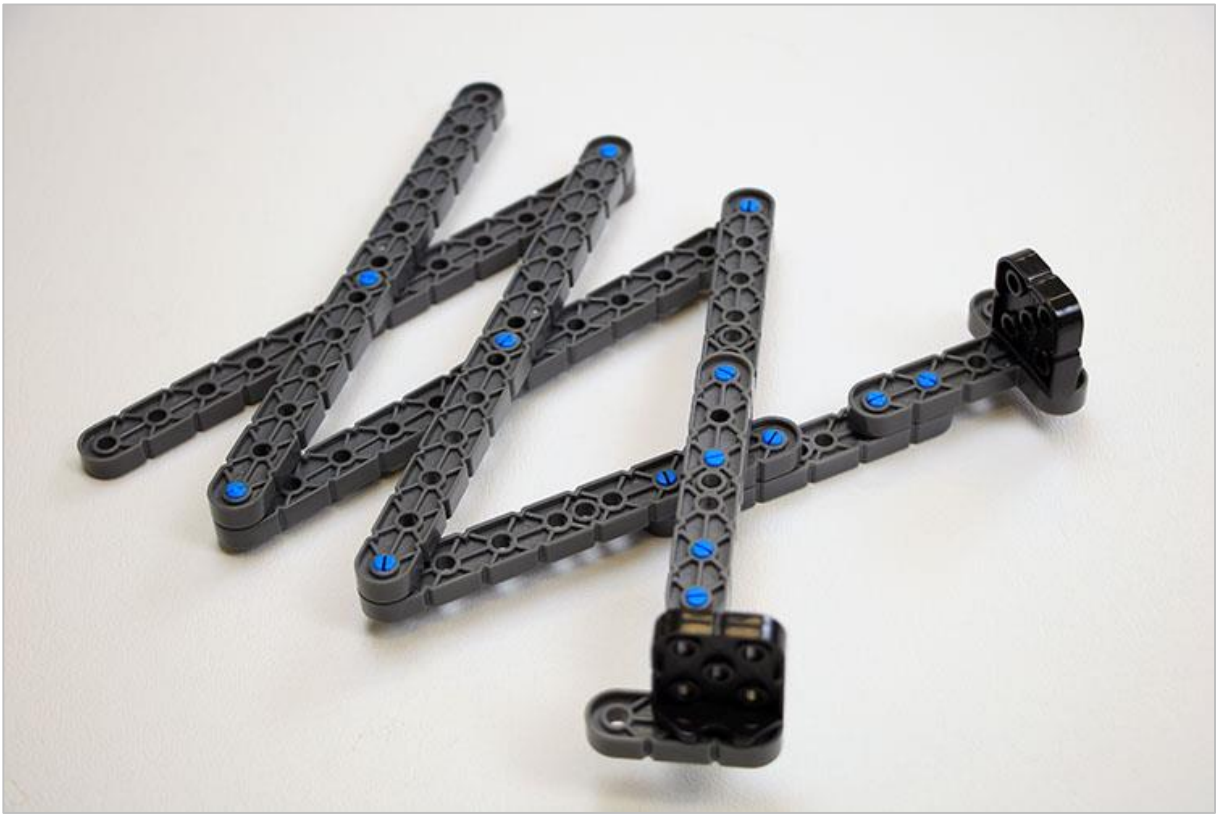
Grabber



Using linkages to build a Grabber!

SPARK
SEEK

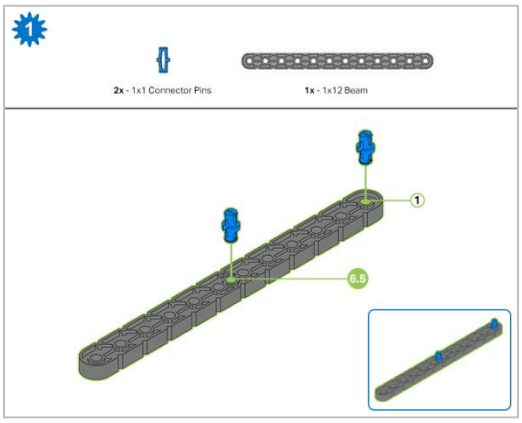
Discover new hands-on builds and programming opportunities to further your understanding of a subject matter.

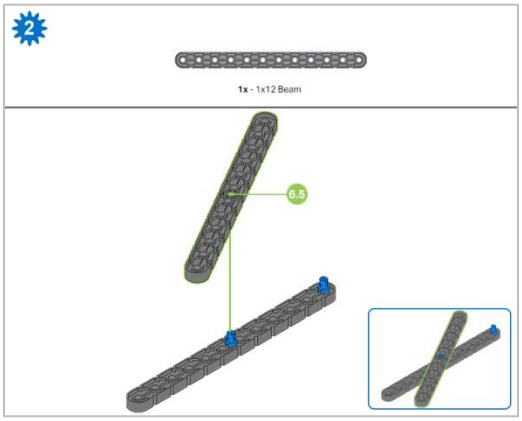
The Completed Look of the Build

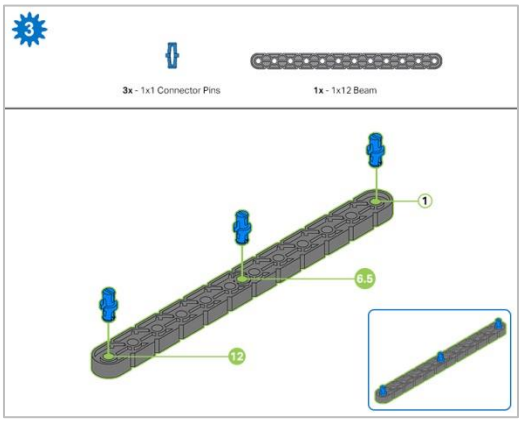
A completed build of the Grabber

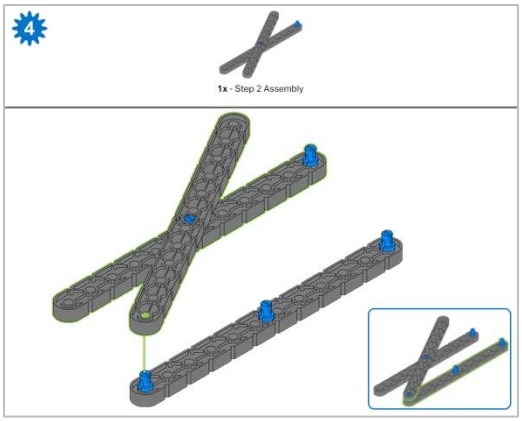
Linkages convert input force or motion into a different output force or motion. There are several types of linkages. The Grabber build uses a scissor linkage to show how a simple design can transfer motion.

Build Instructions





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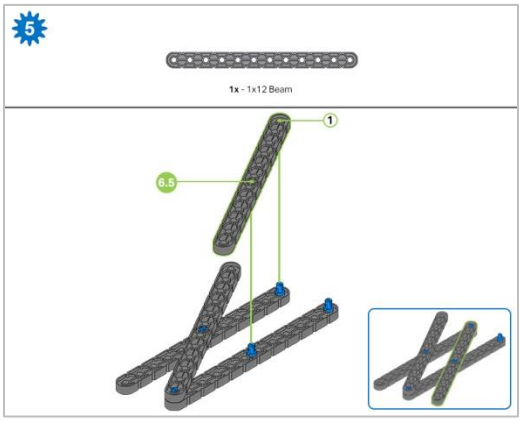
1x - Step 2 Assembly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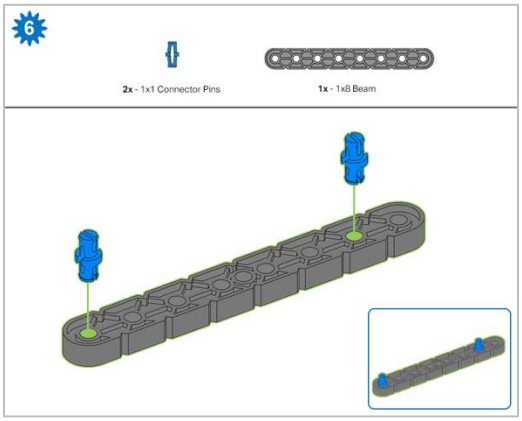
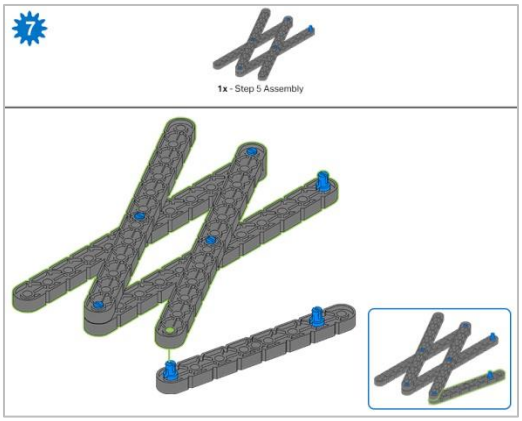
1x - 1x12 Beam
1
6.5


6
2x - 1x1 Connector Pins
1x - 1x8 Beam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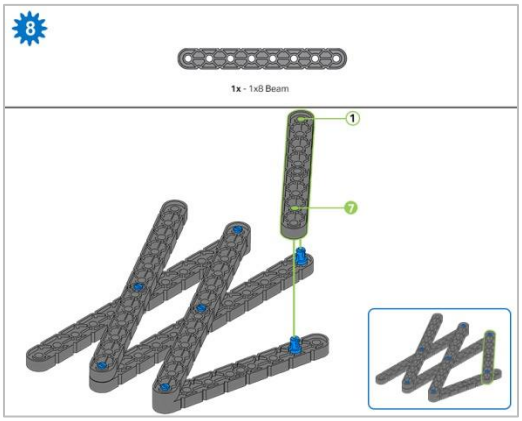
1x - Step 5 Assembly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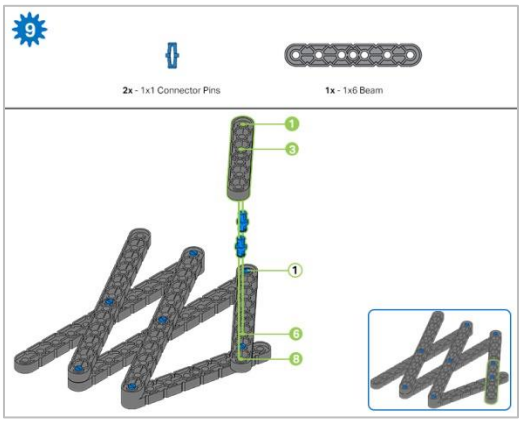
1x - 1x8 Beam
1
7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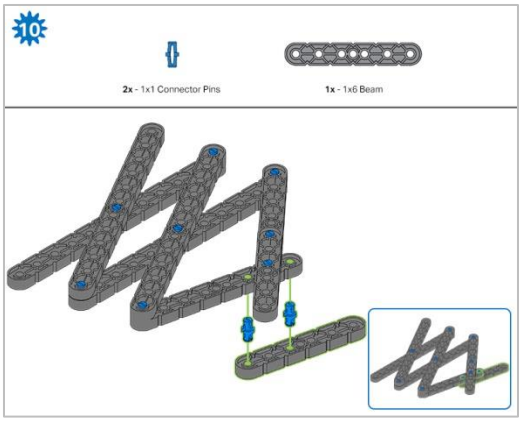
2x - 1x1 Connector Pins
1x - 1x6 Beam
1
3
1
6
8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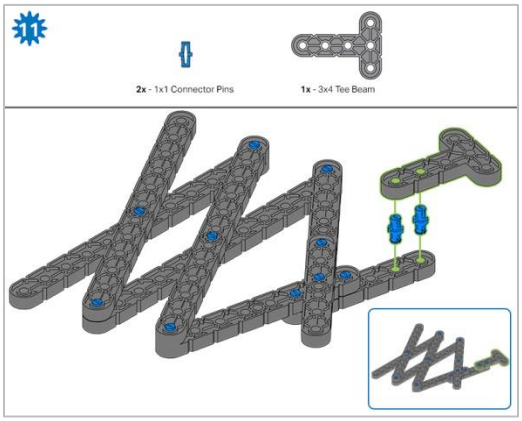
2x - 1x1 Connector Pins
1x - 1x6 Beam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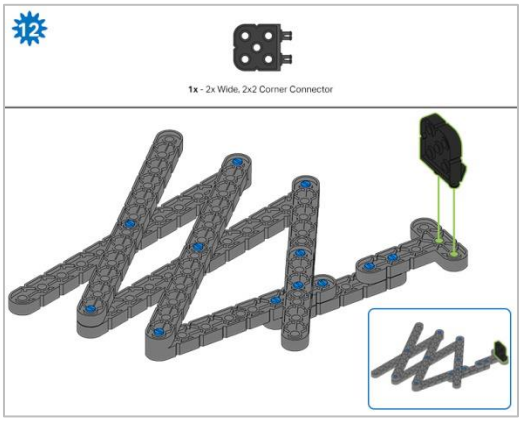
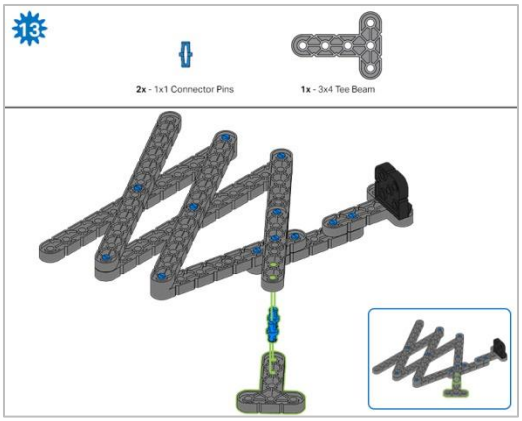
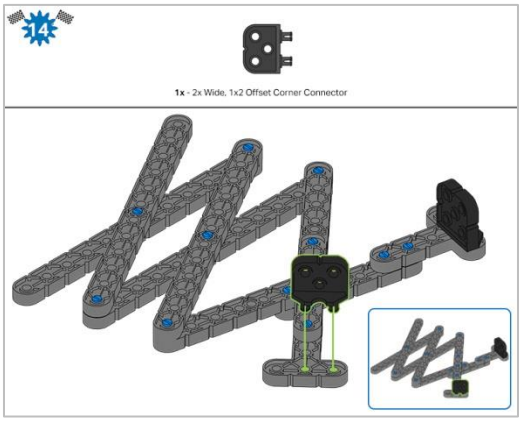
2x - 1x1 Connector Pins
1x - 3x4 Tee Beam


12
1x - 2x Wide, 2x2 Corner Connector





Build Instruction Tips

- **All Steps:** There is important information about which parts are needed for the step above the partition line. The number below the image of a part is the number of that part required in the step. There may be dimension information below the part to help identify which size to use.
- **Step 1:** Count all pieces before starting your build and have them readily available.
- **Step 7:** Insert 1x1 Connector Pins into the first and seventh hole in the 1x8 Beam.
- **Step 9:** Inter the 1x1 Connector Pins into the 1x8 Beam first, before attaching the 1x6 Beam.

Pinch Points:

Be careful when attaching pieces, removing pieces, or manipulating the Grabber that nothing will be pinched in movement.

Safety Hazard:

Exploration

Now that the build is finished, explore and see what it can do. Then answer the following questions in your engineering notebook:

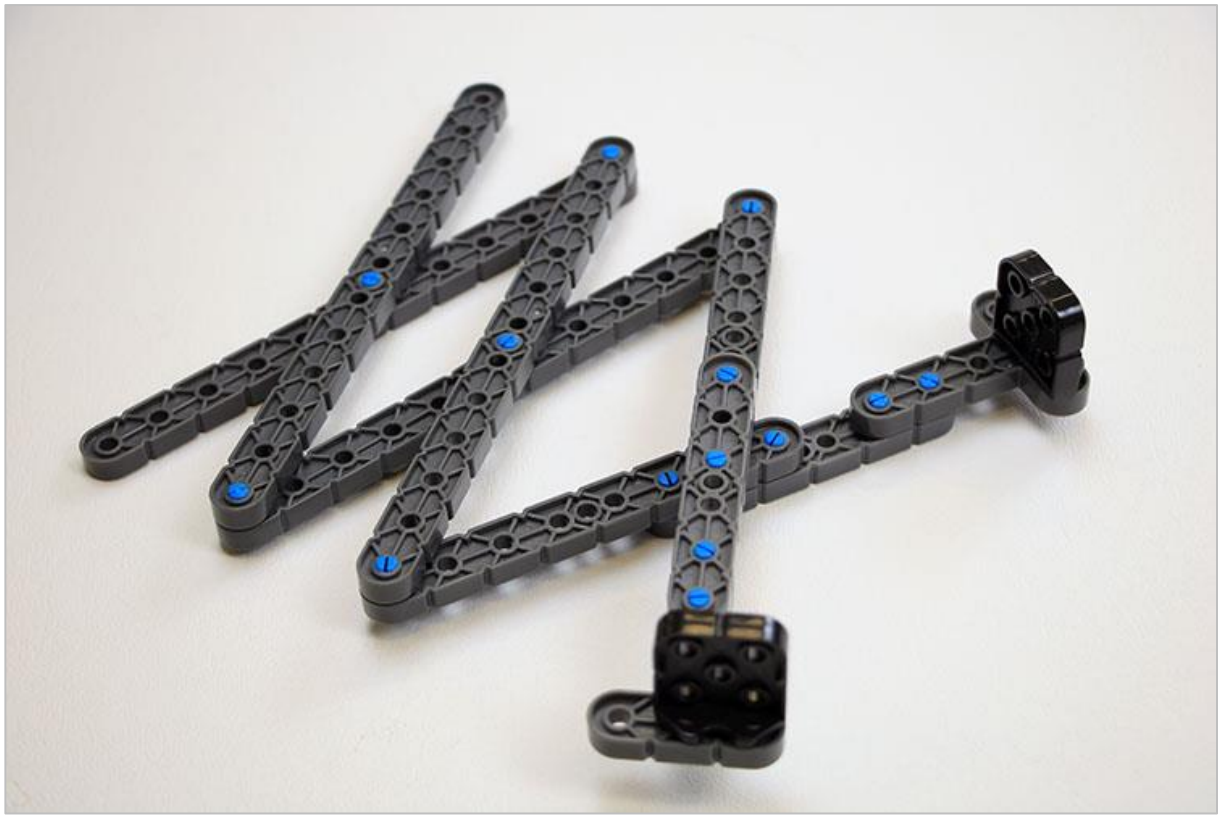
- What does the Grabber do? Explain with details.
- How might the Grabber be used? Explain with details and sketches.
- A mechanical advantage is an advantage gained by the use of a mechanism in transmitting force. Does the Grabber have a mechanical advantage(s)? If so, what is the mechanical advantage? Explain with details.
- Explain this build, using common engineering terminology, to someone who hasn't seen it. Use at least 3 of the following terms in your description: beams, connectors, levers, pivot points, fulcrum, and simple machines. For example, I could say that beam is an engineering term that describes this build because the build requires beams to form its "structure." You may need to look up these terms if you need clarification.

SPARK
PLAY

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

The Grabber's Linkages

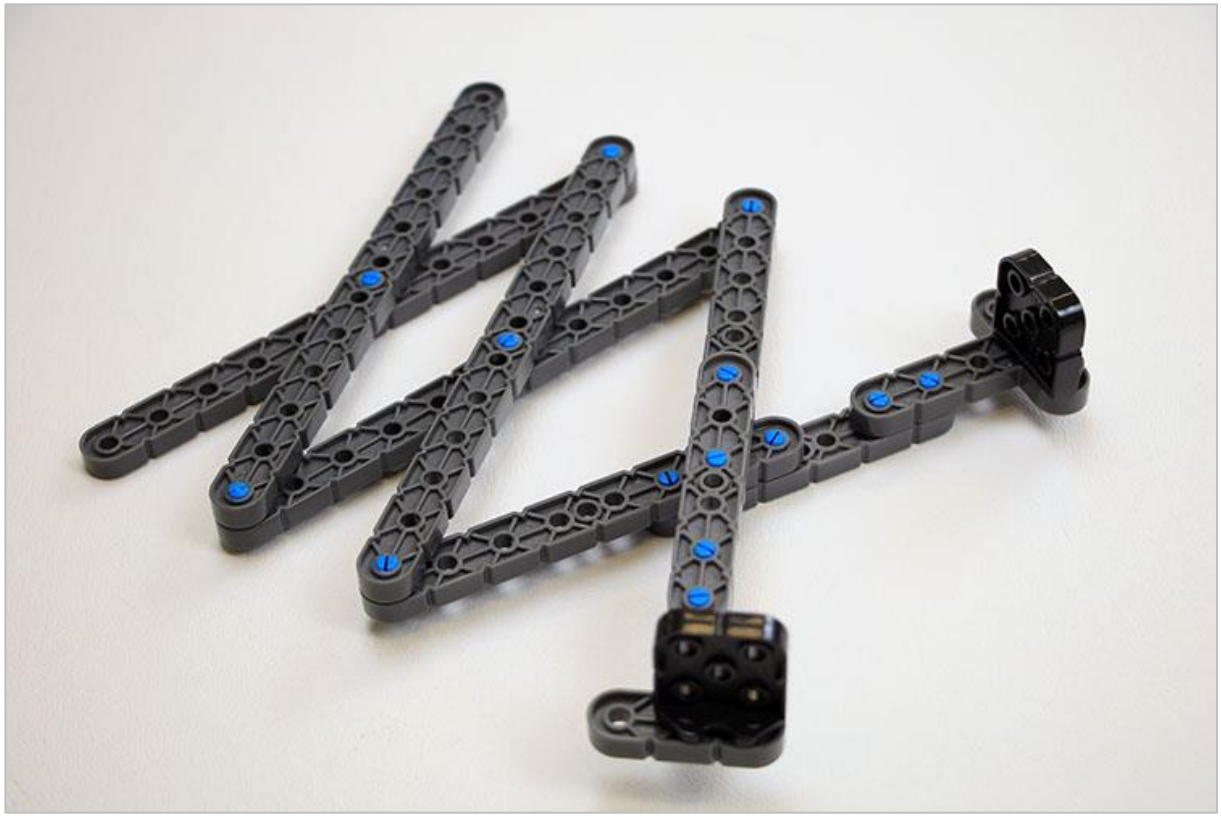
1. Examine the Grabber



In Step 2 of the Grabber build, you created a linkage by attaching two beams together at the center using a pin. This created a scissor linkage. That should be easy to remember when you think of how the sides of scissors move around a center point.

- **Build Expert:** hold the ends of the bottom two beams in each of your hands. Close and open the Grabber by moving your hands apart and back together again, similar to using a single pair of scissors but with two hands.
- **Recorder:** sketch and explain in your engineering notebook how the Build Expert's movements compare to the movements of the Grabber. Compare the direction of each beam's movements and identify a pattern.
  Hint: Look at how the pins affect the beams' movements.

2. Consider Extending the Grabber



The Grabber has three scissor linkages. Adding more scissor linkages would allow the grabber to lift or extend further.

- **Build Expert:** place the Grabber down so that it is halfway opened. Consider how much longer the Grabber would be if two more scissor linkages were added to the build. You can use the length of the two bottom beams to estimate.
- **Recorder:** sketch what the extended Grabber build would look like. Explain why adding two more scissor linkages might not be a good design plan. What could change about how the Grabber works if two more linkages are added to the build?

Converting Motion With Linkages

A scissor lift

Converting Motion With Linkages

Linkages are a fundamental part of how machines are designed because of their ability to create such a wide variety of output motion. Linkages can also change the direction of a force. The picture above shows a scissor lift which uses multiple scissor linkages. A scissor

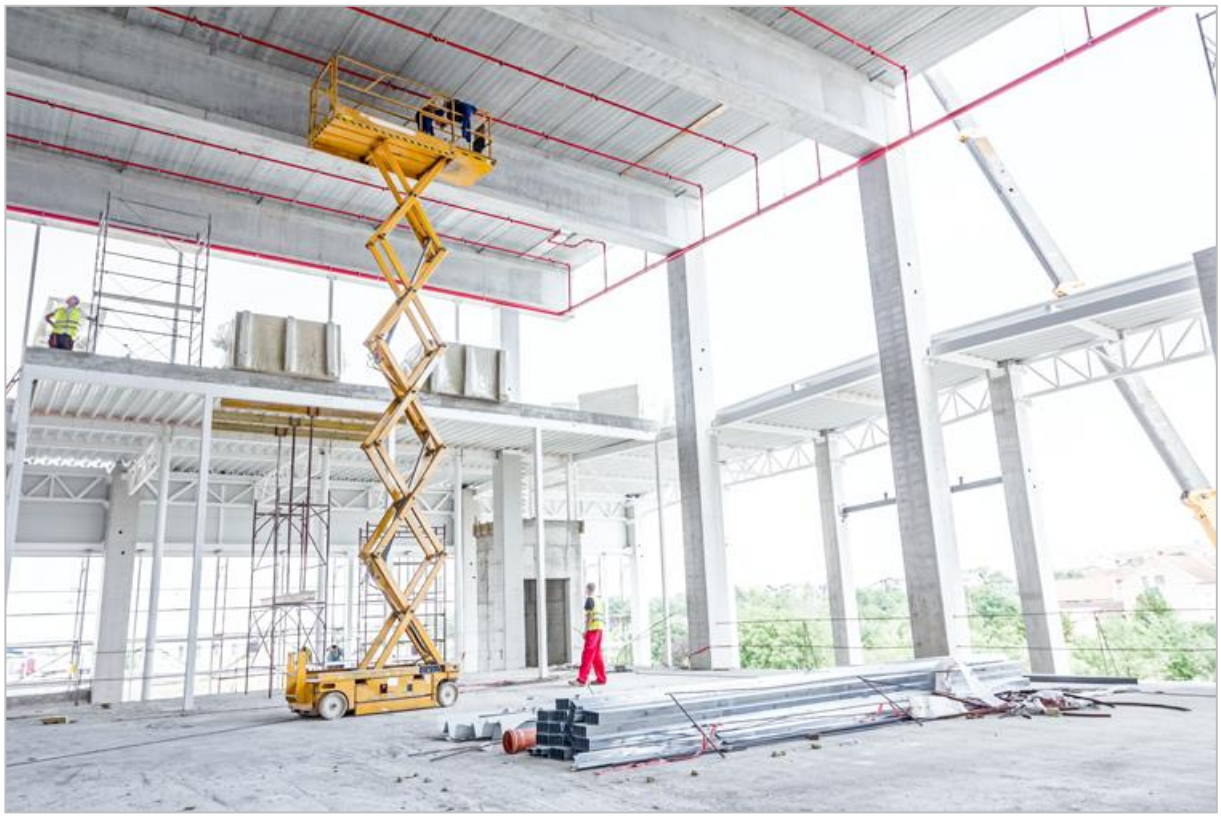
lift is often used to raise or lower people. In order for a scissor lift to raise, force is applied to the outer beams at the bottom of the lift. As force on the beams at the bottom pushes them closer to the center, the lift raises. This is a great example of how a linkage can change the direction of a force. In this case the linkage was again a scissor linkage like the Grabber's, but the force was generated by a motor instead of by the user squeezing the bottom beams.

- **Build Expert:** explain how a platform might be added to the top of the Grabber to create something similar to a scissor lift.
- **Recorder:** sketch and explain the design you decide on in your engineering notebook.

SPARK
APPLY

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

Where We've Seen Scissor Lifts



A scissor lift being used for construction

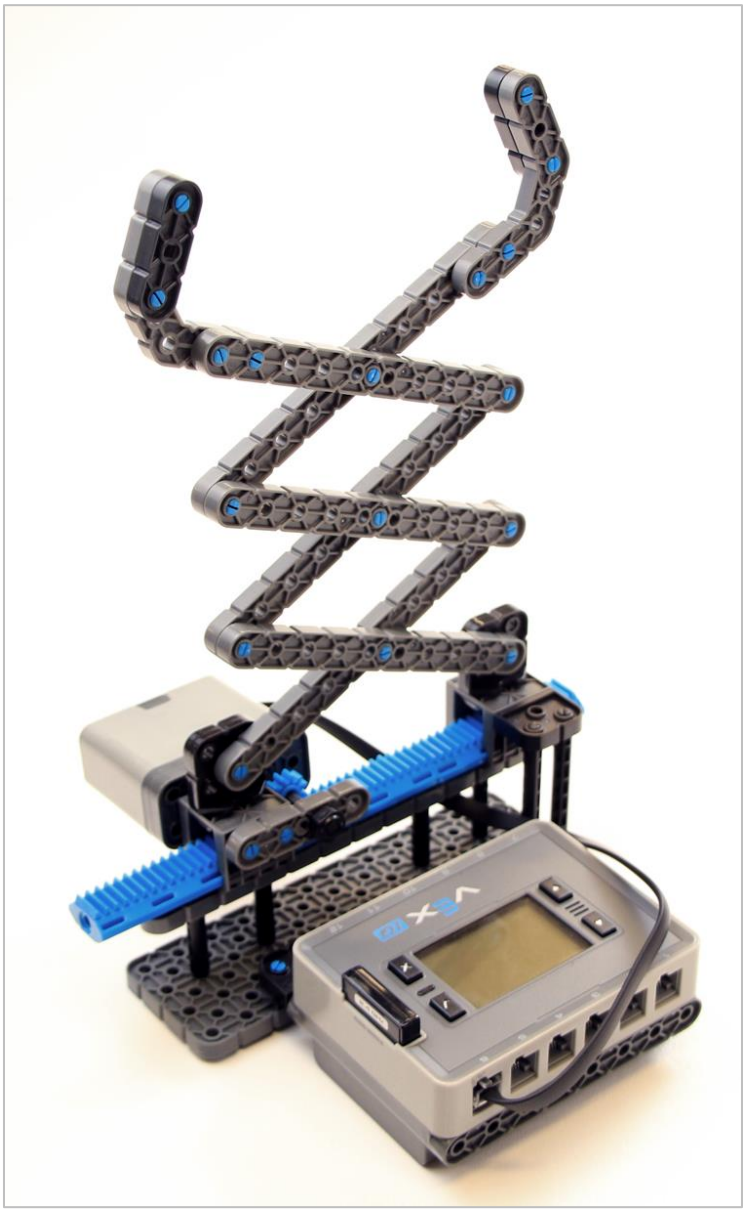
Reach For the Sky!

The Grabber and the scissor lift are very similar devices. Scissor lifts are used in many different professions. They allow workers to reach a variety of different heights as they complete their jobs. In addition, scissor lifts offer a mobile and stable platform to complete work from. They are often used in place of ladders or scaffolding. Their mobility, as well as their stability and security, create a safer and more efficient work environment.

Some of the professions below frequently use scissor lifts:

- Construction Workers
- Electricians
- Carpenters
- Warehouse Workers
- Mechanics

Incorporating a Scissor Linkage on a Competition Robot



A motorized scissor linkage

Designing with Scissor Linkages

You can use a scissor linkage in your design when you need to change the shape and size of your robot to accomplish a specific task. Scissor linkages are often included in robot designs with Rack Gears and Linear Slide Brackets so that their motion can be controlled by a motor. This can be useful when it comes to designing a robot for competitions.

A scissor linkage is helpful in many robot applications.

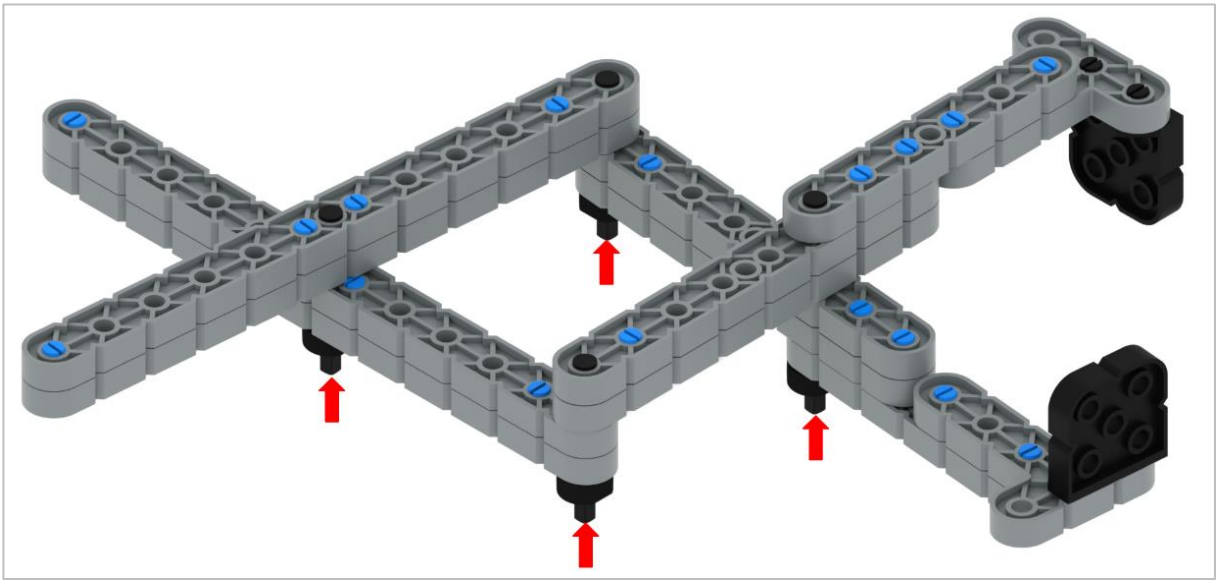
- A scissor linkage can be used to increase a robot's height.
- If your robot needs to start compact, but stretch out horizontally, you can use a scissor linkage to increase its width.
- A scissor linkage can extend a robot's reach if the robot needs to pick up objects and then place them in different locations.

SPARK
RETHINK

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

Improve the Grabber's Design

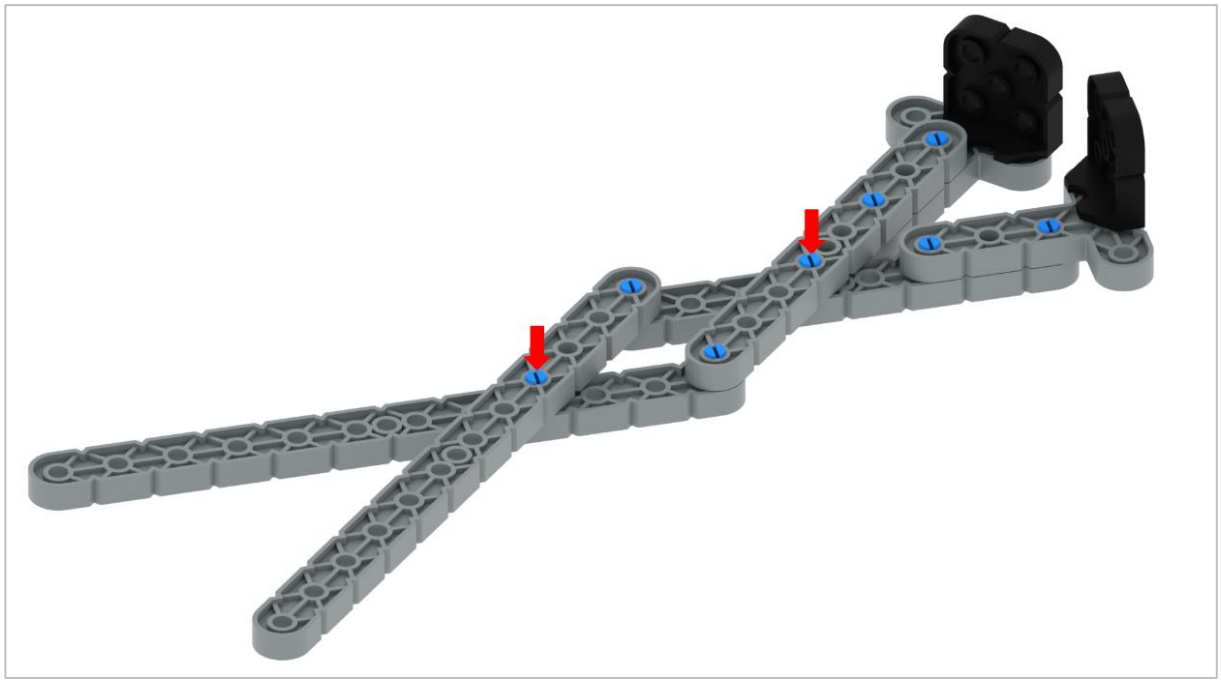
Think about your experience using the Grabber.
Review each of these techniques for building a better Grabber.
As you review each, consider whether your Grabber would be better if you used the engineering technique described to change your build.



- **Technique:** Doubled-up
- **Explanation:** Beams are at least doubled so that the Grabber is more rigid and will not bend when picking up heavy objects.
- **Changes to current Grabber:**
  - Shorter in length and fewer pivot points
  - All beams are doubled and connected to each other with pins
  - Collared shafts and rubber shaft collars are used as pivot points (Red arrows show where)
- **Parts added:**
  - 1x8 Beam (Quantity: 2)
  - 2x Wide 2x2 Corner Connector (Quantity: 1)
  - 3x Pitch Plastic Capped Shaft (Quantity: 3)
  - 4x Pitch Plastic Capped Shaft (Quantity: 1)
  - Rubber Shaft Collar (Quantity: 4)

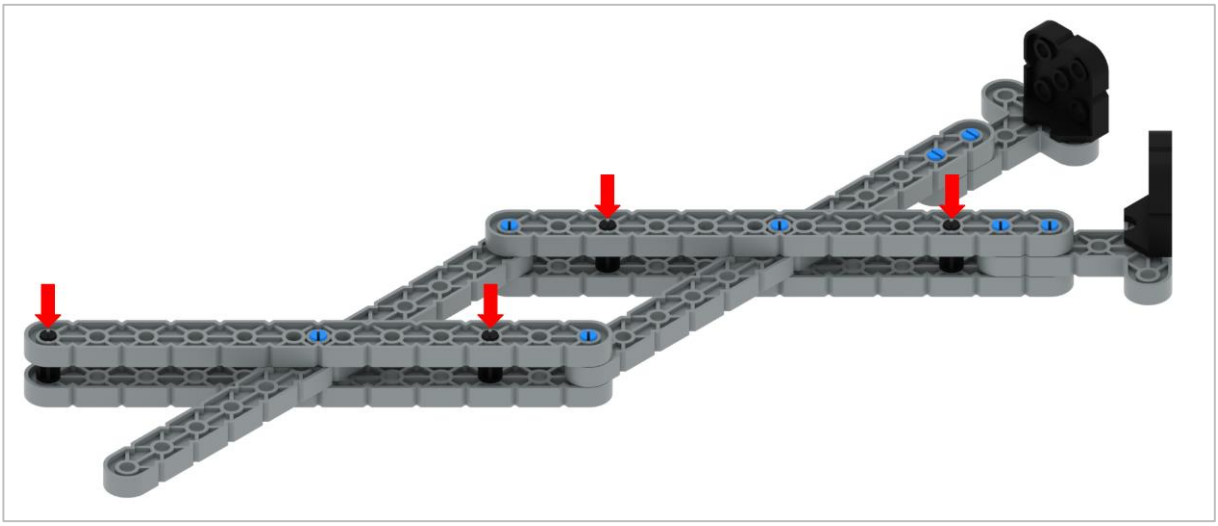
- 1x2 Connector Pin (Quantity: 4)

- **Parts removed or replaced:**
  - 2x Wide 1x2 Offset Corner Connector (Quantity: 1)
  - 1x1 Connector Pin (Quantity: 1)



- **Technique:** Offset-center
- **Explanation:** The pivot points are positioned where they don't make the Grabber open too much or too little.
- **Changes to current Grabber:**
  - Shorter in length and fewer pivot points
  - Pivot points away from center to a location where they work best (Red arrows show where)
- **Parts added:**
  - 2x Wide 2x2 Corner Connector (Quantity: 1)
- **Parts removed or replaced:**
  - 1x6 Beam (Quantity: 2)
  - 1x12 Beam (Quantity: 2)
  - 2x Wide 1x2 Offset Corner Connector (Quantity: 1)

- 1x1 Connector Pin (Quantity: 7)



- **Technique:** Cross-support
- **Explanation:** Pivot points are reinforced so that they are stronger, which makes the Grabber more rigid, stable, and strong.
- **Changes to current Grabber:**
  - Shorter in length and fewer pivot points
  - The beams with center pivot points are reinforced using another beam of the same size and standoffs (Red arrows show standoffs)
  - Added beams require longer pins
- **Parts added:**
  - 2x Wide 2x2 Corner Connector (Quantity: 1)
  - 1x12 Beam (Quantity: 2)
  - 1x2 Connector Pin (Quantity: 6)
  - 1/2x Pitch Standoff (Quantity: 4)
- **Parts removed or replaced:**
  - 1x6 Beam (Quantity: 2)
  - 1x8 Beam (Quantity: 2)
  - 2x Wide 1x2 Offset Corner Connector (Quantity: 1)
  - 1x1 Connector Pin (Quantity: 13)

Plan Your Grabber's New Design

Answer the following questions in your engineering notebook:

- What do you want to change about the build by using other pieces in your VEX Super Kit? Explain at least two changes and name the technique(s) being applied if you are using one of the previous examples.
- What parts will you use to change the build? List the names of all needed parts and how many of each part the build requires.
- Create your own set of Build Instructions for your new Grabber design so that someone else could follow them to make their own Grabber. Start at Step 1 because the person might not have a Grabber yet. Explain with details and/or sketches.
- How do your changes to the Grabber make it better? Explain with details and/or sketches.

SPARK
KNOW

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

Review

1. **The scissor linkage used for the Grabber will:**
   - Pivot through a complete circle.
   - Cause a transfer of motion.
   - Cause the end of the Grabber to stay in one location.
   - Provide a rigid (non-moving) connection.

2. **When adding more linkages to the Grabber, it will:**
   - Increase the distance it can extend but decrease its stability.
   - Increase the distance it can extend and increase its stability.
   - Decrease the distance it can extend and decrease its stability.
   - Decrease the distance it can extend but increase its stability.

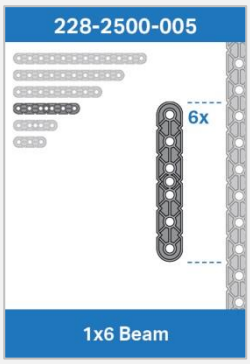
3. **Which of the following professions is <u>NOT</u> likely to use a scissor lift?**
   - Carpenter
   - Warehouse worker
   - Restaurant worker
   - Electrician

4. **When designing a scissor lift for a competition robot, which of these is *most likely* to be used with the scissor lift?**
   - Weaker connection points
   - A motor
   - Rubber belts
   - Pulleys

APPENDIX

Additional information, resources, and materials.

Parts Needed: Doubled-up Grabber



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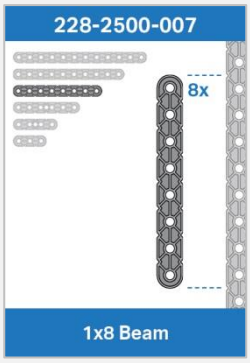

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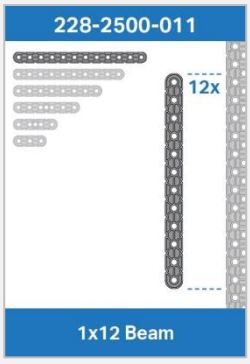

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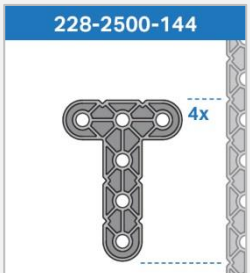
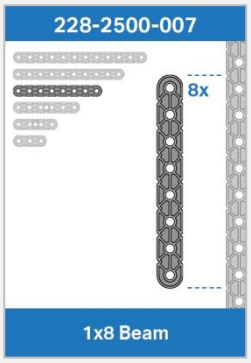


Parts Needed: Offset-center Grabber



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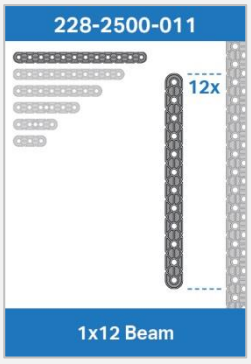

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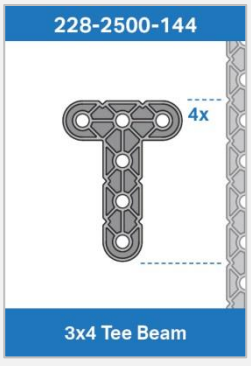
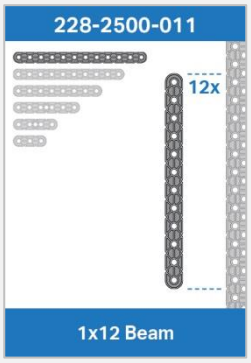


Quantity: 2

Parts Needed: Cross-support Grabber



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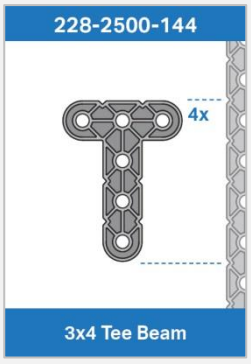

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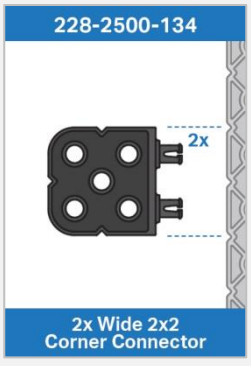

Quantity: 2

VEX Robotics Knowledge Base Articles

Links to Knowledge Base articles for this STEM Lab:

- Ideas for Organizing the VEX IQ Super Kit
- How to Get Started with the VEX Plastic Construction System
- How to Decide on which VEX Plastic Connectors and Standoffs to Use
- How to Select, Capture, and Support VEX Plastic Shafts
- How to Decide on which Beam, Specialty Beam, or Plate to Use