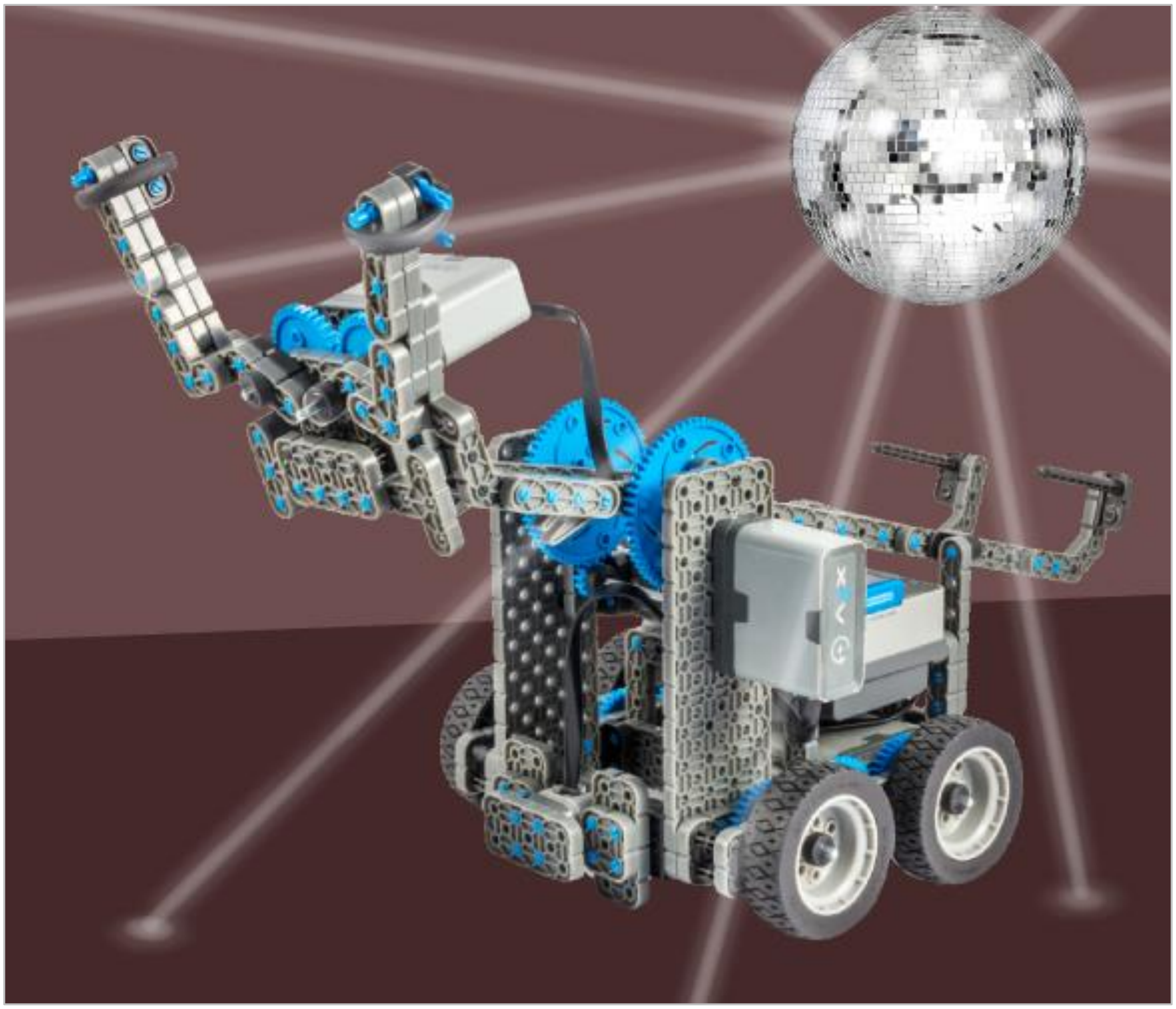
Loop, There It Is!



Learn how to program loops to get your robot grooving!

SPARK

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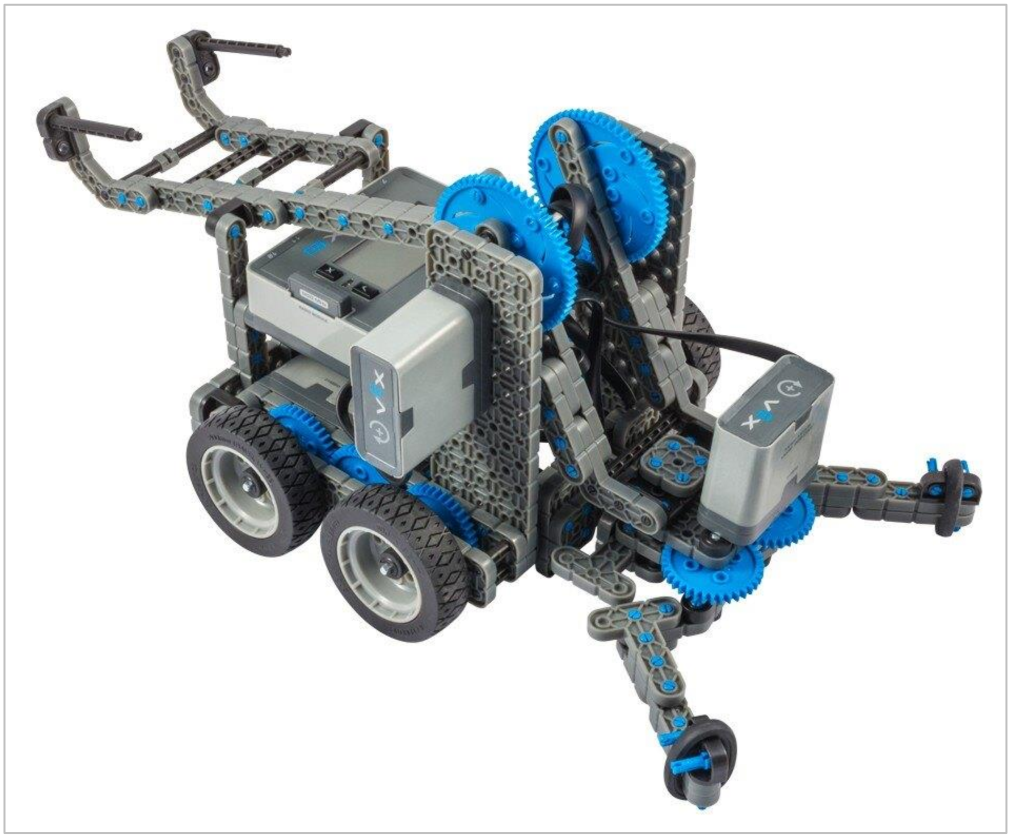
The Completed Look of the Build



The completed Clawbot IQ build.

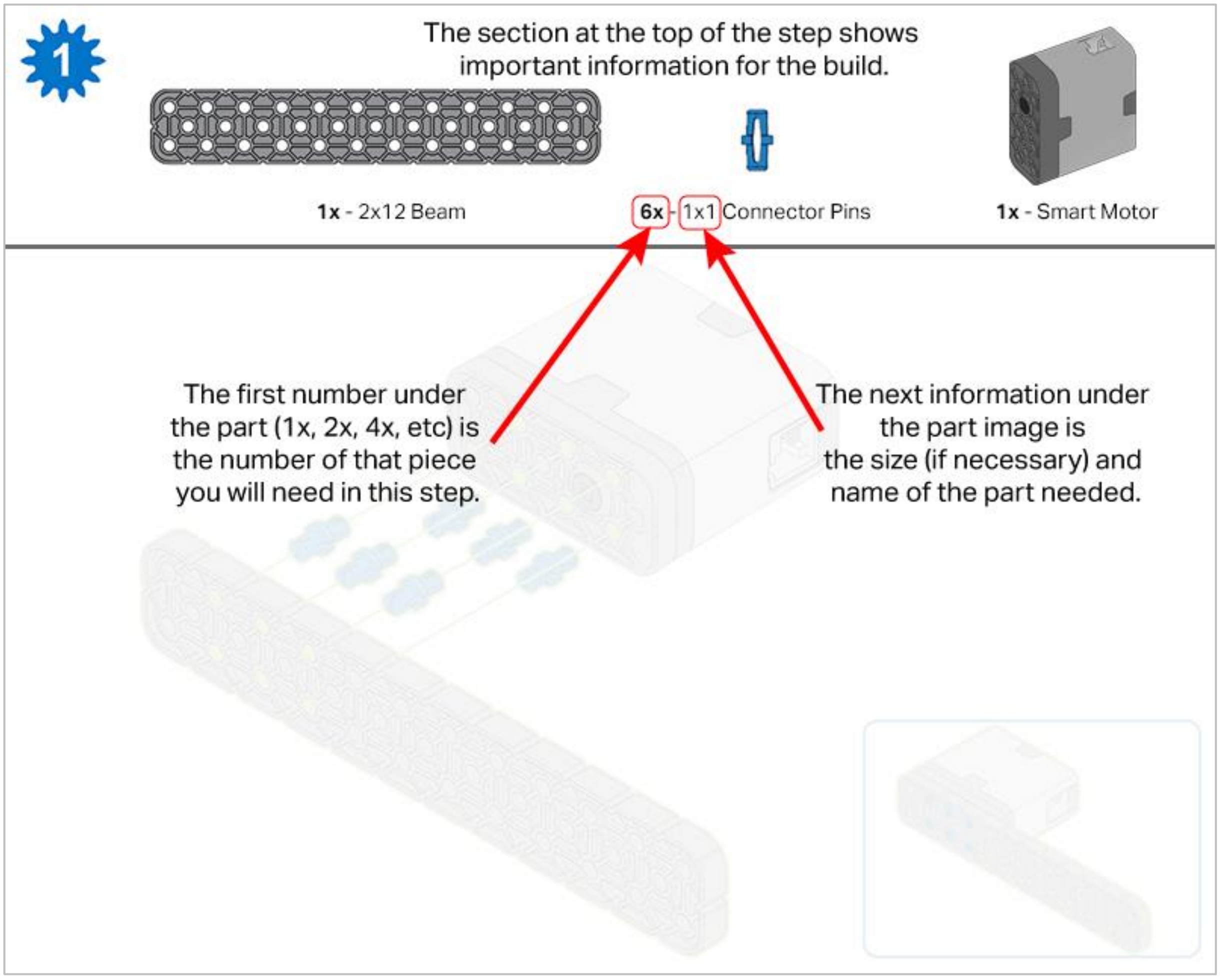
This robot is designed so that it can be built quickly and drive around either autonomously or with the Controller in a short amount of time.

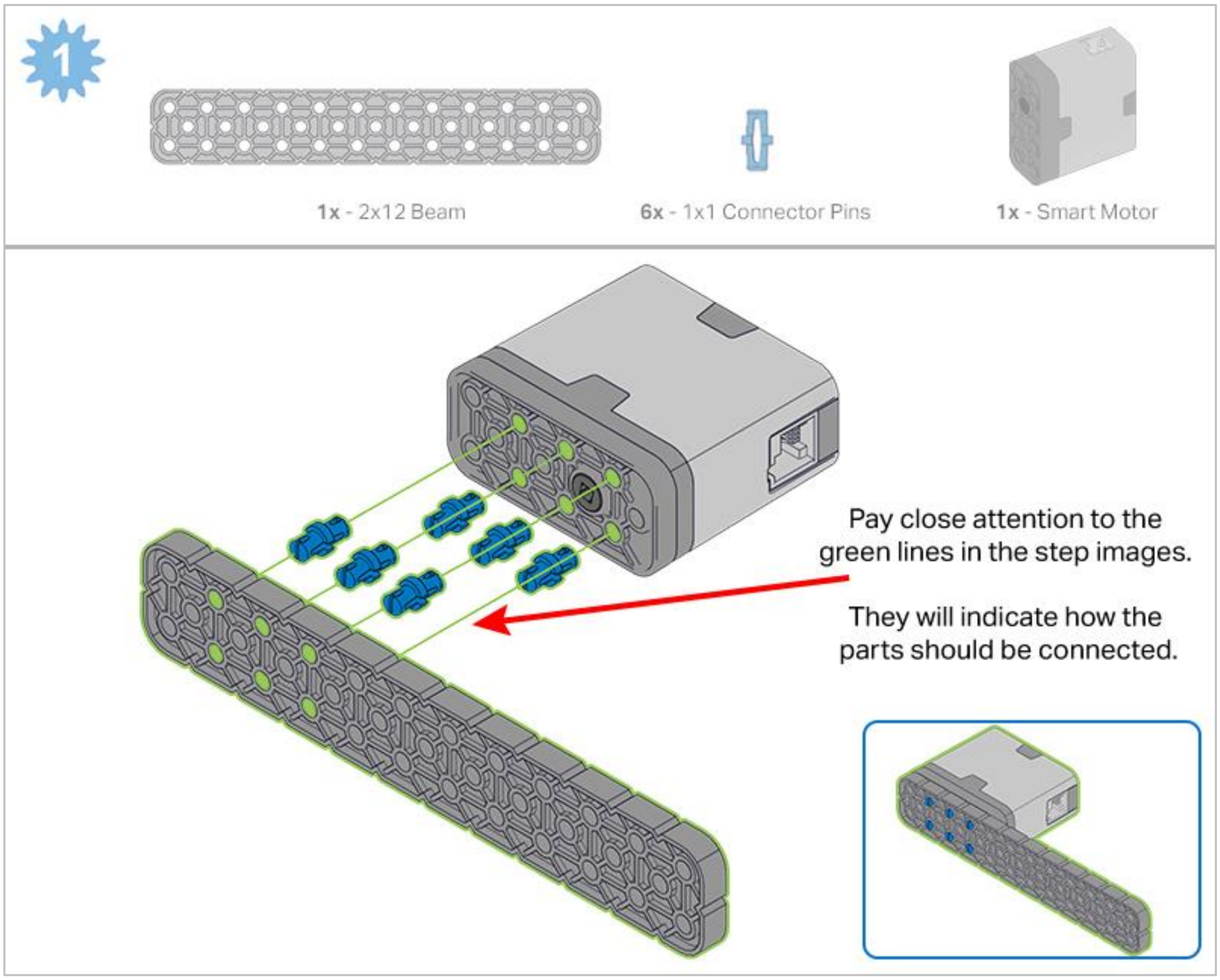
Build Instructions - Drivetrain + Distance

Build Instructions Summary

- **Drivetrain + Distance Building Instructions (19 steps):**
  - Right Wheel: steps 1 to 6
  - Left Wheel: steps 7 to 12
  - Distance Sensor: steps 13 to 19
- **Building Tips for All Steps:**
  - The section at the top of the step shows important information for the build. The first number under the image of the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step. The next information under the part image is the size and description of the part needed.
  - The finished step is illustrated in the box in the lower right corner.

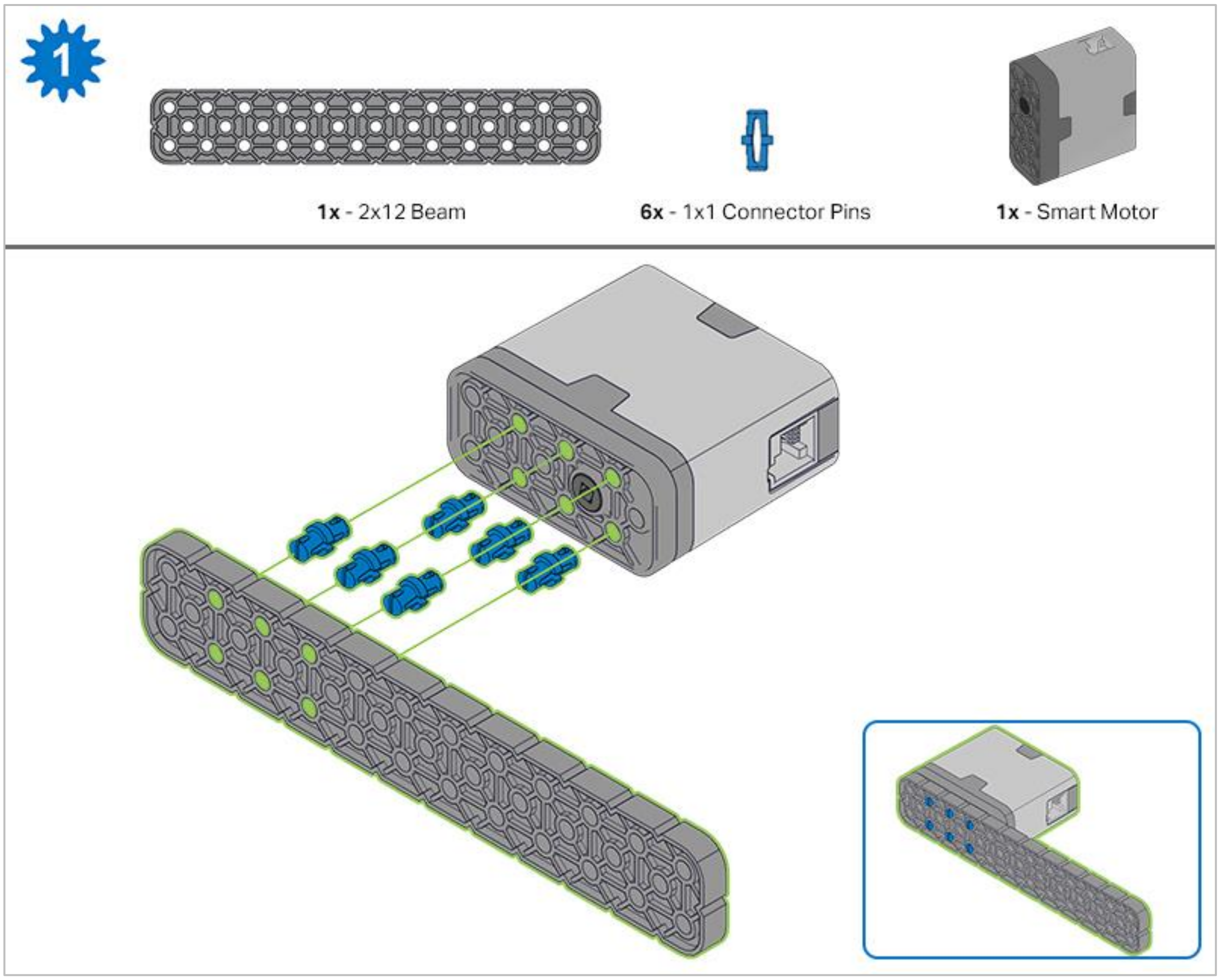
- Play close attention to the green lines in the step images. They will indicate how the parts should be connected.


1
The section at the top of the step shows important information for the build.
1x - 2x12 Beam
6x - 1x1 Connector Pins
1x - Smart Motor
The first number under the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step.
The next information under the part image is the size (if necessary) and name of the part needed.

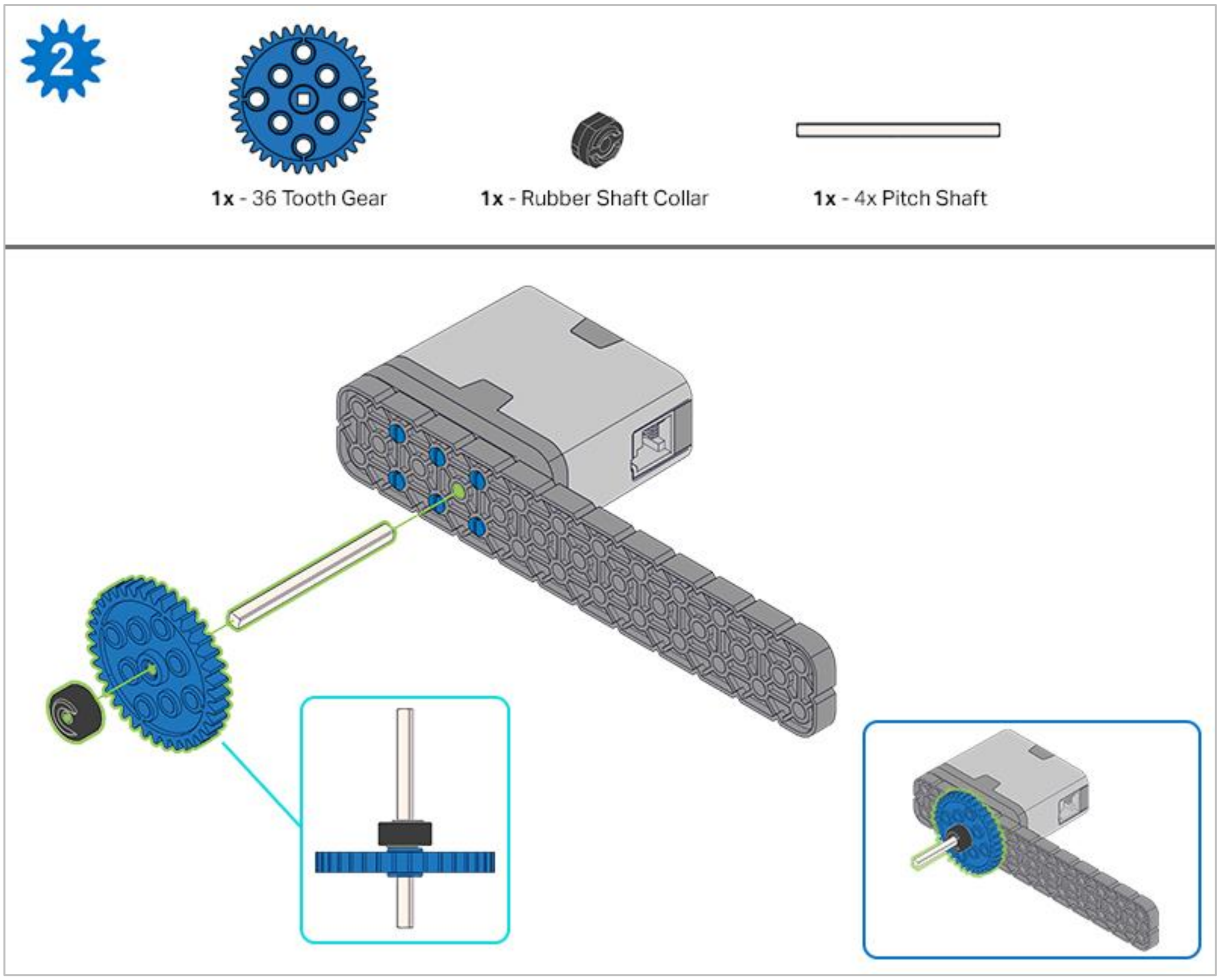


Pay close attention to the green lines in the step images.

They will indicate how the parts should be connected.

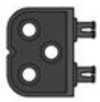


Step 1: Count all pieces before starting your build and have them readily available. Each team member should find the pieces for their section.

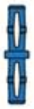


Step 2: When adding the 4x Pitch Shaft, twist the pitch shaft to check for tension while turning. If it spins freely, it is not properly inserted into the motor.

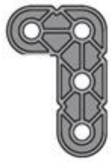
3



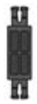
1x - 2x Wide, 1x2 Offset Corner Connector



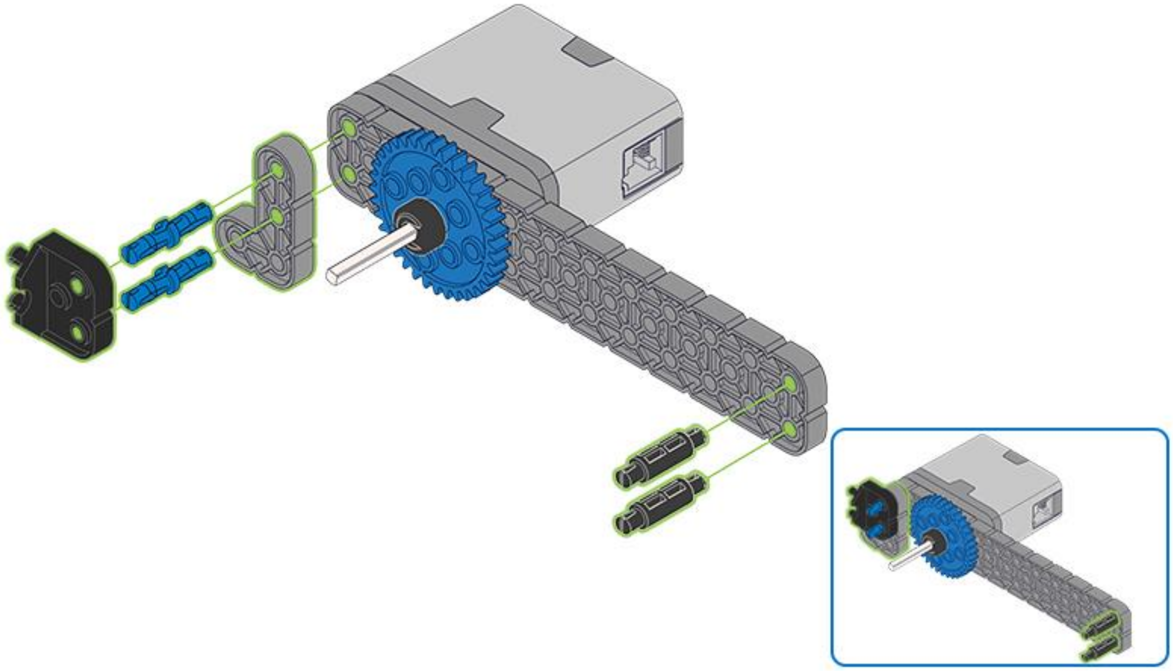
2x - 2x2 Connector Pins

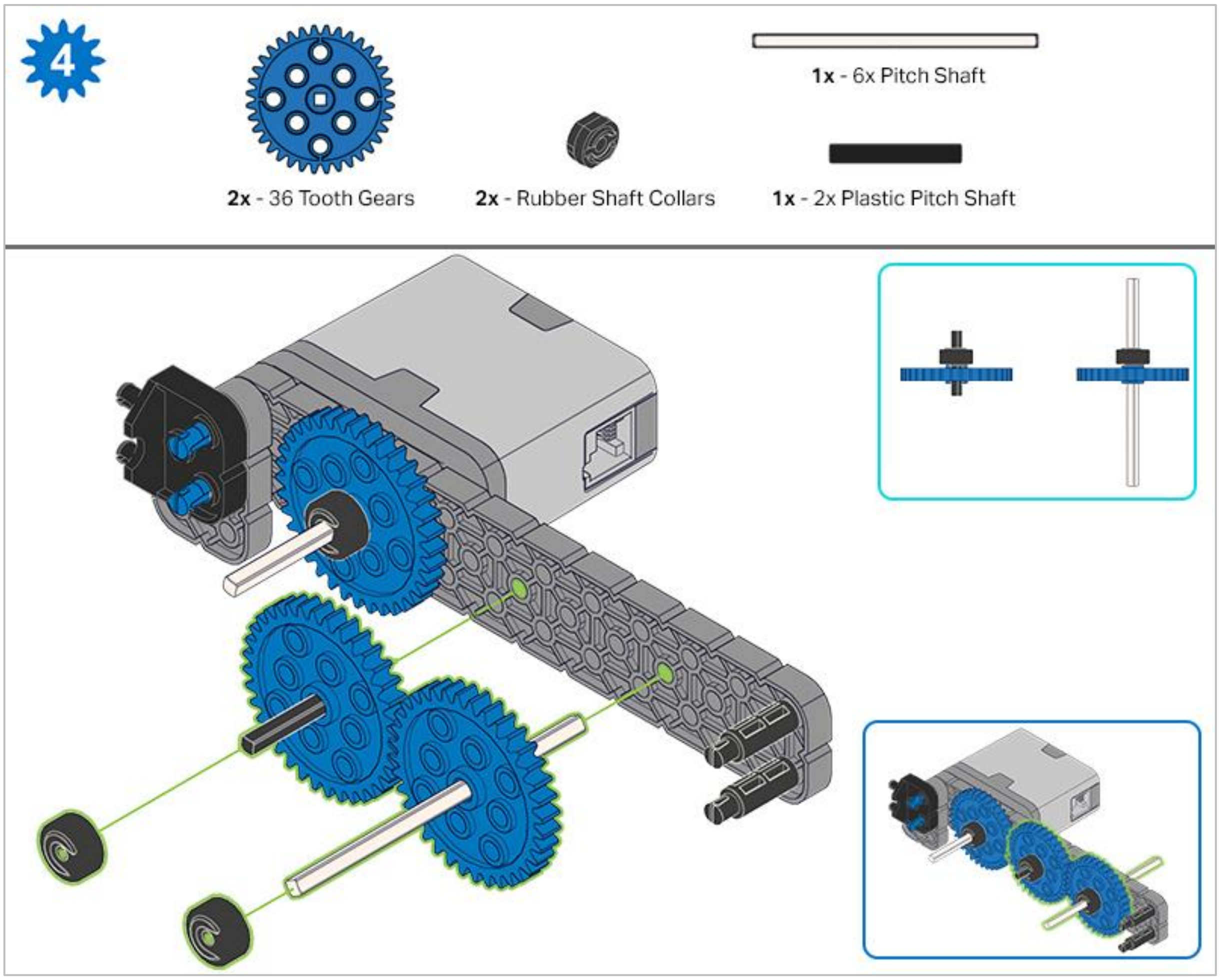


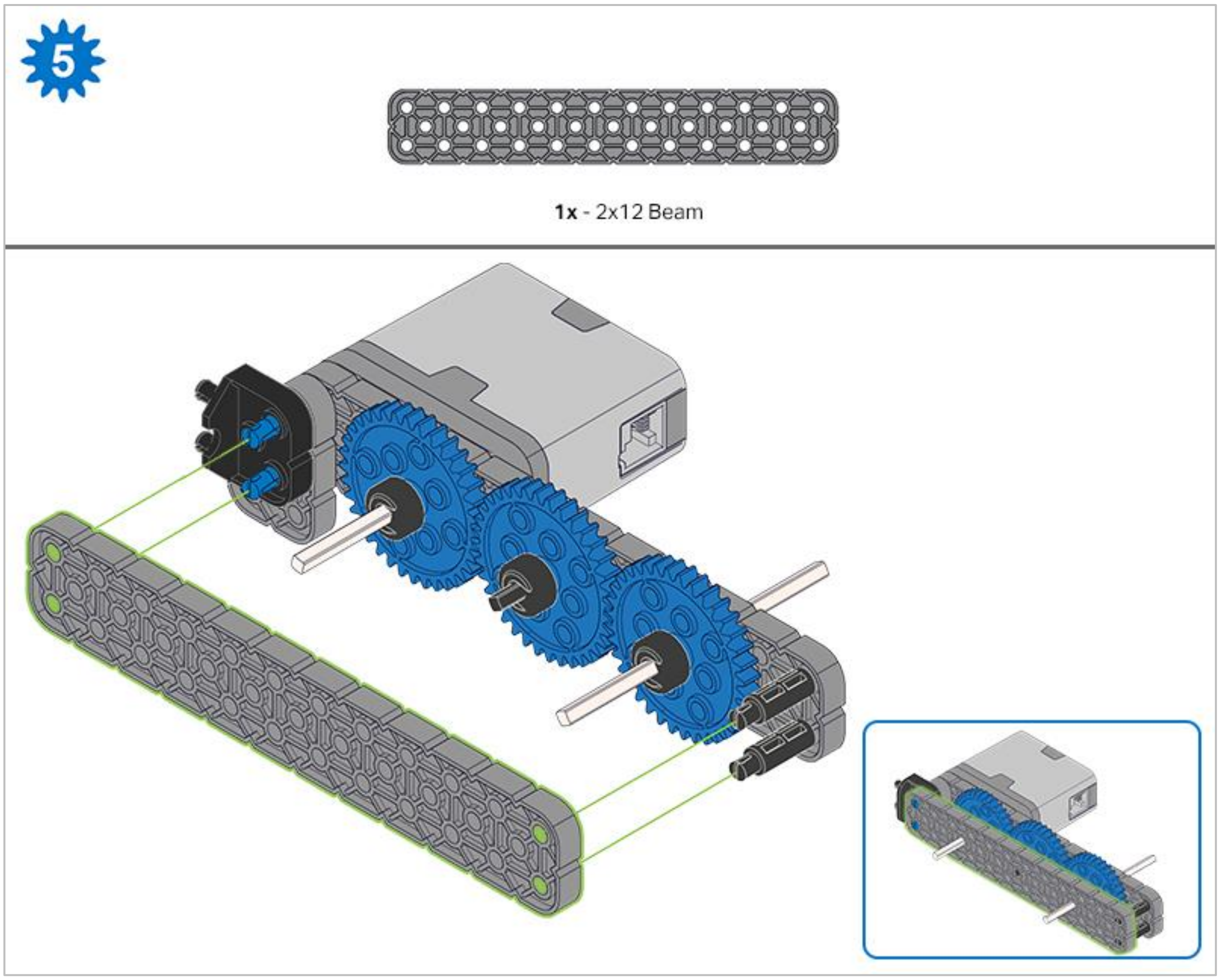
1x - 2x3 Right Angle Beam



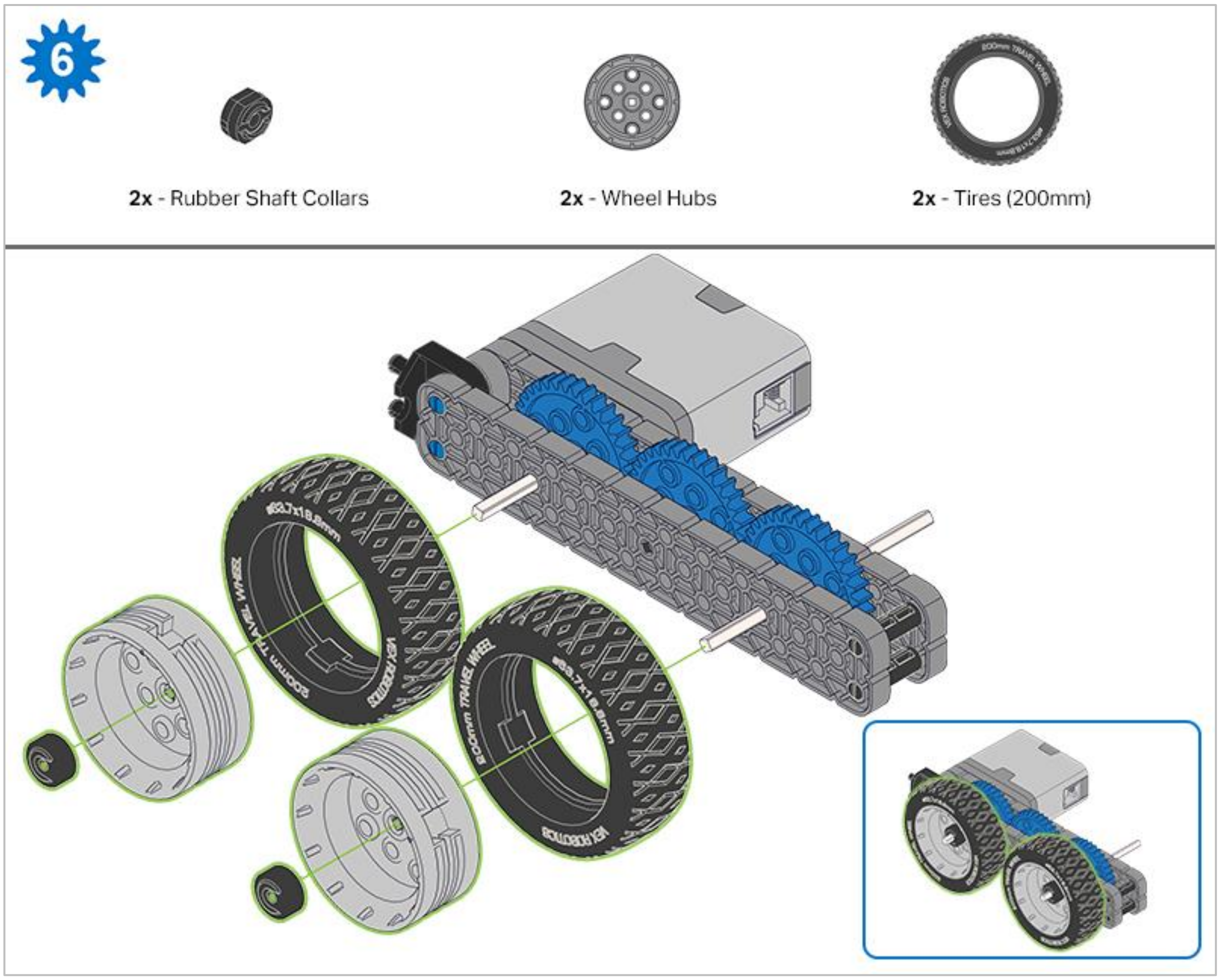
2x - 1x Pitch Standoffs



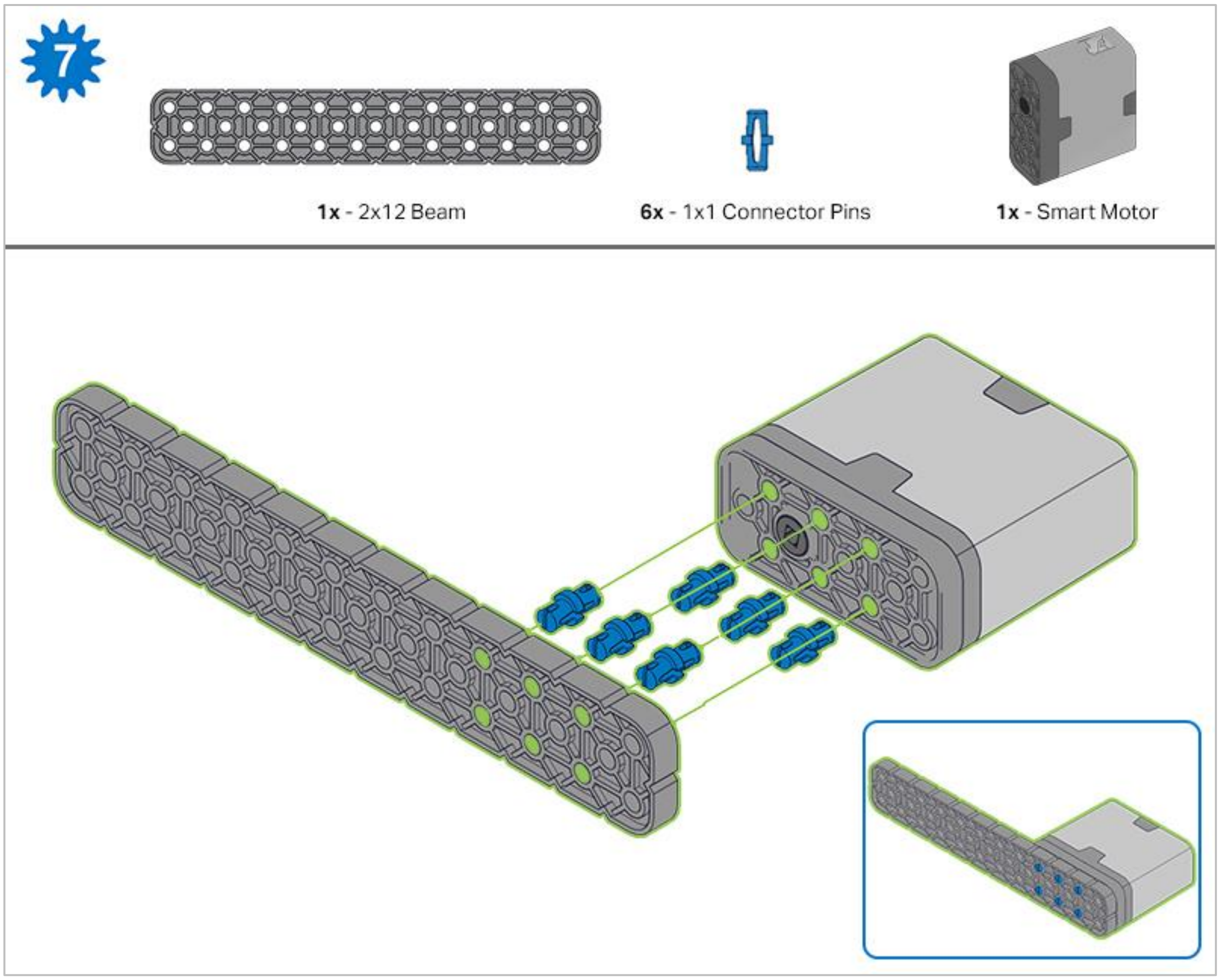

4
2x - 36 Tooth Gears
2x - Rubber Shaft Collars
1x - 6x Pitch Shaft
1x - 2x Plastic Pitch Shaft

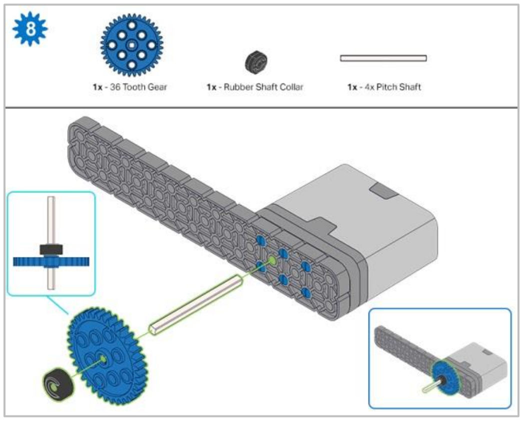


Step 5: Make sure the gears fit together properly before locking the 2x12 Beam in place.

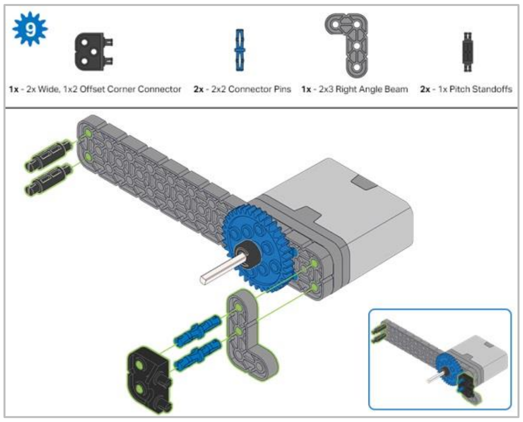


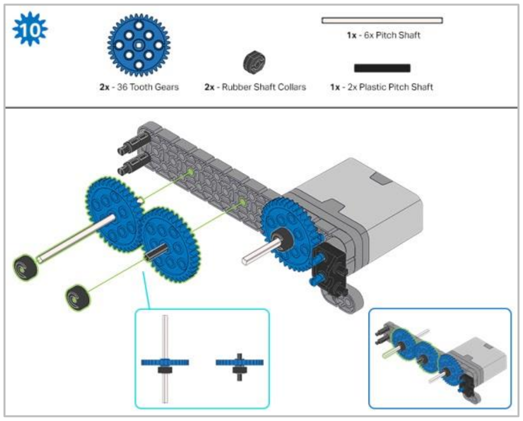
Step 6: After attaching the wheels, twist the wheel that has the shaft going into the motor. If the wheel spins freely and without tension, the 4x Pitch Shaft has slipped out of place.

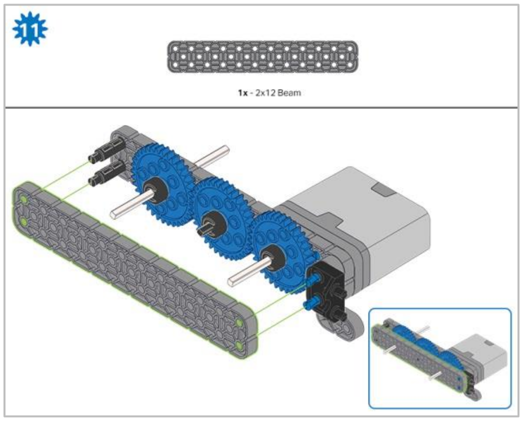




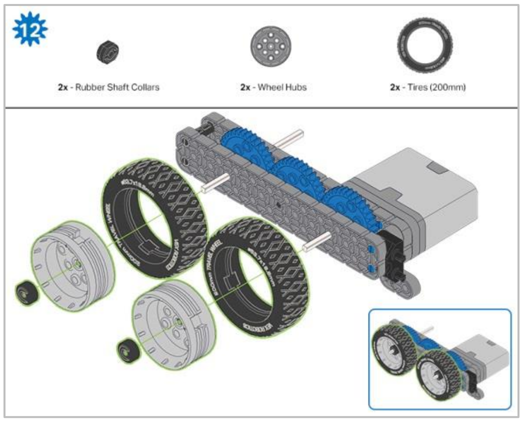
Step 8: When adding the 4x Pitch Shaft, twist the pitch shaft to check for tension while turning. If it spins freely, it is not properly inserted into the motor.


9
1x - 2x Wide, 1x2 Offset Corner Connector
2x - 2x2 Connector Pins
1x - 2x3 Right Angle Beam
2x - 1x Pitch Standoffs

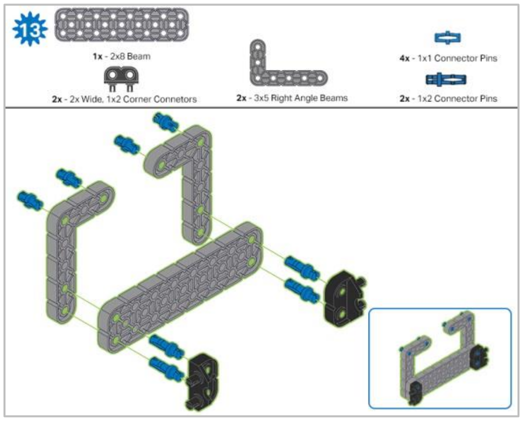


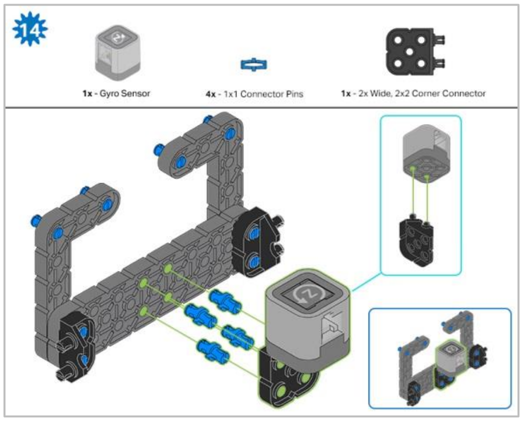


Step 11: Make sure the gears fit together properly before locking the 2x12 Beam in place.

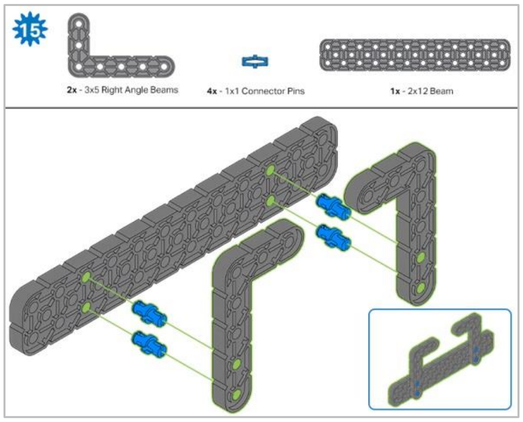


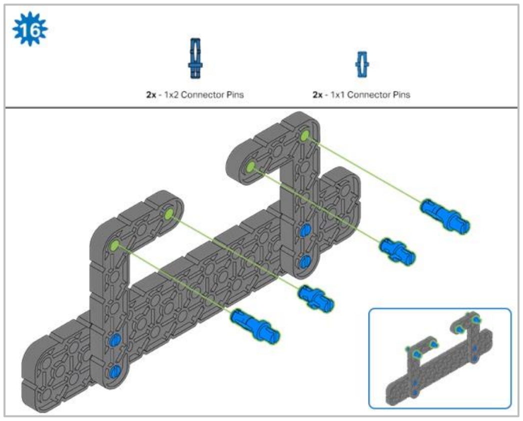
Step 12: After attaching the wheels, twist the wheel that has the shaft going into the motor. If the wheel spins freely and without tension, the 4x Pitch Shaft has slipped out of place.

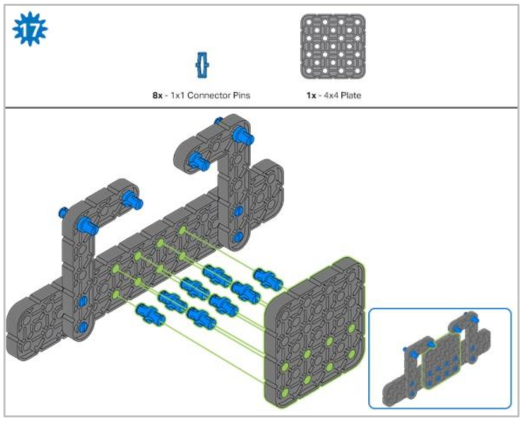


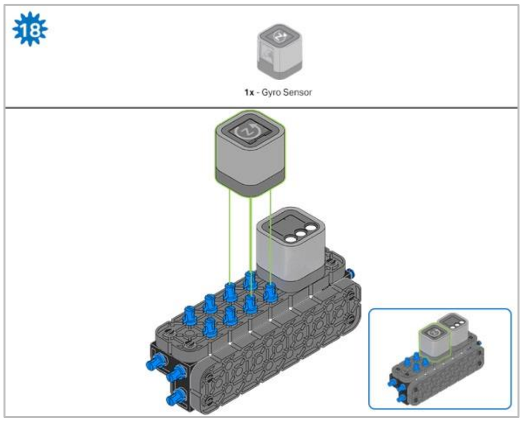


Step 14: Make sure the Gyro is placed the correct way to allow correct cable access.

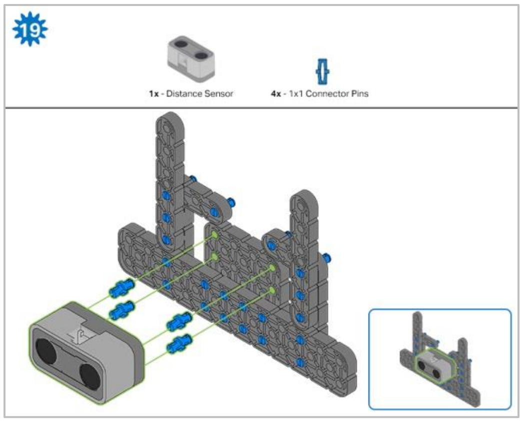








Step 18: The orange arrows mean spin the build around.



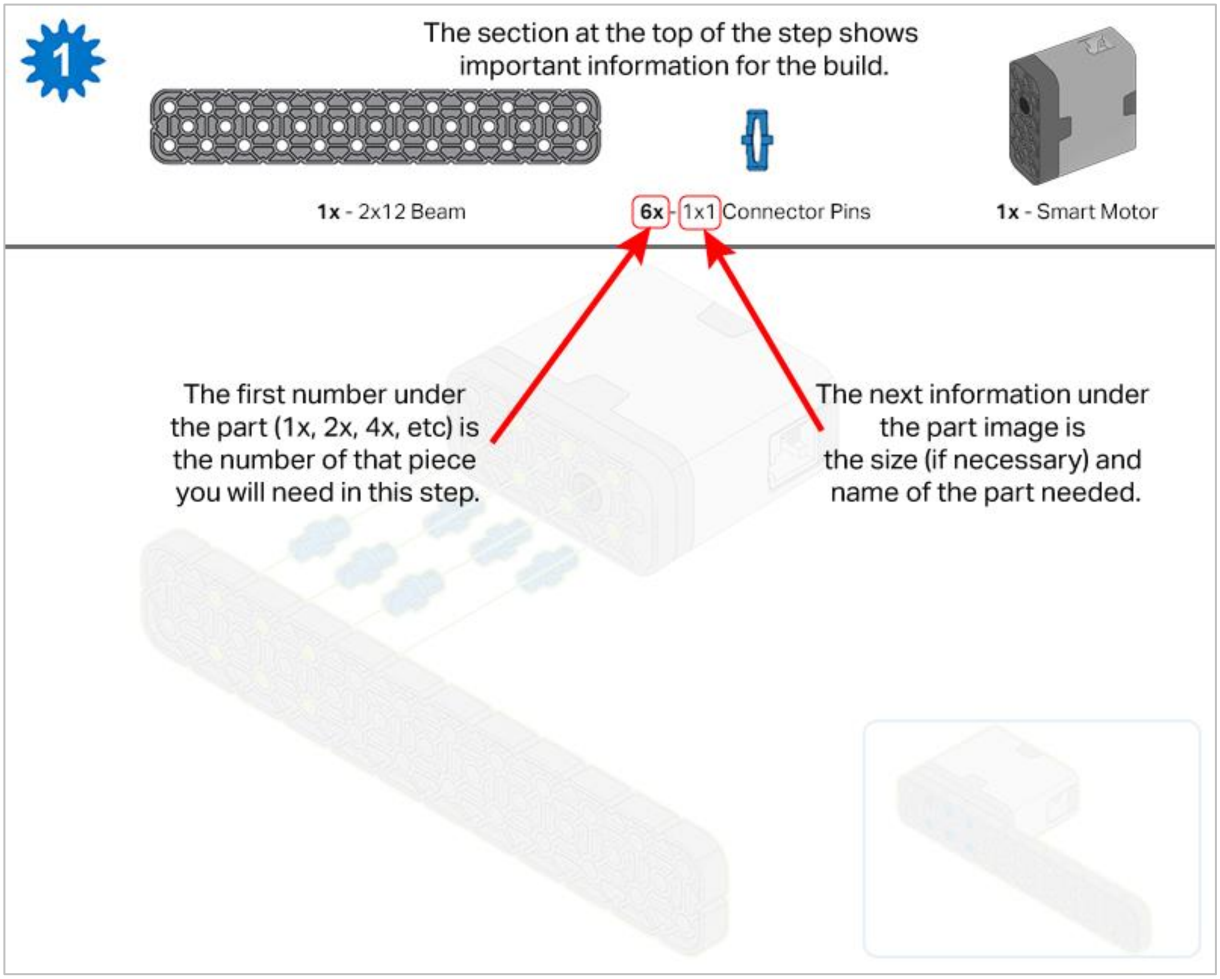
Step 19: When attaching the Distance Sensor, do not push on either of the two mesh covered openings. This will damage the sensor. Ensure the sensor is placed in the correct way to allow cable access.

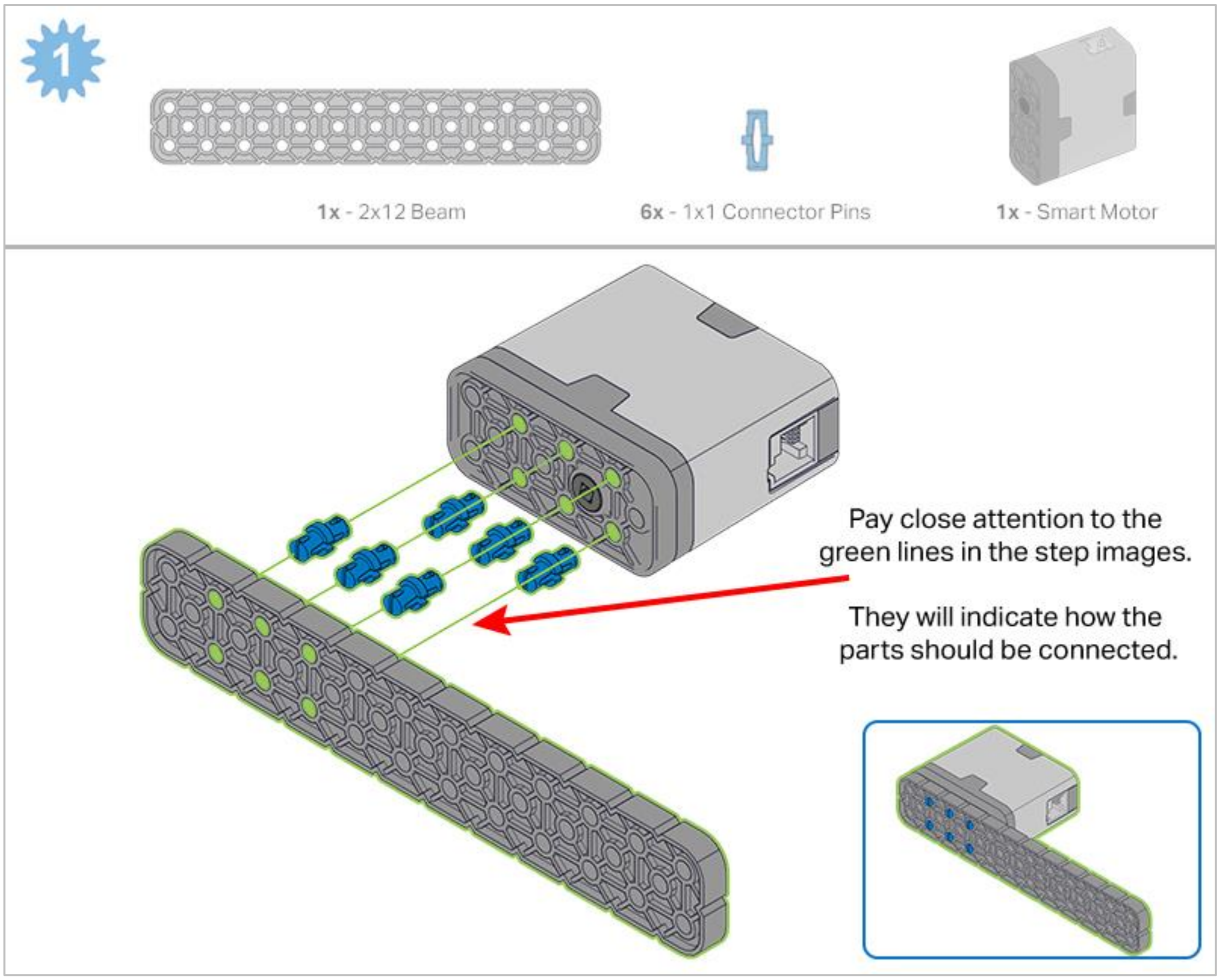
Build Instructions - Robot Frame

Build Instructions Summary

- **Robot Frame Building Instructions (22 steps):**
    - Cargo Holder: steps 20 to 28
    - Arm Base: steps 29 to 41
- **Building Tips for All Steps:**
    - The section at the top of the step shows important information for the build. The first number under the image of the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step. The next information under the part image is the size and description of the part needed.
    - The finished step is illustrated in the box in the lower right corner.

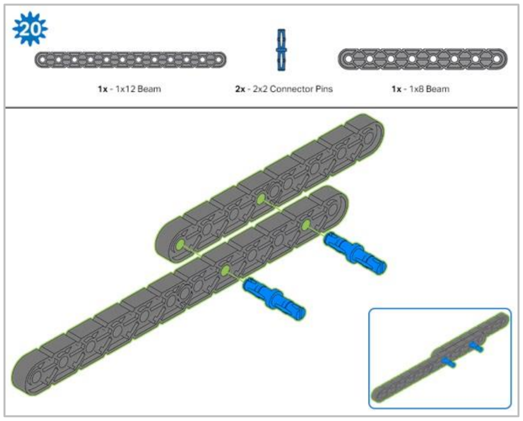
- Play close attention to the green lines in the step images. They will indicate how the parts should be connected.

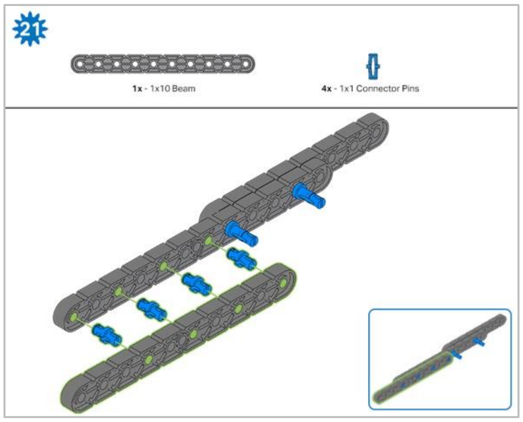

1
The section at the top of the step shows important information for the build.
1x - 2x12 Beam
6x - 1x1 Connector Pins
1x - Smart Motor
The first number under the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step.
The next information under the part image is the size (if necessary) and name of the part needed.

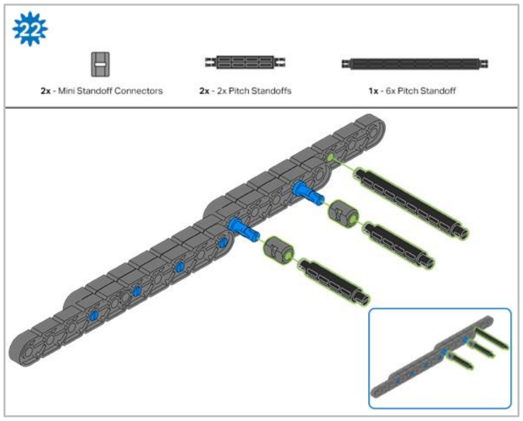


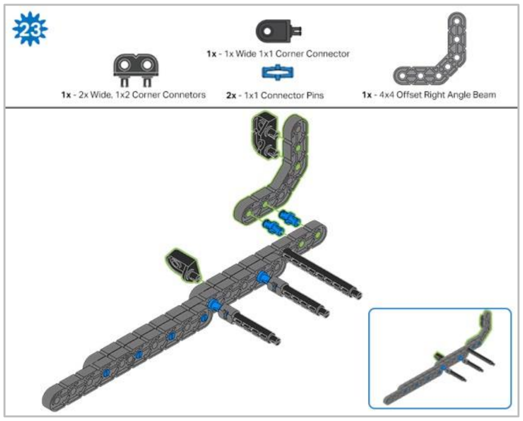
Pay close attention to the green lines in the step images.

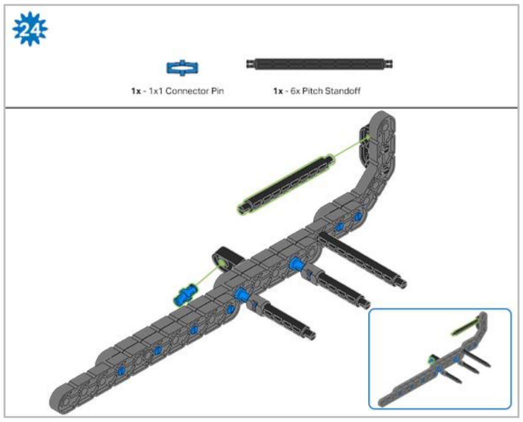
They will indicate how the parts should be connected.

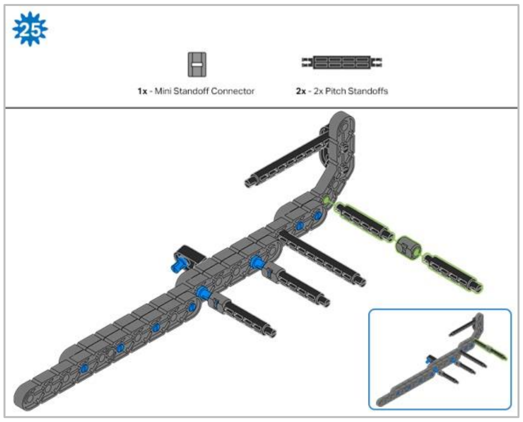



21
1x - 1x10 Beam
4x - 1x1 Connector Pins


22
2x - Mini Standoff Connectors
2x - 2x Pitch Standoffs
1x - 6x Pitch Standoff


23
1x - 1x Wide 1x1 Corner Connector
1x - 2x Wide, 1x2 Corner Connetors
2x - 1x1 Connector Pins
1x - 4x4 Offset Right Angle Beam

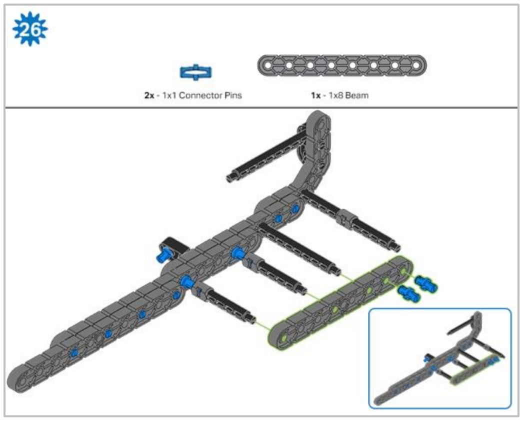

24
1x - 1x1 Connector Pin
1x - 6x Pitch Standoff



25

1x - Mini Standoff Connector

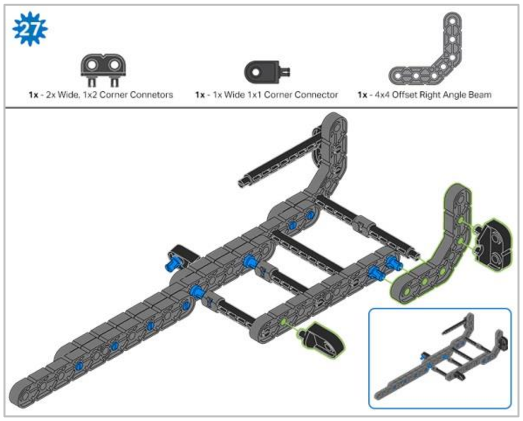
2x - 2x Pitch Standoffs



26

2x - 1x1 Connector Pins

1x - 1x8 Beam

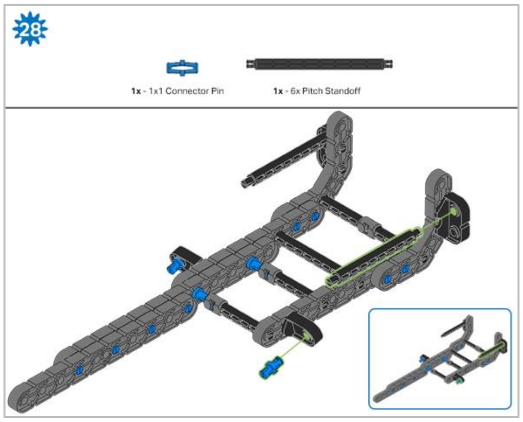


27

1x - 2x Wide, 1x2 Corner Connetors

1x - 1x Wide 1x1 Corner Connector

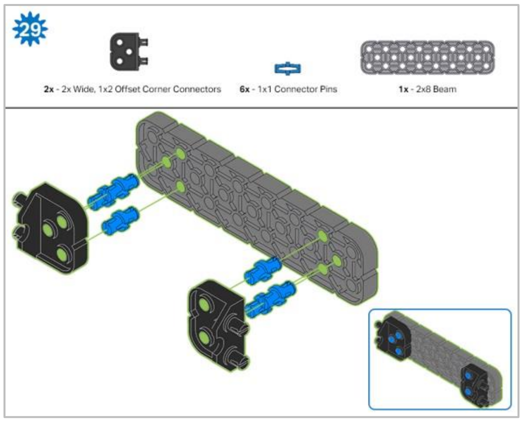
1x - 4x4 Offset Right Angle Beam

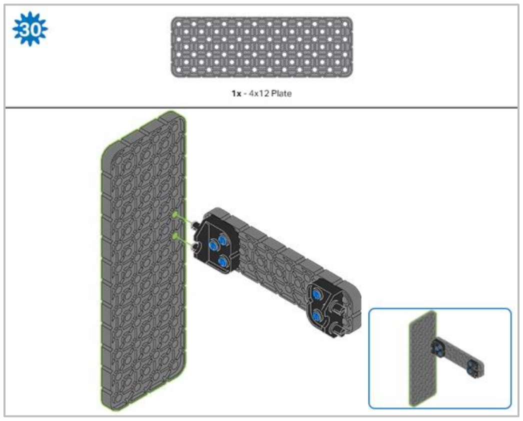


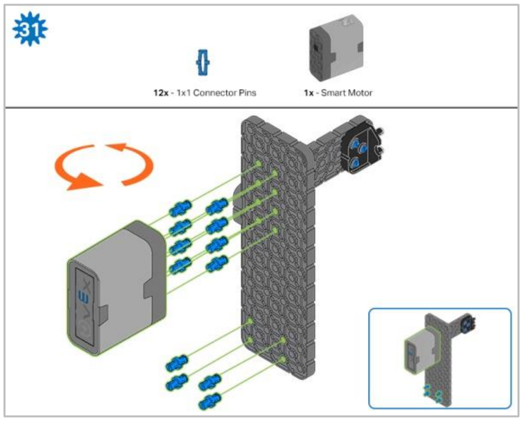
28

1x - 1x1 Connector Pin

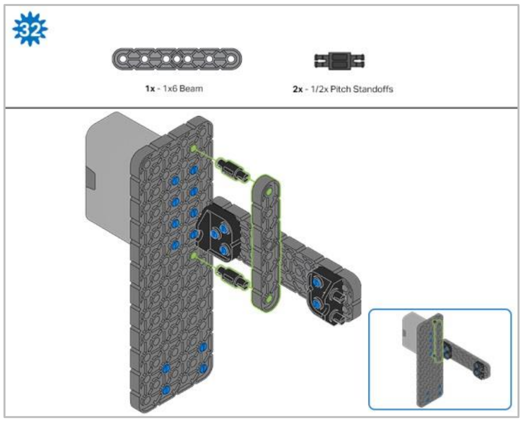
1x - 6x Pitch Standoff

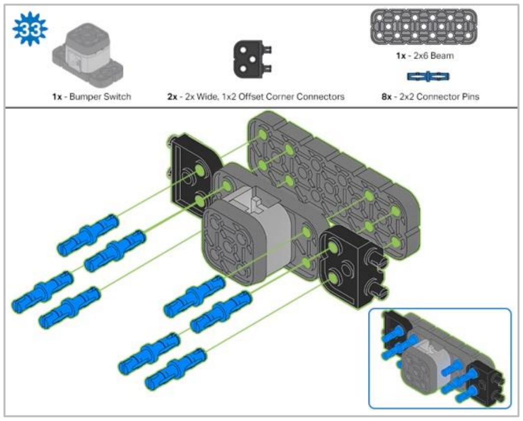




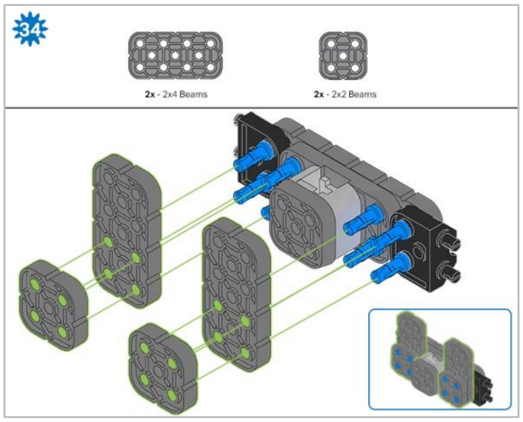


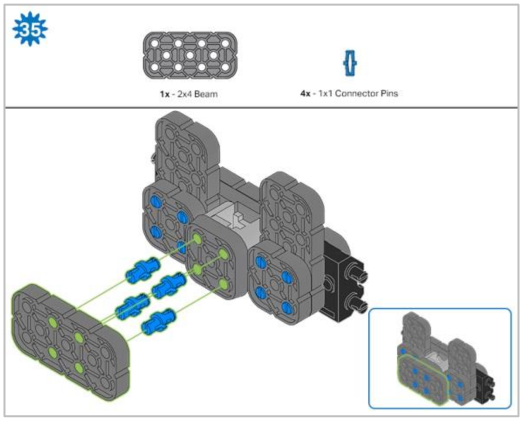
Step 31: The orange arrows mean spin the build around.

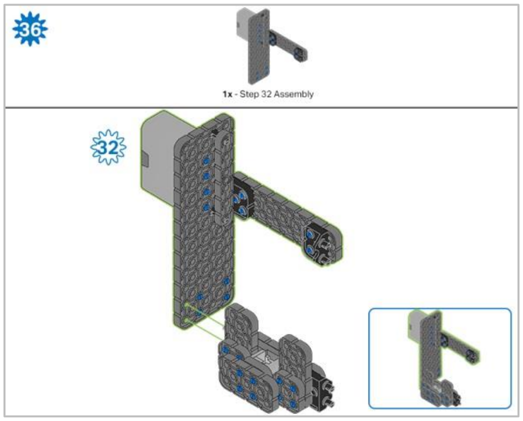




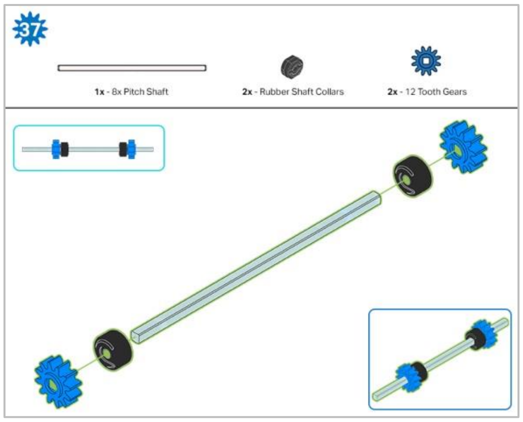
Step 33: Make sure the Bumper Switch is placed in the correct way to allow cable access.

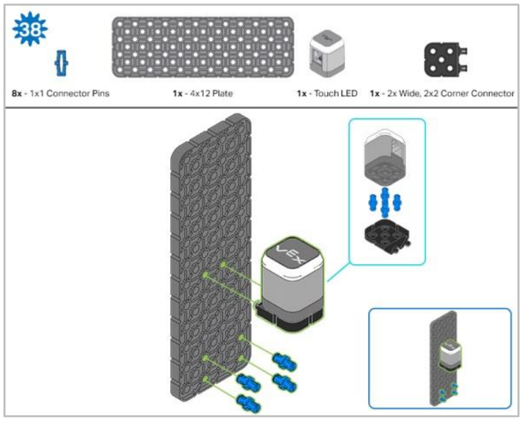




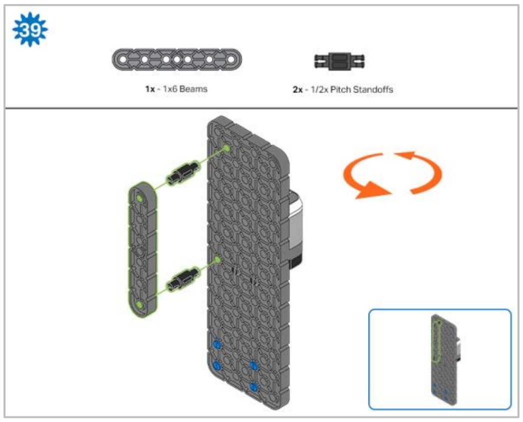


Step 36: Make sure your Smart Motor is are oriented in the correct direction (the hole for the shaft is on the bottom)

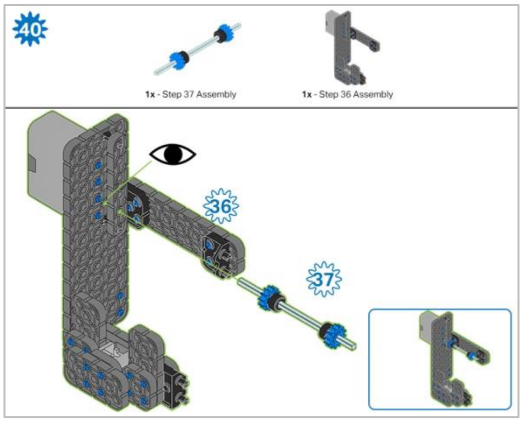




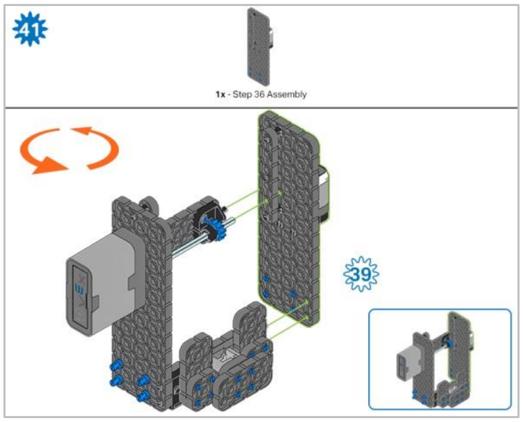
Step 38: Make sure that the Touch LED is placed in the correct way to allow cable access.



Step 39: The orange arrows mean spin the build around.



Step 40: Instead of individual parts, the completed sections of the build needed are shown in the section at the top. When adding the Step 37 Assembly, twist the pitch shaft to check for tension while turning. If it spins freely, it is not properly inserted into the motor.



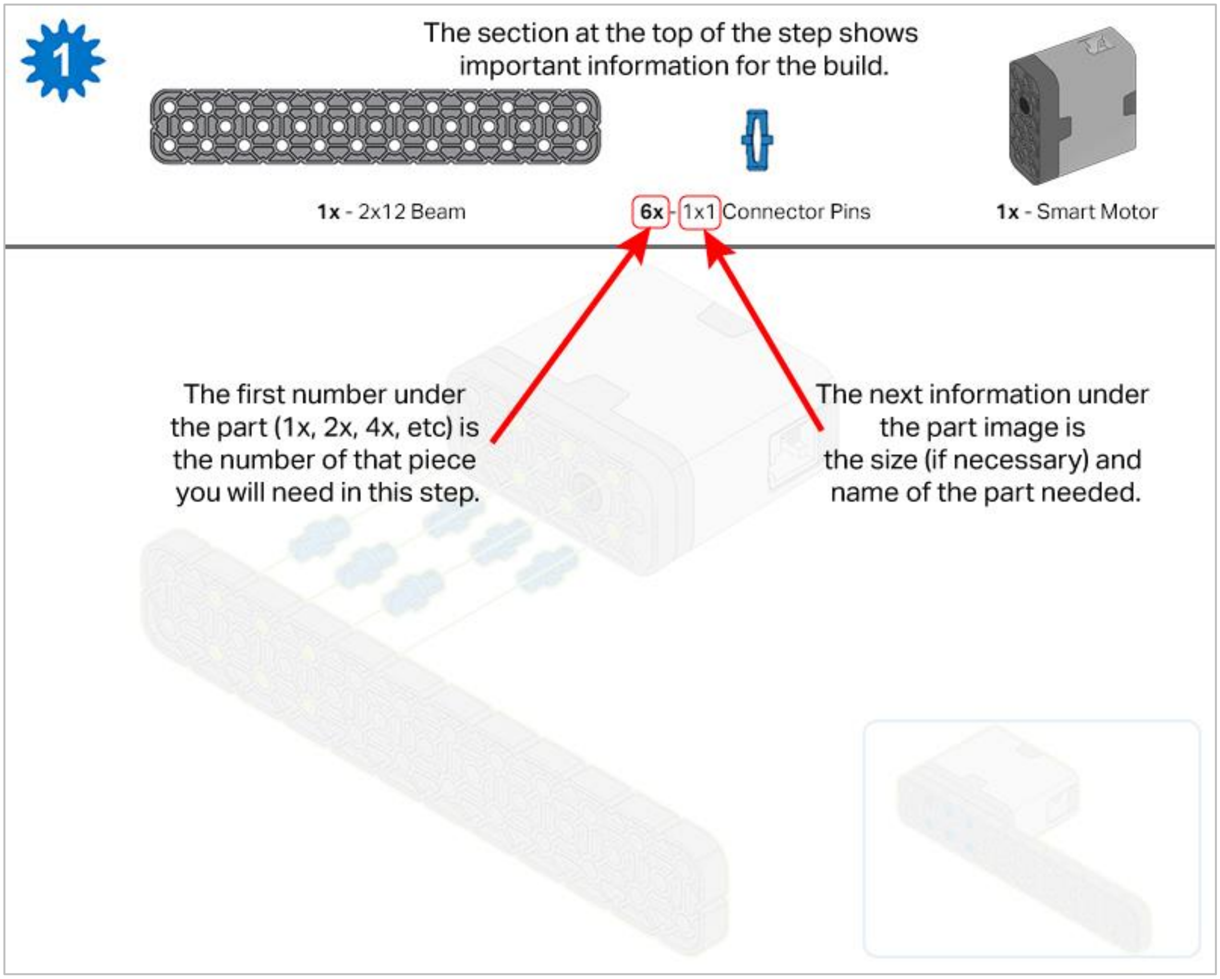
Step 41: Instead of individual parts, the completed sections of the build needed are shown in the section at the top. The orange arrows mean spin the build around.

Build Instructions - Arm

Build Instructions Summary

- **Arm Building Instructions (19 steps):**
  - Arm: steps 42 to 60
- **Building Tips for All Steps:**
  - The section at the top of the step shows important information for the build. The first number under the image of the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step. The next information under the part image is the size and description of the part needed.
  - The finished step is illustrated in the box in the lower right corner.

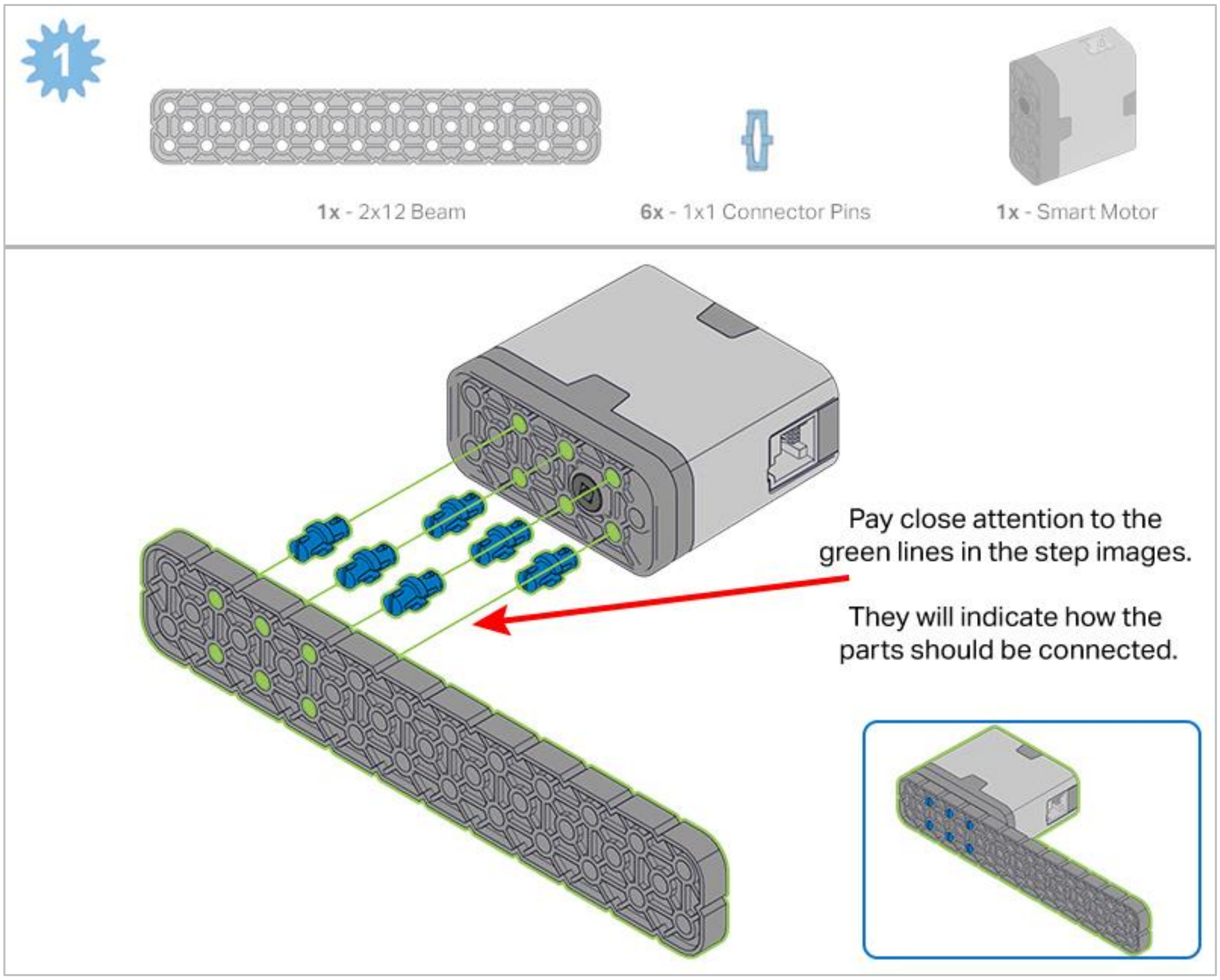
- Play close attention to the green lines in the step images. They will indicate how the parts should be connected.



The section at the top of the step shows important information for the build.

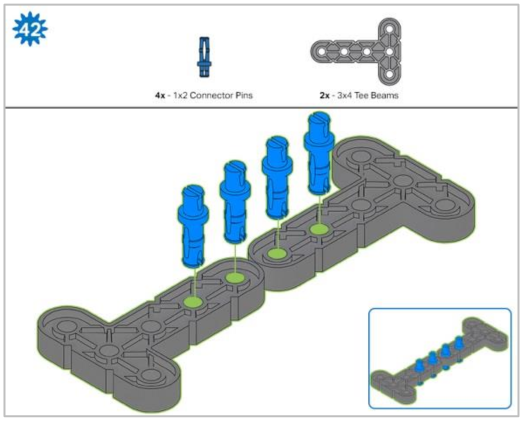
The first number under the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step.

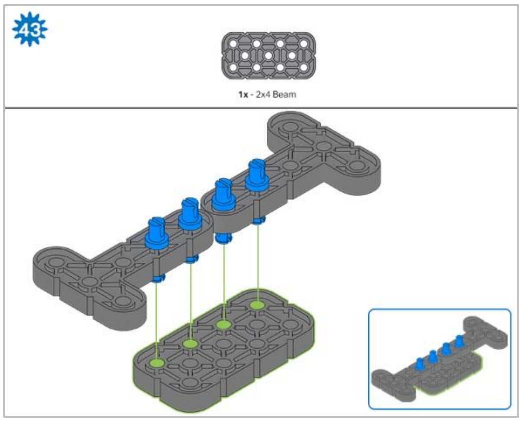
The next information under the part image is the size (if necessary) and name of the part needed.

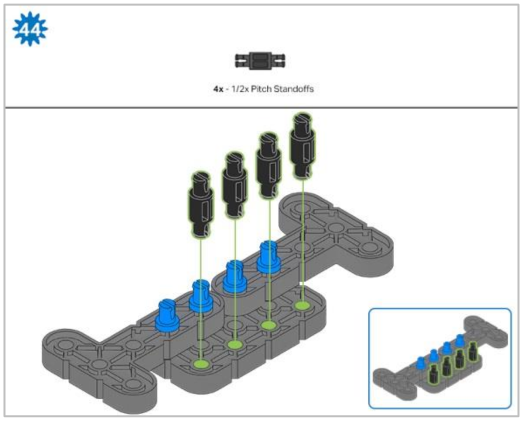


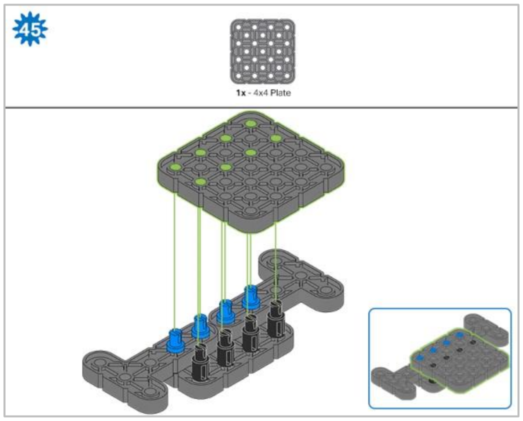
Pay close attention to the green lines in the step images.

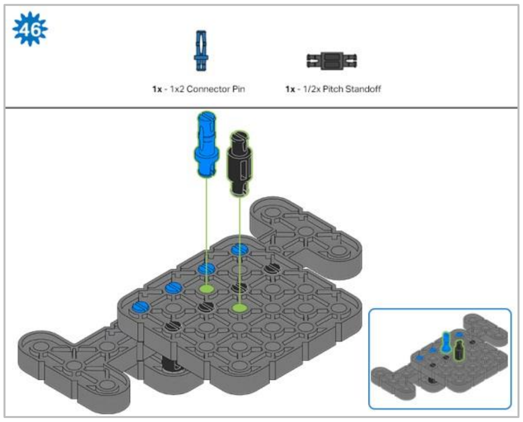
They will indicate how the parts should be connected.

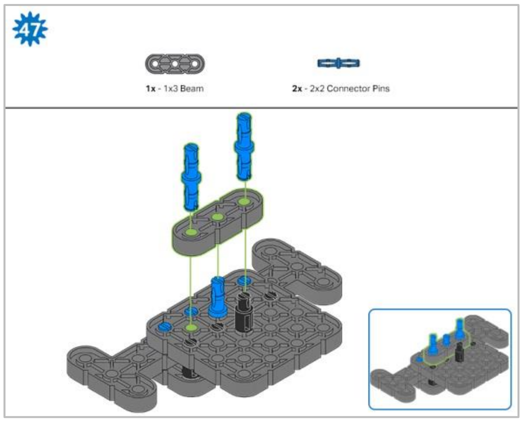


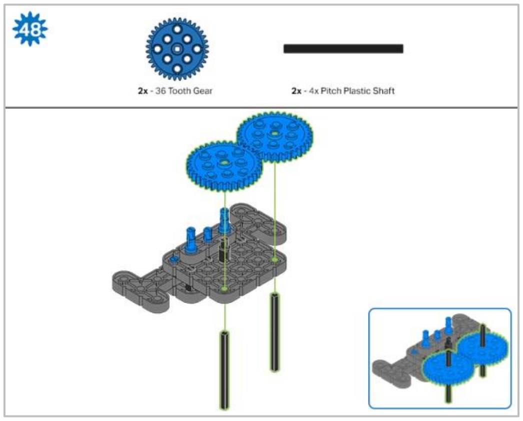

43
1x - 2x4 Beam


44
4x - 1/2x Pitch Standoffs

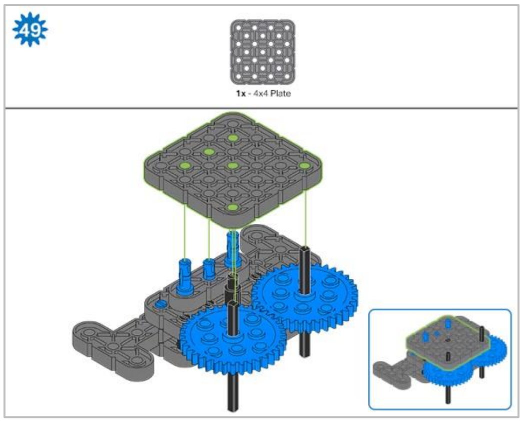

45
1x - 4x4 Plate


46
1x - 1x2 Connector Pin
1x - 1/2x Pitch Standoff





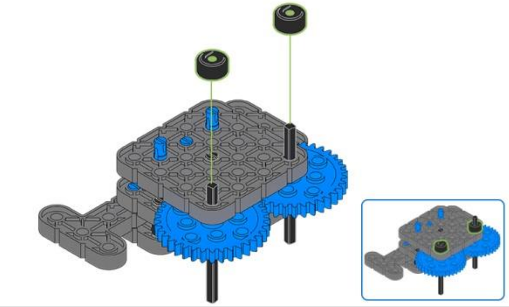
Step 48: Make sure the gears fit together properly before moving on to the next step.



Step 49: Turn one of the black shafts in the center of the gear to make sure they are together and both turn at the same time before adding the 4x4 Plate.

50

2x - Rubber Shaft Collars

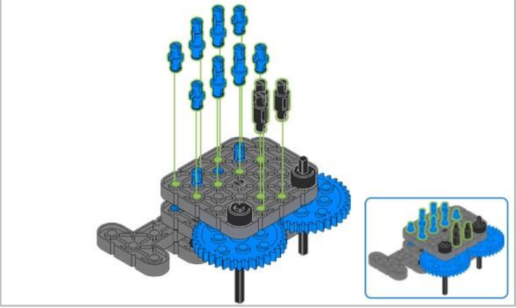


51

4x - 1x1 Connector Pins

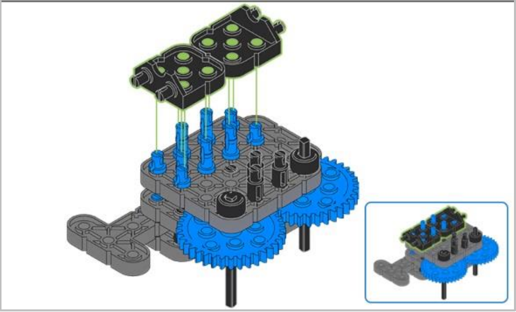
4x - 1x2 Connector Pins

3x - 1/2x Pitch Standoffs



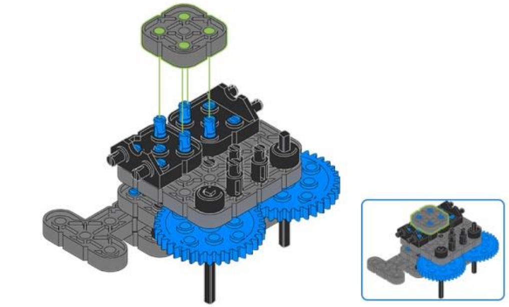
52

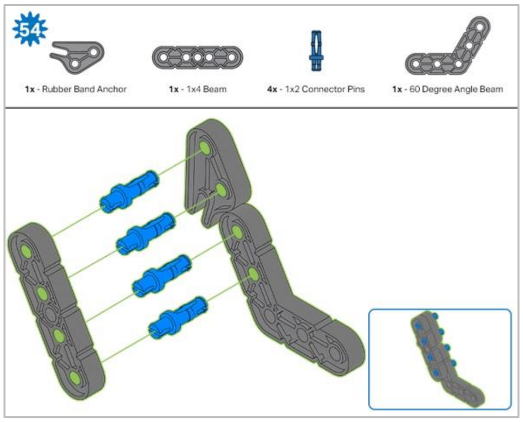
2x - 2x Wide, 2x2 Corner Connectors

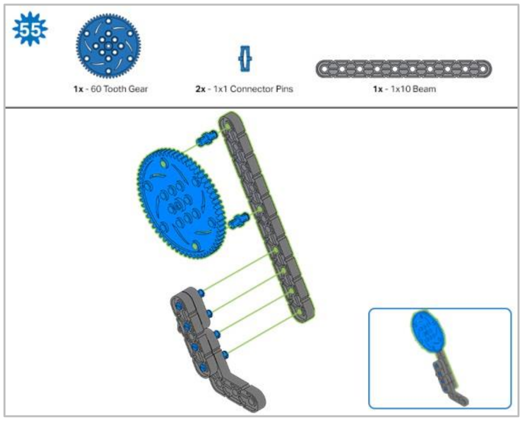


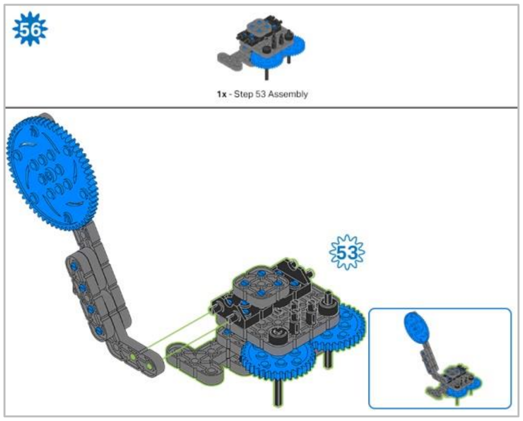
53

1x - 2x2 Beam

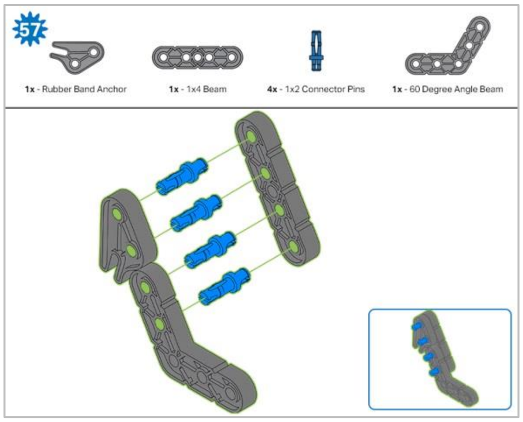


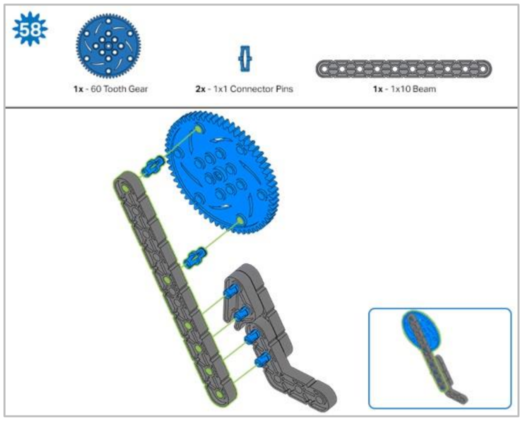


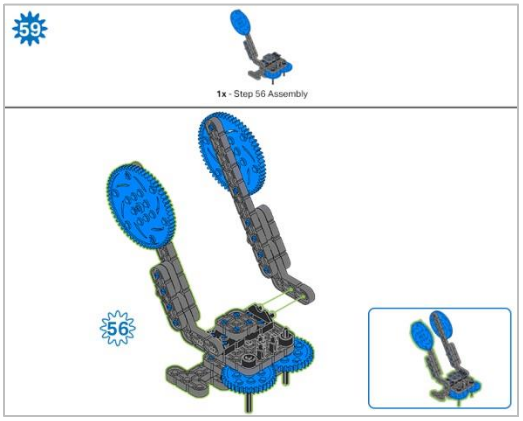




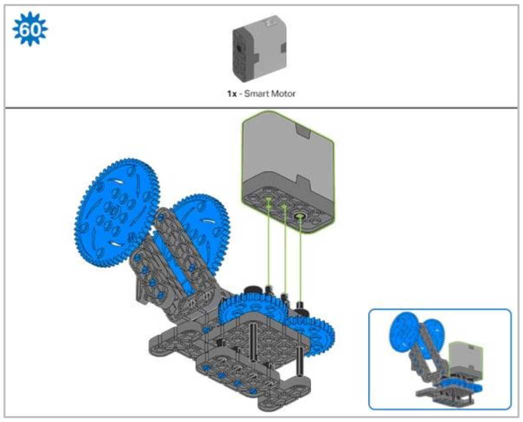
Step 56: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.







Step 59: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.



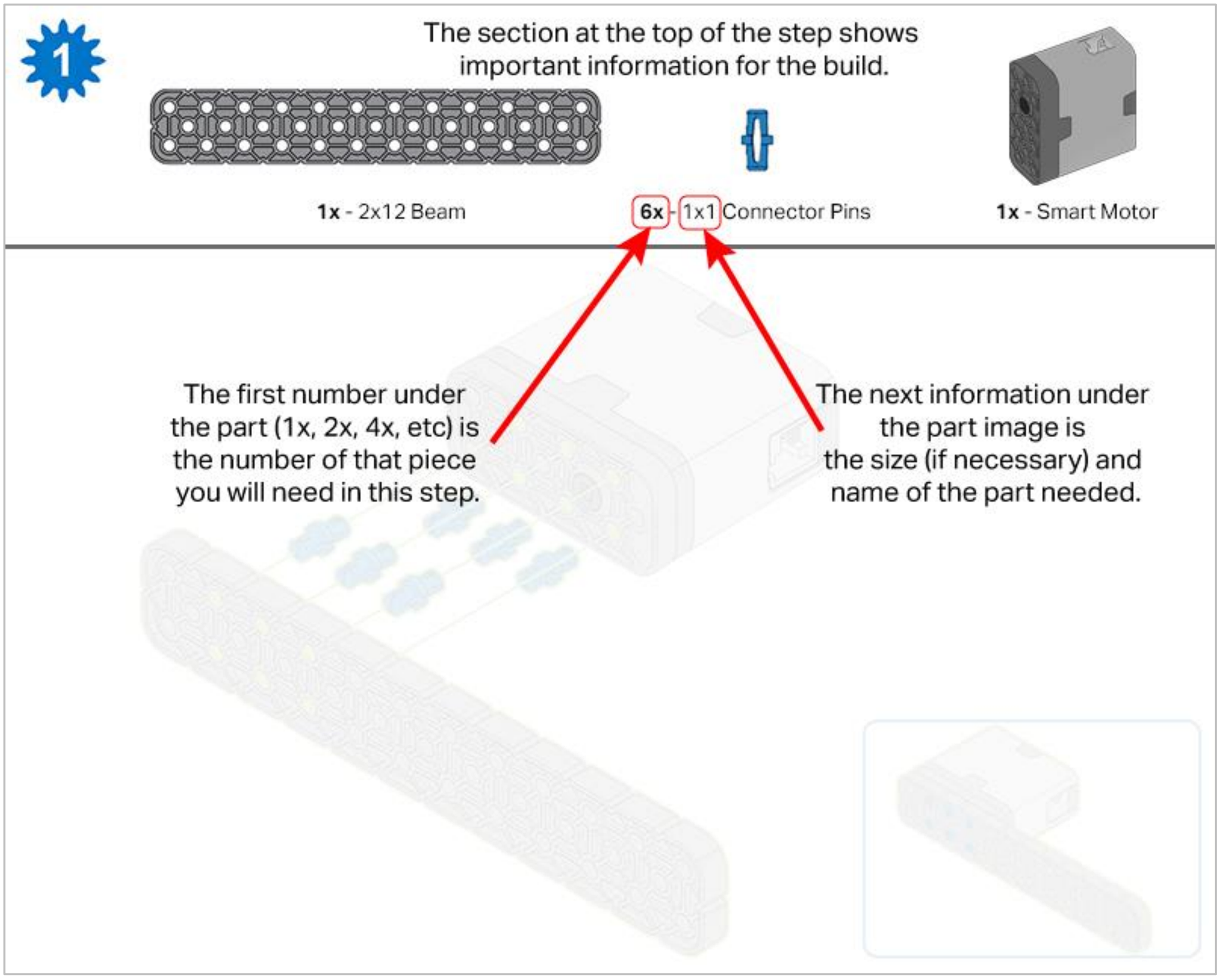
Step 60: Make sure your Smart Motor is are oriented in the correct direction (the hole for the shaft is on the right). After adding motor, turn one of the gears to check for tension while turning. If it spins freely, it is not properly inserted into the motor.

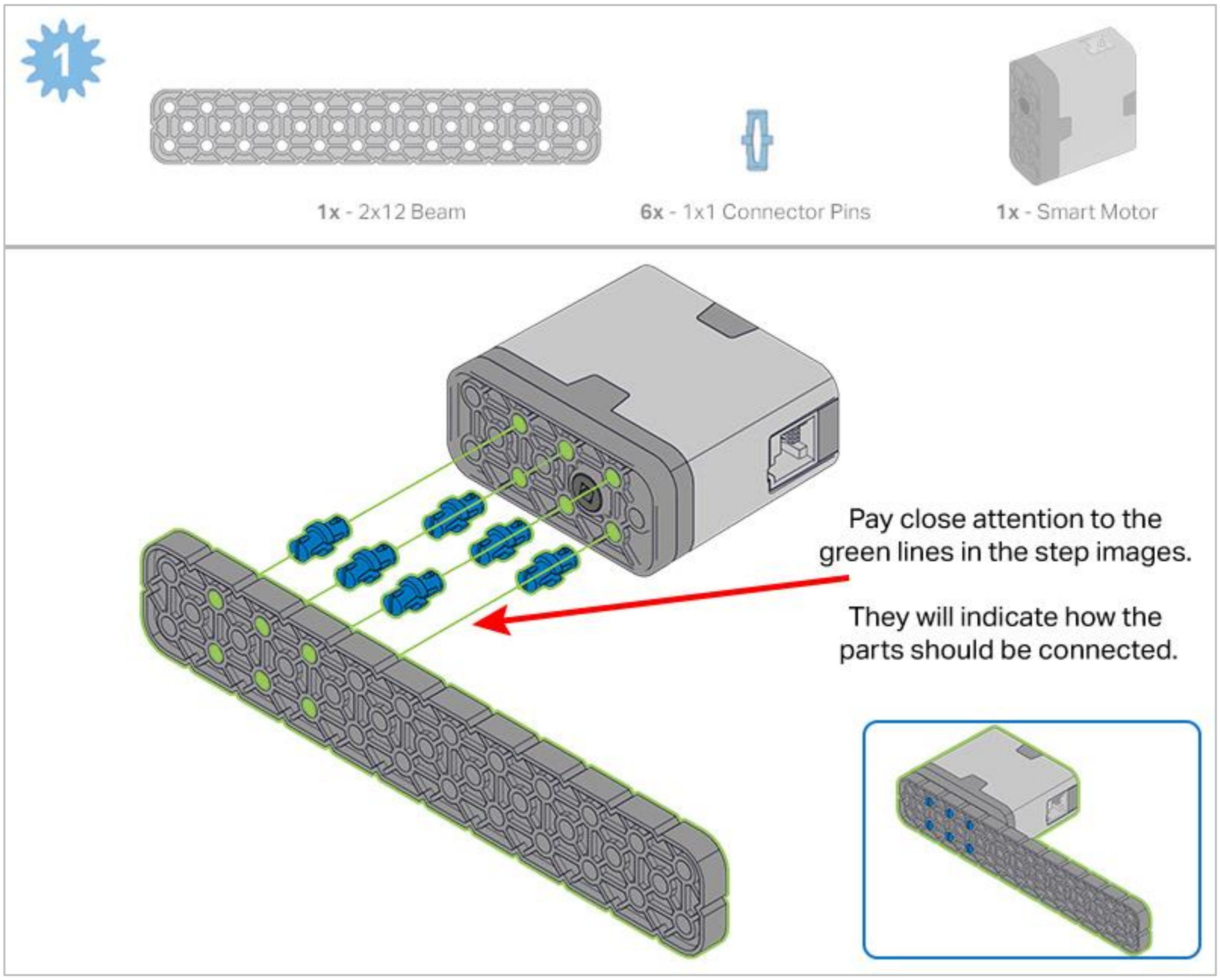
Build Instructions - Claw

Build Instructions Summary

- **Claw Building Instructions (22 steps):**
  - Claw: steps 61 to 82
- **Building Tips for All Steps:**
  - The section at the top of the step shows important information for the build. The first number under the image of the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step. The next information under the part image is the size and description of the part needed.
  - The finished step is illustrated in the box in the lower right corner.

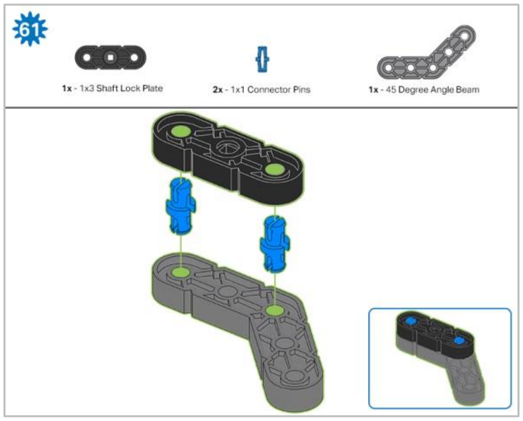
- Play close attention to the green lines in the step images. They will indicate how the parts should be connected.

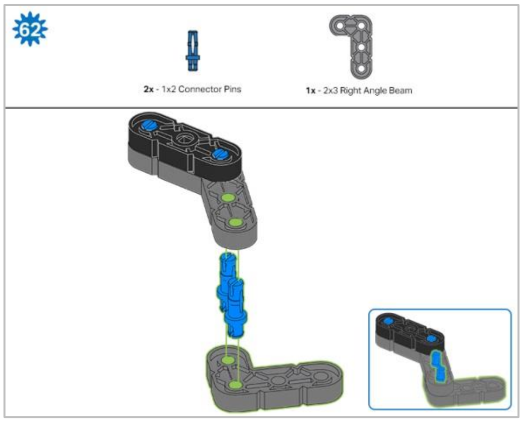

1
The section at the top of the step shows important information for the build.
1x - 2x12 Beam
6x - 1x1 Connector Pins
1x - Smart Motor
The first number under the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step.
The next information under the part image is the size (if necessary) and name of the part needed.

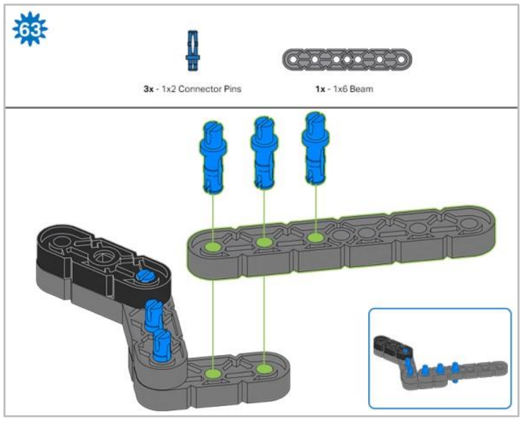


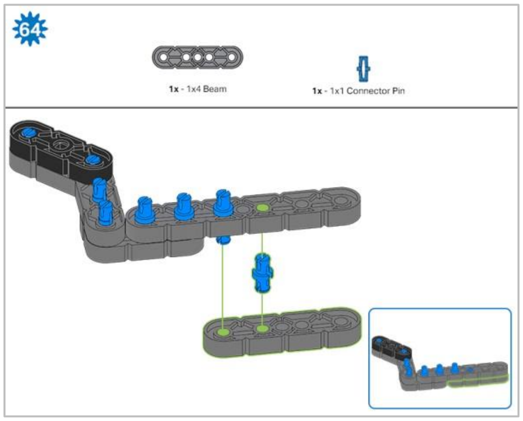
Pay close attention to the green lines in the step images.

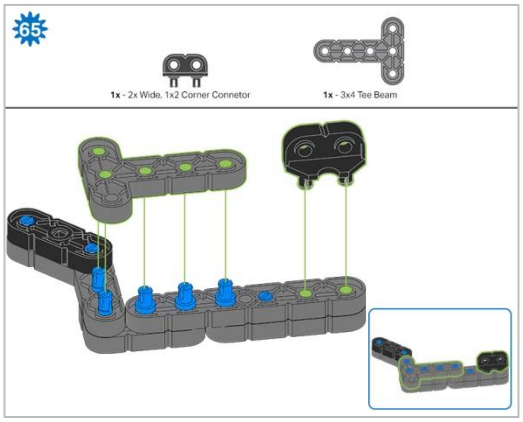
They will indicate how the parts should be connected.

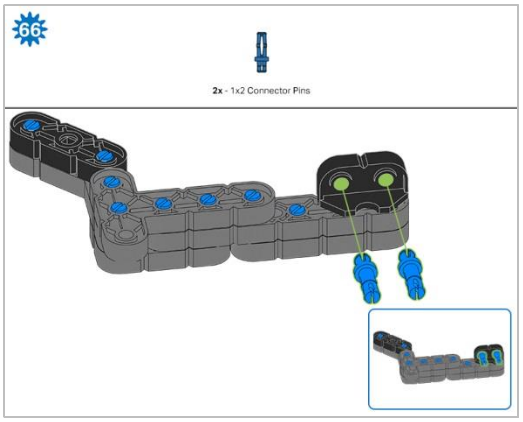


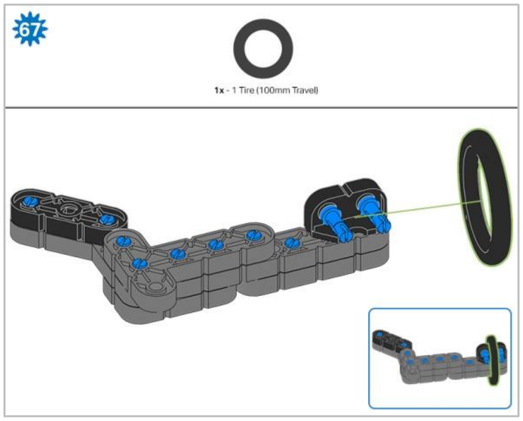

62
2x - 1x2 Connector Pins
1x - 2x3 Right Angle Beam


63
3x - 1x2 Connector Pins
1x - 1x6 Beam

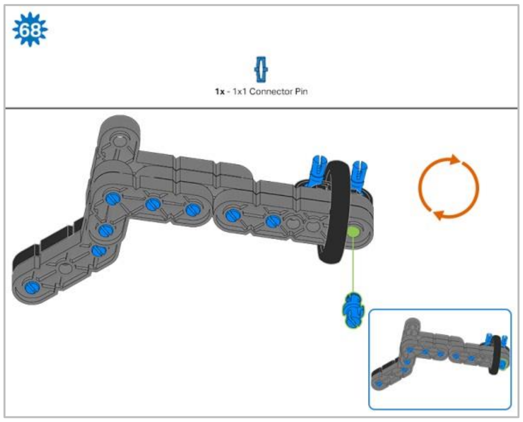

64
1x - 1x4 Beam
1x - 1x1 Connector Pin


65
1x - 2x Wide, 1x2 Corner Connetor
1x - 3x4 Tee Beam

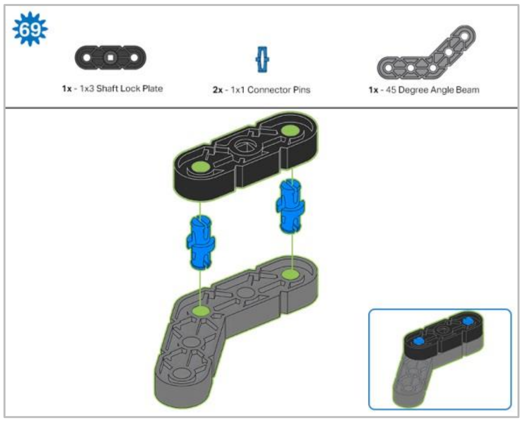


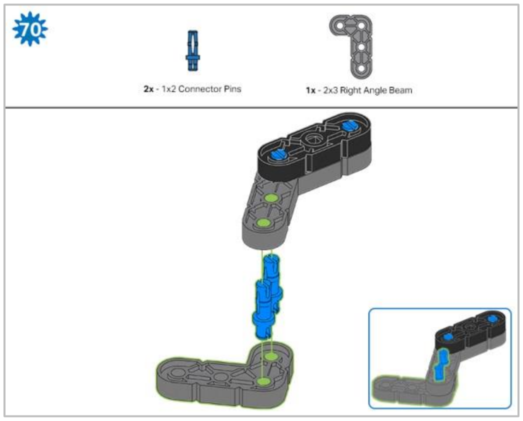


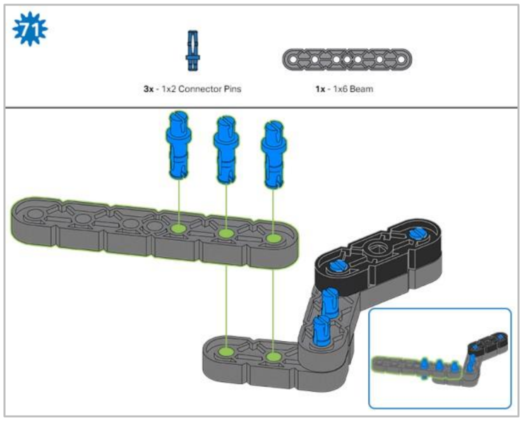
Step 67: Make sure that the 100mm Travel Tire fits snugly in the grove of the 2x Wide, ½ Corner Connector.

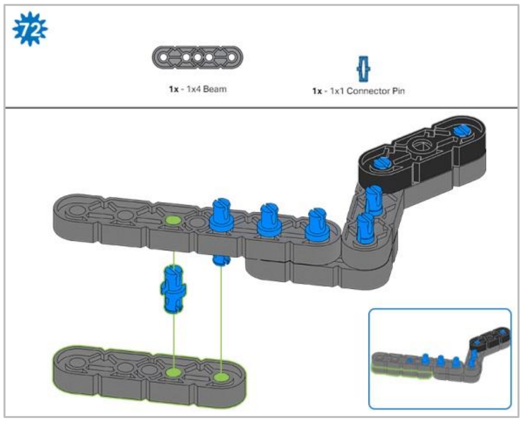


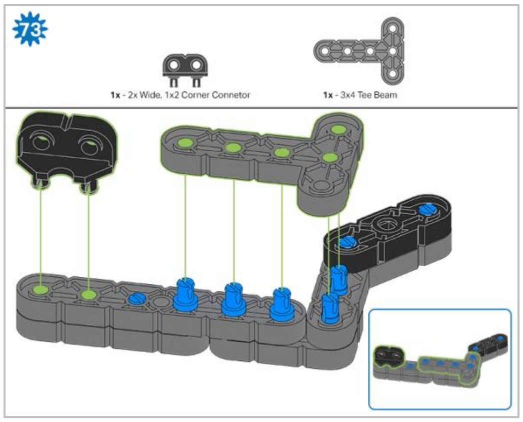
Step 68: The orange arrows mean spin the build around.

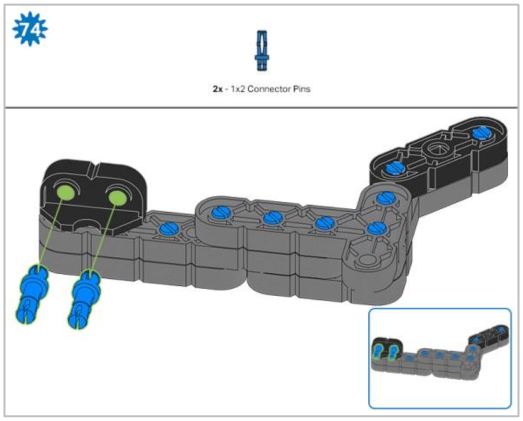

69
1x - 1x3 Shaft Lock Plate
2x - 1x1 Connector Pins
1x - 45 Degree Angle Beam

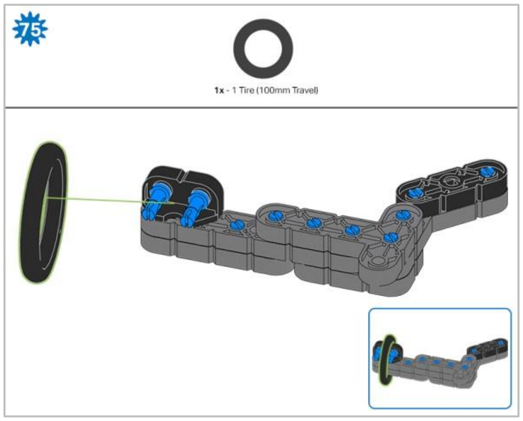

70
2x - 1x2 Connector Pins
1x - 2x3 Right Angle Beam


71
3x - 1x2 Connector Pins
1x - 1x6 Beam

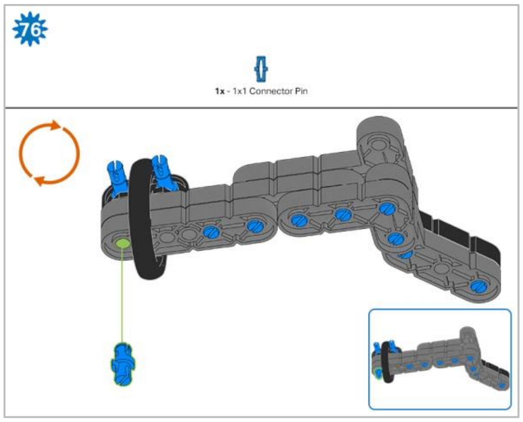

72
1x - 1x4 Beam
1x - 1x1 Connector Pin



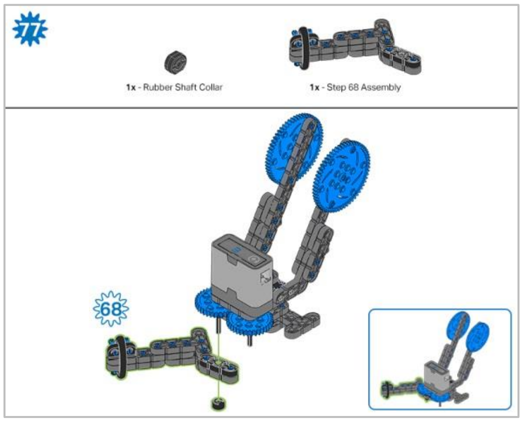




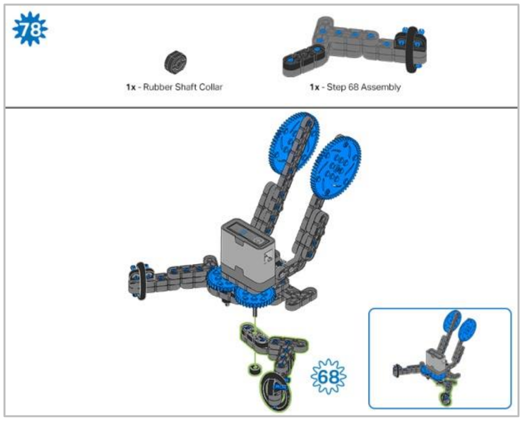
Step 75: Make sure that the 100mm Travel Tire fits snugly in the grove of the 2x Wide, ½ Corner Connector.



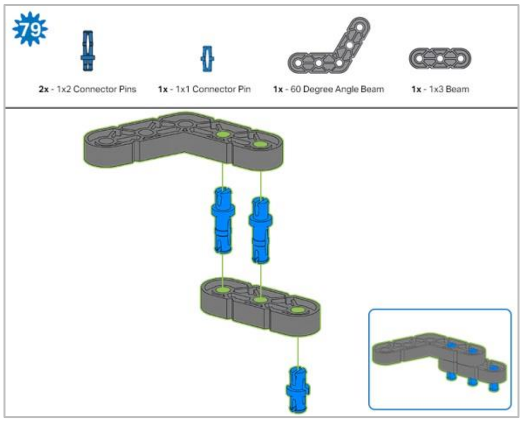
Step 76: The orange arrows mean spin the build around.

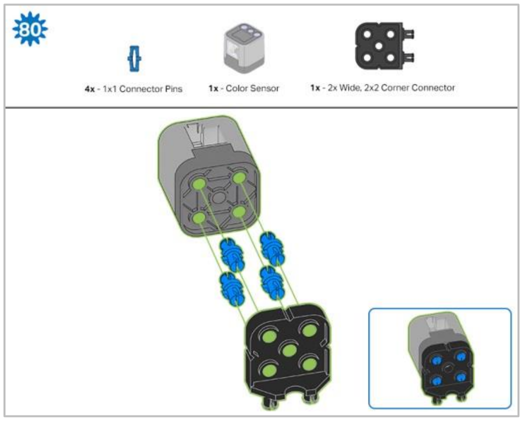


Step 77: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.

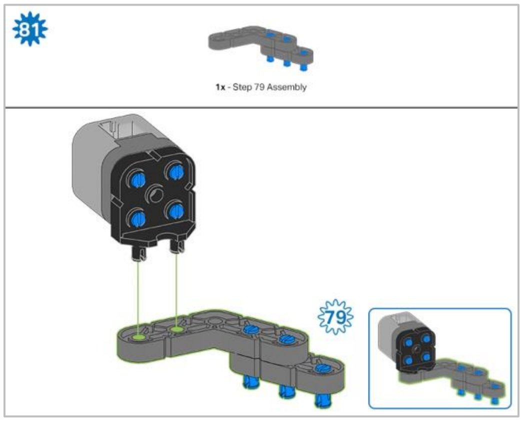


Step 78: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.

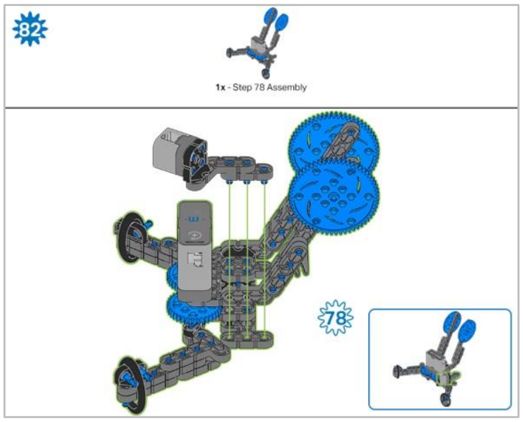




Step 80: The sensor being attached is the Color Sensor. Ensure the sensor is placed in the correct way to allow cable access.



Step 81: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.

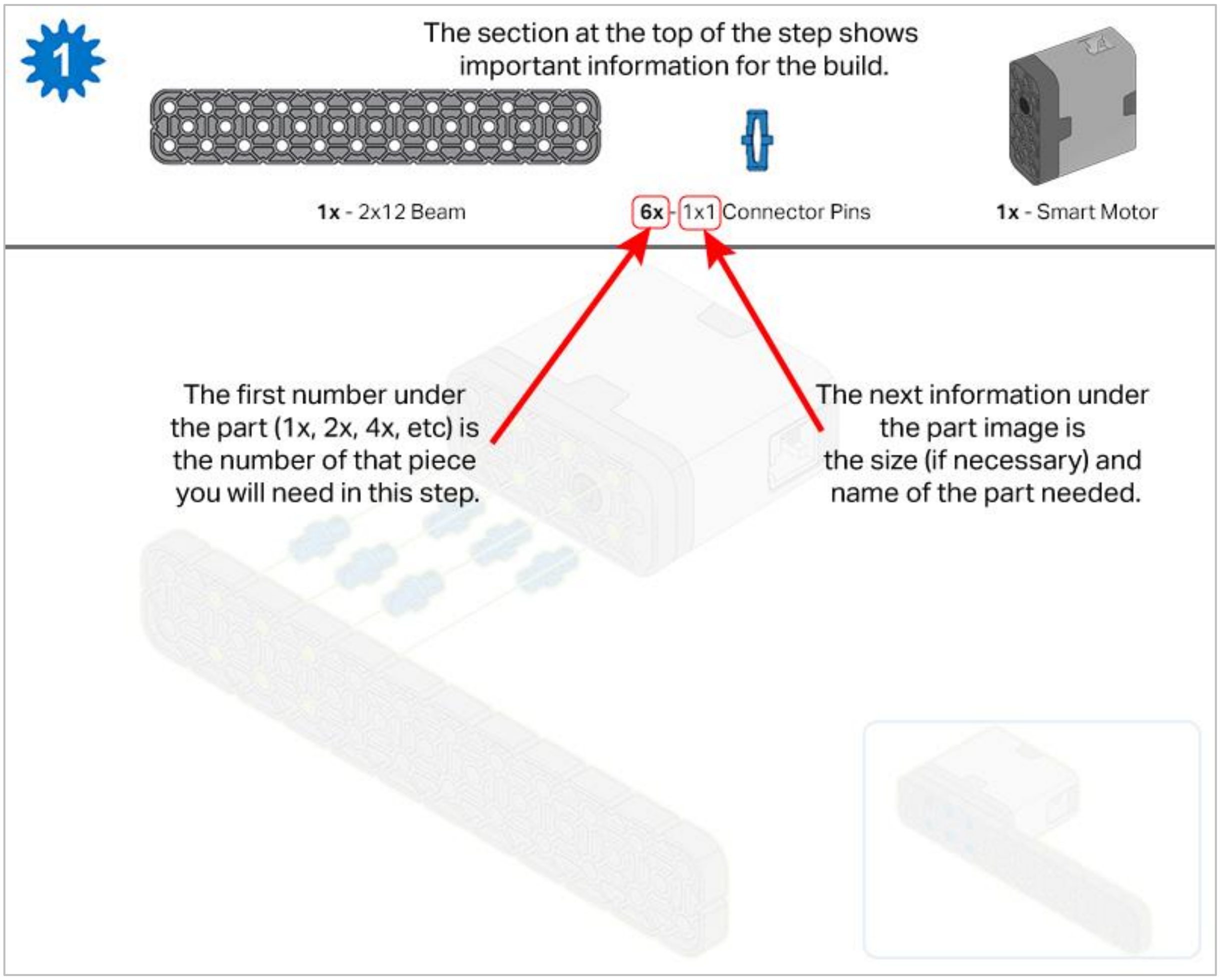

82
1x - Step 78 Assembly
78

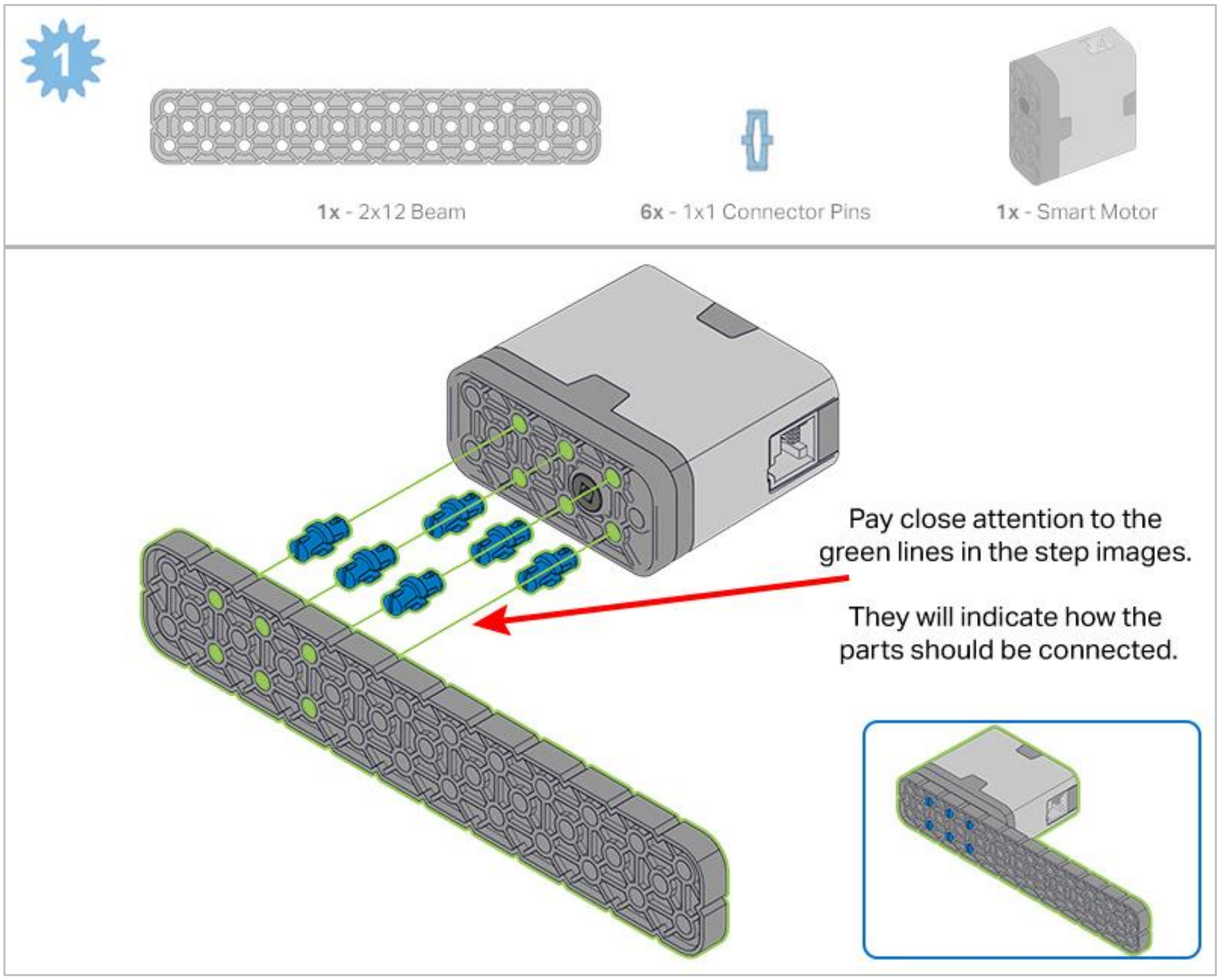
Build Instructions - Assembly and Wiring

Build Instructions Summary

- **Assembly and Wiring (11 steps):**
  - Final Assembly: steps 83 to 93
  - The group is also responsible for making sure the sensors and motors are attached to the correct ports using the designated Smart Cables.
    - Port 1: Left Wheel
    - Port 2: Touch LED
    - Port 3: Color Sensor
    - Port 4: Gyro Sensor
    - Port 6: Right Wheel
    - Port 7: Distance Sensor
    - Port 8: Bumper Switch
    - Port 10: Arm Motor
    - Port 11: Claw Motor
- **Building Tips for All Steps:**
  - The section at the top of the step shows important information for the build. The first number under the image of the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step. The next information under the part image is the size and description of the part needed.
  - The finished step is illustrated in the box in the lower right corner.
  - Play close attention to the green lines in the step images. They will indicate how the parts should be connected.
- **Building Tips for Steps 87-89:**

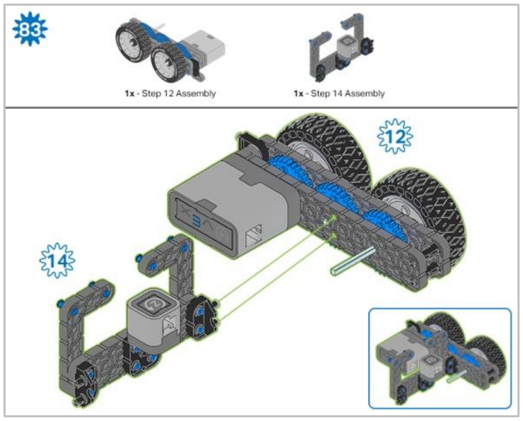
- The solid green numbers represent the numbered port the cable will be connected into. The outlined green number indicates the sensor that cable will connect into. Use the indicated Smart Cable for each sensor or motor. When attaching the Smart Cables, make sure they are tucked away so as to not block the Smart Sensors or interfere with the Clawbot's movement.


1
The section at the top of the step shows important information for the build.
1x - 2x12 Beam
6x - 1x1 Connector Pins
1x - Smart Motor
The first number under the part (1x, 2x, 4x, etc) is the number of that piece you will need in this step.
The next information under the part image is the size (if necessary) and name of the part needed.

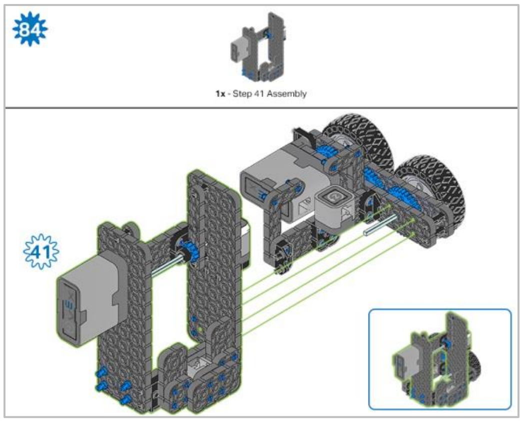


Pay close attention to the green lines in the step images.

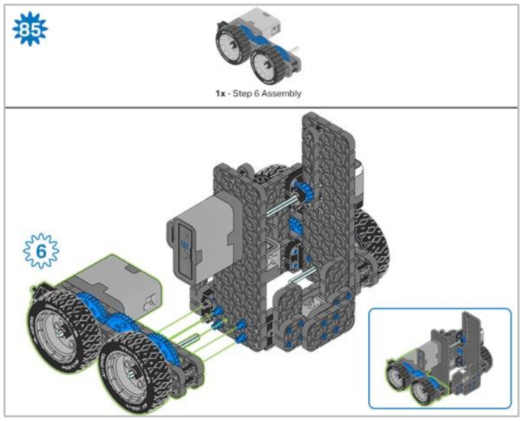
They will indicate how the parts should be connected.



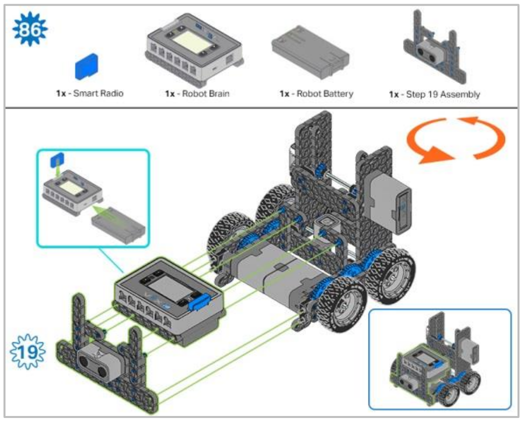
Step 83: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.



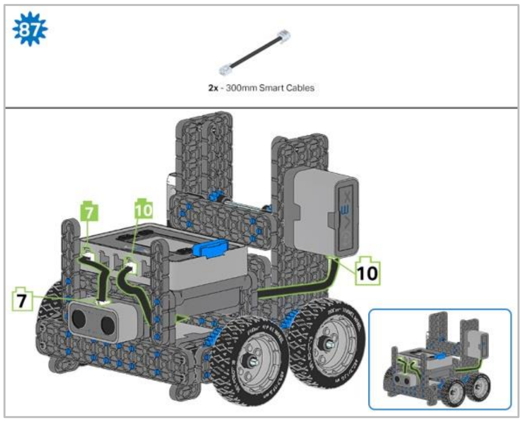
Step 84: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.



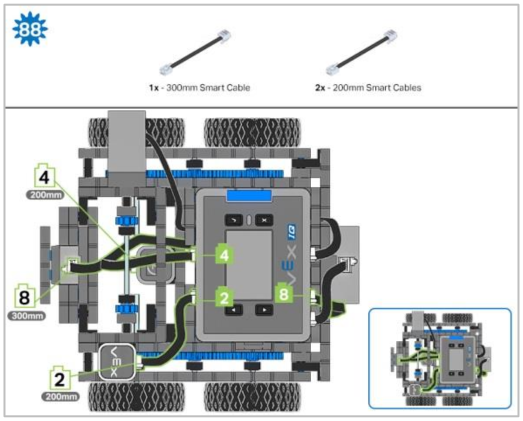
Step 85: Instead of individual parts, the completed sections of the build needed are shown in the section at the top.

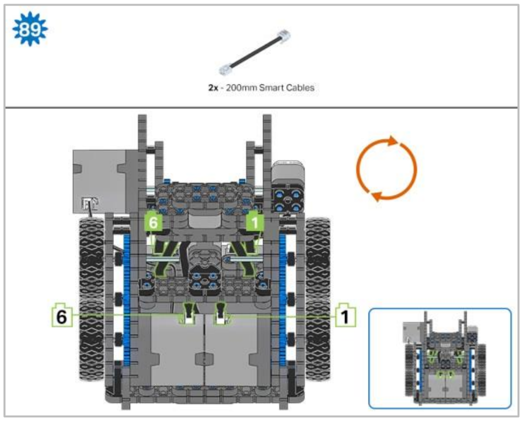


Step 86: Make sure the Smart Radio is pushed in securely. Make sure the Robot Battery is oriented the correct way before inserting. The orange arrows mean spin the build around.

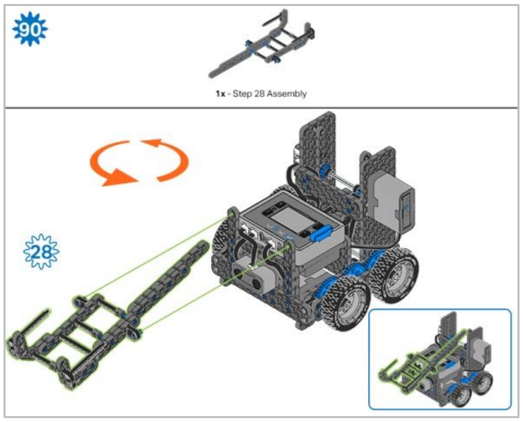


Step 87: The Smart cable for the Arm Motor can be tucked under the Brain and plugged into the correct port (port 10).

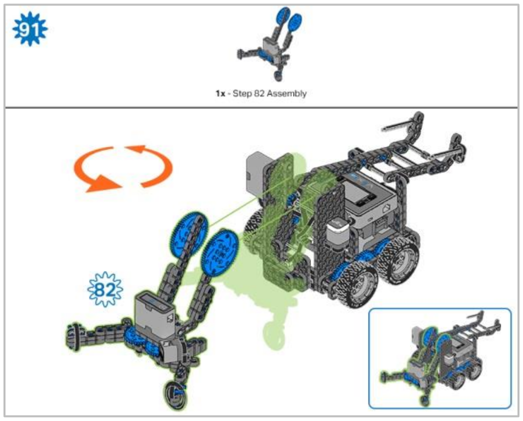




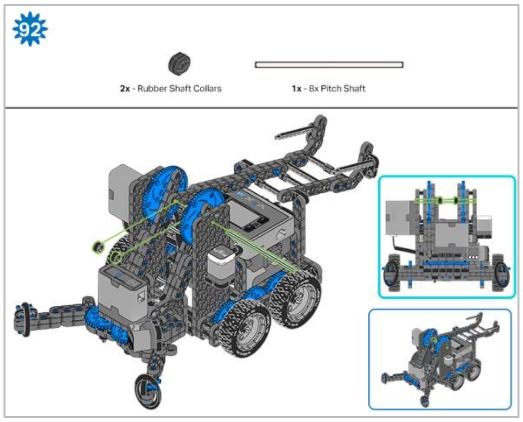
Step 89: The orange arrows mean spin the build around.



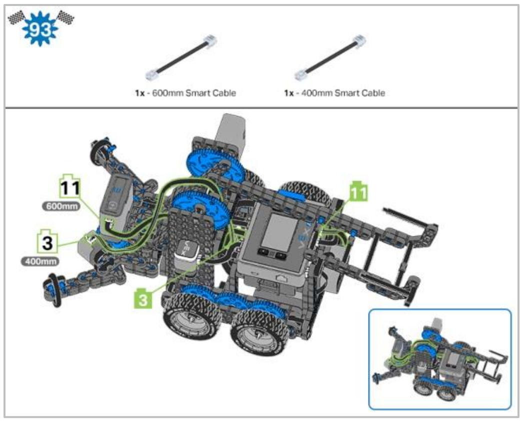
Step 90: Instead of individual parts, the completed sections of the build needed are shown in the section at the top. The orange arrows mean spin the build around.



Step 91: Instead of individual parts, the completed sections of the build needed are shown in the section at the top. The orange arrows mean spin the build around.



Step 92: When adding the 8x Pitch Shaft, twist the pitch shaft to check for tension while turning. If it spins freely, it is not properly inserted into the gears.



Step 93: The solid green numbers represent the numbered port the cable will be connected into. The outlined green number indicates the sensor that cable will connect into. Use the indicated Smart Cable for each sensor. When attaching the Smart Cables, make sure they are tucked away so as to not block the Smart Sensors or interfere with the Clawbot's movement.

Exploration

Now that you've finished the build, test what it does. Explore your build and then answer these questions in your engineering notebook.

Where is the pivot point (the point the robot rotates about) for this robot build?

- Make a prediction and then manually move a wheel on one side forward while at the same time moving a wheel on the opposite side backwards at the same rate.

After manually moving both wheels, now describe where the pivot point is. How would the pivot point of the robot change if the Build design was changed so both of the wheels that are not attached to motors did not use gears?

- For further explanation, notice how when one wheel is moved on one side, both wheels move because they are connected using gears. If they were not connected using gears and the wheels not connected to motors moved freely, how would that change the pivot point of the robot?

Explain how a robot’s pivot point could change its behavior.

SPARK
PLAY

Test your build, observe how it functions,
and fuel your logic and reasoning skills
through imaginative, creative play.

Robot Repetition

Assembly line robots must perform actions repeatedly

Using Loops to Repeat Robotic Actions

Robots and computers are very good at consistency when performing actions multiple times. Computers use repetition to perform millions of calculations per second with incredible consistency. Since robots are built to interact with their environment and perform tasks precisely, they can be effectively used to repeat behaviors.

Behaviors to be repeated are grouped in programming structures called loops. The number of times and how fast they repeat depend on many factors that the programmer can specify.

Here are some examples of where repetition can be useful:

- Performing routine tasks multiple times
- Checking certain conditions multiple times to check for changes

Programming Loops in VEXcode IQ Blocks

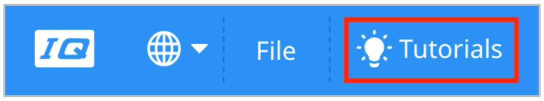
The Builder in each group should get the hardware required. The Recorder should get the group's engineering notebook. The Programmer should open VEXcode IQ Blocks.

Hardware/Software Required:

Quantity	Hardware/Other Items
1	VEX IQ Super Kit
1	VEXcode IQ Blocks (latest version, Windows, macOS, Chromebook, iPad)
1	Engineering Notebook
1	Using Loops (Tutorial)
1	Repeating Actions example project

This activity will give you the tools to program your robot with repeating behaviors.

You can use the Help information inside of VEXcode IQ Blocks to learn about the blocks. For guidance in using the Help feature, see the Using Help tutorial.



1. Preparing for the activity

Before you begin the activity, do you have each of these items ready? The Builder should check each of the following:

- Are all the motors and sensors plugged into the correct port?
- Are the smart cables fully inserted into all of the motors and sensors?
- Is the Brain turned on?
- Is the battery charged?

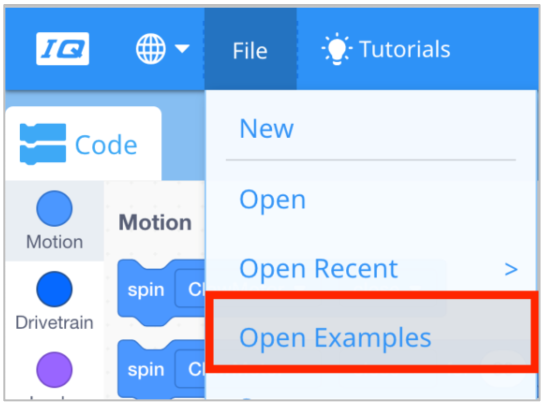
- Is the Radio inserted into the Robot Brain?

2. Let's start programming with loops.

Start by watching the **Using Loops** tutorial video.

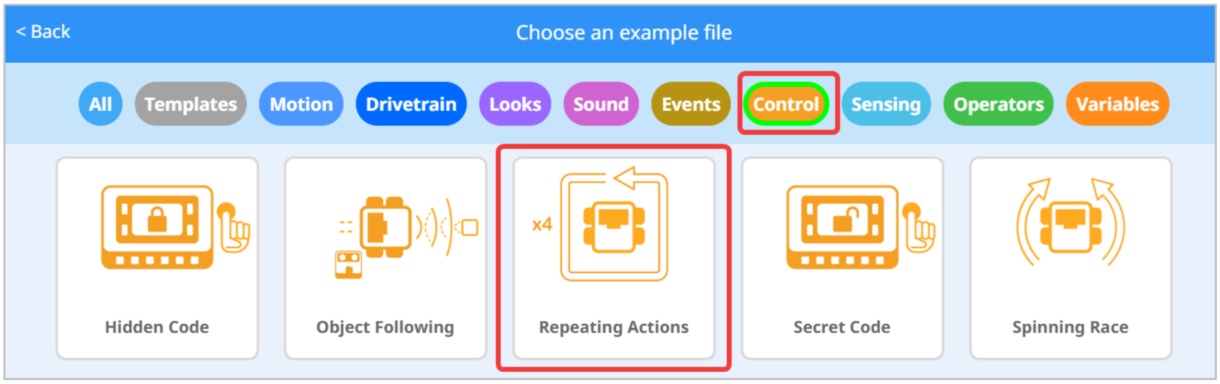
VEXcode IQ Blocks contains many different example projects. You'll use one of them in this exploration. For help and tips on using example projects, check out the Using Examples and Templates tutorial.

Then, open the Repeating Actions example project.



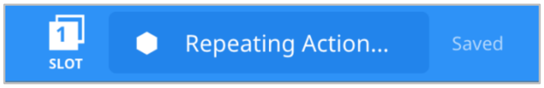
The Programmer should complete the following steps:

- Open the File menu.
- Select **Open Examples**.
- Use the filter bar at the top of the application and select "Control."



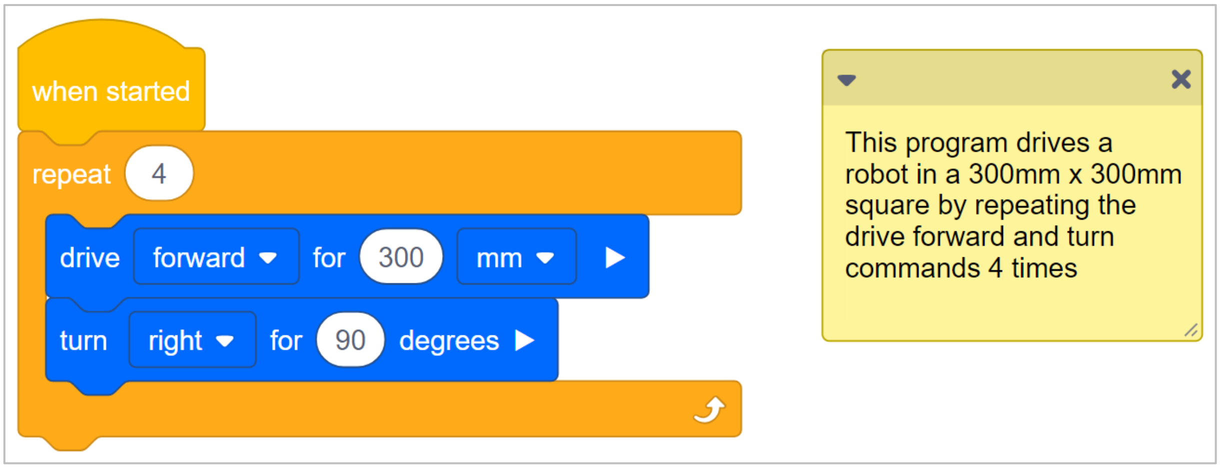
- Select and open the **Repeating Actions** example project.

- **Save** your project as Repeating Actions.



- Check to make sure the project name **Repeating Actions** is now in the window in the center of the toolbar.

What is this project actually doing?



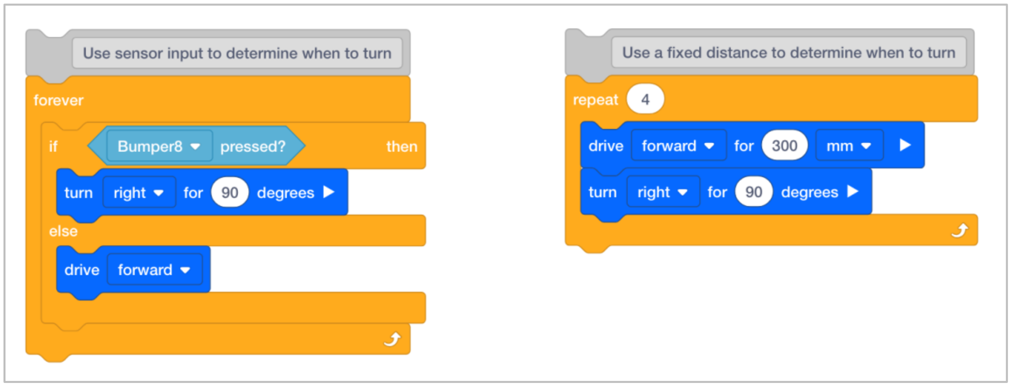
```
when started
repeat 4
    drive forward for 300 mm
    turn right for 90 degrees
```

This program drives a robot in a 300mm x 300mm square by repeating the drive forward and turn commands 4 times

Do the following in your engineering notebook.

Predict what the project will have the Clawbot do. Explain each and every action that the robot will complete.

3. What is the difference between `forever` and `repeat`?



```
Use sensor input to determine when to turn
forever
    if Bumper8 pressed? then
        turn right for 90 degrees ▶
    else
        drive forward
```

```
Use a fixed distance to determine when to turn
repeat 4
    drive forward for 300 mm ▶
    turn right for 90 degrees ▶
```

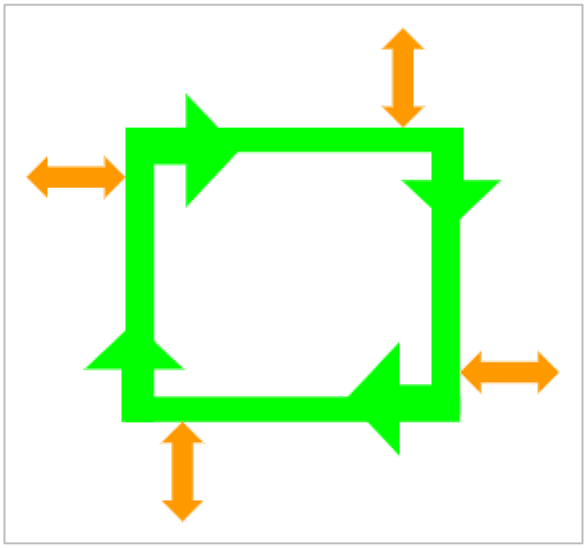
- Look over the **Repeating Actions example project** again. It's also the stack of blocks shown on the right above.
  Notice that the repeat block only has the movements repeating 4 times. Repetitive movements rarely need to repeat forever so a *repeat* block is used when only a certain number of repetitions is needed.

  If the `repeat` block was replaced with the `forever` block, the robot would just repeat in a square forever.

- A `forever` block is often used with a conditional statement in order to continuously check to see if the condition is true. In the stack of blocks above attached to the `forever` block, notice how the robot will drive forward until it meets the condition of bumping into something with the bumper switch. If the bumper switch is pressed, the robot will turn. Otherwise, it will continue driving forward.

  This is a practical use-case of the `forever` block. Imagine a self-driving sweeper that continues to drive forward until it runs into something, then it turns.

4. The Stop and Go Challenge!



- Have your Clawbot drive in a square.
- Before each turn:
  - The claw must be opened and closed.
  - The arm must be raised and lowered.
  - The Touch LED must show at least one color.
  - At least one sound must play.
- The Clawbot cannot drive along a side of the square more than once.
- You can use the Repeating Actions example project as a starting point but save it as **StopAndGo** before making any changes.

StopAndGo

In your engineering notebook, plan the following:

- Have the Driver and Recorder plan out your solution and predict what each block in your project will have the Clawbot do.
- Have the Programmer Download and run your project to test it before submitting it.
- Have the Builder make changes to the project as needed and communicate with the Recorder to take notes about what was changed during testing.

SPARK
APPLY

Become a 21st century problem solver
by applying the core skills and concepts
you learned to other problems.

Robots in Manufacturing

Robots working in a manufacturing plant.

Factory Robots

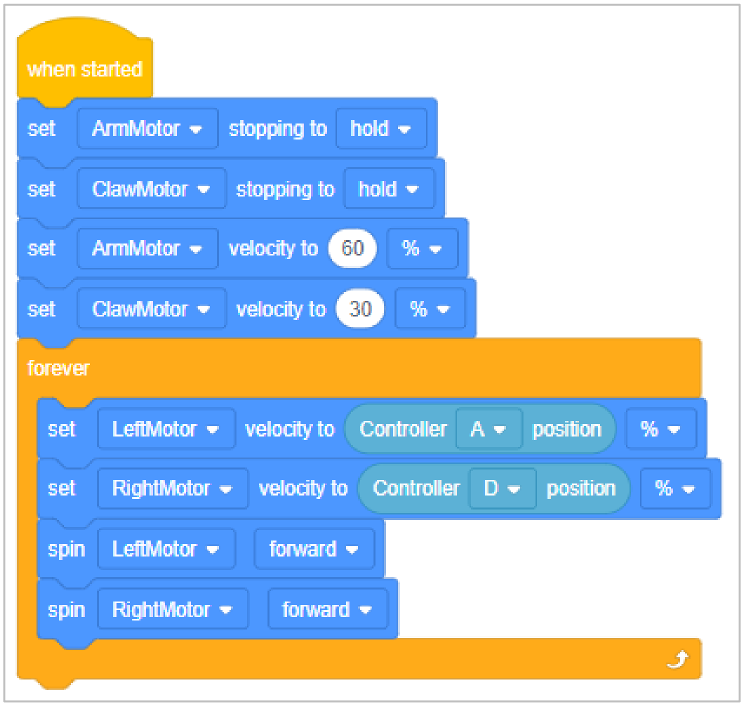
Factories first began using modern industrial robots in the early 1960s. These robots could do the dirty, dull, and dangerous jobs that were previously completed by humans. Since then, factories all over the world have invested millions of dollars to develop and build robots that can manufacture their products quickly and efficiently.

Factory robots are always being improved upon as new technology is expanded. New metals and materials allow robots to be used in high pressure or high temperature environments. Usually separated to keep human workers safe in case of an accident, factory robots are being made from new “softer” materials. These materials, such as rubber and plastic, can help reduce injuries in a robot/human collision. With the introduction of artificial intelligence and sensors, factory robots can be “taught” new ways of delivering these products overnight and adapt their movements in real time. This allows more productivity and precision.

Factory robots are used in the production of many products, but the top three robotic jobs in manufacturing are:

- Drilling
- Welding
- Painting and Sealing

Controllers and Loops



```
when started
set ArmMotor stopping to hold
set ClawMotor stopping to hold
set ArmMotor velocity to 60 %
set ClawMotor velocity to 30 %
forever
    set LeftMotor velocity to Controller A position %
    set RightMotor velocity to Controller D position %
    spin LeftMotor forward
    spin RightMotor forward
```

Clawbot Control example project from VEXcode IQ Blocks

Controllers and Loops

In competitions, teams use controllers to wirelessly control their robots. The controller is programmed to update the robot based on input from the user. Loops are used in the project so that the robot repeatedly checks for updated input information. Loops allow the project to rapidly check which buttons have been pressed, or how far joysticks have been pushed. Once checked, this information is quickly relayed to the robot so that it responds quickly to the controller's instructions.

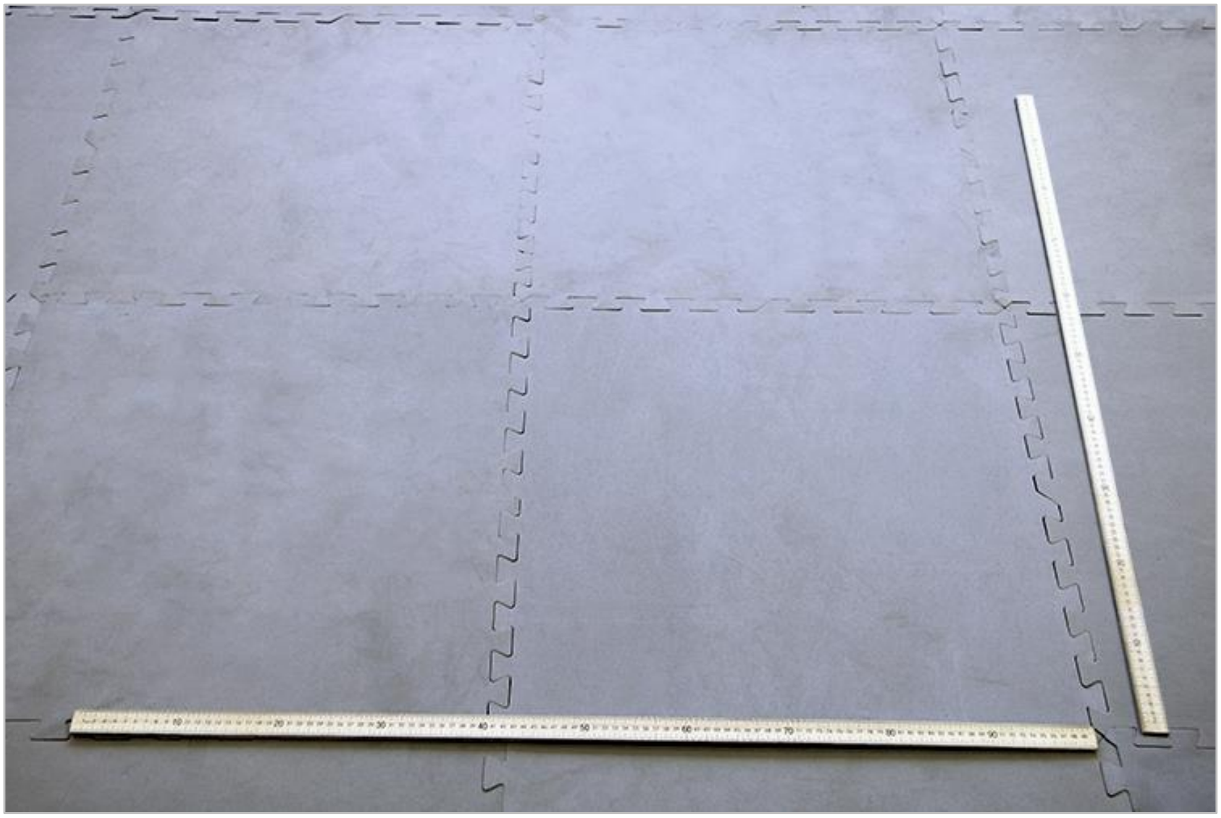
The image above shows the Clawbot Control example project from VEXcode IQ Blocks. The *forever* loop in this project checks the positions of Axes A and D forever in order to set the velocity of the motors.

Loops are important even for autonomous programming without a controller. A loop helps to simplify and organize repeated commands within a project.

SPARK RETHINK

Is there a more efficient way to come to the same conclusion? Take what you’ve learned and try to improve it.

Prepare for the Groove Machine Challenge



Dance floor set up

Prepare for the Groove Machine Challenge!

In the Groove Machine Challenge, you will break up into groups and program your robot to go through a dance routine for a dance-off using your knowledge of loops.

For the challenge, you will need to clear a space on the floor large enough for a Clawbot IQ to move around for a dance routine without bumping into anything. A 1x1 meter area is recommended to give each Clawbot adequate space for moving.

Design, Develop, and Iterate on your Project

Answer the following questions in your engineering notebook as you design your project.

- What type of robot dance will you create? Explain with details.
- What types of loops will you use and why?
- What steps will you follow to test the dance? Explain with details.

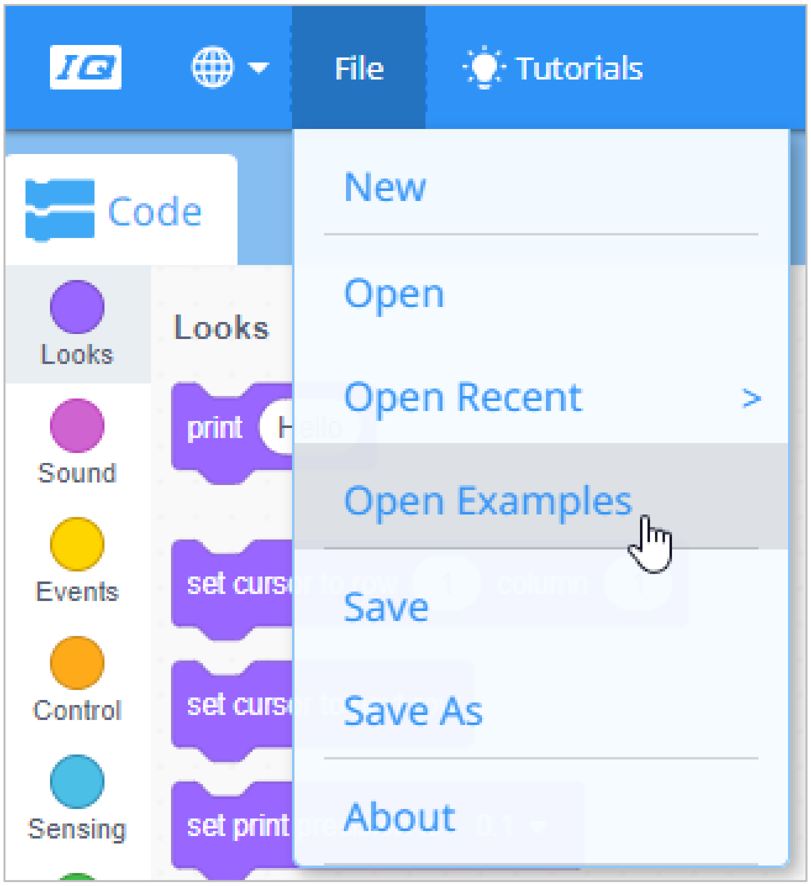
In order to help you plan, click here for a few example dance moves that you might include in the Clawbot's dance.

Follow the steps below as you create your project:

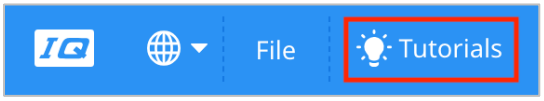
- Plan out the dance using drawings and pseudocode.
- Use the pseudocode you created to develop your project using VEXcode IQ Blocks.
- Run your project to test it often and iterate on it using what you learned from your testing.
- Share your final project with your teacher.

If you're having trouble getting started, review the following in VEXcode IQ Blocks:

- Example projects



- Using Loops tutorial



- Previous versions of your project
- The Help feature to learn more about the blocks

The Groove Machine Challenge

Clawbot IQ with its arm up and claw open

The Groove Machine Challenge

In this challenge, you will break up into teams and program your robot to go through a dance routine using your knowledge of loops. Your teacher will set a time limit for developing/testing the dance and a time limit for the length of the dance. Everyone not on the competing head-to-head dance-off teams will judge the dances and vote on the team that they think is best.

Rules:

- Each Clawbot will dance one-at-a-time within the 1x1 meter area.
- The dancing continues until the Stop button on the Brain's screen is pressed to stop the project from running.
- The arm must be raised and lowered.
- The claw must open and close.
- The Clawbot must turn left and right.
- The Clawbot must drive forward and in reverse.
- The project needs to be stopped immediately if the Clawbot collides with anything or falls over. That is a losing dance.

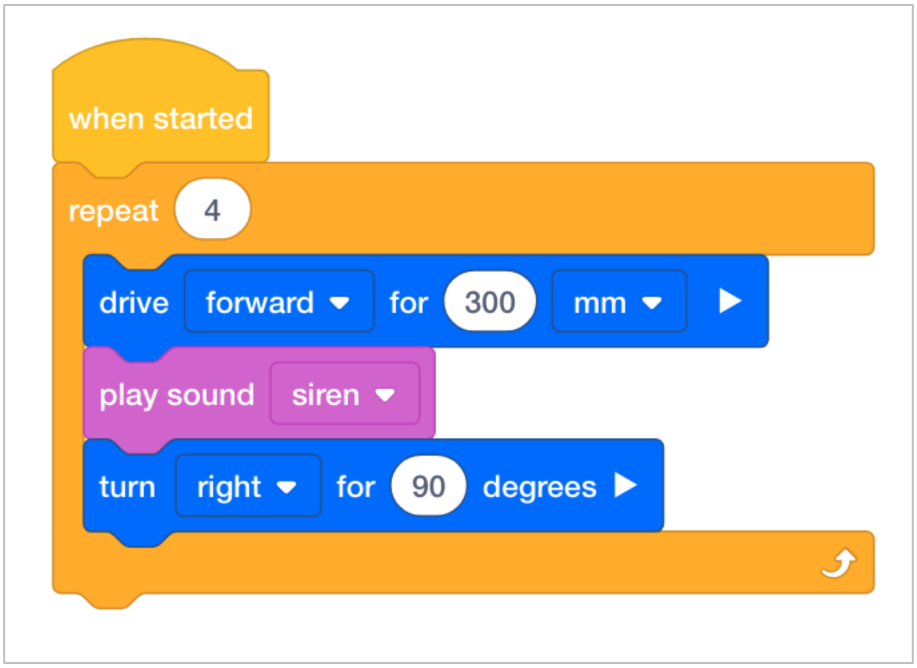
Bonus Challenge: Add sounds from the brain and colored lights from the Touch LED to make your dance routine better than the others.

SPARK KNOW

Understand the core concepts and how to apply them to different situations. This review process will fuel motivation to learn.

Review

1. **What does the *repeat* block do in the following project?**



```
when started
repeat 4
    drive forward for 300 mm
    play sound siren
    turn right for 90 degrees
```

○ It repeats the driving, playing, and turning behaviors four times so that the robot moves in a square.

○ It repeats again and again until the program is stopped.

○ It has the robot drive for 300mm four times before playing a sound and turning right.

○ It has the robot drive for 1200mm, play the siren four times, and then turn right for 360 degrees.

2. **Loops are _____________.**

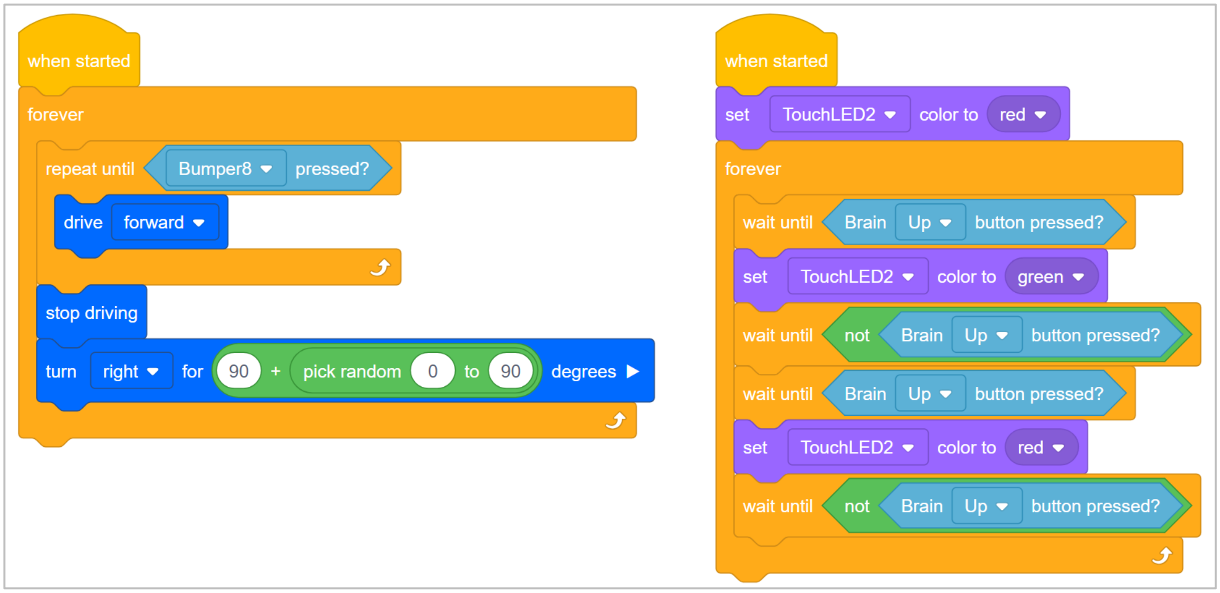
○ documents the data types available

○ conditionally executes a group of statements

○ statement(s) to handle errors that occur

○ programming structures that repeat behaviors

3. **Which of these two projects needs to be stopped by the user because it will not stop on its own?**

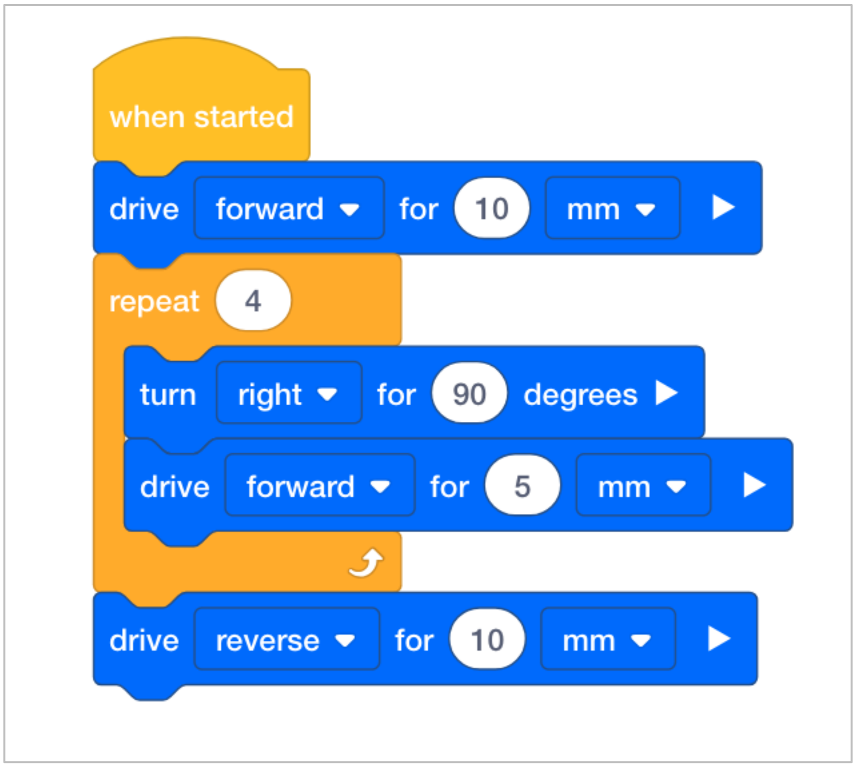


```
when started
forever
    repeat until Bumper8 pressed?
        drive forward
    stop driving
    turn right for 90 + pick random 0 to 90 degrees
```

```
when started
set TouchLED2 color to red
forever
    wait until Brain Up button pressed?
    set TouchLED2 color to green
    wait until not Brain Up button pressed?
    wait until Brain Up button pressed?
    set TouchLED2 color to red
    wait until not Brain Up button pressed?
```

- ○ The project on the left will loop forever and need to be stopped by the user.
- ○ The project on the right will loop forever and need to be stopped by the user.
- ○ Neither project needs to be stopped by the user. Both end on their own.
- ○ Both projects need to be stopped by the user because of their forever loops.

4. **In the following project, how many millimeters does the robot drive in total - in either direction?**



```
when started
drive forward for 10 mm
repeat 4
    turn right for 90 degrees
    drive forward for 5 mm
drive reverse for 10 mm
```

○ 25 millimeters

○ 30 millimeters

○ 40 millimeters

○ 50 millimeters

5. Which of these is NOT a benefit of using factory robots?

○ They can do dangerous work.

○ They cost only a few hundred dollars to build.

○ They can learn new ways of doing tasks overnight.

○ They are precise and efficient.

APPENDIX

Additional information, resources, and materials.

Knowledge Base Articles

Links to the VEX Robotics Knowledge Base Articles for this STEM Lab:

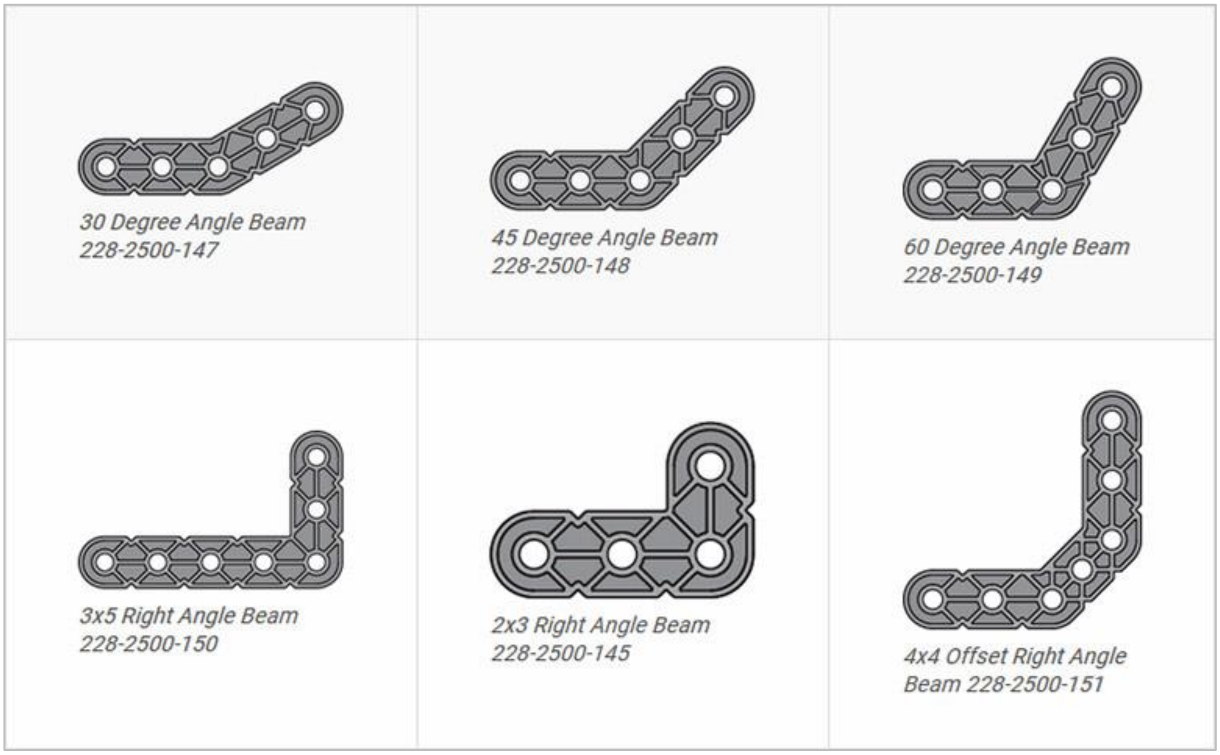
- How to Turn On/Off a VEX IQ Robot Brain
  https://kb.vex.com/hc/en-us/articles/360035952571-How-to-Turn-On-Off-a-VEX-IQ-Robot-Brain
- How to Read Indicator Lights on the VEX IQ Robot Brain
  https://kb.vex.com/hc/en-us/articles/360035590672-How-to-Read-Indicator-Lights-on-the-VEX-IQ-Robot-Brain
- How to Navigate the VEX IQ Robot Brain
  https://kb.vex.com/hc/en-us/articles/360035952331-How-to-Navigate-the-VEX-IQ-Robot-Brain
- How to Connect VEX IQ Devices to Smart Ports
  https://kb.vex.com/hc/en-us/articles/360035952151-How-to-Connect-VEX-IQ-Devices-to-Smart-Ports
- How to Install or Remove the VEX IQ Robot Battery
  https://kb.vex.com/hc/en-us/articles/360035951991-How-to-Install-or-Remove-the-VEX-IQ-Robot-Battery
- How to Charge the VEX IQ Robot Battery
  https://kb.vex.com/hc/en-us/articles/360035955011-How-to-Charge-the-VEX-IQ-Robot-Battery
- How to Use the Autopilot Program in the Demos Folder
  https://kb.vex.com/hc/en-us/articles/360035952031-How-to-Use-the-Autopilot-Program-in-the-Demos-Folder
- Best Practices for Preserving the VEX IQ Robot Battery's Life
  https://kb.vex.com/hc/en-us/articles/360035953671-Best-Practices-for-Preserving-the-VEX-IQ-Robot-Battery-s-Life
- Ideas for Organizing the VEX IQ Super Kit
  https://kb.vex.com/hc/en-us/articles/360035590332-Ideas-for-Organizing-the-VEX-IQ-Super-Kit
- VEX IQ Brain Status (USB Cable)
  https://kb.vex.com/hc/en-us/articles/360035955411-How-to-Understand-the-VEX-IQ-Brain-Status-Icon-USB-VEXcode-IQ-Blocks

Links to VEXCode IQ Blocks Knowledge Base Articles for this STEM Lab:

- How to Begin a New Project in VEXcode IQ Blocks
  https://kb.vex.com/hc/en-us/articles/360035954551-How-to-Begin-a-New-Project-VEXcode-IQ-Blocks

- How to Download and Run a Project
  https://kb.vex.com/hc/en-us/articles/360035591232-How-to-Download-and-Run-a-Project-VEXcode-IQ-Blocks
- How to Save a Project on Windows
  https://kb.vex.com/hc/en-us/articles/360035954531-How-to-Save-a-Project-on-Windows-VEXcode-IQ-Blocks
- How to Save a Project on macOS
  https://kb.vex.com/hc/en-us/articles/360035954511-How-to-Save-a-Project-on-macOS-VEXcode-IQ-Blocks
- How to Save a Project on Chromebook
  https://kb.vex.com/hc/en-us/articles/360035955351-How-to-Save-on-a-Chromebook-VEXcode-IQ-Blocks
- How to Download to a Selected Slot on the Brain
  https://kb.vex.com/hc/en-us/articles/360035591292-How-to-Download-to-a-Selected-Slot-on-the-Brain-VEXcode-IQ-Blocks

Identifying Angle Beams



30 Degree Angle Beam 228-2500-147

45 Degree Angle Beam 228-2500-148

60 Degree Angle Beam 228-2500-149

3x5 Right Angle Beam 228-2500-150

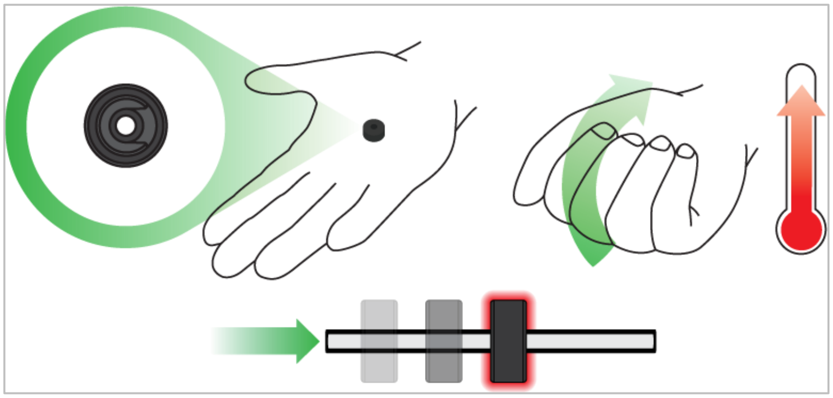
2x3 Right Angle Beam 228-2500-145

4x4 Offset Right Angle Beam 228-2500-151

How to Identify the Different Angles of the Angled Beams

There are four different types of beams that have a bend at an angle: 30^o Angle Beams, 45^o Angle Beams, 60^o Angle Beams, and Right Angle (90^o) Beams. There are also three types of Right Angle Beams: 3x5, 2x3, and Offset. The best way to tell which angles are which is to stack the beams on top of each other. Then you can compare how they look. You can also use a protractor to measure the angle of the beam.

Installing Rubber Shaft Collars

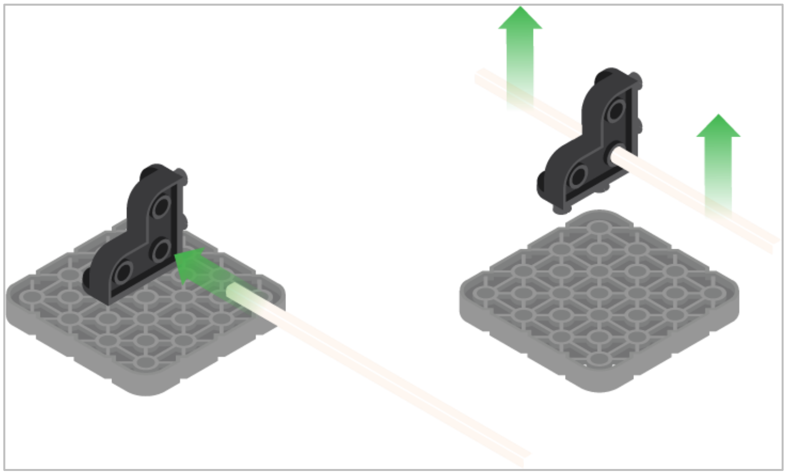


Using your hand to warm a Rubber Shaft Collar

Rubber Softens as it gets Warm

Hold the Rubber Shaft Collars in your hand for 15-30 seconds before you slide them onto a shaft. Holding the Rubber Shaft Collar in your hand will warm and soften the rubber to make it easier to slide onto a shaft.

Removing Connectors from Beams and Plates

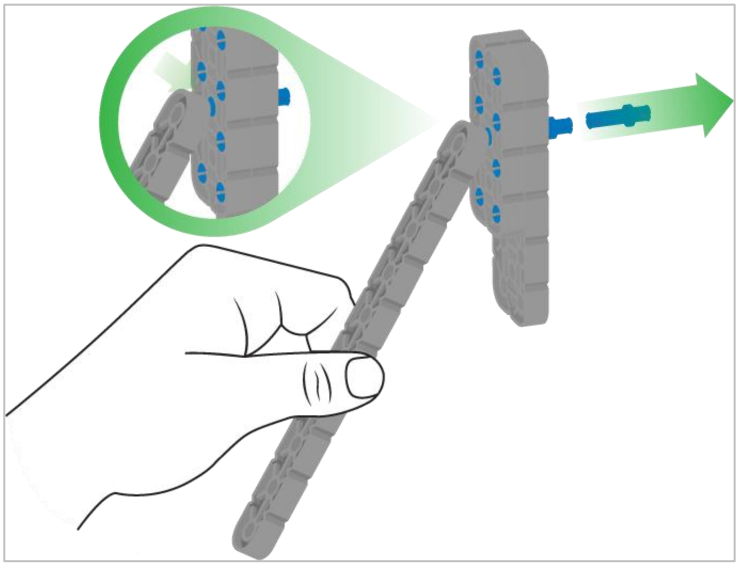


Using a pitch shaft to remove a corner connector

How to Easily Remove Connectors

You can easily remove corner connectors from beams or plates by placing a metal shaft through one of the holes of the corner connector and pulling outward while holding down the beam or plate.

Removing Pins from VEX IQ Beams and Plates

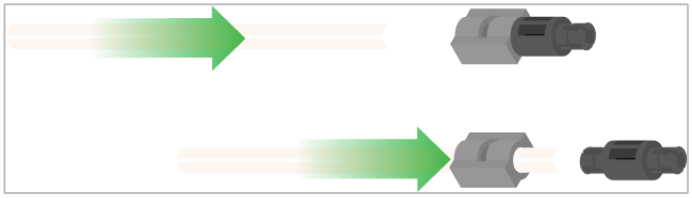


Removing a pin from a plate assembly using a beam

How to Easily Remove Pins from Beams and Plates

You can quickly remove connector pins from beams or plates by pressing a beam against the back of the pin, which partially pushes the pin out, so you can remove it with your fingers. You can use this technique to more easily remove pins from individual plates and beams, or from built structures.

Removing Standoffs from Mini Standoff Connectors

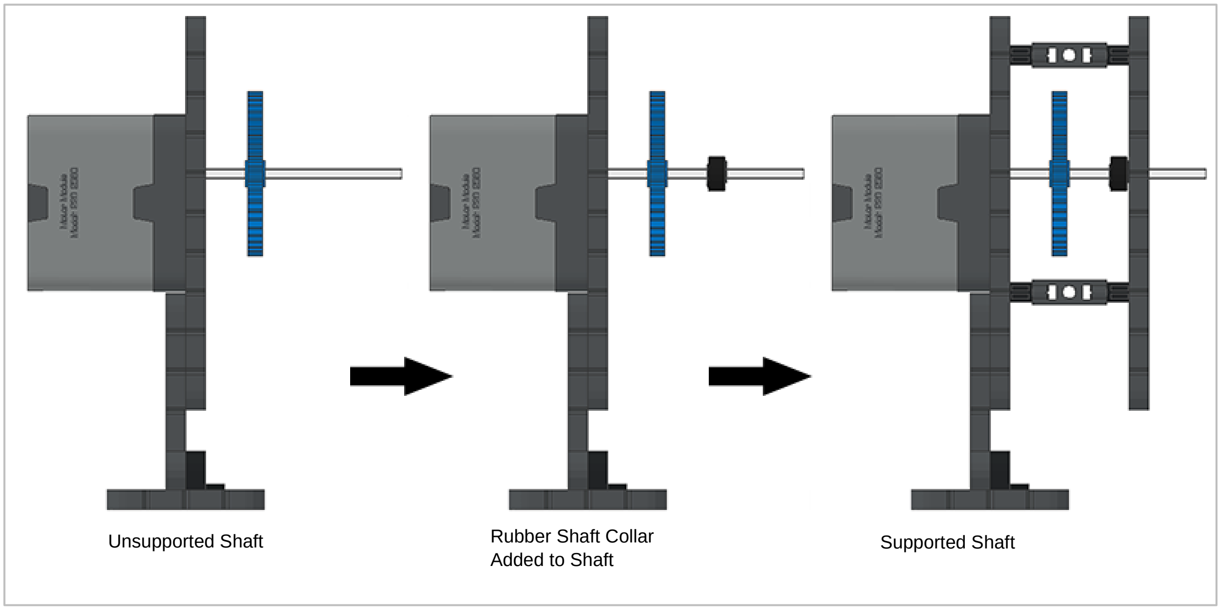


Removal of a standoff from a Mini Standoff Connector

How to Easily Remove Parts from Mini Standoff Connectors

Standoffs and Mini Standoff Connectors can be separated by pushing a shaft through the Mini Standoff Connector. The same technique can be used for parts with similar ends in Mini Standoff Connectors, such as pins.

Supporting Shafts using Rubber Shaft Collars

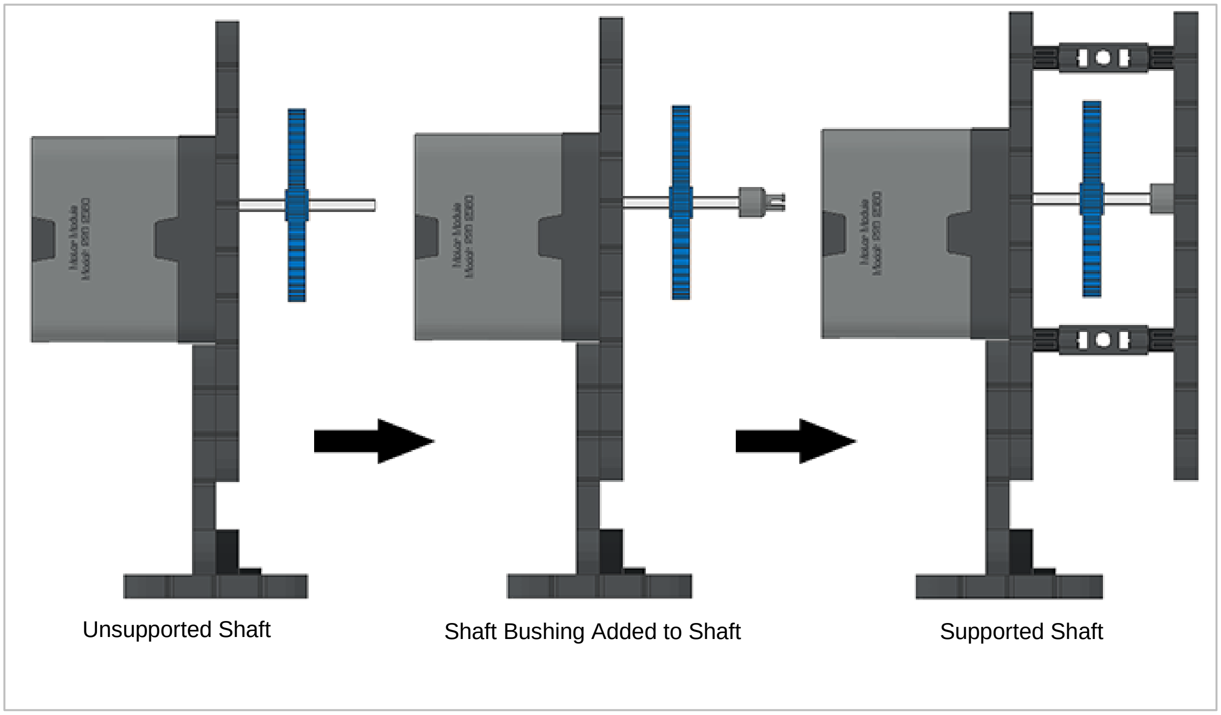


Supporting a shaft with a Rubber Shaft Collar

How to Support Shafts with Rubber Shaft Collars

Shafts can fall out of place or alignment very easily if they aren't supported properly. You can make a shaft more secure and prevent it from falling out of place by putting a Rubber Shaft Collar before the end of it. You can then connect the shaft to a support structure with the shaft collar positioned against it. That will allow the shaft to turn but will prevent it from wobbling or falling out.

Supporting Shafts using Shaft Bushings



Unsupported Shaft

Shaft Bushing Added to Shaft

Supported Shaft

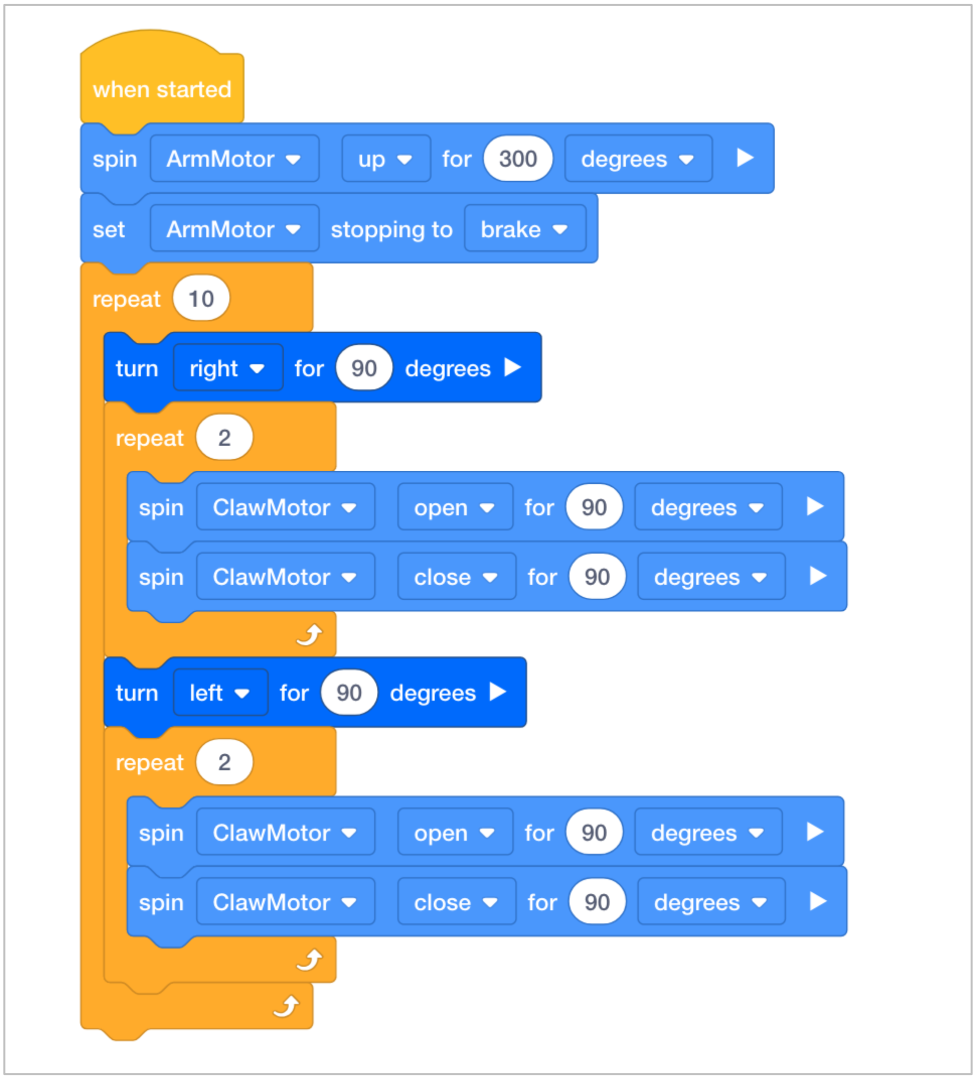
Supporting a shaft with a Shaft Bushing

How to Support Shafts Using Shaft Bushings

Shafts can fall out of place or alignment very easily if they aren't supported properly. You can make a shaft more secure and prevent it from falling out of place by putting a bushing at the end of it. You can then connect that bushing into another beam or additional part. That will allow the shaft to turn but will prevent it from wobbling or falling out.

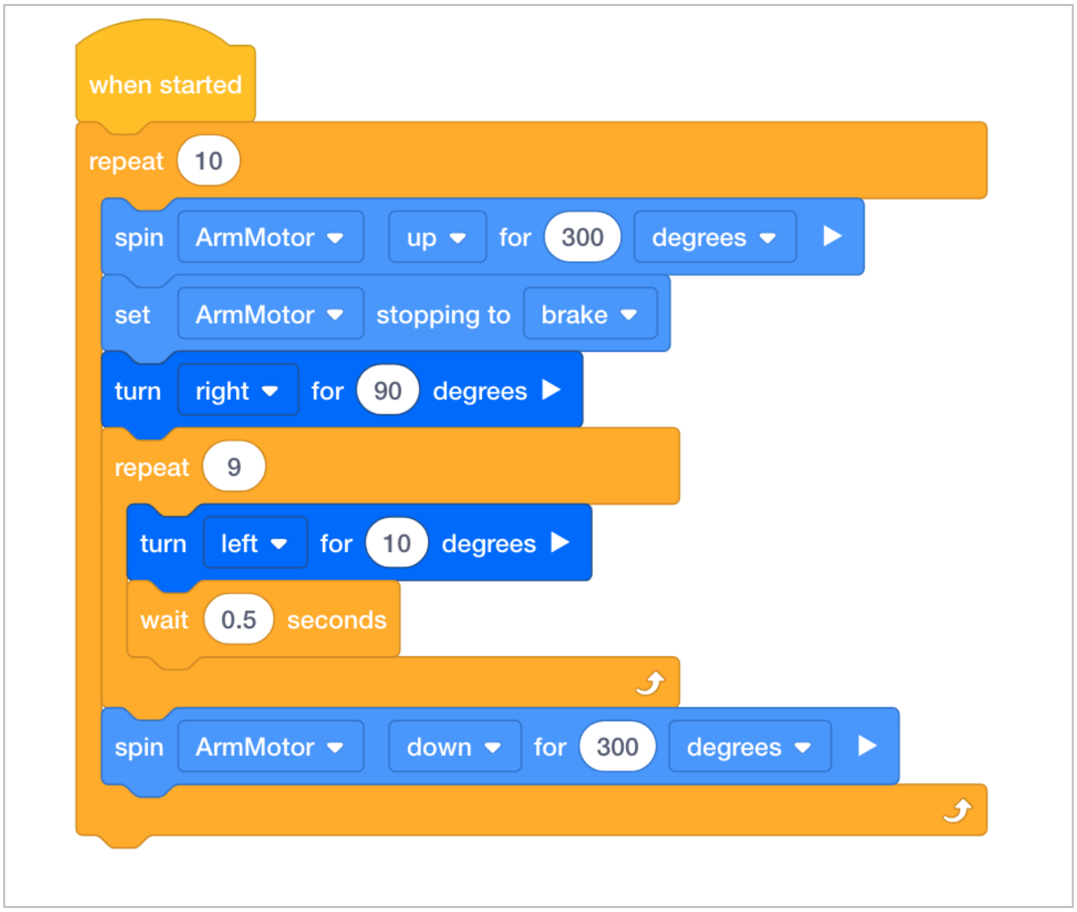
Example Dance Moves

Clap Your Hands!



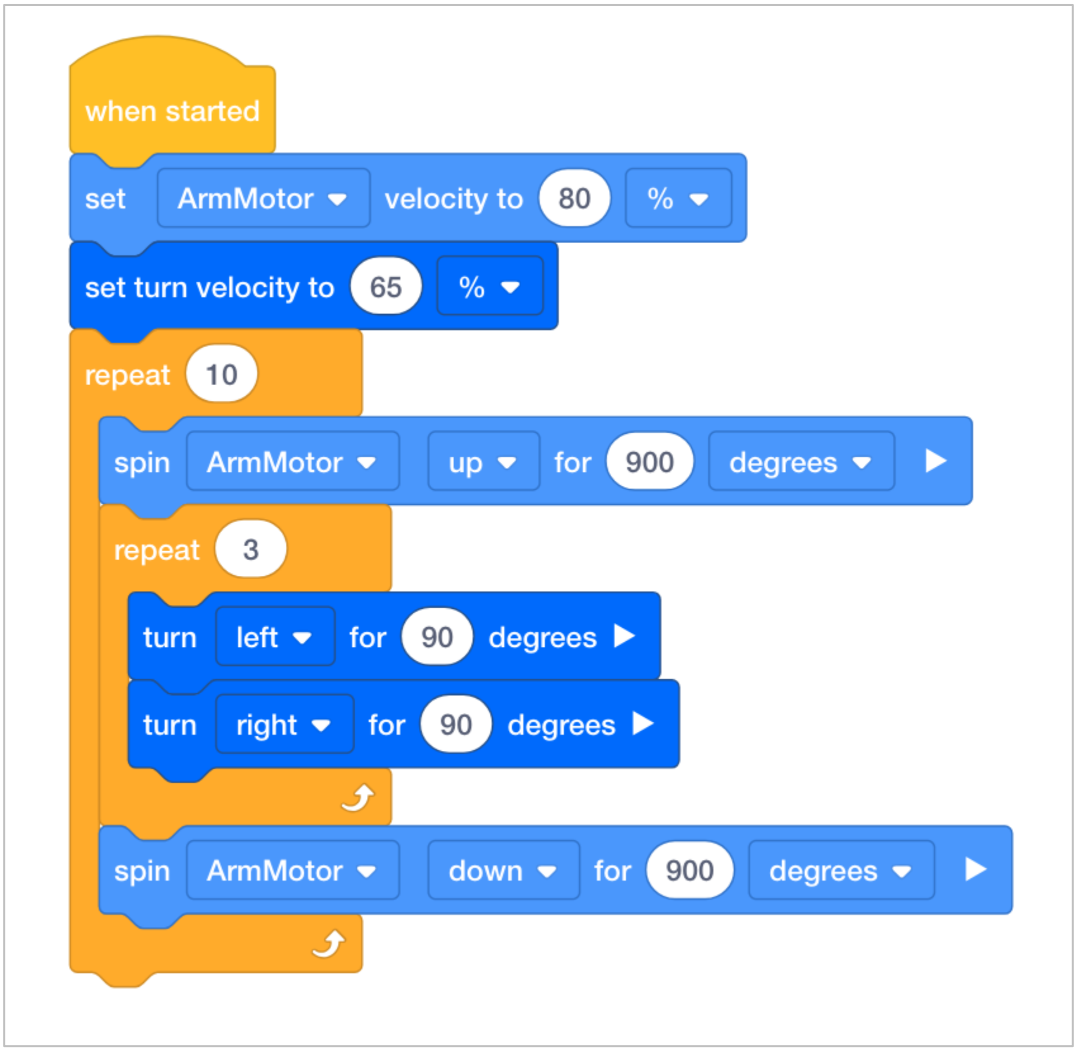
```
when started
spin ArmMotor up for 300 degrees ▶
set ArmMotor stopping to brake
repeat 10
    turn right for 90 degrees ▶
    repeat 2
        spin ClawMotor open for 90 degrees ▶
        spin ClawMotor close for 90 degrees ▶
    turn left for 90 degrees ▶
    repeat 2
        spin ClawMotor open for 90 degrees ▶
        spin ClawMotor close for 90 degrees ▶
```

The Sprinkler



```
when started
repeat 10
    spin ArmMotor up for 300 degrees
    set ArmMotor stopping to brake
    turn right for 90 degrees
    repeat 9
        turn left for 10 degrees
        wait 0.5 seconds
    spin ArmMotor down for 300 degrees
```

Hands in the air!



```
when started
set ArmMotor velocity to 80 %
set turn velocity to 65 %
repeat 10
    spin ArmMotor up for 900 degrees ▶
    repeat 3
        turn left for 90 degrees ▶
        turn right for 90 degrees ▶
    spin ArmMotor down for 900 degrees ▶
```

Organizing Students into Groups

Organize the students into groups before beginning. Students can be organized into groups of two to four students. The following roles can be utilized:

- **Builder** — This person checks that the robot is properly built and ready (e.g., Are all the motors and sensors plugged into the correct ports? Is the Robot Brain turned on?) before a project is run.
- **Programmer** — This person will use the drive block to create a project on the computer or tablet. This person will also download the project to the robot.
- **Driver** — This person selects the project and then runs it on the robot. This person will also be the one to retrieve the robot after it as run.
- **Recorder** — This person writes down all of the group answers/reflections in the engineering notebook.

If there are two students in each group, the students can each choose two roles. If there are three students in a group, one of the students can choose to do two roles. If there are four students in a group, each student can have one role.

Provide the list of roles and their definitions to the students. Once students are in their groups, allow the members to choose their role. Circulate the classroom and make sure that every student has a role. There is an optional collaboration rubric.

Remind the students of roles throughout the exploration. For roles to work, students have to feel as though they will be held accountable for fulfilling those roles. Therefore, interject if you see a student taking over someone else’s role or not fulfilling their assigned role. Reminding students about who is supposed to be doing what can be a useful intervention.

Exploration Roles

Students can be organized groups of two to four students when participating in the exploration.

The following roles can be utilized during the exploration:

- **Builder** -- This person checks that the robot is properly built and ready (e.g. Are all the motors and sensors plugged into the correct port? Is the Robot Brain turned on?) before a project is run.
- **Programmer** -- This person will use the `drive` block to create a project on the computer or tablet. This person will also download the project to the robot.
- **Driver** -- This person selects the project and then runs it on the robot. This person will also be the one to retrieve the robot after it has run.
- **Recorder** -- This person writes down all of the group answers/reflections in the engineering notebook.

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Remind the students of roles throughout the exploration. For roles to work, students have to feel as though they will be held accountable for fulfilling those roles. Therefore, interject if you see a student taking over someone else’s role or not fulfilling their assigned role. Reminders about who is supposed to be doing what can be useful interventions.

Cultivating a Positive Learning Environment

Recognize and reinforce positive behaviors by creating a list of specific behaviors you want to encourage. Examples could include:

- Students self-organizing with the roles within a group
- Students performing each of their roles well within a group
- Students handling the robot and the computers/tablets with care
- Students praising and encouraging one another during the exploration

When students use these behaviors, praise them immediately. Be specific when offering praise. For example, instead of saying, “good job,” you could instead say, “good job carefully returning the Autopilot robot to the correct spot.”

Organizing Students into Groups for the Groove Machine Challenge

Organize the students into groups before beginning the Groove Machine Challenge. Students can be organized into groups of two to four students. The following roles can be utilized:

- **Timer** — Monitors the time remaining for planning and programming the dance, and the performance time (if limit is set).
- **Recorder** — Enters into the engineering notebook any plans for the dance, iterations of the dance program, and observations/refinements during development and performance.
- **Performer** — Downloads and runs the project when ready.
- **Director** — Ensures the robot does not fall over or collide with anything.

If there are two students in each group, the students can each choose two roles. If there are three students in a group, one of the students can choose to do two roles. If there are four students in a group, each student can have one role.

Provide the list of roles and their definitions to the students. Once students are in their groups, allow the members to choose their role. Circulate the classroom and make sure that every student has a role. There is an optional collaboration rubric.

Remind the students of roles throughout the challenge. For roles to work, students have to feel as though they will be held accountable for fulfilling those roles. Therefore, interject if you see a student taking over someone else’s role or not fulfilling their assigned role. Reminding students about who is supposed to be doing what can be a useful intervention.

<u>All students</u> should participate in planning and programming the dance. The "Call and Code" procedure can be used to involve all students:

- The **Recorder** itemizes the movements needed within the project.
- The **Timer** adds the distances of the movements and other parameters to the movements listed by the Recorder.
- The **Director** names all of the blocks needed for the project in sequence and the parameters needed. This includes any Control blocks needed for repetitive movements.

- The **Performer** adds the blocks to the project in VEXcode IQ Blocks.
- **All** students should review the programming closely and provide feedback when needed.

Organizing Students into Groups for an Activity

Organize the students into groups before beginning the activity. Students can be organized into groups of two to four students. The following roles can be utilized during the activity:

- **Builder** — This person checks that the robot is properly built and ready (e.g., Are all the motors and sensors plugged into the correct ports? Is the Robot Brain turned on?) before a project is run.
- **Programmer** — This person will use the drive block to create a project on the computer or tablet. This person will also download the project to the robot.
- **Driver** — This person selects the project and then runs it on the robot. This person will also be the one to retrieve the robot after it as run.
- **Recorder** — This person writes down all of the group answers/reflections in the engineering notebook.

If there are two students in each group, the students can each choose two roles. If there are three students in a group, one of the students can choose to do two roles. If there are four students in a group, each student can have one role.

Provide the list of roles and their definitions to the students. Once students are in their groups, allow the members to choose their role. Circulate the classroom and make sure that every student has a role. There is an optional collaboration rubric.

Remind the students of roles throughout the exploration. For roles to work, students have to feel as though they will be held accountable for fulfilling those roles. Therefore, interject if you see a student taking over someone else's role or not fulfilling their assigned role. Reminding students about who is supposed to be doing what can be a useful intervention.