World Robot Olympiad 2019

Regular Category

Senior

SMART CITIES

SMART NETWORK

Version: January 15th

WRO International Premium Partners

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1. Introduction

Future IT networks face challenges such as holographic video conferencing, driverless cars, and interactive robots, just to name a few of the options that are expected to occur in the near future. In IT data transfer, not only is the goal to increase the speed, but also to create complex systems that can intelligently adapt to the needs of users so that technology remains hidden from the everyday user. Hardware and software solutions will work together to run the future networks.

Creating these future networks involves adapting the current technology, developing new devices, and strengthening wireless technologies. Only a fast, reliable, and secure system can serve as the base for the smart city of the future. It is necessary to create a system that does not require specific IT knowledge from the user. By hiding the technology, only the benefits and the convenience are presented to users. Hungary is one of the centers of 5G research, which can provide a foundation for intelligent networks.

This year, it is the mission to create a robot that modernizes the network within a city by installing new wireless node devices and establishing an optical network between them.

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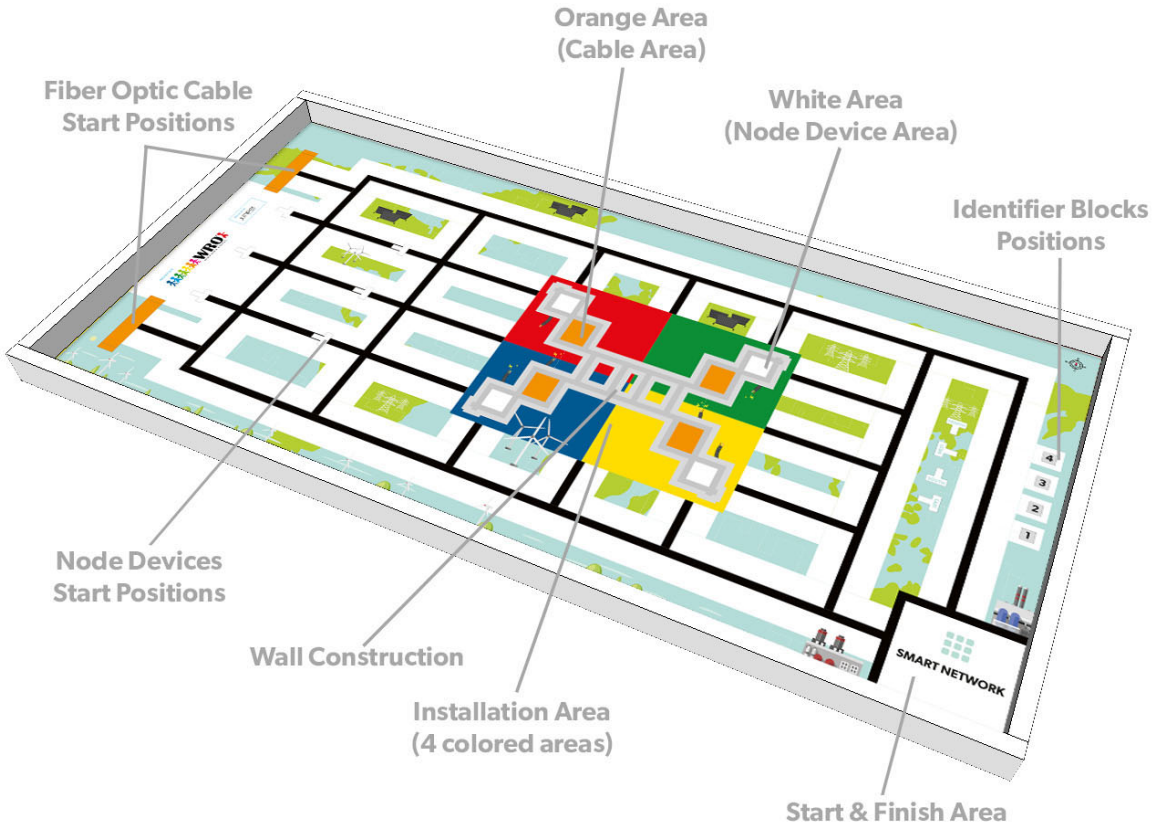
2. Game Field

The following graphic shows the game field with the different areas.



If the table is larger than the game mat, use the Start & Finish Area as a guide and place the Start & Finish Area at the edge of the wall to set up the game mat.

For more information about the table and game mat specifications, please take a look at WRO Regular Category General Rules Rule 4. The printable file of the mat and a PDF with the exact measurements are available on www.wro-association.org.

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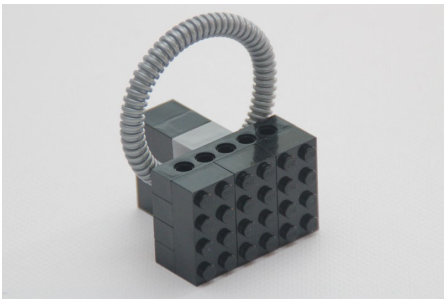
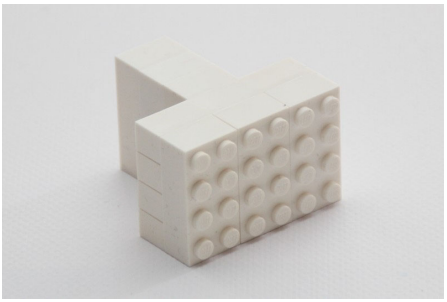
3. Game Objects

There are **two different node devices**: black colored, ring-shaped objects (new devices) and white colored without a ring (old devices).

There are **4 black and 2 white node devices**.

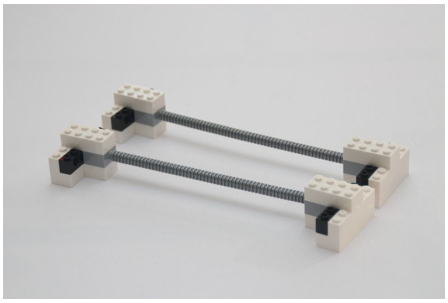


New devices (4 elements)



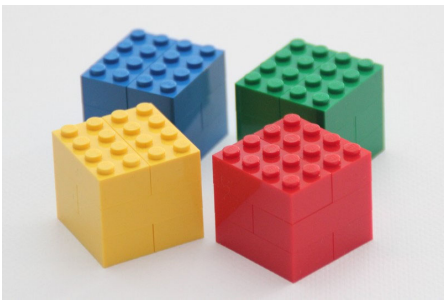
Old devices (2 elements)

2 fiber optic cables are used to connect different areas on the field.



Fiber optic cables

There are 4 identifier blocks in the colors red, green, yellow, and blue that are used to determine the orientation of the node devices.



Identifier Block

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There is a wall construction that defines the **White Areas to place the node devices** (one in every colored part) and **Orange Areas to place the fiber optic cables** (one cable from red to blue and one cable from green to yellow).

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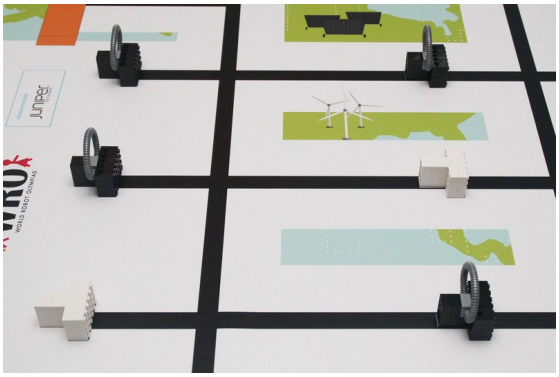
4. Positioning of Game Objects / Randomization

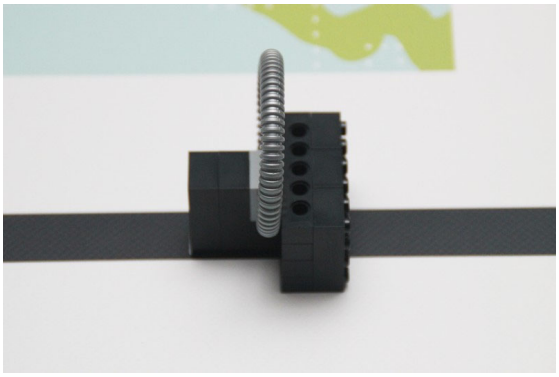
Positioning of node devices

The node elements are placed on the left side on the field. There are two lines with 3 elements each. Every line contains 2 black node devices and 1 white node device that are randomly selected. The position of the nodes in the two columns (left and right line) is drawn separately, e.g. by placing a white and two black cubes in a non-transparent box and then draw the cubes twice, once for each line.

The following photo shows **an example of a possible starting position**:



One possible starting position



Starting orientation of a black node device, always facing this way.

Positioning of identifier blocks

The 4 identifier blocks are randomly placed on the 4 positions (numbered 1 to 4) on the right side above the starting area, e.g. by placing all cubes in a non-transparent box and then draw them one by one. The following photo shows **an example of a possible starting position**:

Empty starting position (with numbers)

A possible starting position

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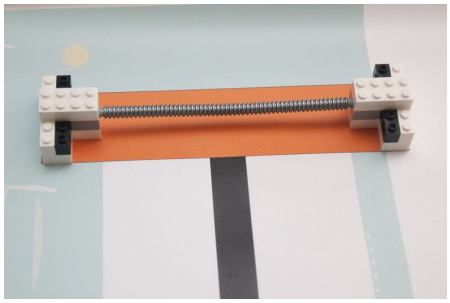
Positioning of fiber optic cables

The fiber optic cables will be placed on the orange rectangles on the left side of the field. The size of the orange rectangles and the cables is the same. It should look like photo on the right.



Positioning of wall construction

The wall construction is placed on the dark grey area. This dark part is exactly the size of the wall construction.

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5. Robot Missions

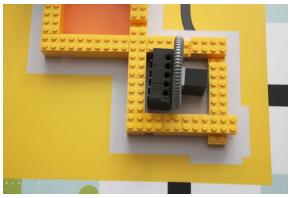
For a better understanding, the missions will be explained in multiple sections. But of course, the team can decide in which order they will do the missions.

5.1 Mission: Place the node devices in the correct orientation

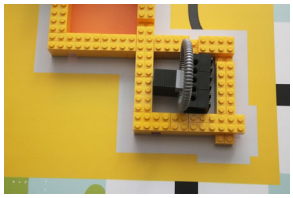
The black node devices must be transported from their initial positions to the White Areas in the installation area. White objects must be left in their initial positions.

The black node devices must be aligned in specific orientations that are determined by the identifier blocks. The identifier blocks define the orientation each black node device should have in the surrounding colored frame, example: Green block on position 4 means that the node device should be placed pointing NORTH in the green wall area (see example on the next page).

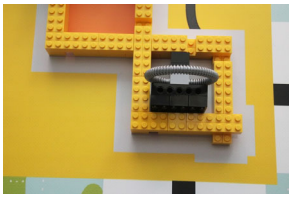
In each game, all **4 orientations** shown in these photos will be used.



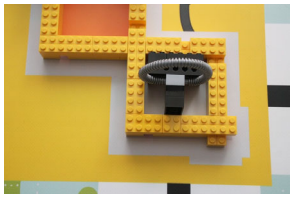
WEST Orientation



EAST Orientation



SOUTH Orientation



NORTH Orientation

See a full solution for this orientation on the next page.

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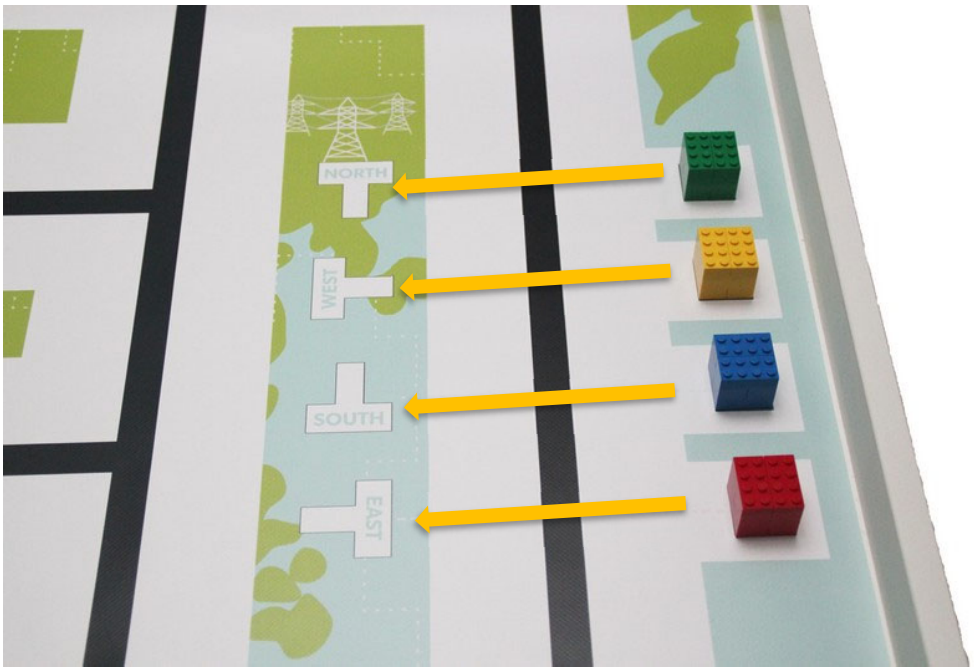
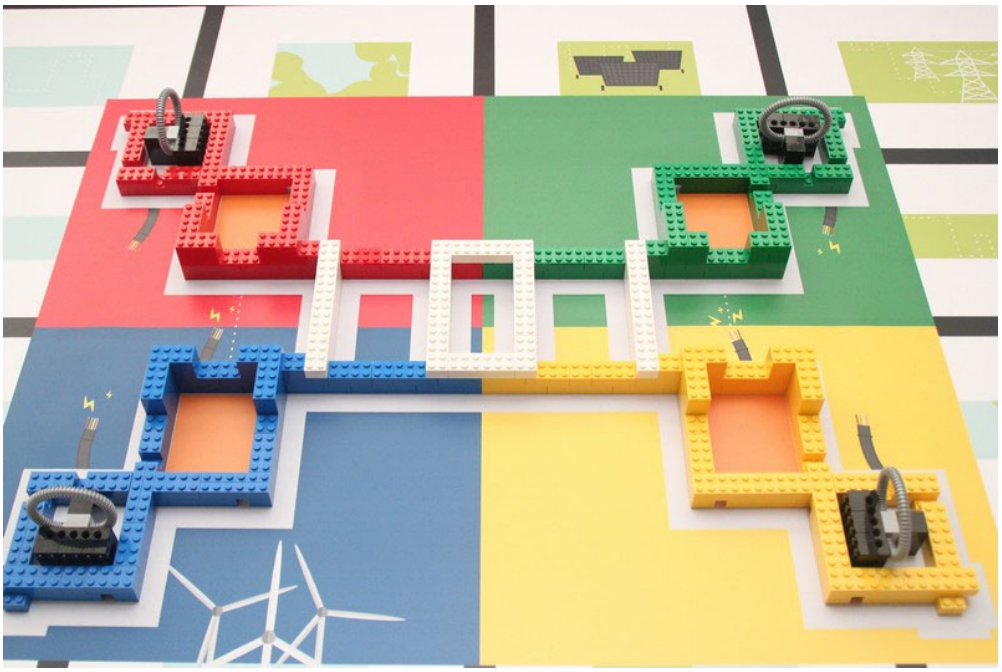
Start position of the identifier blocks:



Optimal end position of node devices:



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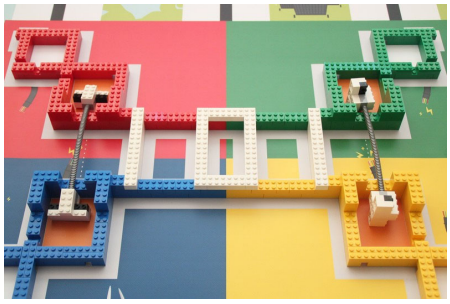
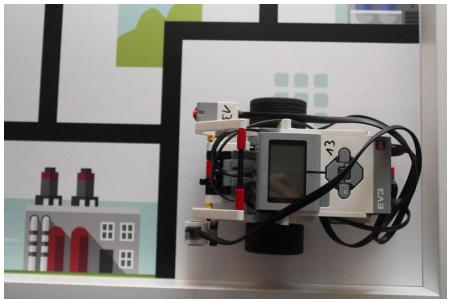
5.2 Mission: Connect the fiber optic cables



The robot should connect the two fiber optic cables between the different areas.

The cable connection should be made between the red and blue and the green and yellow areas. In the best case, the fiber optic cables touch the orange areas of the installation area.

5.3 Mission: Park the robot



Before the start of the run, the robot must start completely within the Start & Finish area (the surrounding line is not included in the Start & Finish Area. At the start, the cables count toward the maximum size of the robot, so they need to be included in the Start & Finish Area).

The mission is completed when the robot returns to the Start & Finish area, stops, and the chassis of the robot is completely (top-view) within the Start & Finish area (cables are allowed to be outside of the Start & Finish area).

5.4 Penalty points (walls)

The walls must not be damaged or moved from the grey area. If the walls are damaged or moved **outside the light grey area**, a penalty is given but will never result in a negative score (see General Rules 6.15).

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6. Scoring

Definitions for the scoring

- **“Correct / Wrong Orientation”** is defined by the identifier blocks, please take a look at Mission 1 for an explanation.
- **“Touching only”** means that the object is touching the **white node device area inside the installation area on the mat** (completely lying on one side). Every other situation where only a part of the object touches the white area inside the installation area (e.g. if the object is partly held up by the wall) is defined as **“Touching partly”**
- **Note:** Points for node devices and fiber optic cables are only awarded if the objects are lying inside the wall construction. You cannot move the wall construction to the side to score points.

Tasks	Each	Total
A black node device: • **Correct** orientation • **Touching only** the field mat	**30**	**120**
A black node device: • **Wrong** orientation • **Touching only** the field mat	10	40
A black node device: • **Any** orientation • **Touching partly** the field mat	5	20
Fiber optic cable – Full Connection: The connection between the two areas is complete, both ends of the cable are touching the orange colored area on the mat.	**30**	**60**
Fiber optic cable – One-Side Connection: The connection between the two areas is almost done. On one side, the end of the cable touches the orange colored area on the mat. On the other side the end of the cable touches the **surrounding wall** of the orange colored area.	20	40
Fiber optic cable – Wall Connection: The connection between the two areas not worked out, on both sides the ends of the cable touche the **surrounding wall** of the orange colored area.	10	20
The white node elements remain in the initial position. *(only if other points with black node devices are assigned)*	**5**	**10**
Robot completely stops within Start & Finish Area. *(only if other points are assigned)*		**10**
Robot damages or displaces the wall construction.		-10
Maximum Score		**200**

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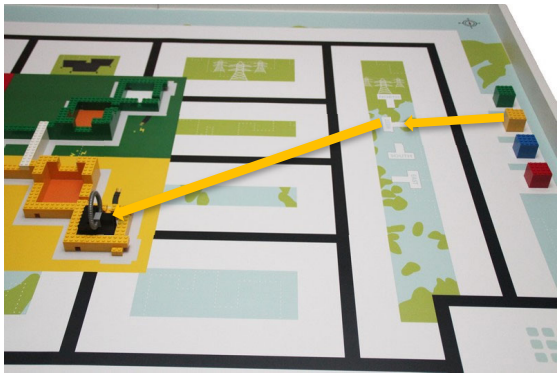
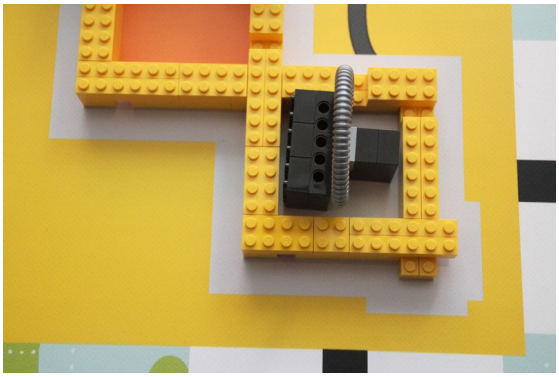
Scoring Interpretation

A black node device with **CORRECT orientation**, **touches only** the mat ➔ 30 points

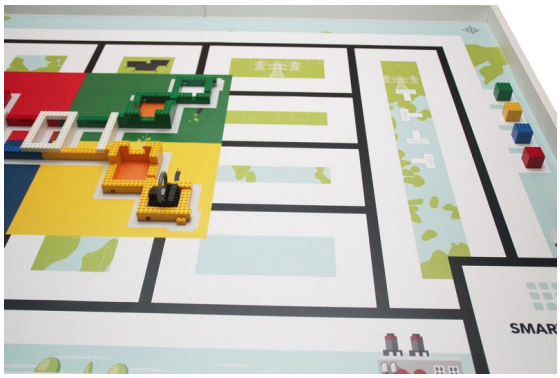


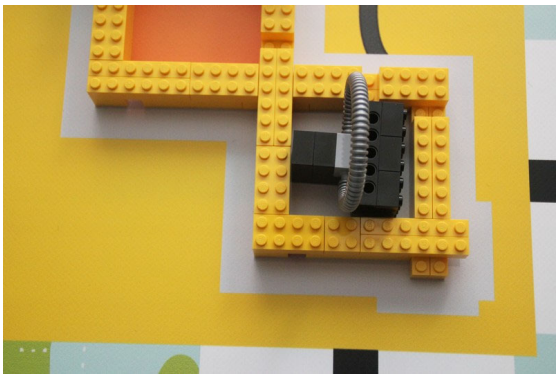
You can see that the yellow block is lying on the *WEST Orientation.*



The node device is lying completely on the field in the correct orientation *(WEST orientation)*, the lower side only touching the mat and not held up by the wall.

A black node device with **WRONG orientation**, **touches only** the mat ➔ 10 points





The node device is lying completely on the field **but in the wrong orientation** *(EAST instead of WEST orientation)*, the lower side only touching the mat and not held up by the wall.

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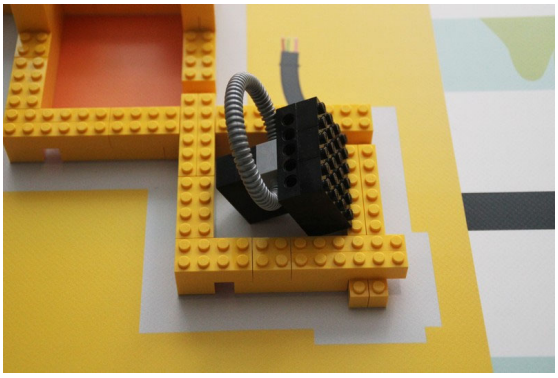
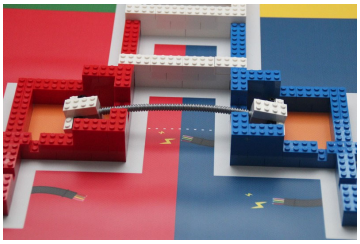
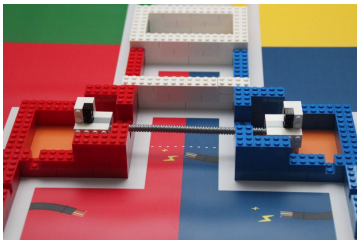
A black node device with **ANY orientation**, **touches PARTLY** the mat ➔ 5 points

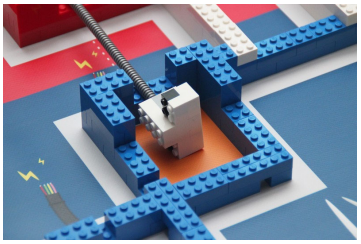


The node device is not completely lying on the field, held up by the wall as well.

Fiber Optic Cable – Full Connection (both cable ends touch the orange areas) ➔ 30 points

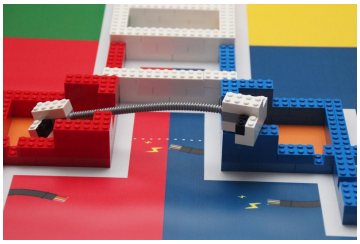






Fiber Optic Cable – One-Side-Connection (one cable end is touching the orange area, one cable end is touching the side the wall)

➔ 20 points



It is important that the surrounding walls (in this case red or blue) are touched.

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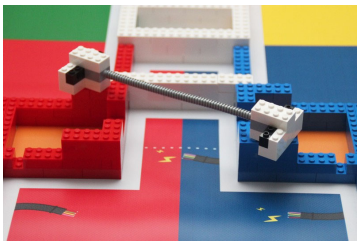
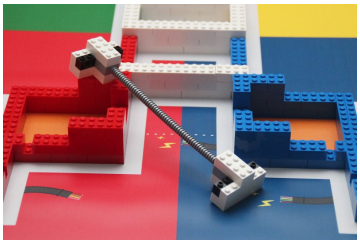
Fiber Optic Cable – Wall-Connection (both cable ends are touching the wall) ➔ 10 points

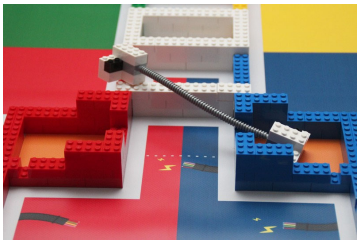


It is important that the surrounding walls (in this case red or blue) are touched.

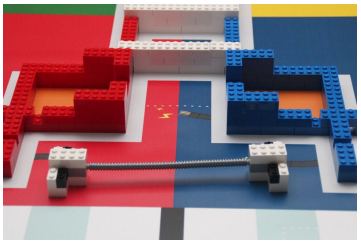
Fiber Optic Cable – no (ZERO) points for these situations**:**



No points for touching the mat with one cable end

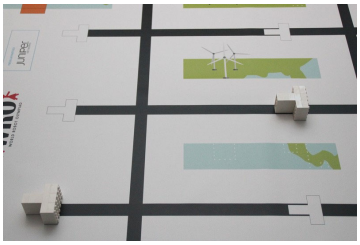


No points for touching the white part of the wall (the surrounding red wall must be touched)

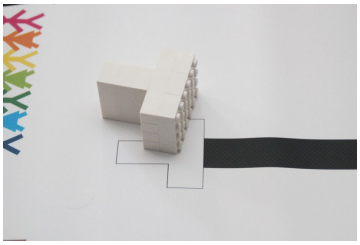


No points if the cable is only lying on the field mat.

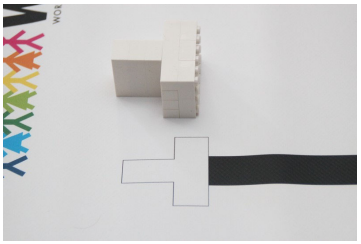
The white node elements remain in the initial position ➔ 10 points
(only if other points with black node devices are assigned)



Both elements are lying completely fine on their starting positions.



It is OK if the white element touches the starting position (like this one here).



<u>No points</u> if one or both white elements are no longer touching the starting position.

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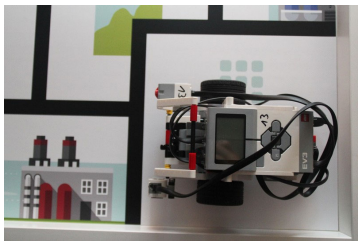
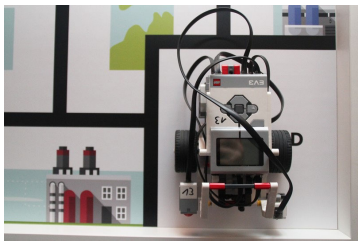
Robot completely stops within Start & Finish Area ➔ 10 points
(only if other points are assigned)



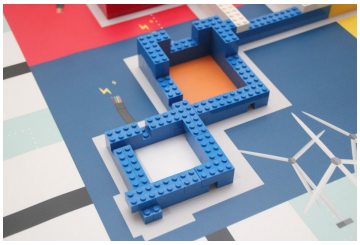
The projection of the robot is completely inside the start area. Well done ☺.



The projection of the robot is completely inside, and cables are out. That is still OK.

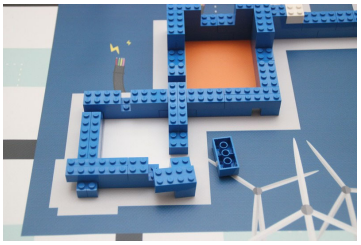
No points if the projection of the robot is not in the start area.

Penalty points: Robot damages or displaces the wall construction ➔ **-10 points**



It is OK if the wall is moved inside the light grey area.

Penalty points if the wall is outside the grey area.



Penalty points if the wall is damaged.

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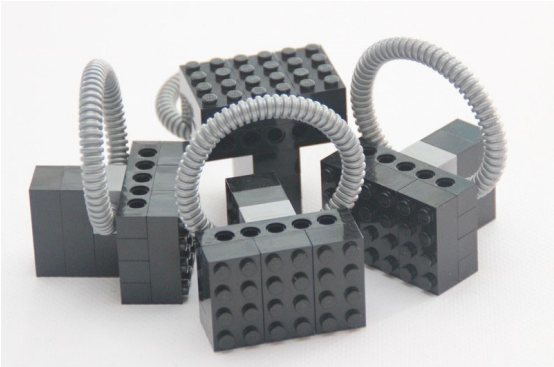
7. Assembly of Game Objects

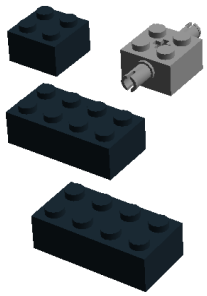
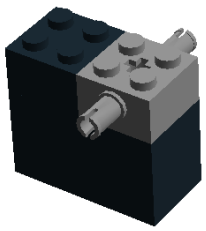
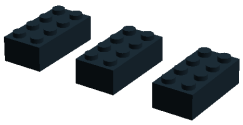
Assembly of node devices



There are **2 white (old)** and **4 black (new) node devices** on the field.

For one **black node** device you need:

- 5 black 2x4 bricks
- 1 black 2x2 brick
- 1 grey 2x2 bricks with the connection for the ribbed hosepipe
- 1 grey ribbed hosepipe
- 4 black 1x6 bricks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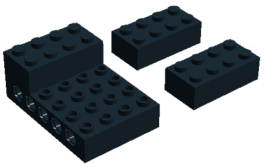
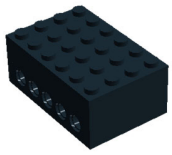
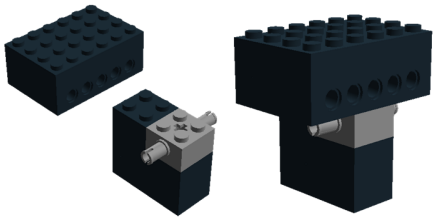
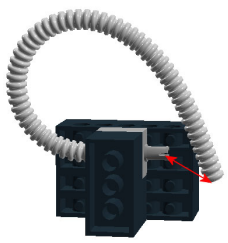
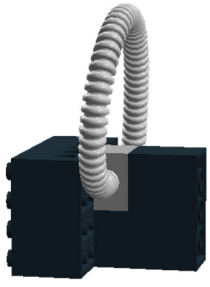
			
Step 5	Step 6	Step 7	
			
Step 8	Step 9		

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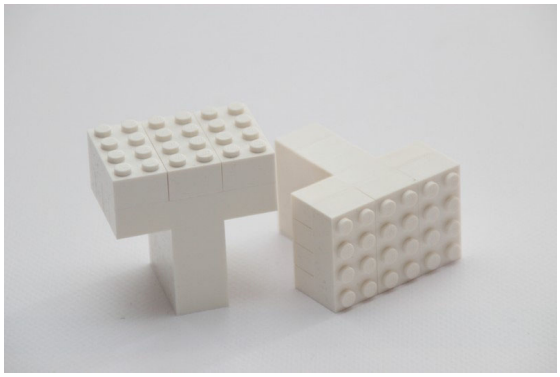
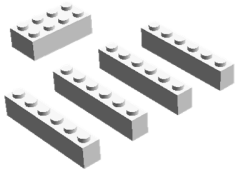
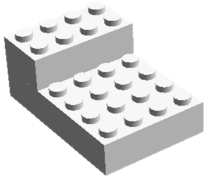
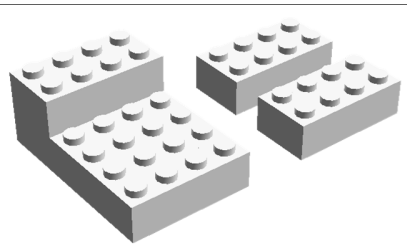
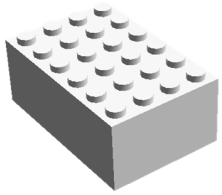
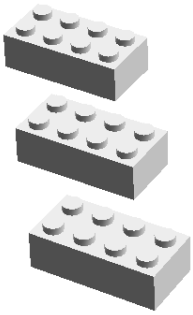
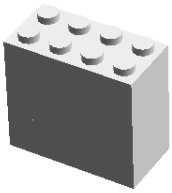
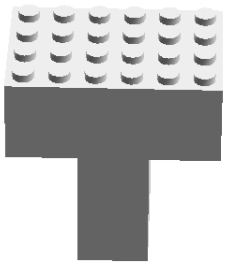
For one **white node device** you need:

- 6 white 2x4 bricks
- 4 whit 1x6 bricks

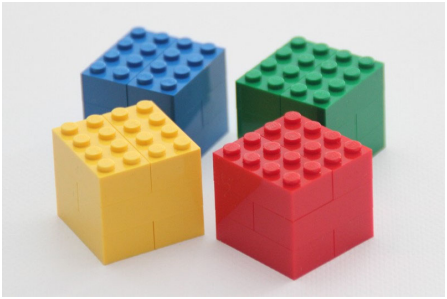


			
Step 1	Step 2	Step 3	
			
Step 4	Step 5	Step 6	Step 7

Assembly of identifier blocks

There are 4 identifier blocks, one red, one yellow, one green, and one blue.

For each identifier block you need **6 2x4 LEGO bricks** in the specific color.



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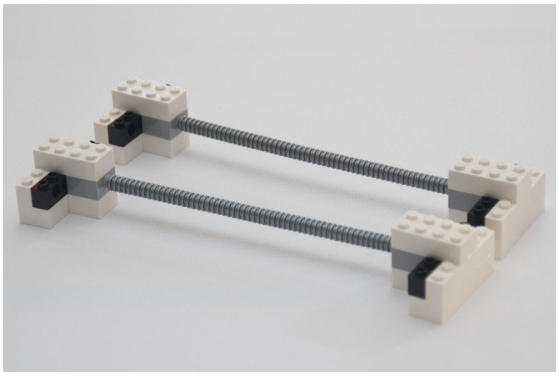
Assembly of the fiber optic cable



There are **2 fiber optic cables** on the field.

For **one fiber optic cable** you need:

- 4 white 2x2 bricks
- 4 white 2x4 brick
- 2 white 1x6 brick
- 2 black 1x6 brick
- 2 grey 2x2 bricks with the connection for a hosepipe
- 1 grey ribbed hosepipe

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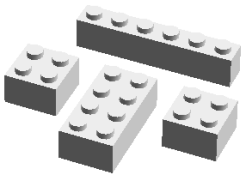
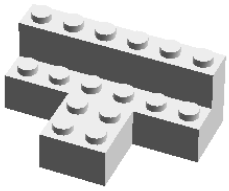
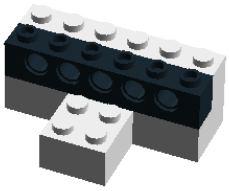
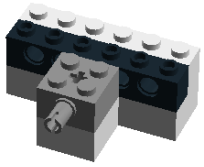
<tr><td>  </td><td>  </td><td>  </td><td>  </td></tr>
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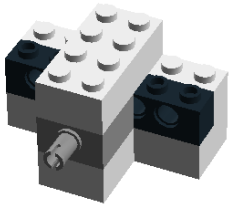
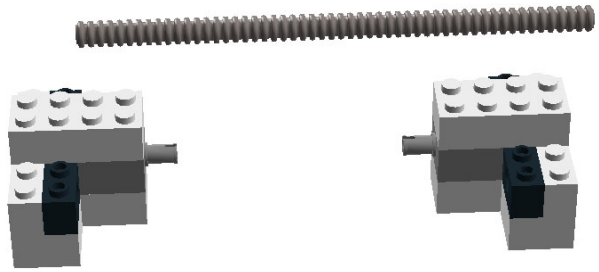
<tr><td>  </td><td colspan="3">  </td></tr>
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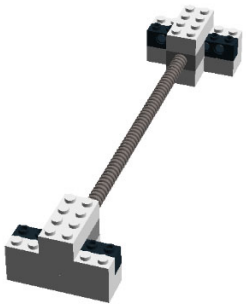
<tr><td colspan="3"> </td><td>  </td></tr>
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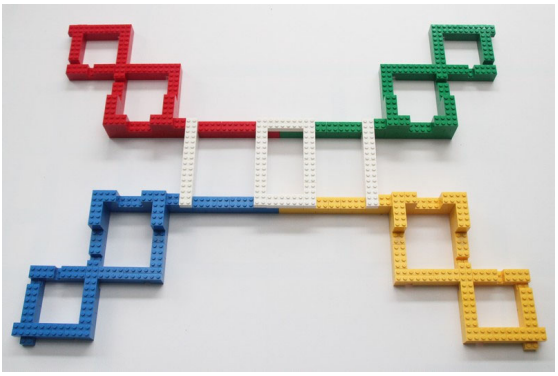
Assembly of the wall construction



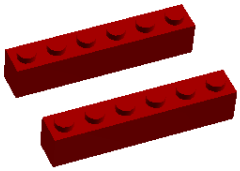
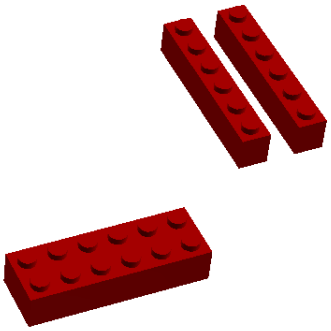
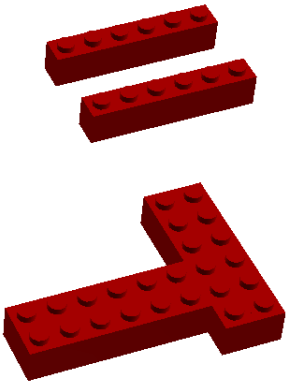
The assembly of the wall will be done in multiple steps:

1. Assembly of the red and yellow parts
2. Assembly of the blue and green parts
3. Connecting walls

Red and Yellow target areas for node devices and cables

For the red or yellow wall part you need:

- 4 2x2 bricks
- 25 2x4 bricks
- 26 1x6 bricks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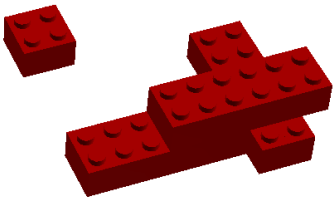	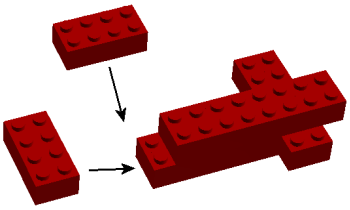	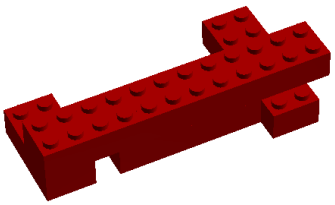
Step 4	Step 5	Step 6

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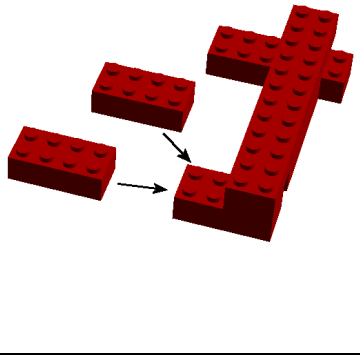	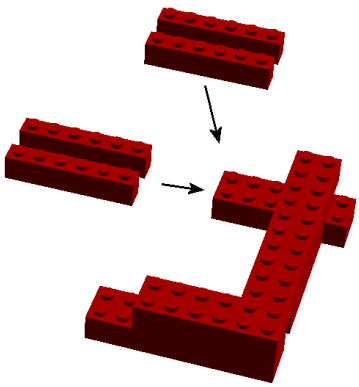	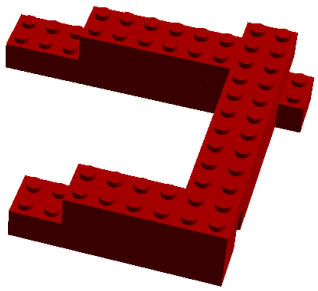
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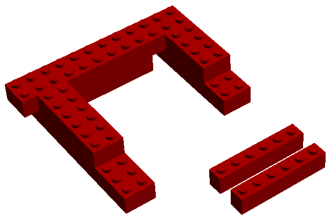	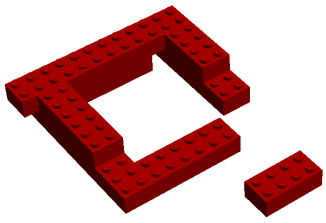	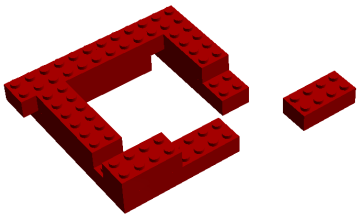
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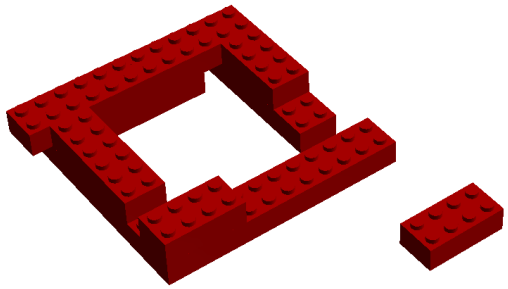	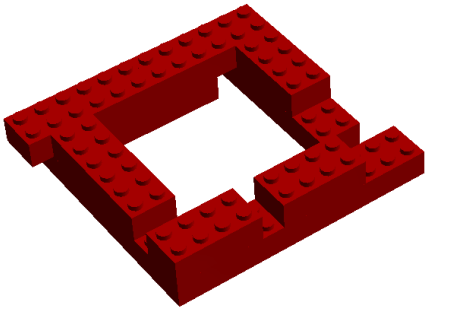	
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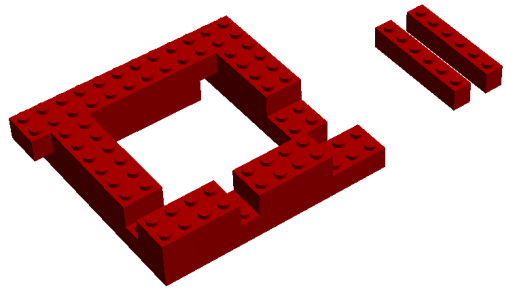	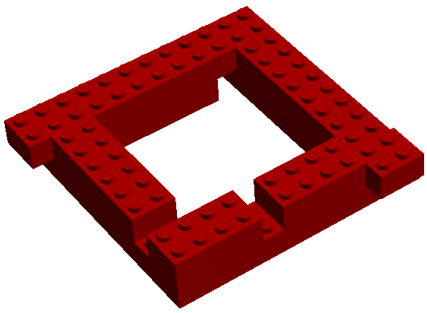
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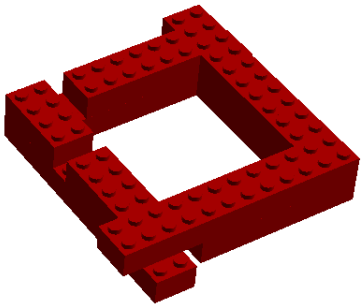	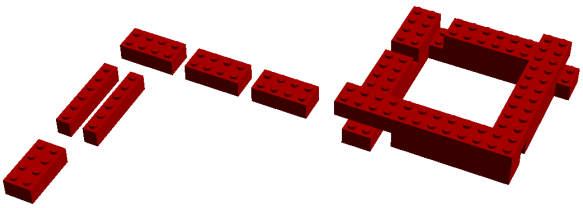
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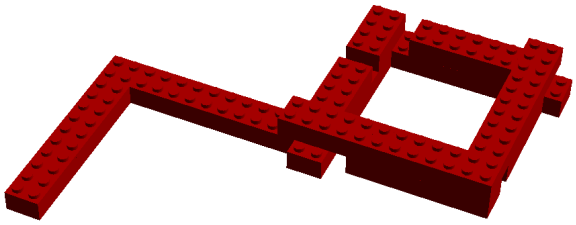	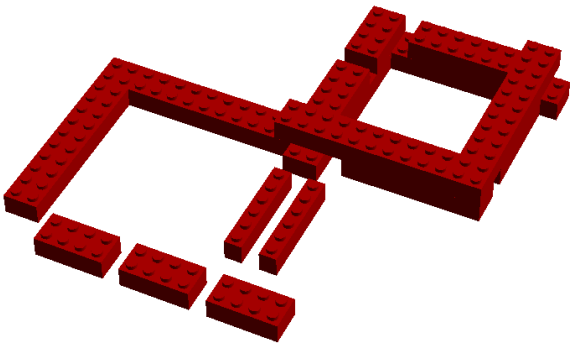
Step 19	Step 20

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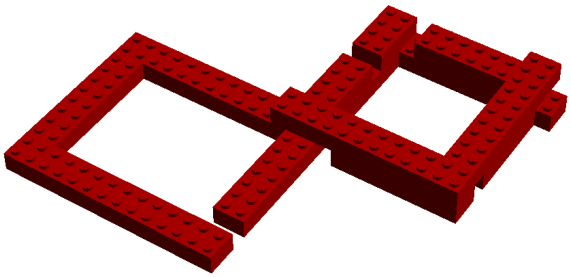	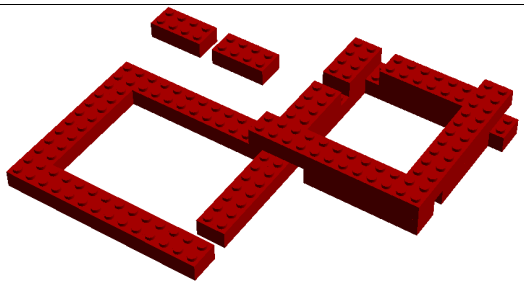
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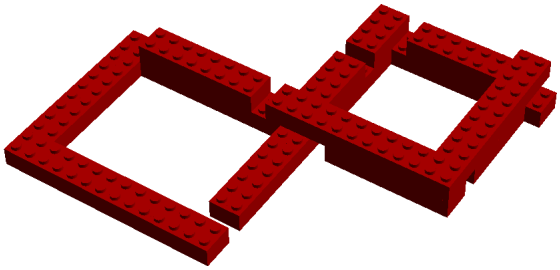	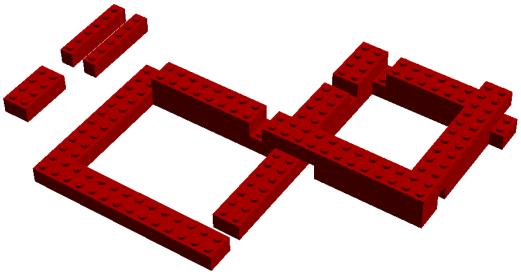
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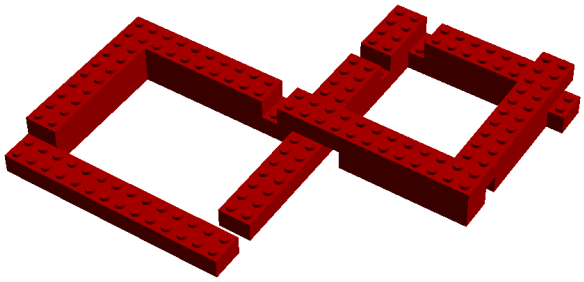	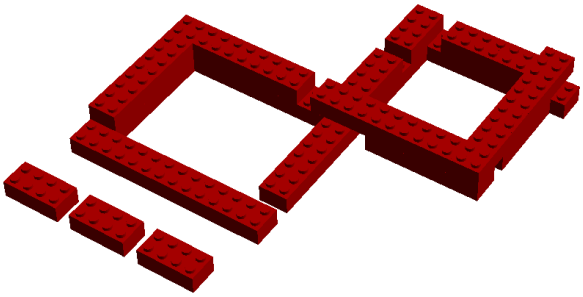
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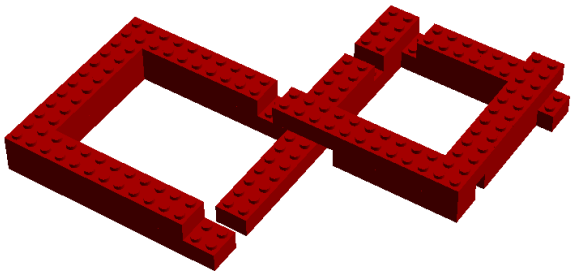	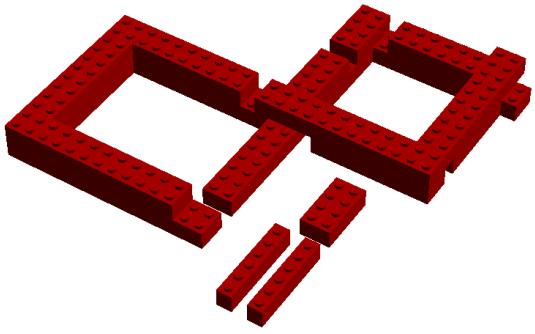
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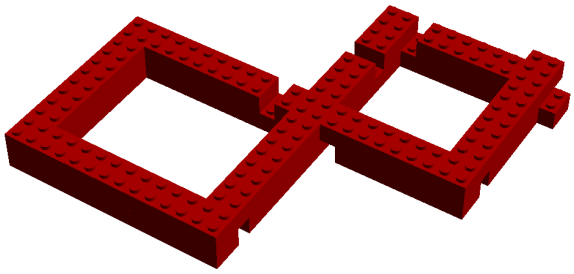	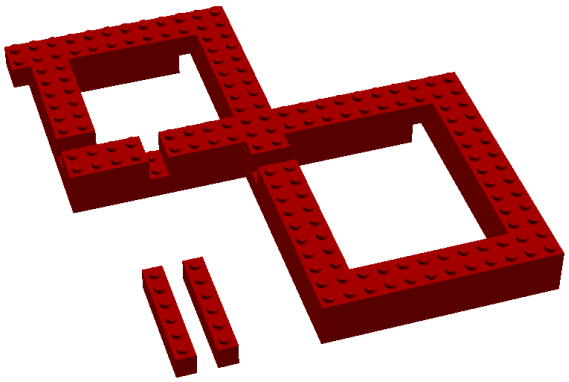
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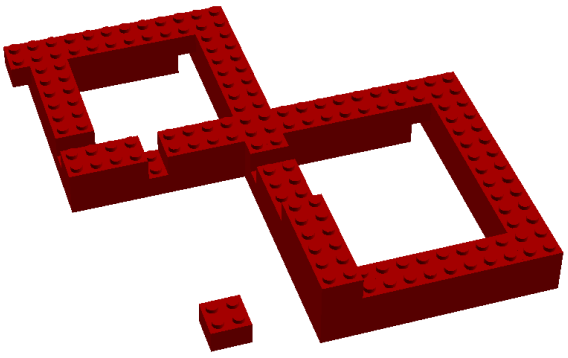	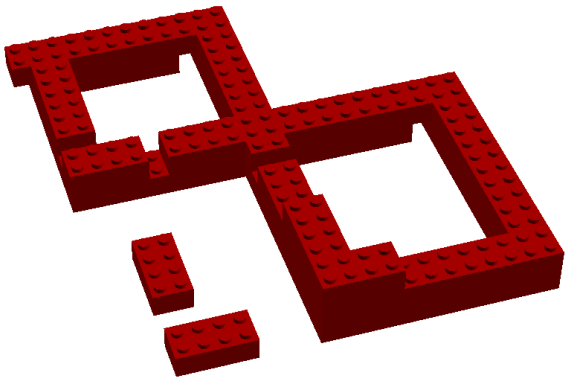
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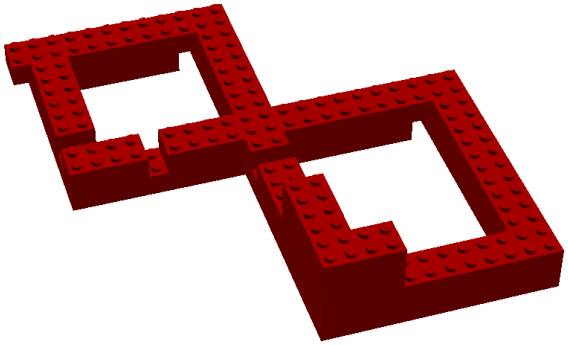	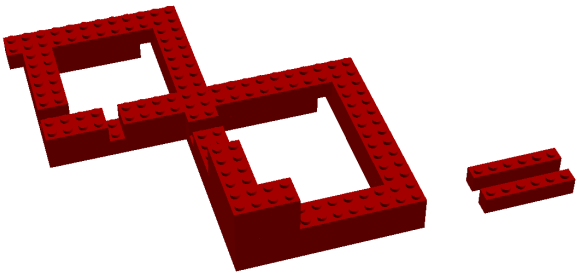
Step 33	Step 34

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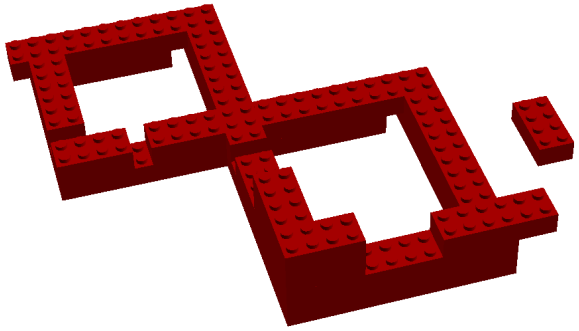
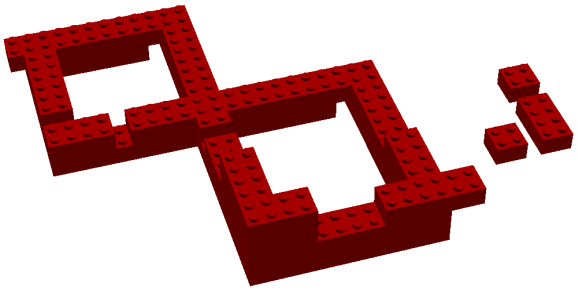
<tr><td>  </td><td>  </td></tr>
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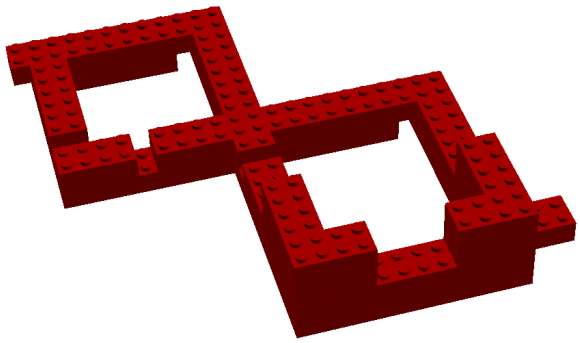
<tr><td>  </td><td></td></tr>
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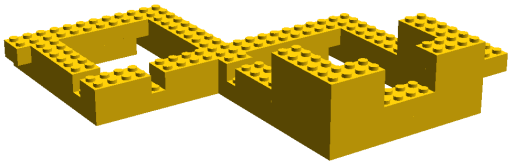
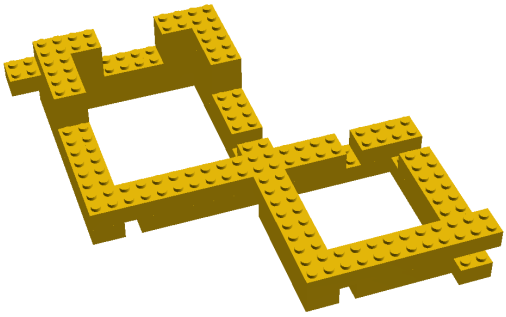
<tr><td>  </td><td>  </td></tr>
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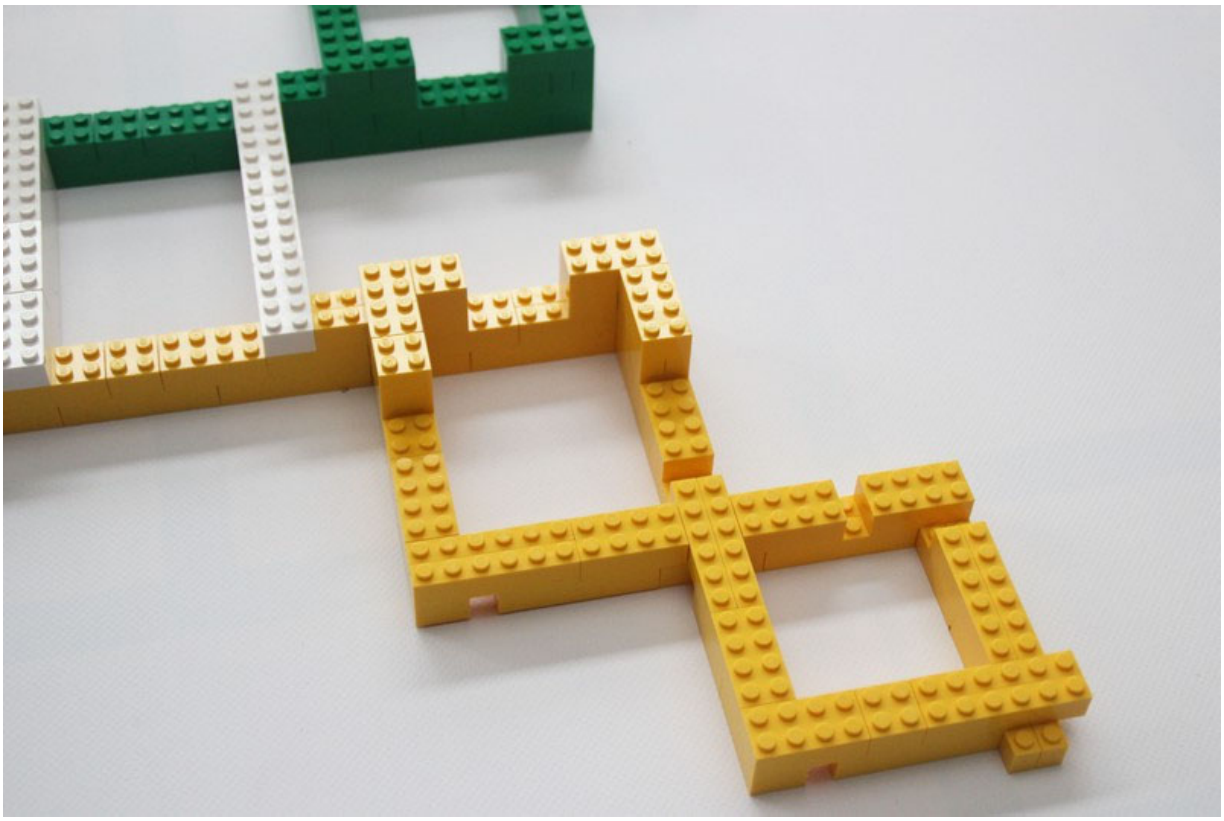

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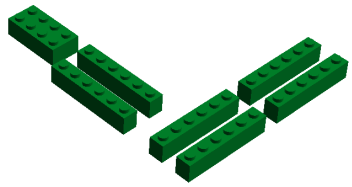
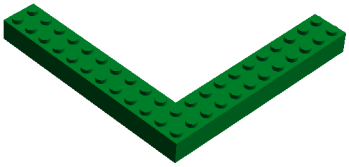
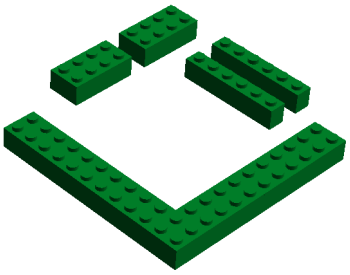
Green and Blue target areas for node devices and cables

For the green and blue wall part you need:

- 4 2x2 bricks
- 25 2x4 bricks
- 26 1x6 bricks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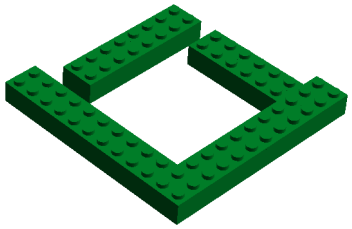	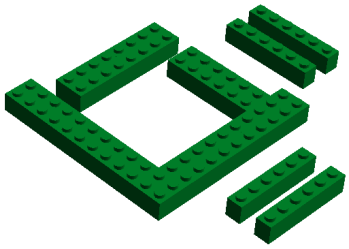	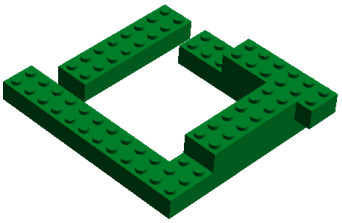
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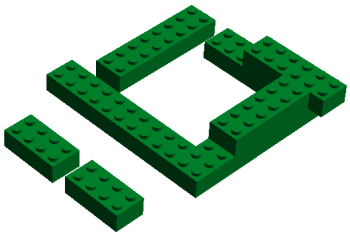	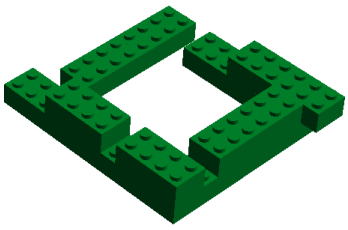	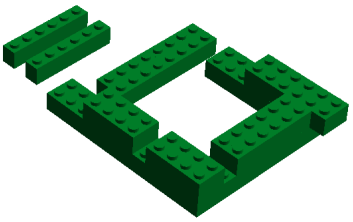
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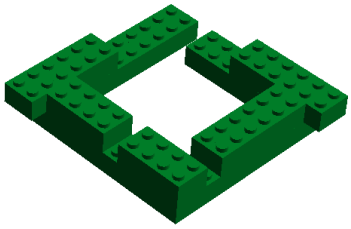	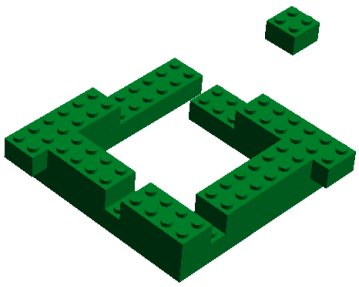	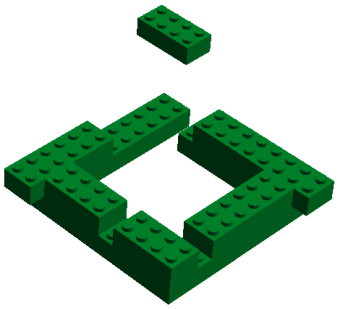
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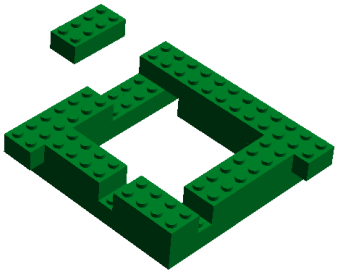	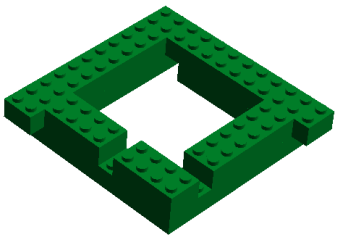	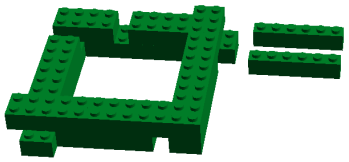
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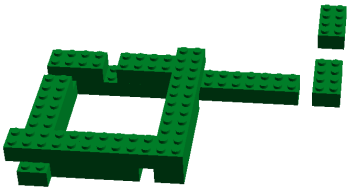	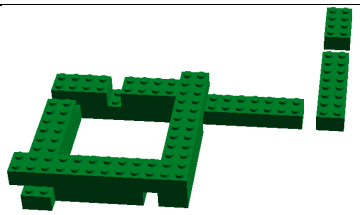	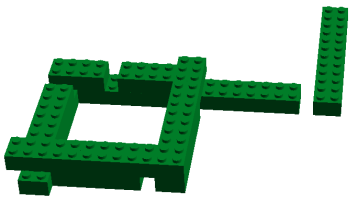
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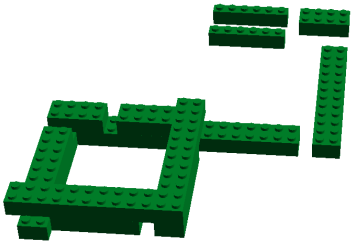	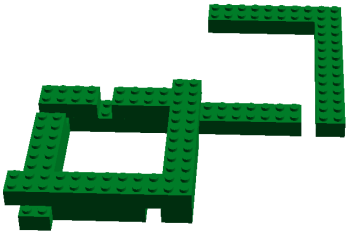	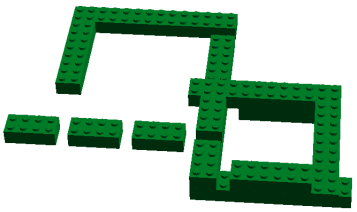
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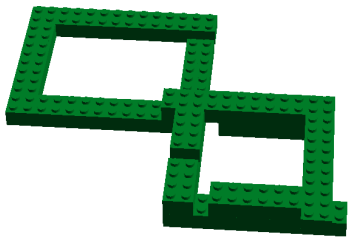	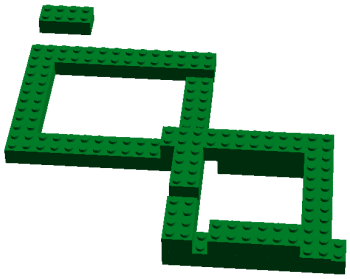	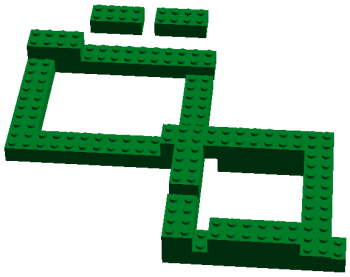
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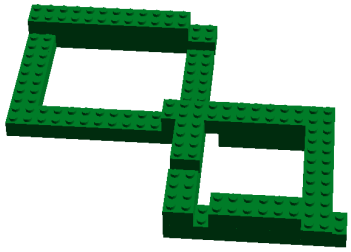	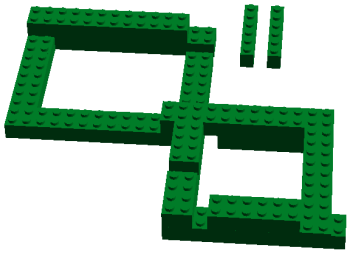	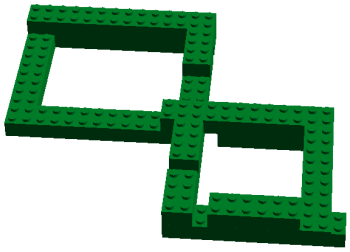
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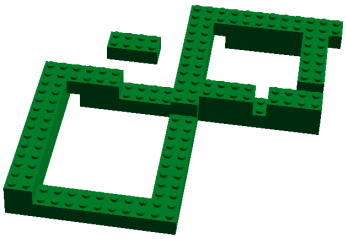	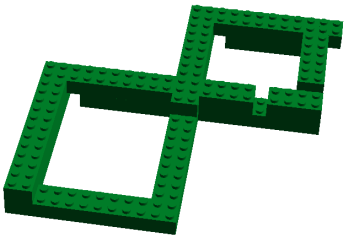	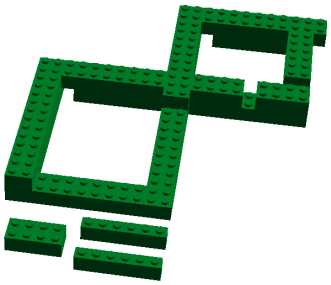
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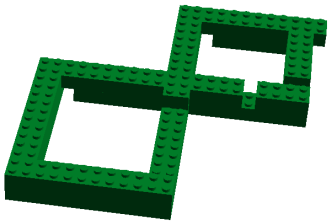	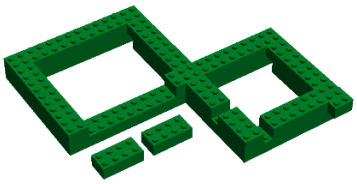	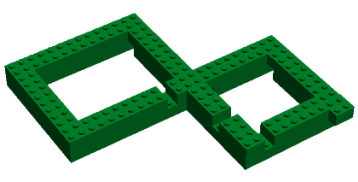
Step 31	Step 32	Step 33

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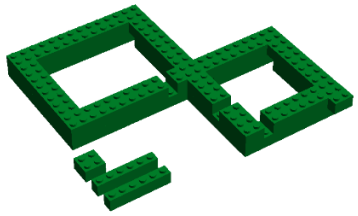
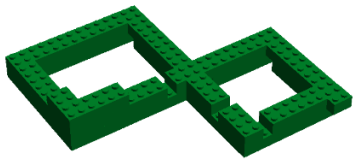
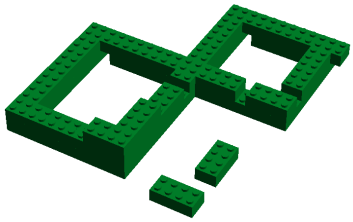
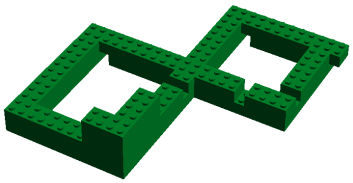
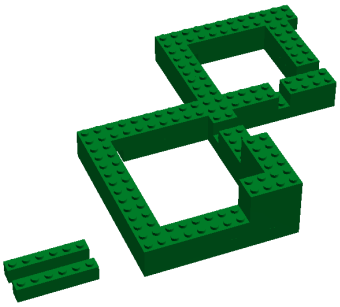
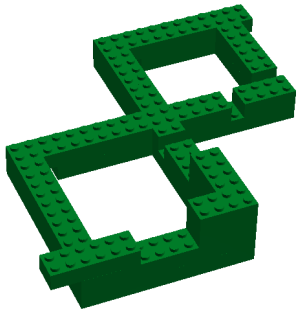
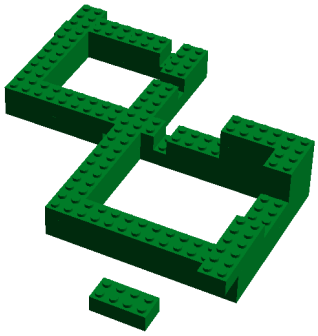
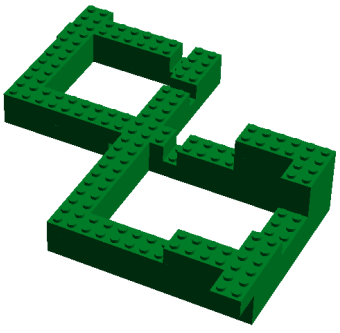
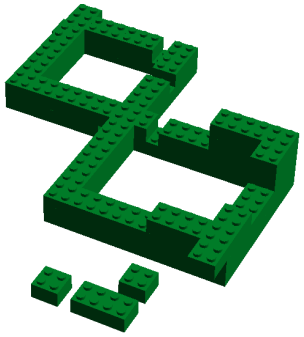
		
Step 34	Step 35	Step 36
		
Step 37	Step 38	Step 39
		
Step 40	Step 41	Step 42

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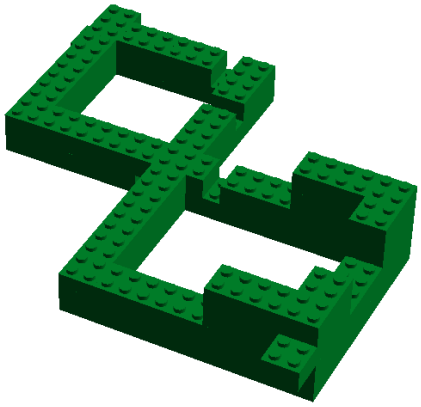
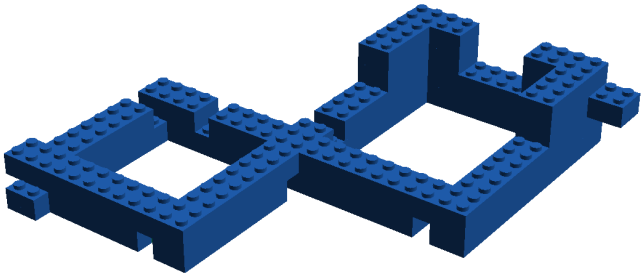
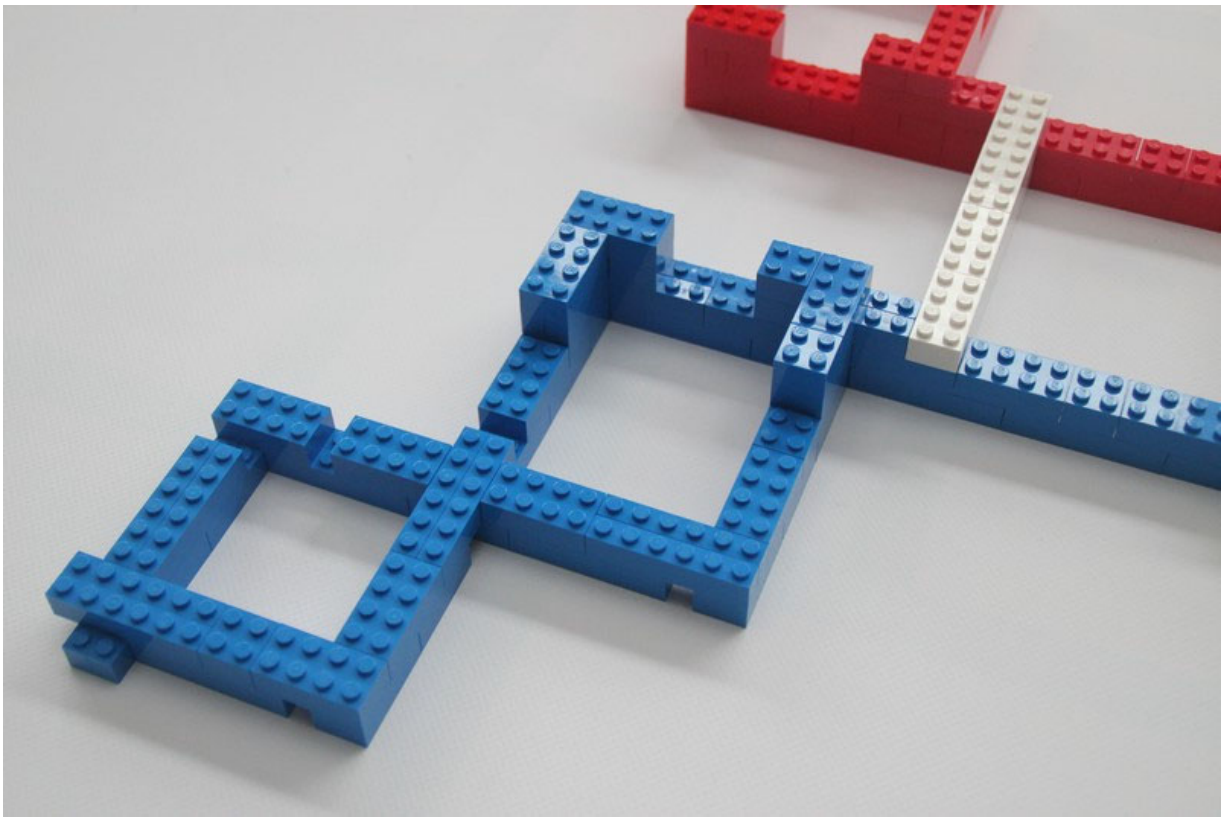
	
Step 43	The steps for building the blue storage are the same as the green storage.



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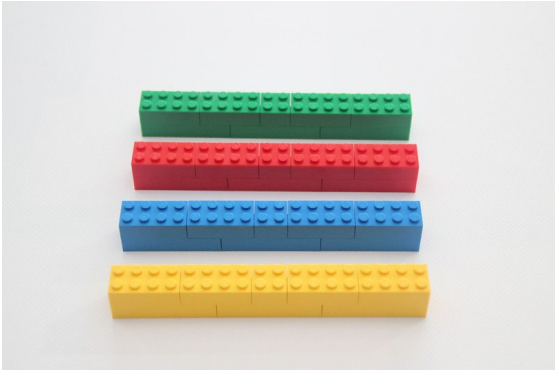
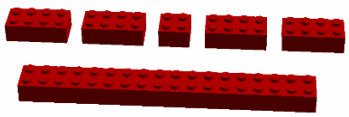
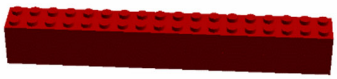
Connecting walls

Color: red, yellow, blue, green (one of each)

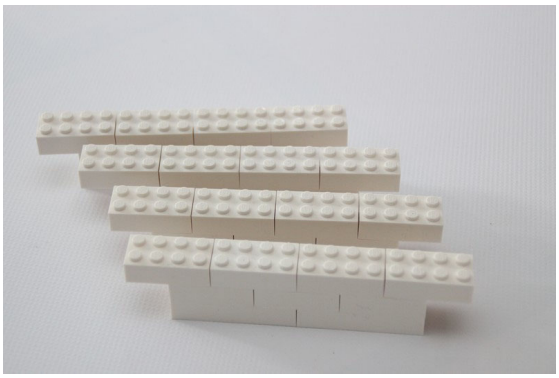


You need the following number of bricks for each wall:

- 1 2x2 bricks
- 4 2x4 bricks
- 6 1x6 bricks

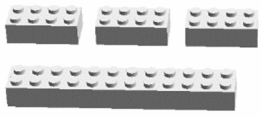
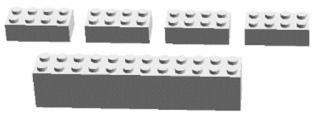
		
Step 1	Step 2	Step 3

Color: white (4 pieces)



You need the following number of bricks for one wall:

- 7 white 2x4 bricks
- 4 white 1x6 bricks

		
Step 1	Step 2	Step 3
		
Step 4	Step 5	

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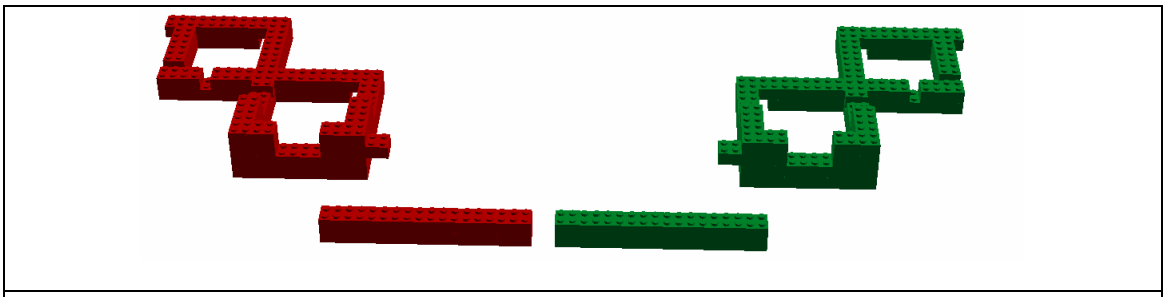
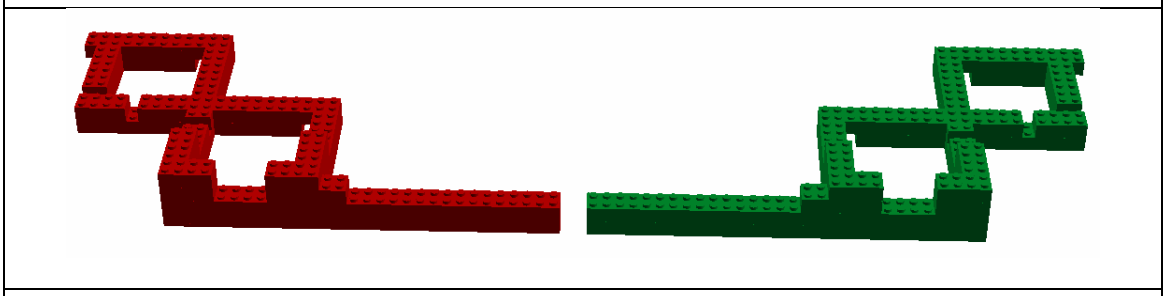
Connect the different elements for the full construction

For the connection between red / green and blue / yellow area you need:

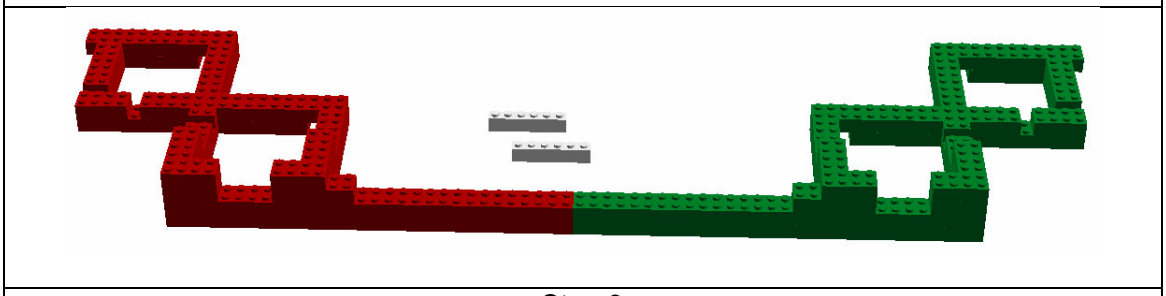
- 4 white 1x6 bricks



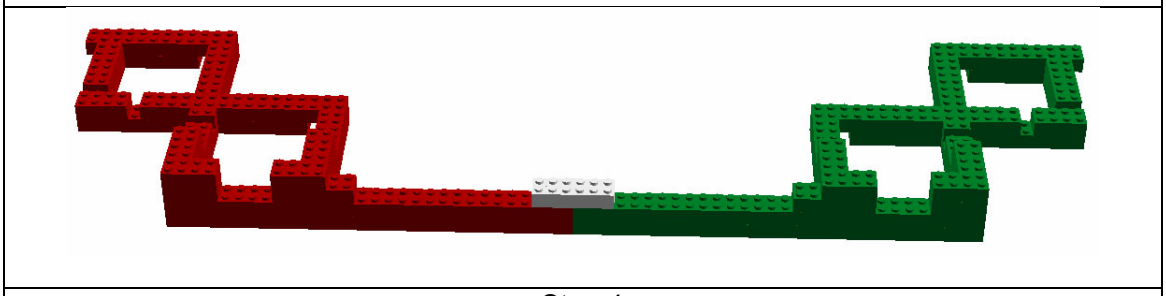
Step 1



Step 2



Step 3



Step 4

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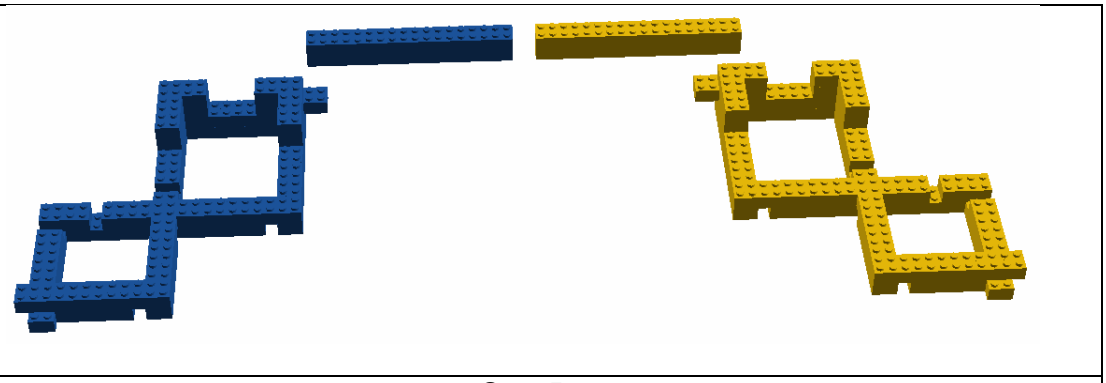
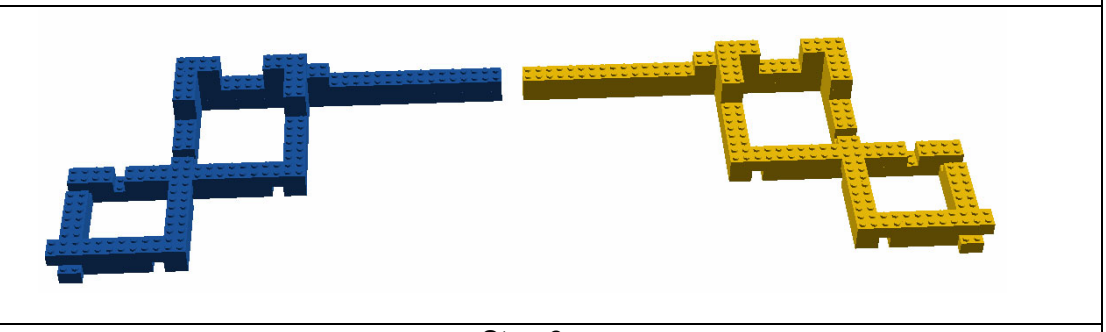


Step 5



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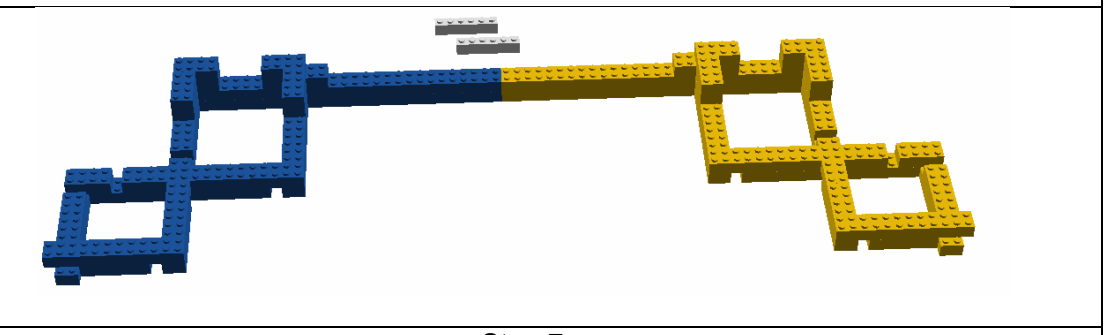
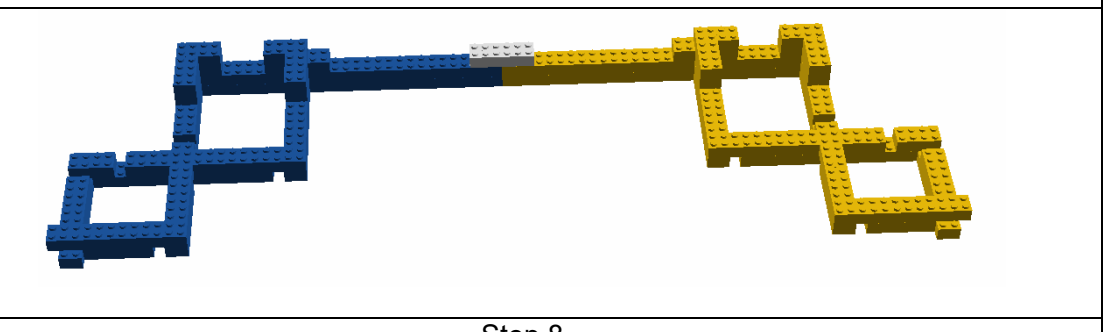


Step 7



Step 8

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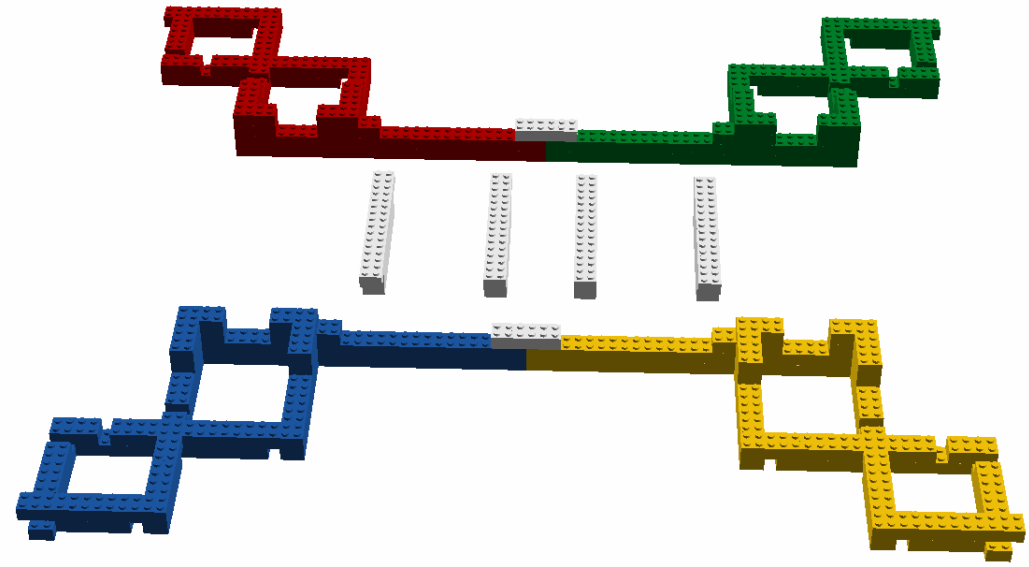
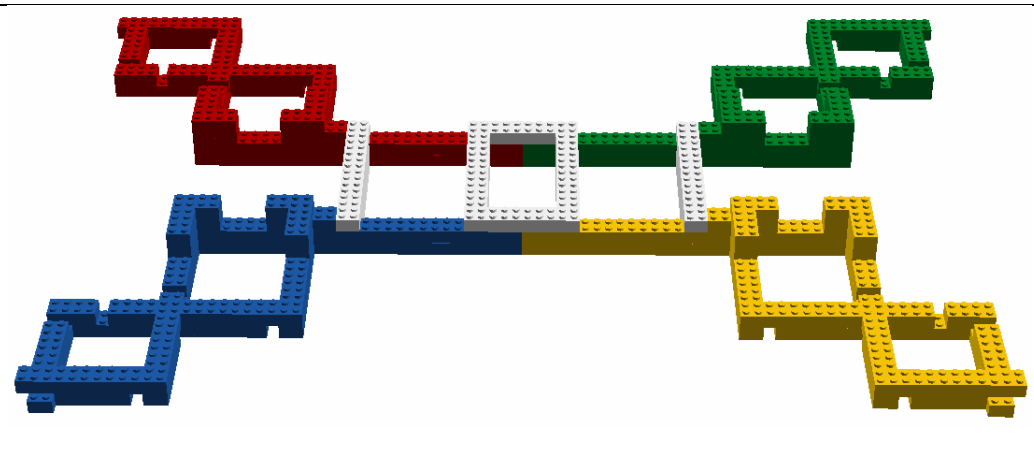


Step 9



Step 10

Congratulations, you made it! ☺

Take a look at the photos on the next page to check if you have built everything correctly.

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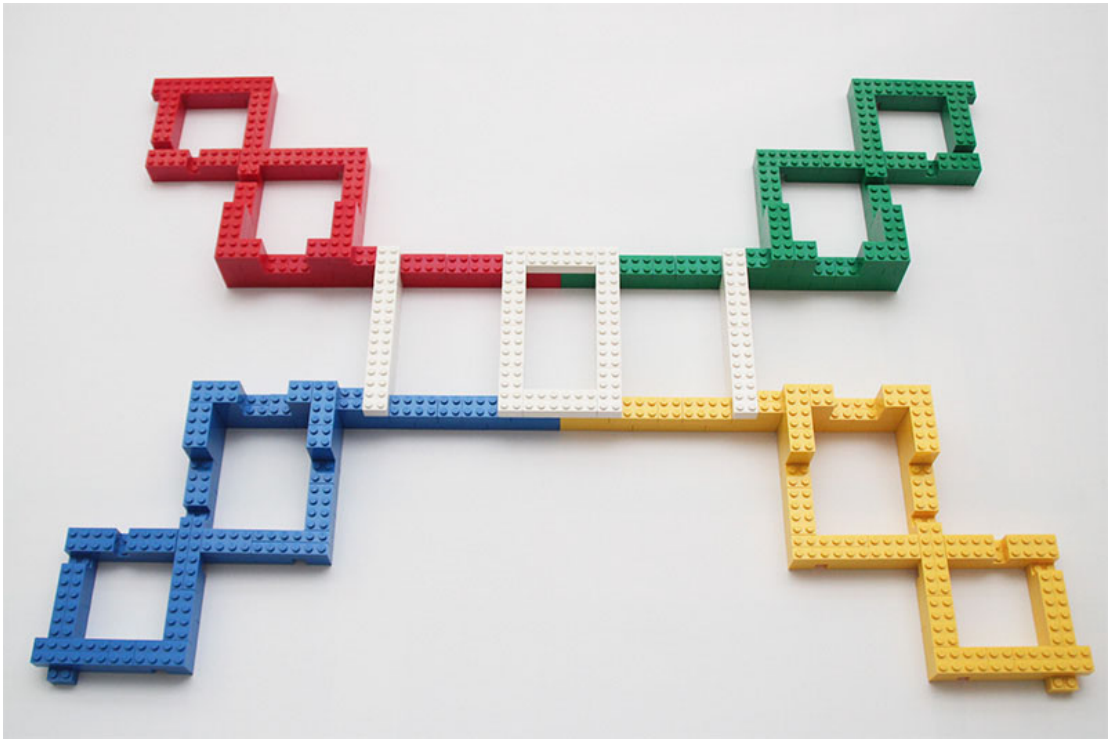

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