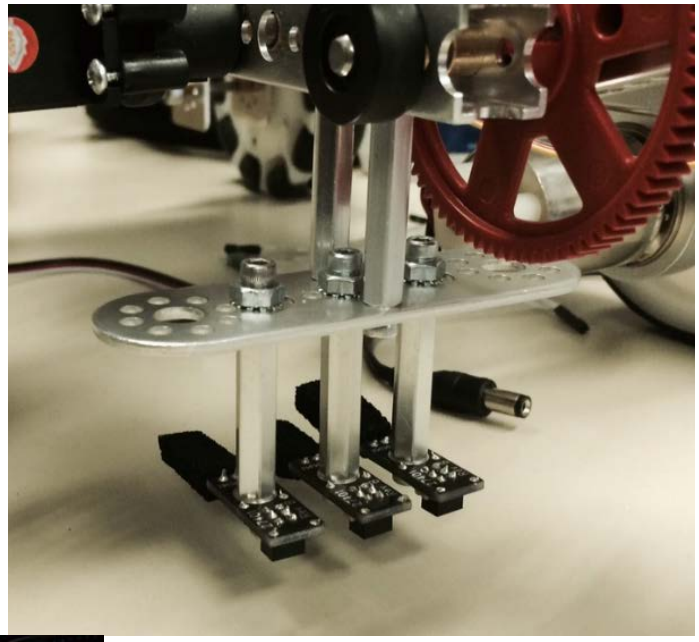
Structure - Mechanisms

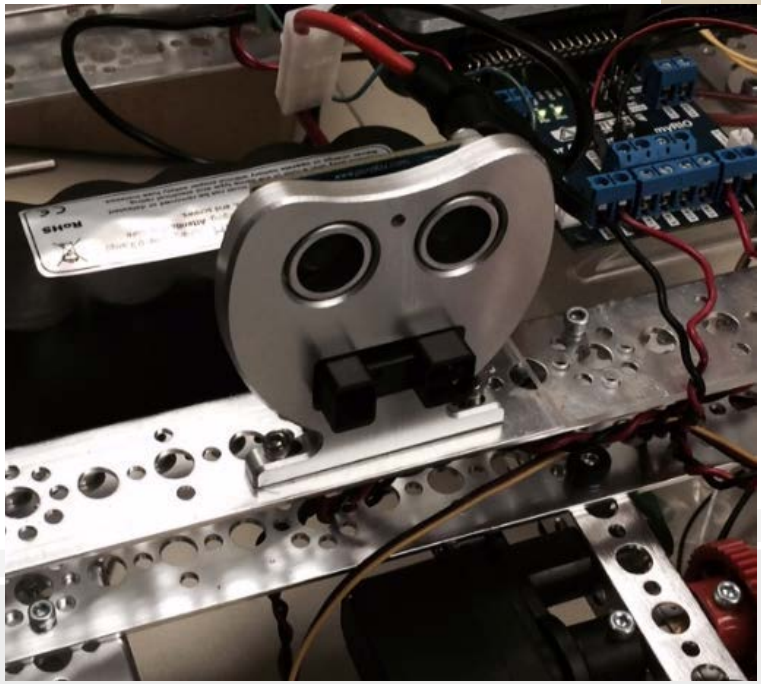




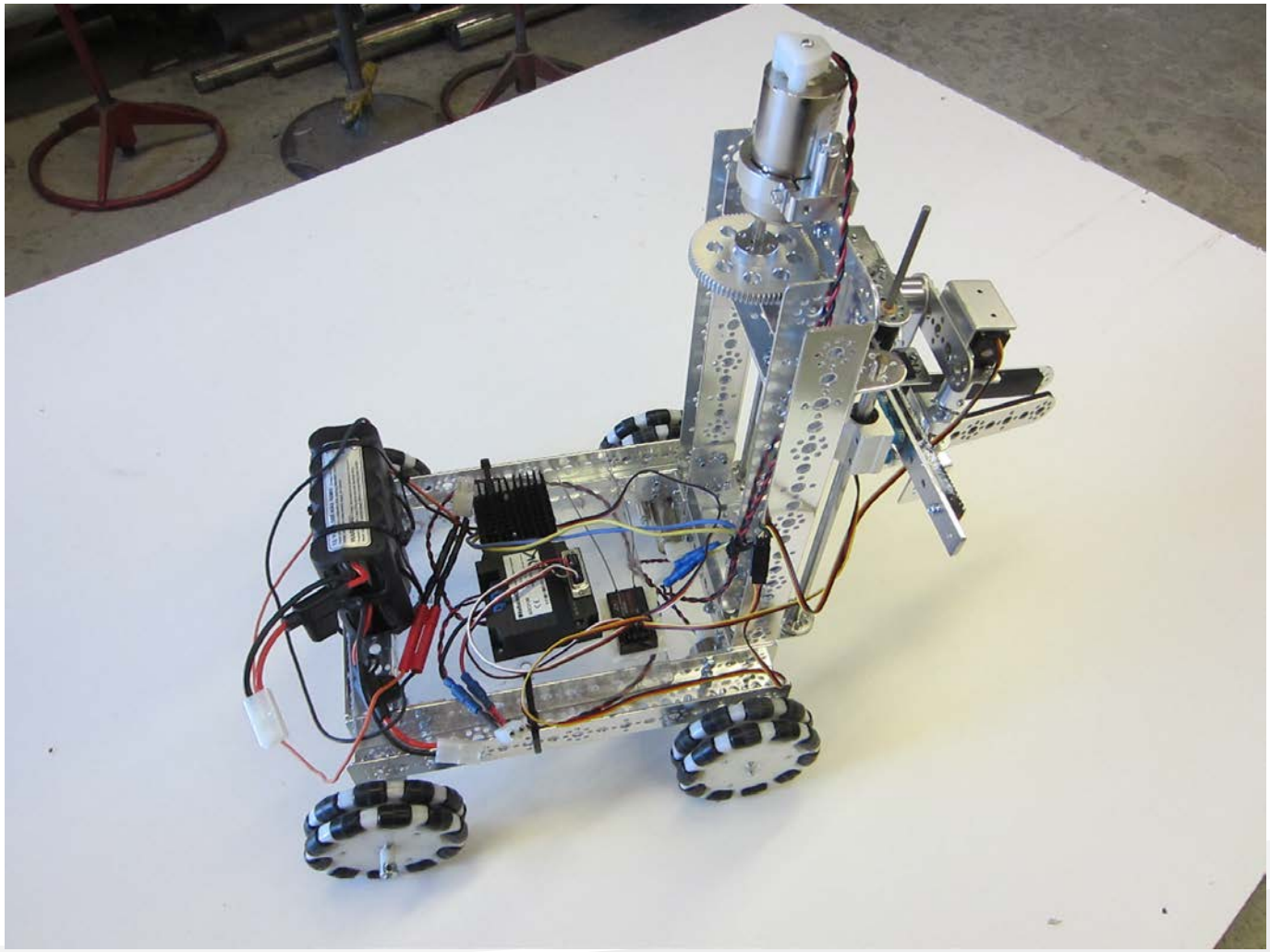


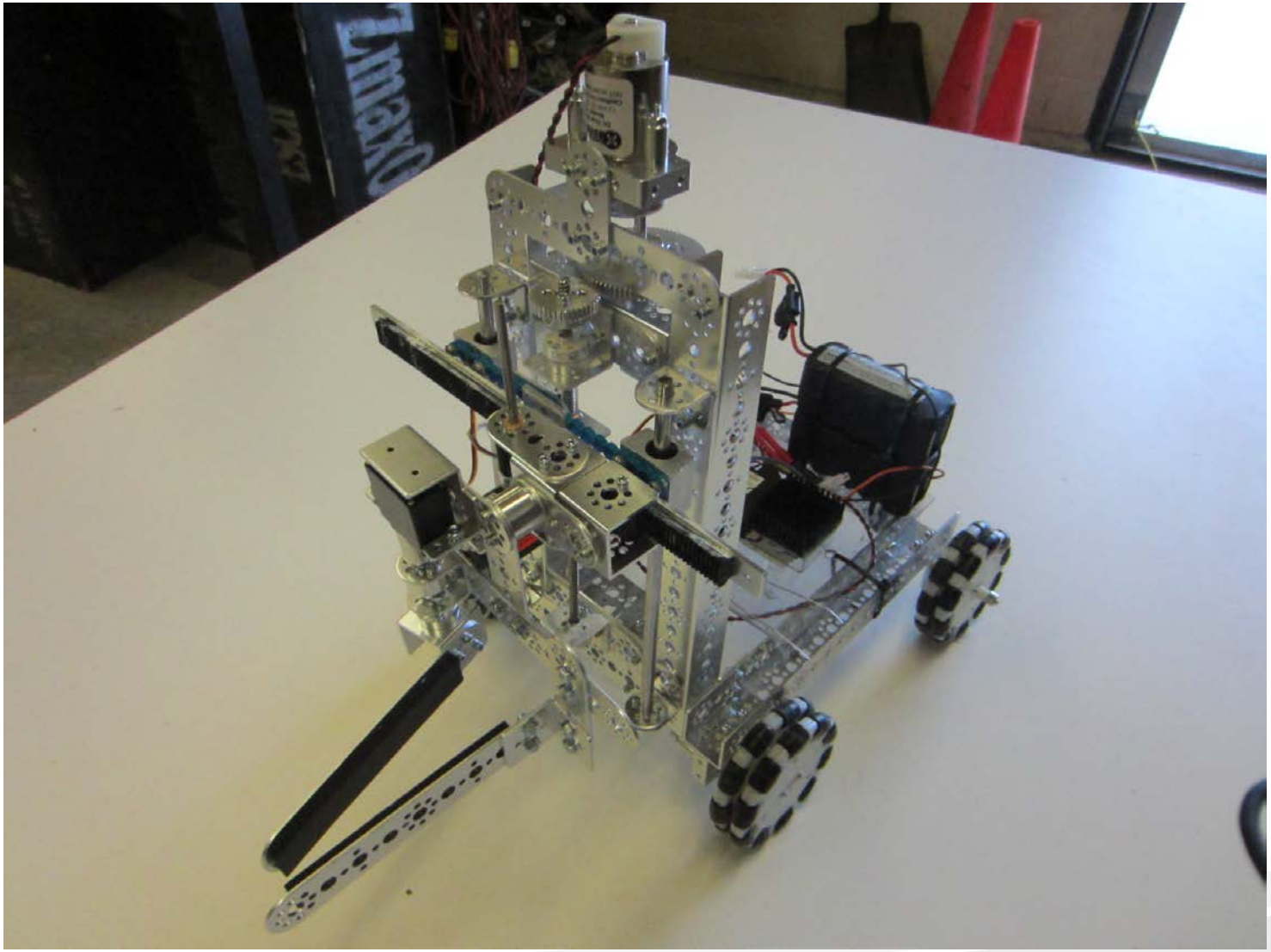
Sensors

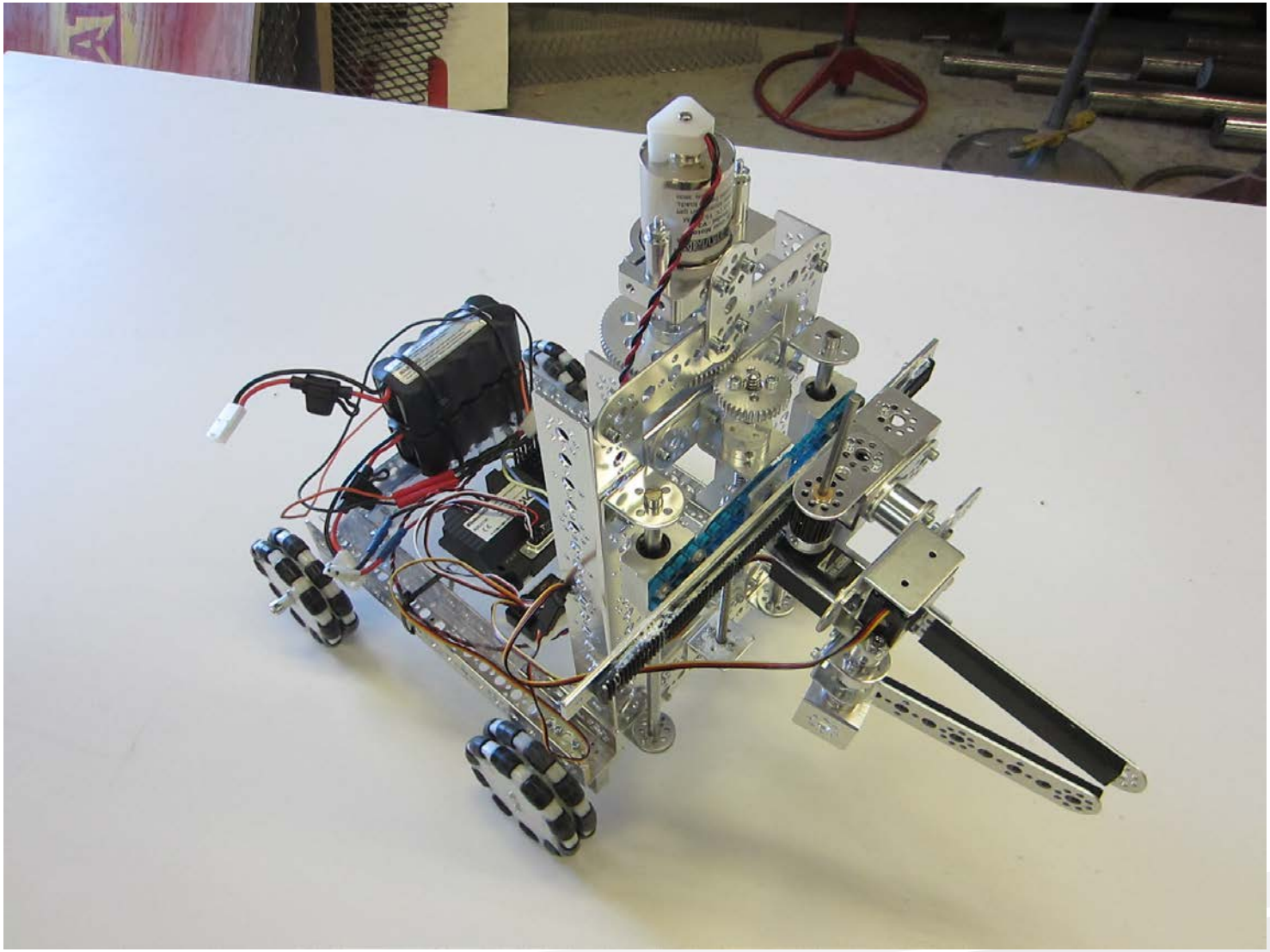


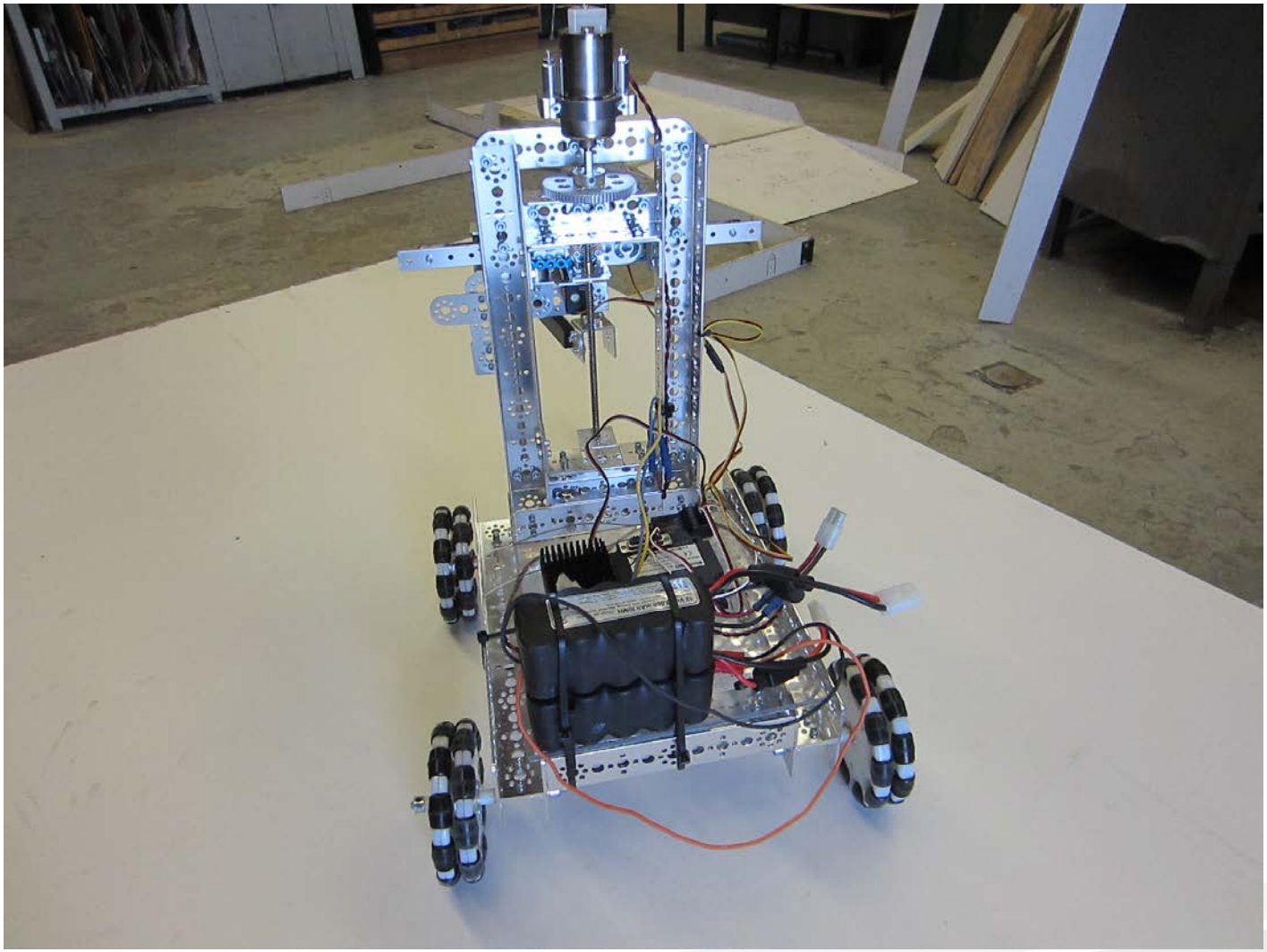


Prototype



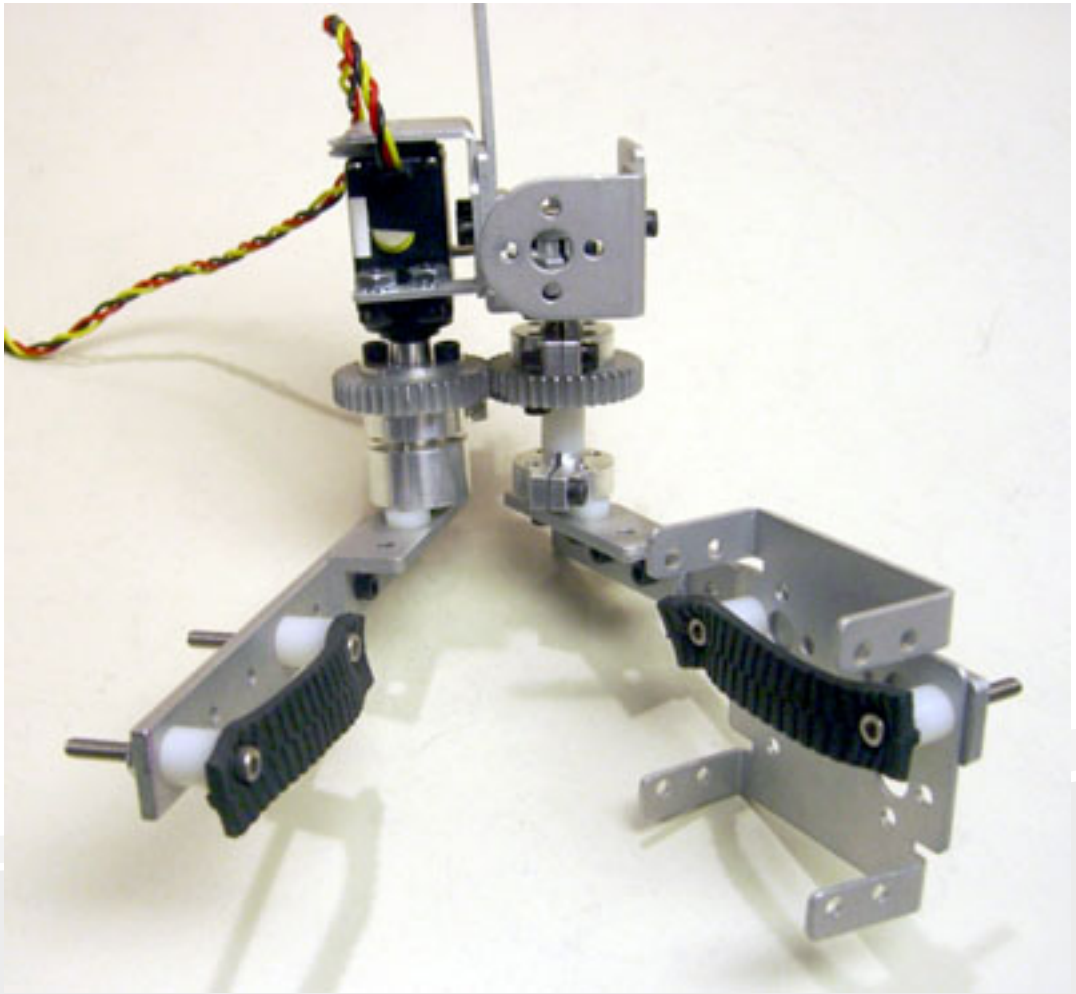




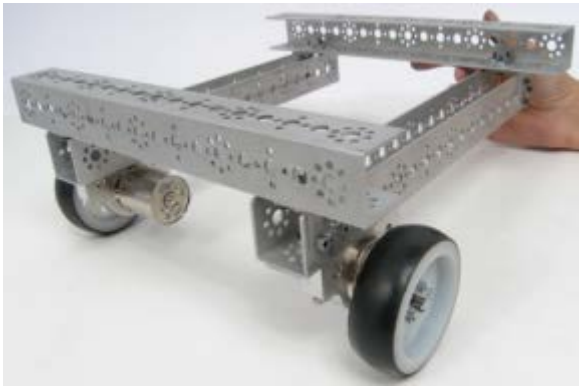


Arms and Grabbing

- Be creative…

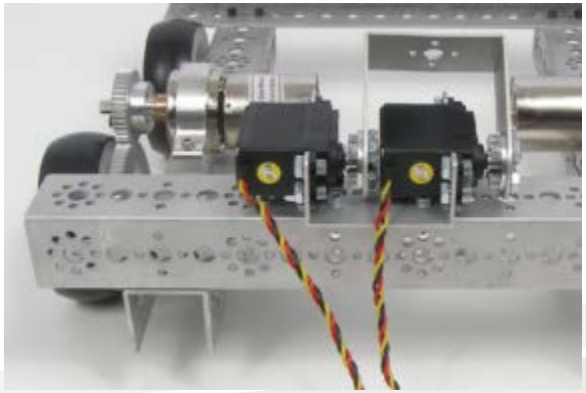


Subassemblies



One effective way of building a robot is to construct it in sections, or subassemblies. Begin by building the chassis, the robots frame and drivetrain. Make sure your chassis construction is solid, as it will be the foundation for the rest of your robot.

Next build any attachments and connect them to the chassis. Note that if you use this method, you should still have an overall plan for the robot's design.



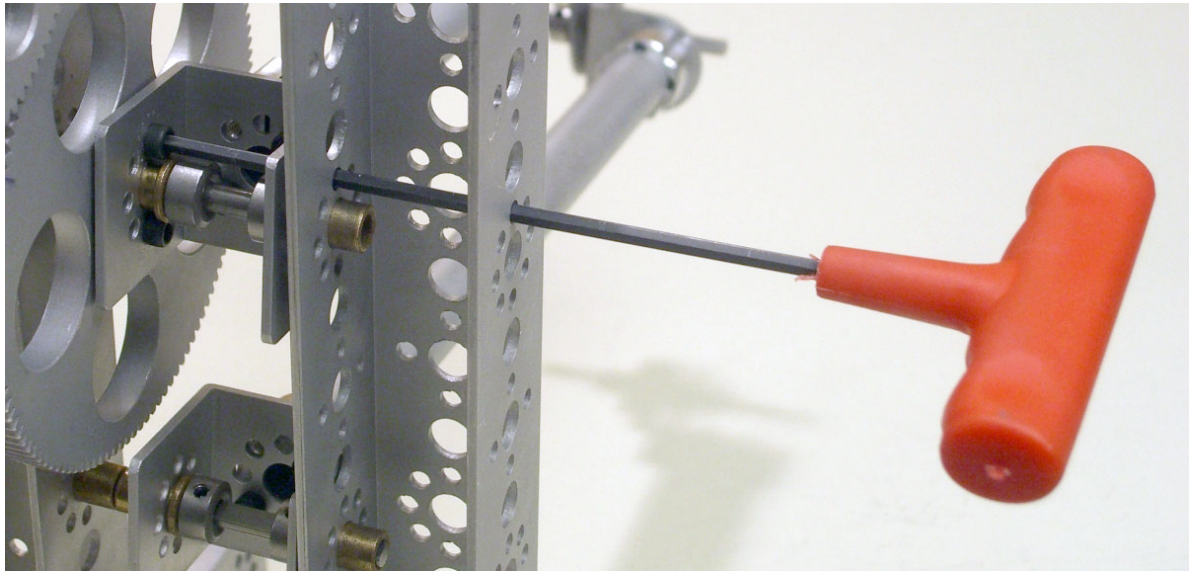
Tools, Construction Tips and Techniques

- It is always good to have more tools…
- Ball-end Allen wrenches, electric screwdriver
- Extras you might need

Tools, multi nut pliers

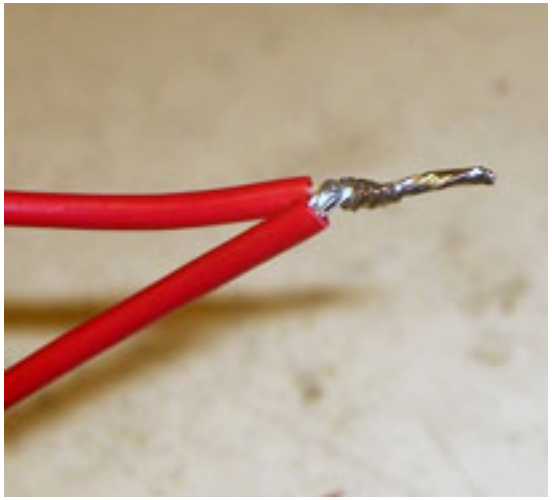
Tools, construction, and tips

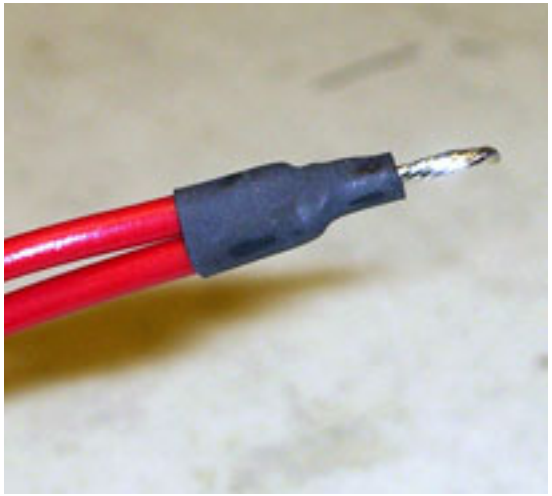
- Long Allen wrenches are useful for reaching through holes



Electrical - Battery management and electrical issues

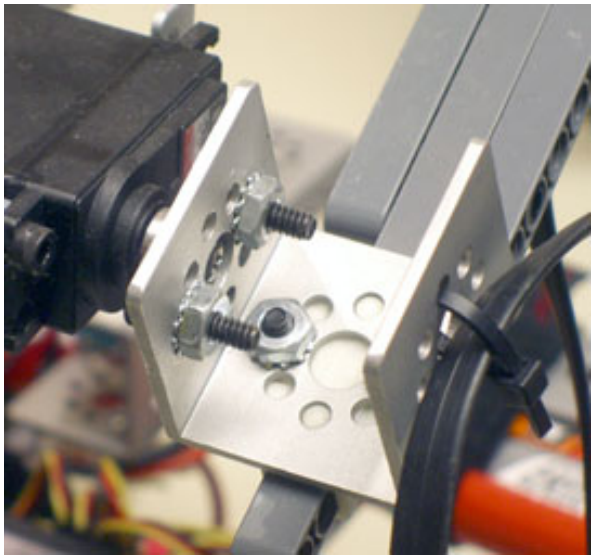
- Stranded wire can cause shorts due to single strands escaping
- Solder wires or use heat-shrink tubing!





Electrical - Battery management and electrical issues

Cable routing is important – cables are rather inflexible.

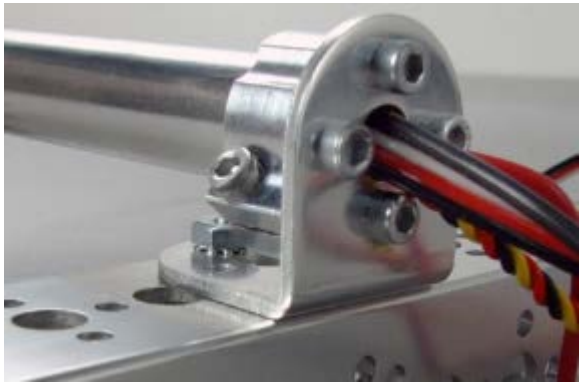


- It's a good idea to attach the cable at the pivot point
- An extra battery is essential

Electrical - Wire management

When wiring, secure the wires to the robot, and away from any moving parts. Wire ties can be used to secure wires to the robot.

Also, note that wires can be run through the tubing for added protection.

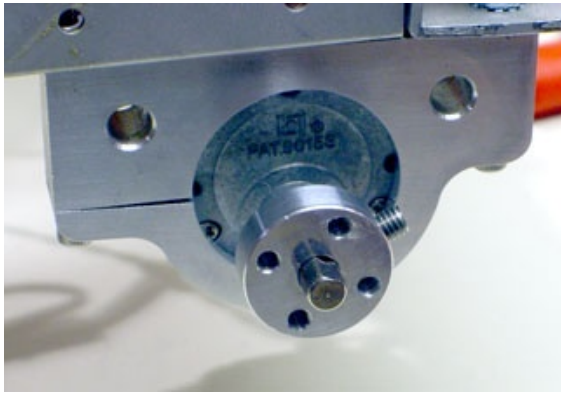


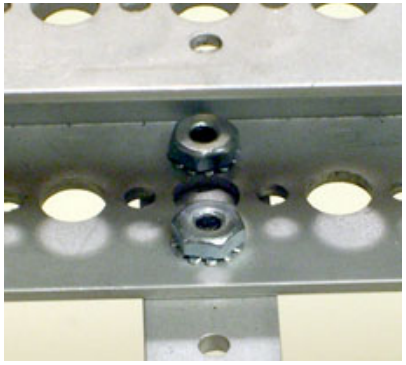
Electrical - Battery management and electrical issues

- Wiring up the controllers is where caution is needed. There's a real potential for shorts.
- The encoders are very delicate and expensive…
- Use a prototyping board

Hardware - Pitfalls and Problems

Use proper attachment techniques!





- In general, the WSR guide recommends using ½" screws
- Other sizes used where small clearance needed.

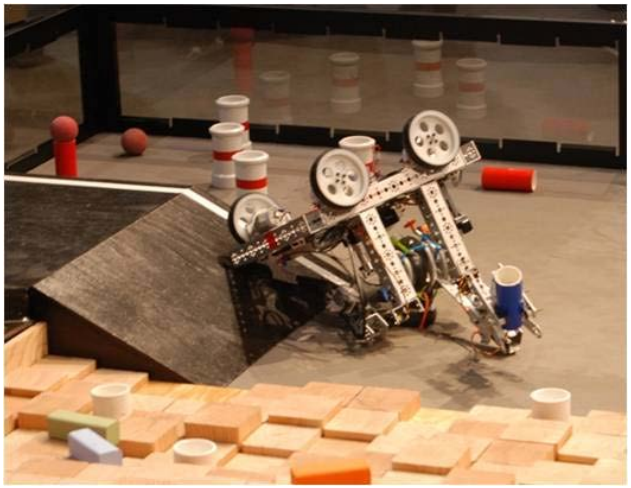
Hardware - Pitfalls and Problems

Ping **Sensor can** be difficult to use for reading at high speed

Low center of gravity, long wheel base is good

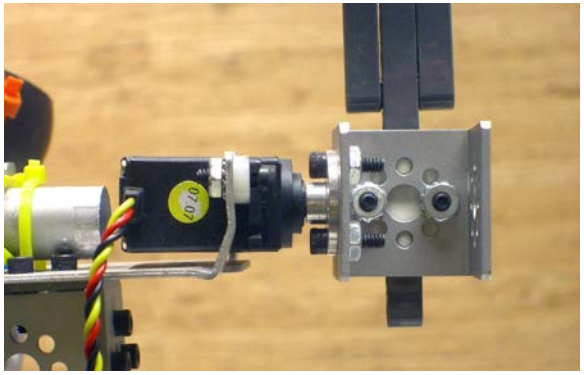
However, you might want to plan for a tip-over -or make the 'bot unable to tip over

How do you recover from a tip-over or being stuck in the sand?

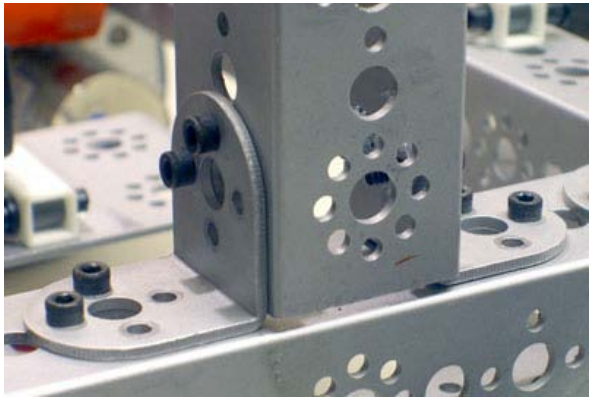


Hardware - Pitfalls and Problems

Unsupported servos can cause problems



Too few screws might be judged against the team



Avoid crooked constructions

Both of these look unprofessional