Grade 3: Rocks and Minerals

Lesson 1: Building the Magic School Bus

Lesson Objective:

- To create a sturdy car to serve as a model of the "Magic School Bus" that will travel through the layers of the Earth based on the book by Joanna Cole.

Learning Objective:

- To follow directions to create a sturdy car that will be able to travel across different terrains.
- To understand the basic components that go into building a sturdy car.

Time:

- Two-Three 45-50 minute periods

Challenge:

- Can you build a car that will travel through the different layers of the Earth?

Materials:

- Lego Team Challenge kits for each group of 2-4 students
- The Magic School Bus: Inside the Earth by Joanna Cole.
- Laminated sheets showing the step-by-step construction of the vehicle.

Vocabulary:

- RCX
- Bricks
- Axles
- Beams
- Plates
- Touch Sensor
- Layers of the Earth: Crust, Mantle, Outer Core, and Inner Core
- Metamorphic, Sedimentary, Igneous Rock

Procedure:

1. Begin the lesson by reading The Magic School Bus: Inside the Earth by Joanna Cole. Through discussion, emphasize the differences among the four layers of the Earth (crust, mantle, outer core, and inner core).
2. Present the challenge to students. Tell them that they will become engineers, building vehicles that will explore and gather information about the four layers of the Earth. Tell them that they will have challenges to meet at each step along the way.
3. Explain to students that they will work in small groups to construct their "School Bus" by carefully following directions. Show students a completed car that they will use as a model. Distribute laminated copies of the step-by-step instructions. Distribute Lego kits and briefly discuss vocabulary. (i.e. Names of Lego pieces)
4. Demonstrate the building of the "School Bus," stopping between each step to ensure that groups have completed that step correctly.
5. When all the cars are completed, give students an opportunity to run their "School Bus" up and down a simulated volcano. Work with students to troubleshoot any problems that arise.

Assessment:

- Teacher observations
- Students' ability to complete a sturdy car that moves forward.

Trouble Shooting:

1. Some students will be very familiar with vocabulary and building while for others this will be a new experience.
2. This will be their first experience of the school year with Legos. A discussion about managing Legos will be important.

Resources:

- CEEO Curriculum Website – http://www.ceeo.tufts.edu/robolabatceeo/
- The Magic School Bus: Inside the Earth by Joanna Cole
- Miscellaneous rocks and minerals books and videos

Grade 3: Rocks and Minerals

Lesson 2: Cracking the Crust

Lesson Objective:

- Students' Magic School Bus breaks through the soil of the crust and moves through the three layers of rock in the Earth's crust.

Learning Objective:

- Students can identify the crust and recognize there are three distinct layers: sedimentary rock, metamorphic rock and igneous rock.
- Students learn the order of the layers and specific features of each.
- Students correctly program their Magic School Bus to stop at each layer for a given period of time.

Time:

- Two-Three 45 minute time periods

The Challenge: Can your Magic School Bus crack the crust and complete a tour through the crust of the Earth?

Materials:

- Sturdy car built in lesson one
- One Team Challenge kit for each group of 2-4 students
- Magic School Bus: Inside the Earth by Joanna Cole
- Simulated Earth Crust using: wooden base, sand paper (sedimentary rock), bubble wrap (metamorphic rock), gravel (igneous rock)
- Saran Wrap
- Pilot 4

- How Will We Crack the Crust? Planning Sheet
- Cruising Through the Crust Programming Sheet

Vocabulary:
- Sedimentary, Metamorphic and Igneous rock
- Earth's Crust
- Limestone Cave

Procedure:
- Students are given the challenge of becoming travel group organizers. Their task is to organize a group tour of the layers of the Earth. They must transport passengers through the three layers of the crust: sedimentary, metamorphic and igneous. We will begin with breaking through the soil and moving through the crust.
- They have each completed sturdy cars which we know can travel up and down a volcano. Now they must add an extension that will cut through the soil (a piece of Saran Wrap). Students plan their attachment by filling out the sheet titled, "How Will We Crack the Crust?"
- When their plan is checked by a teacher, students are instructed to return to their Team Challenge kits and design a tool to attach to the front of their car to "crack the crust" using the Legos that remain in their kits.
- The remaining tasks involve programming their Magic School Bus based time intervals needed to complete their tour. The teacher explains that since they must complete a tour of the Earth's Crust, there will be tourists that need to be dropped off and picked up at different layers. The following are their programming tasks:

1. It is a busy day for the Magic School Bus Inside the Earth Tour Company. Before entering the Earth, the Magic School Bus will pick up a father and daughter. After cracking the crust, the Magic School Bus will continue into the first layer, the sedimentary rock (sandpaper). Here the two passengers choose to get off to explore the limestone cave.
2. After dropping the passengers off, the Magic School Bus must continue on to the metamorphic layer (bubble wrap) where they pick up two new passengers still talking about the amazing marble they had just observed.
3. It started getting warm on the Magic School Bus as they continued to move through the Earth's crust into the igneous rock level (gravel). Here the bus must stop once more to pick up another passenger who got onto the bus informing the rest of the passengers that rocks actually melt!
4. The final programming task involves the bus transporting the remaining passengers through the rest of the igneous level, exiting the crust. The Magic School Bus must stop once it leaves the crust.

- Students should be filling out their Cruising Through the Crust programming sheet as they program the Magic School Bus to complete their challenge.

Extensions:

- Students can design an attachment to scoop up samples of each rock type
- Early finishers can create a brochure for the Magic School Bus Inside the Earth tour describing the vehicle and what you might observe and experience on the tour of the crust. This can be an ongoing assignment as they complete future challenges of exploring layers of the Earth.

- Send a postcard from a layer of the crust including an illustration of what you saw and a written explanation of your experience.

Assessment:
Teacher observation
Lego Reflection sheet

Trouble Shooting:

Resources:

- Magic School Bus: Inside the Earth by Joanna Cole
- CEEO Curriculum Website - http://www.ceeo.tufts.edu/robolabatceeo/

Simulating the Earth:

A Teacher Project

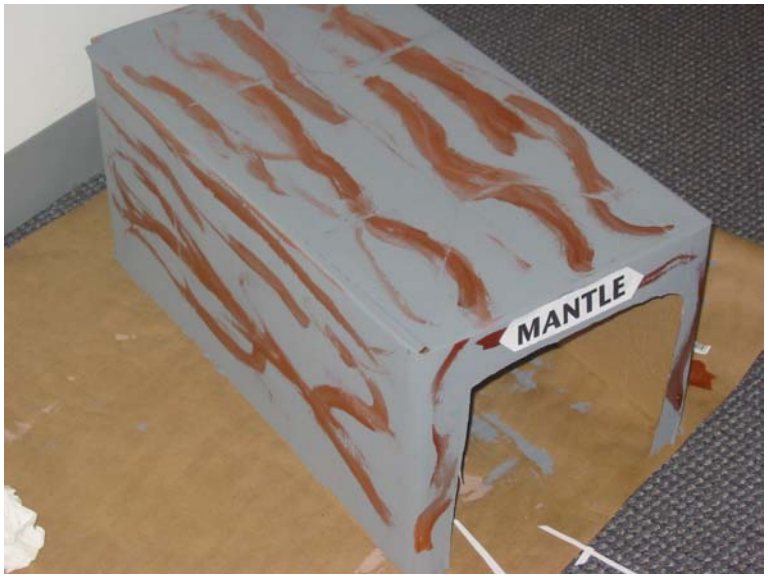
One easy way to simulate the Earth is to build each of the different layers of the earth on foam board or sturdy cardboard. To begin, build the three layers of the crust (sedimentary, metamorphic, and igneous). The challenges for each layer are different and include letting passengers on and off to explore different layers such as limestone caves, magnets and solid marble. Examples of some of the layers are shown below (keeping the layers separate makes transporting them easier).

Crust - Sedimentary (sandpaper on bottom)

Crust - Metamorphic (staple bubble wrap to the bottom)

Crust - Igneous (add small pebbles to the bottom)

Next in the layers is the mantle. For this obstacle, the students will have to push igneous rocks out of the way and then find a mechanism to break through solid rock (packing peanuts).



Mantle (fill the Mantle with packing peanuts and place sponge rocks at the entrance)

Finally, the students will have to design a way to retrieve a magnet from the core (sorry, no picture yet!).

Engineers_____

How Will You Crack the Crust?

Design an attachment for your Magic School Bus to crack through the soil at the top of the crust. Draw what you are thinking.

Write about how your invention works.

_____

_____

_____

_____

_____

_____

Engineer: _____ Date: _____

Partner(s): _____

Engineer's Programming & Data Sheet

Your programming challenge is to move your Magic School Bus into each of the Earth's crust's layers. The bus must stop in each layer to drop off and/or pick up passengers.

Step 1: The Magic School Bus will go forward for _____ seconds before stopping in the Sedimentary layer of the crust. Paste the icons from the next page into the space below to reflect how you will program your Magic School Bus.

1. Now using your **Step 1** icons you pasted above, prepare to program the computer in Programmer, Pilot 4
2. Download **Step 1** on to your RCX.
3. Test and record your results in the data table below.
4. Change program time & repeat steps 1-4.

Time entering layer	Stop Time	Time exiting layer	Observations

Step 2: The Magic School Bus will go forward for _____ seconds before stopping in the Metamorphic layer of the crust. Paste the icons from the next page into the space below to reflect how you will program your Magic School Bus to travel from the Sedimentary to the Metamorphic layer of the crust.

1. Now using your **Step 2 icons** you pasted above, prepare to program the computer in Programmer, Pilot 4
2. Download **Step 1 followed by Step 2** on to your RCX.
3. Test and record your results in the data table below.
4. Change program time & repeat steps 1-4 until you're pleased with the result.

Time entering layer	Stop Time	Time exiting layer	Observations

Step 3: The Magic School Bus will go forward for _____ seconds before stopping in the Igneous layer of the crust. Paste the icons from the next page into the space below to reflect how you will program your Magic School Bus to travel from the Metamorphic to the Igneous layer of the crust.

1. Now using your **Step 3** icons you pasted above, prepare to program the computer in Programmer, Pilot 4
2. Download **Step 1 followed by Step 2 followed by Step 3** on to your RCX.
3. Test and record your results in the data table below.
4. Change program time & repeat steps 1-4 until you're pleased with the result.

Time entering layer	Stop Time	Time exiting layer	Observations

Step 4: The Magic School Bus will go forward for _____ seconds before leaving the crust. Paste the icons from the next page into the space below to reflect how you will program your Magic School Bus to travel from the Igneous layer out of the crust.

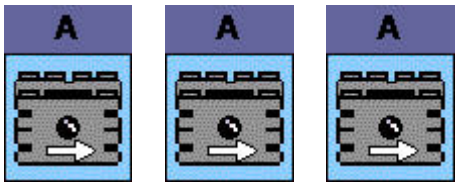
1. Now using your **Step 4** icons you pasted above, prepare to program the computer in Programmer, Pilot 4
2. Download **Step 1 followed by Step 2 followed by Step 3 and Step 4** on to your RCX.
3. Test and record your results in the data table below.
4. Change program time & repeat steps 1-4 until you've successfully completed the challenge.

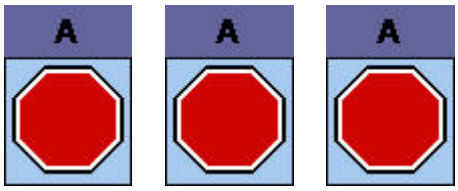
Time entering layer	Stop Time	Time exiting layer	Observations

Now that you have successfully completed the challenge, use the icons on the following page to show your final programming that took your Magic School Bus on a tour through the Crust of the Earth:

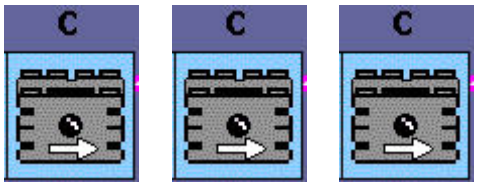
The Magic School Bus needs to travel _____ seconds to get to the _____ layer of the crust. They must wait there for _____ seconds to _____ before continuing for _____ seconds to reach the next layer.

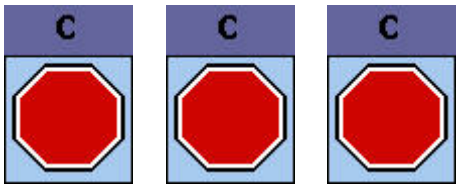
Port A – Motor:



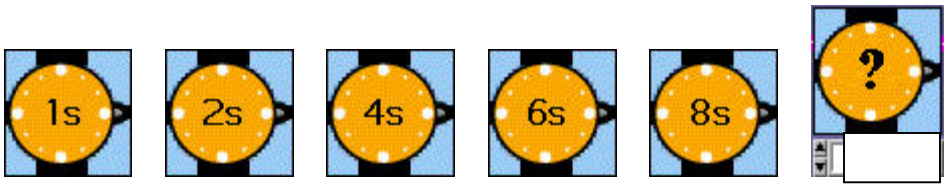


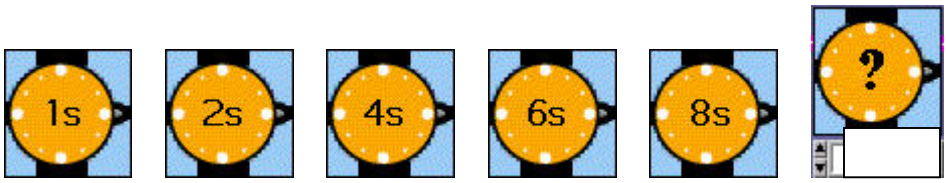
Port C – Motor:

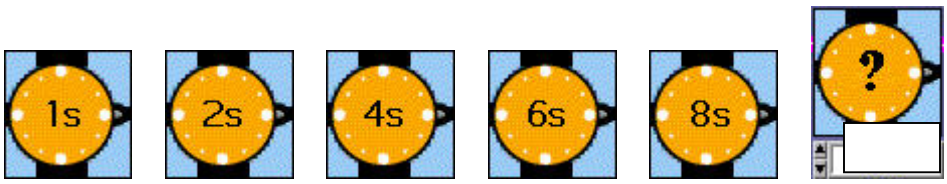




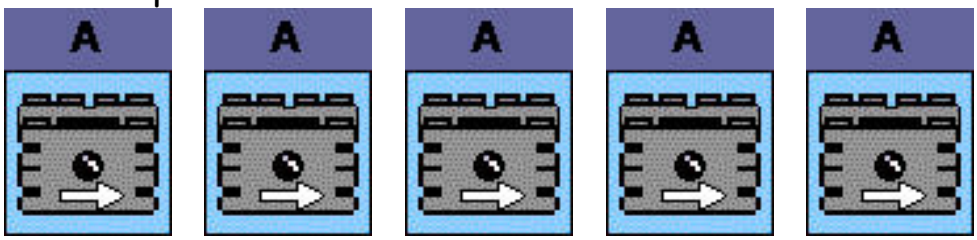
Time:

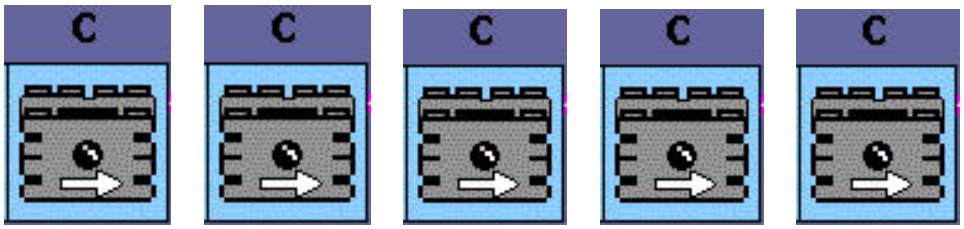


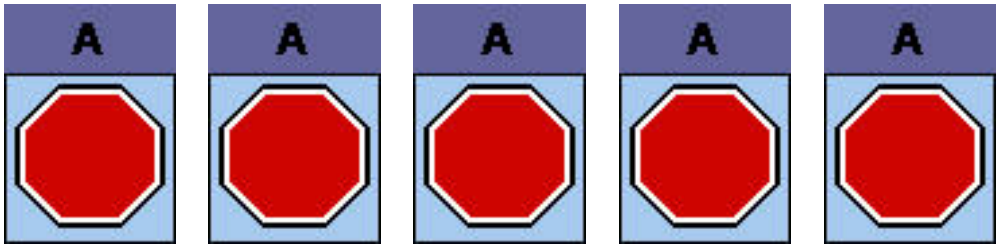


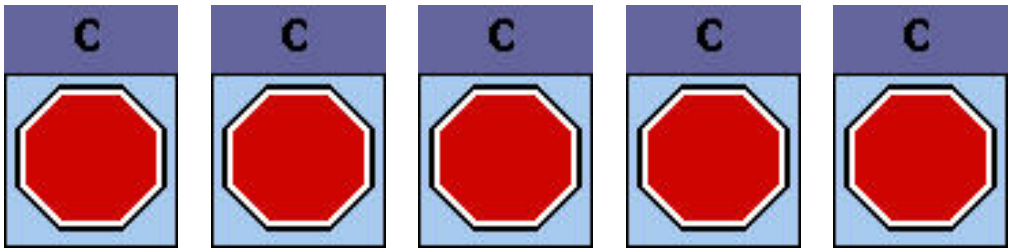


Motor Options:

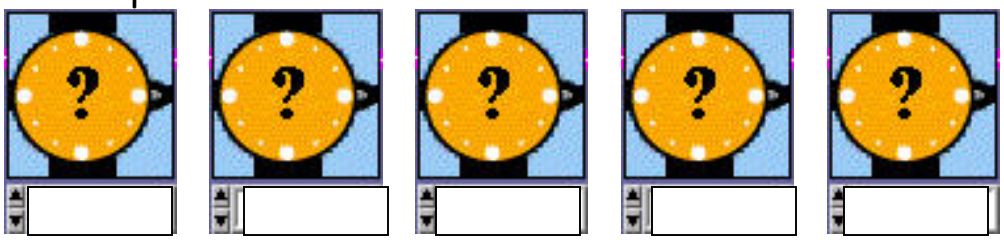


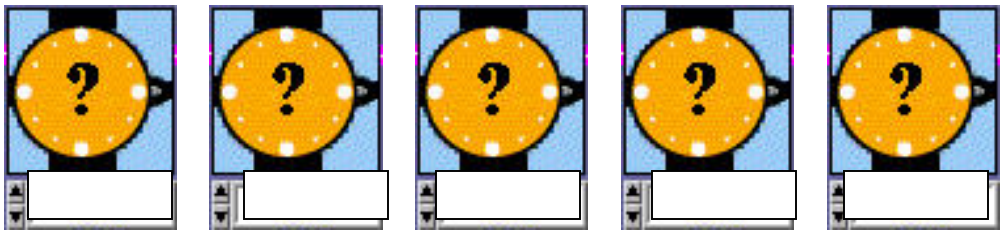






Time Options:





Grade 3: Rocks and Minerals

Lesson 3: Moving Through the Mantle

Lesson Objective:

- To build an extension to the Magic School Bus that will clear a path through the igneous rocks in order to travel through the mantle to transport passengers.

Learning Objective:

- Students will design a structure that is capable of moving objects.
- Students will program the Magic School Bus to travel for a given length of time.

Time:

- 45 minutes

Materials:

- Lego ROVs
- Various Lego pieces
- Pre-assembled tunnel
- Sponge igneous rocks
- Miscellaneous objects (extension)

Vocabulary:

- Mantle
- Igneous

Procedure:

- Teacher will explain that the students' challenge is to navigate their Magic School Bus through the mantle. In order to enter the mantle, students must first design and build an extension

for their ROV that will allow them to break through the igneous rocks at the beginning. They will need to program their ROV to travel through the mantle and stop once it has made its way through. At this point students will drop off their passengers and pick up others.

- Students will use various Lego pieces to design and build extensions.
- They will then test their extensions on materials available in the classroom that they feel have similar properties to the igneous rocks.
- Students will problem solve and use Pilot 4 to program their ROVs to travel through the mantle and stop exactly where passengers are located.
- The class will come together and take turns trying to get their ROVs through the mantle. Teams may revise their extensions and programming if they initially are not successful.

Extension:

- Program the ROV to play a song once it gets through the mantle.
- Try moving heavier objects in place of the igneous rocks, which may require redesigning the extension.

Assessment: Teacher observation and/or reflection sheet

Resources:

- CEEO Curriculum Website - http://www.ceeo.tufts.edu/robolabatceeo/

Grade 3: Rocks and Minerals

Lesson 4: Retrieving the Core

Lesson Objective:

- To retrieve a sample of the magnetic core of the Earth.

Learning Objectives:

- To build a retrieving devise for the Magic School Bus to grab a sample of the core of the Earth.
- To program in Robolab: Programmer, Pilot 4 to travel to the Core, retrieve the sample and travel back to the surface of the Earth.

Materials:

- Engineer's design sheet
- Pre-built sturdy cars (with two motors)
- Robolab software
- RCX
- Additional motors
- Lego building pieces
- Pre-built model of the Earth's core with magnets (the rock samples) dispersed around
- The Magic School Bus Inside the Earth by Joanna Cole
- Lego Reflection Response Sheet
- Engineer's Design Sheet

Vocabulary:

- Invention
- Earth's core
- Magnetic
- Magnet

Procedure:

- The lesson begins with a review about the inside of the Earth. Questions you might ask could include:
  - What are the layers inside the earth called? (crust, mantle, outer core, inner core)
  - What is the crust made of? Who can name the 3 types of rocks found there?
  - Who can tell me about the mantle? The core?
- Discuss the core of the Earth, explaining the difference between the outer core and the inner core. Review what the children know about magnets.
- Divide the class into teams of two students. Explain that they will be using the Magic School bus (the RCX car) from the previous lesson for this challenge.
- Introduce the challenge:

Your design challenge is to design an invention to build on your Magic School Bus to collect a magnetic sample from the core of the Earth.

- Write this challenge on the easel. Using the model of the core, explain that their Magic School bus must travel to the core with the passengers from the previous lesson. Once in the inner core, the collecting invention must collect a sample from the core. Then the Magic School bus must travel back to the surface of the Earth to the lab with the sample.
- Brainstorm with the group some ideas of what might work to retrieve the rock sample. Write these ideas on the easel for future reference. Explain that another motor may be need for this revise. Have additional motors available as well as an assortment of Lego building blocks.

- Distribute the "Engineer's Design Sheet" to each child. Model how the children should complete the sheet. Ask the children to have their design sheet checked with a teacher before starting to build.
- After the groups have completed the design sheet, and have them checked with a teacher, allow them to work on building their invention. Projects should be stored until the next class period when finished or when time is up. Engineer's Design Sheets should be stored in journals until next class period.

The next class period:

- Bring up Robolab software on the computer & mirror it on a TV monitor so all the children can see. Click on the "Programmer" icon. Tell the children that they will be using "Pilot 4" for this activity because it has multiple steps available. Click on Pilot 4. Show the children how to add additional steps to their program. Explain when they are finished building their invention, they will be given an "Engineer's Programming Sheet" to complete before they program their RCX.
- Pass out the "Engineer's Programming Sheet" and the "Programmer's Icon Sheet" to each child. On an overhead, demonstrate how to cut and paste a program on the "Engineer's Programming Sheet". Tell the children that after they have cut and pasted a program, they will get on a computer & select their choices on the Pilot 4 program. They will then download the program on to their RCX and complete the challenge.
- After answering any questions, let the groups work on the challenge at their own speed. If groups finish before the class is over, the children can work on the extensions listed below.
- When class is over, the children should return the cars for further lessons and store their data sheets in their journals for discussion during the next class period.

- Begin the next class period with the "Lego Reflection Response Sheet". After the children have completed this, hold a discussion about their experiences.

Extensions:

- After retrieving the sample of the core, turn your Magic School Bus around & go back through the mantle and the crust to get back to the surface.

Assessment:

- Student journal (design sheet)
- Completion of the challenge with teacher interview and observations

Resources:

- CEEO Curriculum Website – http://www.ceeo.tufts.edu/robolabatceeo/
- Magic School Bus: Inside the Earth by Joanna Cole

Engineer: _____ Date: _____

Partner: _____

Engineer's Design Sheet

Your design challenge is to design an invention to build on your Magic School Bus to collect a magnetic sample from the core of the Earth.

Draw what you are thinking:

Write about how your invention works:

_____

_____

_____

_____

_____

Engineer: _____ Date: _____

Partner: _____

Engineer's Programming Sheet

Using the icons on the icon sheet cut and paste the icons for each step below:

Your programming challenge is to

- Step 1: Run your Magic School Bus through the core to the inner core of the Earth

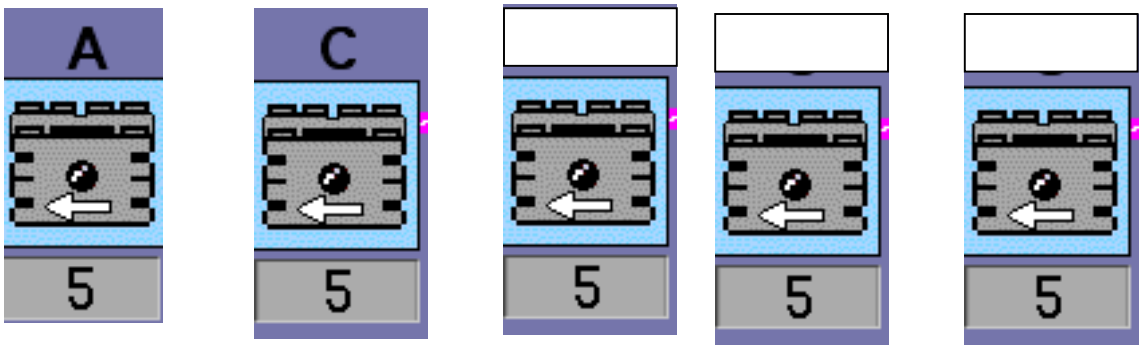
- Step 2: Use your collecting invention on your Magic School Bus must collect a magnetic sample from the core of the Earth

- Step 3: Travel out of the core to the Earth's surface with the sample

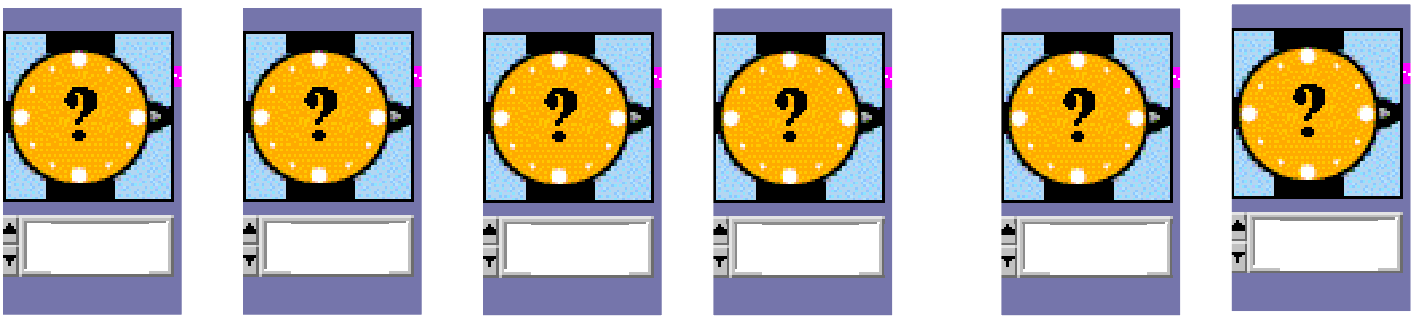
Programmer's Icon Sheet

Cut and paste the icon desired on your "Engineering Programming Sheet"

Motor:

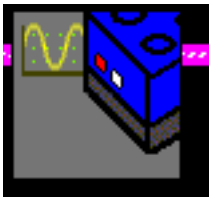


Time:



Sensors

Light



Touch

Resources on the Earth's Layers

http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Earths_layers/Earths_layers1.html - Short Presentation on the Four Layers of the Earth

http://pubs.usgs.gov/publications/text/inside.html - Explanation of the various layers of the Earth with short descriptions of each layer

http://www.usoe.k12.ut.us/curr/science/sciber00/7th/earth/acrobat/erlayers.pdf - Description of the three main layers (crust, mantle, and core)

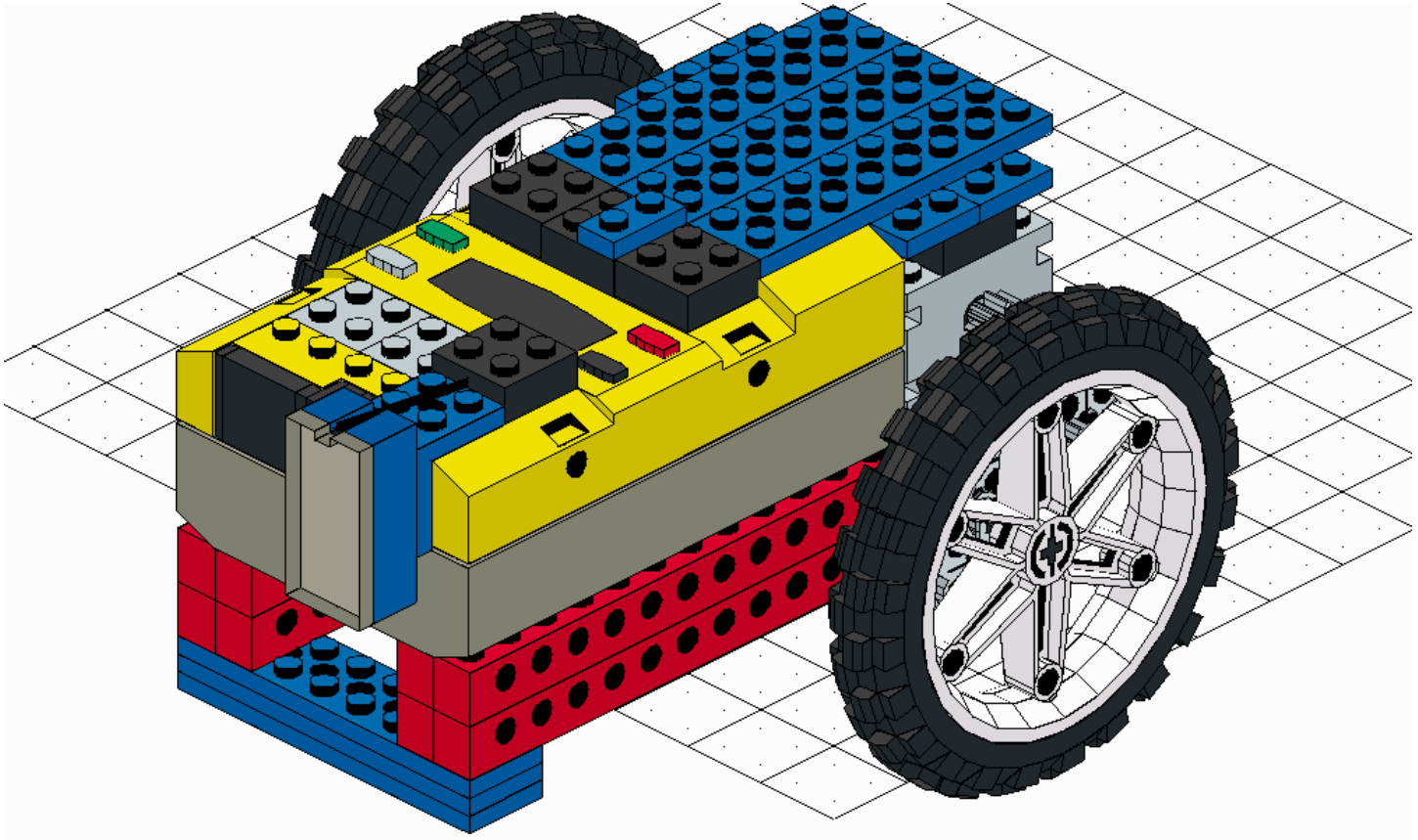
http://www.nides.bc.ca/Assignments/Rocks/layers10.htm - A short history of the discovery of the layers of the Earth

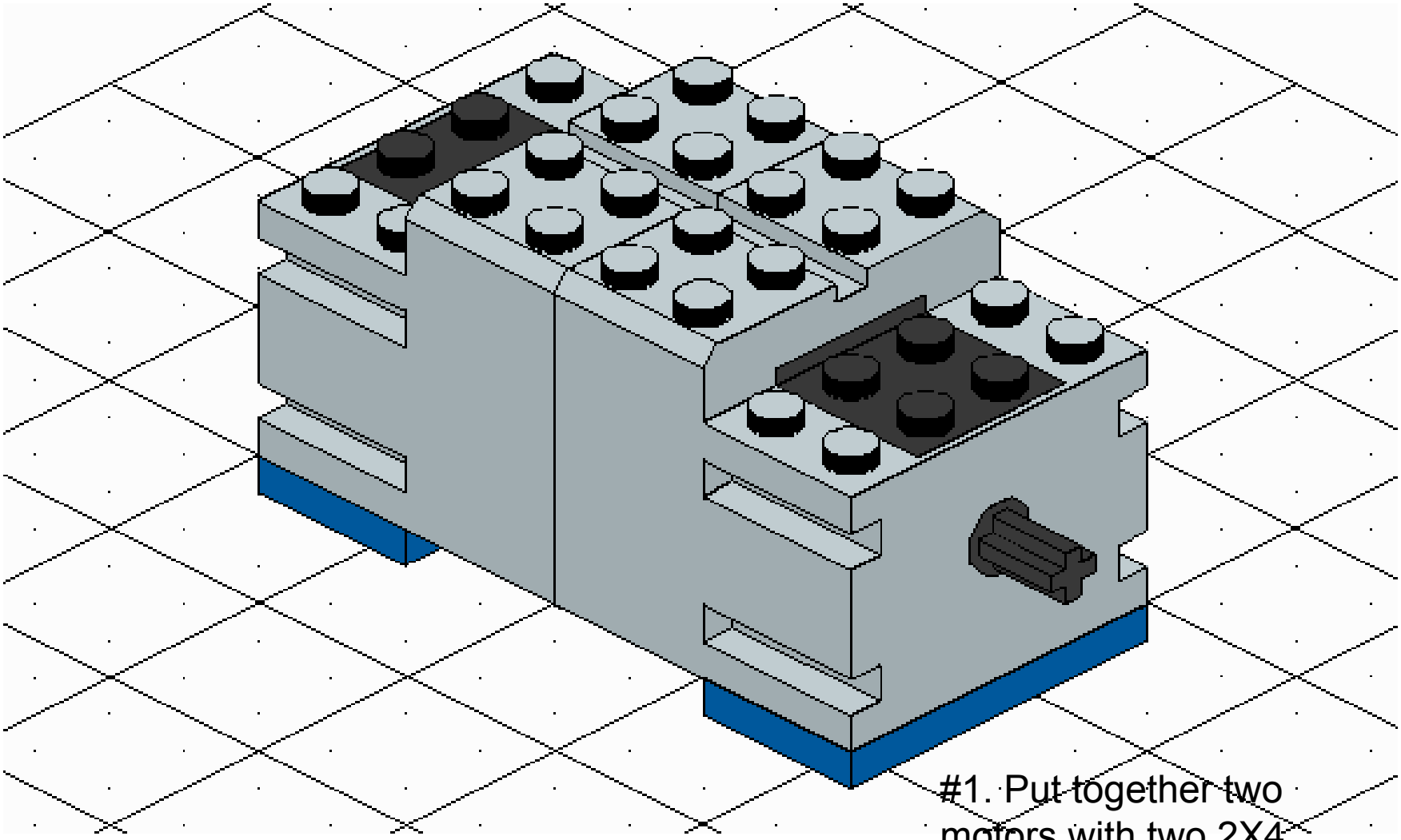
http://www.ttsd.k12.or.us/schools/haz/curriculum/science/journey/ - Links to various websites on the layers of the Earth

http://www.geocities.com/RainForest/Andes/5227/earthlayers.html - Another short description of the various layers of the Earth

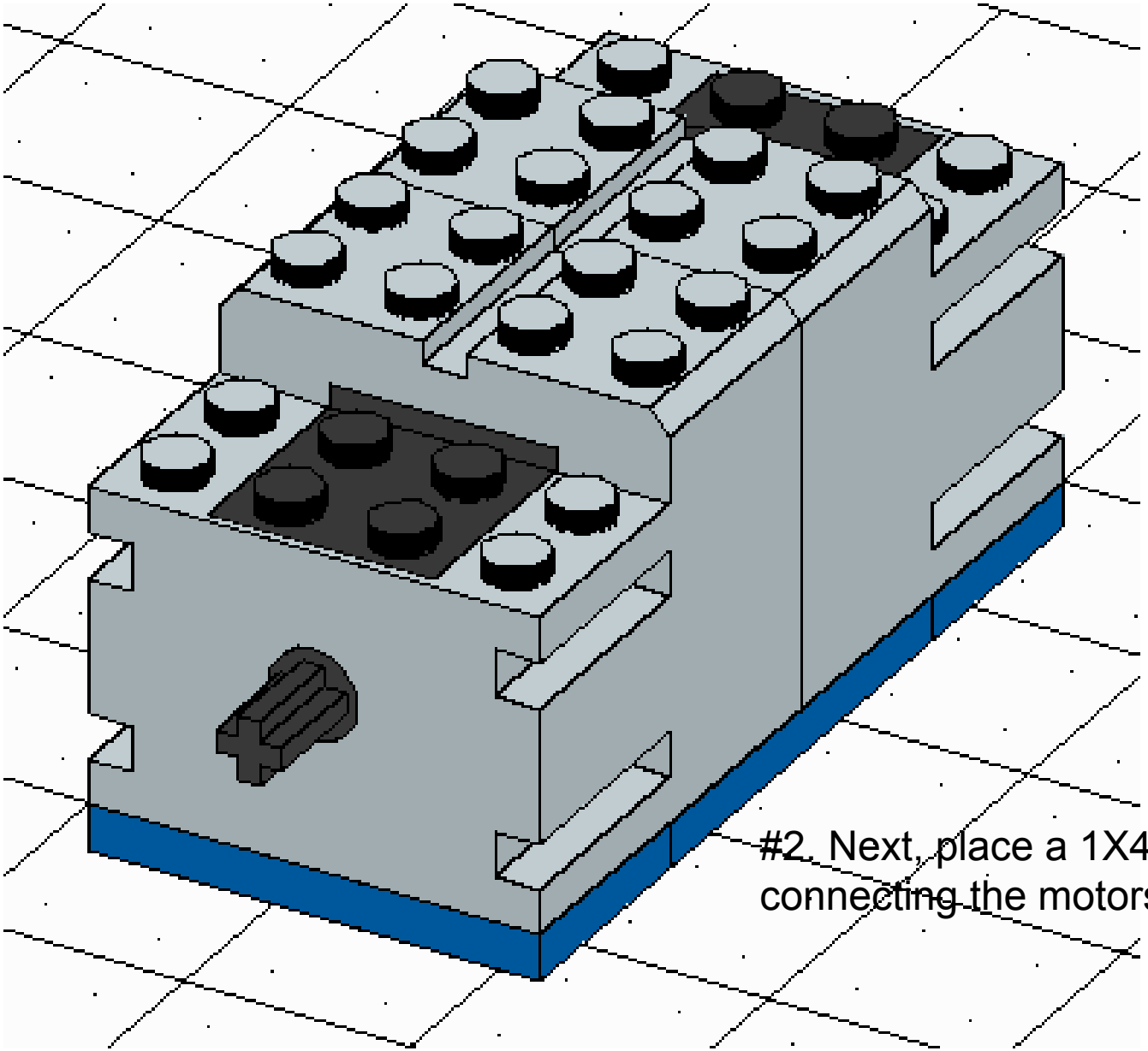
http://library.thinkquest.org/28327/html/universe/solar_system/planets/earth/interior/layers_of_earth.html - A "virtual" journey to the center of the Earth

ROVER

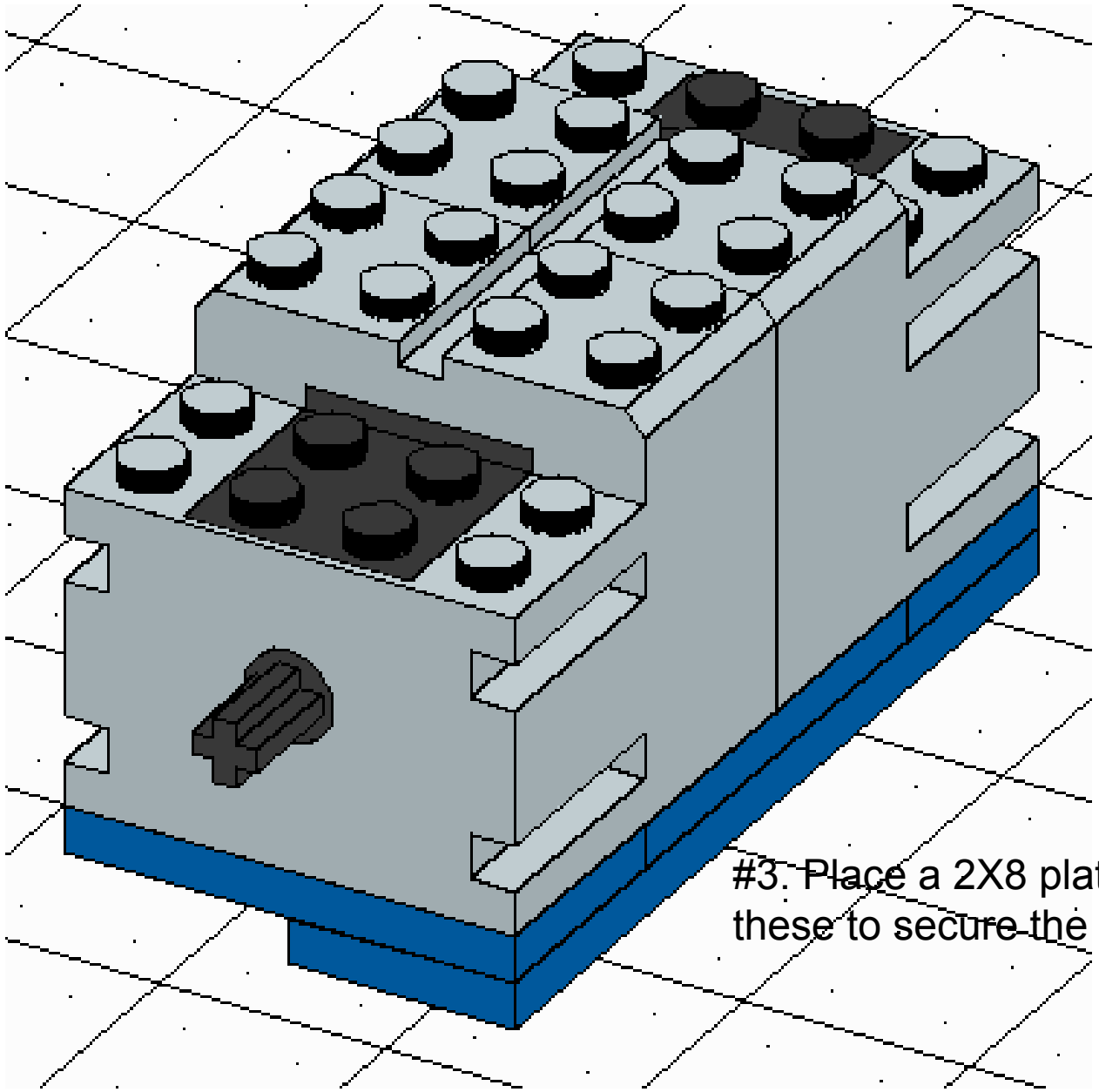




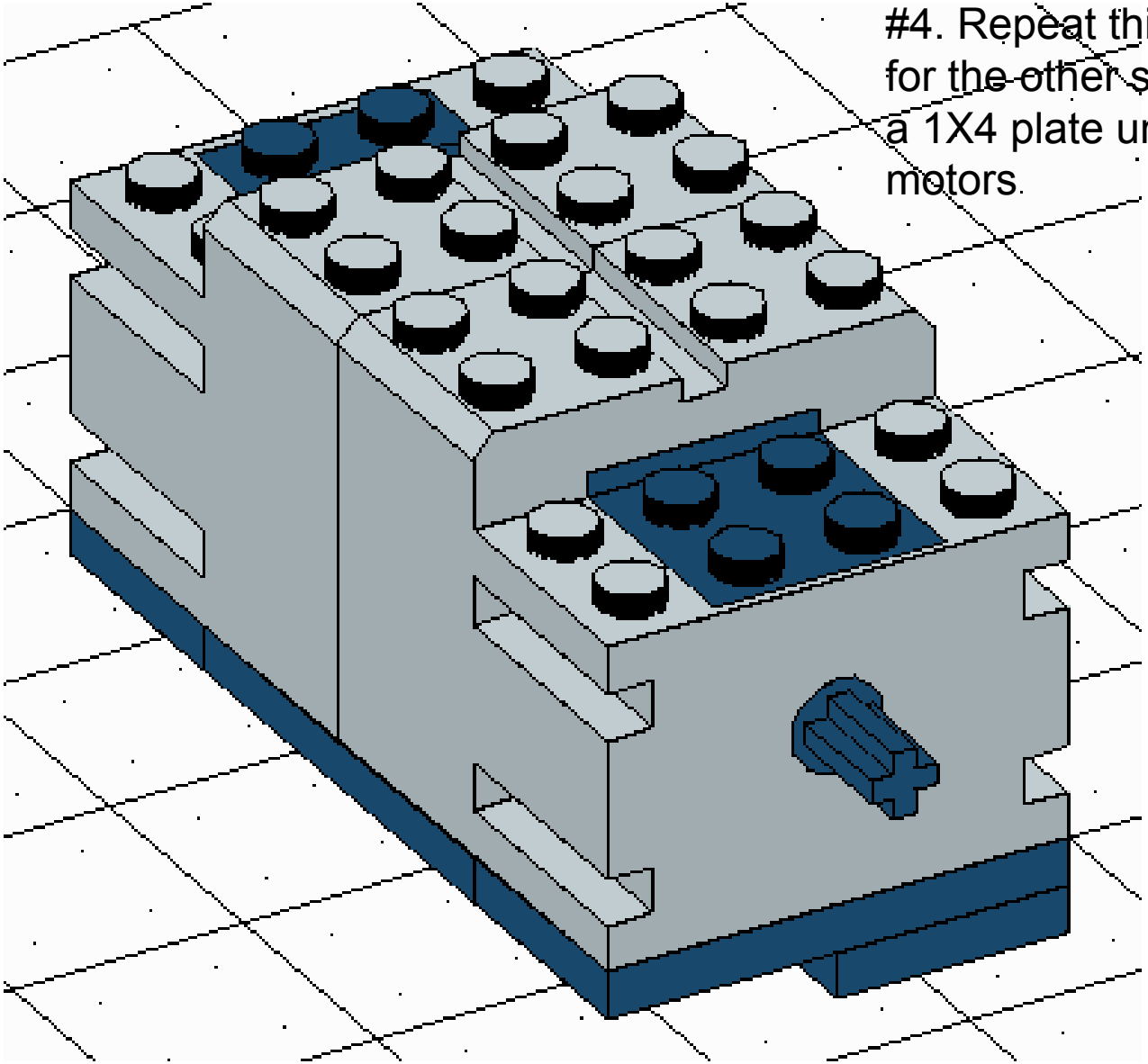
#1. Put together two motors with two 2X4 plates underneath them



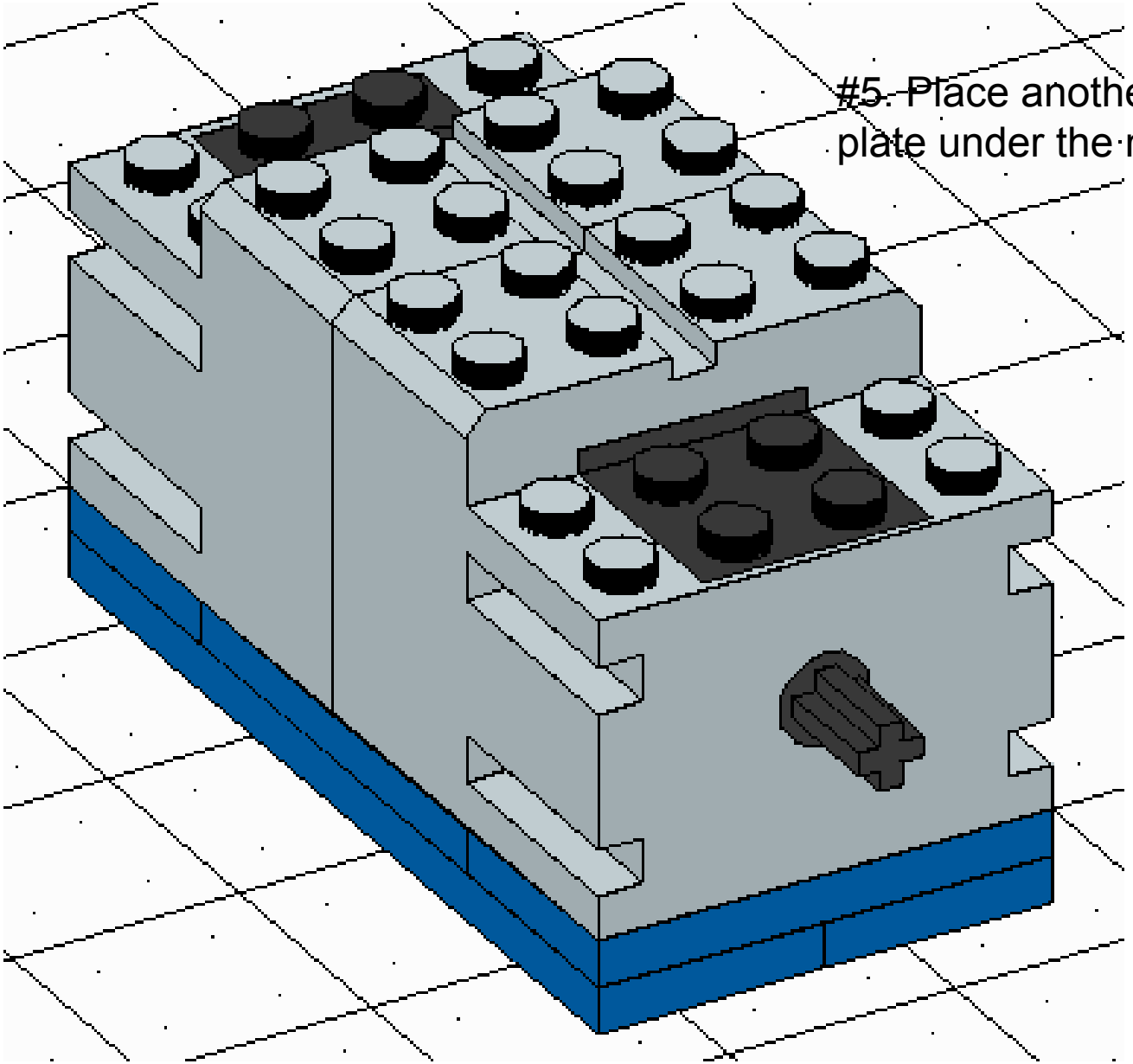
#2. Next, place a 1X4 plate connecting the motors as shown



#3. Place a 2X8 plate underneath these to secure the motors

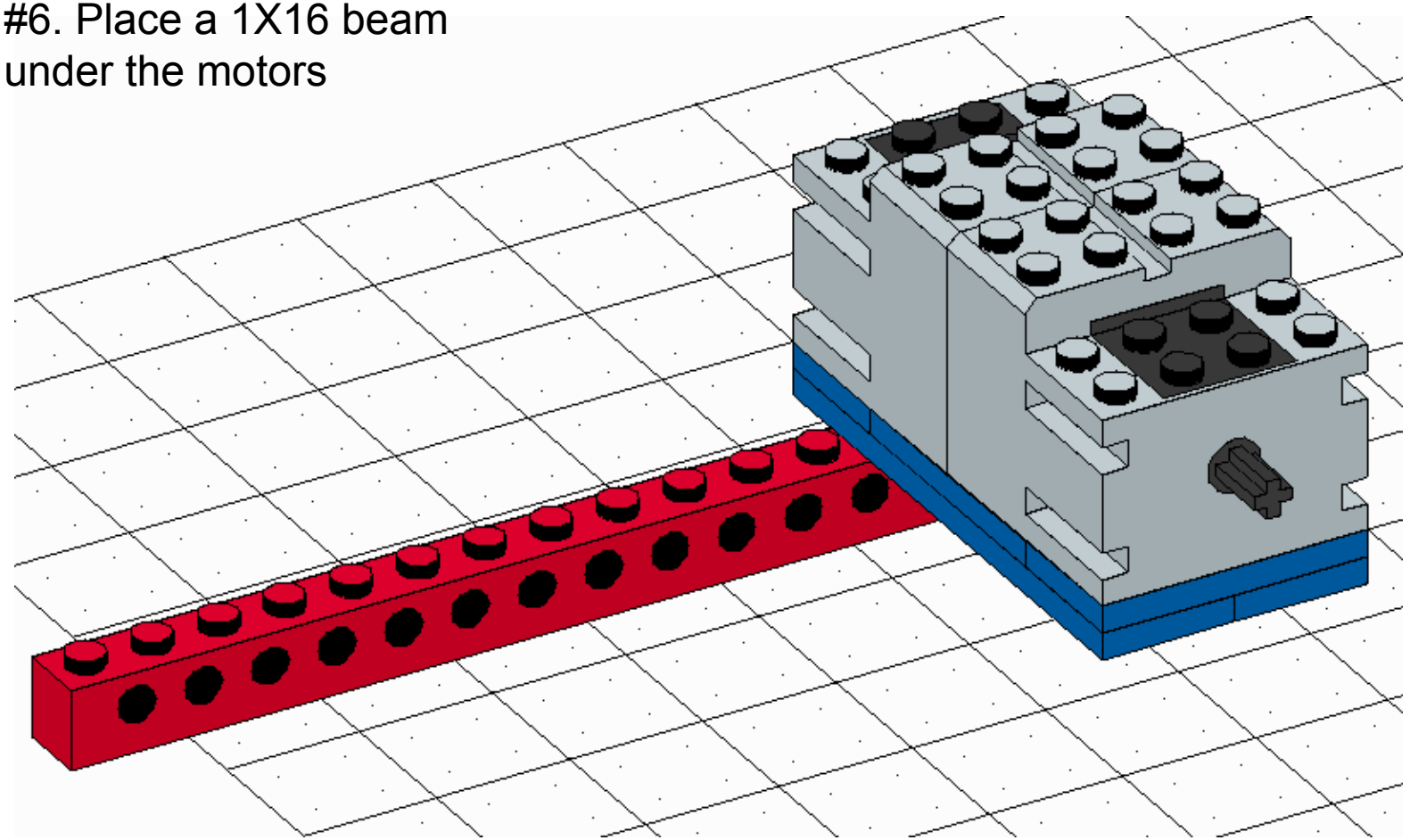


#4. Repeat this procedure for the other side, placing a 1X4 plate under the two motors.

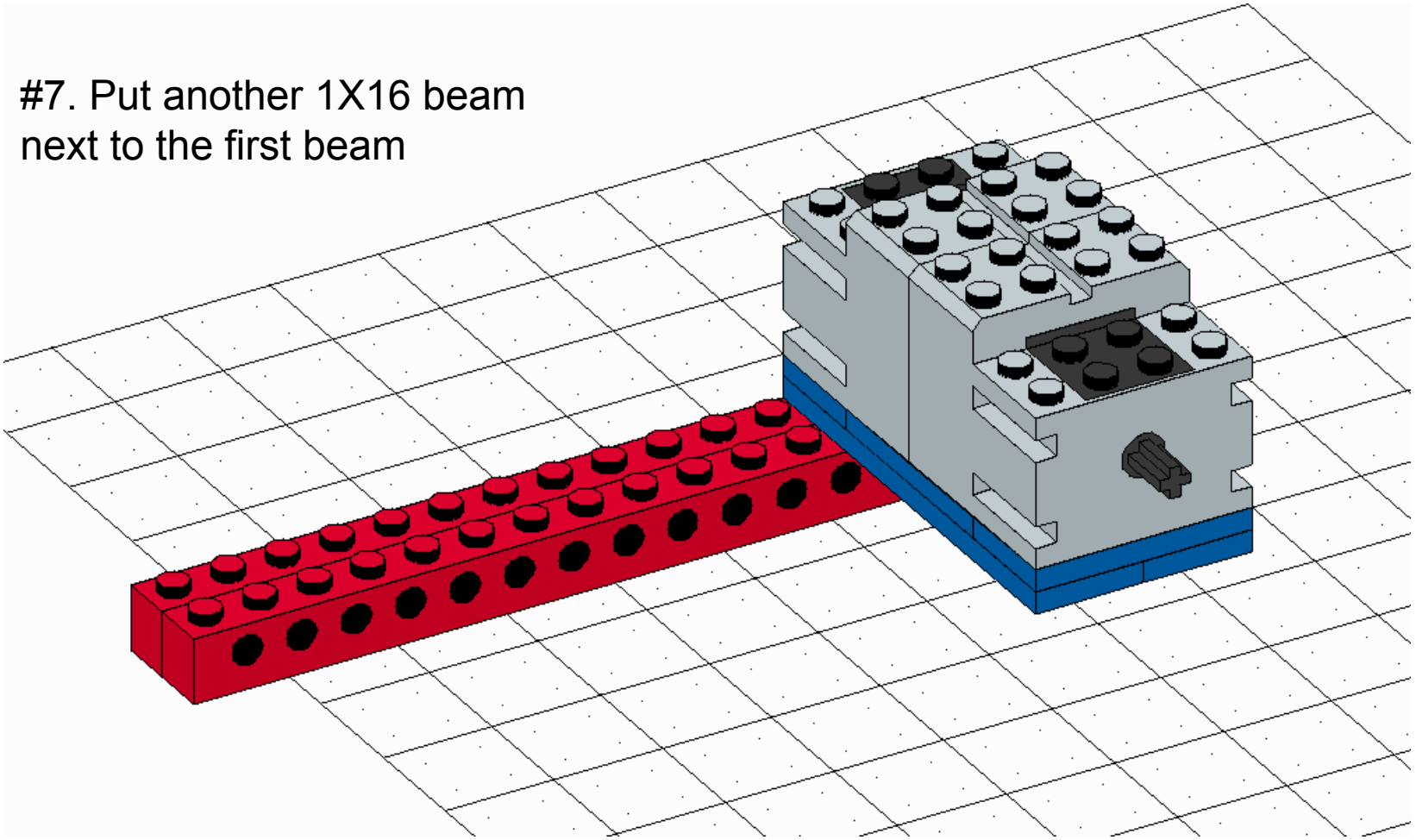


#5. Place another 2X8 plate under the motors

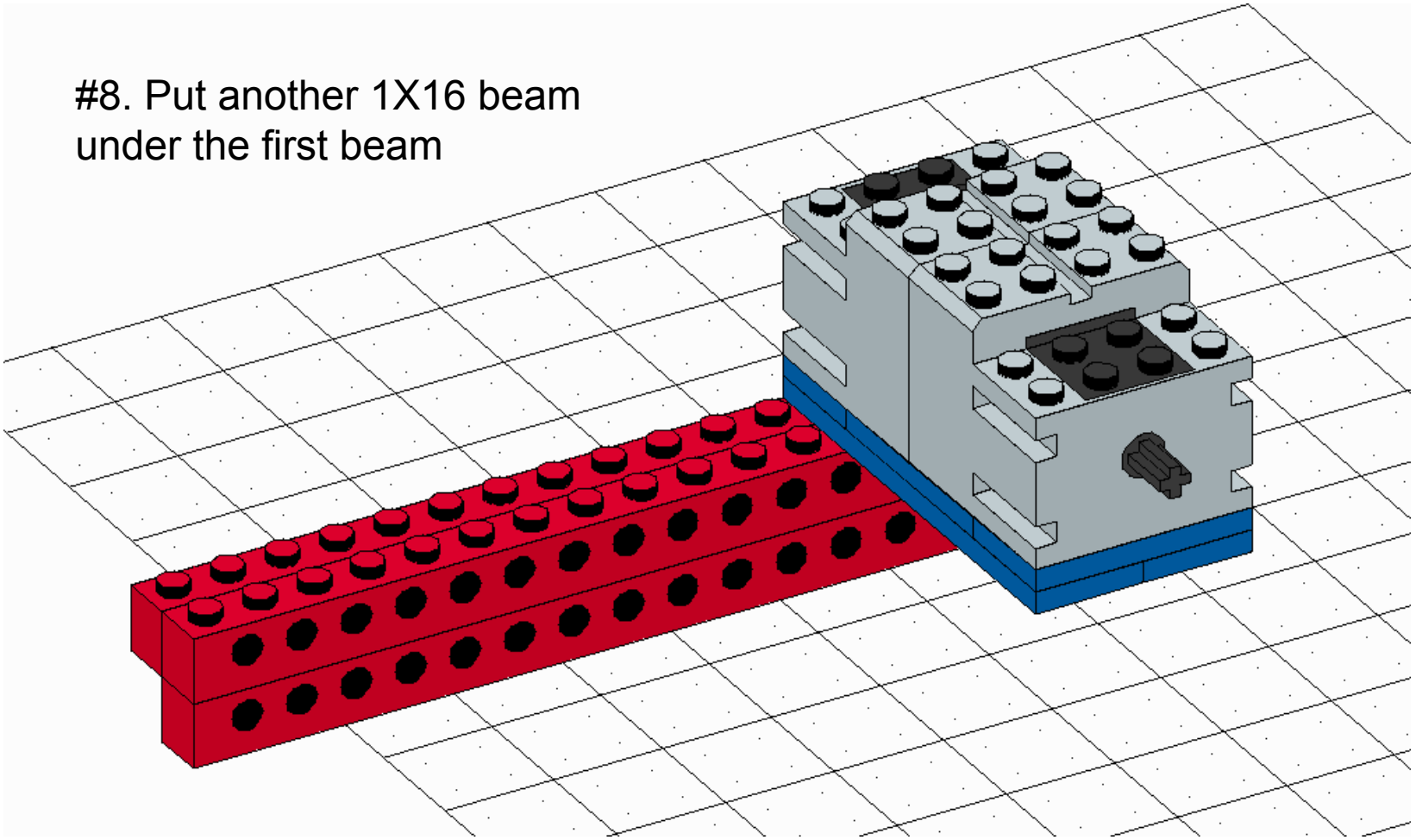
#6. Place a 1X16 beam under the motors



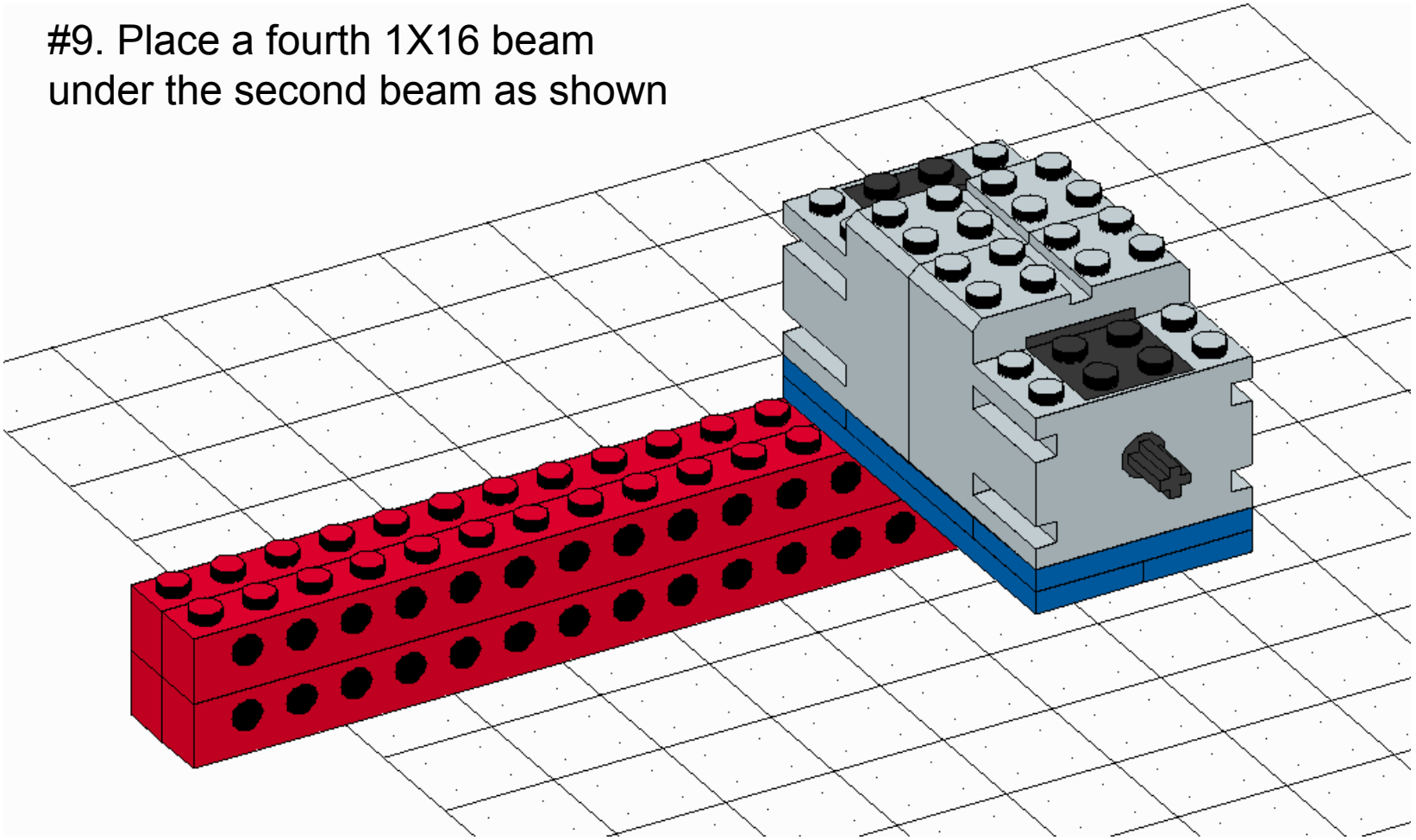
#7. Put another 1X16 beam next to the first beam



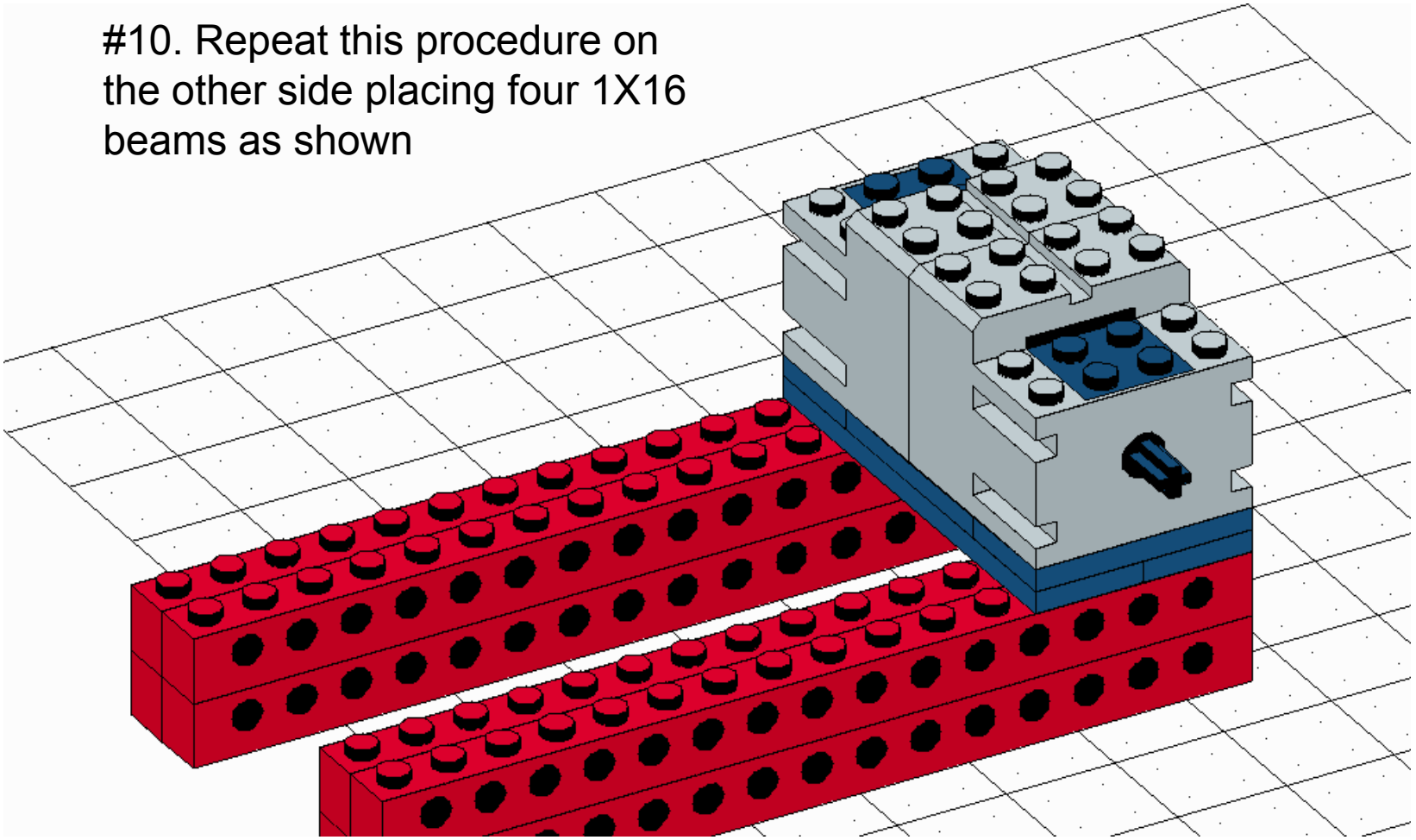
#8. Put another 1X16 beam under the first beam



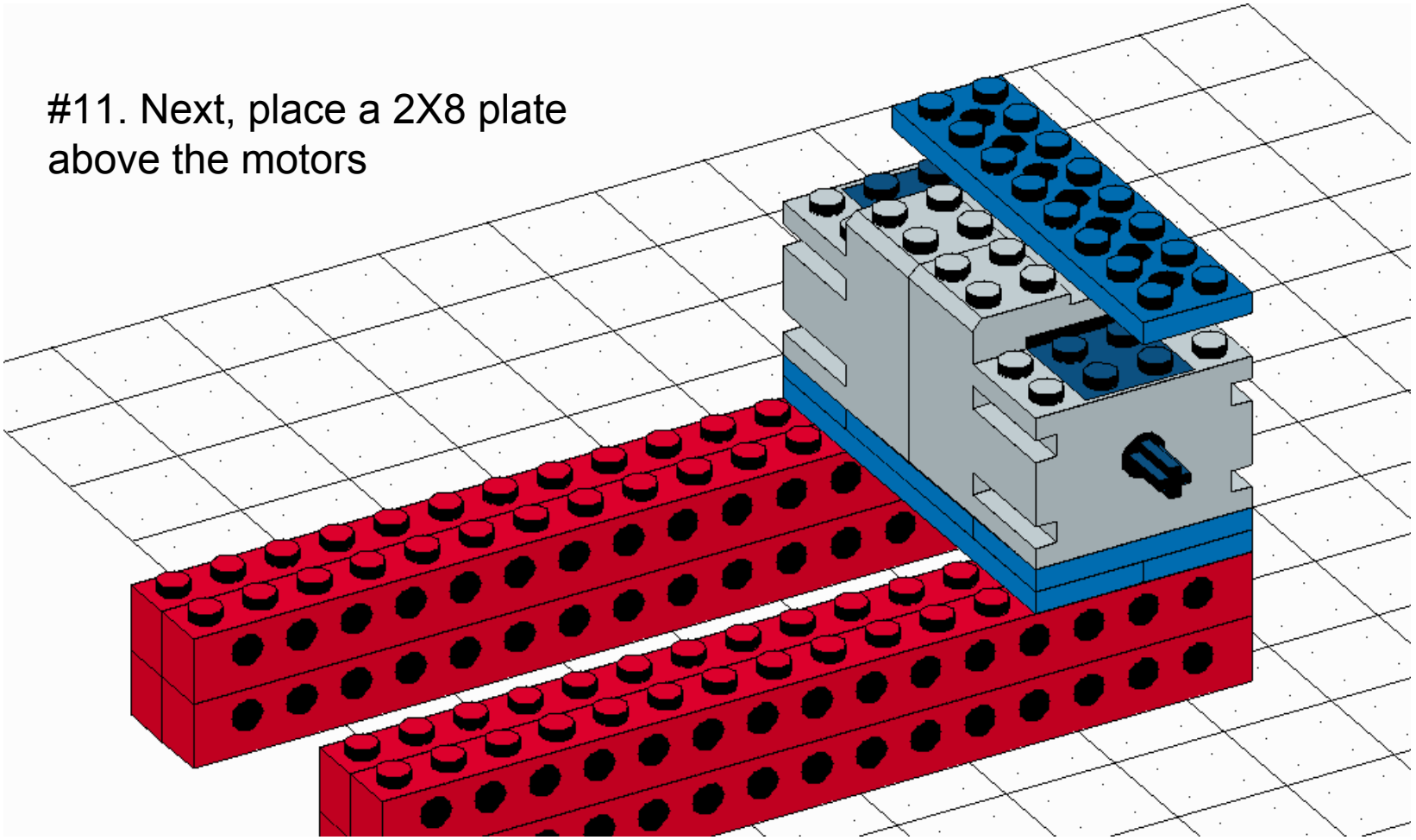
#9. Place a fourth 1X16 beam
under the second beam as shown



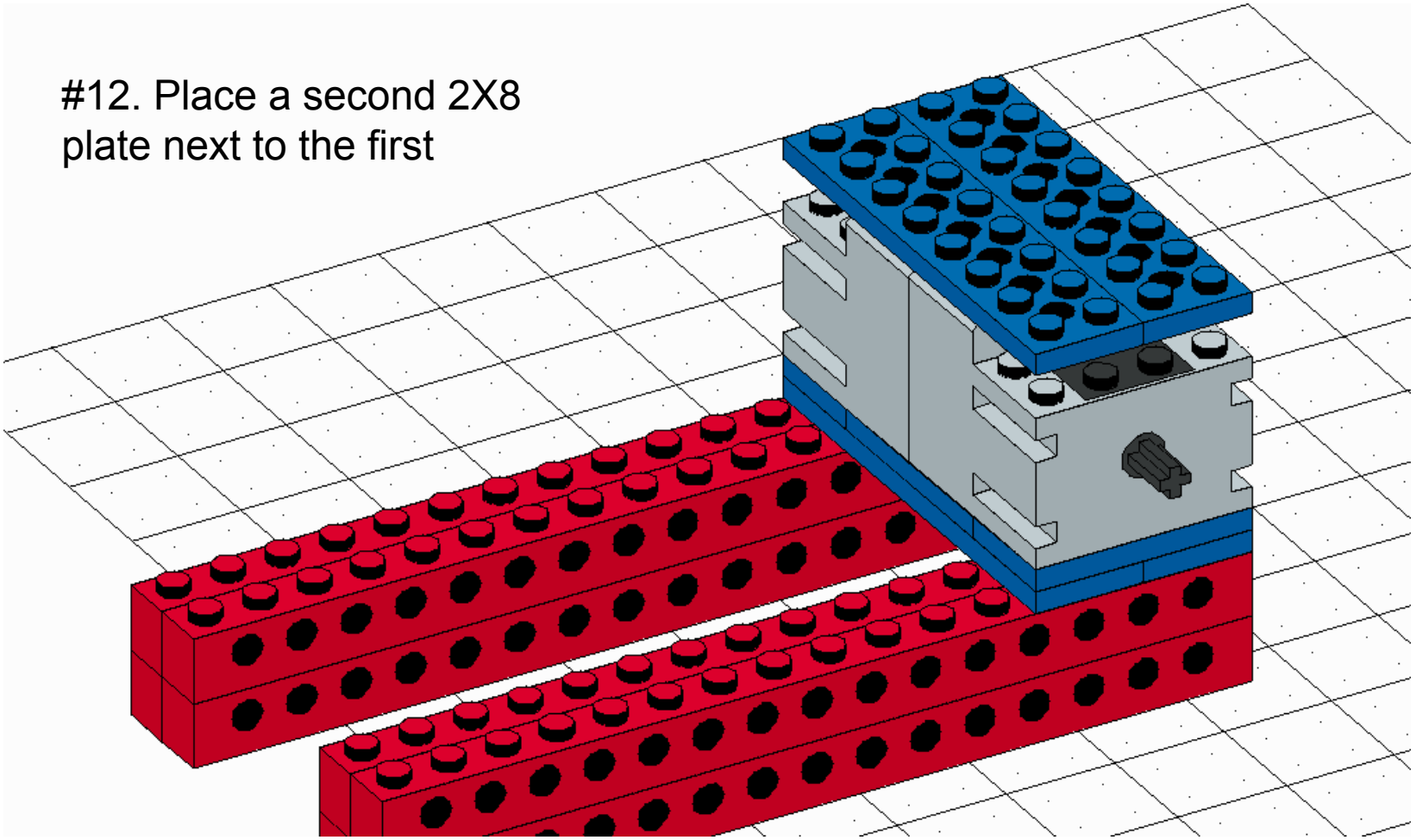
#10. Repeat this procedure on the other side placing four 1X16 beams as shown



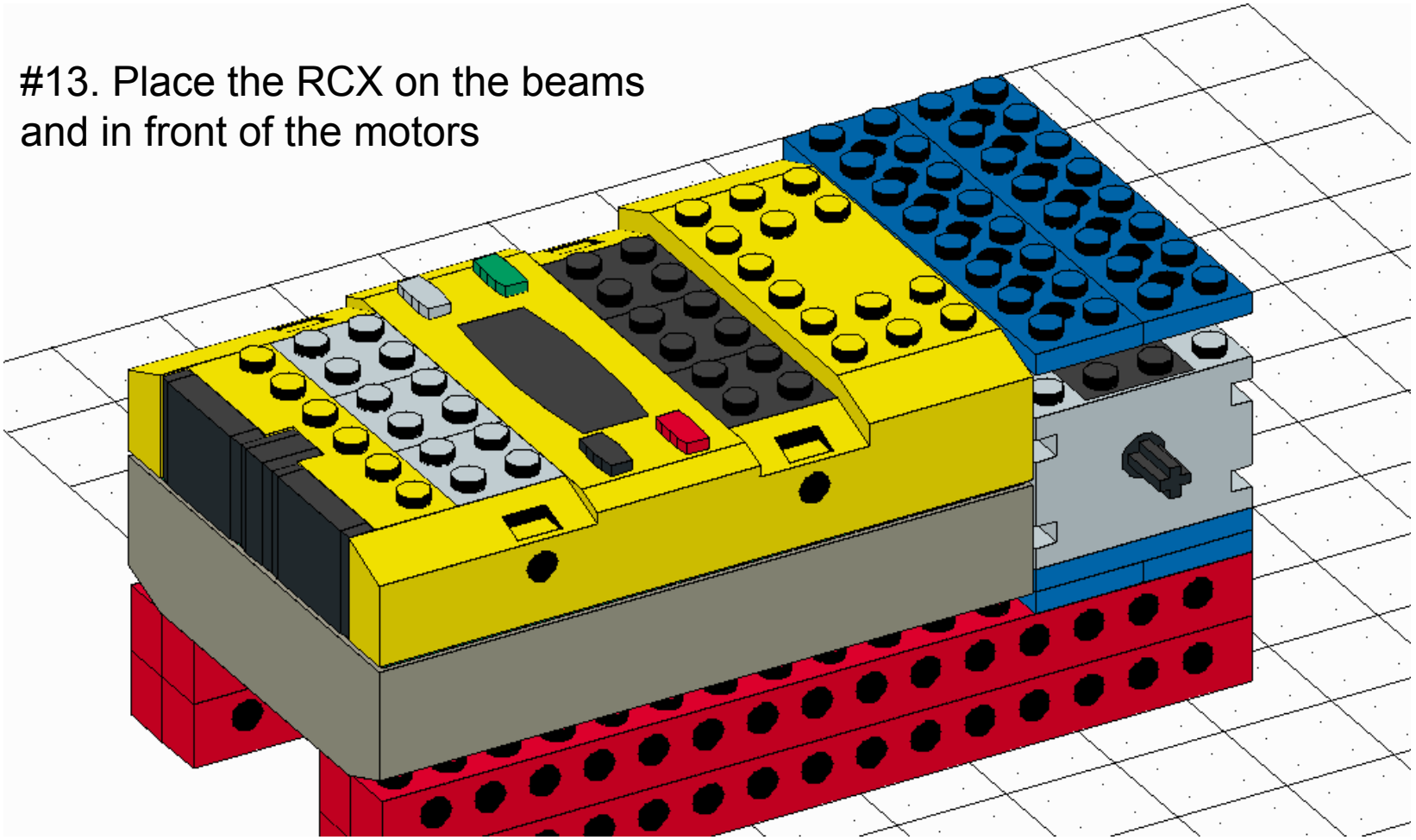
#11. Next, place a 2X8 plate above the motors



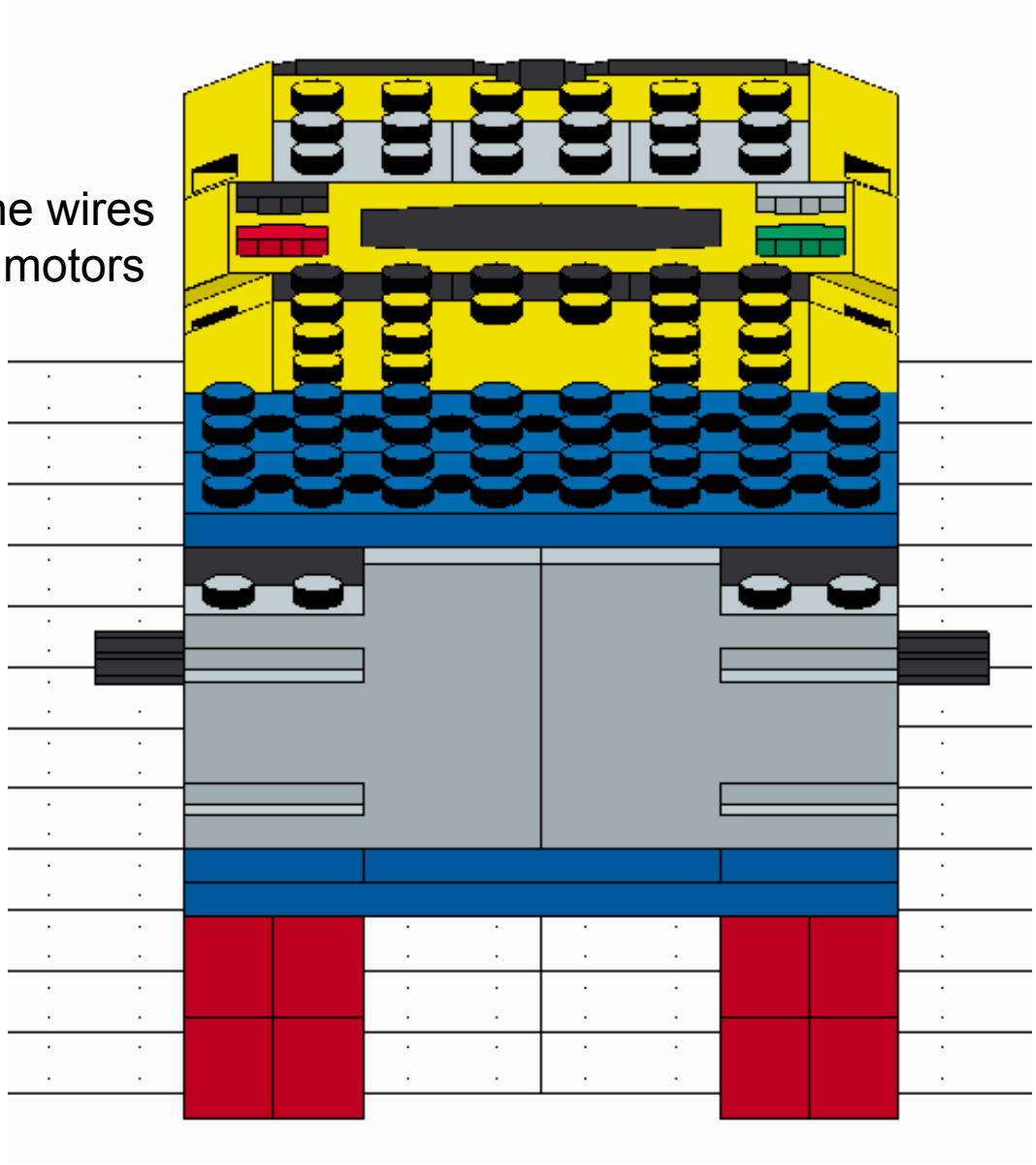
#12. Place a second 2X8 plate next to the first

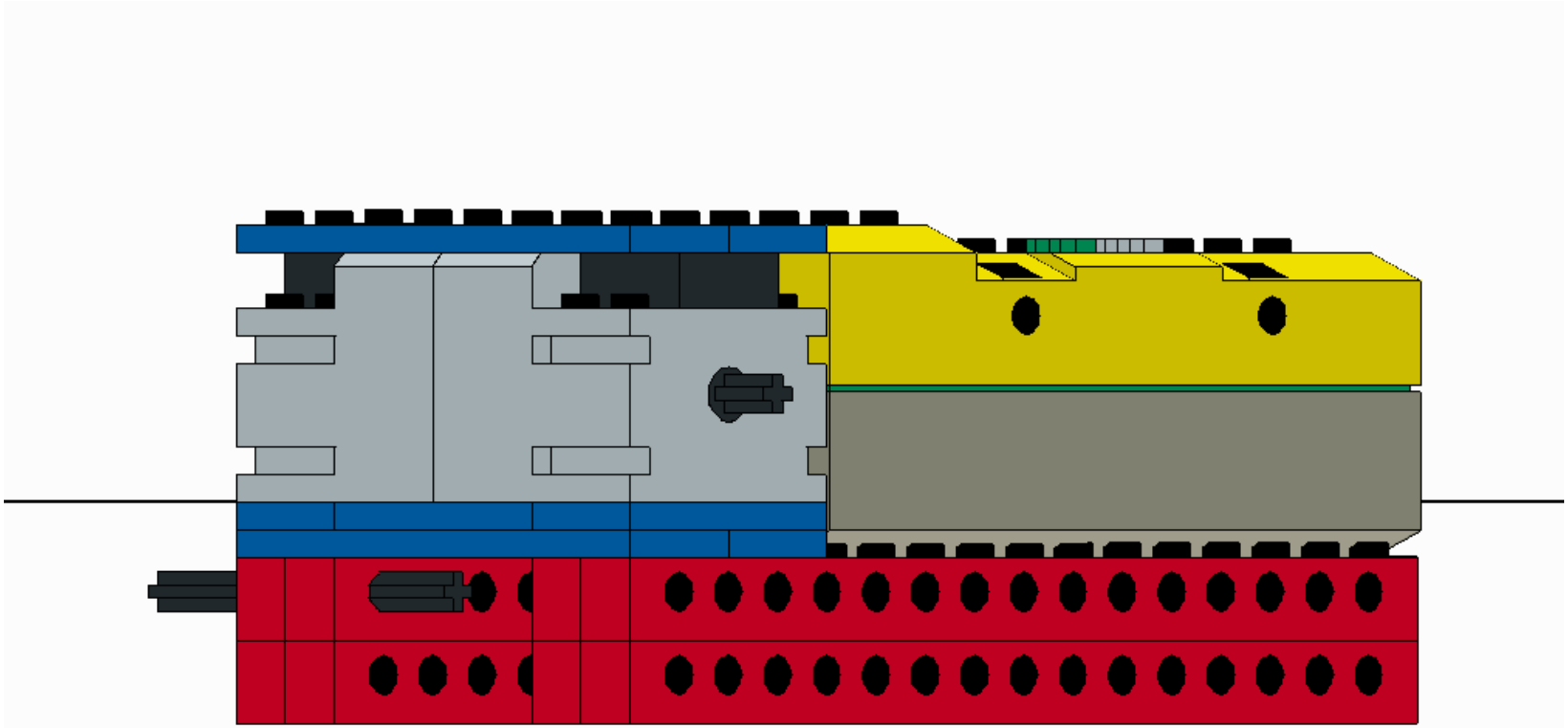


#13. Place the RCX on the beams and in front of the motors

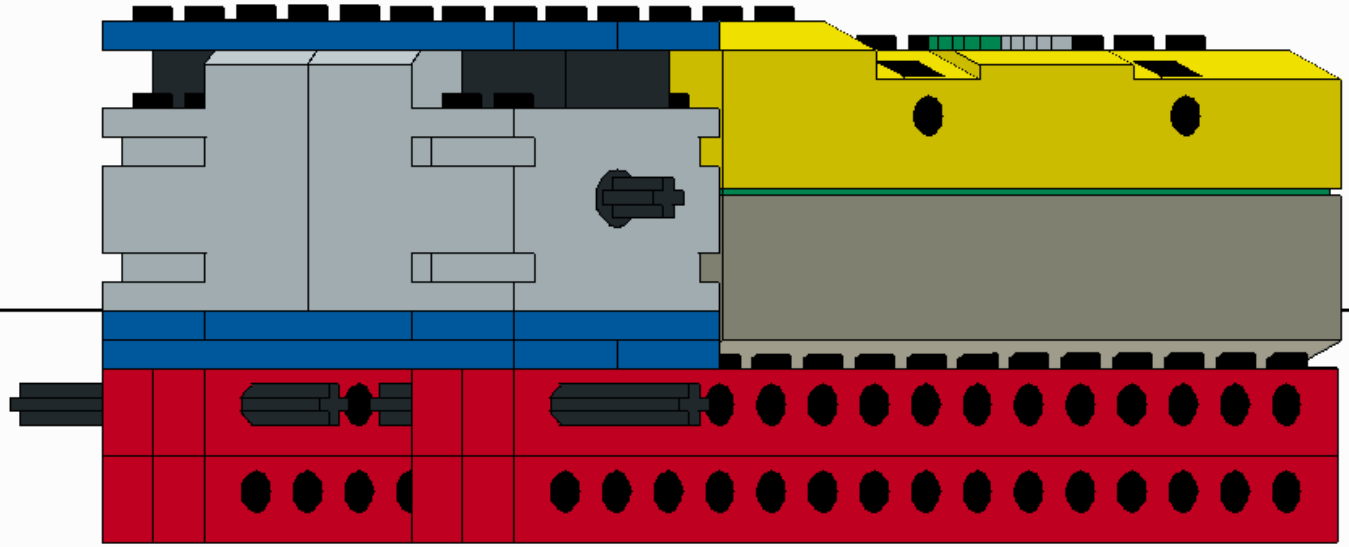


#14. Place the wires onto the two motors



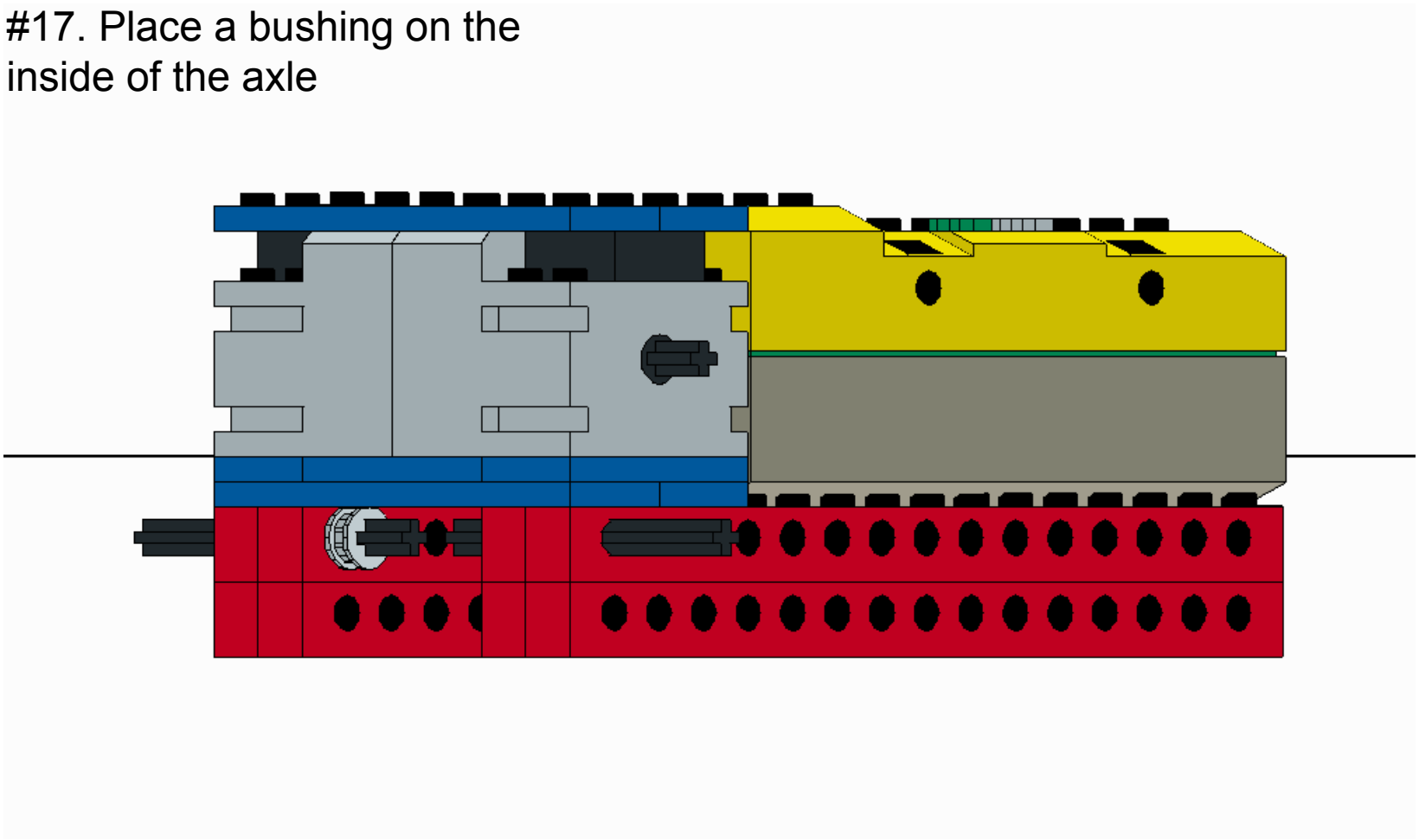


#15. Put a 6 stud axle through the last top hole

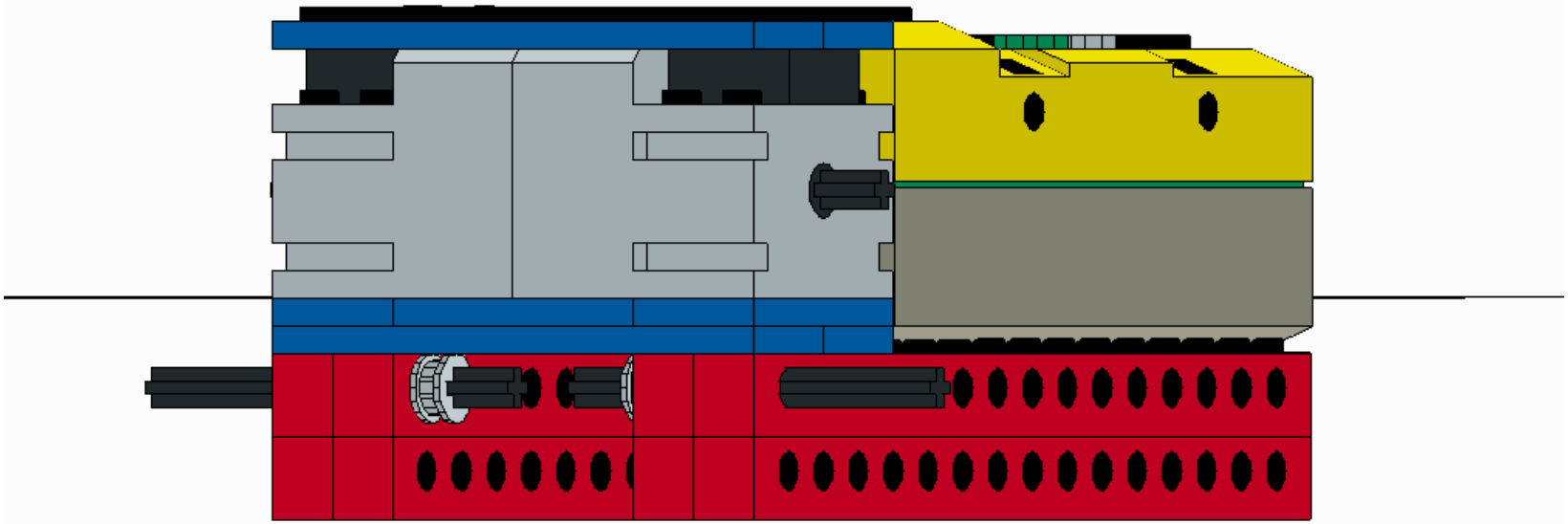


#16. Place a second 6 stud axle on the opposite side

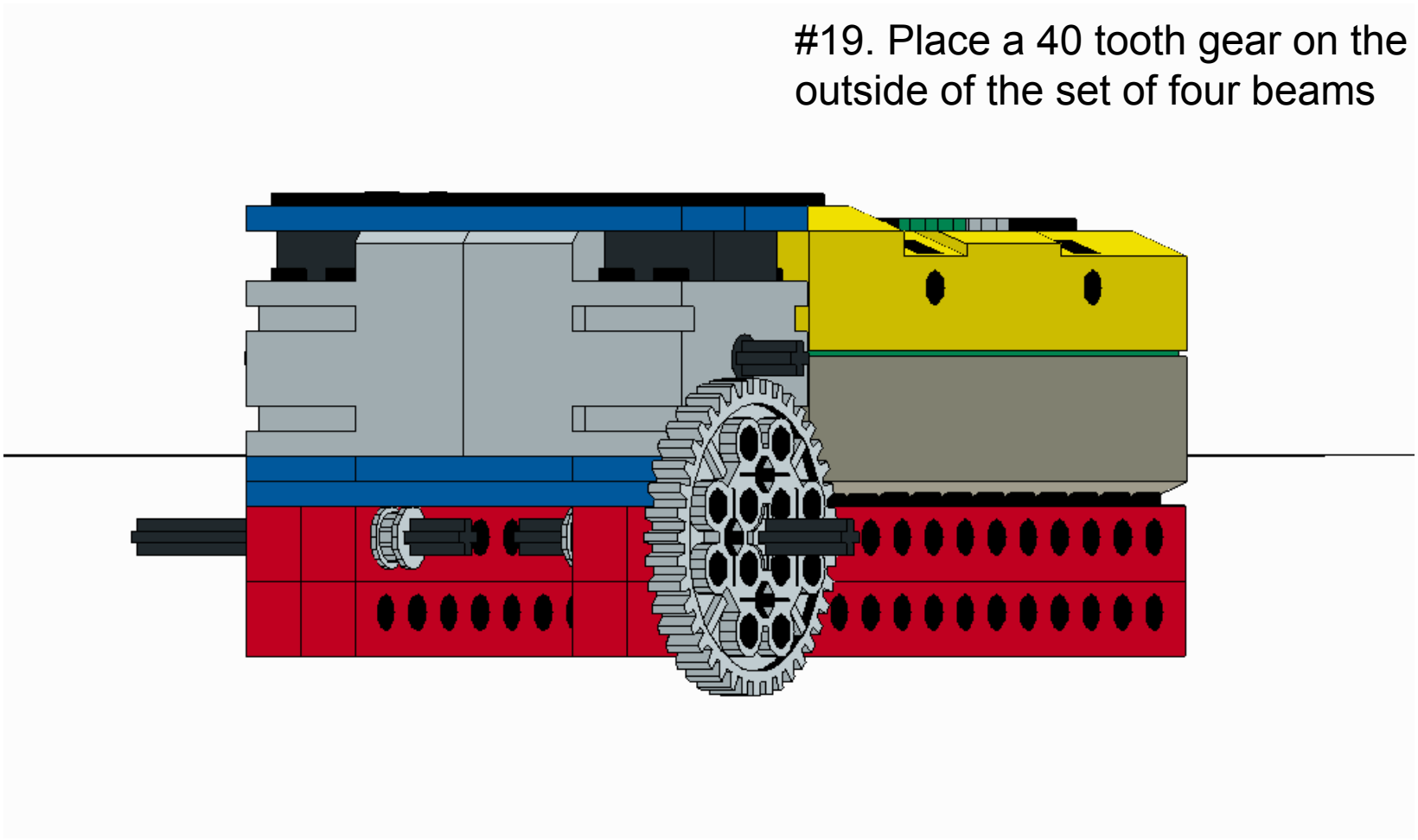
#17. Place a bushing on the inside of the axle

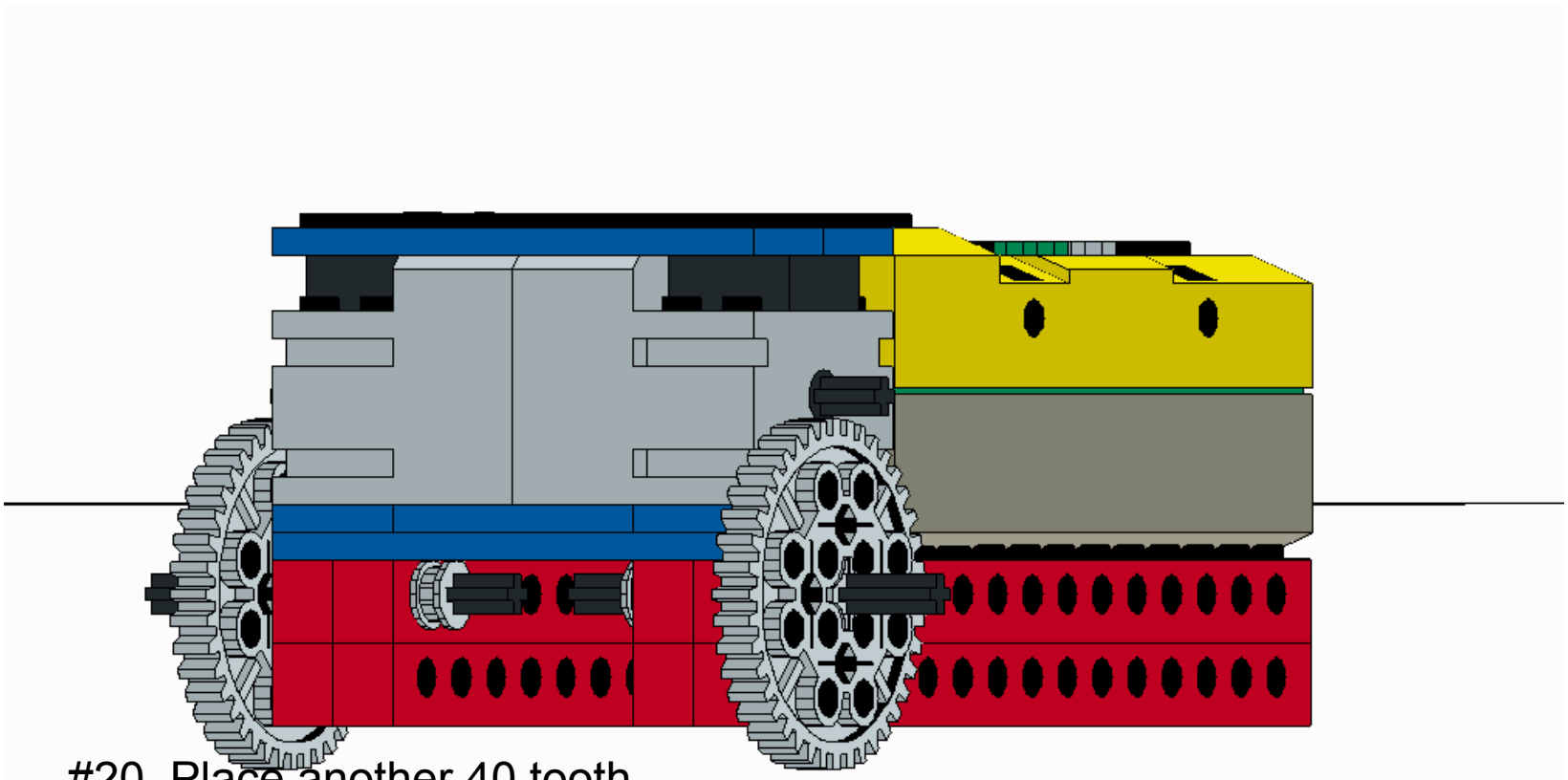


#18. Place another bushing on the second axle



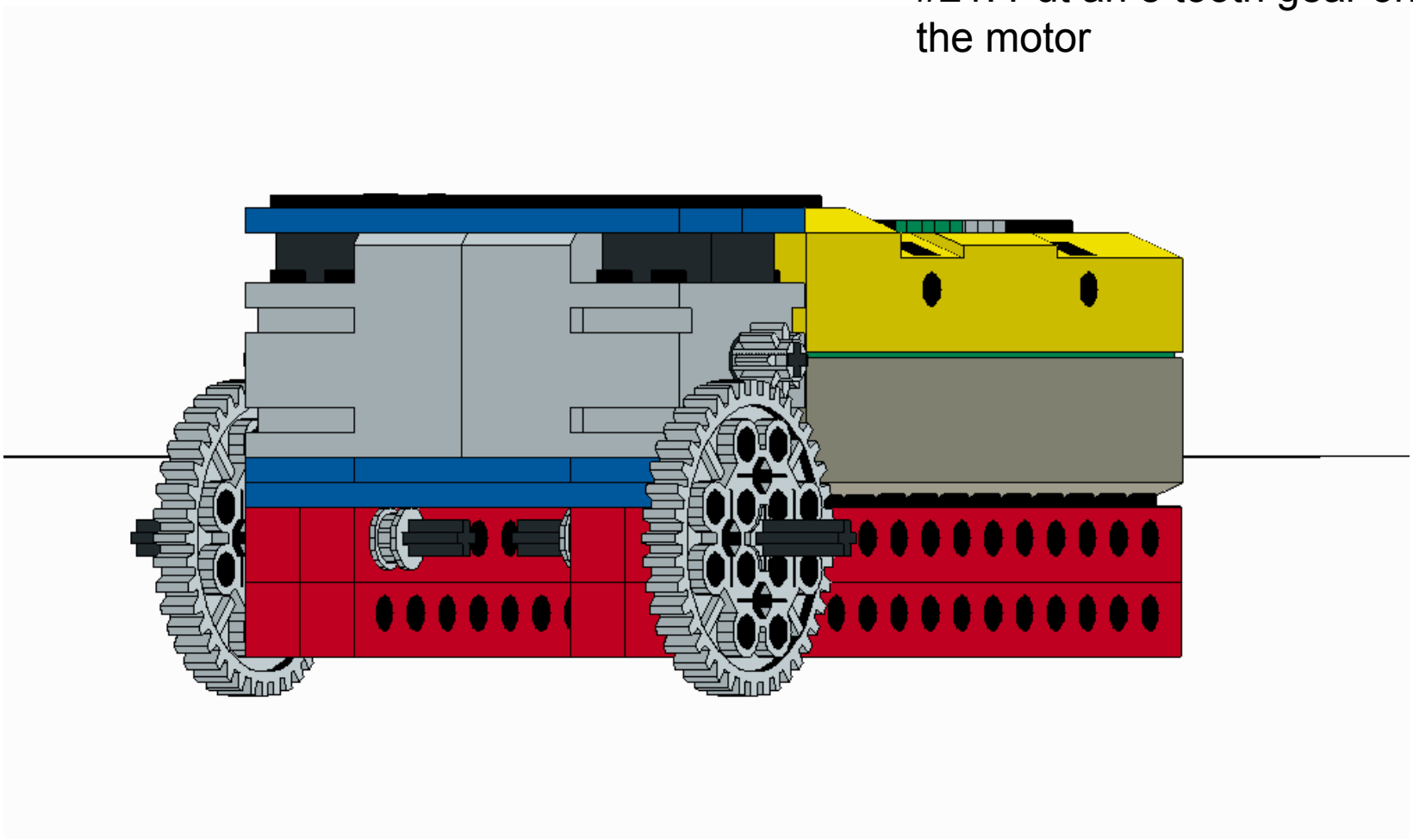
#19. Place a 40 tooth gear on the outside of the set of four beams

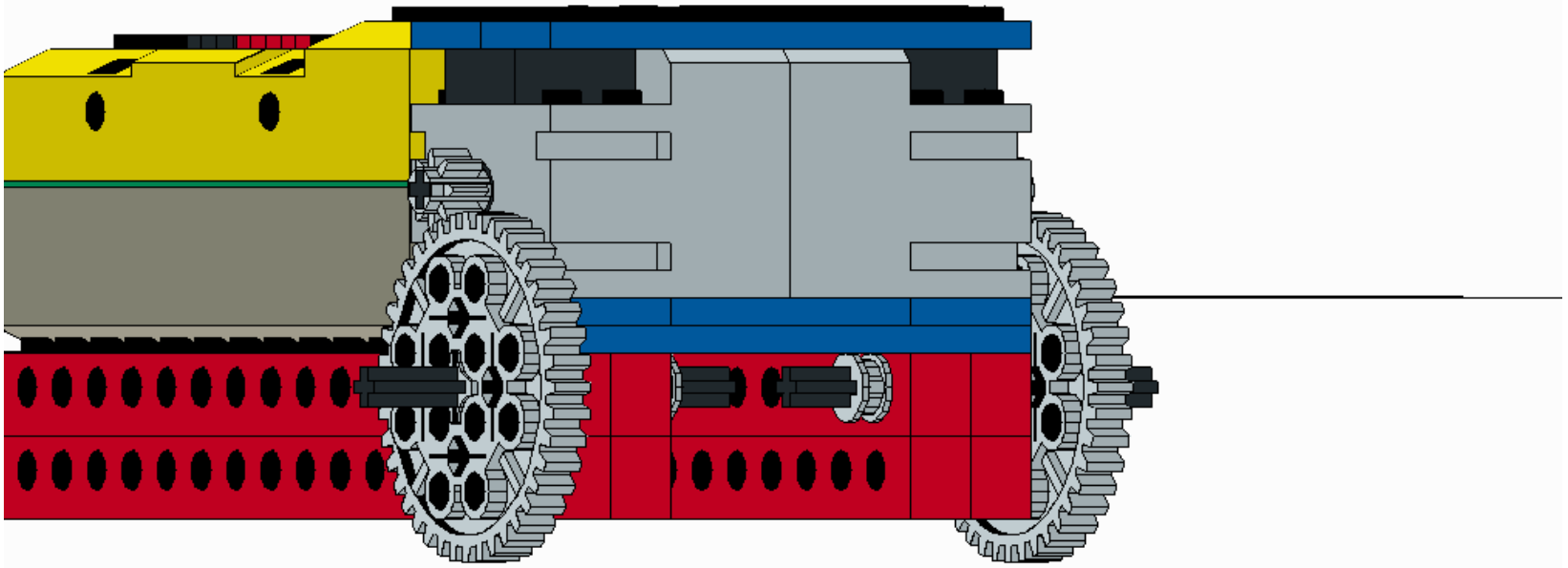




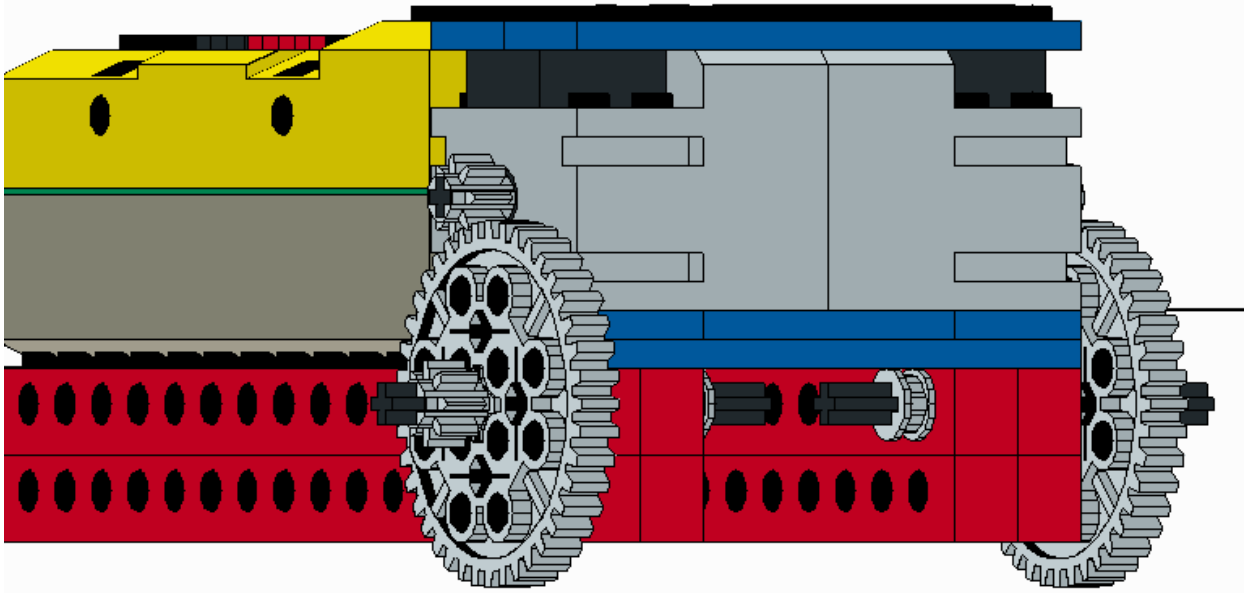
#20. Place another 40 tooth gear on the opposite axle (on the outside again)

#21. Put an 8 tooth gear on the motor



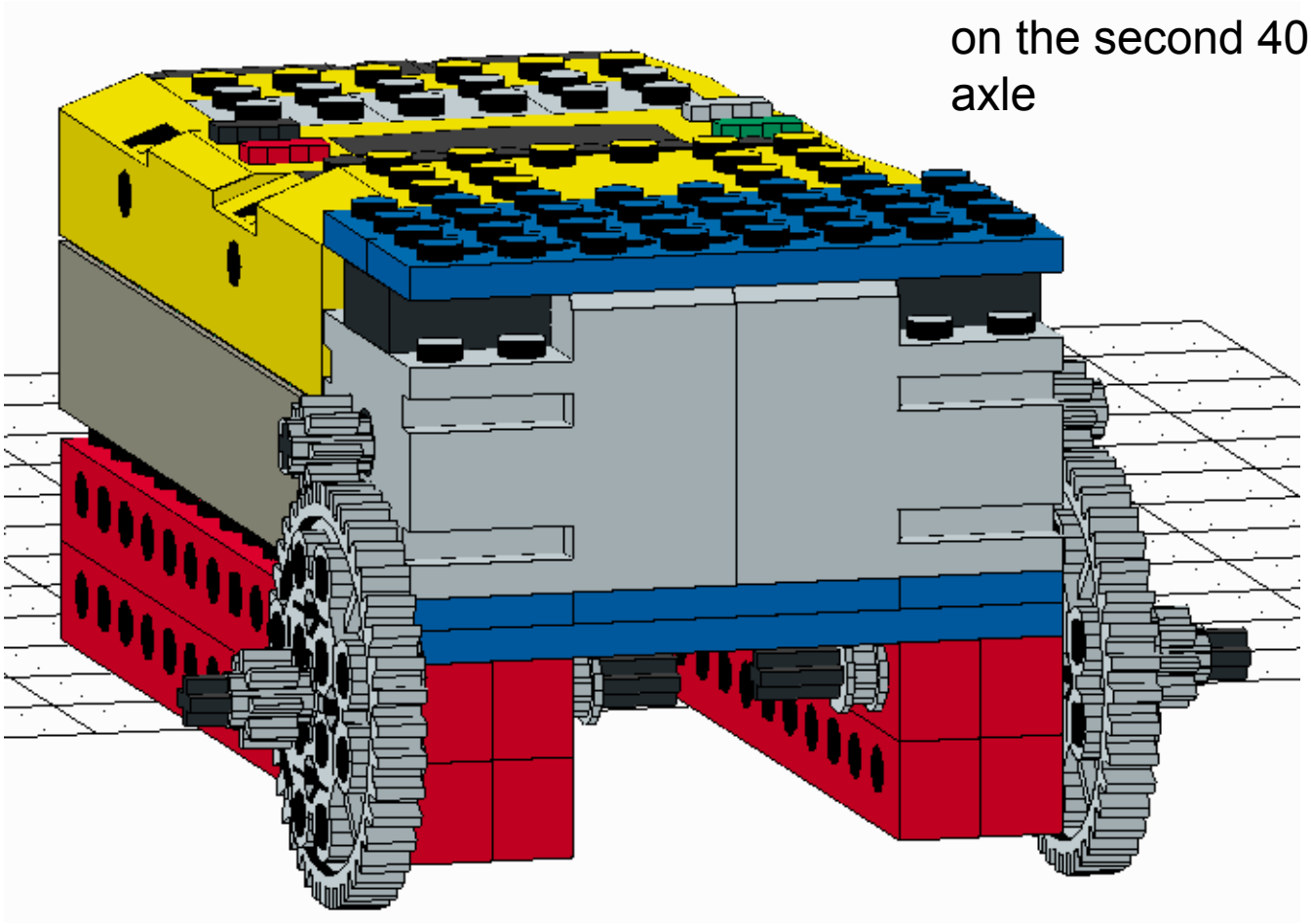


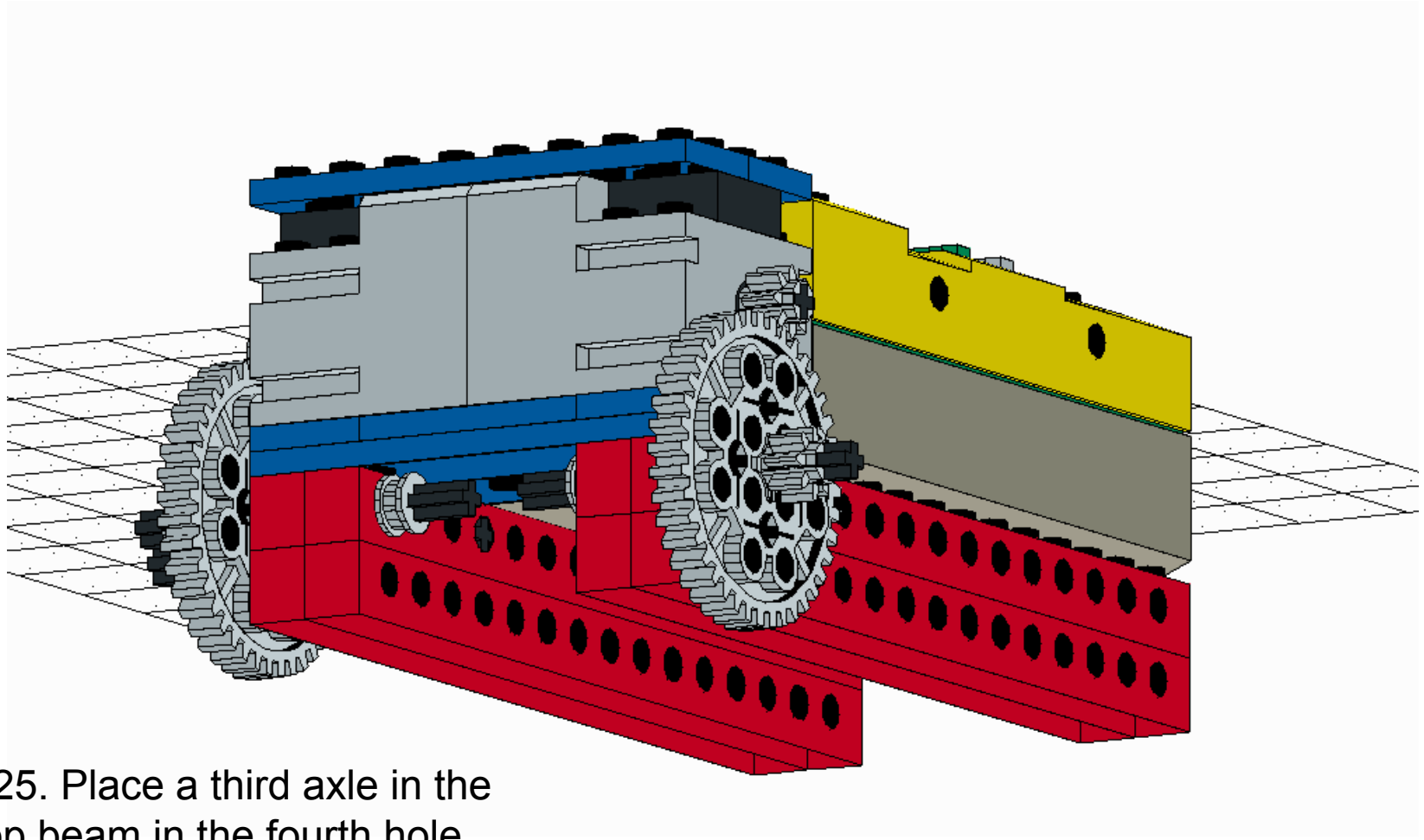
#22. Put another 8 tooth gear on the second motor



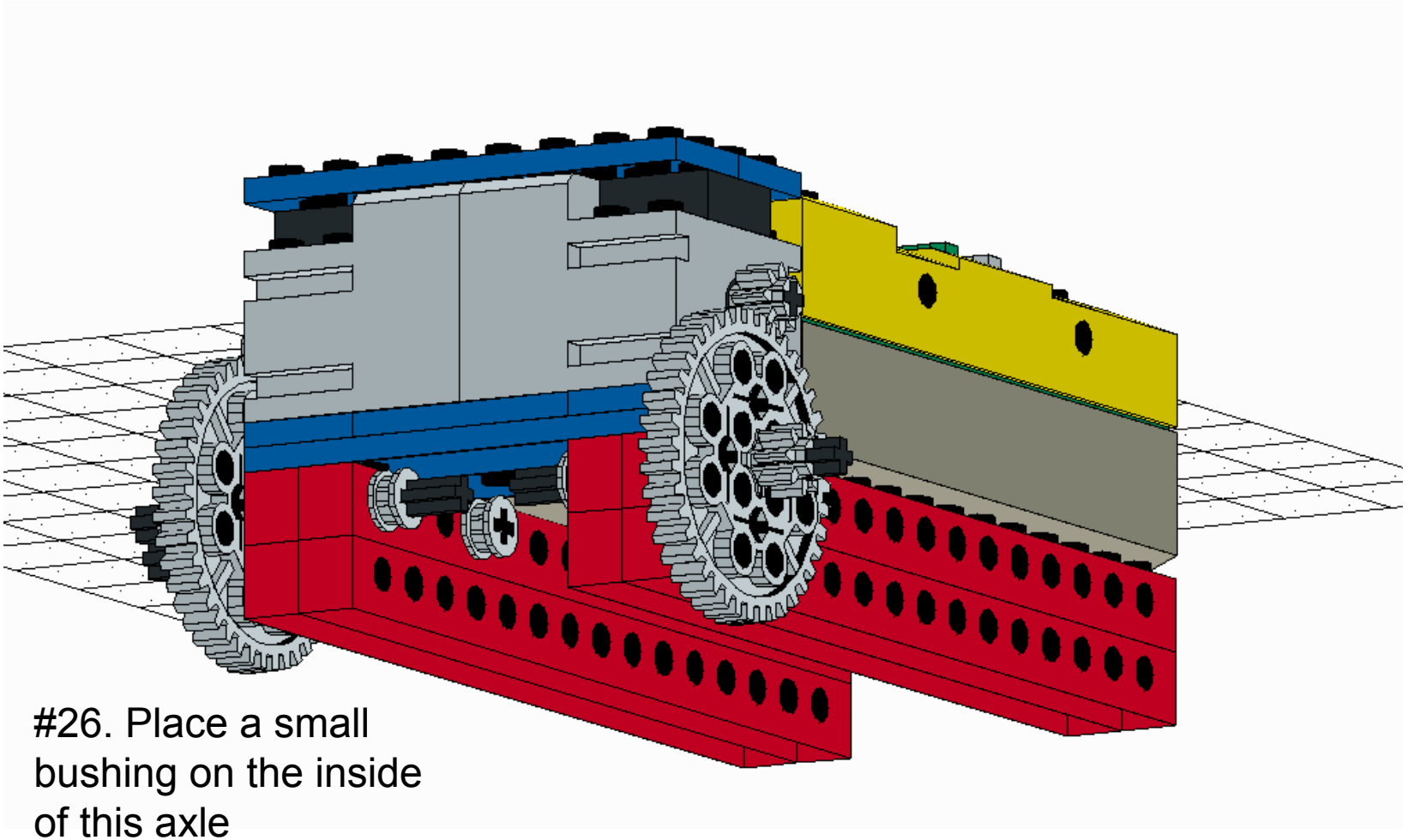
#23. Place an 8 tooth gear on the same axle as the 40 tooth gear

#24. Put another 8 tooth gear on the second 40 tooth gear axle

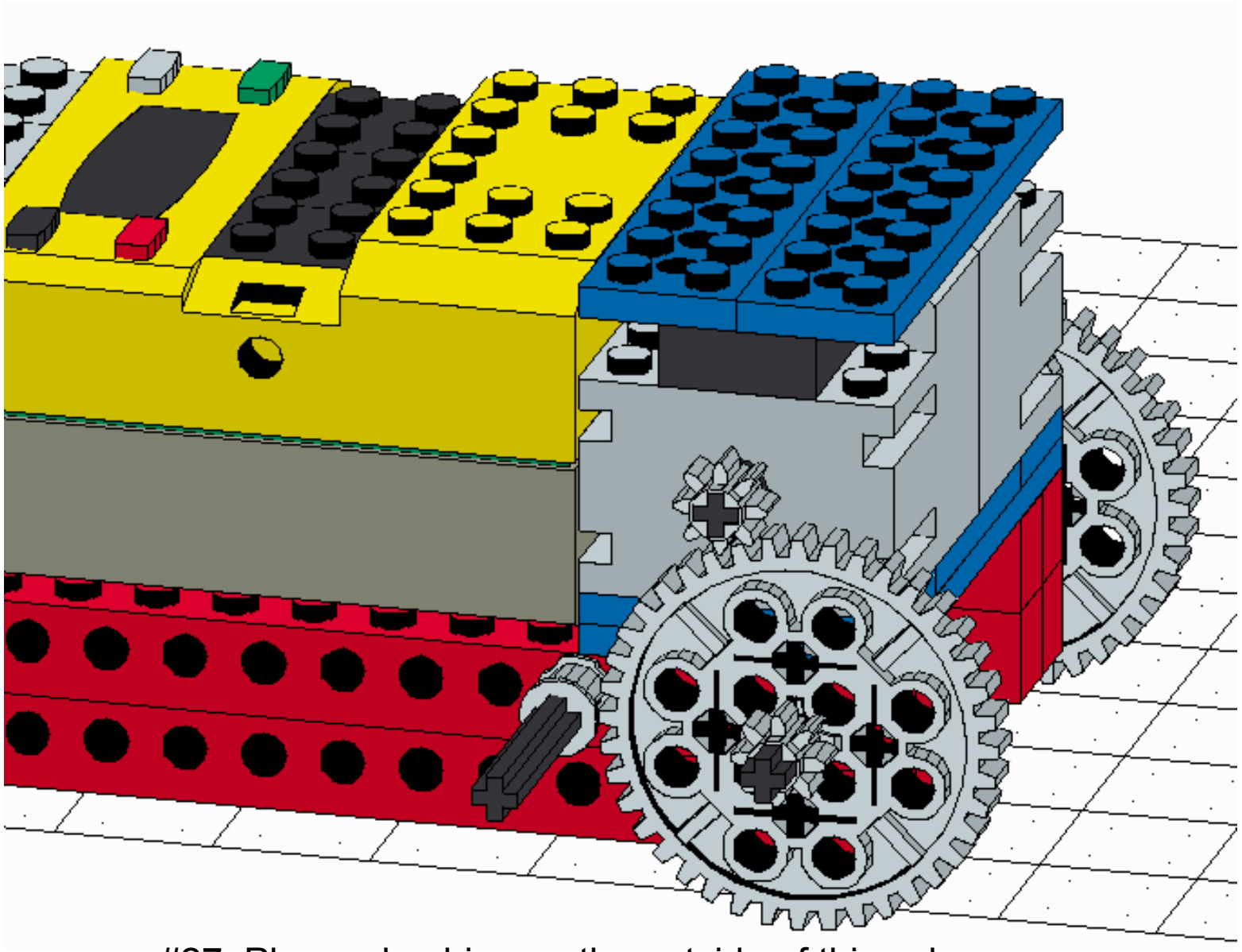




#25. Place a third axle in the top beam in the fourth hole

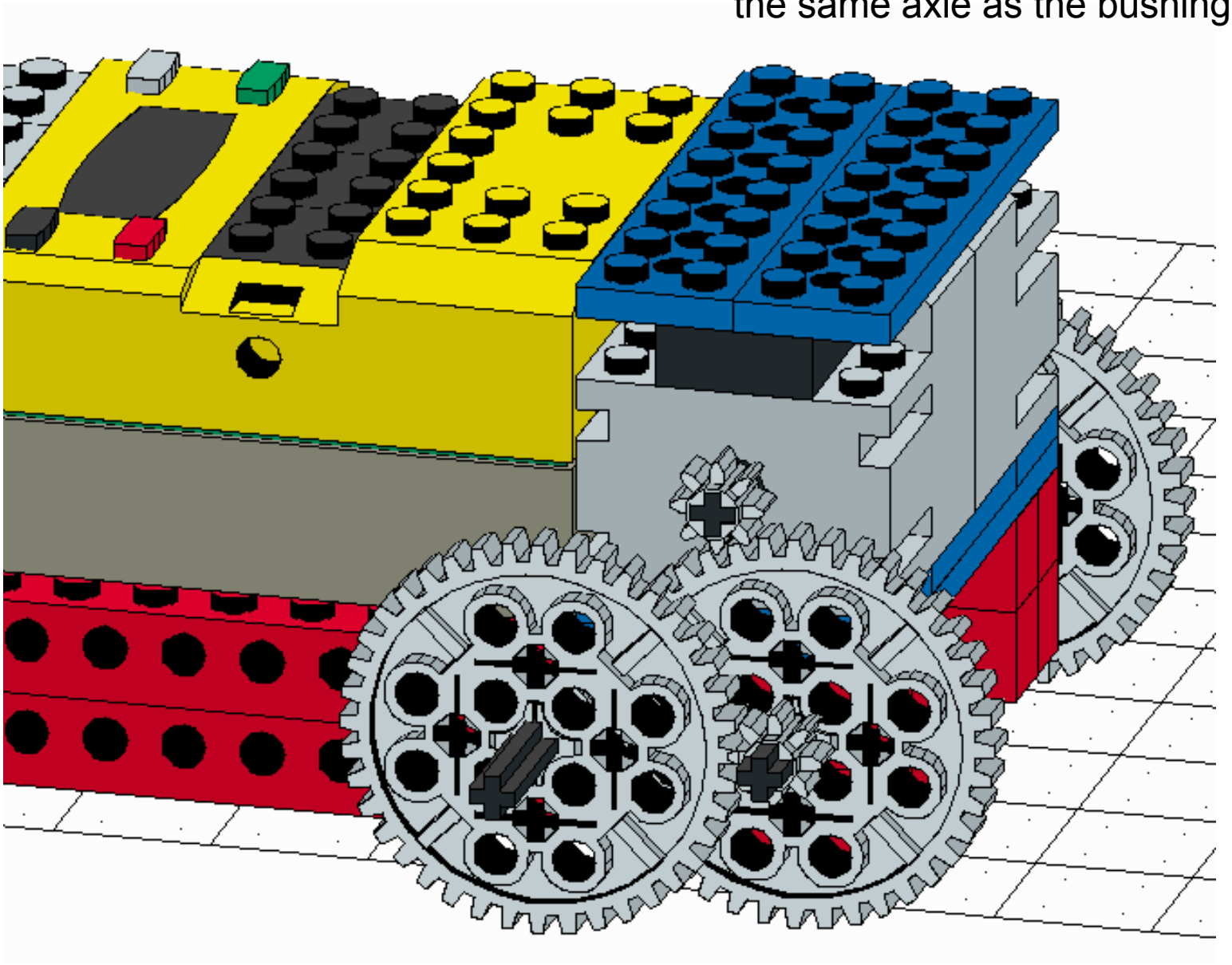


#26. Place a small bushing on the inside of this axle

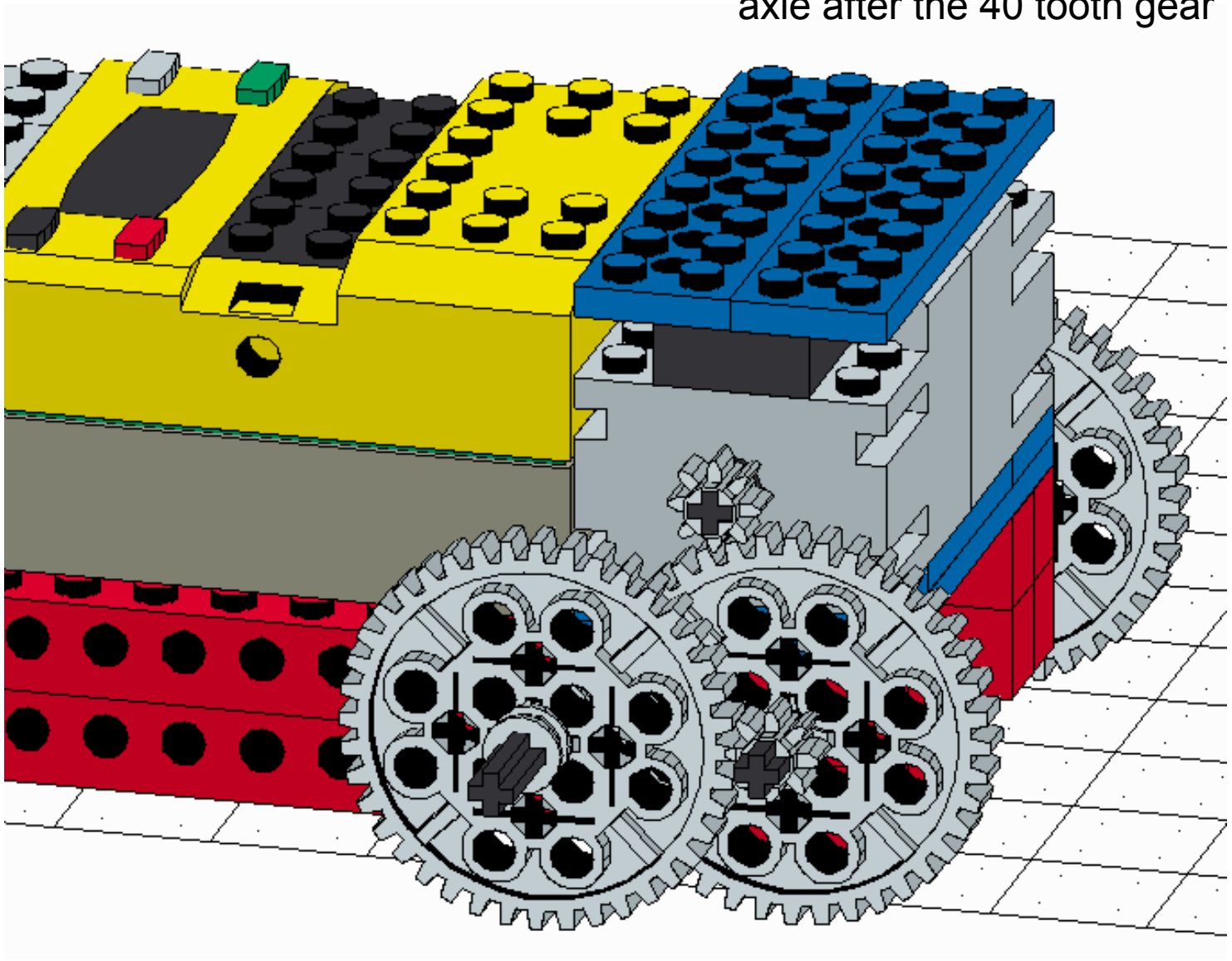


#27. Place a bushing on the outside of this axle

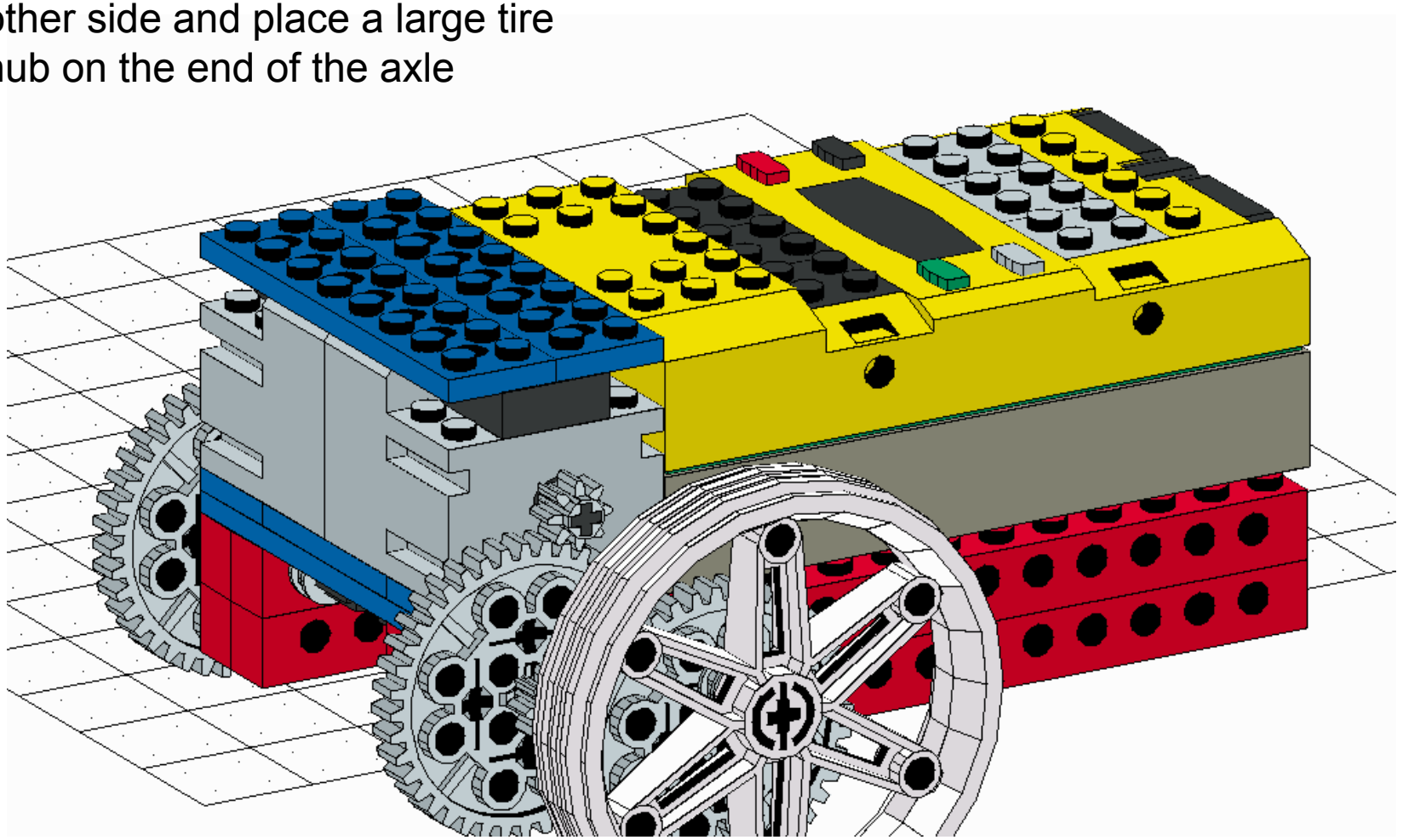
#28. Place a 40 tooth gear on the same axle as the bushing



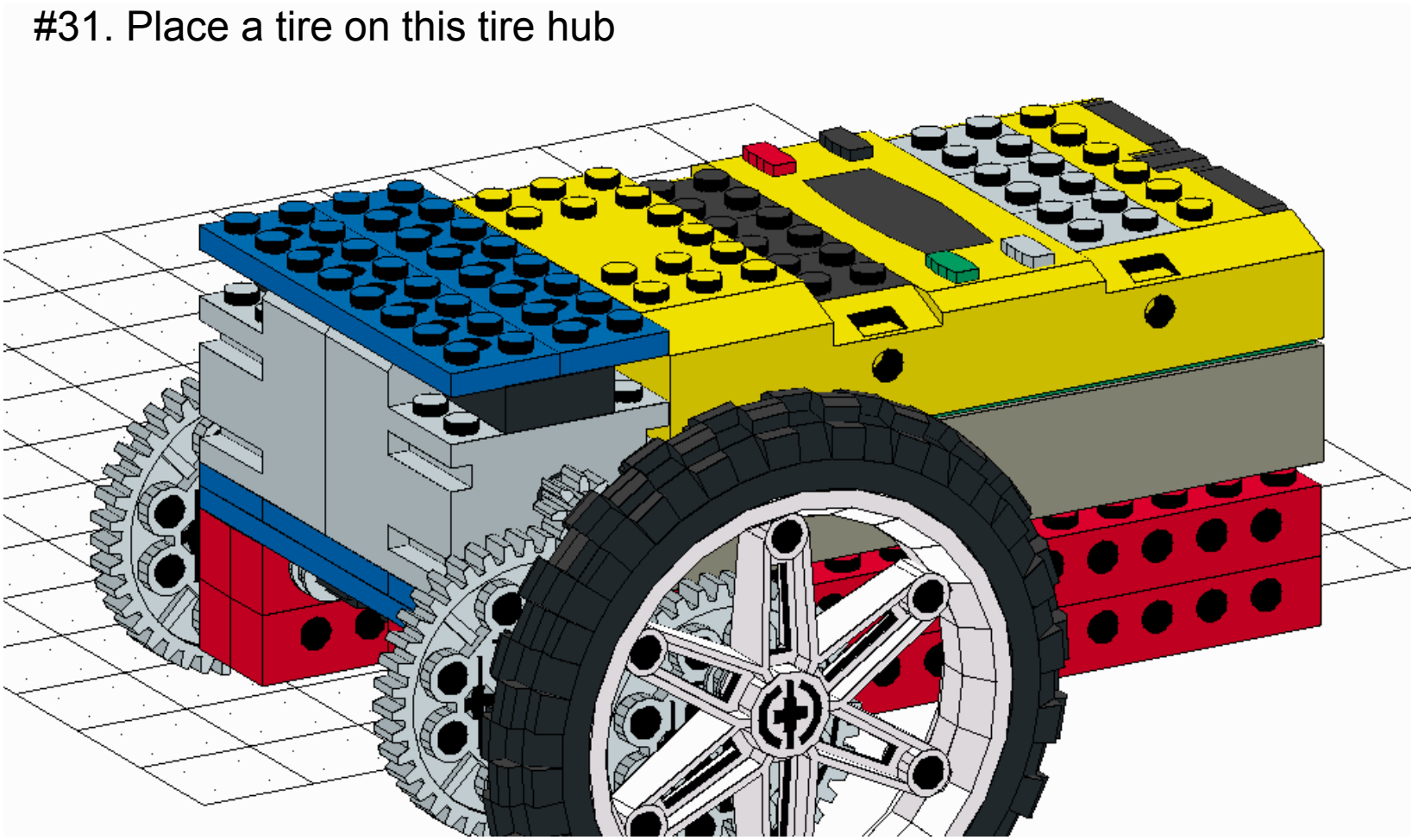
#29. Place a small bushing on the axle after the 40 tooth gear

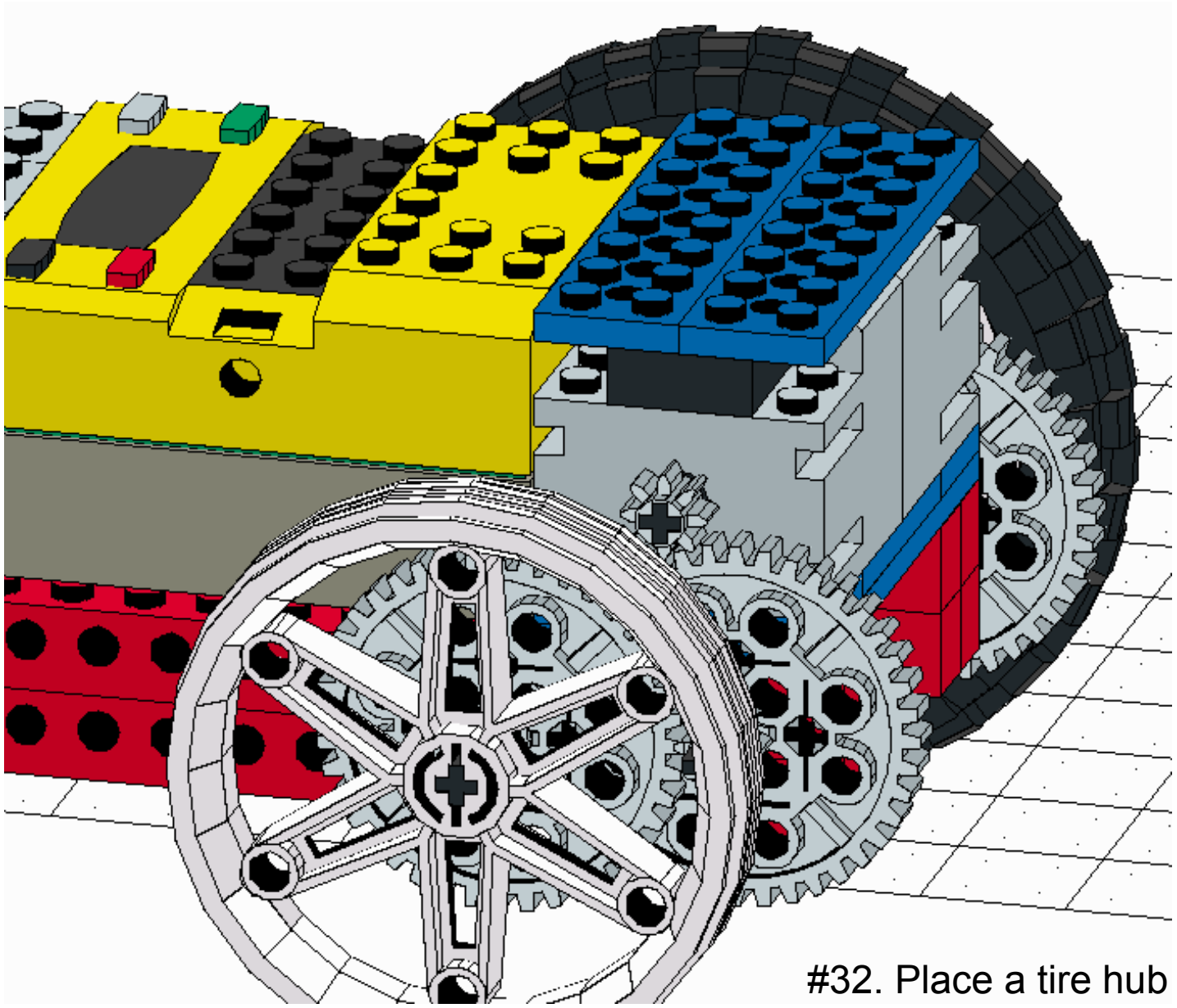


#30. Repeat this procedure on the other side and place a large tire hub on the end of the axle

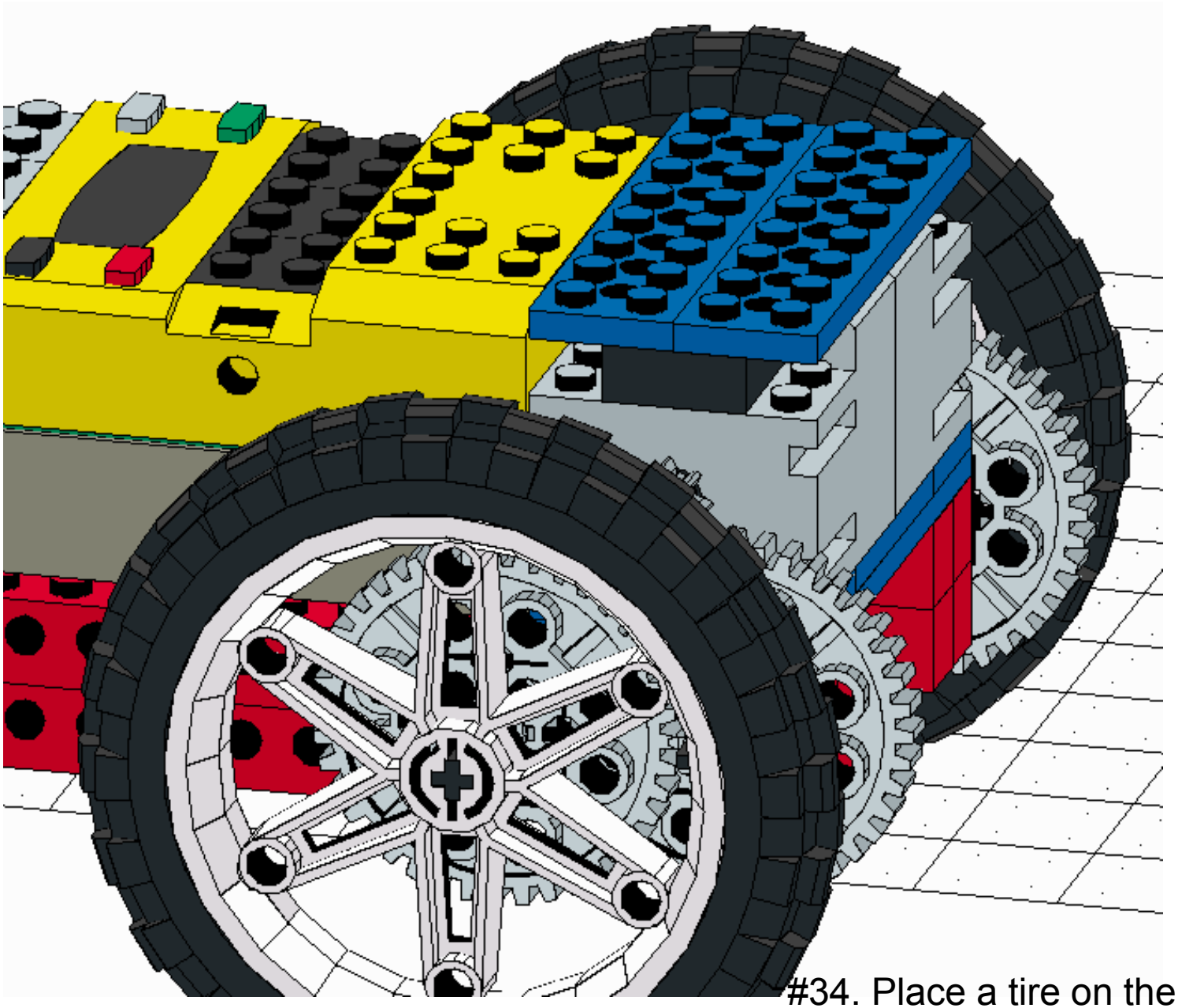


#31. Place a tire on this tire hub

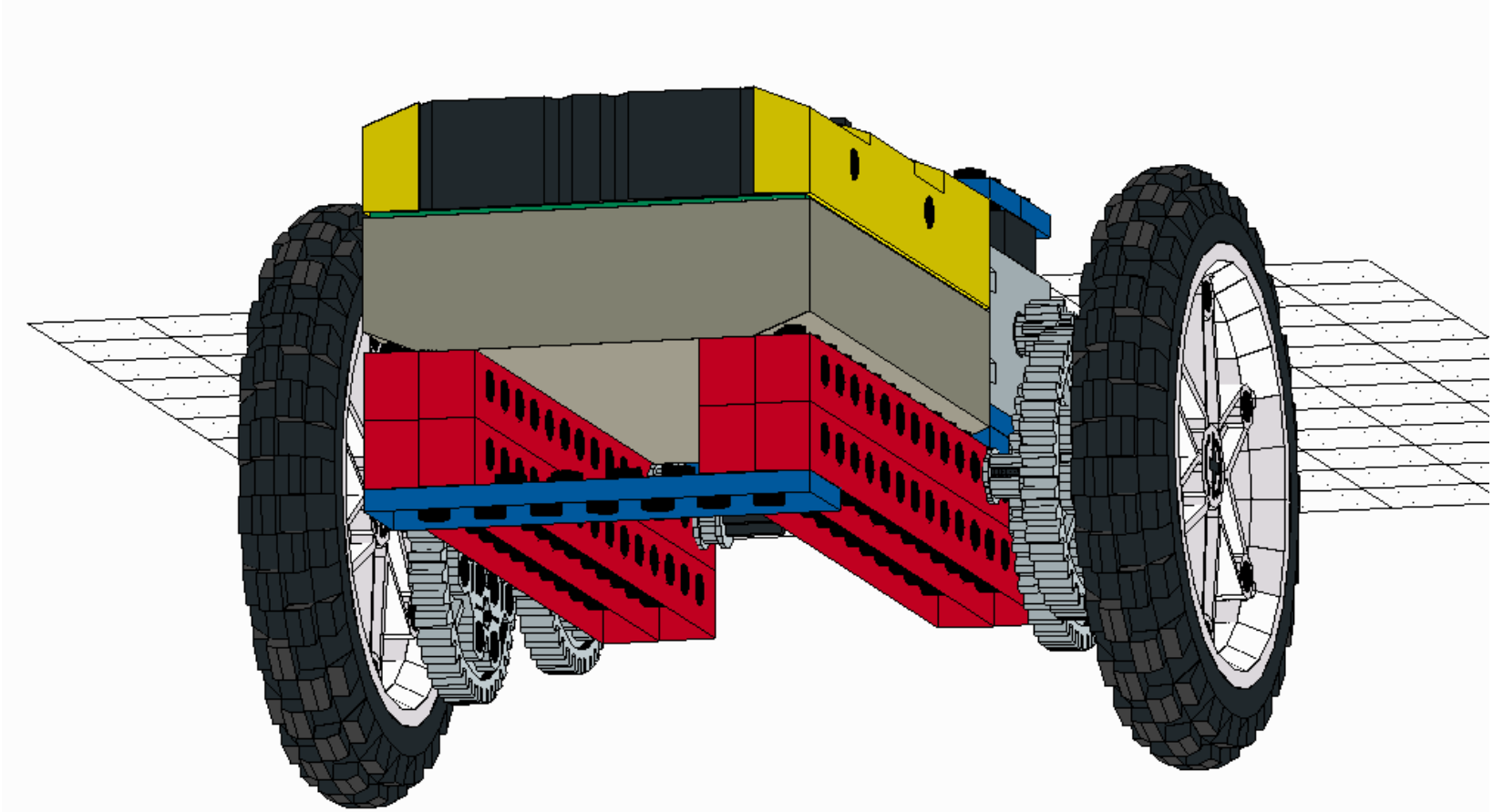




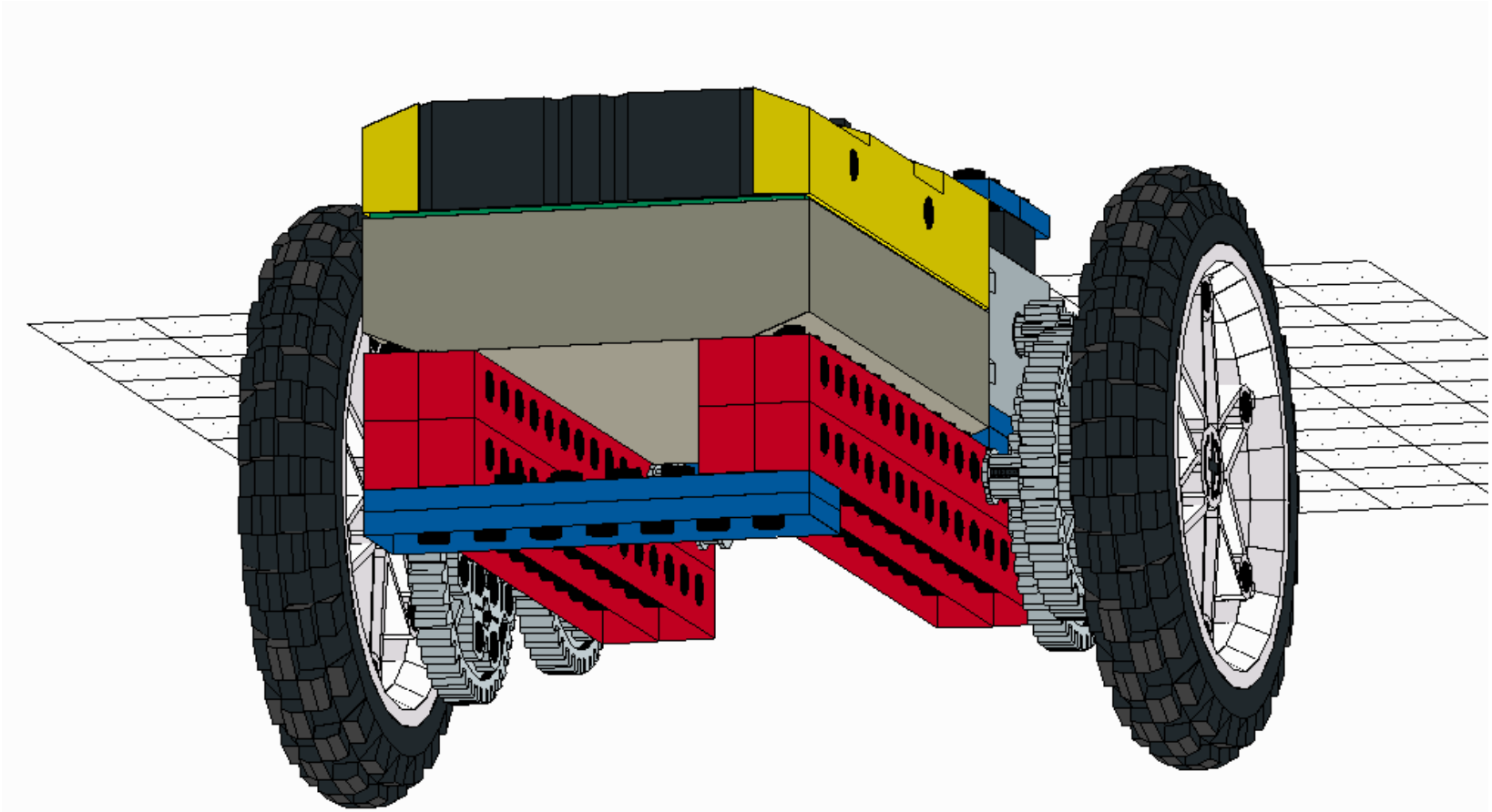
#32. Place a tire hub on the opposite side



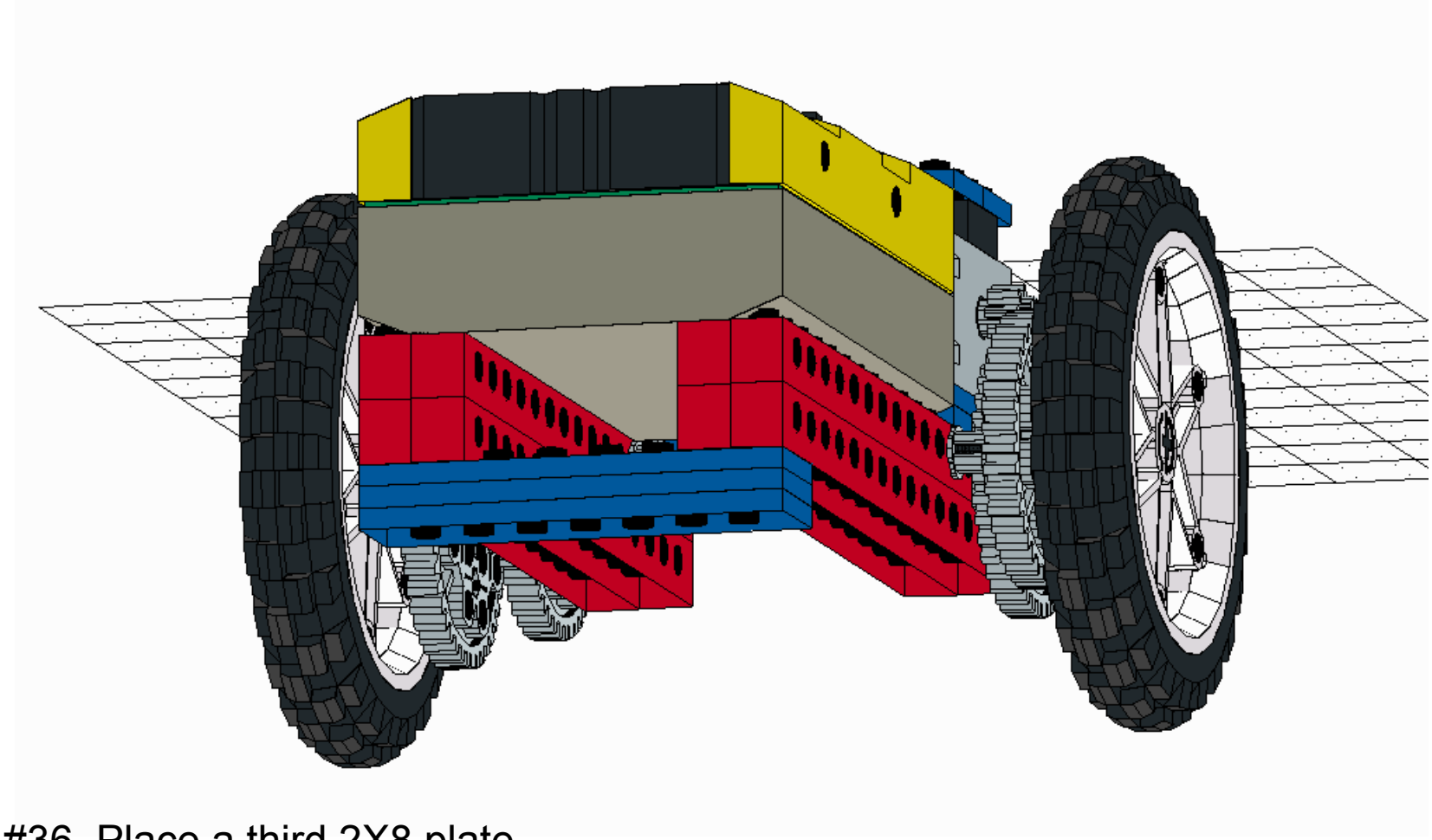
#34. Place a tire on the tire hub



#34. Now, move to the front of the car
and place a 2X8 plate under the beams

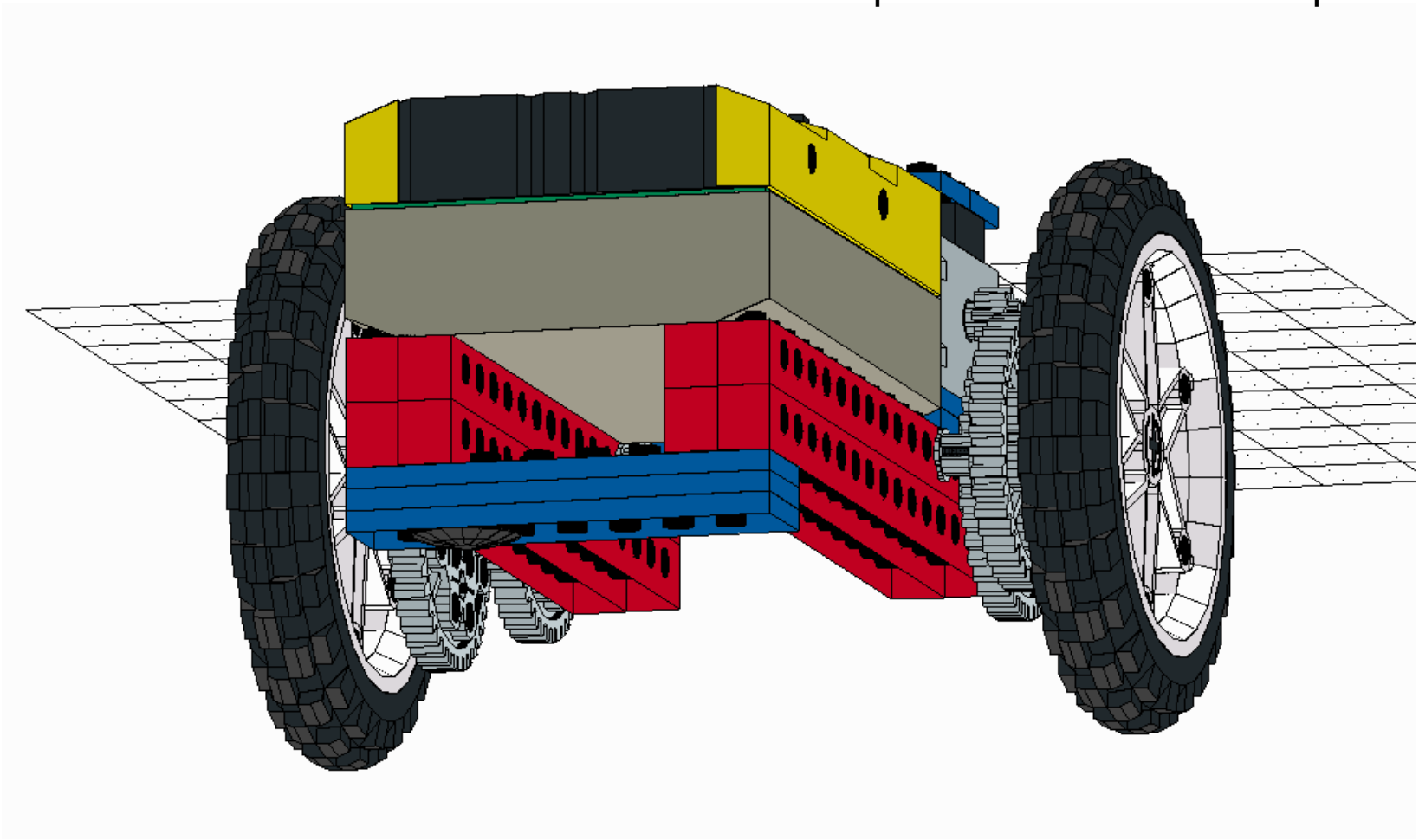


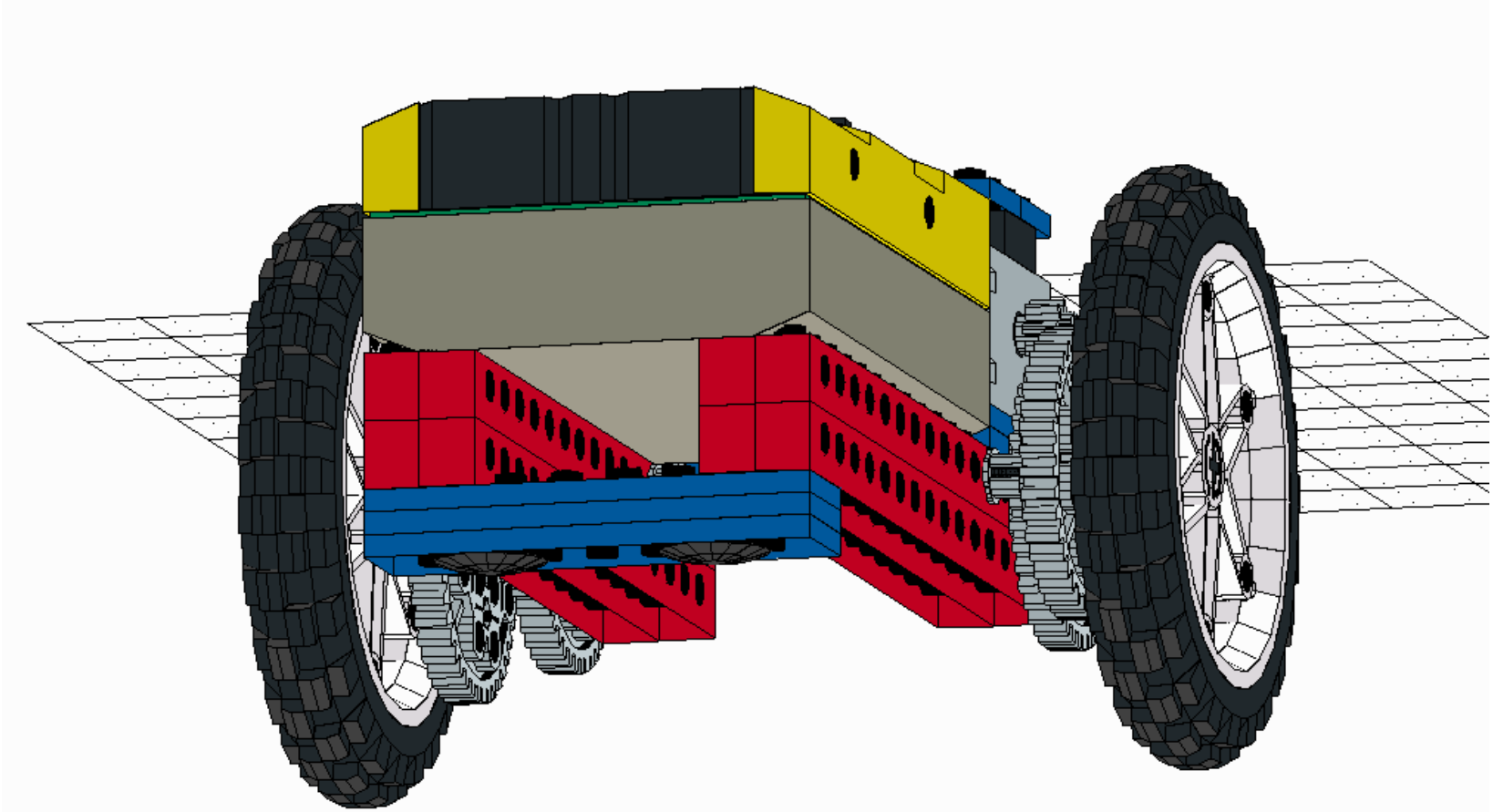
#35. Place a second 2X8 plate under the first



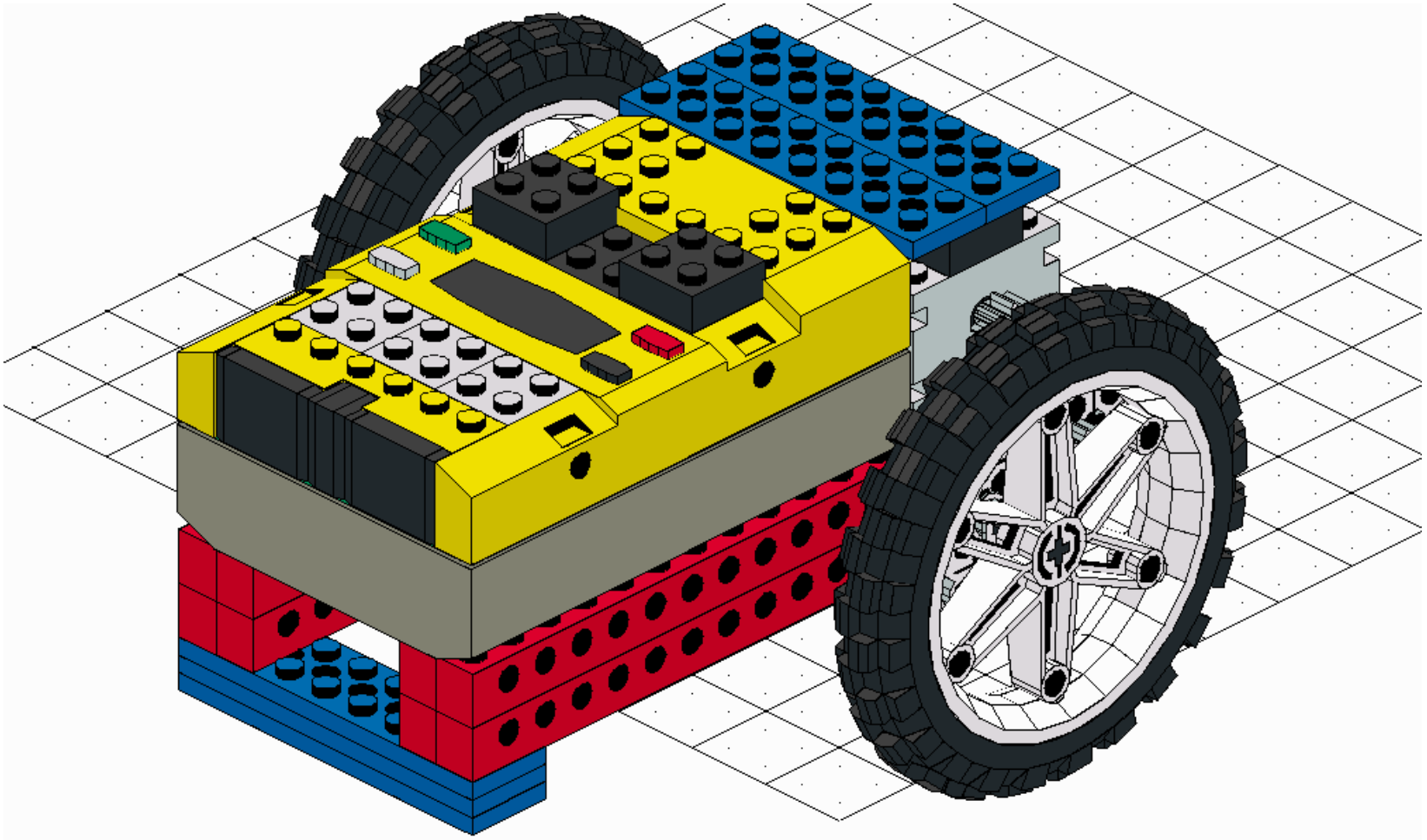
#36. Place a third 2X8 plate under the first two plates

#37. Place a skid plate under these three plates



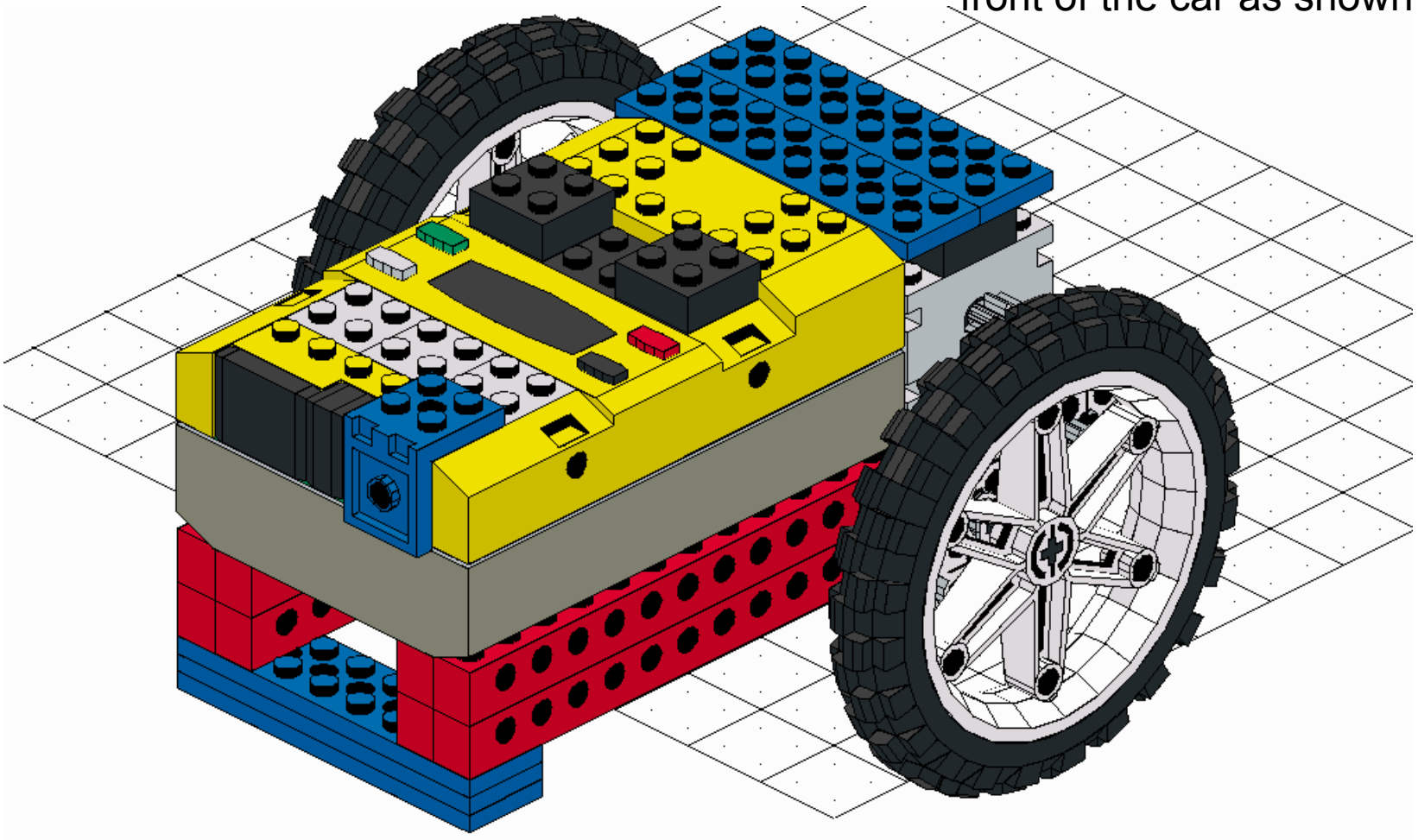


#38. Place a second skid plate
next to the first skid plate

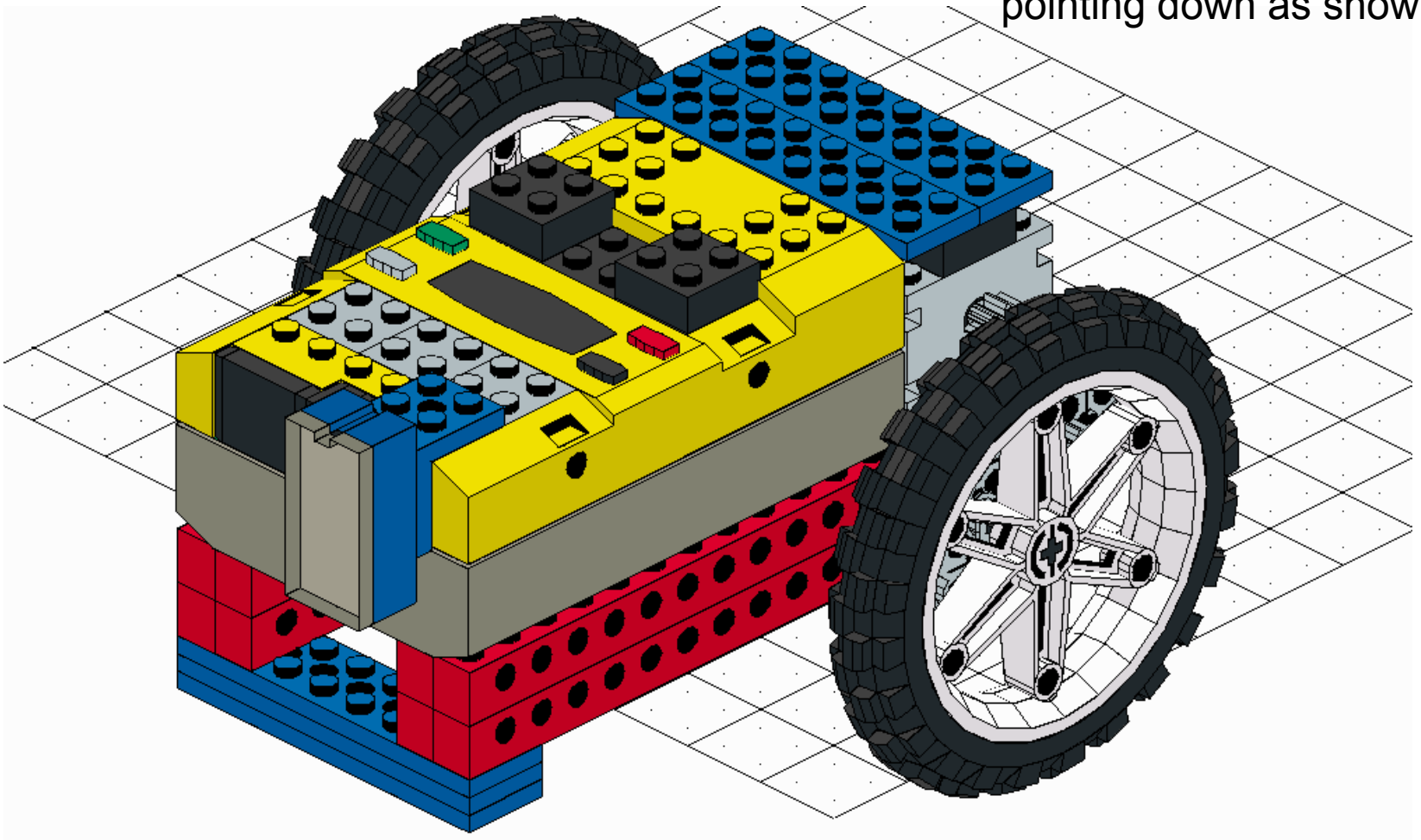


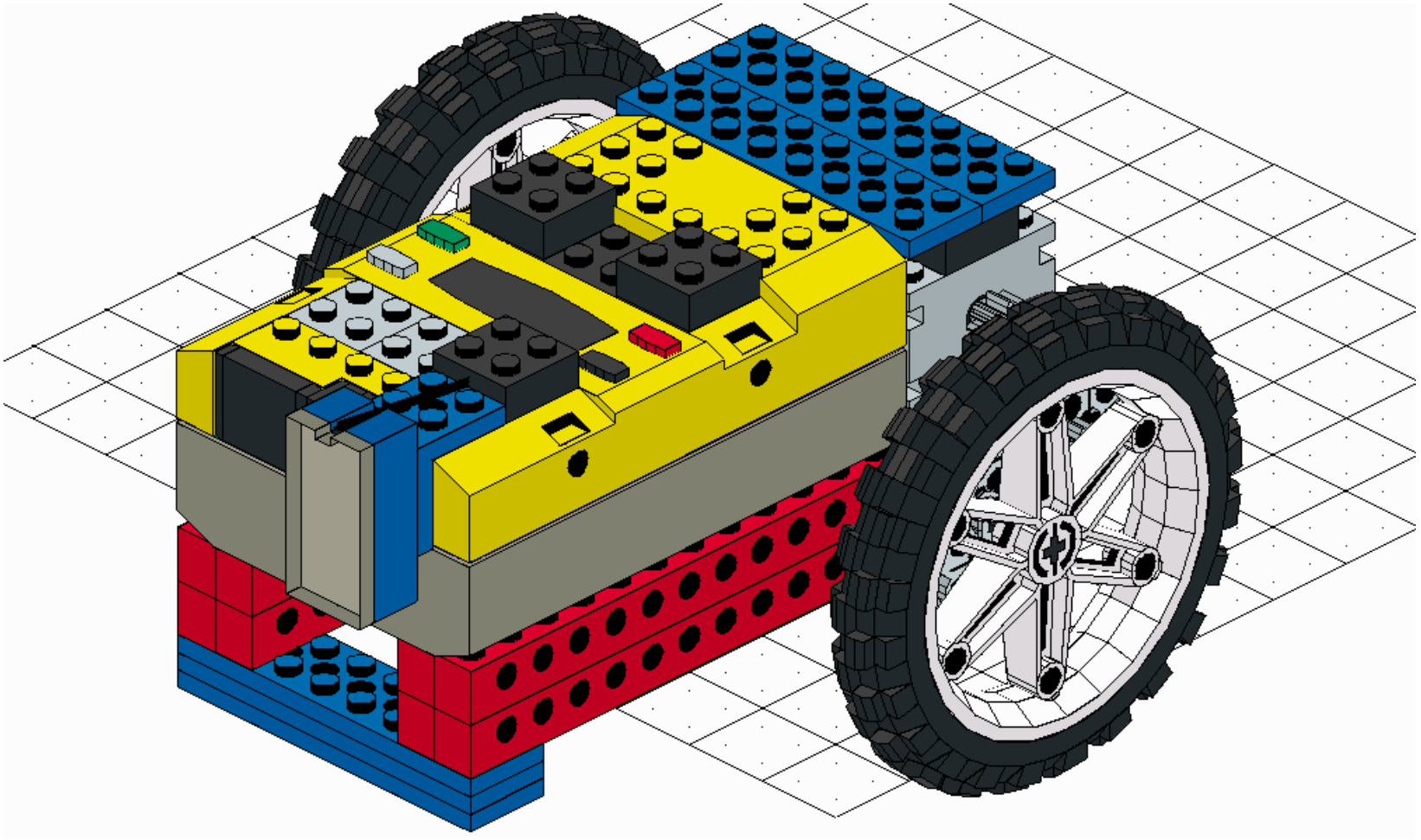
#39. Now, attach the wires to the RCX making sure they are on outputs A and C

#40. Place a brace on the front of the car as shown



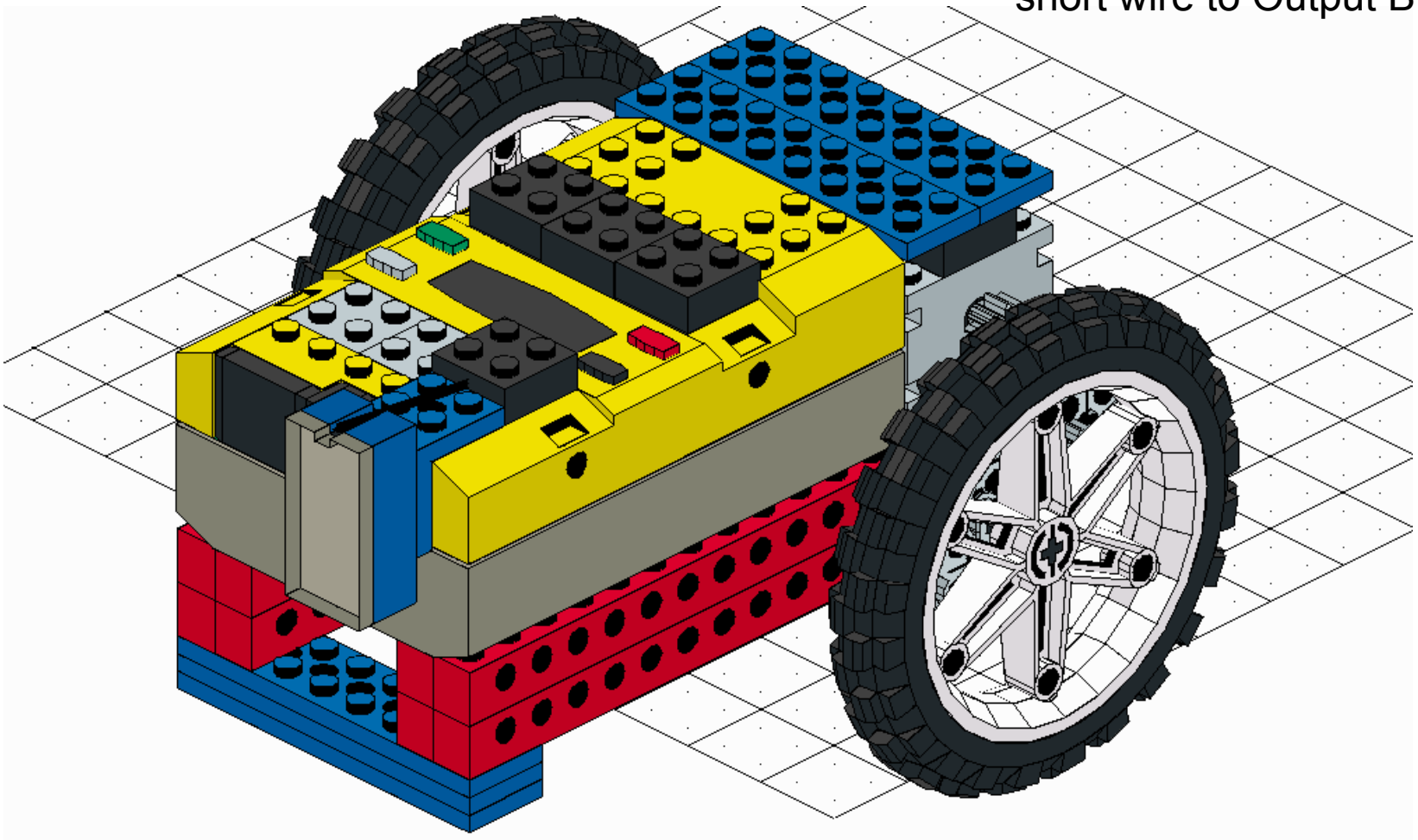
#41. Attach the light sensor to the brace pointing down as shown

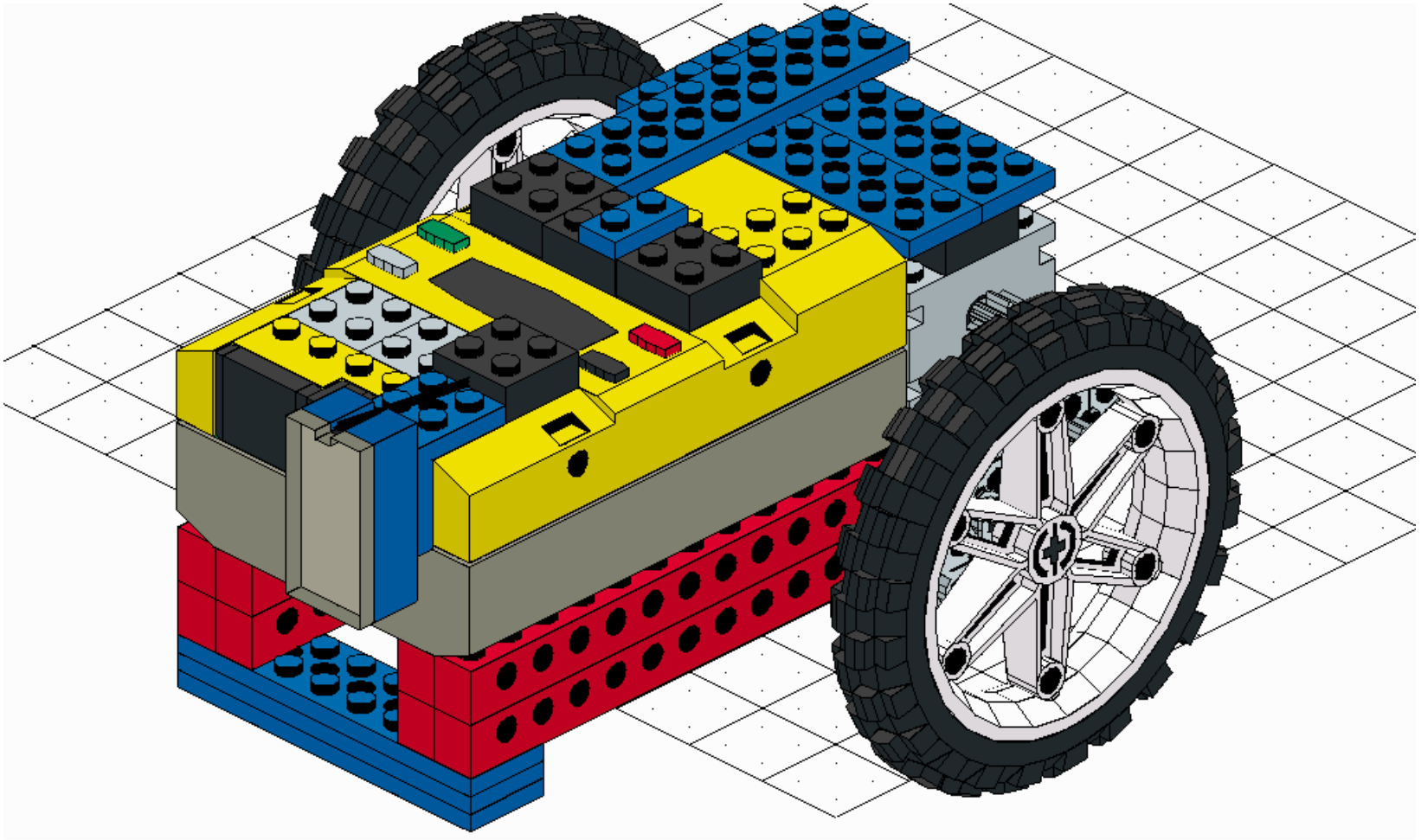




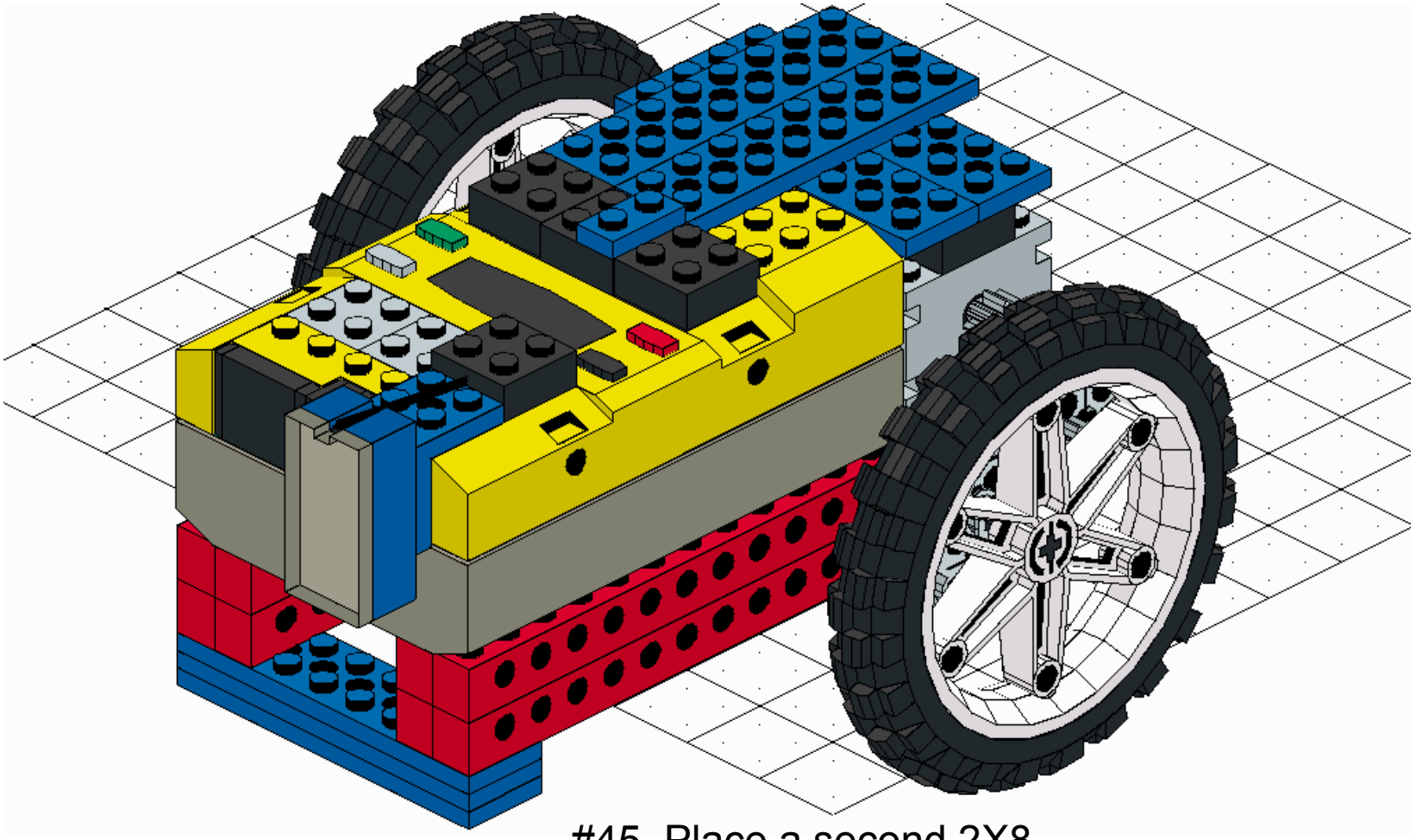
#42. Attach the wire for the light sensor to Port 1

#43. Attach another short wire to Output B

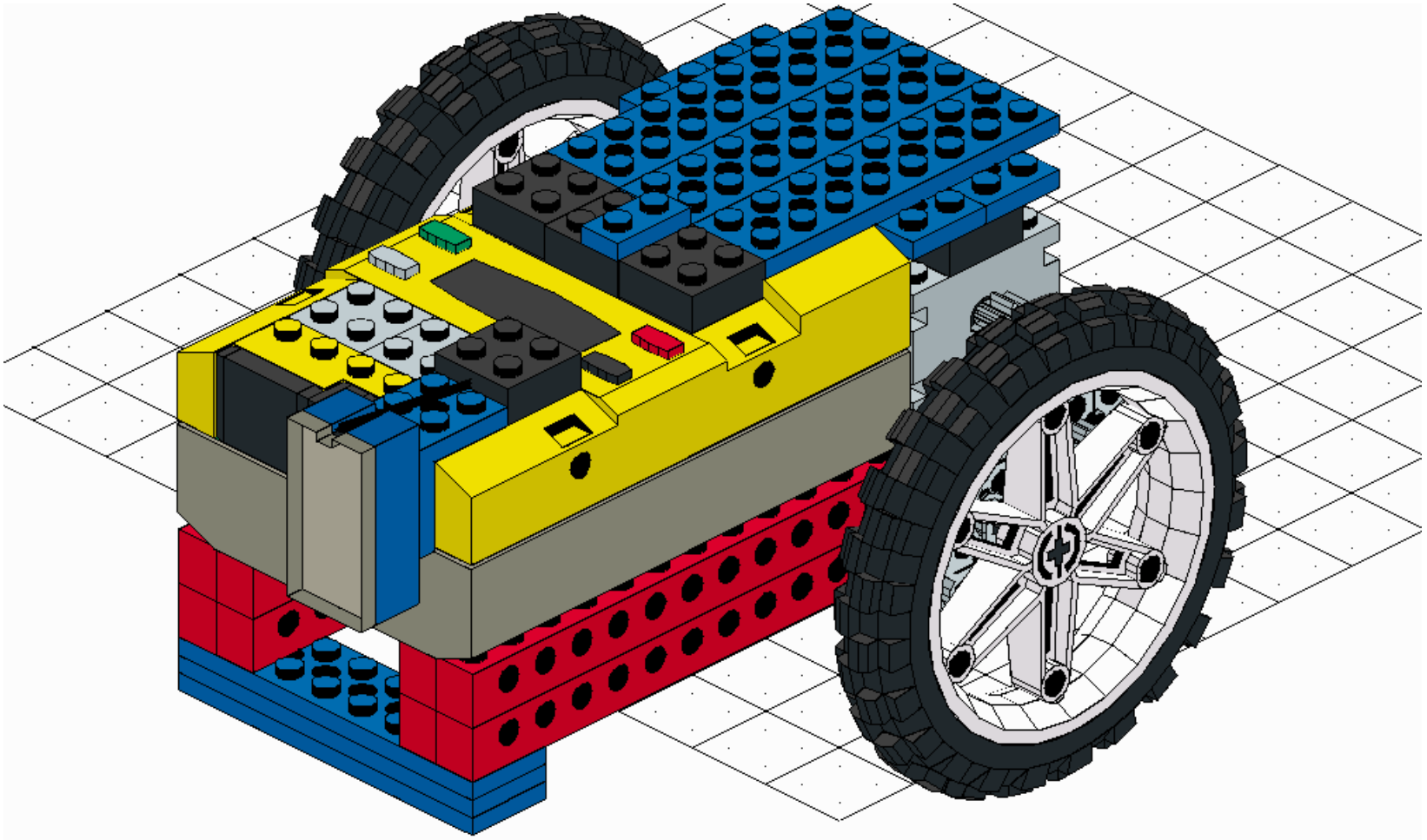




#44. Add a 2X8 plate attaching the motors to the RCX



#45. Place a second 2X8 plate next to the first



#46. Put a third 2X8 plate
next to the first two plates