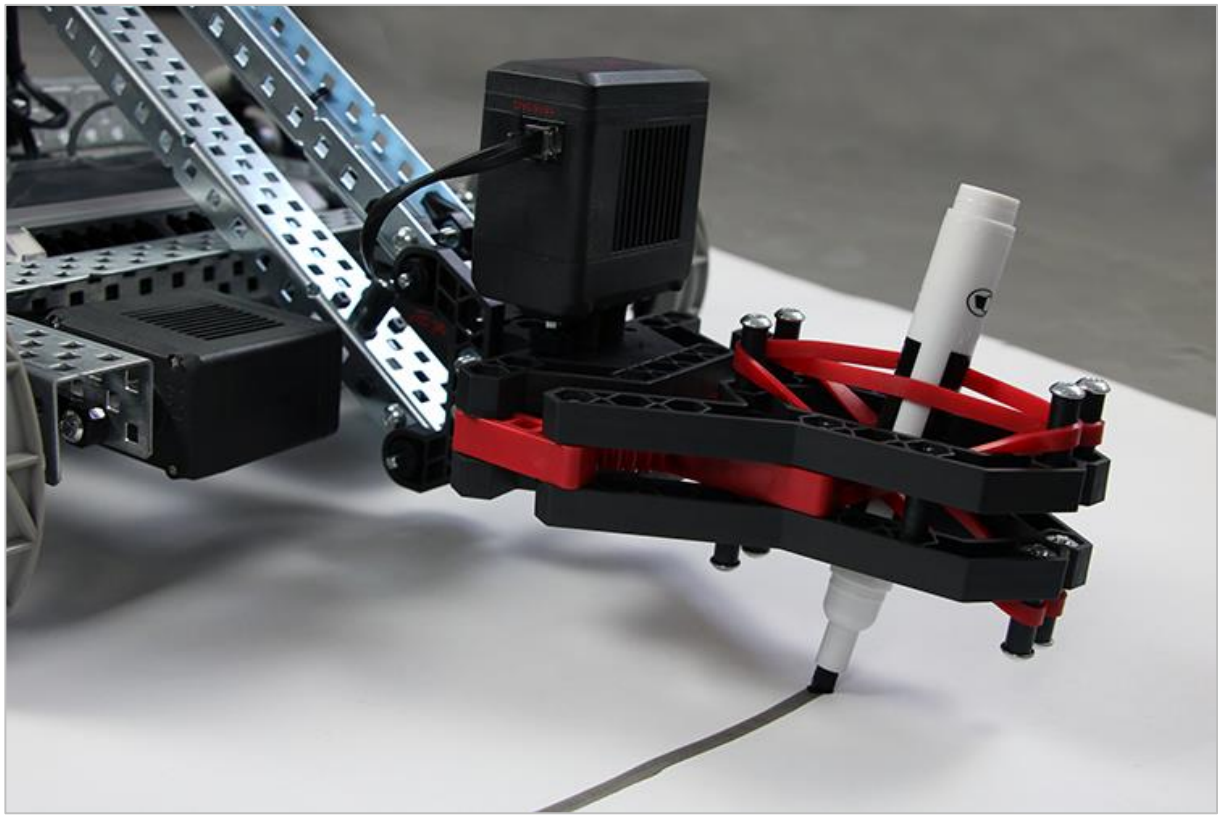
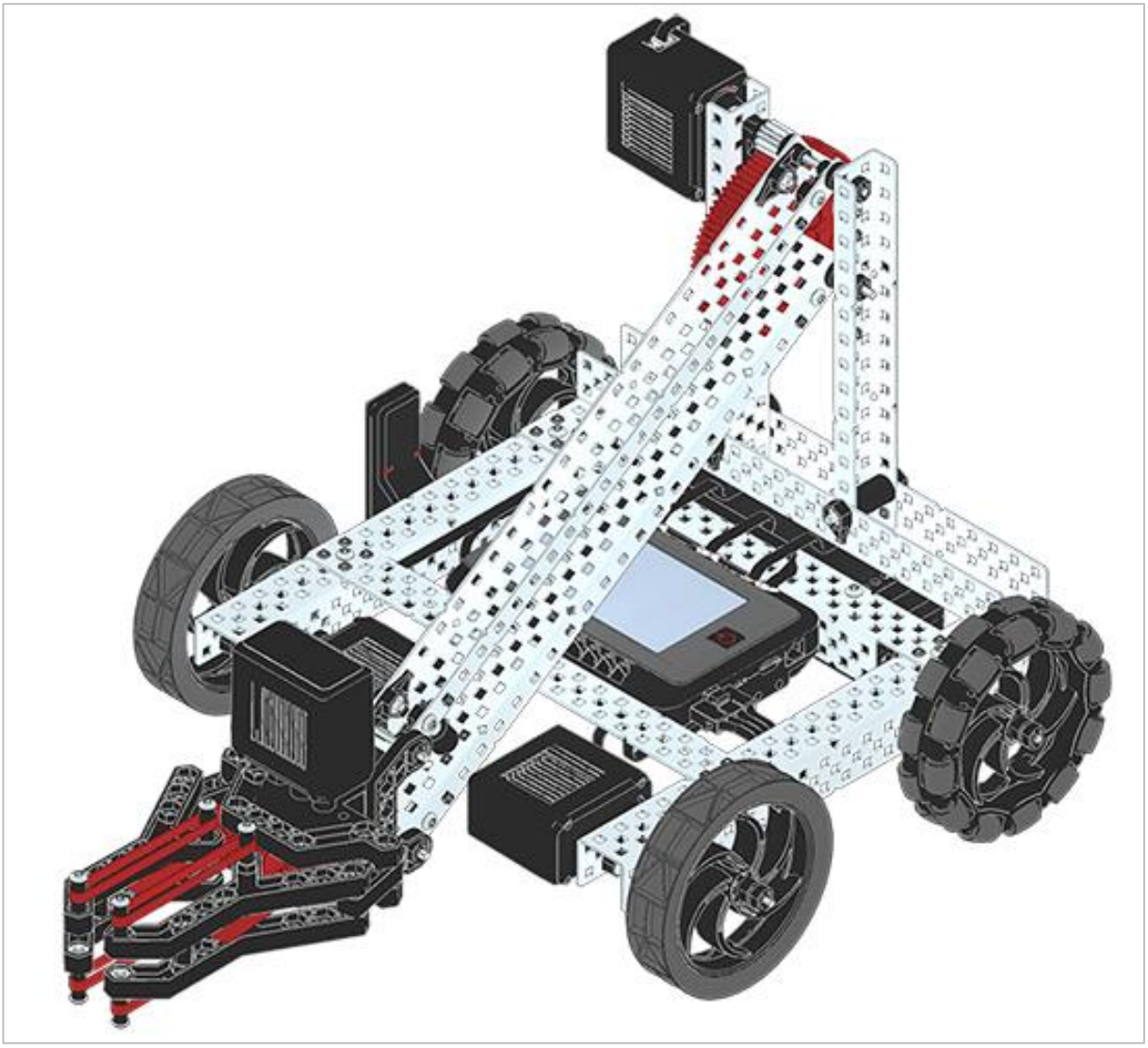
It's a Draw!



Test your robot drawing skills in It's a Draw!

Discover new hands-on builds and programming opportunities to further your understanding of a subject matter.

The Completed Look of the Build



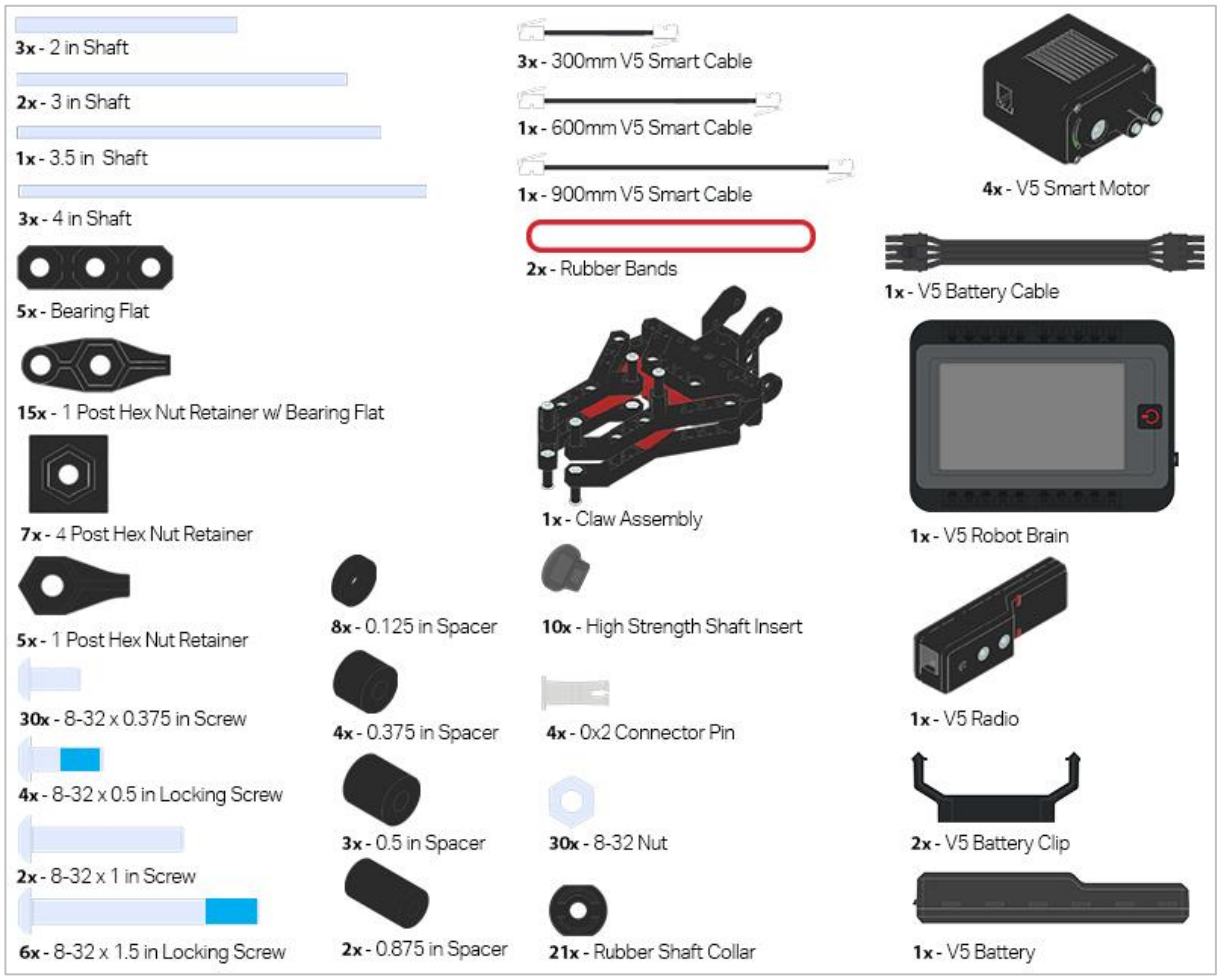
Completed VEX V5 Clawbot

The VEX V5 Clawbot is an extension of the VEX V5 Speedbot that can be programmed to move around and interact with objects.

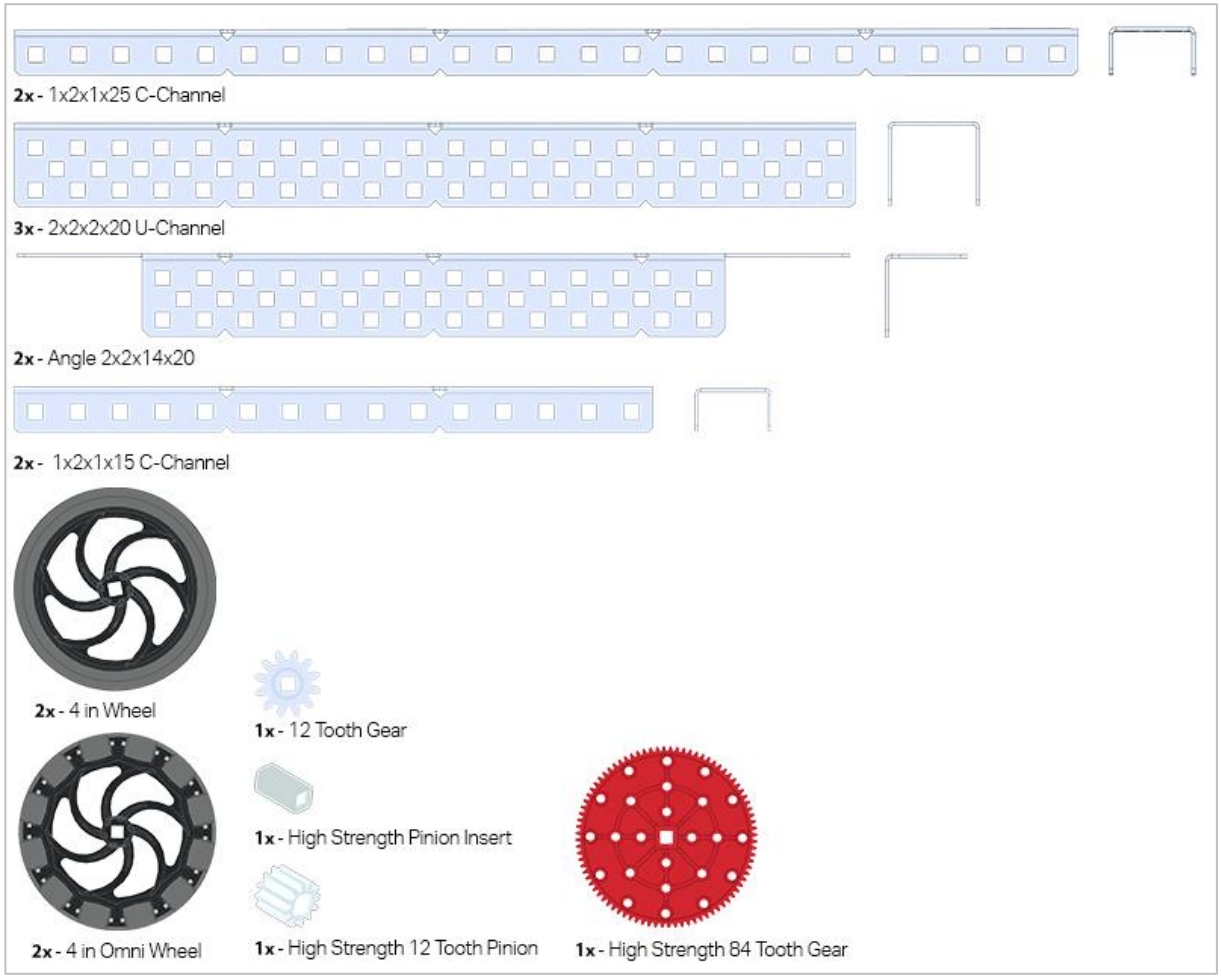
Parts Needed: Part 1

Can be built with:

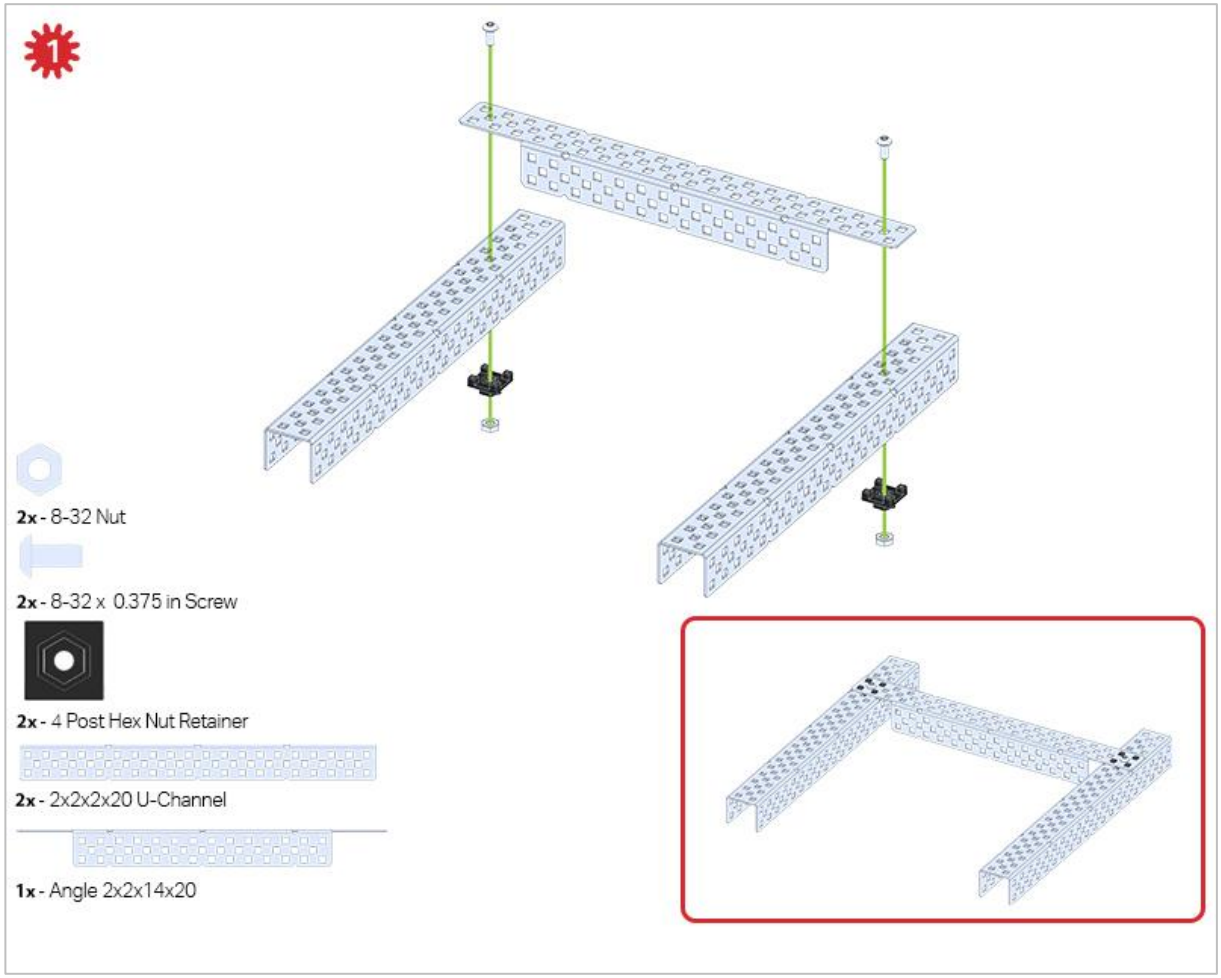
- VEX V5 Classroom Starter Kit



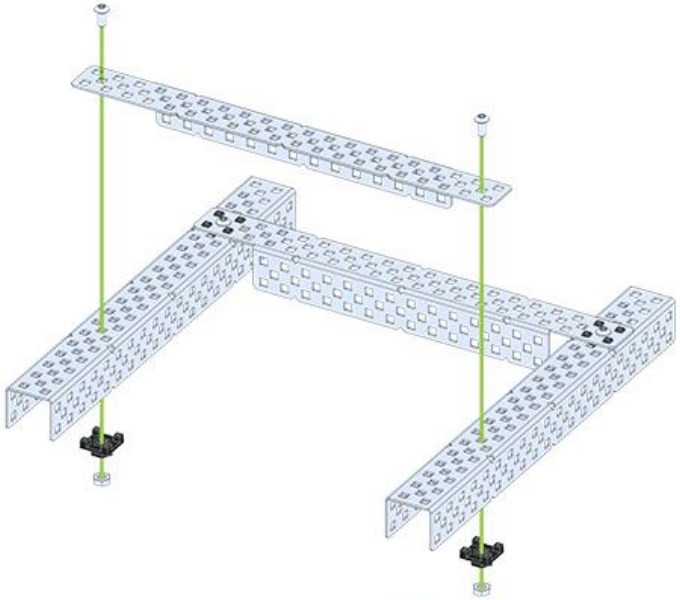
Parts Needed: Part 2



Build Instructions



2

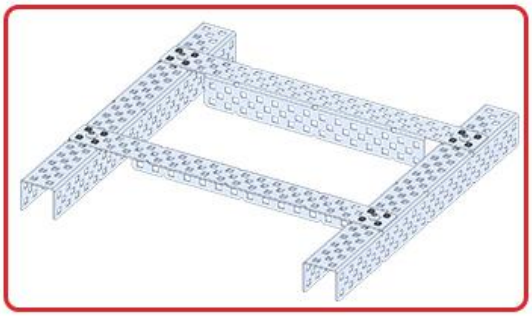


2x - 8-32 Nut

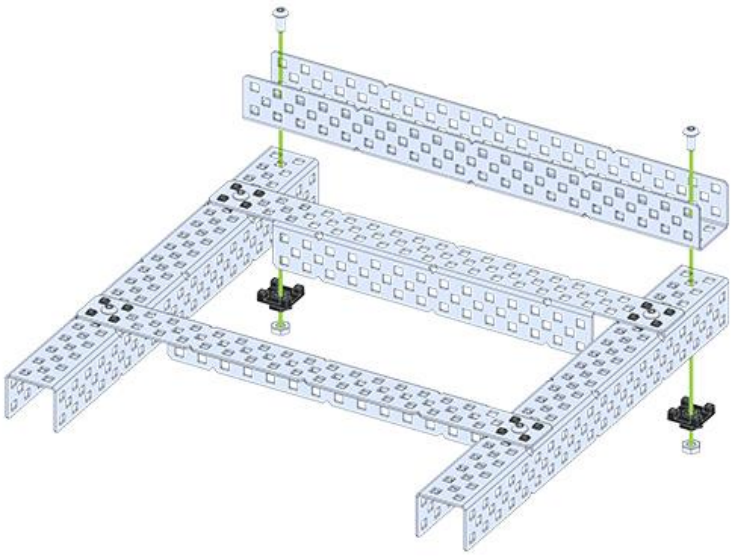
2x - 8-32 x 0.375 in Screw

2x - 4 Post Hex Nut Retainer

1x - Angle 2x2x14x20



3

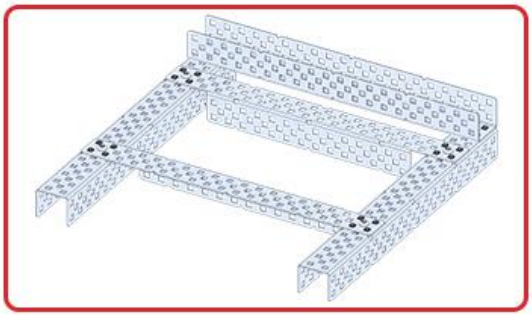


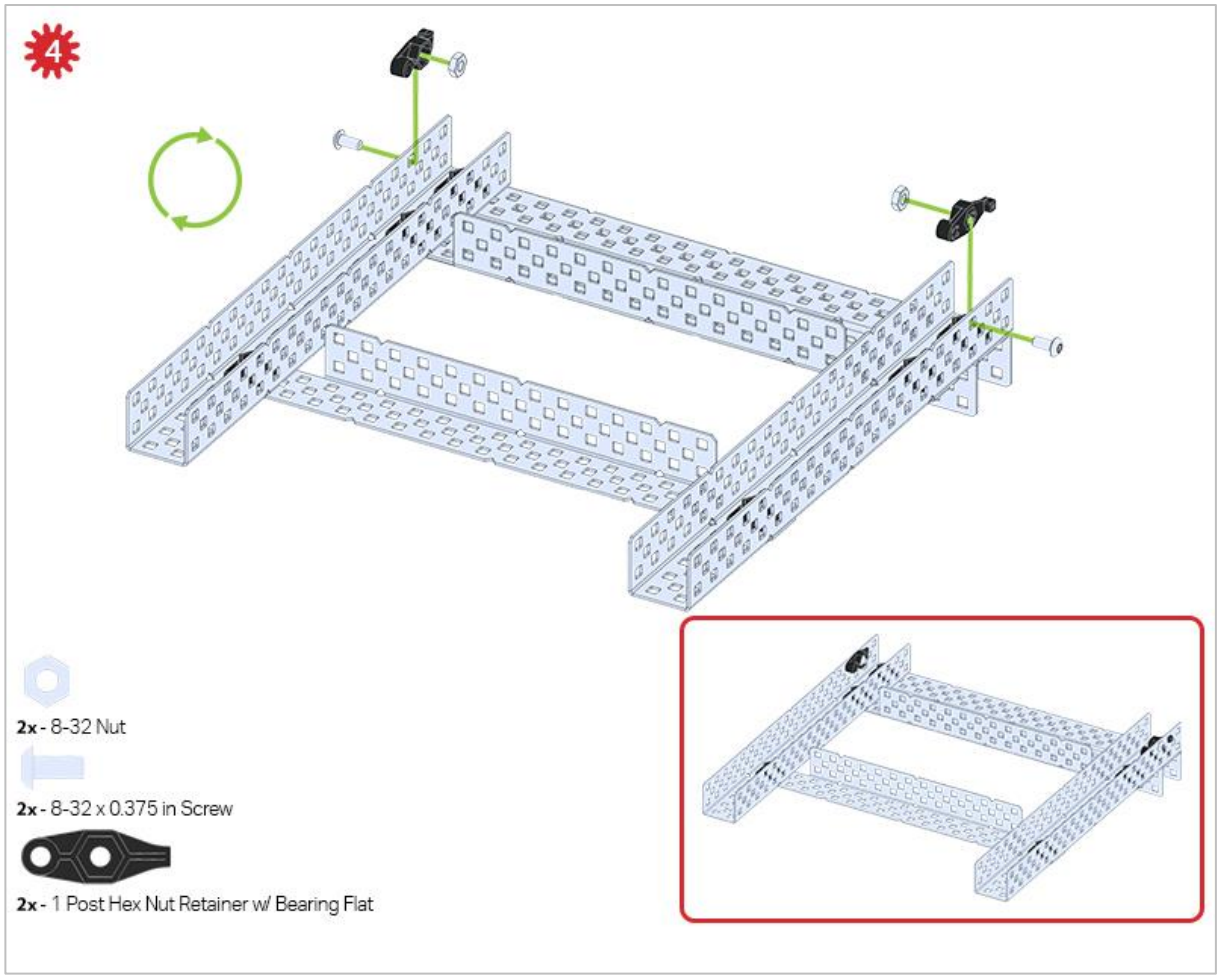
2x - 8-32 Nut

2x - 8-32 x 0.375 in Screw

2x - 4 Post Hex Nut Retainer

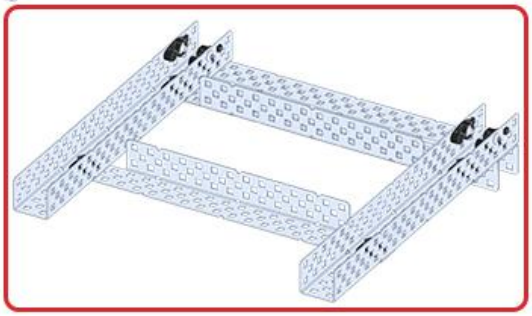
1x - 2x2x2x20 U-Channel





The green icon indicates that the build needs to be flipped over (upside down).

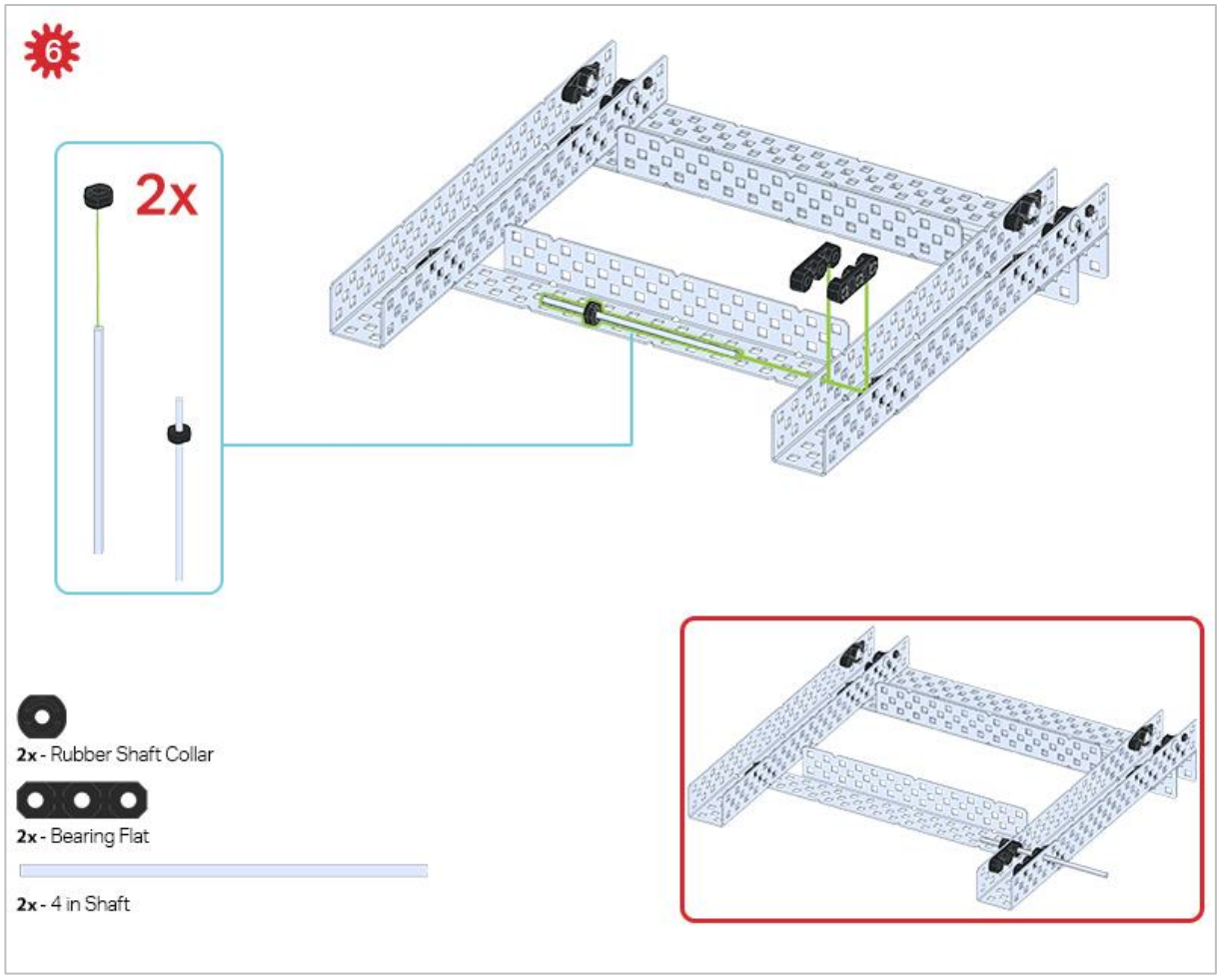
5



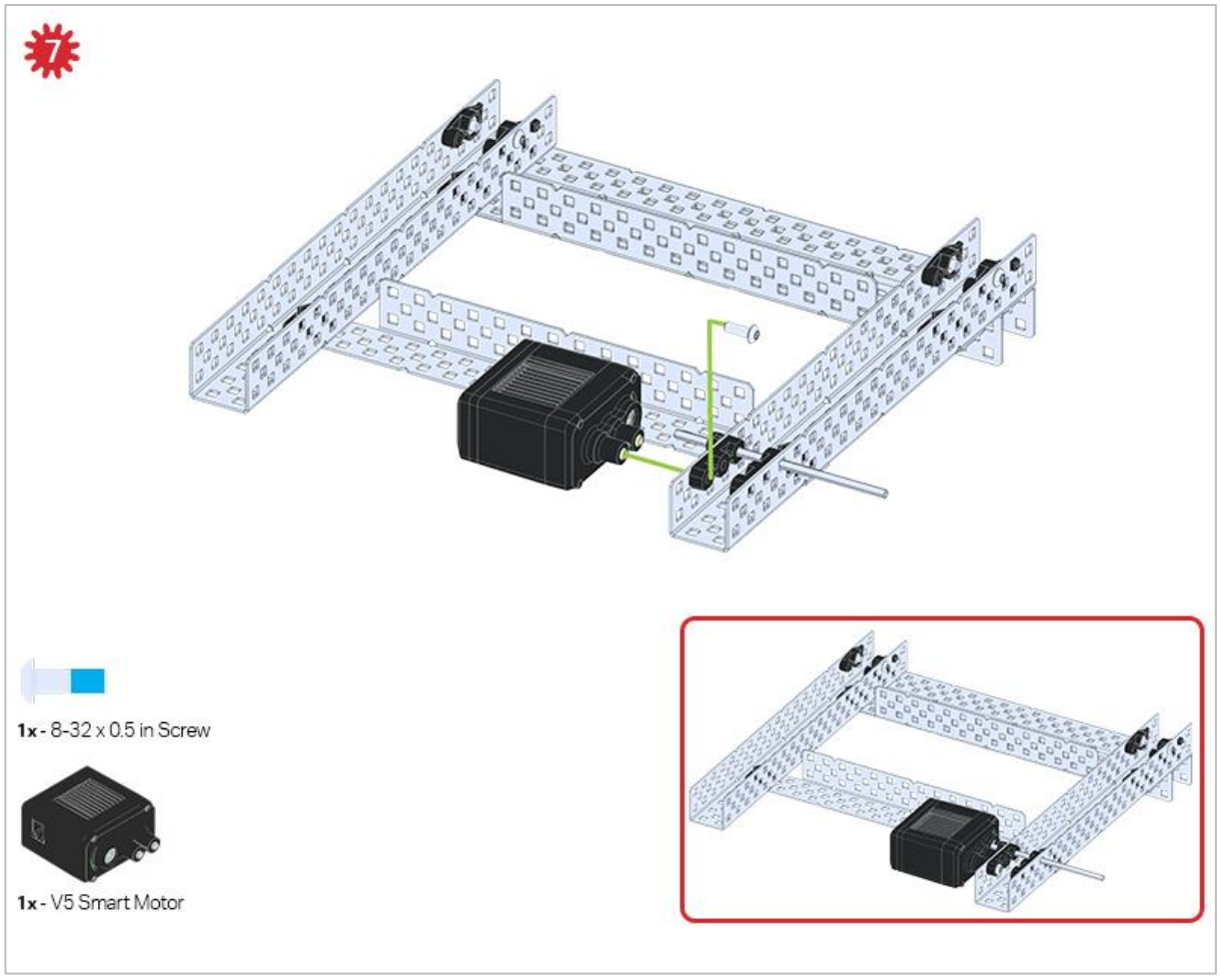
2x - 8-32 Nut

2x - 8-32 x 0.375 in Screw

2x - 1 Post Hex Nut Retainer w/ Bearing Flat

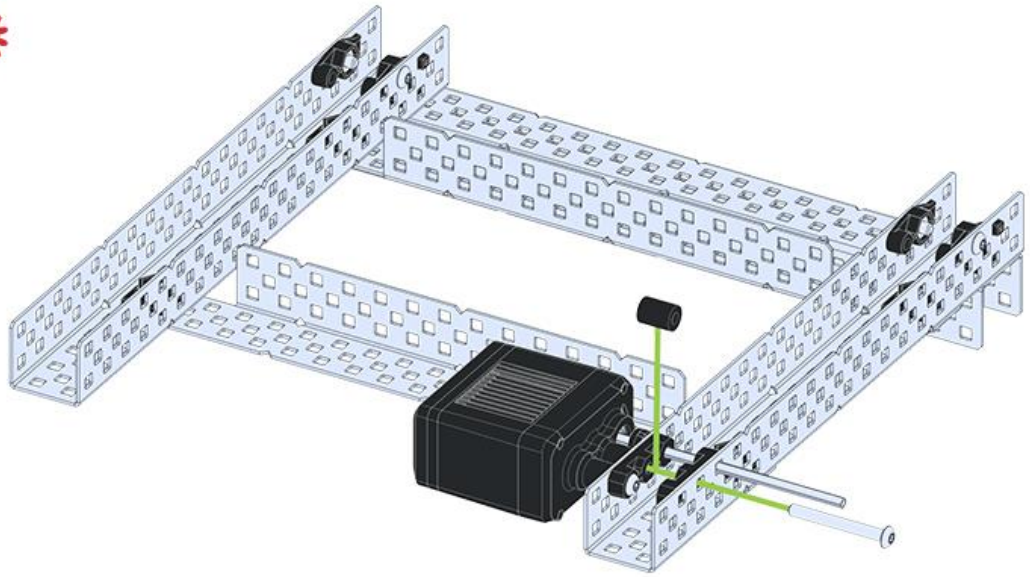


Only one of the two sub-assemblies made in this step is used right now. The other will be used later in step 9.



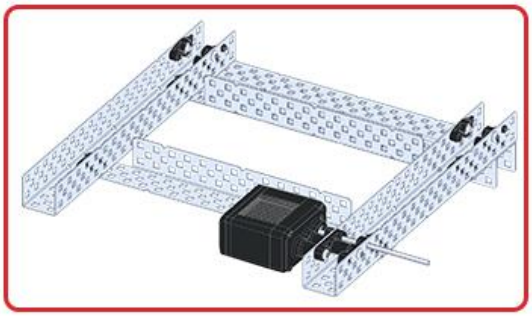
Make sure your Smart Motors are oriented in the correct direction (screw holes facing the outside of the build and the shaft hole towards the inside).

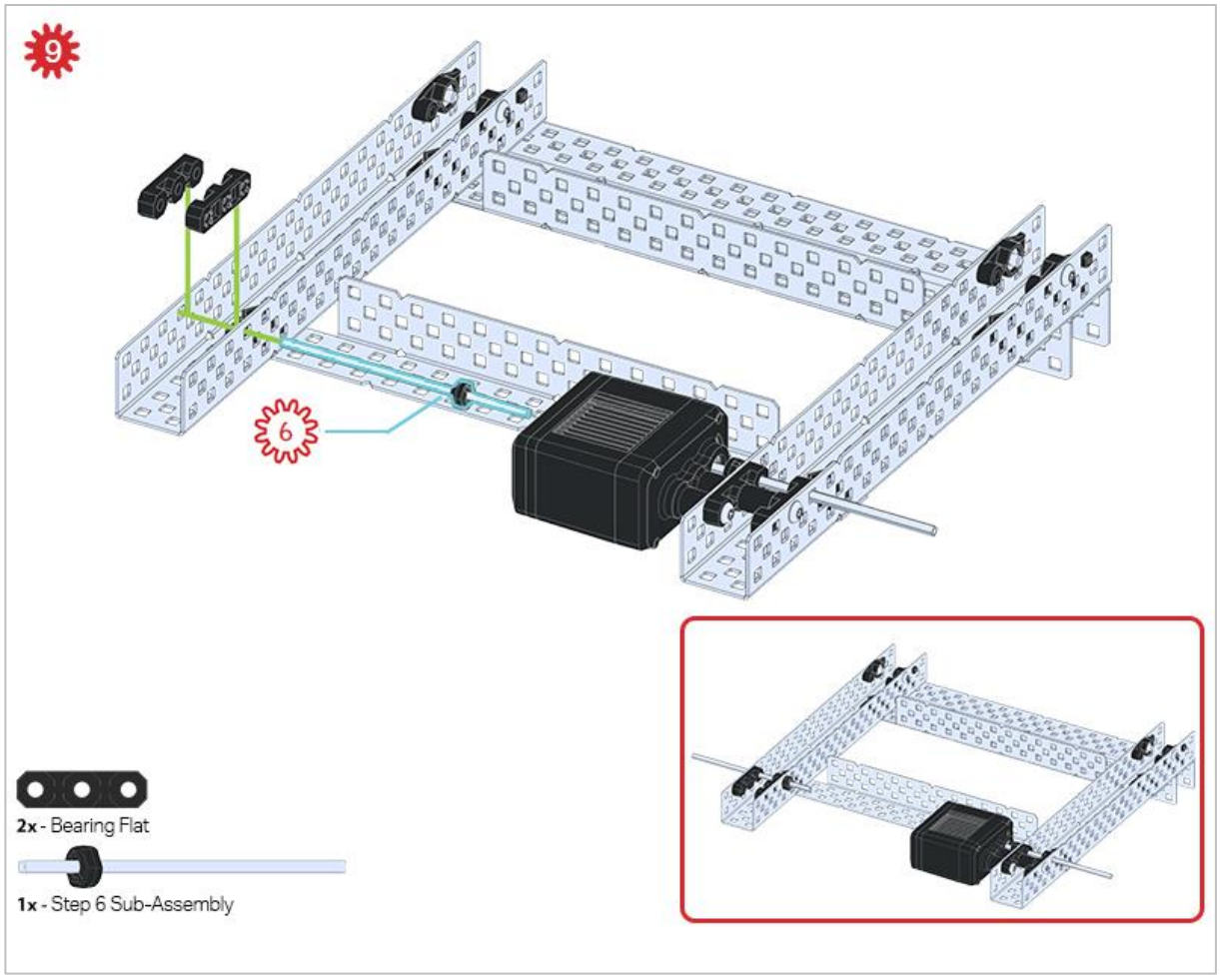
8

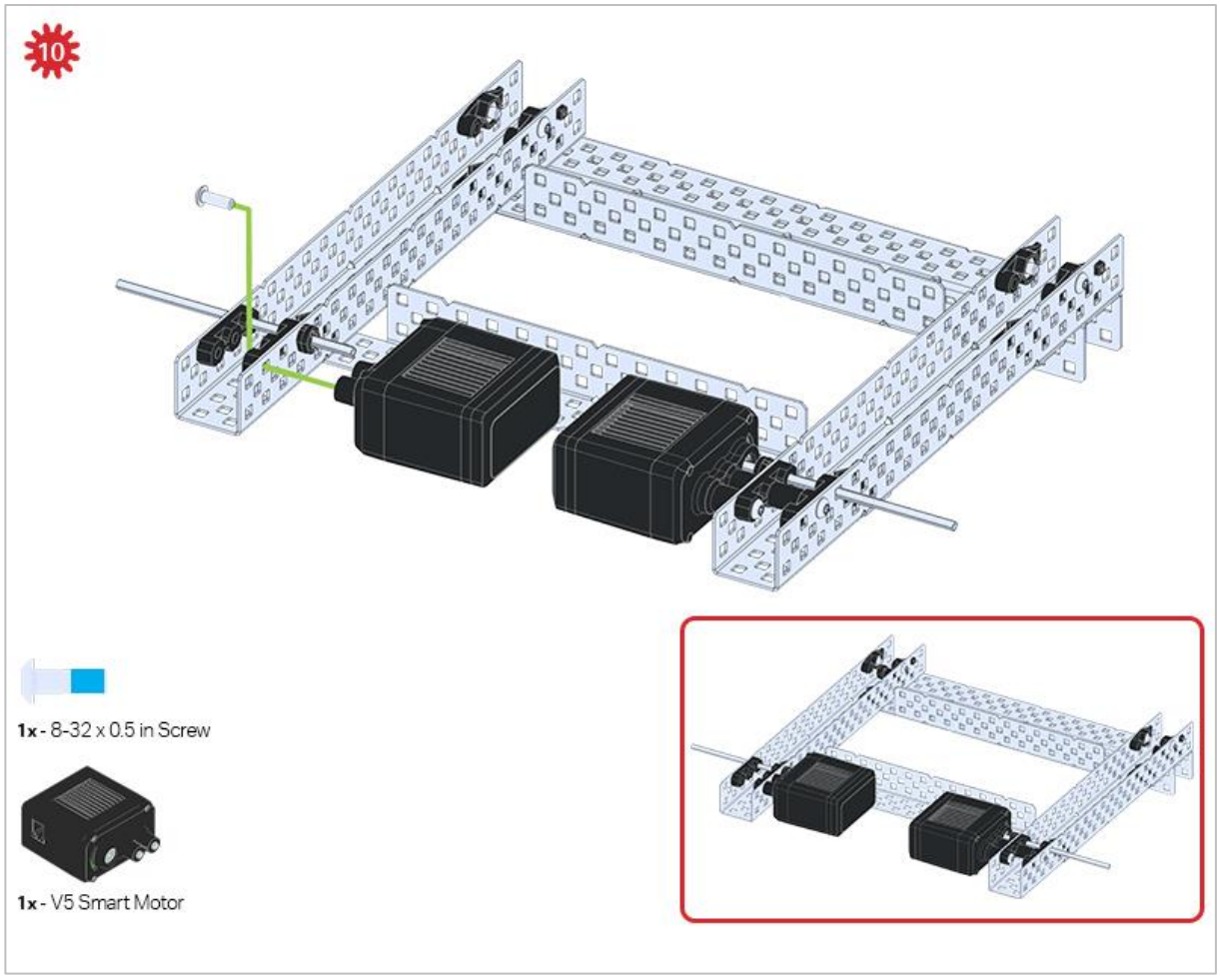


1x - 0.5 in Spacer

1x - 8-32 x 1.5 in Screw

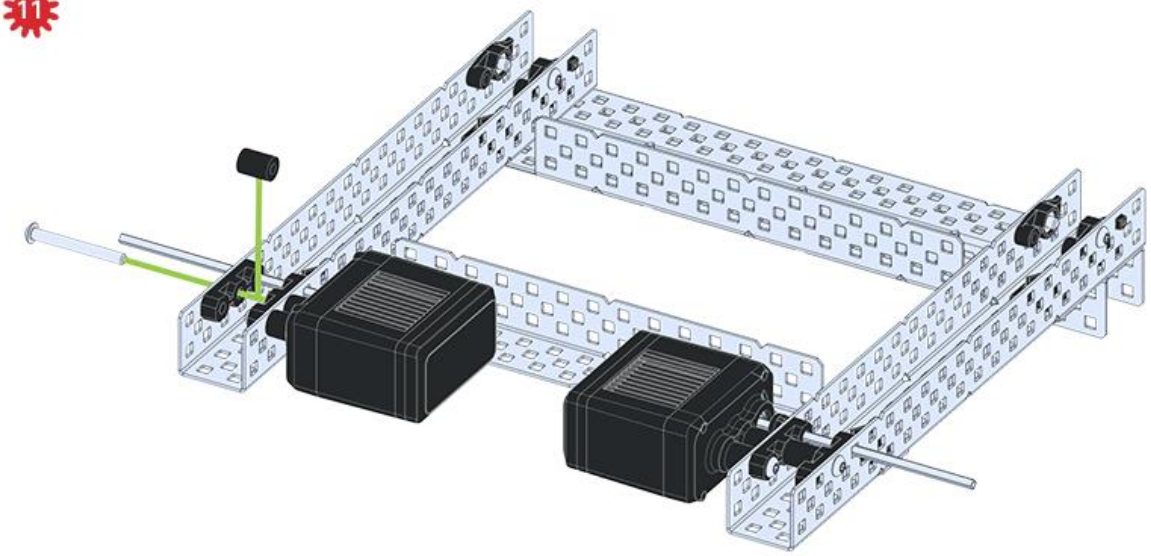



9
6
2x - Bearing Flat
1x - Step 6 Sub-Assembly



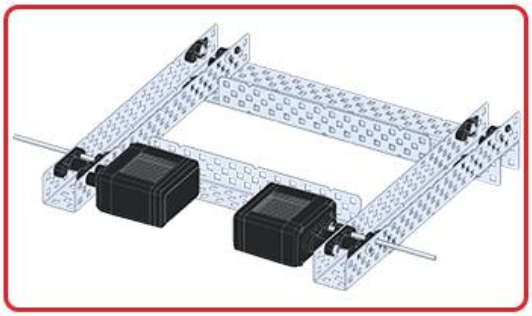
Make sure your Smart Motors are oriented in the correct direction (screw holes facing the outside of the build and the shaft hole towards the inside).

11

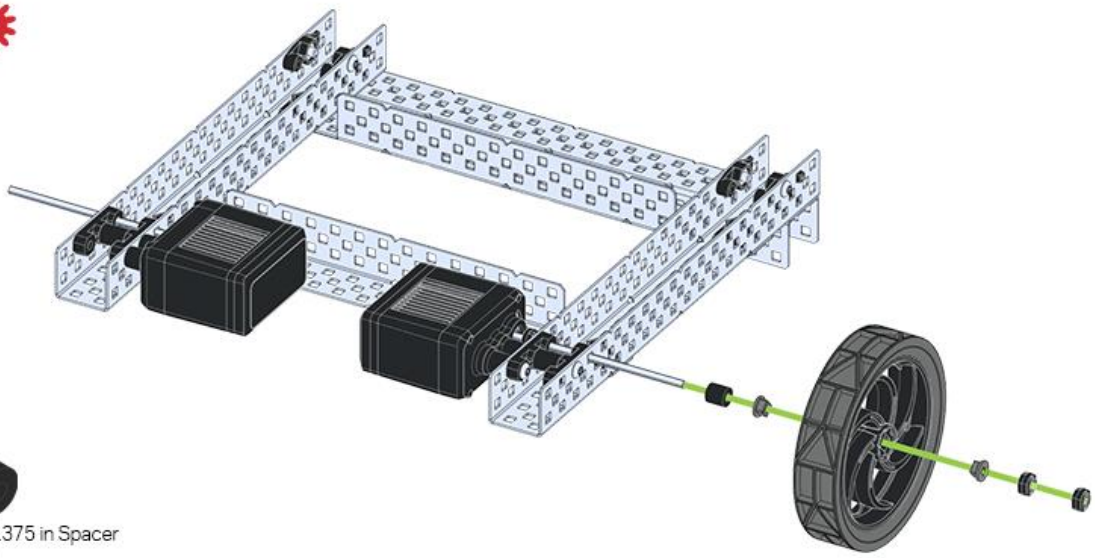


1x - 0.5 in Spacer

1x - 8-32 x 1.5 in Screw



12

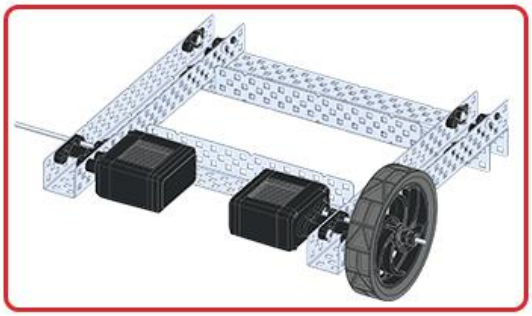


1x - 0.375 in Spacer

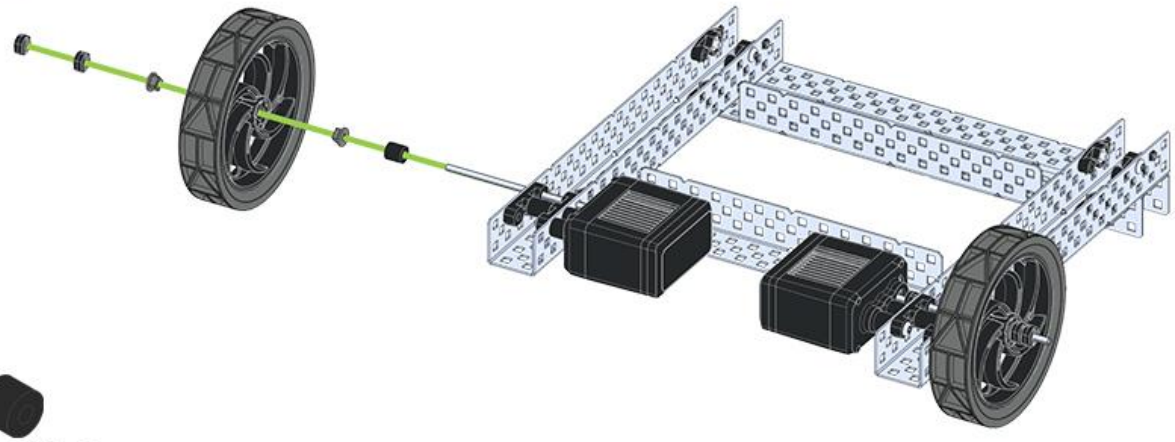
2x - Rubber Shaft Collar

1x - 4 in Wheel

2x - High Strength Shaft Insert



13

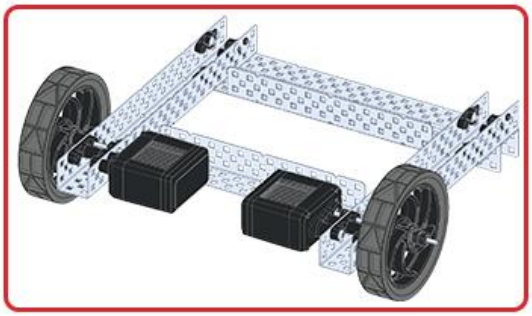


1x - 0.375 in Spacer

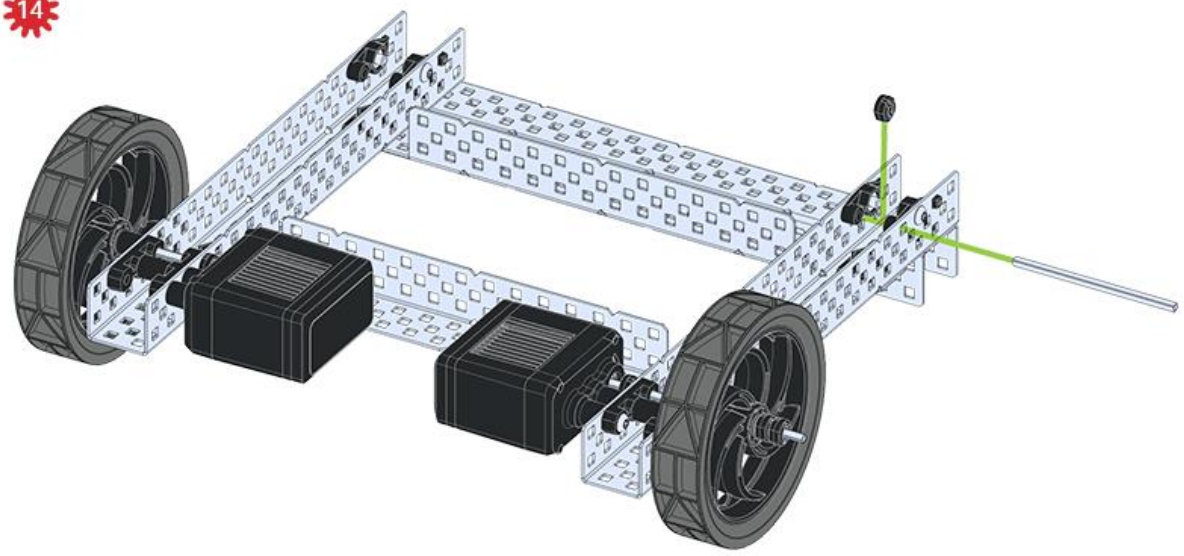
2x - Rubber Shaft Collar

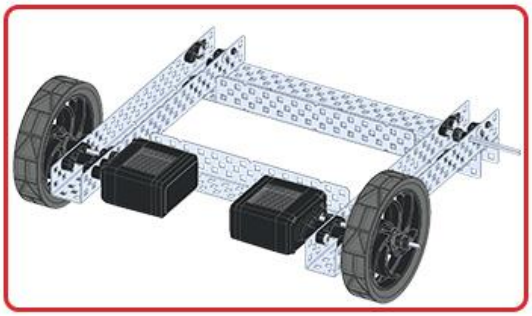
1x - 4 in Wheel

2x - High Strength Shaft Insert



14

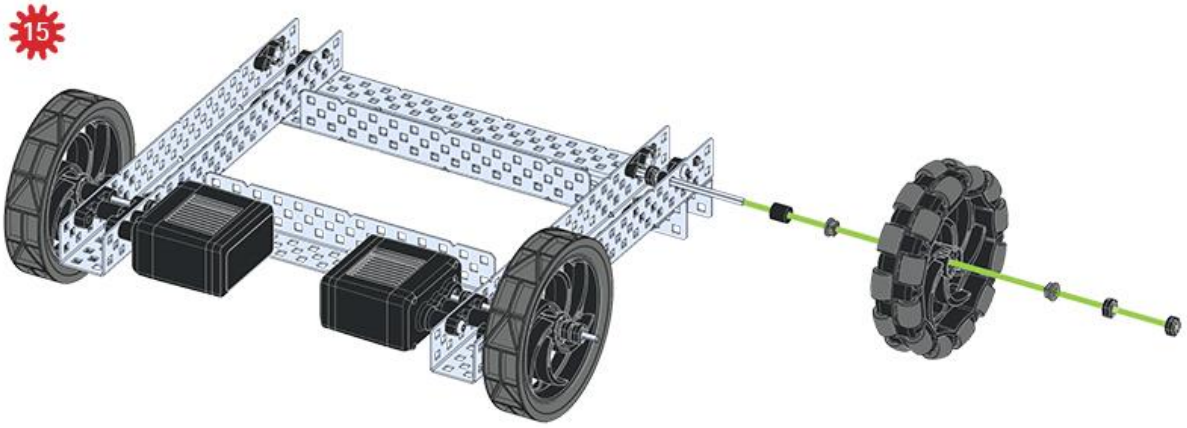




1x - Rubber Shaft Collar

1x - 3 in Shaft

15

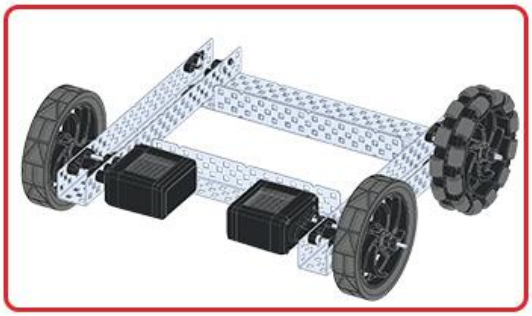


1x - 0.375 in Spacer

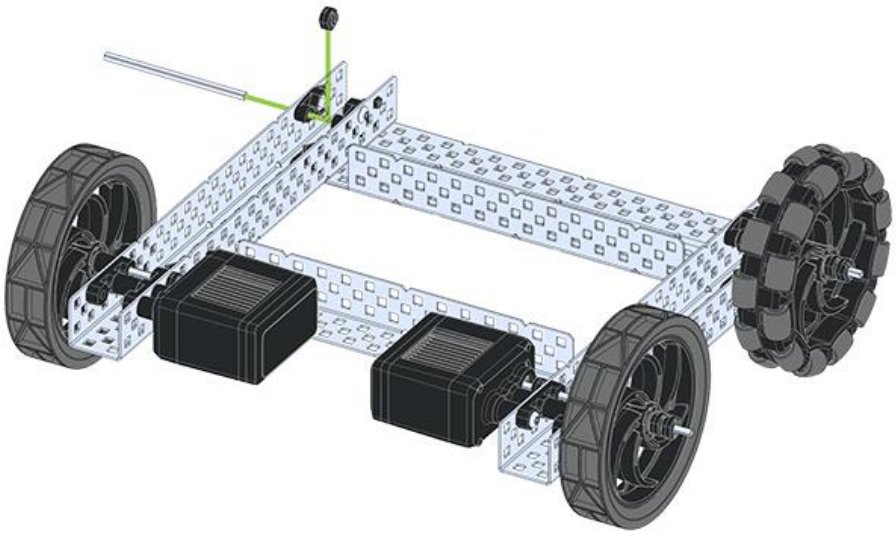
2x - Rubber Shaft Collar

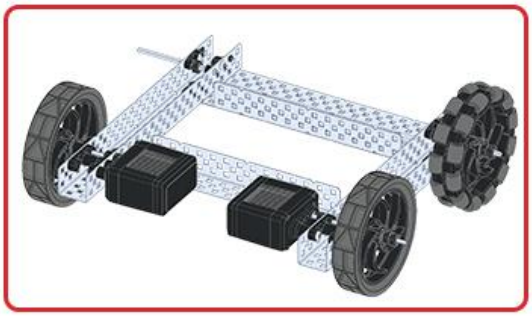
1x - 4 in Omni Wheel

2x - High Strength Shaft Insert



16

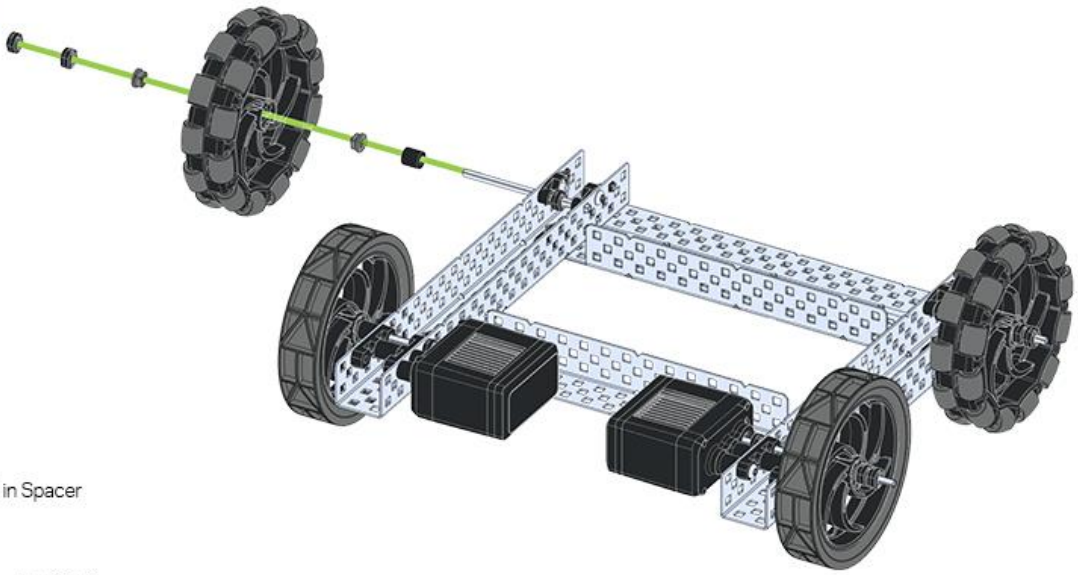




1x - Rubber Shaft Collar

1x - 3 in Shaft

17

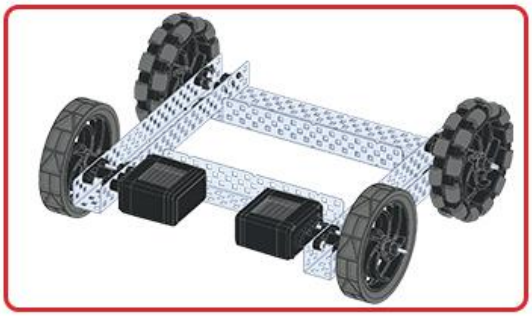


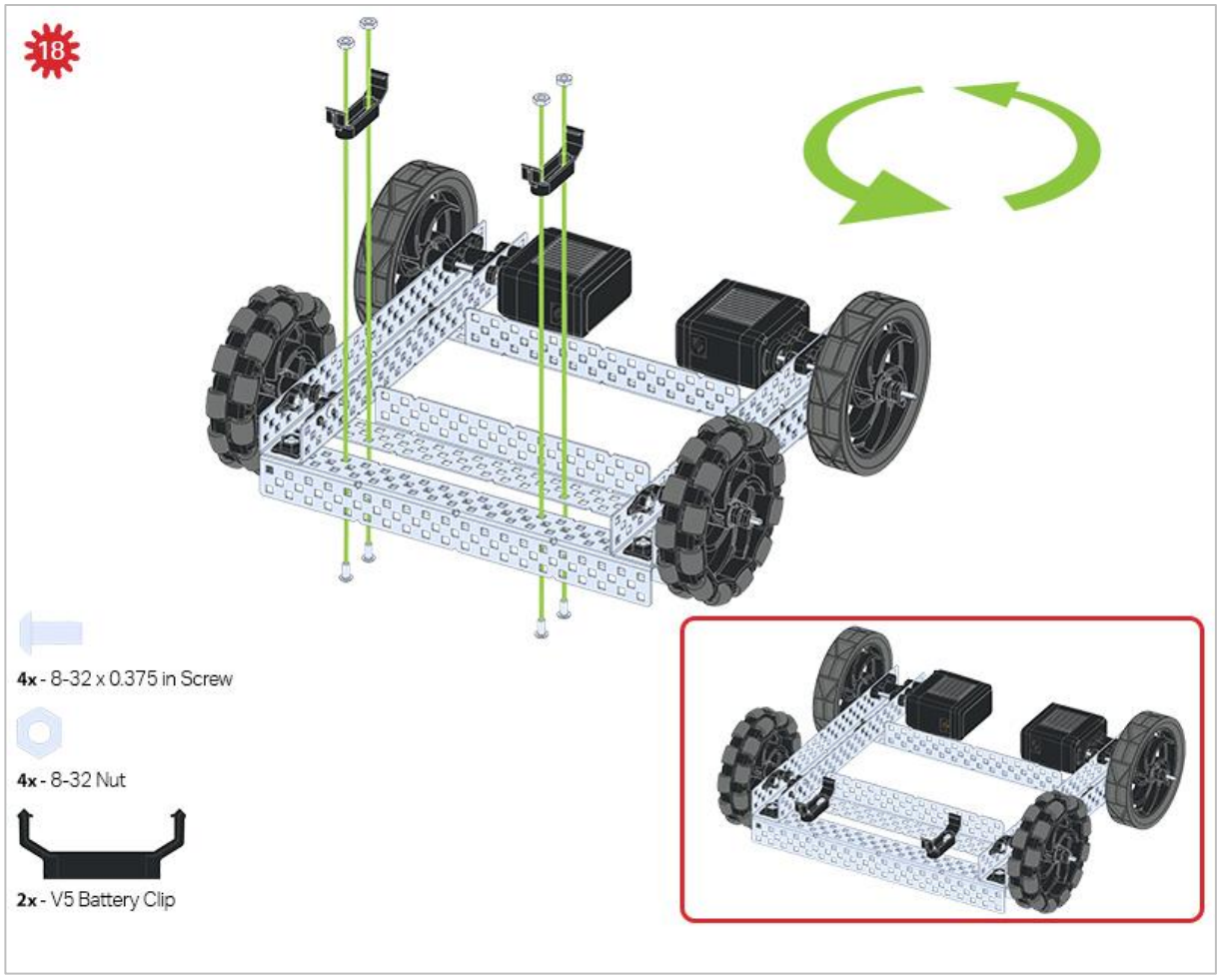
1x - 0.375 in Spacer

2x - Rubber Shaft Collar

1x - 4 in Omni Wheel

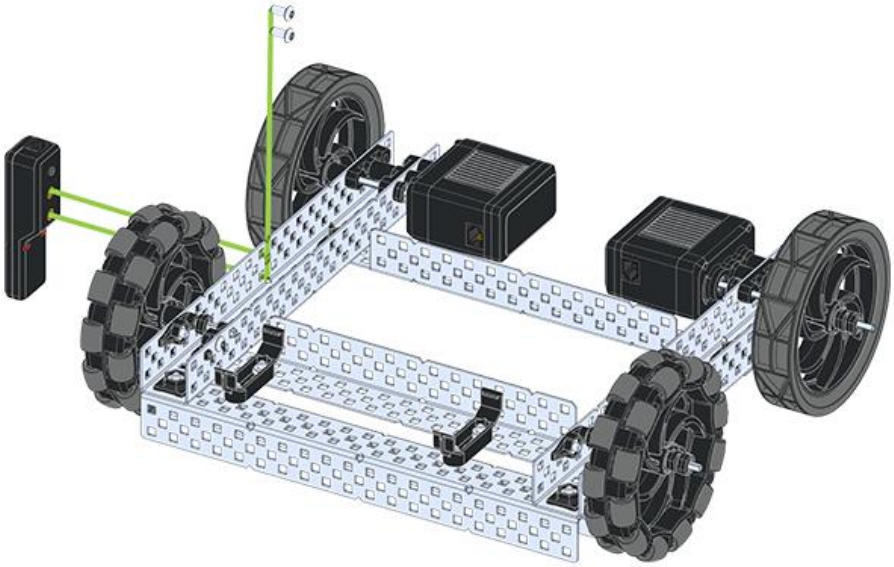
2x - High Strength Shaft Insert





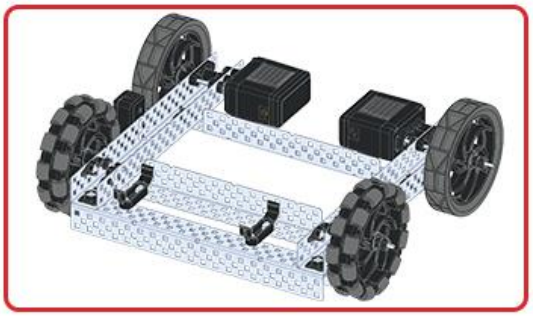
The green icon indicates that the build needs to be rotated (180 degrees).

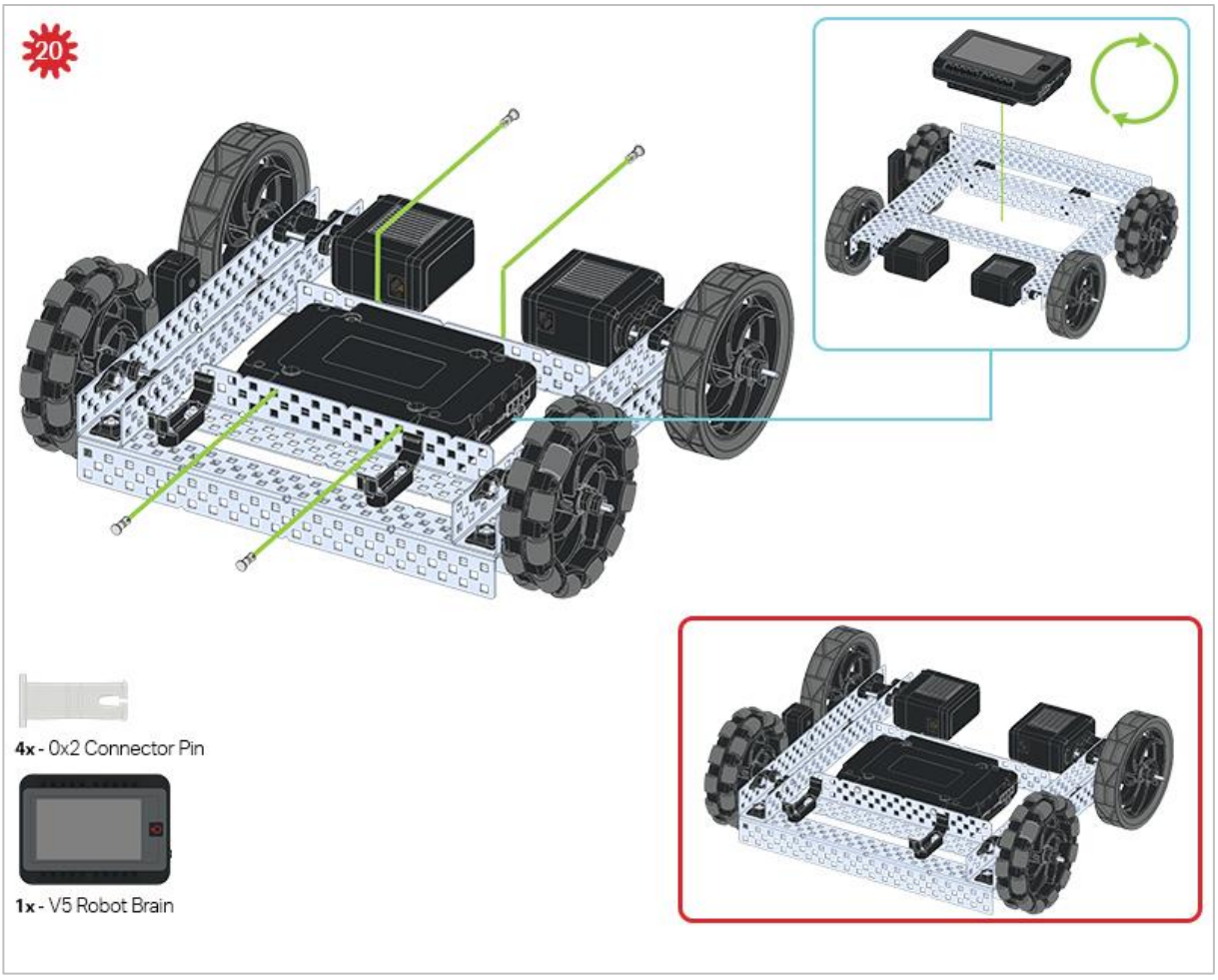
19



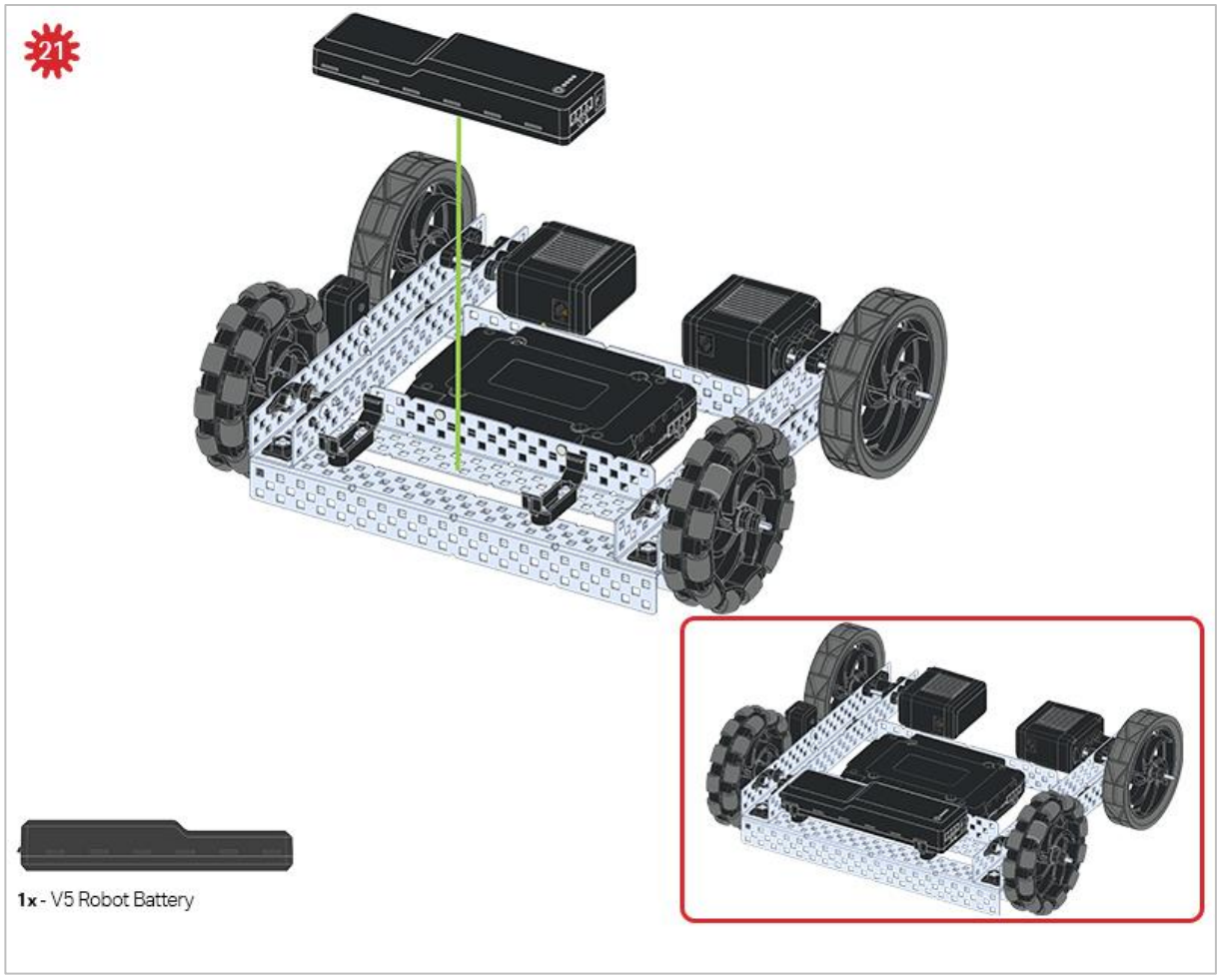
1x - V5 Radio

2x - 8-32 x 0.375 in Screw

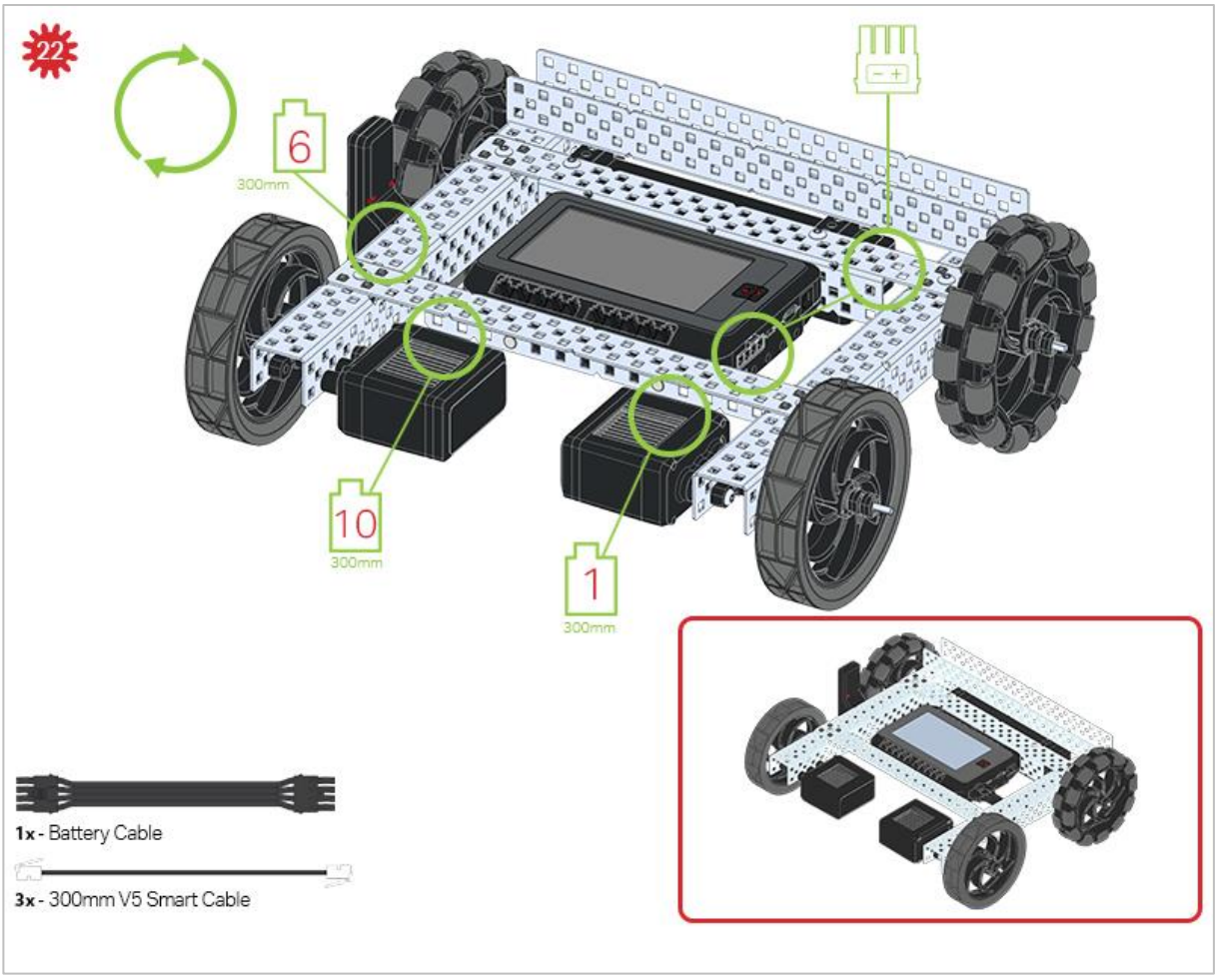




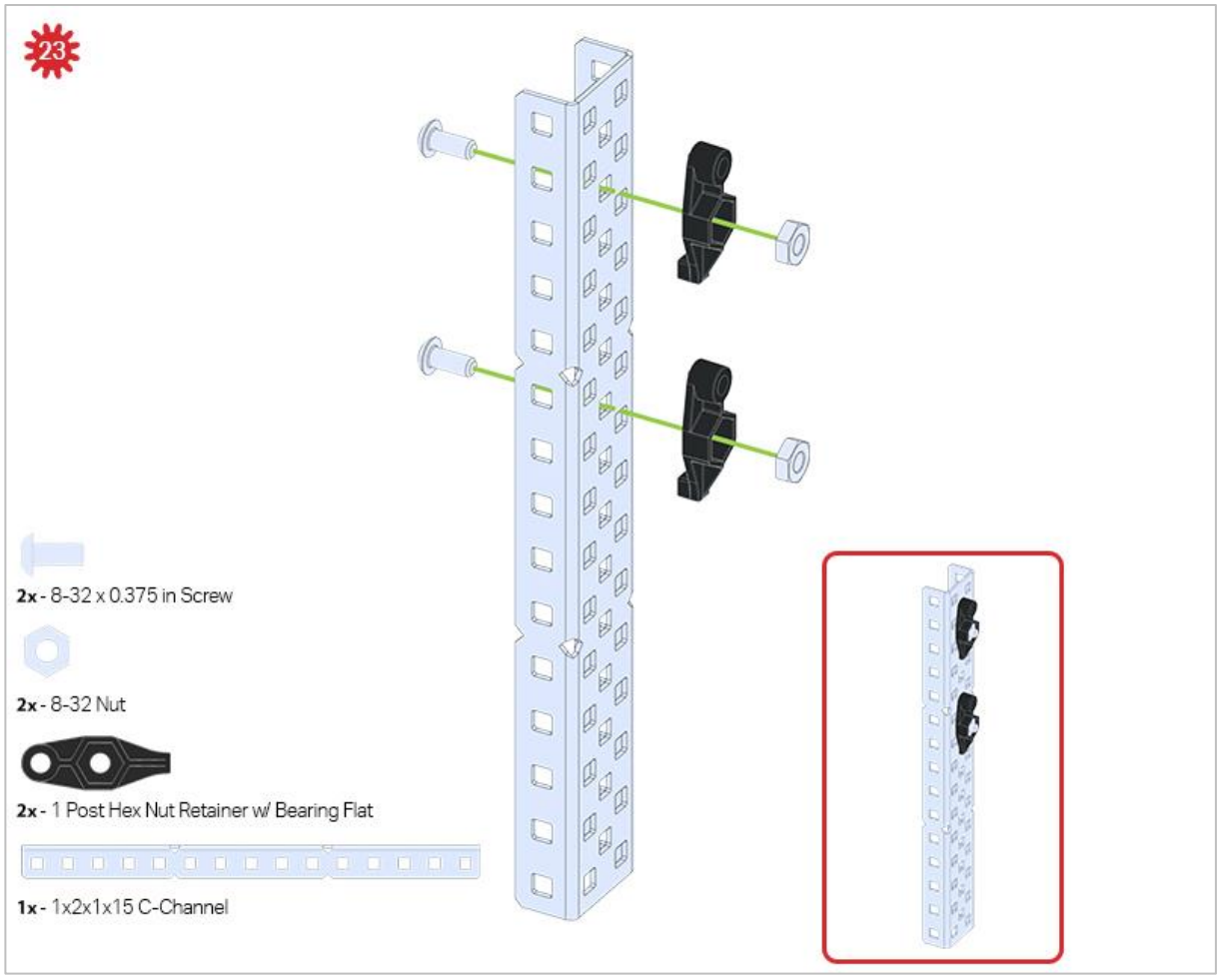
The blue call out shows what the orientation of the Robot Brain should be if the build were flipped right side up. Make sure the 3 wire ports on the Robot Brain are facing the V5 Radio!

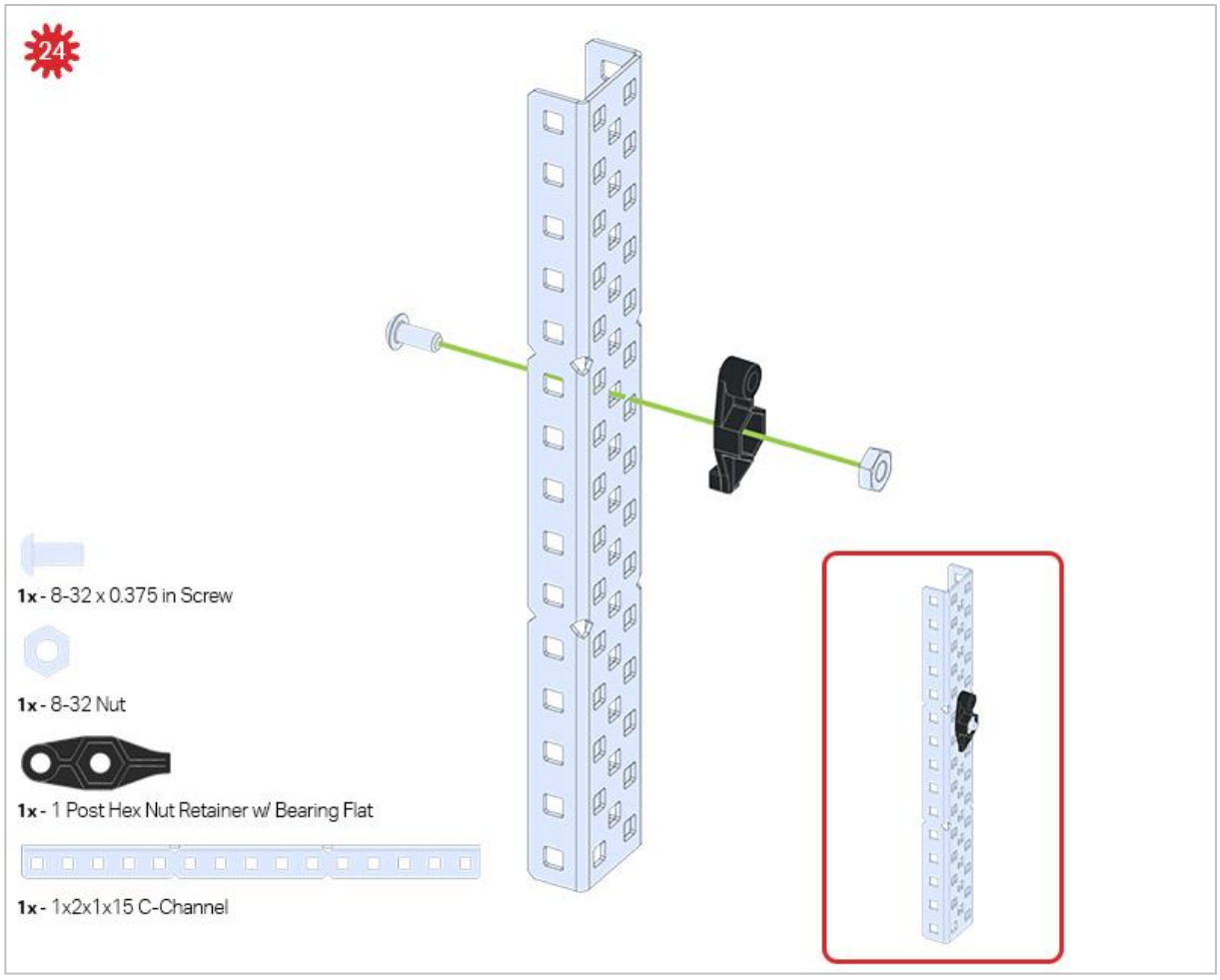


1x - V5 Robot Battery

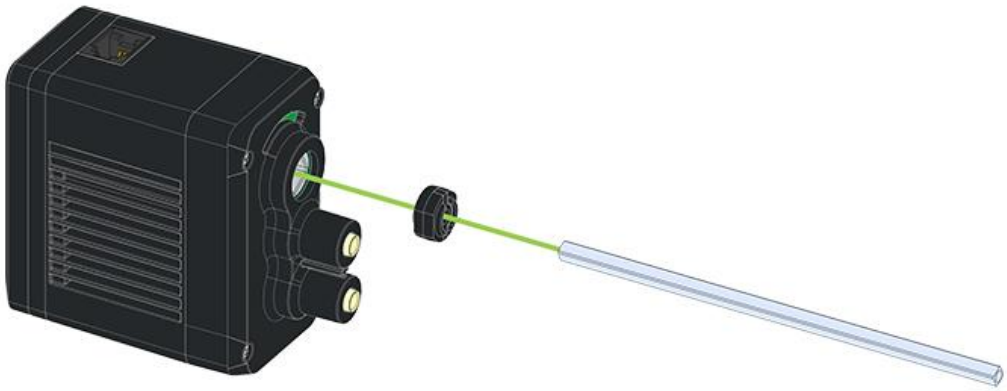


The green call outs indicate which port on the Robot Brain to plug each device into using their respective cable.


23
2x - 8-32 x 0.375 in Screw
2x - 8-32 Nut
2x - 1 Post Hex Nut Retainer w/ Bearing Flat
1x - 1x2x1x15 C-Channel


24
1x - 8-32 x 0.375 in Screw
1x - 8-32 Nut
1x - 1 Post Hex Nut Retainer w/ Bearing Flat
1x - 1x2x1x15 C-Channel

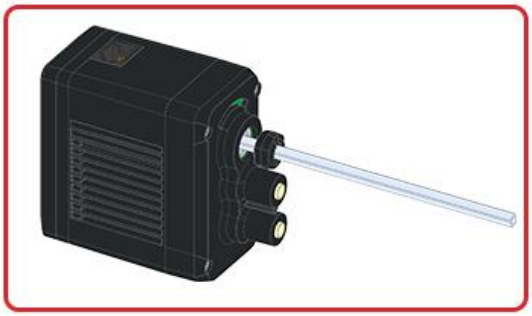
25

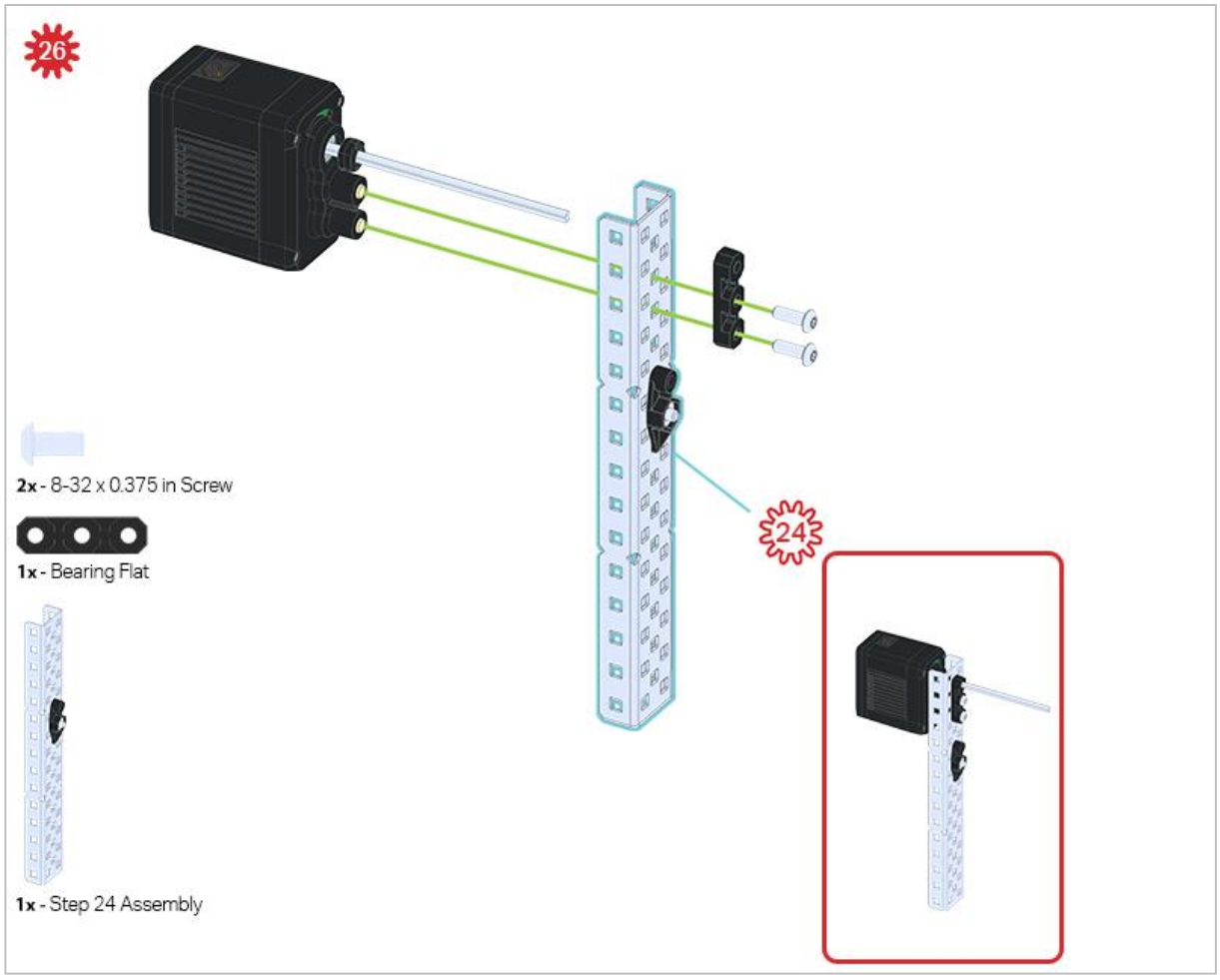


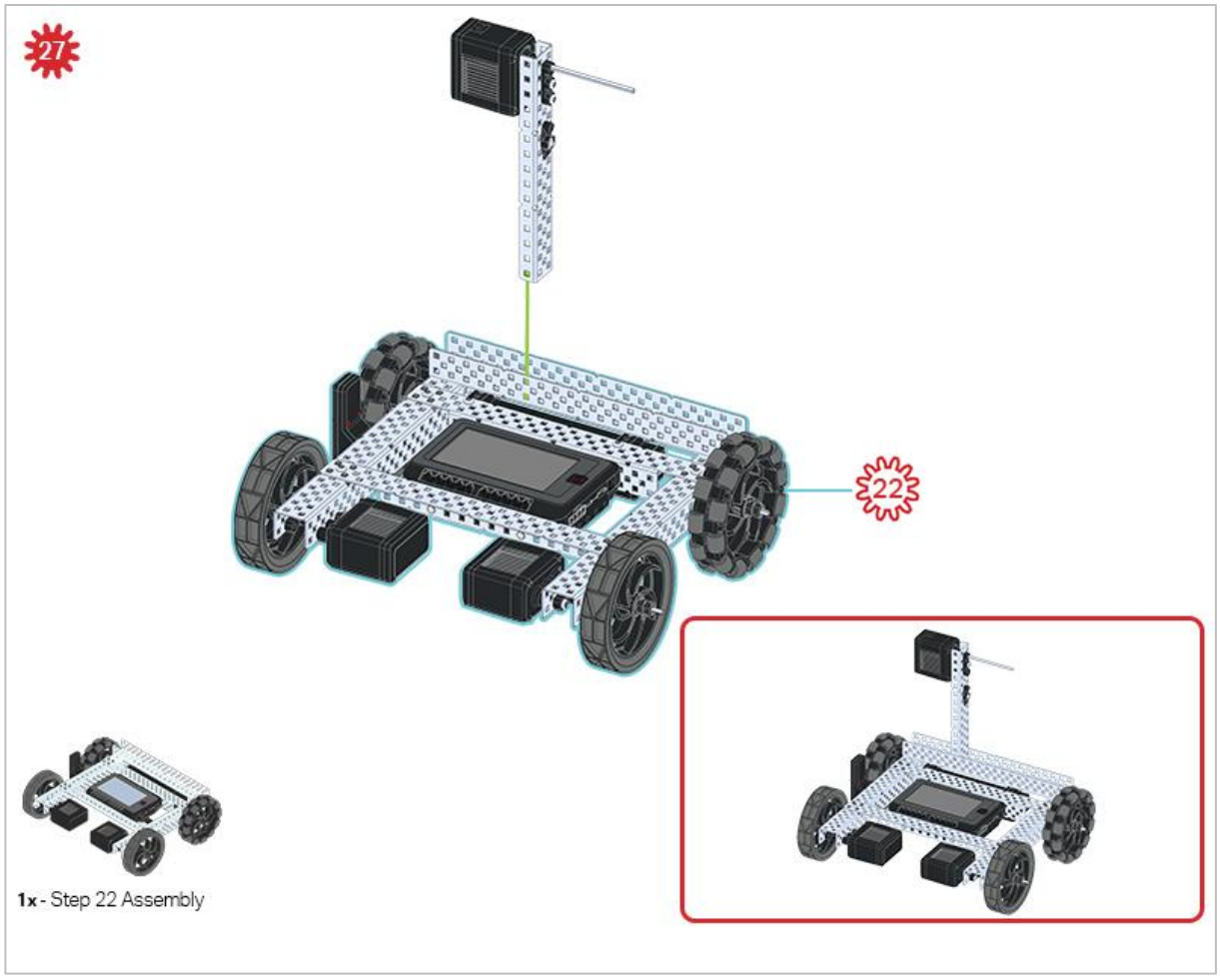
1x - Rubber Shaft Collar

1x - V5 Smart Motor

1x - 4 in Shaft




26
2x - 8-32 x 0.375 in Screw
1x - Bearing Flat
1x - Step 24 Assembly
24


27
22
1x - Step 22 Assembly

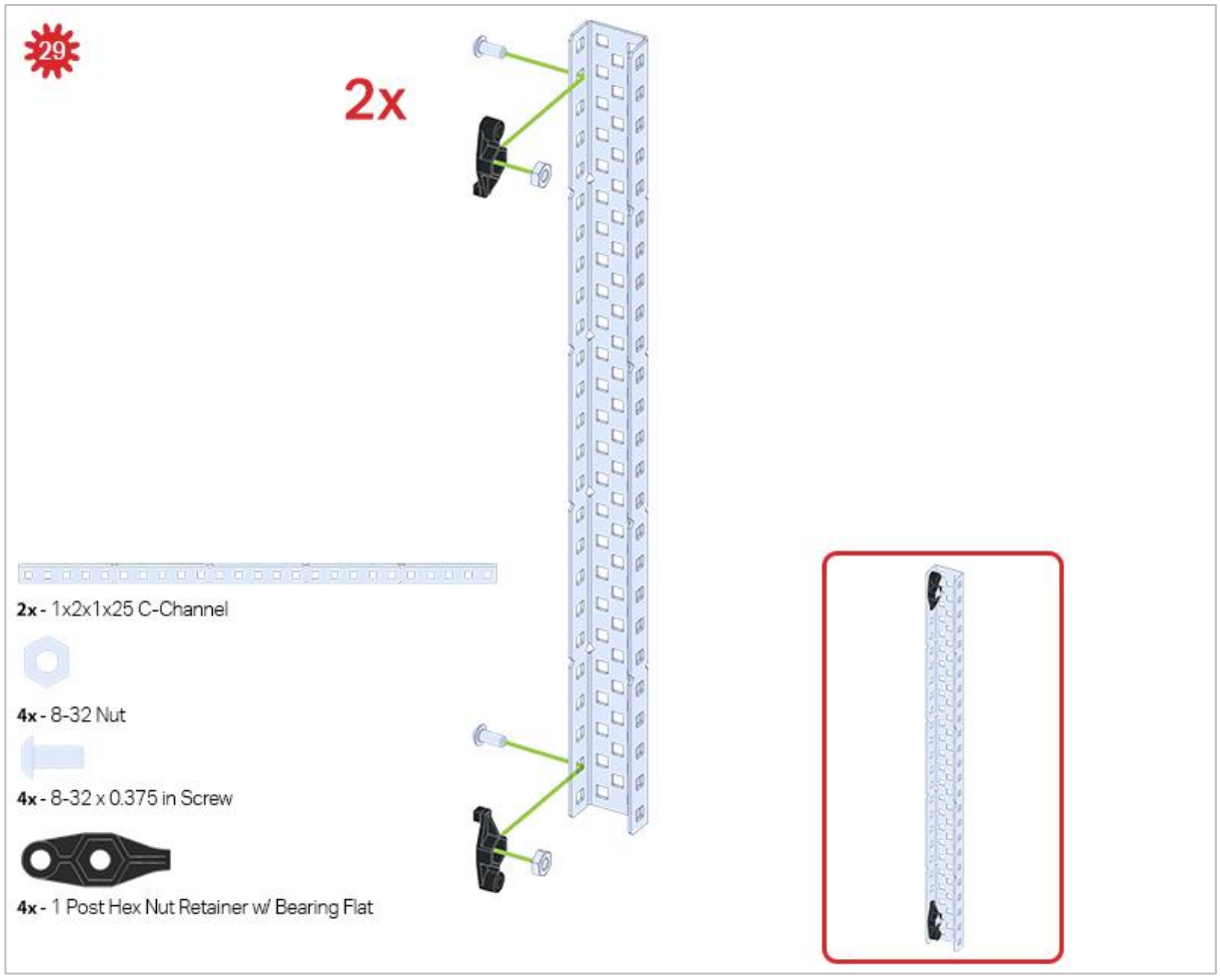
28

1x - 8-32 Nut

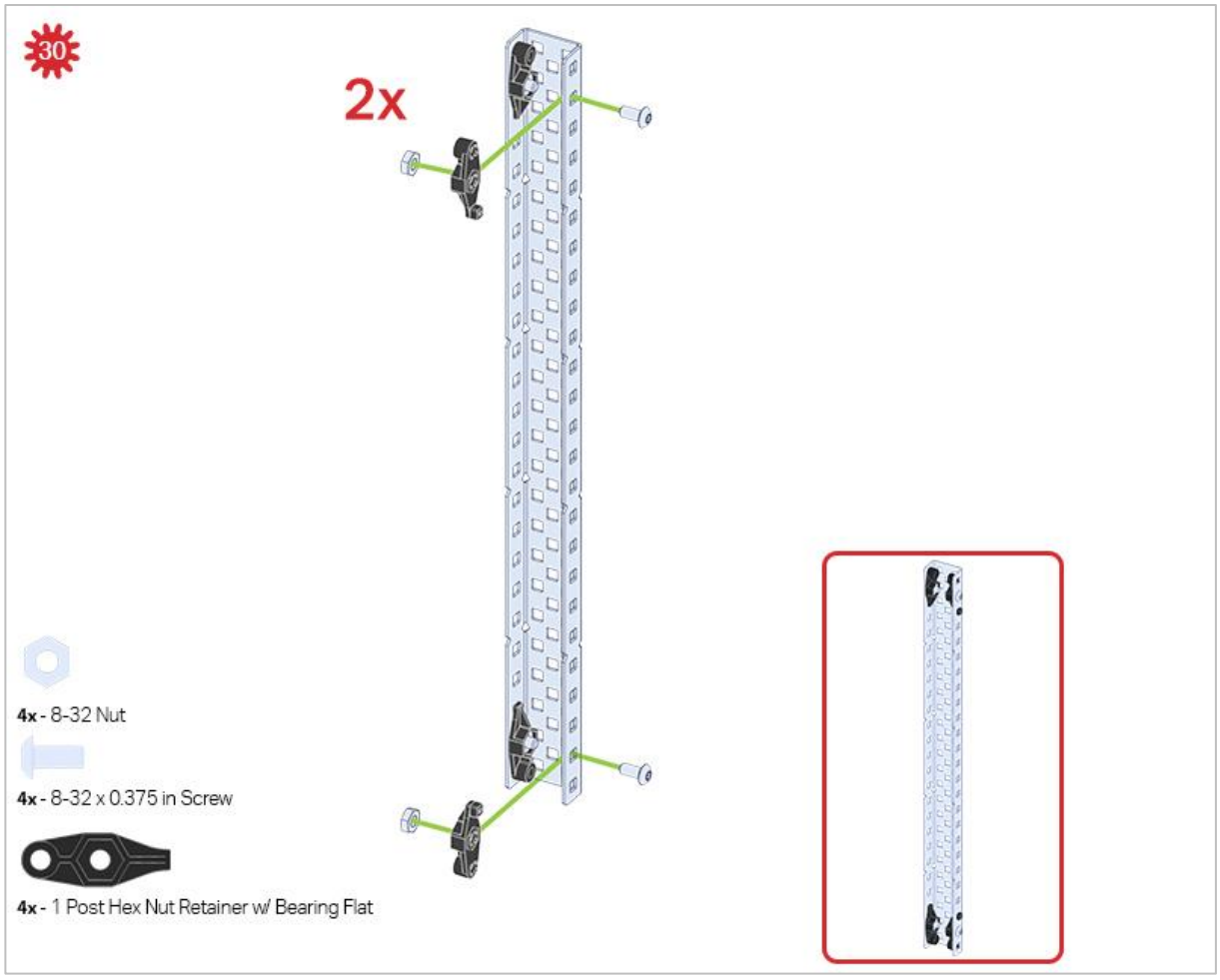
1x - 0.875 in Spacer

2x - 1 Post Hex Nut Retainer

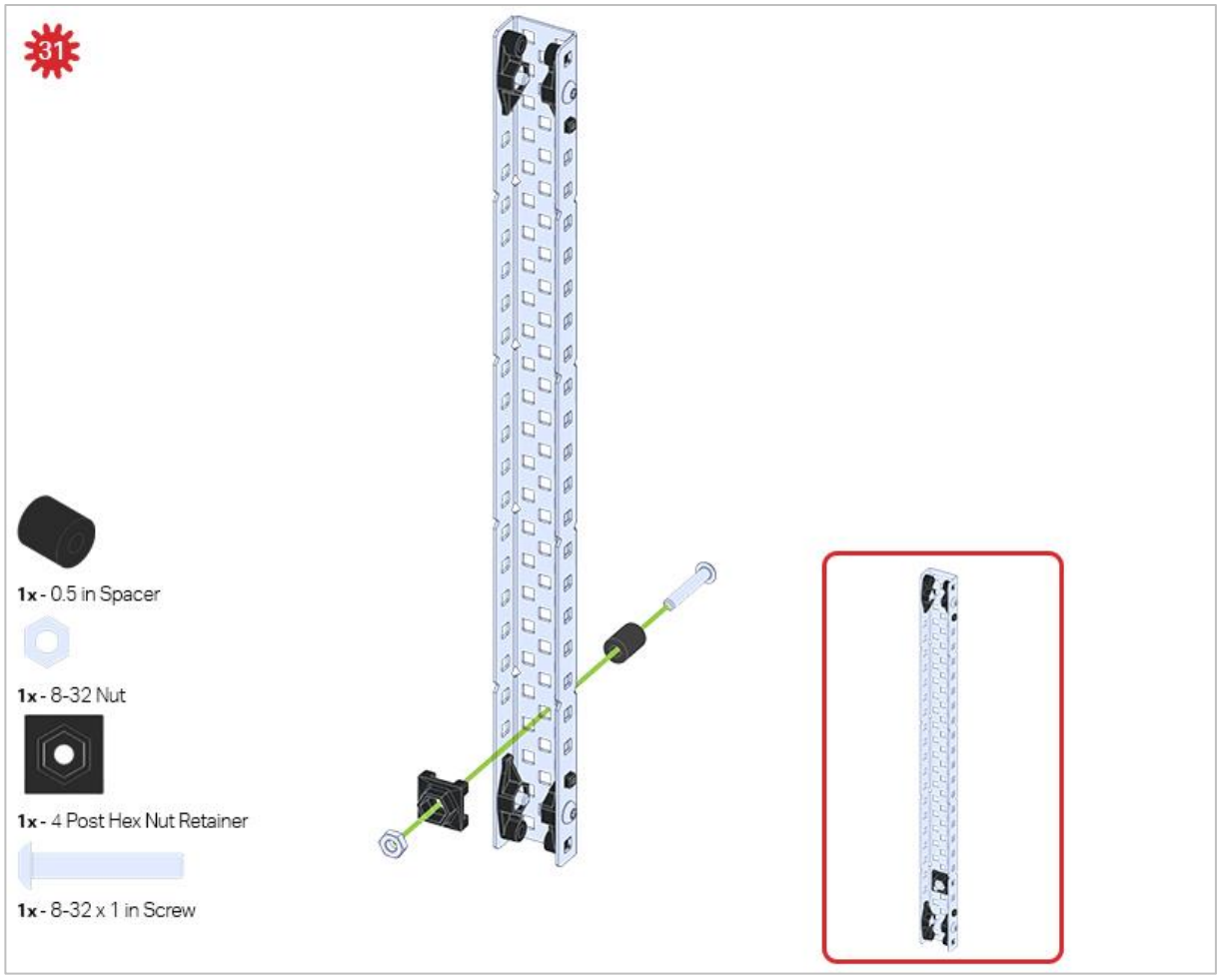
1x - 8-32 x 1.5 in Screw



Be sure to make two assemblies in this step!



This step adds onto the two assemblies started in Step 29.



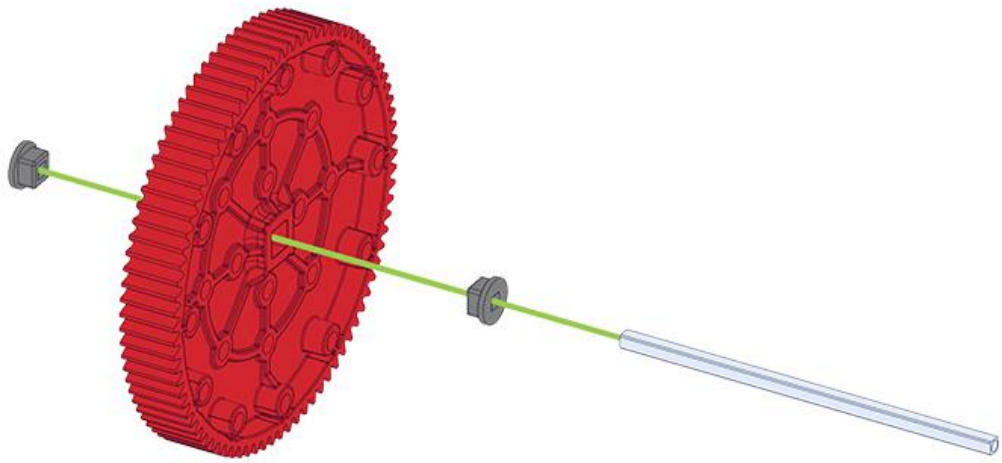
Make sure to add this to only one of the two sub-assemblies you just made.

32

1x - 8-32 Nut

1x - 1 Post Hex Nut Retainer

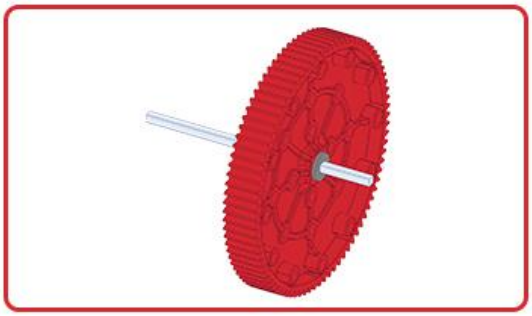
33

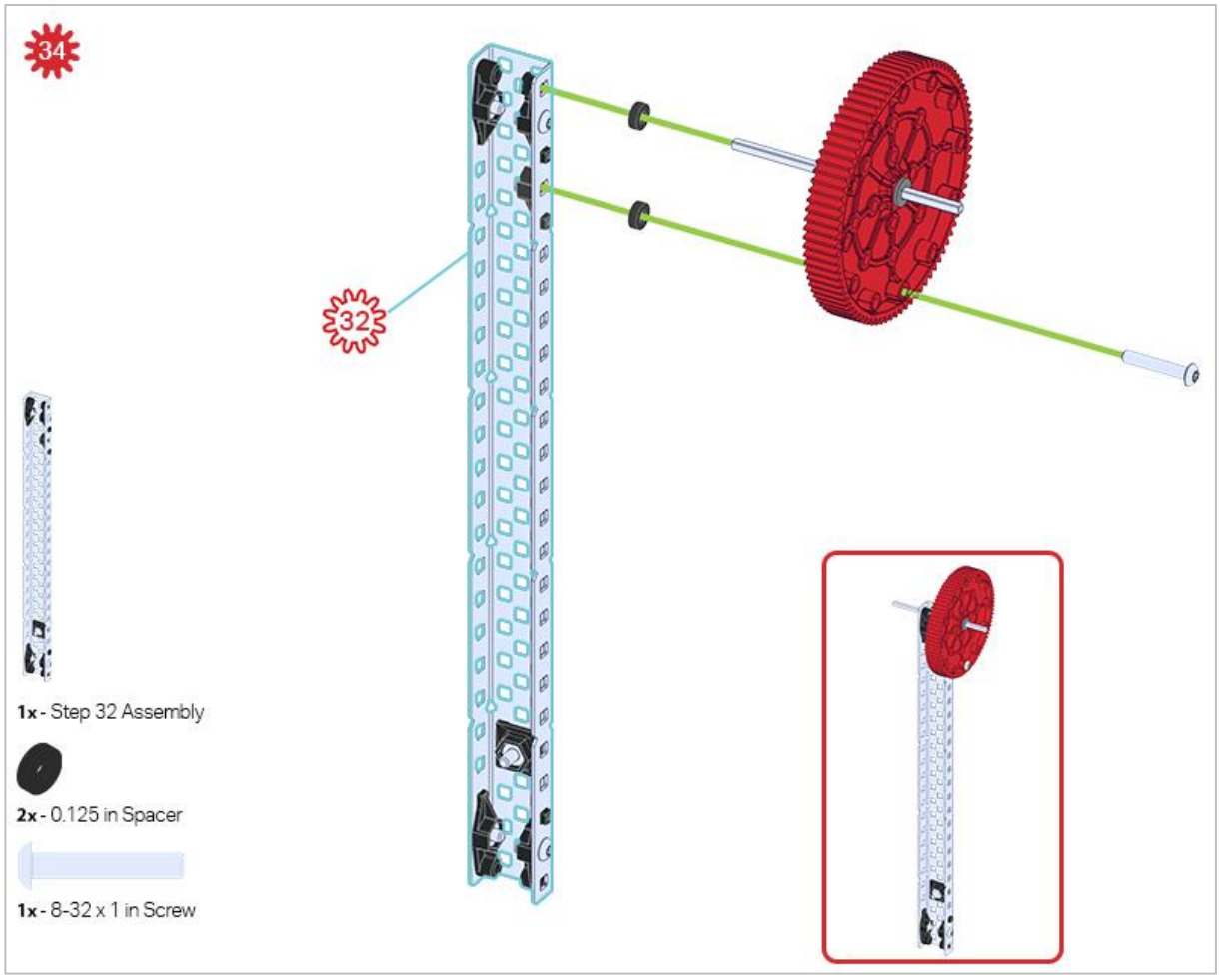


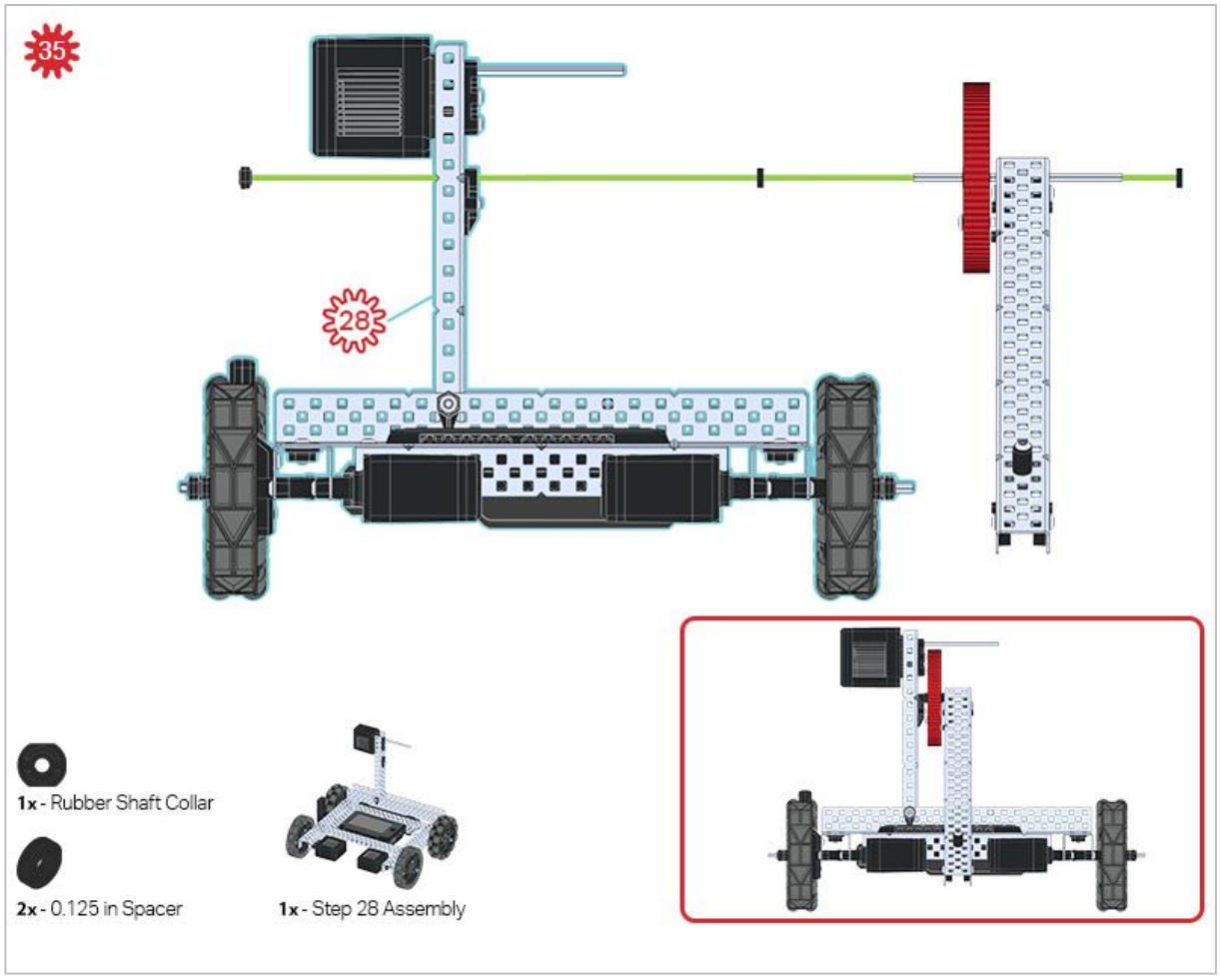
1x - High Strength 84 Tooth Gear

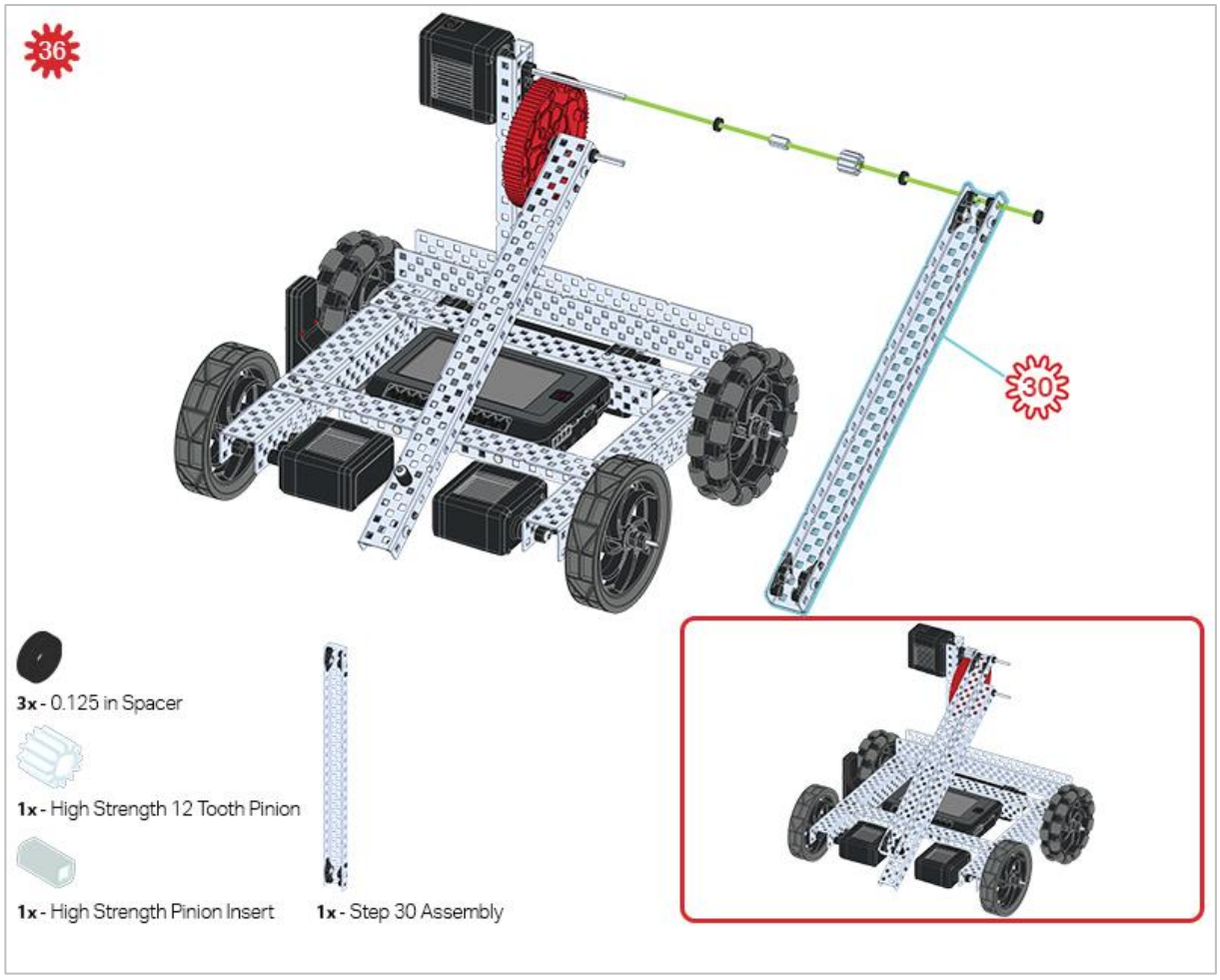
2x - High Strength Shaft Insert

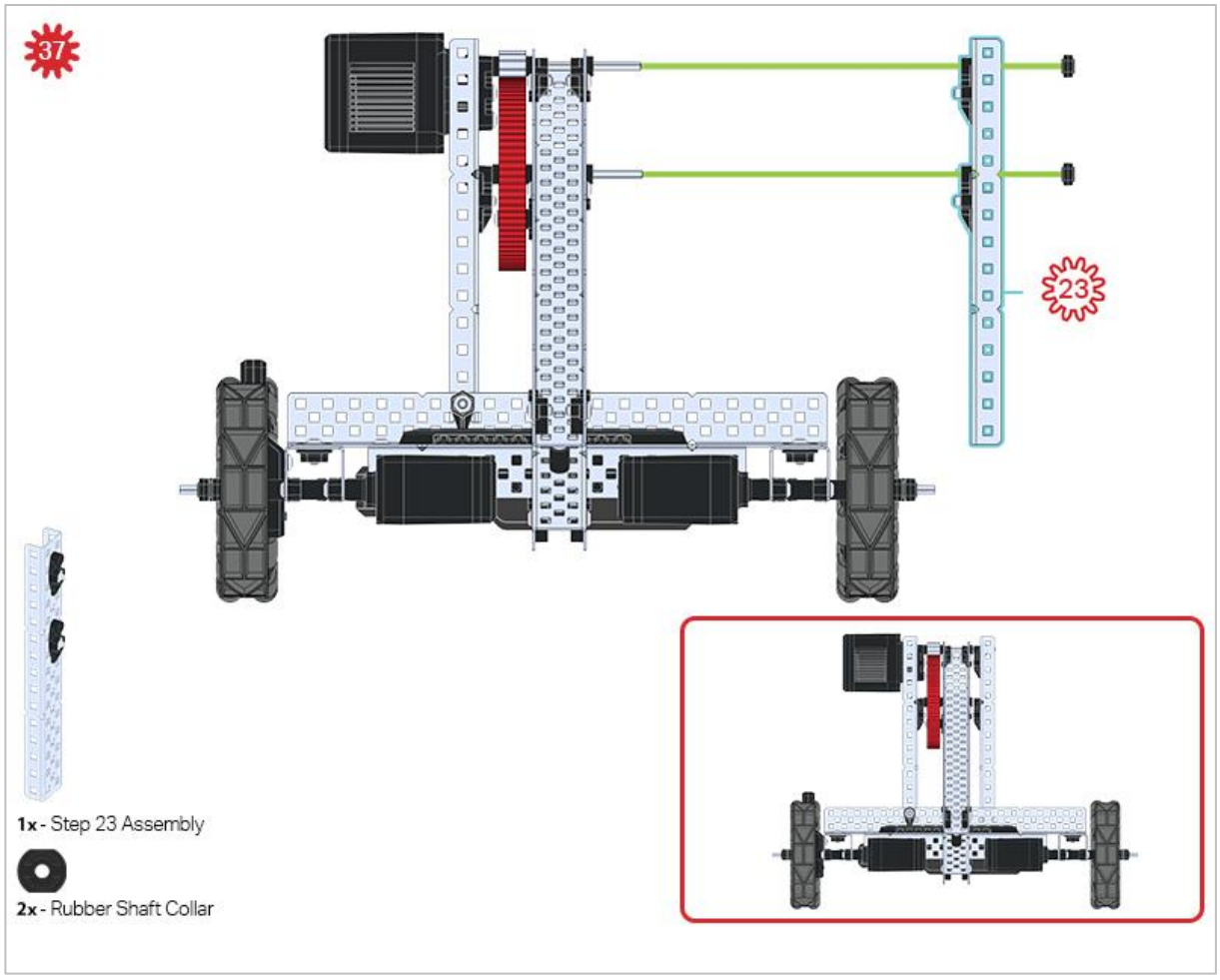
1x - 3.5 in Shaft




34
32
1x - Step 32 Assembly
2x - 0.125 in Spacer
1x - 8-32 x 1 in Screw


35
28
1x - Rubber Shaft Collar
2x - 0.125 in Spacer
1x - Step 28 Assembly

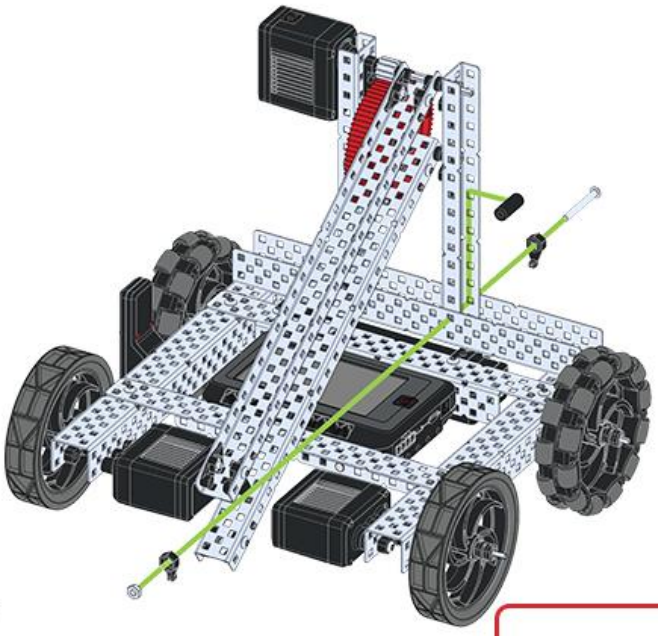

36
30
3x - 0.125 in Spacer
1x - High Strength 12 Tooth Pinion
1x - High Strength Pinion Insert
1x - Step 30 Assembly



1x - Step 23 Assembly

2x - Rubber Shaft Collar

38

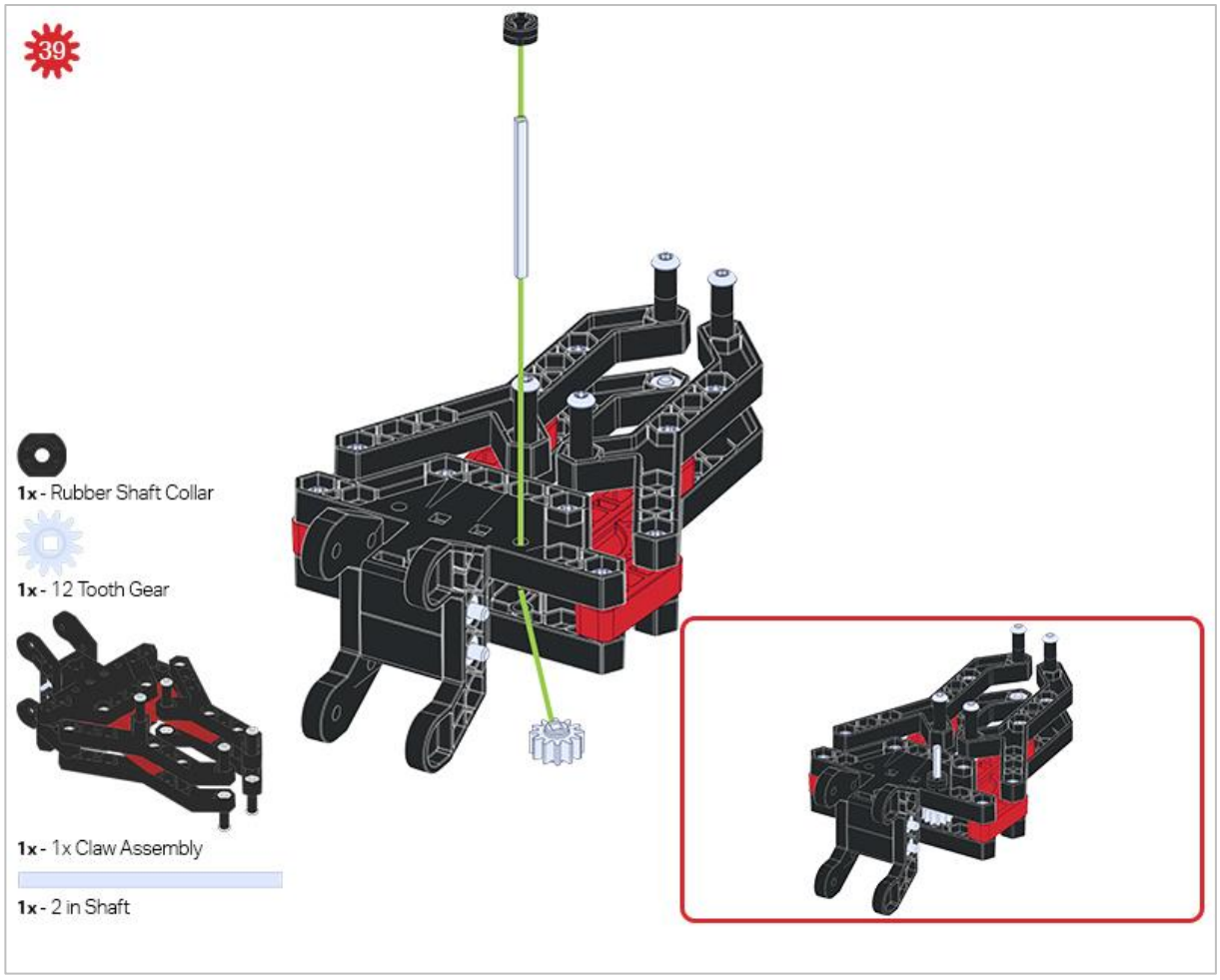


1x - 0.875 in Spacer

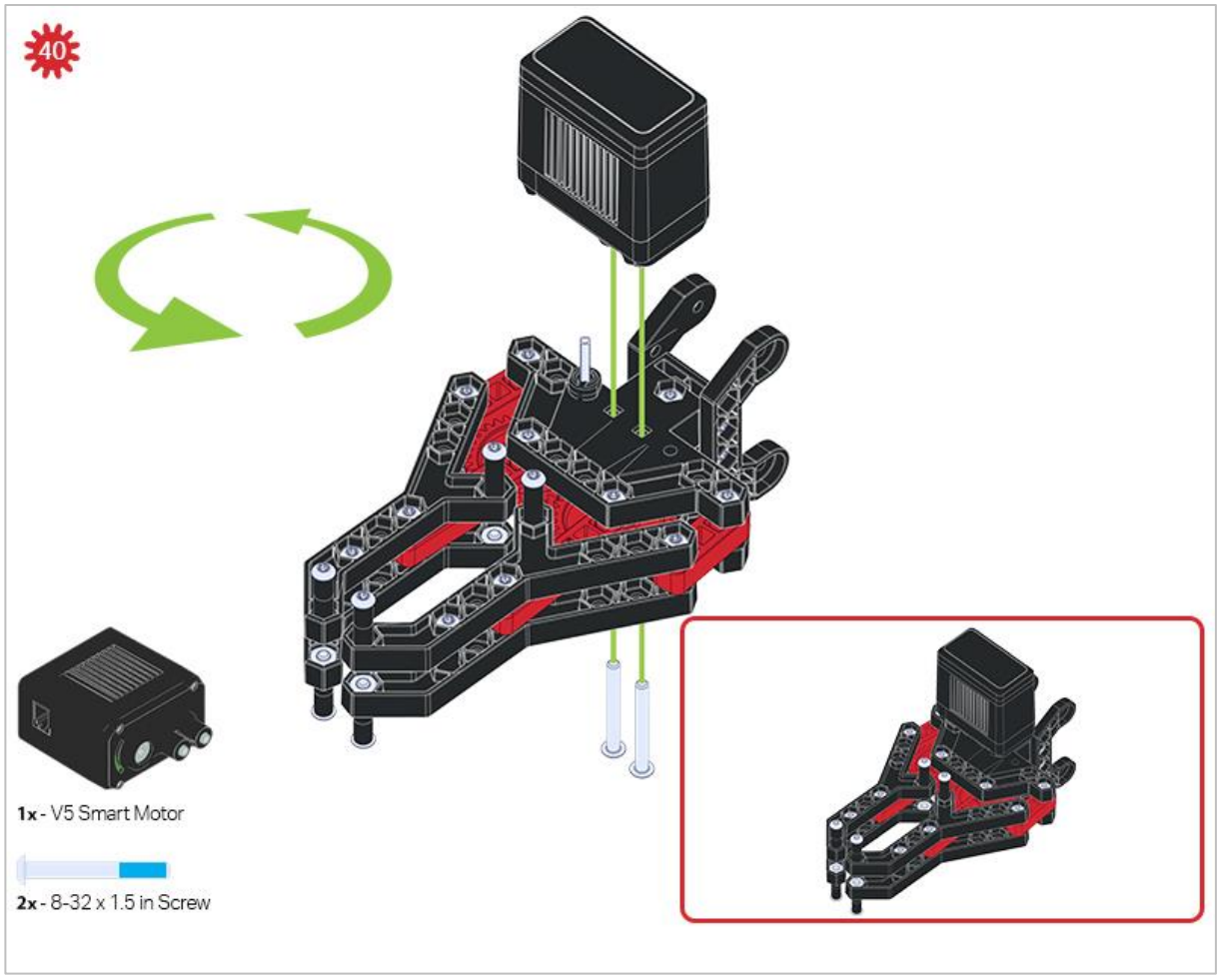
1x - 8-32 Nut

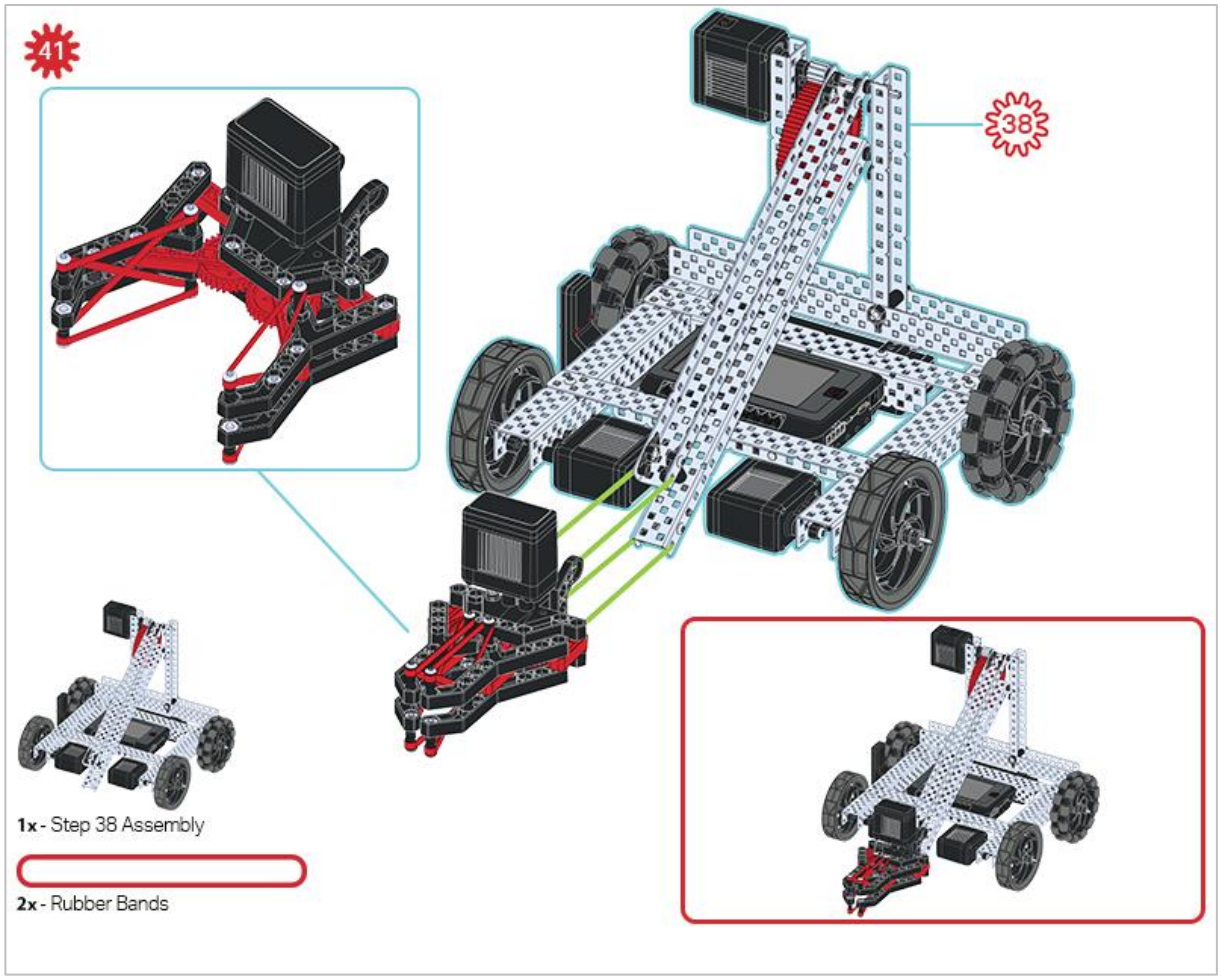
2x - 1 Post Hex Nut Retainer

1x - 8-32 x 1.5 in Screw



Make sure the 12- tooth gear is installed on the right side of the claw.


40
1x - V5 Smart Motor
2x - 8-32 x 1.5 in Screw



Make sure that the port on the Smart Motor is facing the right side of the robot when the claw is installed (the same side as the V5 Radio).

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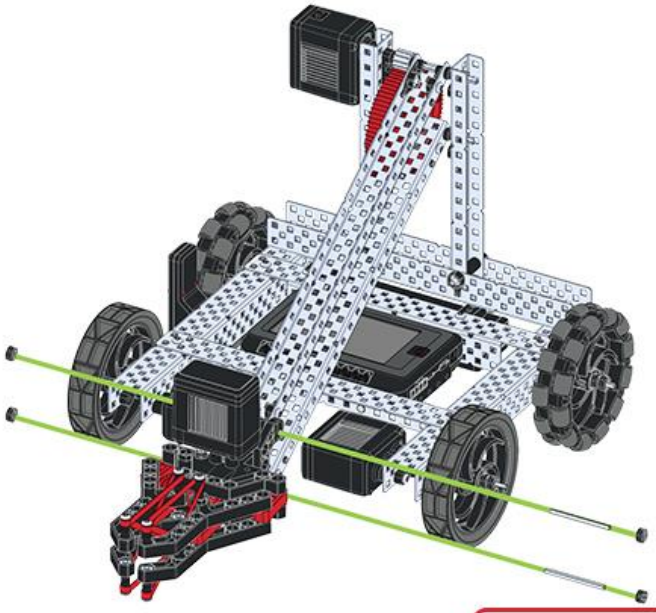
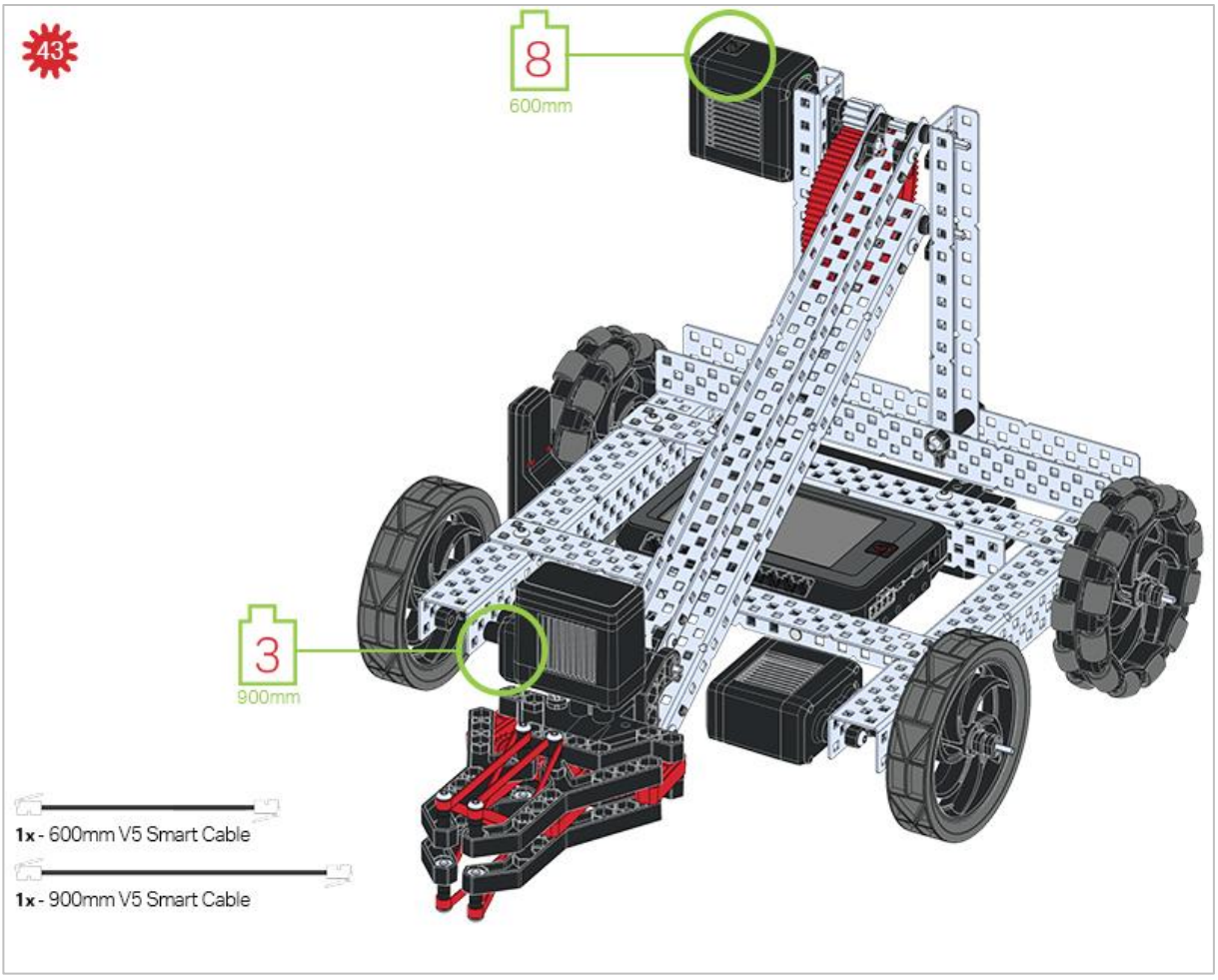


4x - Rubber Shaft Collar

2x - 2 in Shaft



Build Instruction Tips

Check the Appendix for information on how to use the new Hex Nut Retainers.

Exploration

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

- What types of activities could this V5 Clawbot be used for in the real-world? Explain with details.
- If this V5 Clawbot was 5 times larger, how would that modification change the capabilities of the robot? What advantages would there be with a bigger robot? Explain with details.
- If this V5 Clawbot was 5 times smaller, how would that modification change the capabilities of the robot? What advantages would there be with a smaller robot? Explain with details.

SPARK
PLAY

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

Robots are Precise

An assembly line robot making repeated, precise movements

Robots are Precise

Robots do exactly what you tell them to do. If a robot doesn't quite do what you planned in your pseudocode, it may mean that your instructions weren't quite right. Using precise measurement to program movement is critical for a robot to successfully complete a task.

For example:

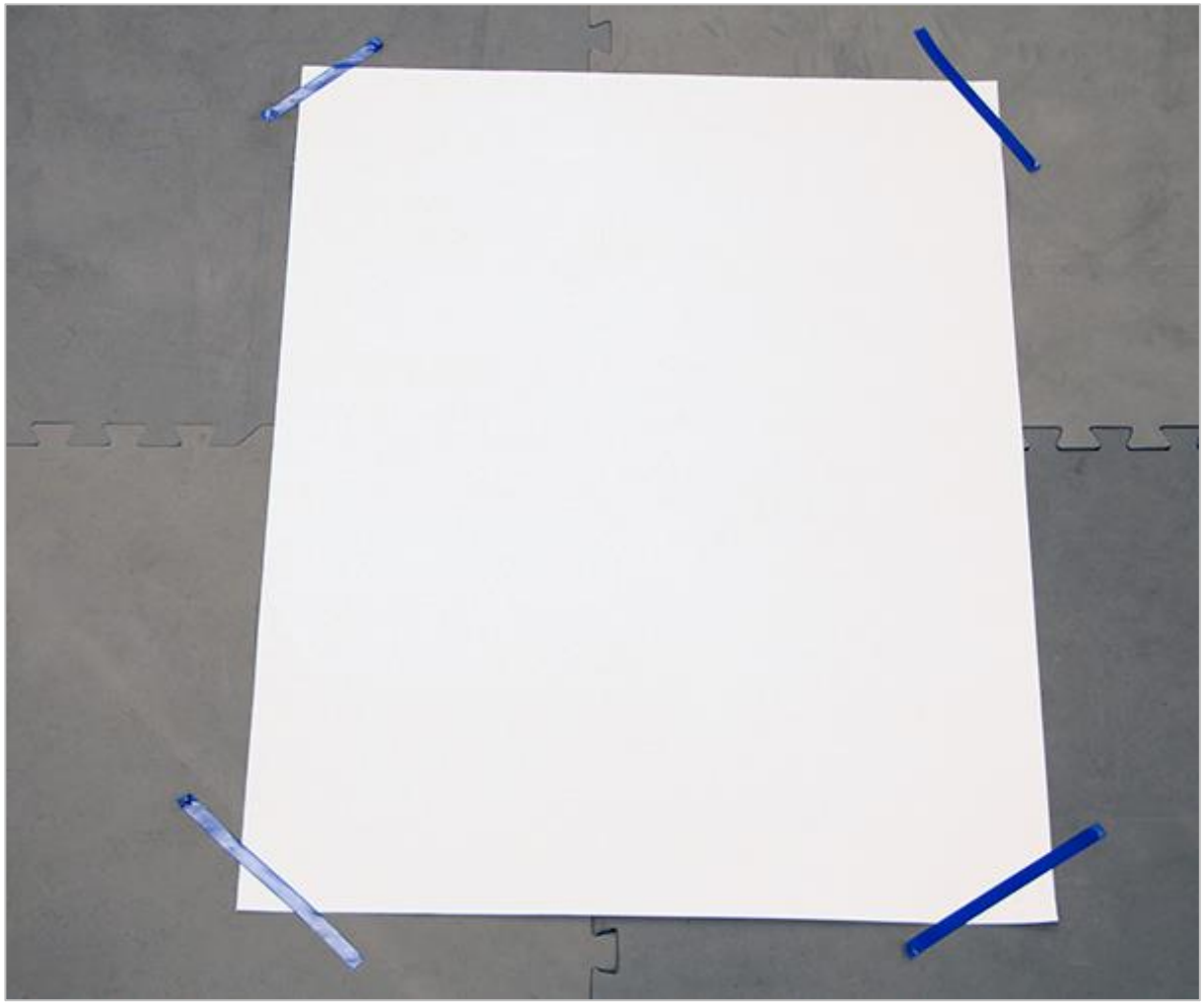
- Surgical robots must have pinpoint accuracy in order to treat certain areas while avoiding others.
- Robots that need to complete a series of movements must make each of those movements precisely. An error in robot movement accumulates and increases dramatically with each subsequent movement.
- Assembly robots must be continuously precise in order to guarantee the quality of the product they are helping to manufacture.

Drawing with Your Robot

Hardware/Software Required:

Quantity	Hardware/Other Items
1	VEX V5 Classroom Starter Kit (with up-to-date firmware)
1	Large sheet of paper/dry erase board (for drawing)
1	Marker
1	Roll of tape
1	Engineering Notebook

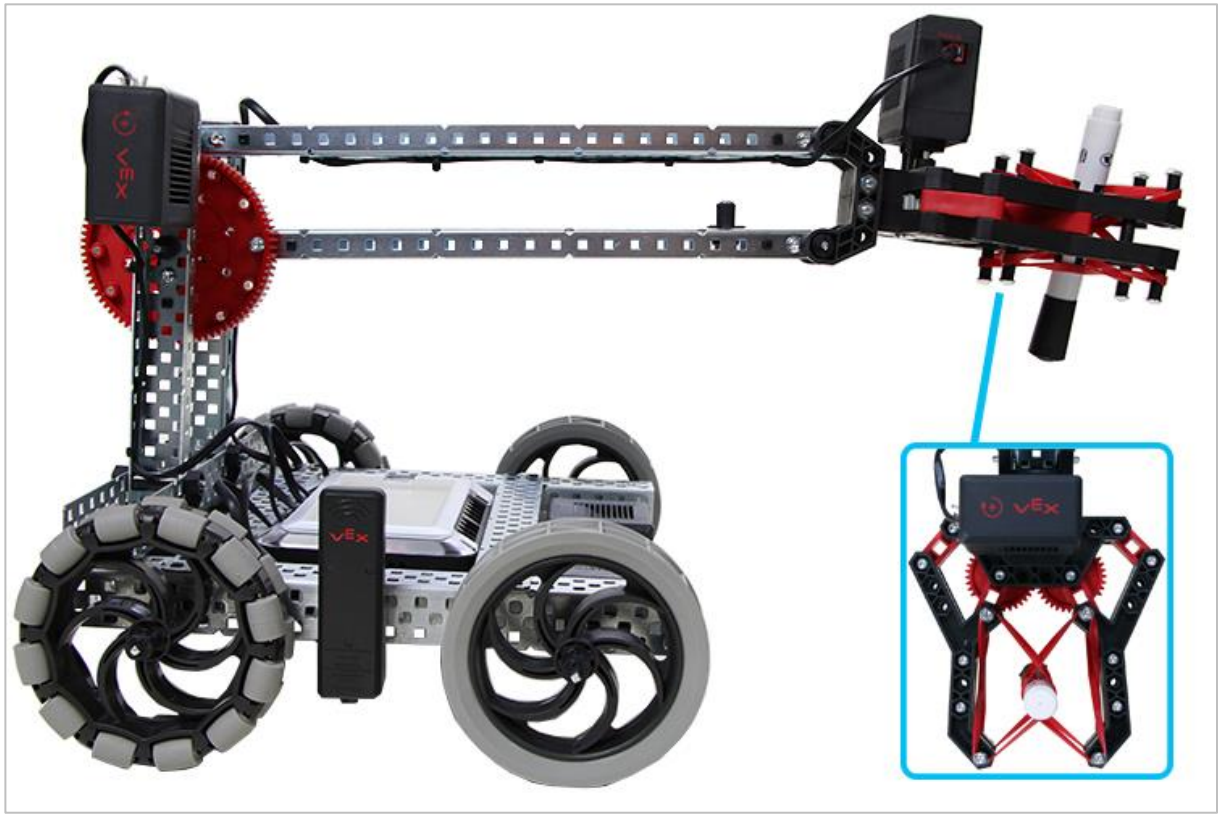
1. Preparing Your Canvas



Paper taped down on the floor

Lay a large sheet of paper or a poster board flat on the ground in an open area. Use tape to secure each side of the paper to the ground to prevent it from sliding. You will be driving your robot around on top of this surface to draw, so make sure the area around the canvas is free of obstructions.

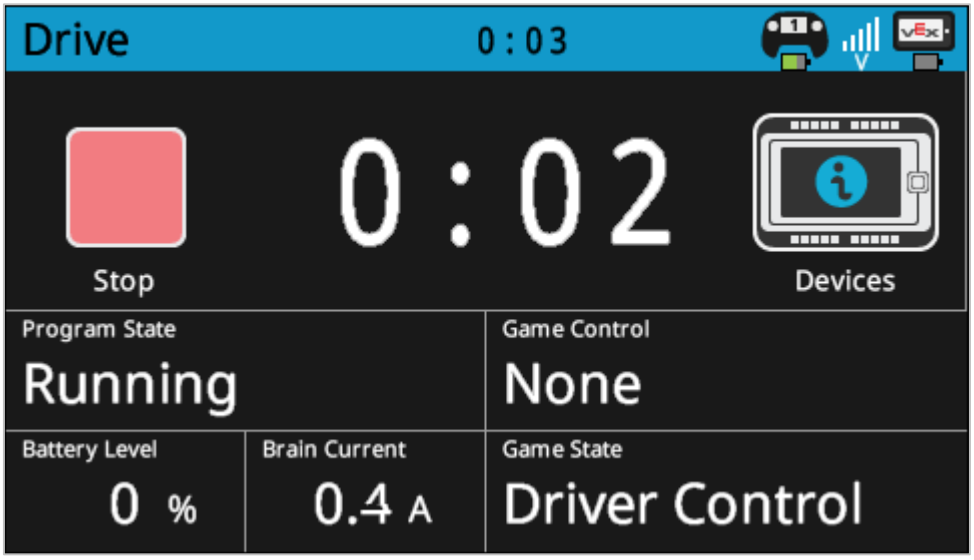
2. Adding the Marker to Your Robot



V5 Clawbot with a marker in its claw

Start by lifting the robot arm up so that it is parallel to the ground. You can prop the arm up with a box if necessary. Next, completely close the claw. Once the claw is closed, weave a capped marker into the claw between each set of the rubber bands as shown in the image. The drawing end of the capped marker should be facing the floor.

3. Preparing Your Robot



V5 Robot Brain running the Drive program

Power on the V5 Robot Brain. Make sure the V5 Robot Brain is paired with the V5 Controller and run the Drive program so that you're able to wirelessly drive your robot with the controller.

4. Practicing Movement

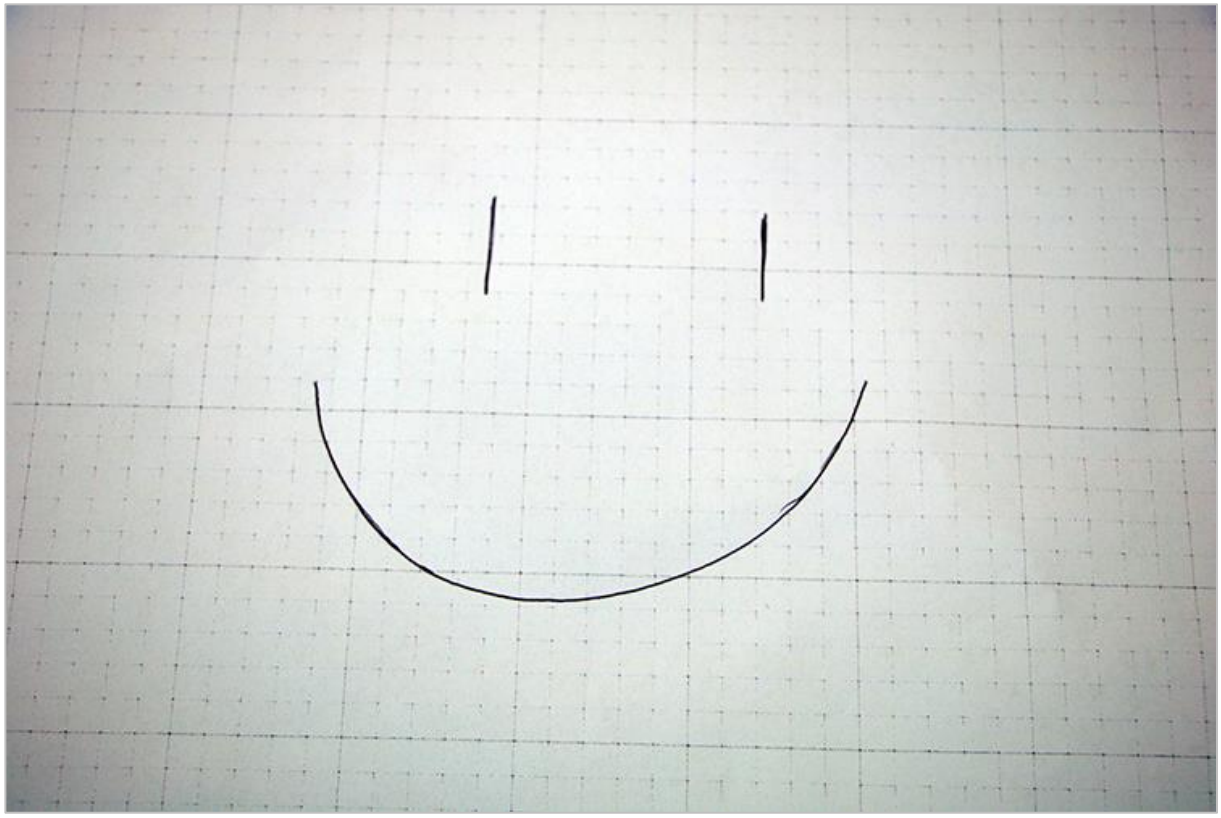
V5 Clawbot with capped marker touching the ground

Lower the robot arm so that the cap of the marker is touching the ground. Using the V5 Controller, drive your robot around while raising and lowering the arm to get a feel for how you will draw with the robot.

Respond to the questions below in your engineering notebook:

- What strategies will you use while drawing to ensure precision? Explain with details.
- What problems might you encounter while drawing with the robot?
- How do you plan on overcoming the above problems? Explain with details.

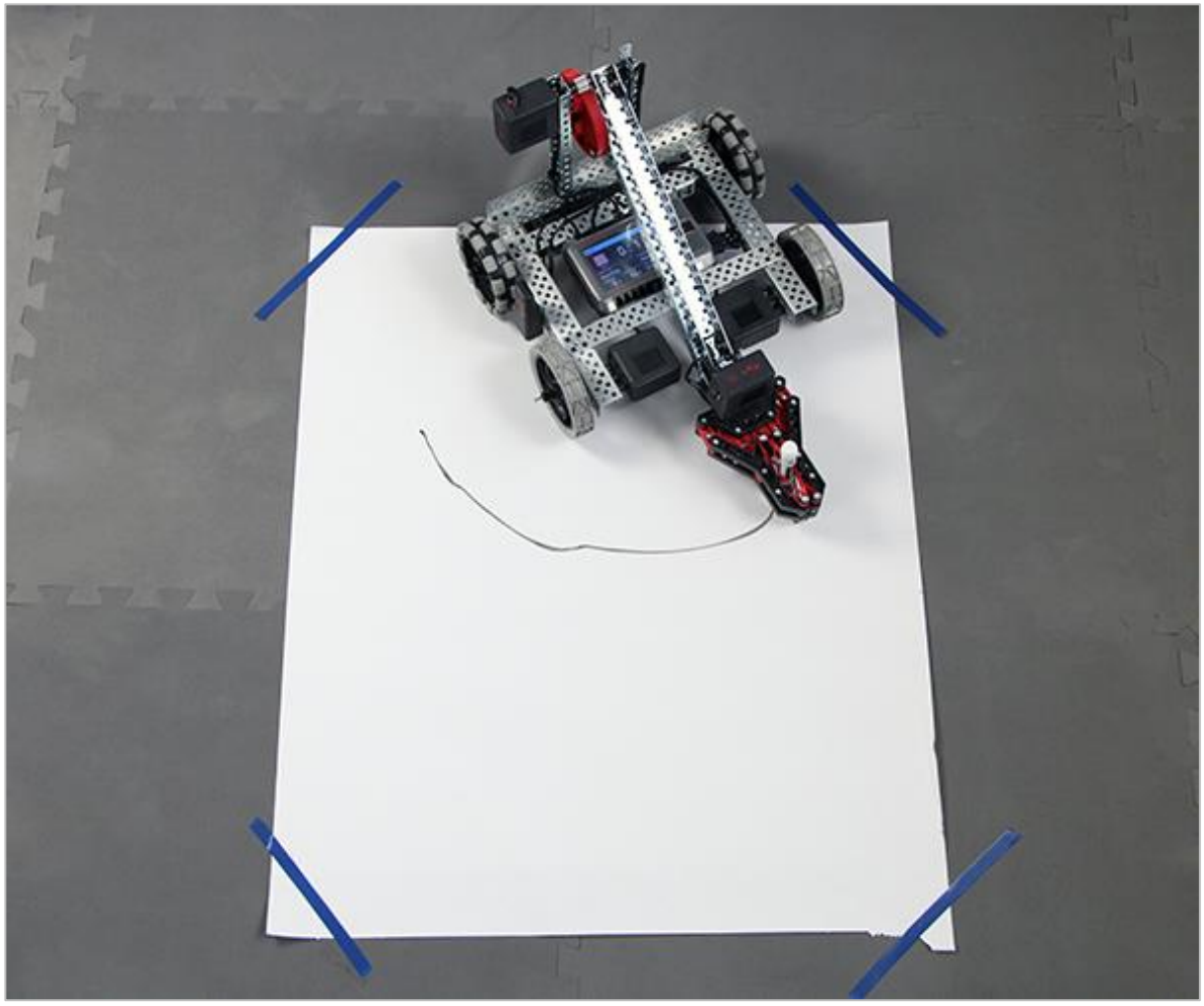
5. Planning Your Drawing



Example sketch

Draw a simple sketch by hand that you would like to replicate using the robot in your engineering notebook. Keep the sketch as simple as possible. After finishing the sketch, choose a location on the sketch that you will use as the starting point for your robot.

6. Drawing with Your Robot



V5 Clawbot drawing on the canvas

Raise the robot arm and remove the cap of the marker in its claw. Position the robot on your canvas so that the drawing end of the marker is in the location where you would like to start drawing. Using the V5 Controller, drive the robot around using the marker to recreate your sketch.

Respond to the questions below in your engineering notebook:

- Did the strategy(ies) you implemented for drawing with the robot work? Explain with details.
- What problems did you encounter when drawing with the robot? Explain with details.
- What would you change about the design of the robot to improve its ability to draw? Explain with details and sketches.

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

Robots in the World of Art

Robot using an art tool.

Creative Robots

Robots usually come to mind when speaking about math, science, or engineering. However, as technology seeps into all aspects of our lives, robots are everywhere, including the art world. With the development of artificial intelligence, artists are now able to watch as robots not only replicate famous works of art, but create art of their own. These robots aren't just mimicking brushstrokes, but the actual process a human artist uses to paint. Some artistic teams are working on a variety of methods including using a remote control to guide a robot's paintbrush, using eye-tracking systems to determine the robot's movements on a canvas, and programming a robot to disassemble and reconstruct input images. Robots can use these abilities to allow the physically disabled to create art via remote control. All these developing techniques produce innovative new works that art viewers can appreciate.

Being Creative at a Competition

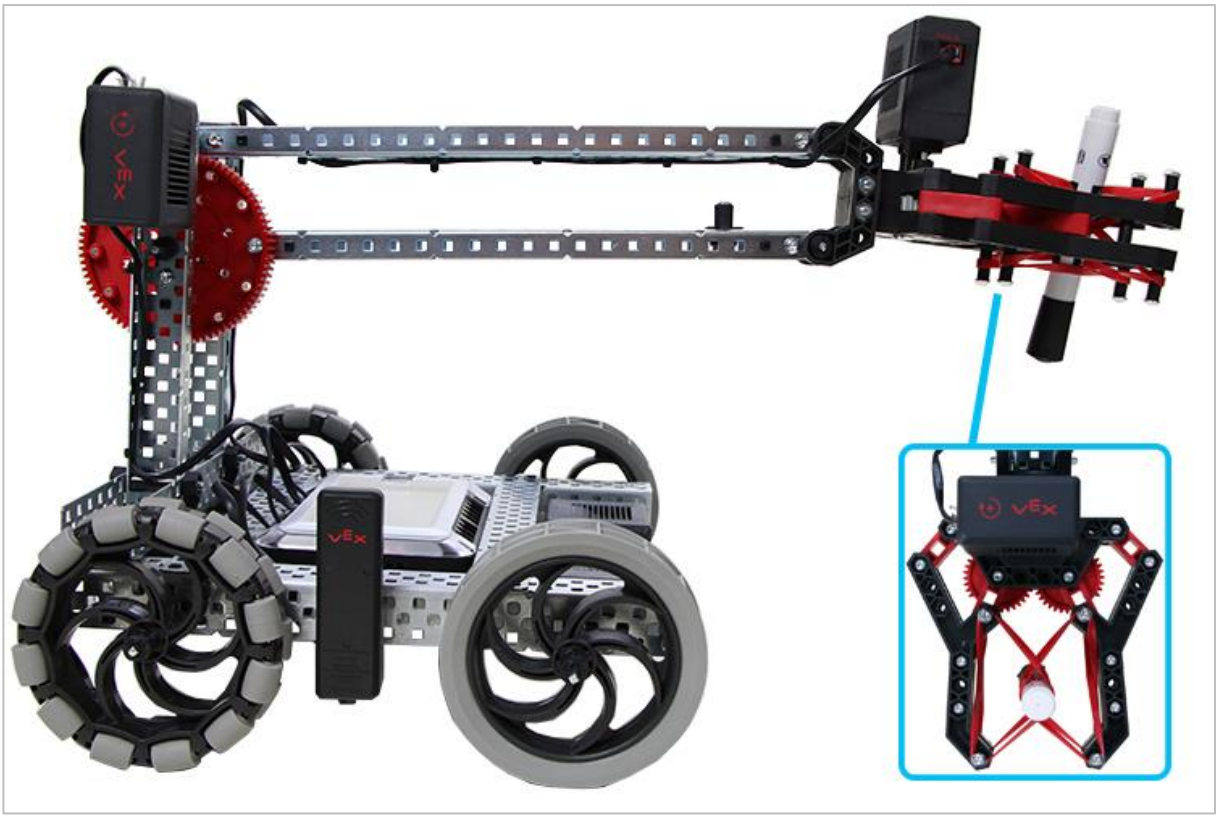
A student works on his team's robot.

Create! Compete!

There are many teams that compete at a VEX Robotic Competition, so individual teams use creativity to stand out in the crowd. They create cool team names, costumes, and unique robot builds. As long as the robot meets the game's requirements, teams can iterate and design their robot not only to perform the tasks needed to score the most points in the game, but also to represent their creativity. VEX creates parts in a variety of sizes, so teams can build some great robots!

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 It's a Draw! Challenge



V5 Clawbot with a marker in its claw

Prepare for the It's a Draw! Challenge

In this challenge, you will be tasked with using your robot to draw the things on your set of It's a Draw! cards as a second person tries to guess the drawing! To perform your best in this challenge, you should practice drawing with your robot.

To complete this challenge you will need:

- 2 or more players
- Multiple large sheets of paper (at least 75cm x 60cm is recommended)
- Printed It's a Draw! cards
- 1 marker
- Stopwatch

Improve your Build

Answer the following questions in your engineering notebook as you try to improve the design of your build for the challenge.

- How can you make this build better for drawing? Explain with details.
- What steps will you follow to change the build? Explain with details and/or sketches.
- Will your changes to the build enhance your control of the marker or your control of the robot? Explain how.

Make your changes to the build and then test them.

- Did your changes make the build better for drawing? Explain how, or why not.
- Do you think that your design changes were generally successful? Explain why or why not.
- Is there a change you would like to make but need additional pieces? Explain with details and/or sketches.

It's a Draw! Challenge

It's a Draw! cards

It's a Draw! Challenge

In this challenge, you will play a game called "It's Draw". In this game, your team will try to earn as many points as they can by using the V5 Clawbot to draw clues.

How to Play:

- Divide players into two teams. Players on the team will take turns acting as the “robot artist”. If you only have three players, one person must be designated to draw for both teams.
- Whichever team has the youngest player will go first.
- Each team will select one "It's a Draw!" card.
- Only the robotic artist for each team can look at the card. The robotic artist has only five seconds to look at the card and plan their robotic drawing strategy.
- Each team will have 2 minutes to identify the right word from clues drawn on a piece of paper by the robot. If they are successful, a point is earned.

- The winning team will have the most earned points after a predetermined number of rounds.
- Additional rules for the game:
    - Verbal communication and gestures by the robotic artist is not allowed.
    - Writing numbers or letters on your paper is against the rules.
    - An “X” can be used to cross something out but not as a letter.
    - Have fun!

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

Review

1. **You can use an engineering notebook to _____.**
   - organize and document your work.
   - reflect on activities and projects.
   - record your thoughts and ideas.
   - All of the above.

2. **True or False: Robots can be designed and programmed to imitate the creative process.**
   - True
   - False

3. **True or False: The 4 Post Hex Nut Retainer with Bearing Flat allows shafts to spin smoothly through holes in structural components.**
   - True
   - False

4. **True or False: The VEX V5 Clawbot uses four V5 Smart Motors.**
   - True
   - False

5. **True or False: The VEX V5 Speedbot is an extension of the VEX V5 Clawbot.**
   - True
   - False

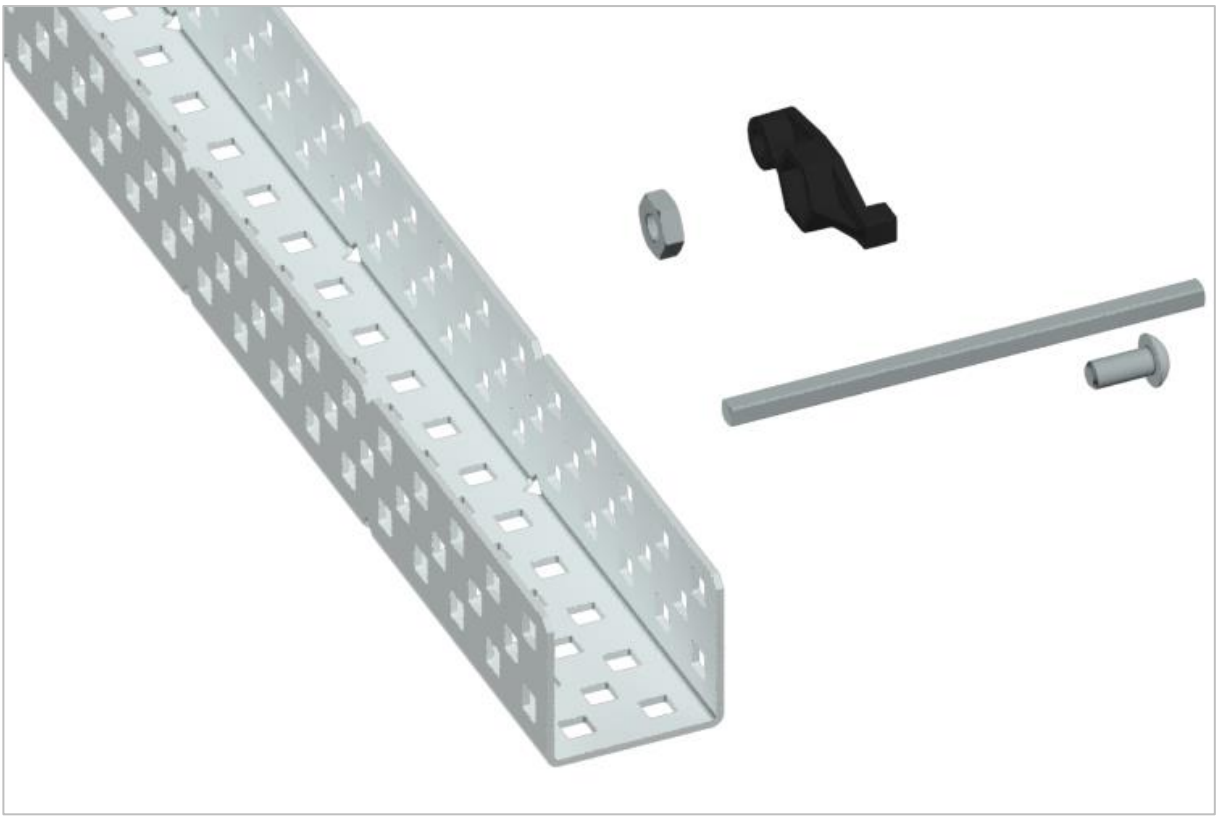
6. **Robots that need to complete a series of movements must make each of those movements _____.**
   - loops

- events
- short
- precisely

APPENDIX

Additional information, resources, and materials.

Using the 1 Post Hex Nut Retainer w/ Bearing Flat



1 Post Hex Nut Retainer w/ Bearing Flat

Using the 1 Post Hex Nut Retainer w/ Bearing Flat

The 1 Post Hex Nut Retainer w/ Bearing Flat allows shafts to spin smoothly through holes in structural components. When mounted, it provides two points of contact on structural components for stability. One end of the retainer contains a post sized to securely fit in the square hole of a structural component. The center hole of the retainer is sized and slotted to securely fit a hex nut, allowing a 8-32 screw to easily be tightened without the need for a wrench or pliers. The hole on the end of the Retainer is intended for shafts or screws to pass through.

To make use of the retainer:

- Align it on a VEX structural component such that the end hole is in the desired location, and the center and end sections are also backed by the structural component.

- Insert the square post extruding from the retainer into the structural component to help keep it in place.
- Insert a hex nut into the center section of the retainer so that it is flush with the rest of the component.
- Align any additional structural components to the back of the main structural component, if applicable.
- Use an 8-32 screw of appropriate length to secure the structural component(s) to the retainer through the center hole and hex nut.

Using the 4 Post Hex Nut Retainer

4 Post Hex Nut Retainer

Using the 4 Post Hex Nut Retainer

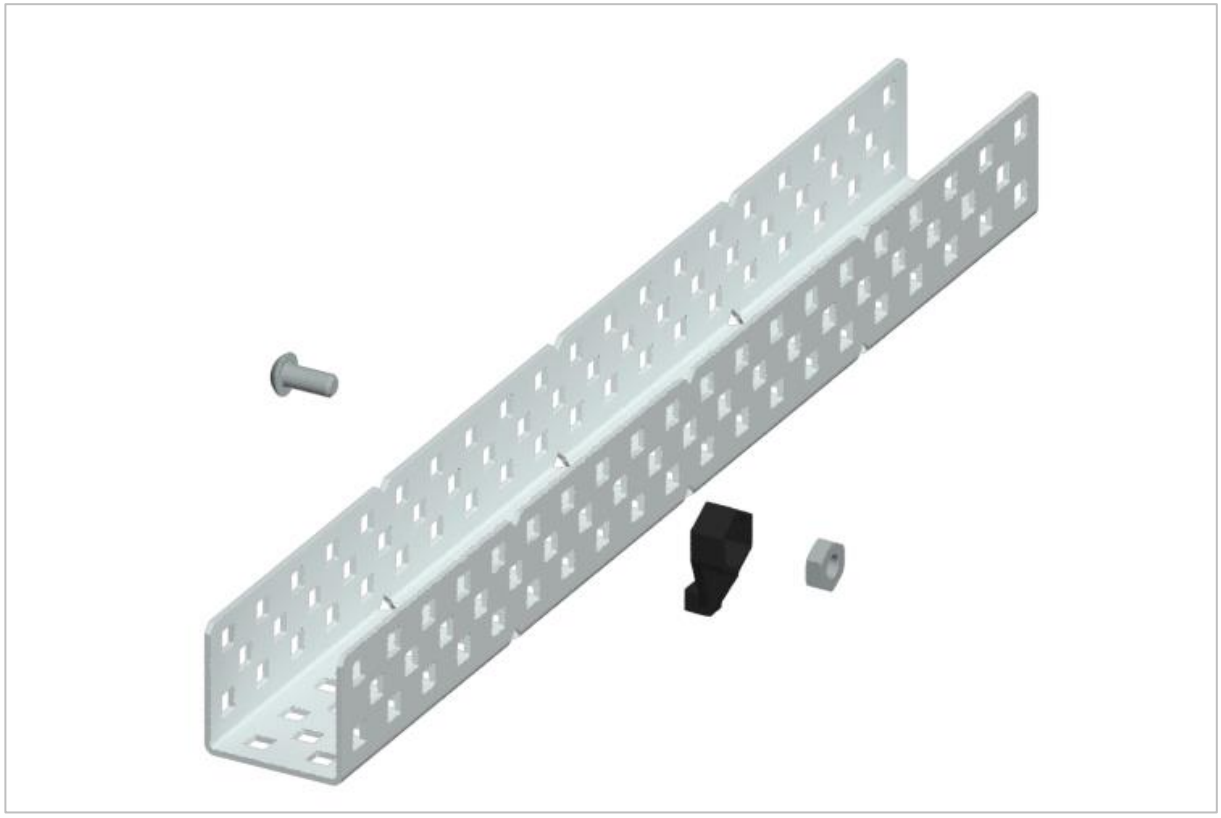
The 4 Post Hex Nut Retainer provides five points of contact for creating a strong connection between two structural components using one screw and nut. Each corner of the retainer contains a post sized to securely fit in a square hole within a structural component. The center of the retainer is sized and slotted to securely fit a hex nut, allowing a 8-32 screw to easily be tightened without the need for a wrench or pliers.

To make use of the retainer:

- Align it on a VEX structural component such that the center hole is in the desired location, and each corner is also backed by the structural component.
- Insert the square posts extruding from the retainer into the structural component to help keep it in place.
- Insert a hex nut into the center section of the retainer so that it is flush with the rest of the component.

- Align any additional structural components to the back of the main structural component, if applicable.
- Use an 8-32 screw of appropriate length to secure the structural component(s) to the retainer through the center hole and hex nut.

Using the 1 Post Hex Nut Retainer



1 Post Hex Nut Retainer

Using the 1 Post Hex Nut Retainer

The 1 Post Hex Nut Retainer provides two points of contact for connecting a structural component to another piece using one screw and nut. One end of the retainer contains a post sized to securely fit in the square hole of a structural component. The other end of the retainer is sized and slotted to securely fit a hex nut, allowing a 8-32 screw to easily be tightened without the need for a wrench or pliers.

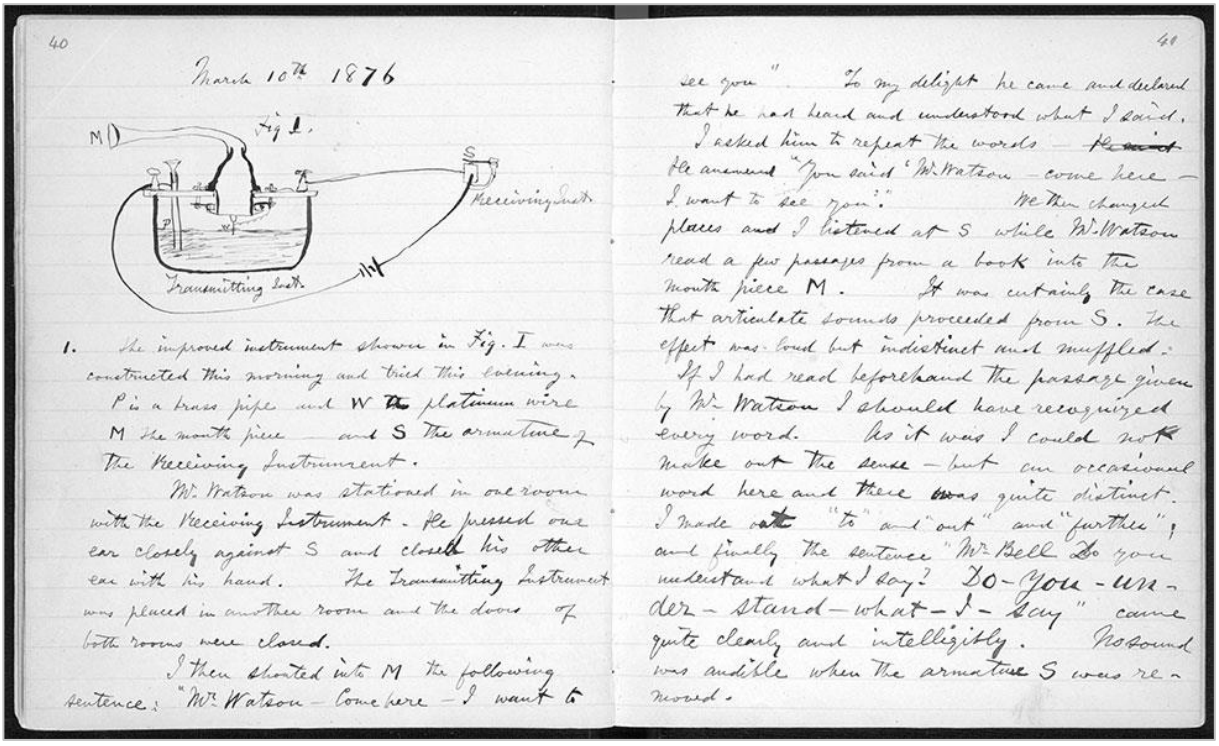
To make use of the retainer:

- Align it on a VEX structural component such that both ends are backed by the structural component and positioned to secure the second piece.
- Insert the square post extruding from the retainer into the structural component to help keep it in place.
- If the retainer is being used to secure two structural components, insert a hex nut into the other end of the retainer so that it is flush with the rest of the component. If used to secure

a different type of component, such as a standoff, it may be appropriate to insert the screw through this side.

- Align any additional components to the back of the main structural component, if applicable.
- If the retainer is being used to connect two structural components, use an 8-32 screw of appropriate length to secure the structural components through the hole and hex nut. If used to connect a different type of component, such as a standoff, secure it directly or with a hex nut.

Engineering Notebooks



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March 10th 1876

Fig 1.

M

S

Receiving Instr.

Transmitting Instr.

1. The improved instrument shown in Fig. I was constructed this morning and tried this evening. P is a brass pipe and W the platinum wire M the mouth piece — and S the armature of the Receiving Instrument.

Mr. Watson was stationed in one room with the Receiving Instrument - He pressed one ear closely against S and closed his other ear with his hand. The Transmitting Instrument was placed in another room and the doors of both rooms were closed.

I then shouted into M the following sentence: "Mr. Watson — Come here — I want to

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see you" To my delight he came and declared that he had heard and understood what I said.

I asked him to repeat the words He answered "You said 'Mr. Watson — come here — I want to see you.'"

We then changed places and I listened at S while Mr. Watson read a few passages from a book into the mouth piece M. It was certainly the case that articulate sounds proceeded from S. The effect was loud but indistinct and muffled.

If I had read beforehand the passage given by Mr. Watson I should have recognized every word. As it was I could not make out the sense — but an occasional word here and there was quite distinct. I made out "to" and "out" and "further", and finally the sentence "Mr. Bell Do you understand what I say? DO-YOU-UN-DER-STAND-WHAT-I-SAY" came quite clearly and intelligibly. No sound was audible when the armature S was removed.

Alexander Graham Bell's notebook entry from a successful experiment with his first telephone

An Engineering Notebook Documents your Work

Not only do you use an engineering notebook to organize and document your work, it is also a place to reflect on activities and projects. When working in a team, each team member will maintain their own journal to help with collaboration.

Your engineering notebook should have the following:

- An entry for each day or session that you worked on the solution
- Entries that are chronological, with each entry dated
- Clear, neat, and concise writing and organization
- Labels so that a reader understands all of your notes and how they fit into your iterative design process

An entry might include:

- Brainstorming ideas
- Sketches or pictures of prototypes

- Pseudocode and flowcharts for planning
- Any worked calculations or algorithms used
- Answers to guiding questions
- Notes about observations and/or conducted tests
- Notes about and reflections on your different iterations