Chassis & Attachments 101

Attachments and Sensor Mounting

2016

Overview

- What is an attachment?
- 12 Attachment Tips
- Types of Attachments
- Senor Mounting

What is an *FLL*® attachment?

- A device that is designed to assist in accomplishing a particular mission or missions.
  - Mechanical attachments physically interact with something to accomplish the particular mission programmed.
  - Sensors are devices and considered attachments. Their purpose is to provide input to the program to accomplish the particular mission programmed. For sensors to work properly, they must be mounted correctly.

12 Attachment Tips

Based on Dr. Ken Berry's Attachment Tips

Tip #1 Consistency

- Consistency, consistency, consistency, consistency, consistency, consistency, consistency, consistency.
- No, seriously, CONSISTENCY!!! It's important that your attachment behaves the same way every single time it use it. If it doesn't, then your attachment does not work.
- Robotics is not about luck, it's about consistency.

Tip #2 Respect your programmer

- The purpose of an attachment is to make the programmer's job easier. Try to make the attachment as compact as possible. (See next tip.)
- If touching the mat, reduce friction between the attachment and the mat as much as possible. Friction when moving greatly increases the programmer's job.
- Also, make sure the attachment helps your programmer guide your robot to the task and try to incorporate sensors (such as a touch sensor) into your attachment, it will help your robot know whether or no the task has been accomplished.

Tip #3 Leave room for error

- That one 2M axle on the attachment may be the perfect piece to accomplish the task at the other end of the mat when trying the attachment by hand, but this may not be the case when it is used on the robot.
- Make sure that you can always hit the target no matter what. In order to do so you can make the attachment bigger to make sure that a little error will not affect the outcome.

Tip #4 Use the field pieces

- A lot of the field pieces are always there and don’t move. Have your attachments take advantage of this. Running into your task, if done properly, can be very beneficial if you can make sure that your robot always ends up in the same position.
- If your robot is always in the same position after completing the task, it makes your programmer’s job easier and it also opens up the opportunity to add more tasks in one run.

Tip #5 Merge

- Try to make as few attachments as possible.
- Merge attachments if possible.
- For example, if a task requires an attachment to be on the mat and another task to have an attachment way up high, you can merge those two attachments into one if doing so does not prevent the attachments to work properly.
- Merging attachments will reduce time in the base changing them out.

Tip #6 Life is too short

- Don’t get hung-up on one mission.
- If you have absolutely no idea how to build an attachment for a task, don’t try to build one. There are many other tasks can worked on.
- Building attachments is all about combining mechanisms. Maybe by working on an attachment for another task you’ll find a way to accomplish the task you couldn’t do earlier.

Tip #7 All for one and one for all

- Try to make all attachments so that they attach to the robot the same way.
- Spend time early to come up with an attachment mechanism that will be common to all your attachments. This will save a lot of time in the future.

Tip #8 You don’t always need a motor

- You are permitted four motors only, use them wisely.
- Teams tend use a motor for everything even though there are ways to complete the task without one. If you really want to use a motor for more than one attachment, try to make sure the connection from the motor to your attachment is easy and doesn’t require much fiddling with pieces.
- Motors should be used mostly for tasks that require precision and force at the same time or if you really need your attachment to spin.

Tip #9 Don’t forget Galileo

- Gravity is free, use it. If you need something to fall, think gravity.
- There are many release mechanisms available to make things fall using gravity, use them, don’t use a motor when gravity can do the same thing for free.

Tip #10 Rubber bands are your friends

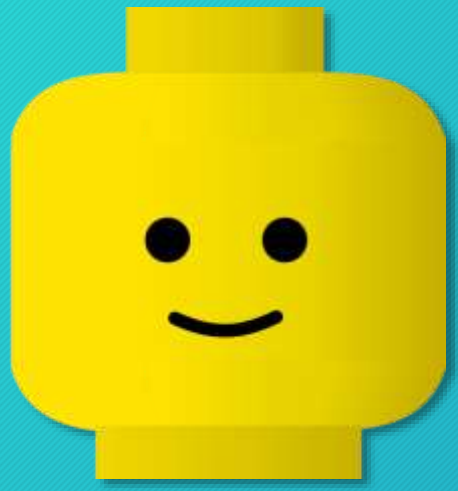
- Rubber bands can, under certain circumstances, do the same job as a motor. At times, they can also do it far better and faster.
- Rubber bands are very useful for many things such as:
  - guiding your robot in position
  - compensating for gravity
  - releasing a lot of energy very fast
  - holding things in place
- Of course, rubber bands, especially the LEGO® ones, are fragile so use them wisely and have spares.

Tip #11 The need for speed in the base

- One of the most important uses of axles is to mount attachments to the frame.
- Many teams use pegs, which can be hard to attach/detach cleanly during a robot game match.
- The use of axles, friction, and gravity for putting attachments on the robot minimizes time (and mistakes) in base.
- Technician's plan and practice

Time spent is base is time not scoring points. Matches are only 150 seconds long.

Tip #12 K.I.S.S



- **K**eep **I**t **S**imple **S**illy
- Less moving parts are easier to maintain
- Less moving parts = less to go wrong or break

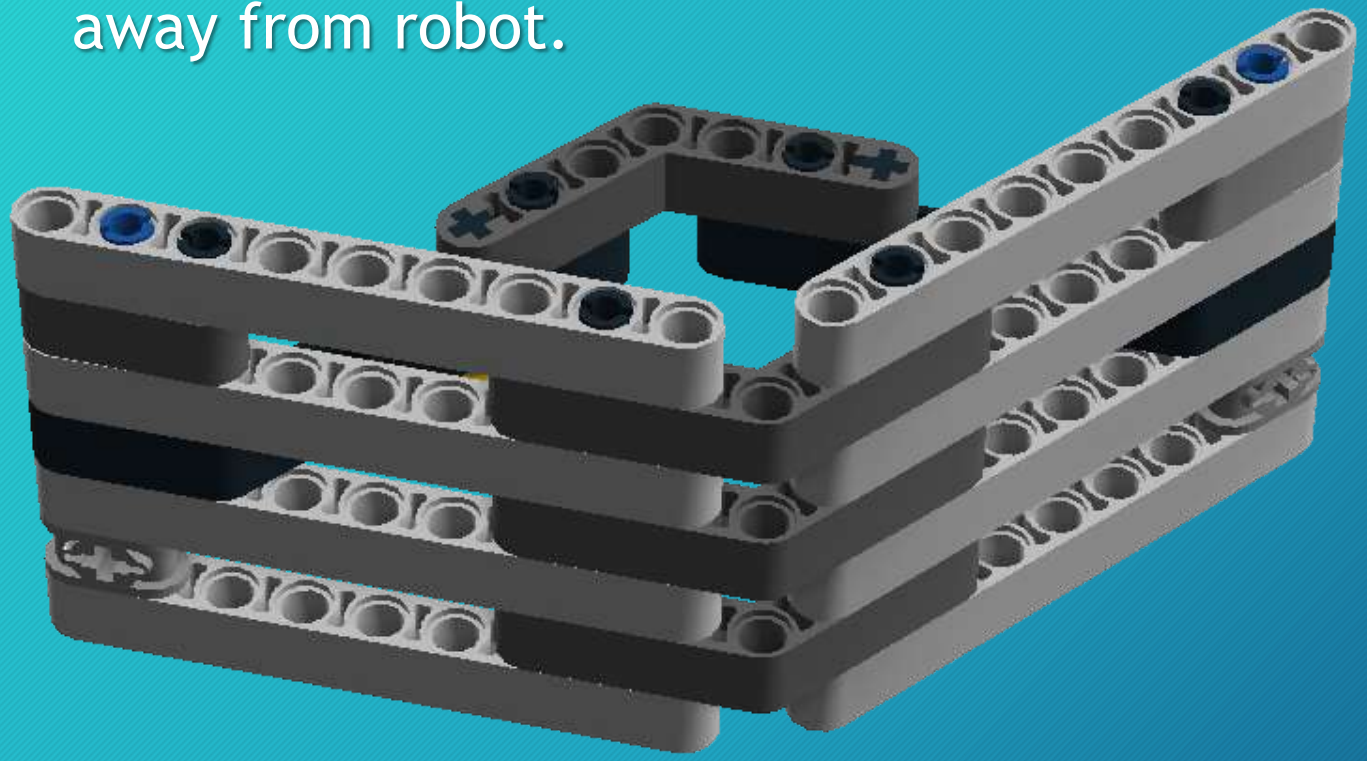
Types of Attachments

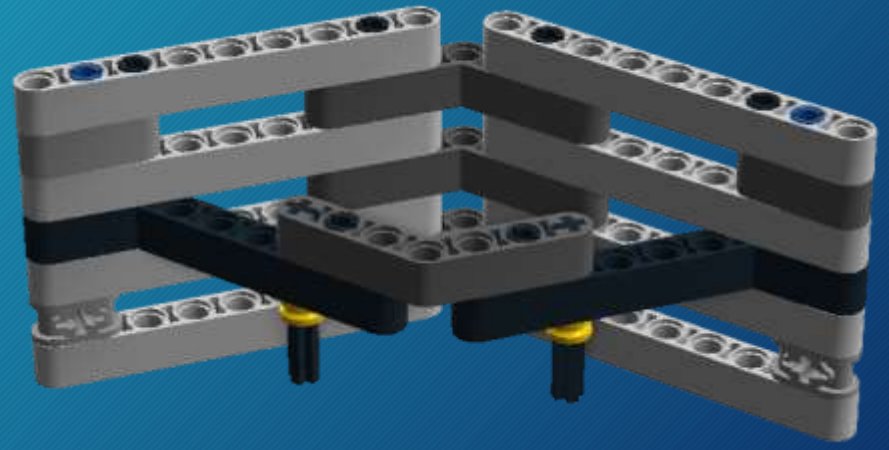
Types of attachments

- The two main types of attachments are those that are programmed and those that are mechanical.
- Programmed attachments require command(s) from programming to perform its task. For example a moving arm.
- Mechanical attachments react mechanically to mechanical stimuli such as a door that closes itself after it is opened using a rubber band.
- Of course, there are attachments that are a combination of both.

Plow

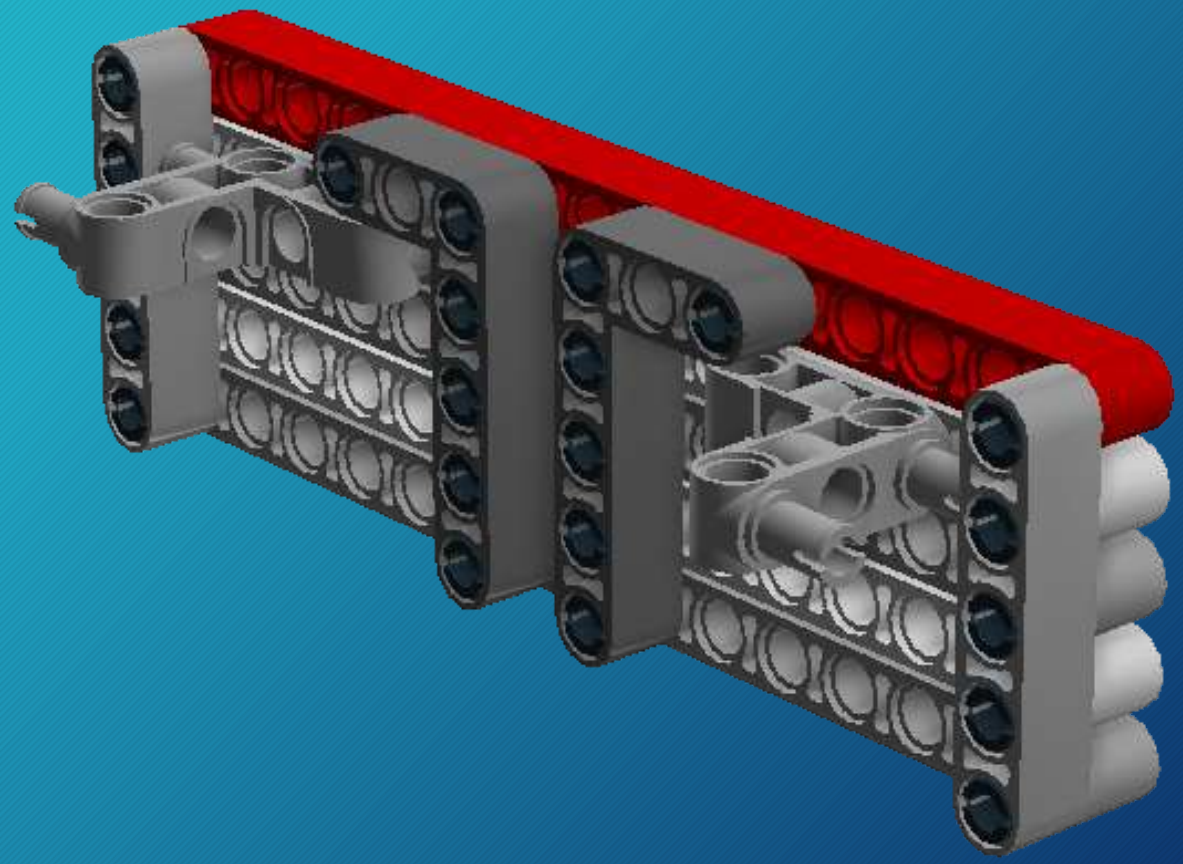
- Used to plow/push items out and away from robot.





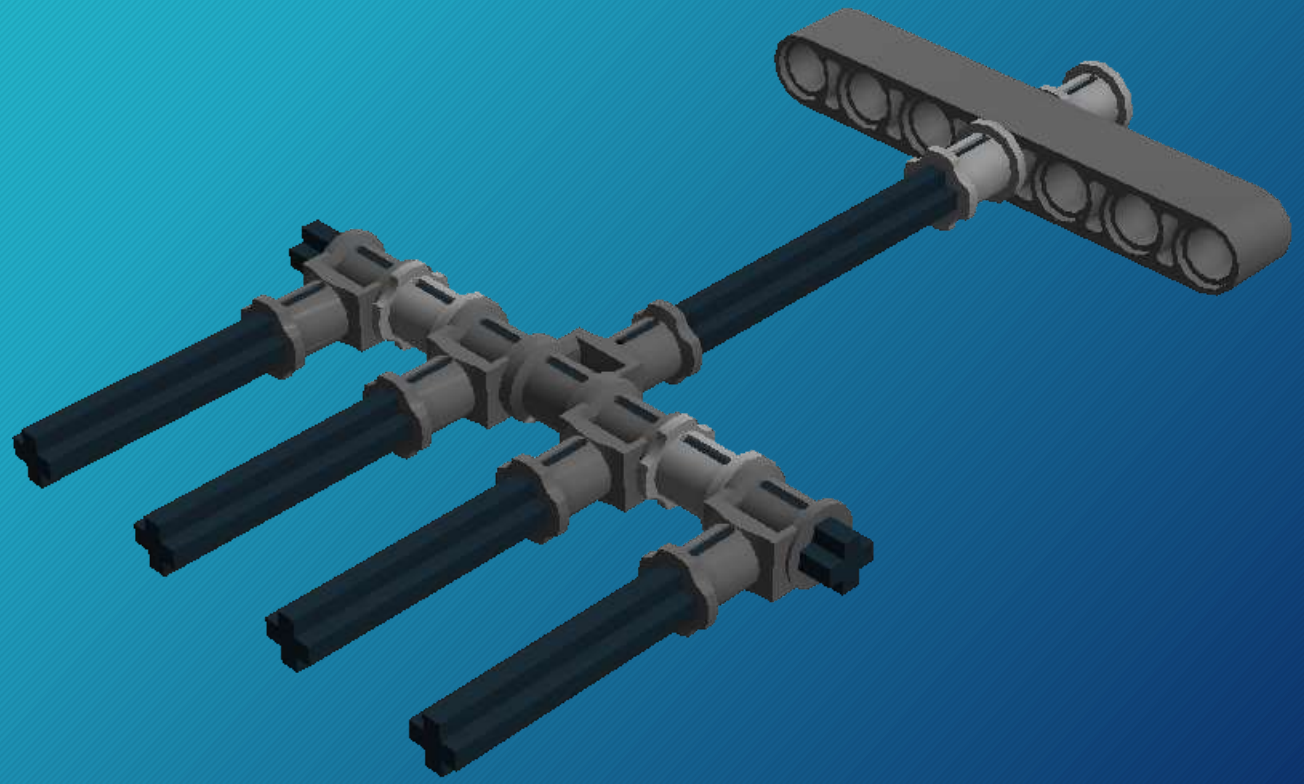
Bulldozer

- Great for pushing objects around.



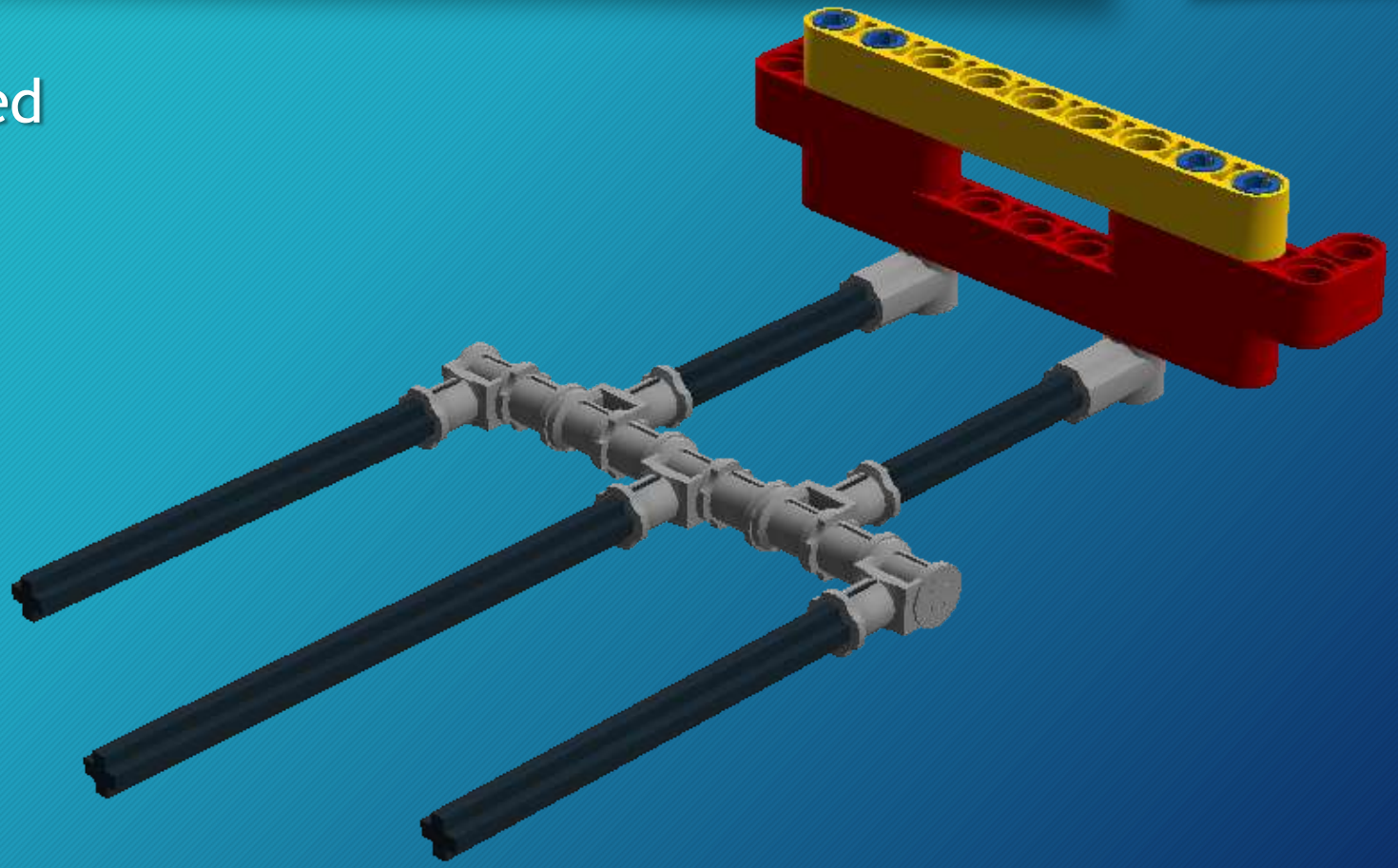
Rack - Original

- Used like a forklift to pick items up.
- Can be fixed mounted or used with a motor.



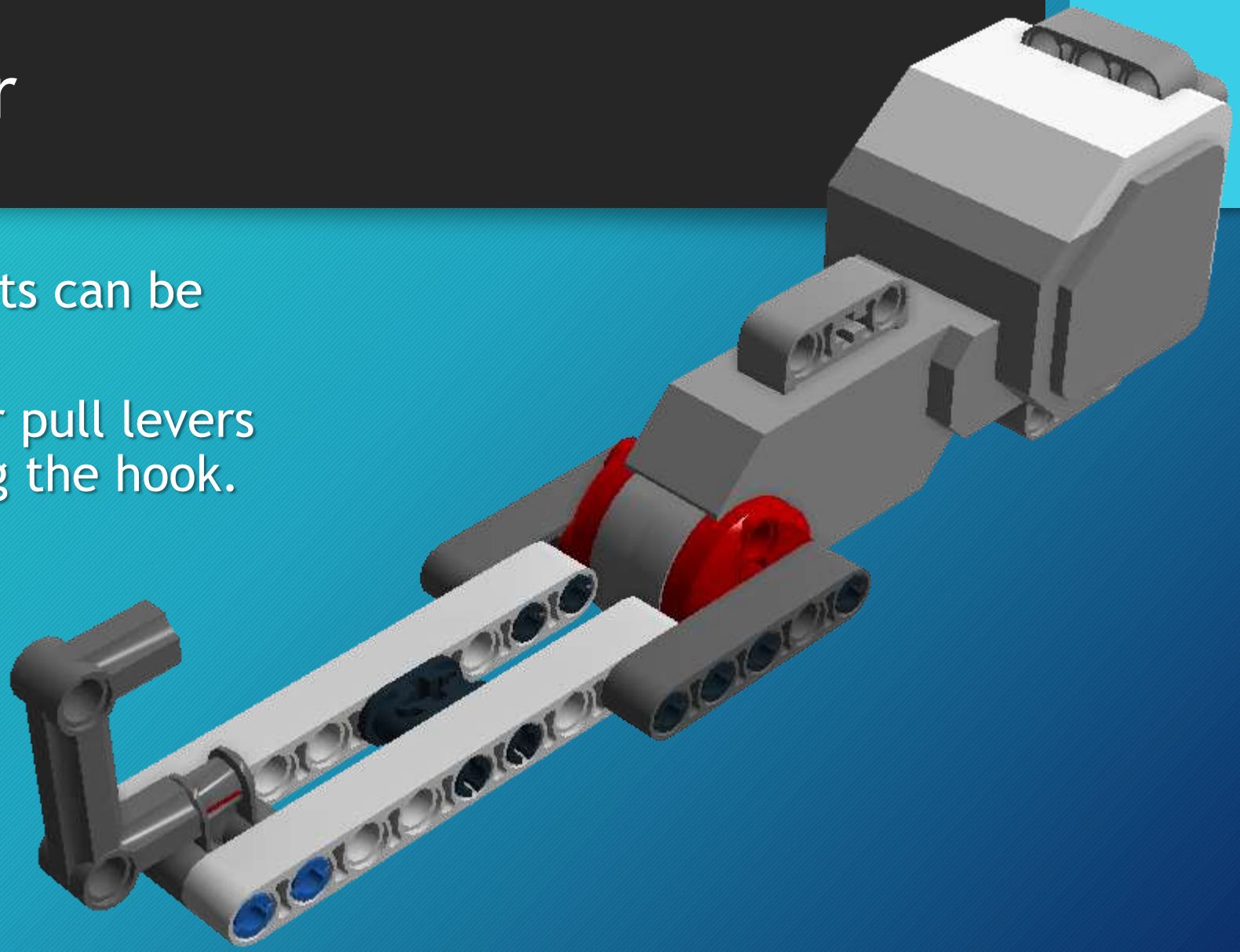
Modified Rack

- A second support axle added
- Common mounting
- Three forks



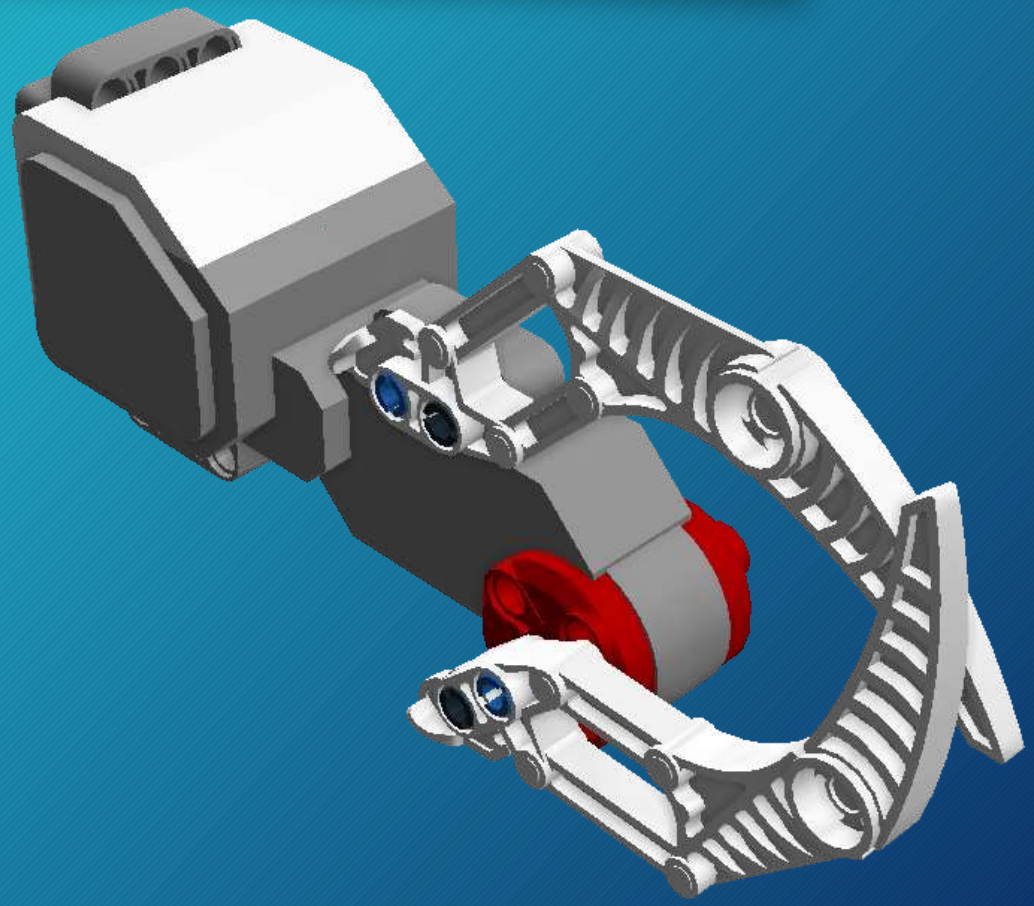
Hook with motor

- Hook-types attachments can be useful in handle loops.
- Can be used to push or pull levers simply by repositioning the hook.



Claw gripper

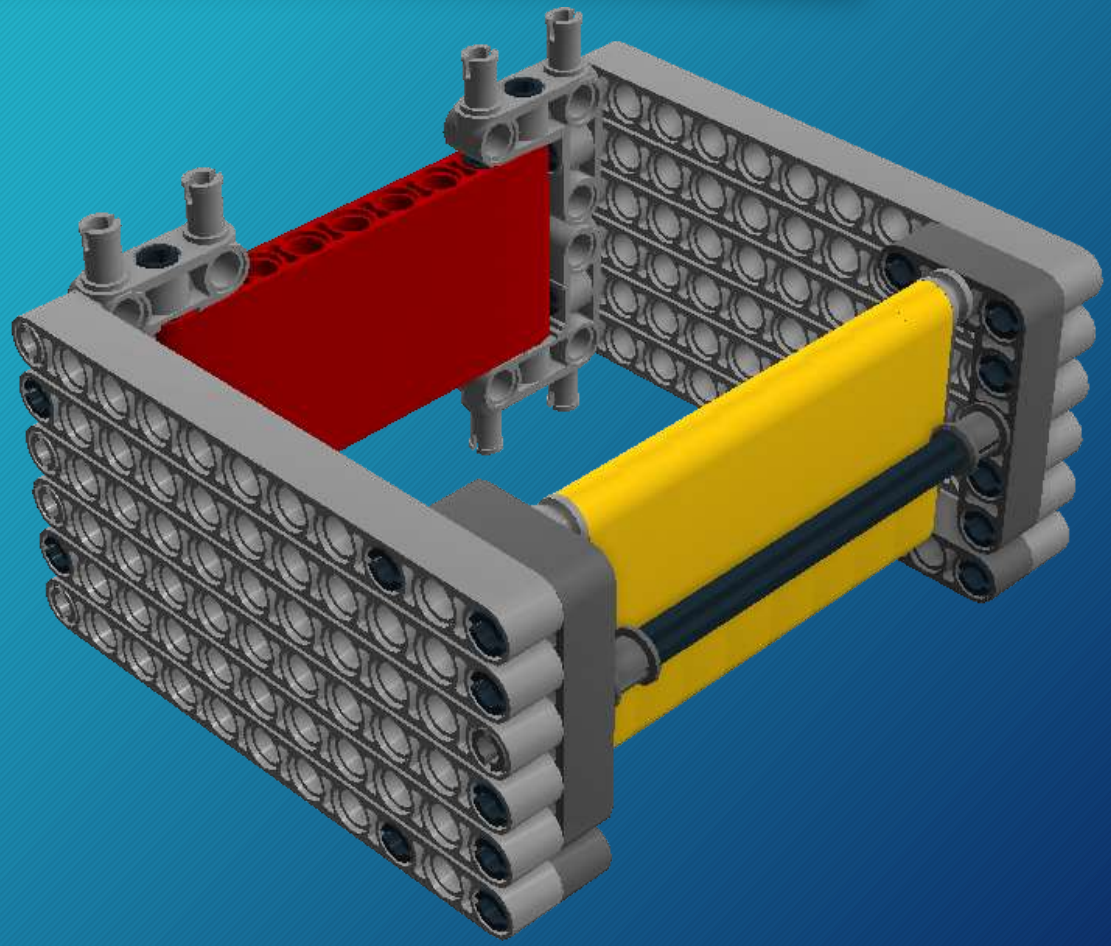
- Useful for grabbing items.
  - 4508600: Tool 4X12 Nr. 4 (2)
  - EV3 motor
  - Connector with Friction Cross axle (2)
  - Connector Peg with Friction (2)



LEGO® Digital Designer demonstration.
http://ldd.lego.com/en-us/download/

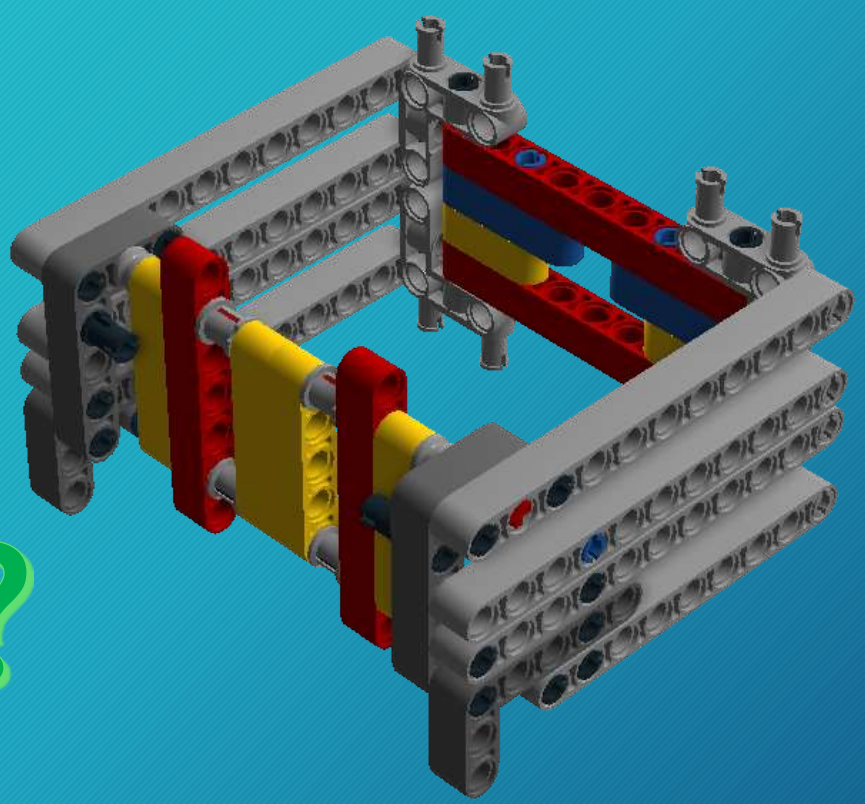
Trap box - Original

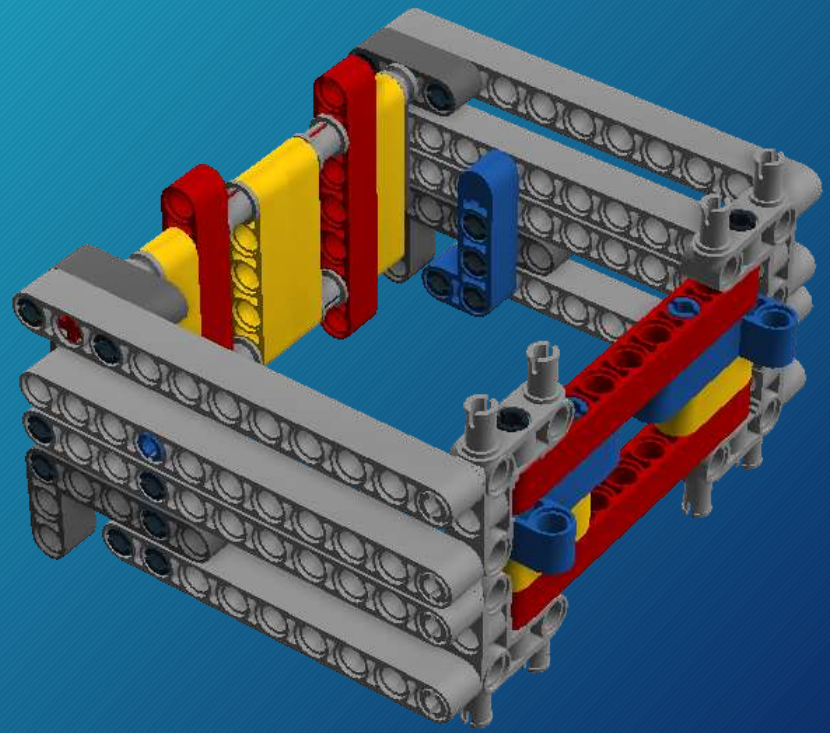
- Trap type attachments are good at retrieving objects, especially at retrieving balls and objects that roll.



Modified trap box

- Modified to reduce weight and use a drop-in mount.

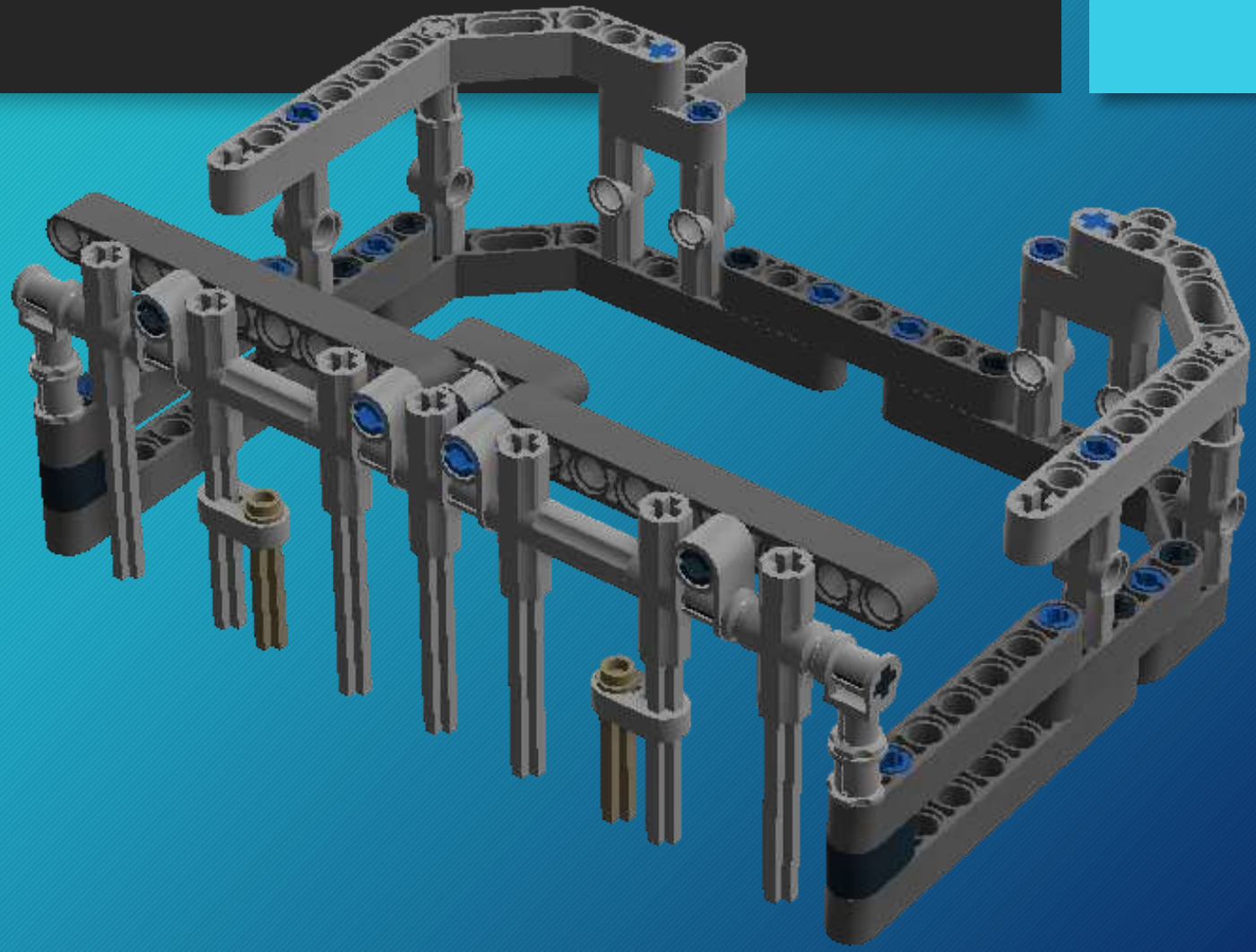




Why would you want to reduce an attachments weight

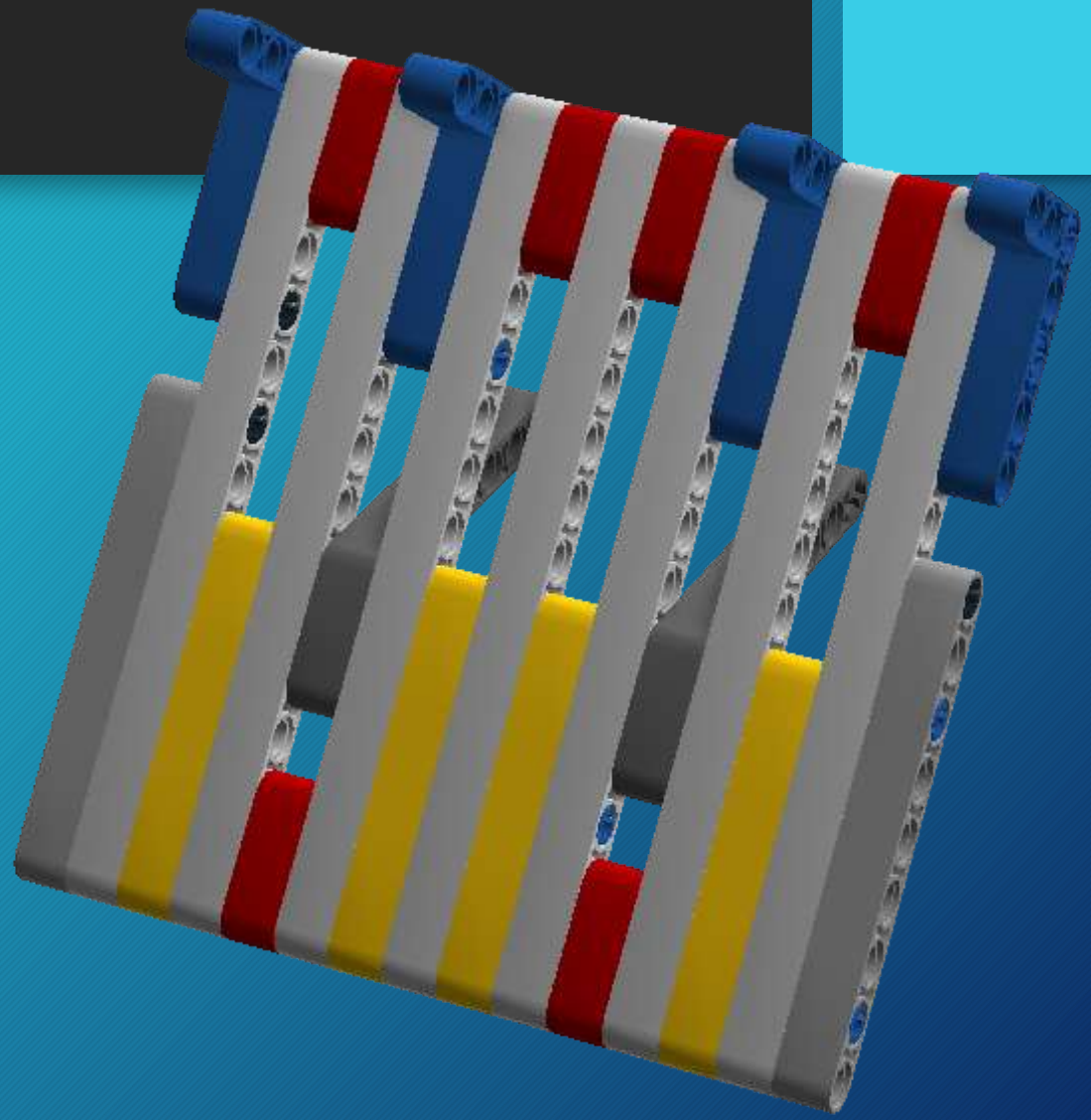
Trap box – Type 2

- Axle gate to allow lighter objects to enter.
- Axles swing independently to permit lighter objects to enter.
- Uses common mount points.



SuGo styled plow

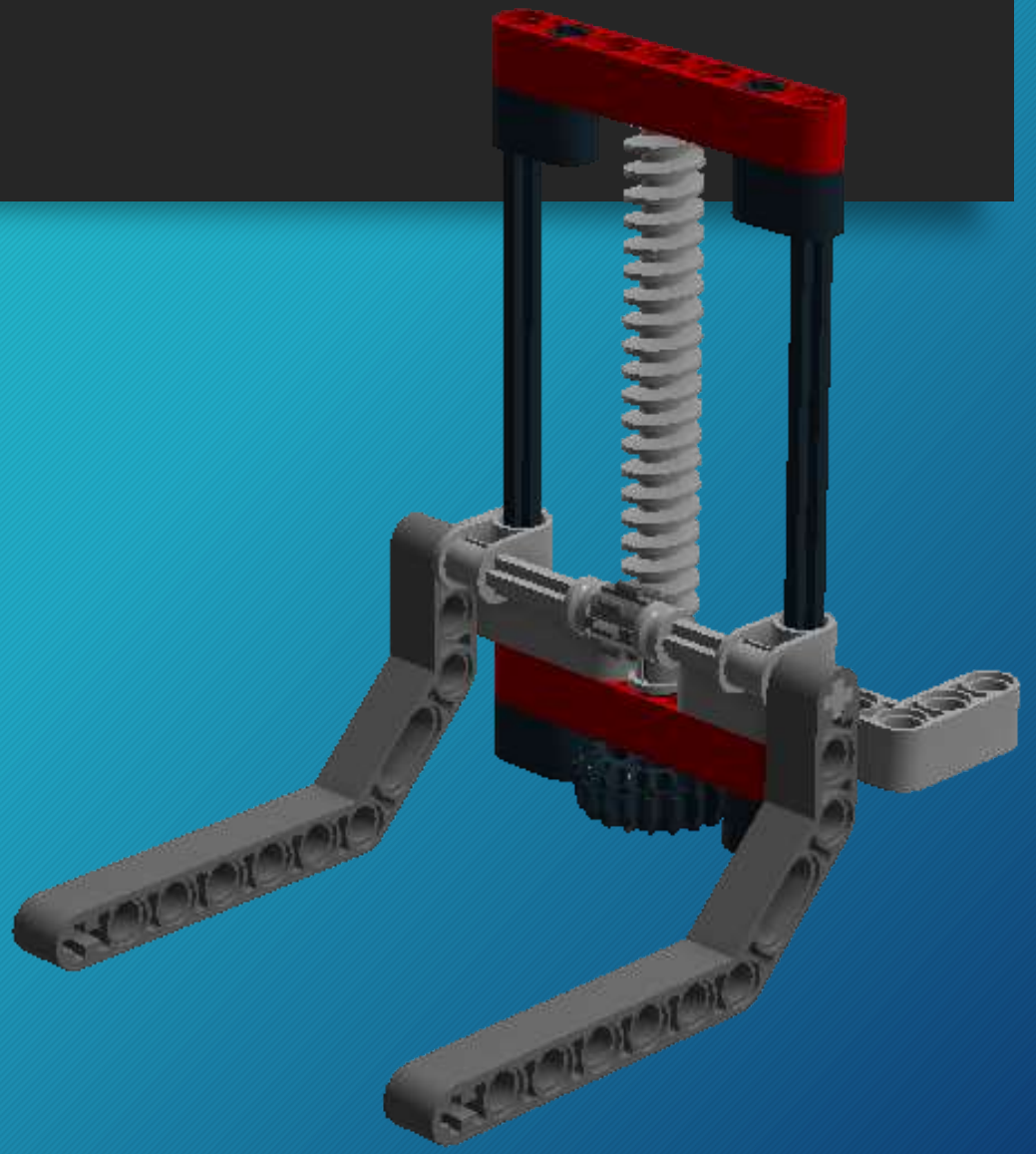
- SuGo styled plows are designed to push other robots out of a SuGo wrestling field.



http://www.sugobot.com/

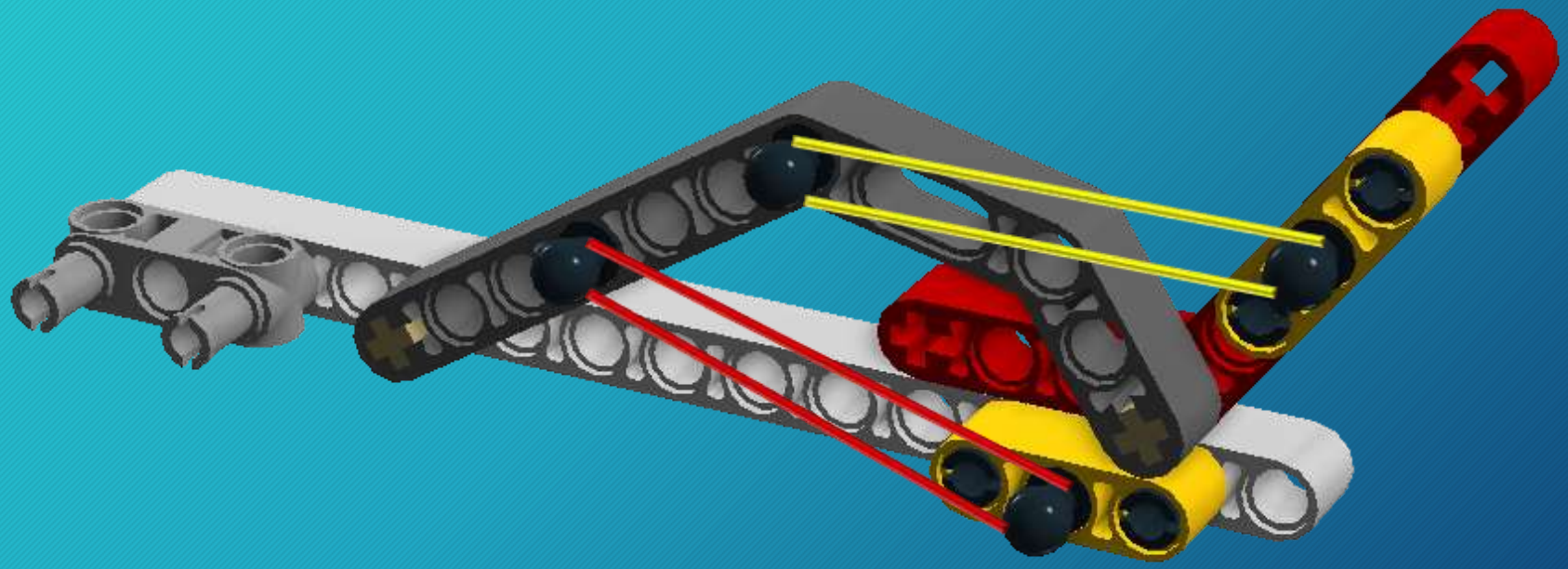
Forklift

- Uses worm gears to lift and lower the forklift tines.



Caribiner

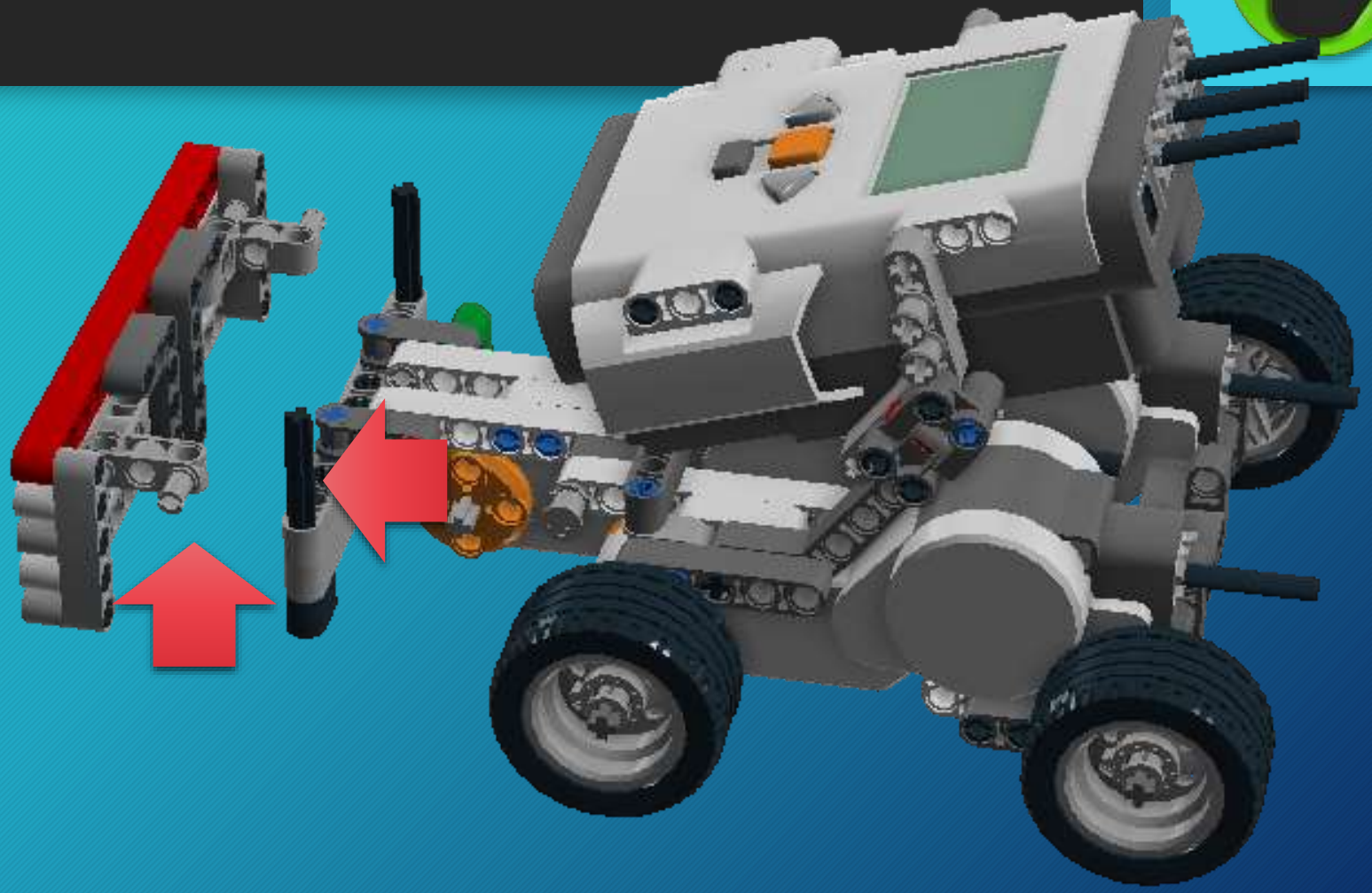
- The caribner demonstrates use of rubber bands for action.



Mounting Attachments

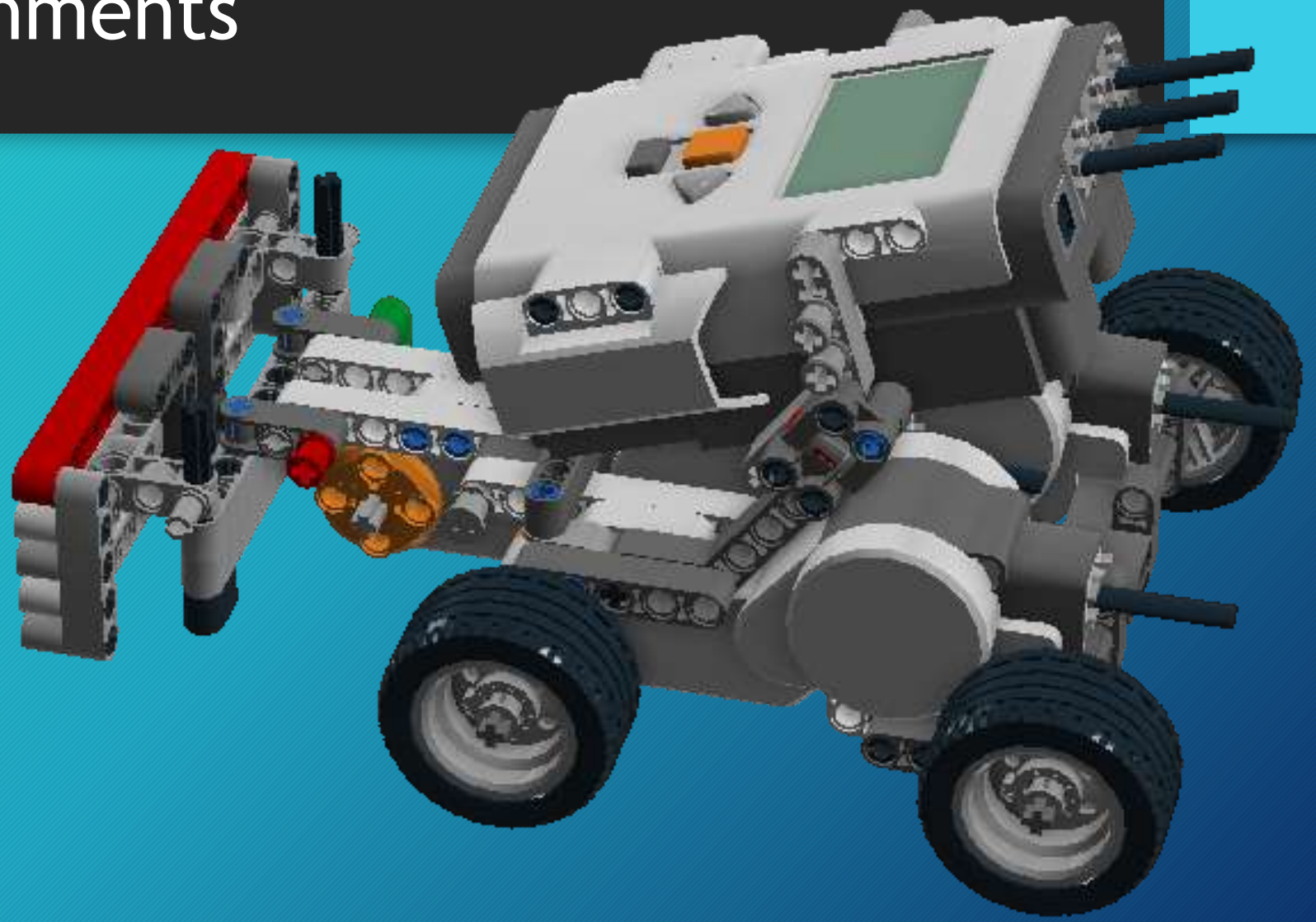
Drop-on attachments

- Drop-on attachment typically use axles and gravity to mount to the chassis.
- Quick to change.
- Multiple attachments can mount to the same bracket.

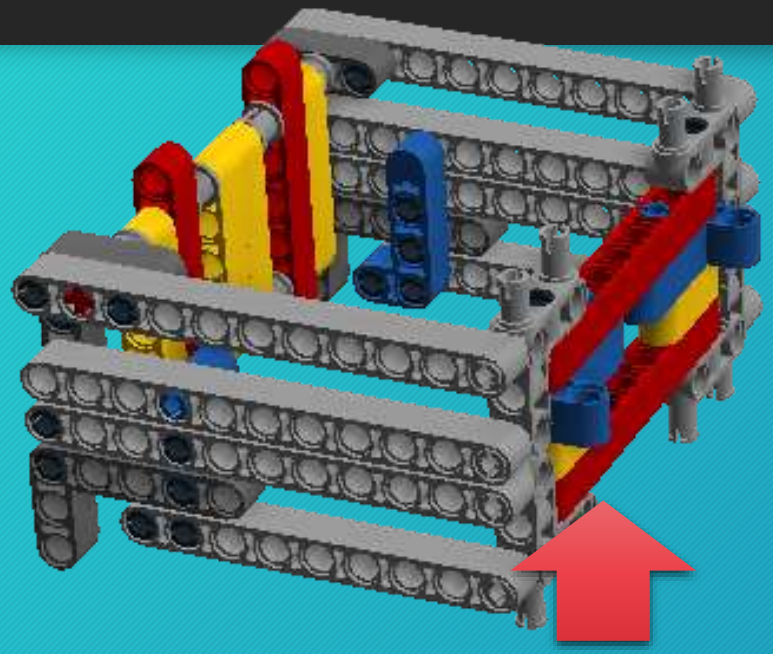


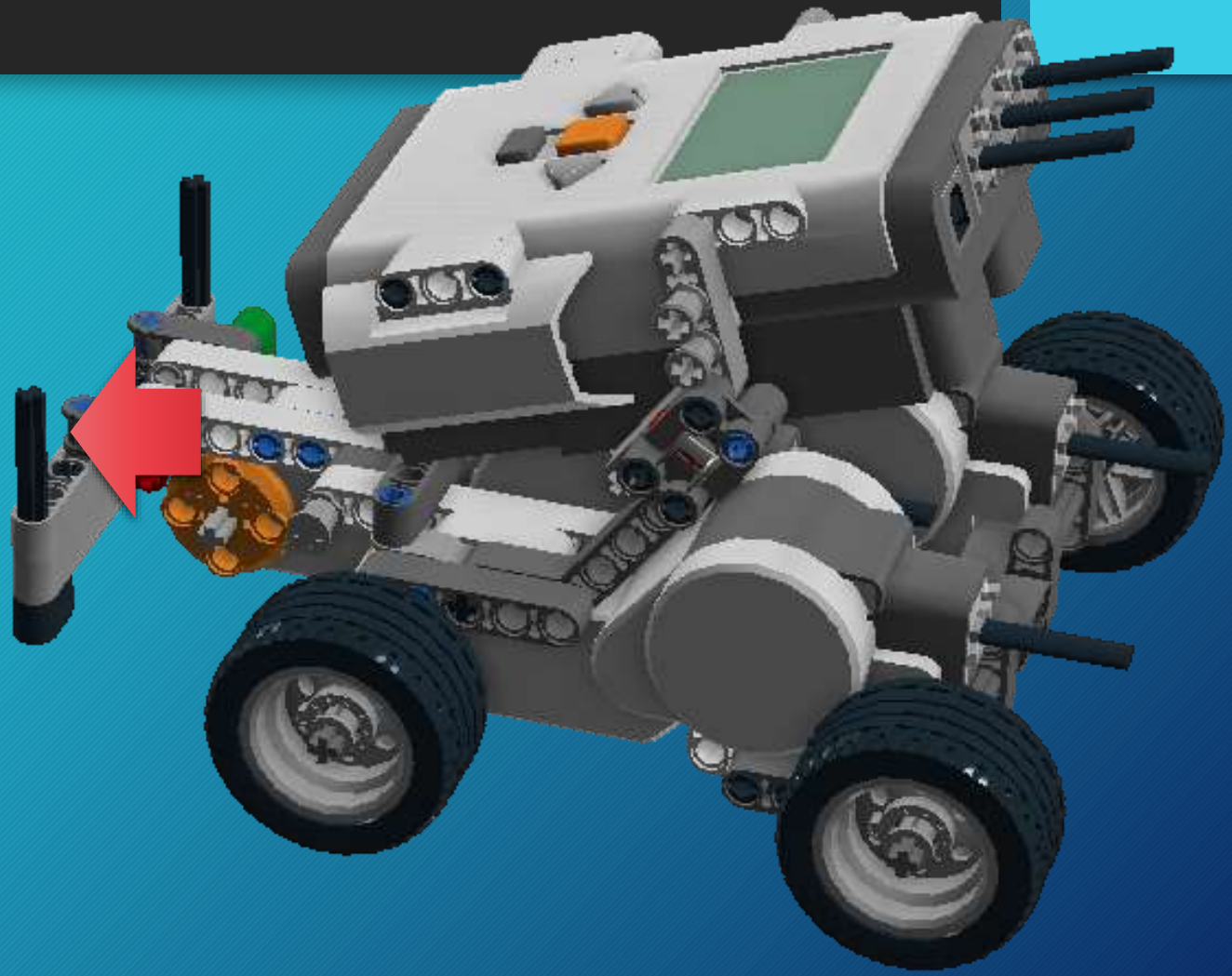
Drop-on attachments

- Here it is attached.



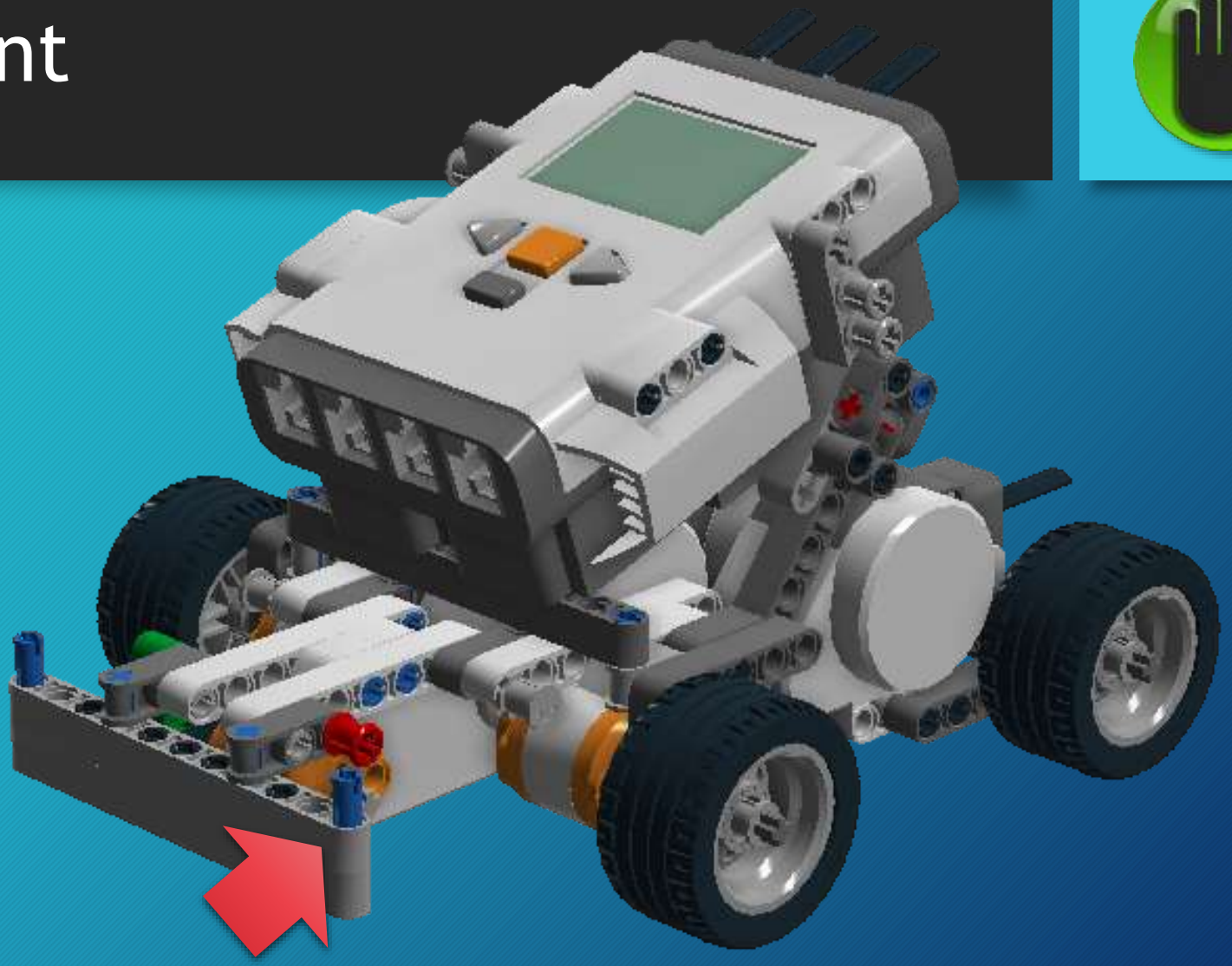
Drop-on attachments





- Different attachment, same mount points to the chassis.

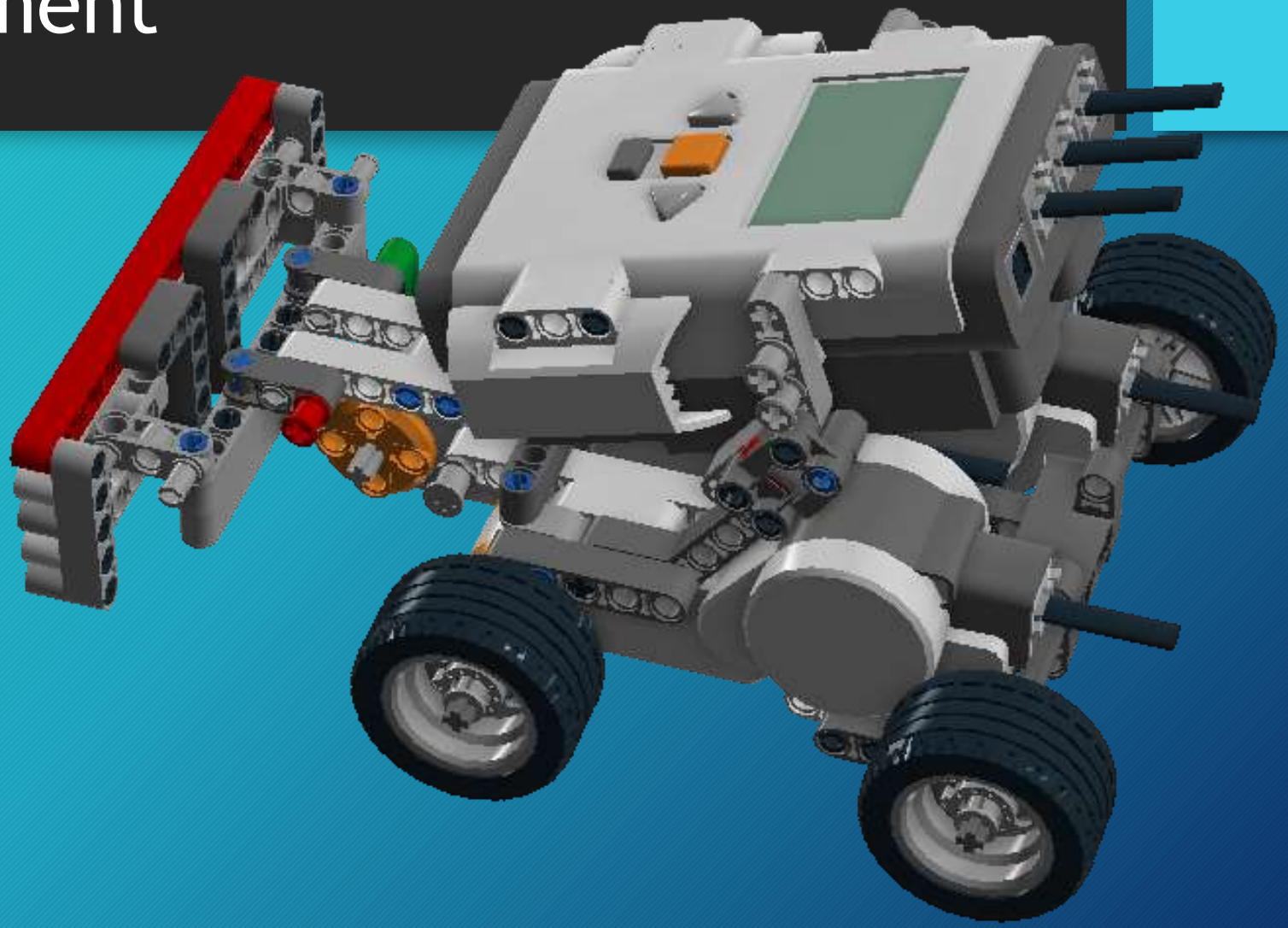
Mounted attachment



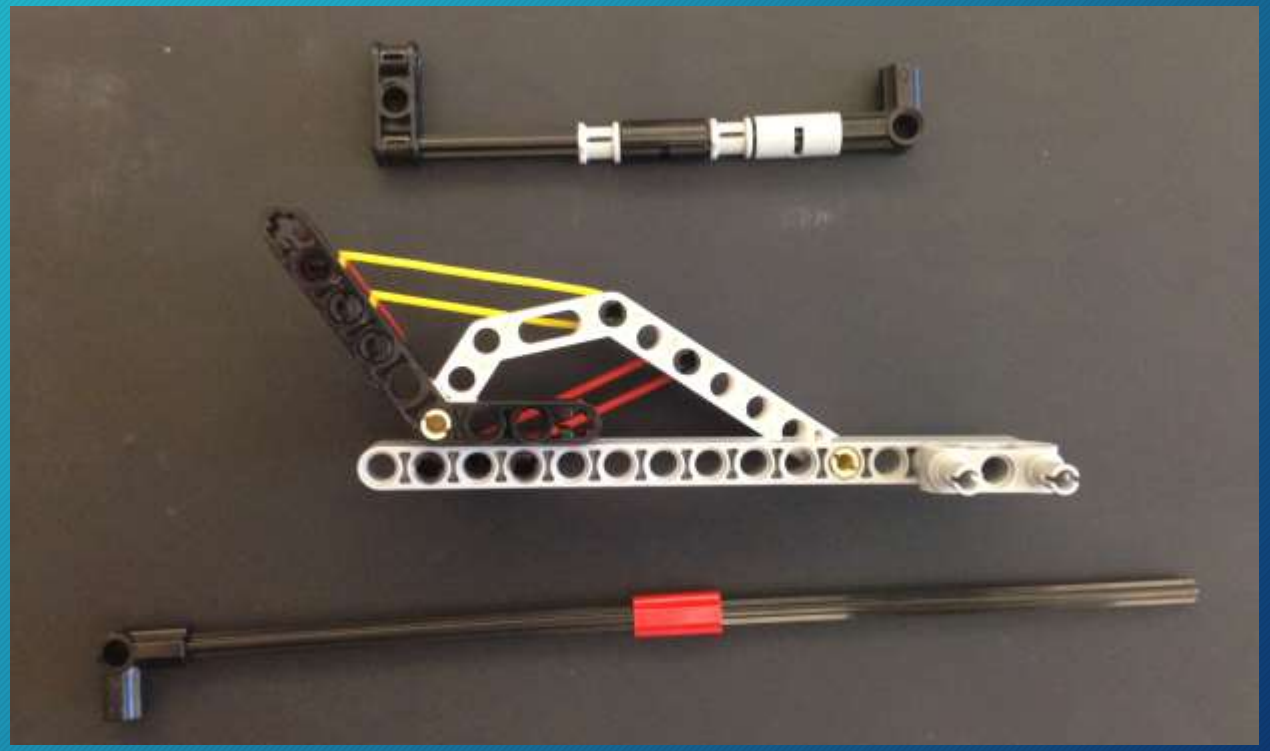
- Mounted attachment typically use pegs and/or other Lego® pieces to mount to the chassis.
- Not as easily changed.
- Best when structural strength is required.

Mounted attachment

- Here it is attached.

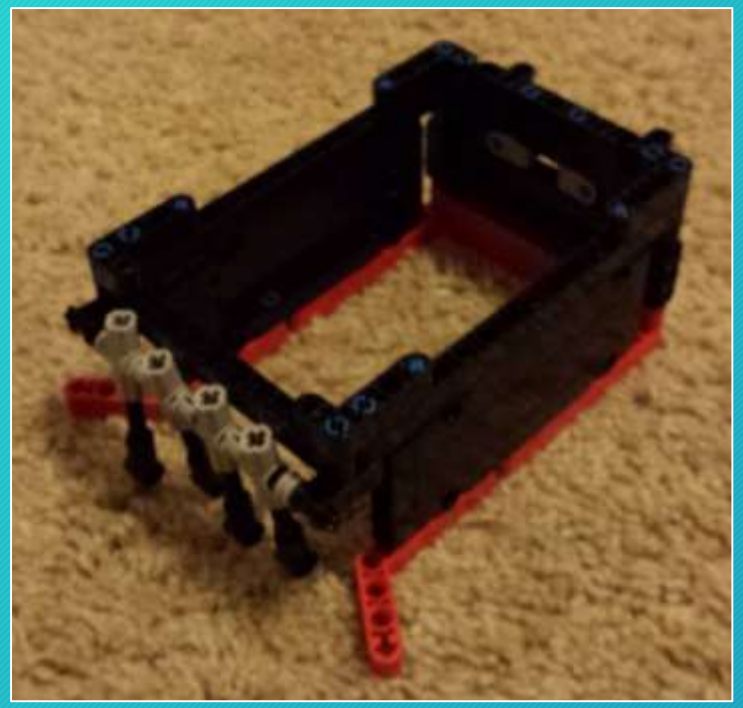


2013 Nature's Fury Attachments Examples

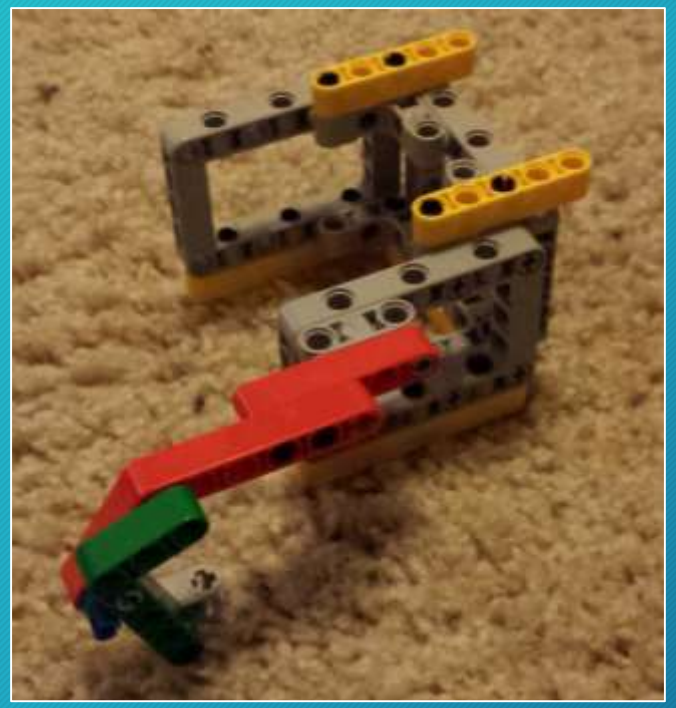


Courtesy of FCA Robotics

2015 Trash Trek Attachments Examples



Trap box



Push tool with hook

Plow

Courtesy of Team #15528

Senor Mounting

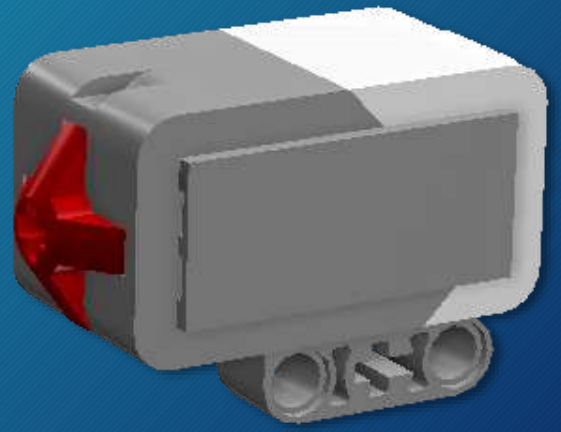
Why use sensors?

- Sensors provide input to the program to accomplish the particular mission programmed.
- A sensor should be used if it enables the robot to accomplish its mission faster, more accurately, more reliably, more efficiently, or safer than with some other resource like power, weight or time.
- To create the best possible robot for a task, it's important to fully understand all the available sensor options, and how each sensor type can help the robot in achieving its mission.

General senor mounting

- Lego® sensors have mounting interfaces on “bottom”.
  - NXT sensors have three holes.
  - EV3 sensors have a cross mount in-between two holes.
- These holes align with beams and other Lego® pieces.
- To function constantly, sensor must not be loose or wobble.

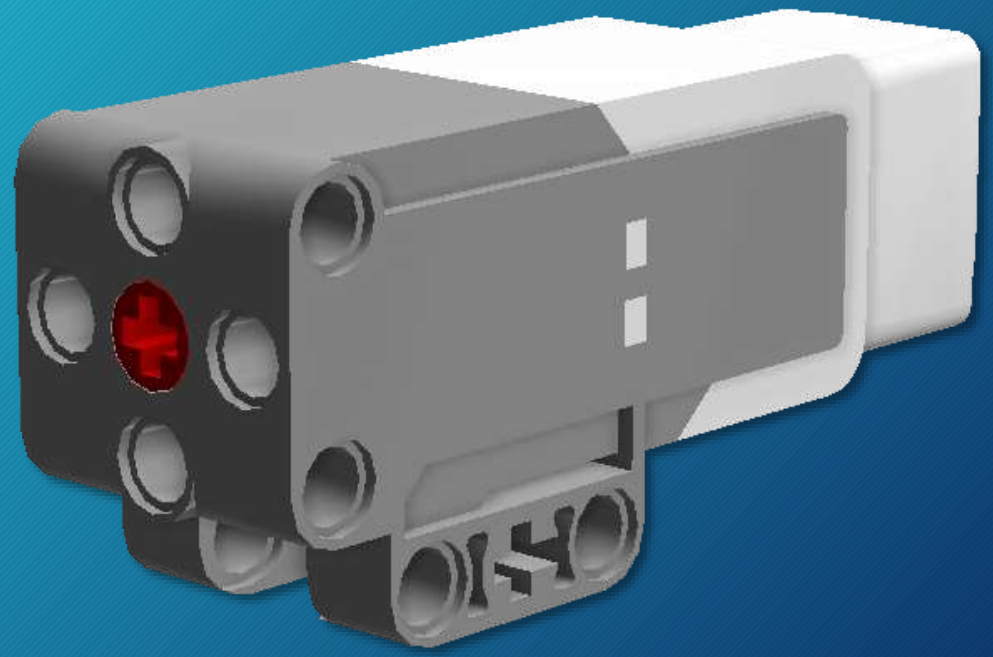
NXT Touch Sensor



EV3 Touch Sensor

Motors

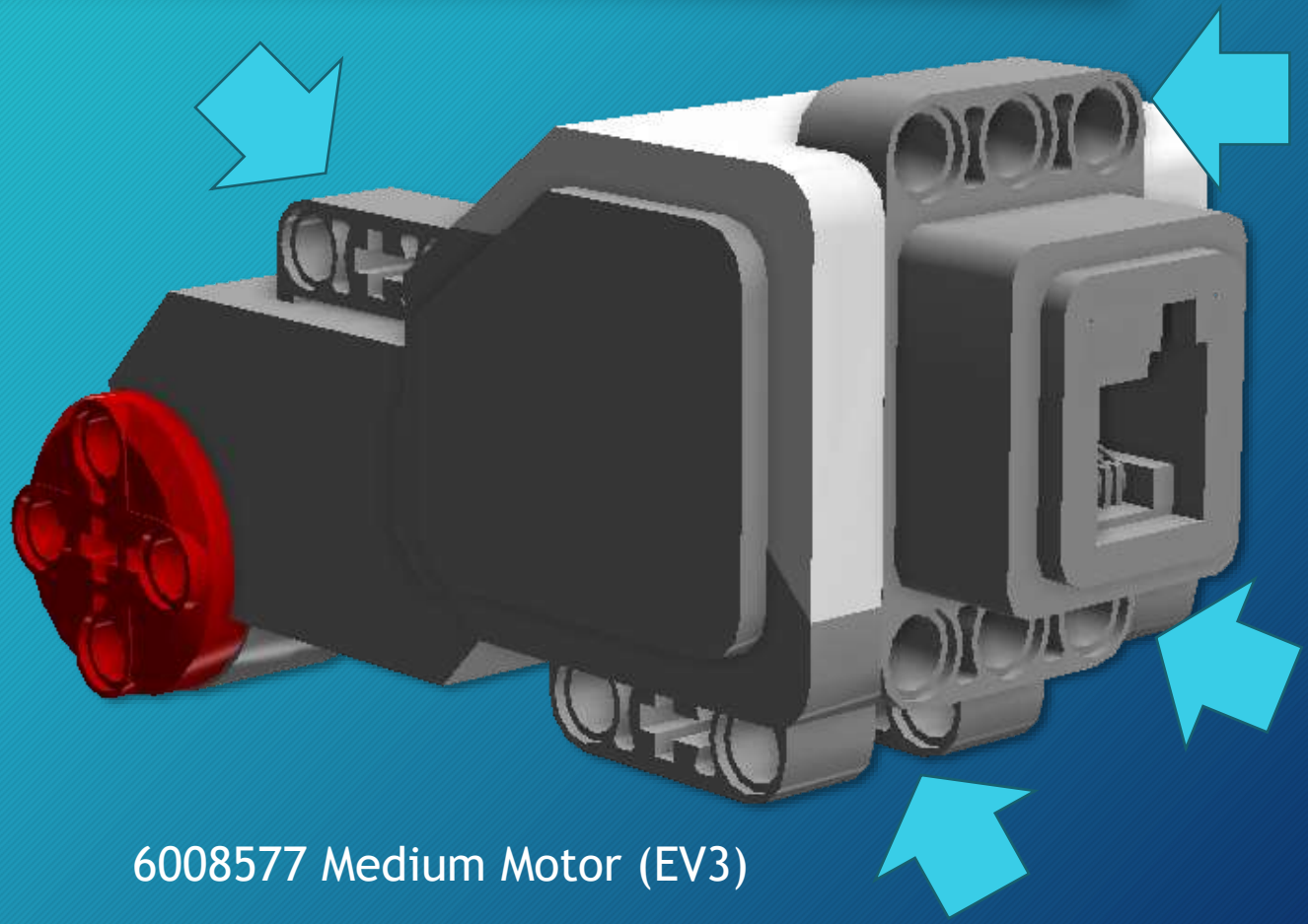
- Yes, motors are sensors!
- They can provide feedback to the program.
  - How many rotations/degrees have they turned.
  - In what direction did they turn.
  - How fast they are going.
- Motors have additional mounting points.



6008577 Medium Motor (EV3)

Motors

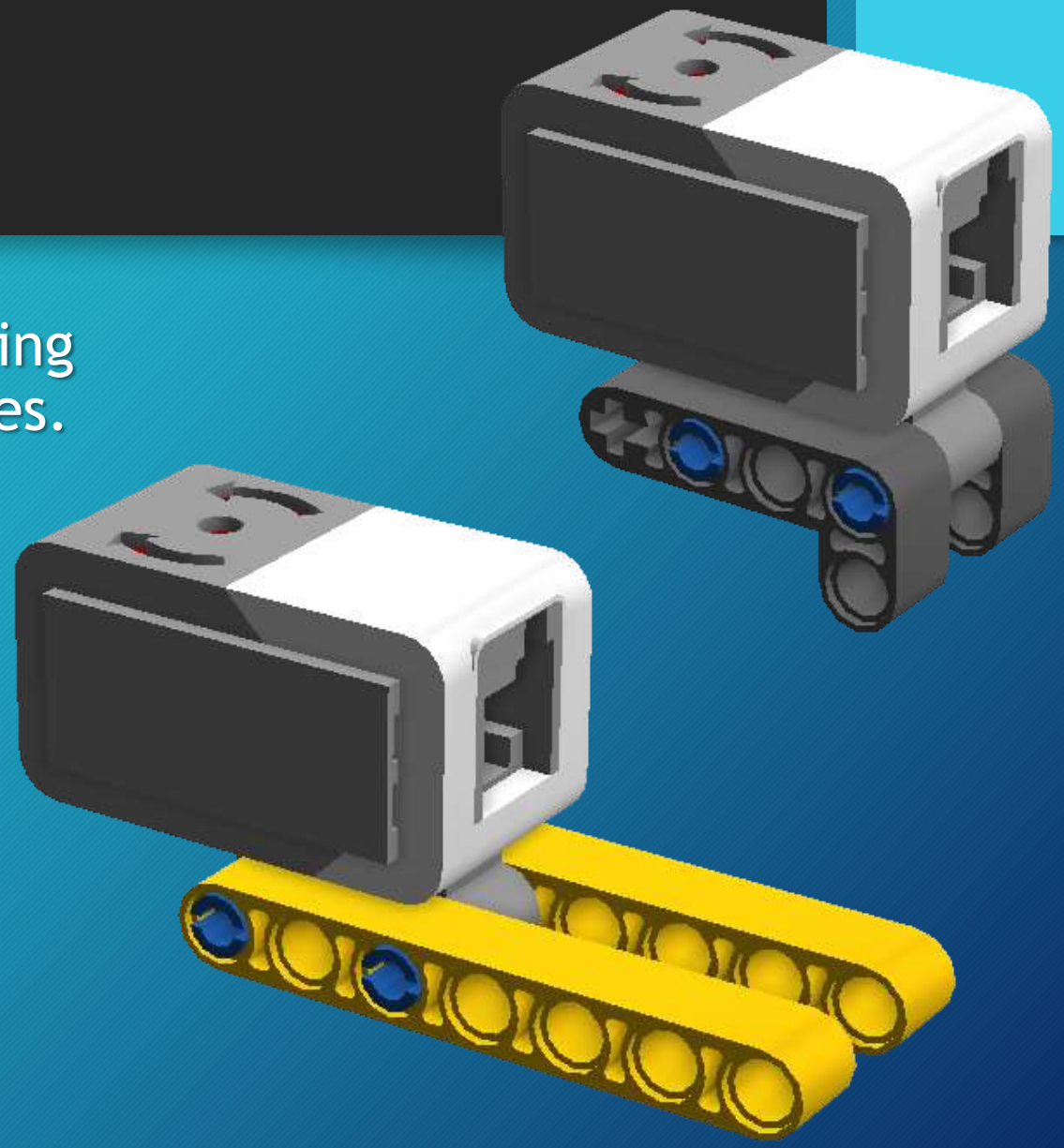
- Additional motor mount points permit mounting in many orientations.
- Multiple mounting points on motor drive enables numerous movement methods



6008577 Medium Motor (EV3)

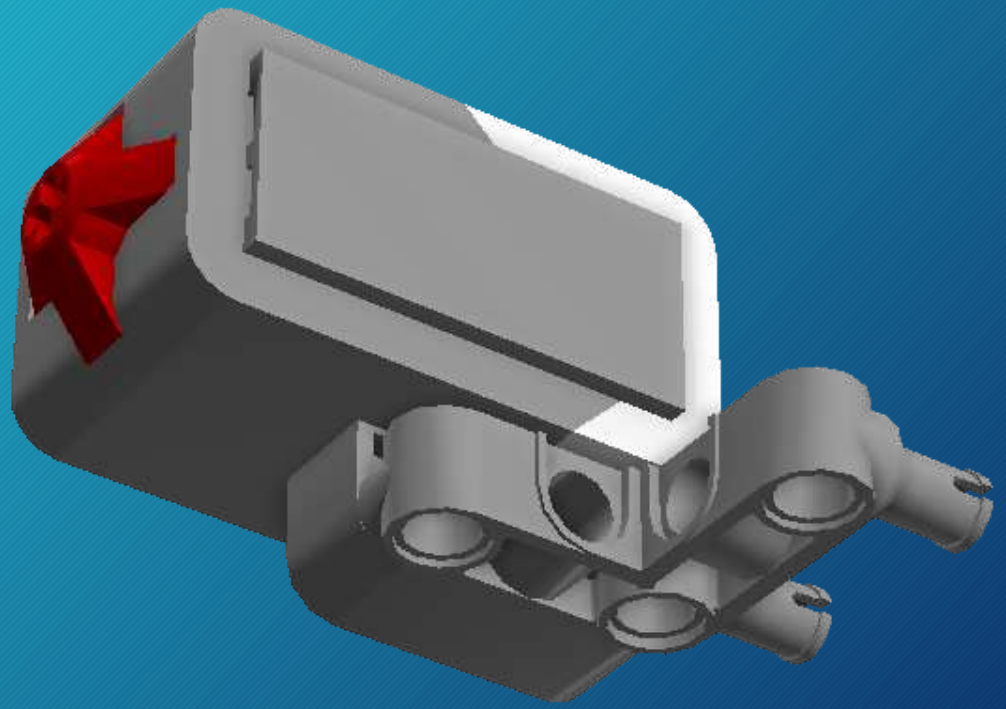
General senor mounting

- An almost unlimited number of mounting options are available using Lego® pieces.
- Remember to keep the cable port accessible.



General senor mounting

- Often a simple, but stable mount works best.



Connecting sensors – Default ports

- Port 1: Touch Sensor
- Port 2: Gyro Sensor/Temperature Sensor
- Port 3: Color Sensor
- Port 4: Ultrasonic Sensor/Infrared Sensor

Mindstorms® software defaults to these ports for sensors.

Connecting Motor – Default Ports

- Port A: Medium Motor
- Port B & C: Large Motor to each
- Port D: Large Motor

Mindstorms® software defaults to these ports for motors.

Color sensor overview

- The color sensor is a digital sensor that can detect the color or intensity of light that enters the small window on the face of the sensor.
- The color sensor has three modes:
  - Color mode
  - Reflected Light Intensity mode
  - Ambient Light Intensity Mode

Color sensor overview

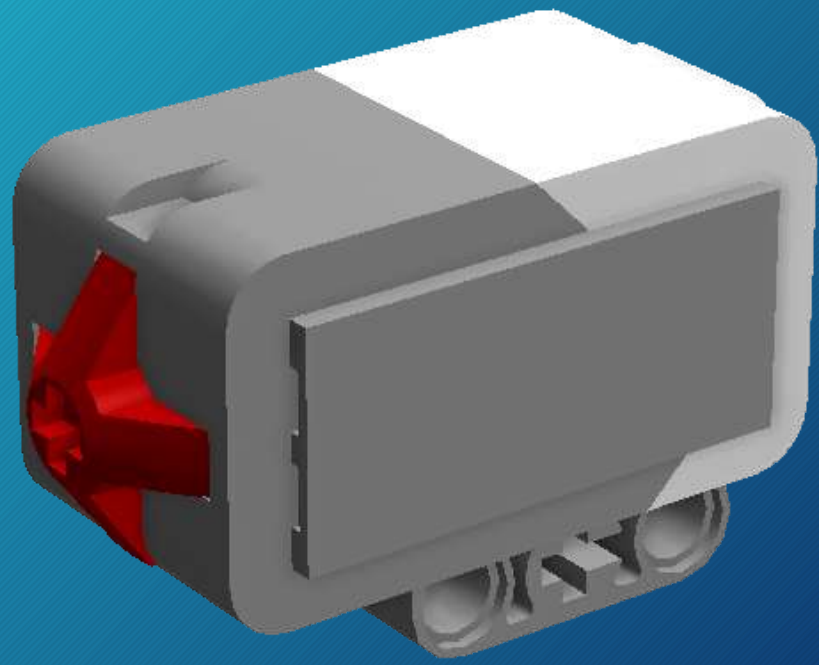
- Color mode: the Color sensor recognizes seven colors – black, blue, green, yellow, red, white, and brown. Plus no color.
- Reflected Light Intensity mode: measures the intensity of light reflected back from a red light-emitting lamp using a scale of 0 (very dark) to 100 (very light).
- Ambient Light Intensity mode: measures the strength of light that enters the window from its environment using a scale of 0 (very dark) to 100 (very light).
- The sample rate is 1 kHz/sec

Color sensor mounting

- Mounted at right angle to surface be measured for color and reflected modes
- Mount no more than 1 cm from surface being measured, but not touching
- Shrouds can help ambient light from interfering in color and reflected modes.
- For line followers, mount in front of wheels

Touch senor overview

- The Touch Sensor is an analog sensor that can detect when the sensor button has been pressed and/or released.
- Can be programmed to respond to three conditions:
  - Pressed
  - Released
  - Bumped (pressed and released)



Touch sensor

- Touch sensor can be mounted in an orientation that permits the sensor button to be activated.
- Touch sensor can be used to start and stop programs.

Ultrasonic senor overview

- The Ultrasonic Sensor is a digital sensor that measures distance to an object using high-frequency sound waves.
- Distance can be measured in centimeters or inches.
  - 3-250 cm (±1 cm)
  - 1-99 in. (0.394 in.)
- EV3 – a steady light around the sensors “eyes” indicates the sensor is in measure mode. A blinking light indicates it is “Presence mode” which means it detects another Ultrasonic Sensor operating nearby.

Ultrasonic sensor mounting

- In the same direction as the object being sensed.
- At about the same height of the object being sensed.
- Can be mounted in any orientation to face object to sense.

4297174 (NXT)

6063629 (EV3)

Gyro sensor overview

- The Gyro Sensor is a digital sensor that detects rotational motion on a single axis in the direction of the arrows on the sensor case.
- The Gyro Sensor can detect rotation up to a spin rate of 440 degrees per second.
- The Gyro keeps track of the total rotation angle in degrees with an accuracy of ±3 degrees.

Gyro sensor

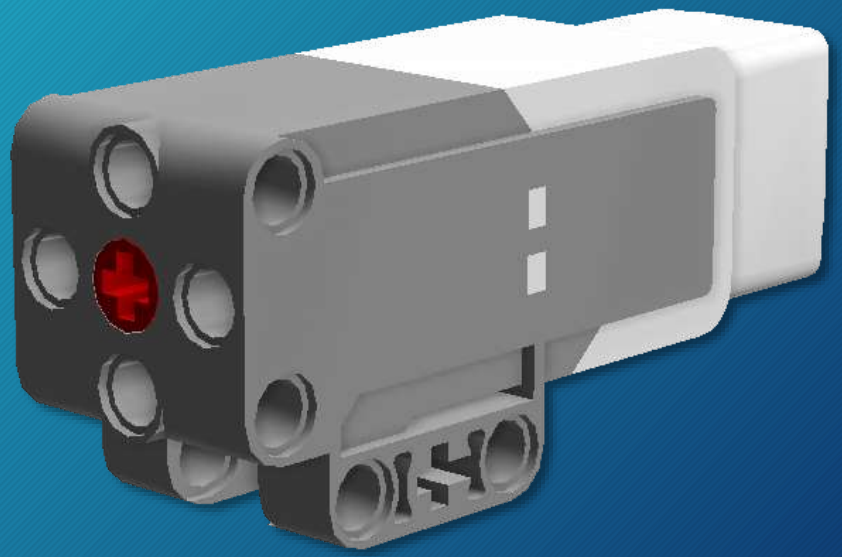
- Typically mounted with axis parallel to surface that robot is on (Arrows and dot up).
- In this case top must be level with surface.
- As with most gyros there can be drift. A short program can be used to minimize the draft.

6008916 (EV3)

6008577 Medium Motor (EV3)

- Built-in Rotation Sensor with 1 degree resolution.
- Smaller and lighter, more responsive.

- Runs at 240-250 rpm, with a running torque of 8 Ncm and a stall torque of 12 Ncm.
- Supports Auto ID.

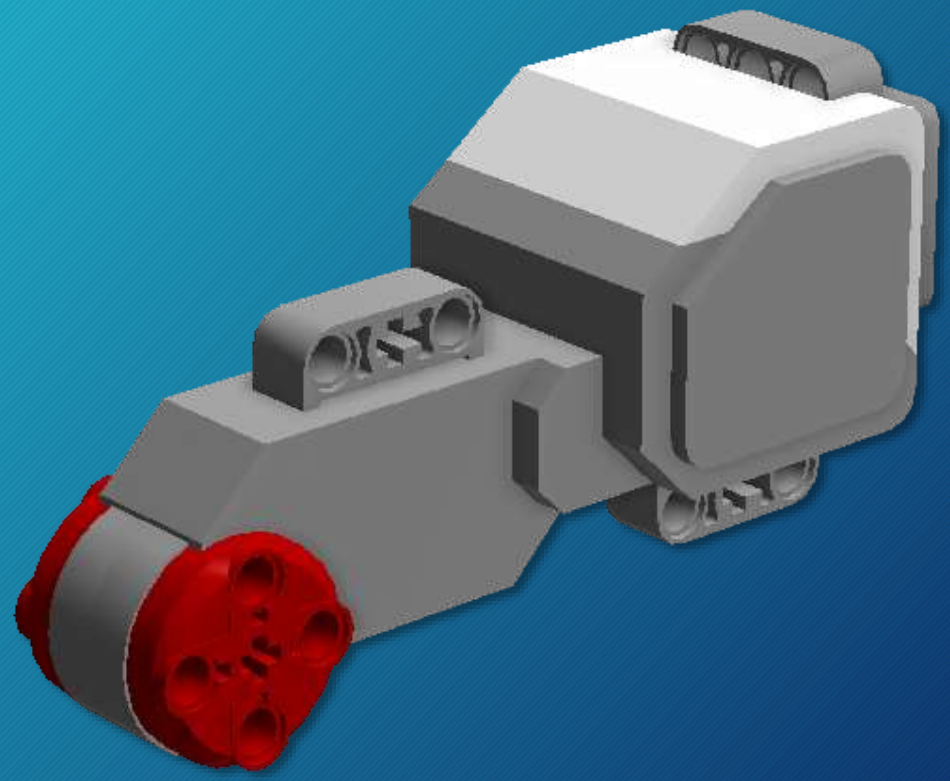


6008577 Medium Motor (EV3)

6009430 Large Motor (EV3)

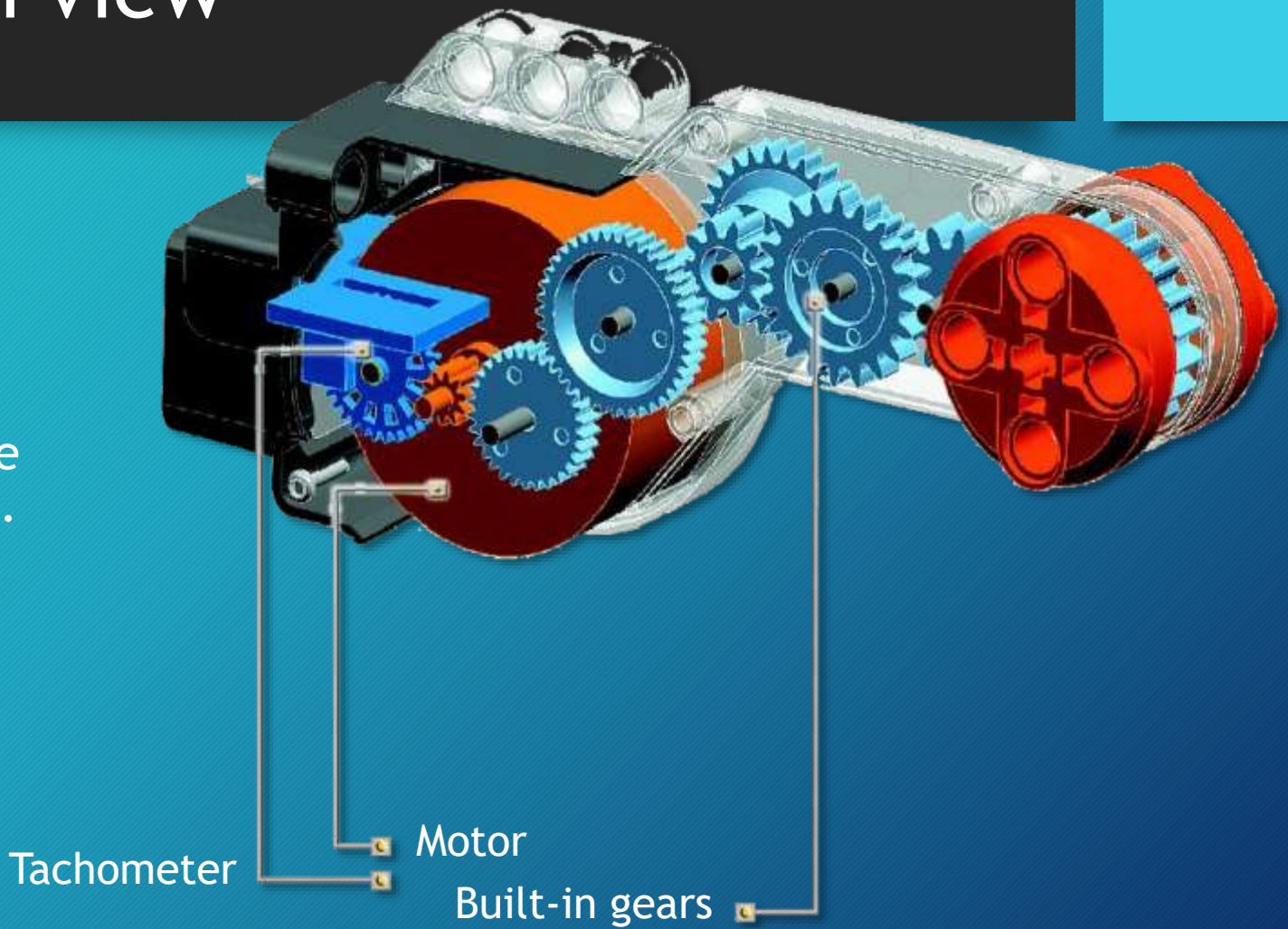
- Built-in Rotation Sensor with 1 degree resolution.
- Optimized for driving base of robot.
- Using Move Steering or Move Tank programming block will coordinate motors.

- Runs at 160-170 rpm, with a running torque of 20 Ncm and a stall torque of 40 Ncm.
- Supports Auto ID.



NXT motor phantom view

- Tachometer
  - An instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine usually displayed the Revolutions Per Minute (RPM).
- Motor
- Built-in gears
- Data can be read by brick.



Questions

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Cyrille Chiari

- http://youtu.be/5a4AYvKQUFU - One Way Gate
- http://youtu.be/X3RY7AjmTgo - Latch
- http://youtu.be/LOau4GNrei8 - Wide Touch Sensor
- http://youtu.be/EiXpqENqm1U - Light Sensor Shield