World Robot Olympiad 2019

Regular Category

Junior

SMART CITIES

SMART LIGHTING

Version: January 15th

WRO International Premium Partners

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1. Introduction

Engineers and developers have been working for a long time to help us live in a healthier environment with as few harmful emissions as possible and with economical energy consumption. The aim is to minimize our ecological footprint and live in comfort and safety. This has led the scientists to develop the automated operation of various systems in our buildings.

During long years of work, industries have been creating solutions for smart systems that work without human intervention. As a result of the developers' work, "smart homes" have been created to regulate the operation of various equipment and systems in a building.

In the future, smart homes will be maintained and operated by autonomous moving robots. The robots will follow pre-programmed instructions.

This year, the mission is to design a robot that can replace old light bulbs with smart lights. Your robot will take new smart lights from the storage area and bring them into different rooms (red, blue, yellow, and green areas) in the building. In addition, the robot will find old light bulbs and bring them to the trash area. This way, the robot can modernize the lighting system in the building and help save energy.

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2. Game Field

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

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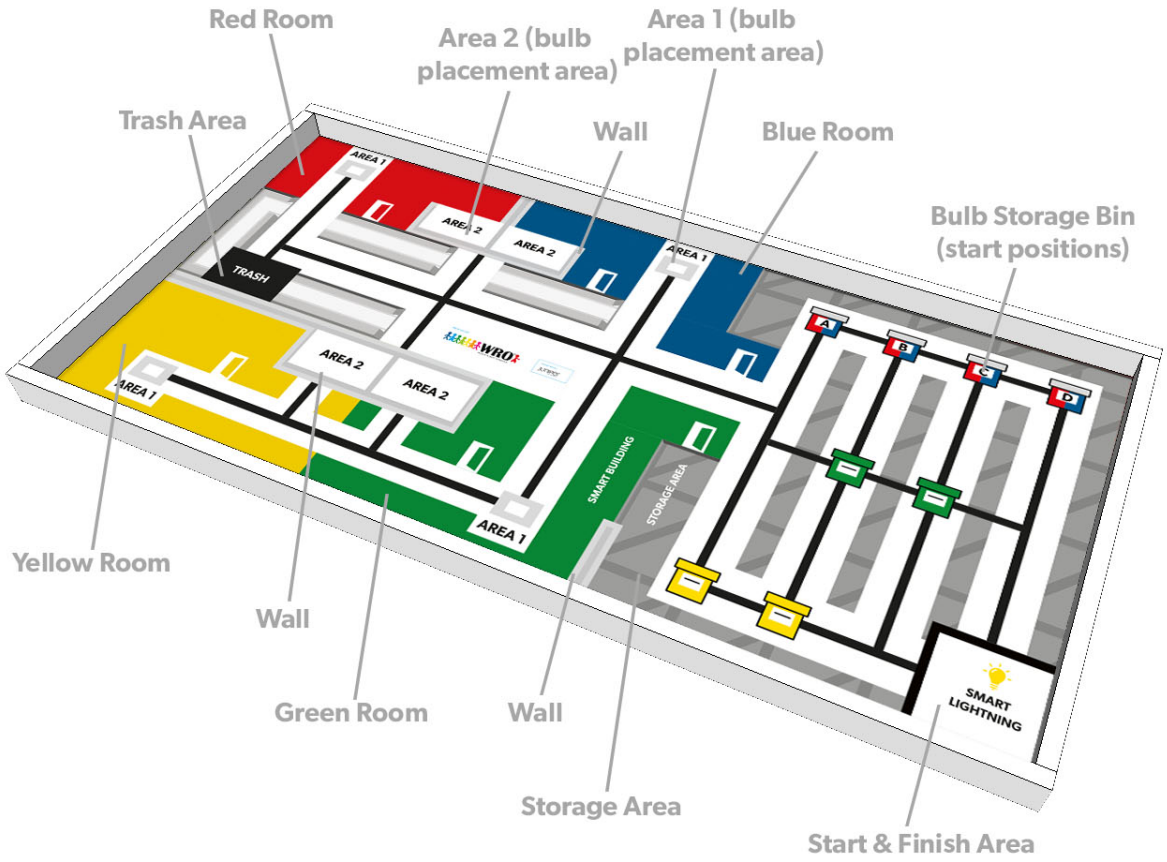

If the table is larger than the game mat, use the Start & Finish Area as a guide and place the Start & Finish Area at the edge of the wall to set up the game mat.

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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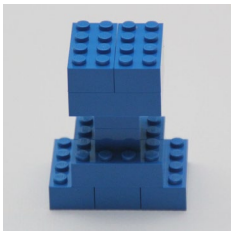
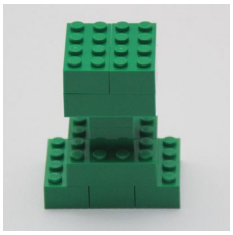
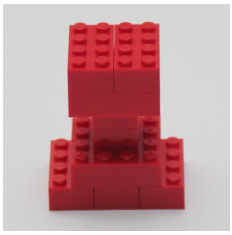
3. Game Objects

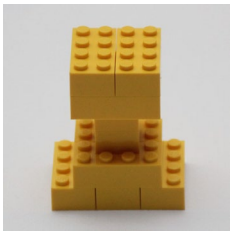
There are **10 bulbs: 2 old black bulbs and 8 new smart lights in blue, green, red, and yellow.**
Note: Not all bulbs are used in one run. Please take a look at the next chapter for more information.

2x Old bulb (black)

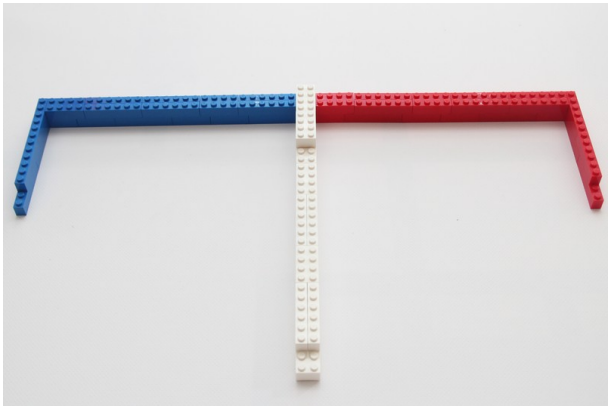

2x Smart bulb (blue)

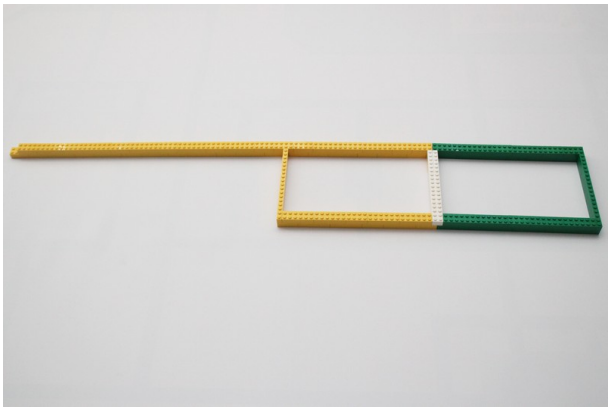

2x Smart bulb (green)

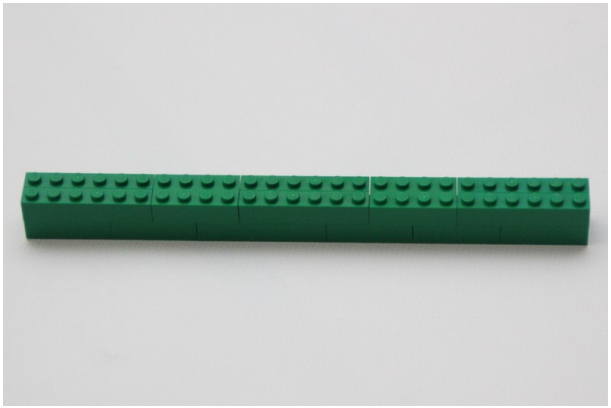

2x Smart bulb (red)


2x Smart bulb (yellow)

There are 3 walls on the field. Movement or destruction of walls is not allowed.


Wall between the red and blue area


Wall between the yellow and green area


Wall on the right side of the green area

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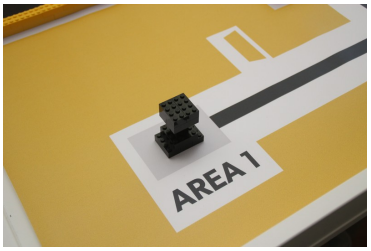
4. Positioning of Game Objects / Randomization

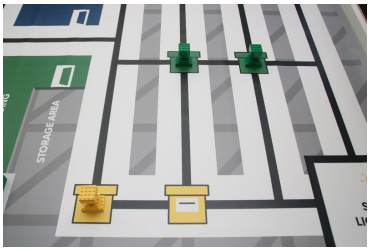
Positioning of the bulbs

The positions of the bulbs are randomized at the start of each round. The randomization is done in the following steps.

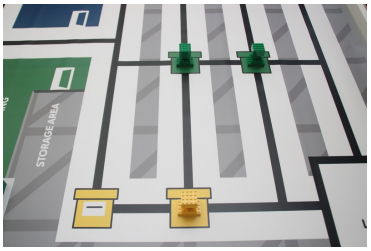
1. **Position of the black bulb in the green or yellow area:**
   Put the two yellow and two green bulbs into a bag and draw one object. The black bulb will be placed into the AREA 1 of the room that you have drawn (e.g. if you draw a yellow bulb, then the black bulb will be placed in AREA 1 in the yellow room). The other three bulbs (the bulbs that have not been drawn) will be **randomly placed** (e.g. by flipping a coin) on the yellow and green bulb storage bins.



Black bulb in AREA 1 (grey rectangle) in **yellow room**

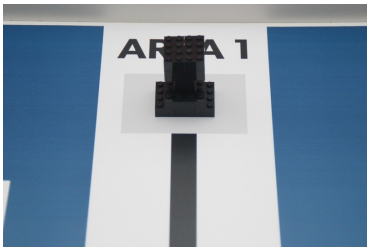


Example 1: Randomly placed yellow and green bulbs

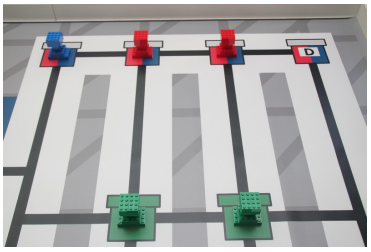


Example 2: Randomly placed yellow and green bulbs

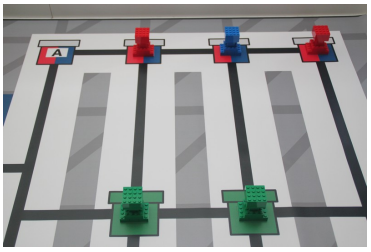
2. **Position of the black bulb in the red or blue area:**
   Put the two blue and two red bulbs into a bag and draw one object. The black bulb will be placed in the AREA 1 of the room color that you have drawn (e.g. if you draw a blue bulb, then the black bulb will be placed in AREA 1 in the blue room). The other three bulbs (the bulbs that have not been drawn) will be **randomly placed** (e.g. by drawing cards A to D from a bag) on the red/blue bulb storage bins.



Black bulb in AREA 1 (grey rectangle) in **blue room**



Example 1: Randomly placed red and blue bulbs



Example 2: Randomly placed red and blue bulbs

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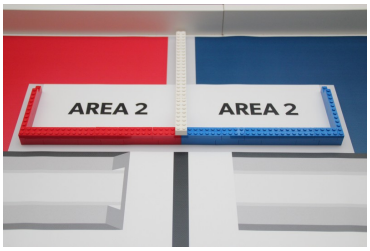
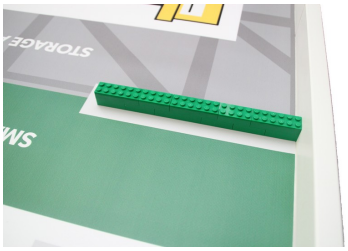
At the end of positioning, the two black bulbs are placed in 2 different rooms, and in the storage area there are 6 bulbs, one empty position in the blue or red room and one empty position in the green or yellow room. An example could look like (1. Draw: Yellow, 2. Draw: Blue):

Positioning of walls

The walls are placed on the dark grey areas that match exactly the size of each wall. One wall sits between the red and blue areas, one between the green and yellow areas, and one on the right side of the green area.





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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: Collect the black bulbs in the Trash Area

The robot should collect the black bulbs and take these bulbs to the Trash Area.

5.2 Mission: Deliver the smart lights to the different rooms

The robot should take the smart lights to the different rooms:

- Yellow bulb into yellow room
- Green bulb into green room
- Blue bulb into blue room
- Red bulb into red room

Smart lights need to be taken to AREA 1 (light grey rectangles) and AREA 2 (white rectangles) in the different rooms. **Only one smart light per area counts.**

Example: If there are two green smart lights on the field, you need to bring one to AREA 1 and one to AREA 2. If you bring both to AREA 2, you will only get the points for one smart light. If there is a black old bulb in AREA 1, you will need to remove that to the Trash Area in order to place a new green smart light in AREA 1.

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 complete when the robot returns to the Start & Finish area, stops, and the chassis of the robot is entirely (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 areas. If a wall is damaged or moved **outside its 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

- **"Standing"** means that the game object is still in upright position (like the initial position). **"Not Standing"** means any other position.
- **"Completely"** means that the game object is only touching the corresponding area (not including the black lines). "**Partly"** means that the game object is at least touching the area with one part.
- **Please remember:** Only one smart light per area counts.

Tasks	Each	Total
Red / **Yellow** / **Blue** / **Green** smart bulb: • **Standing** in the **correct** colored room • **Completely** in AREA 1 or AREA 2	**25**	**150**
Red / **Yellow** / **Blue** / **Green** smart bulb: • **Not Standing** but in the **correct** colored room • **Completely** in AREA 1 or AREA 2	15	90
Red / **Yellow** / **Blue** / **Green** smart bulb: • **Standing** in the **correct** colored room • **Partly** in AREA 1 or AREA 2	10	60
Red / **Yellow** / **Blue** / **Green** smart bulb: • **Not Standing** but in the **correct** colored room • **Partly** in AREA 1 or AREA 2	5	30
Black (old) bulb: • **Standing** inside the Trash Area • **Completely** in the Trash Area	**20**	**40**
Black (old) bulb: • **Not Standing** inside the Trash Area • **Completely** in the Trash Area	10	20
Black (old) bulb: • **Not Standing or Standing** in inside the Trash Area • **Partly** in the Trash Area	5	10
Robot completely stops within the Start & Finish Area. *(only if other points are assigned)*		**10**
Robot damages or displaces a wall from its initial position.	-15	-45
Maximum Score		**200**

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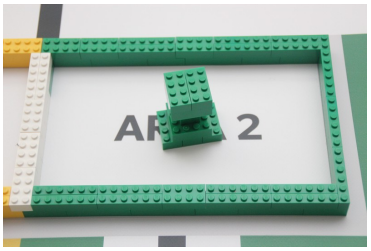
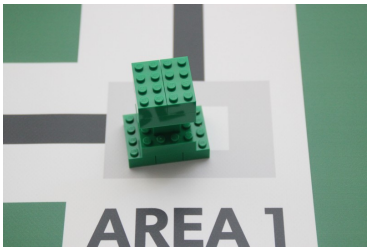
Scoring Interpretation

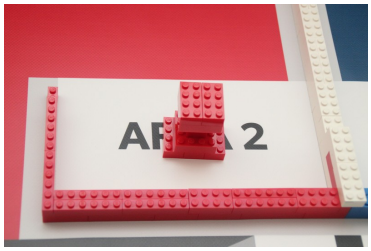
Standing in the **correct colored room**, **completely** in AREA 1 or AREA 2 ➔ 25 points



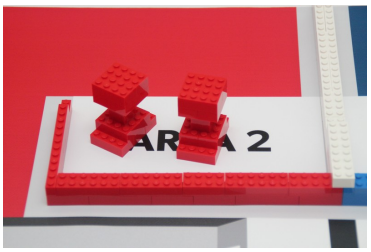
AREA 2 is defined by the white rectangle.



AREA 1 is defined by the light grey rectangle.

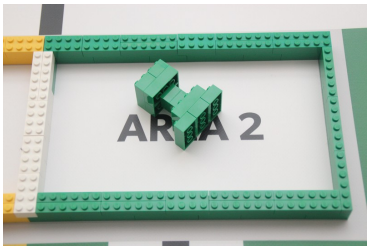


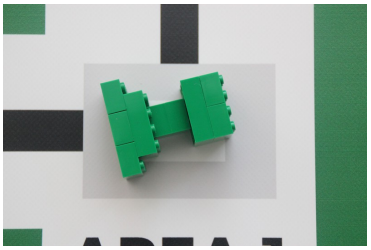
AREA 2 is defined by the white rectangle.

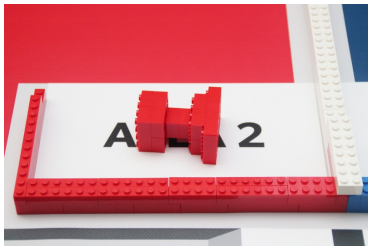


Always remember:
Only one bulb per area counts!

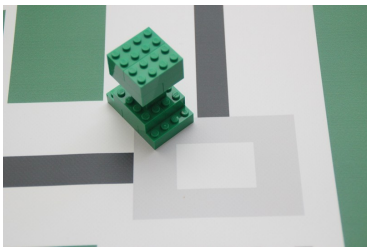
Not Standing in the **correct colored room**, **completely** in AREA 1 or AREA 2 ➔ 15 points







Standing in the **correct colored room**, **partly** in AREA 1 or AREA 2 ➔ 10 points



Partly touching AREA 1 (light grey rectangle)

Partly touching AREA 2 (white area)

Yellow wall has been moved, yellow bulb partly in AREA 2 (white area)

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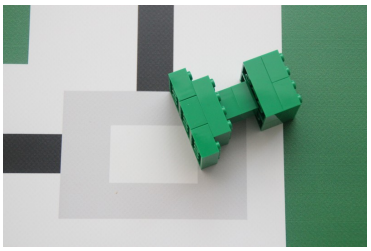
Not standing in the **correct colored room**, **partly** in AREA 1 or AREA 2 ➔ 5 points

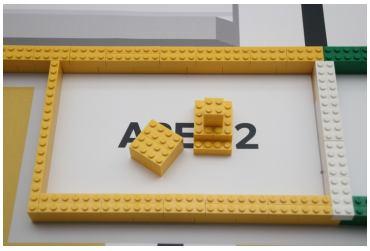
Not standing, only partly (lying on the wall) in the area



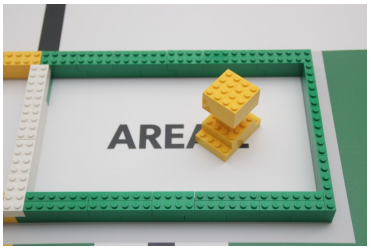
Partly in the light grey rectangle area

The red bulb is not standing and only partly (top-view) inside the AREA 2

No (ZERO) points for every other situation like:

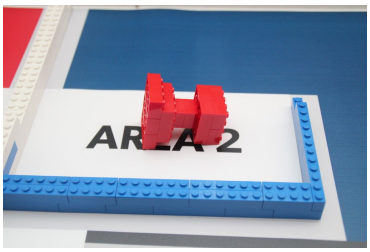


Damaged bulb

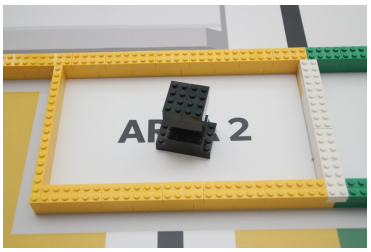


Bulb in wrong room

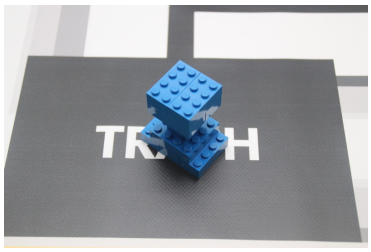
Not inside the area



Bulb in wrong room



No points for black bulbs in colored rooms



No points for colored bulbs in trash area

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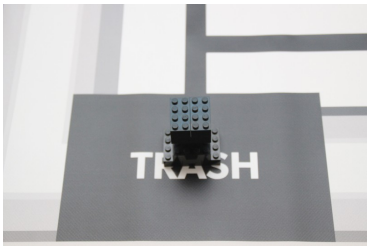
Black (old) bulb **standing inside the Trash Area, completely** inside ➔ 20 points



Black (old) bulb **not standing but inside the Trash Area, completely** inside ➔ 10 points

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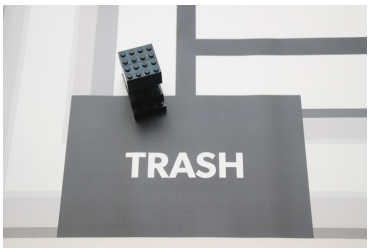
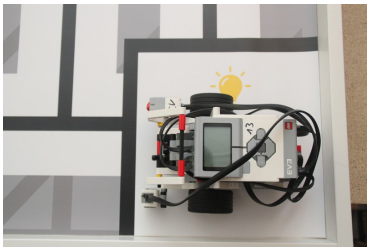
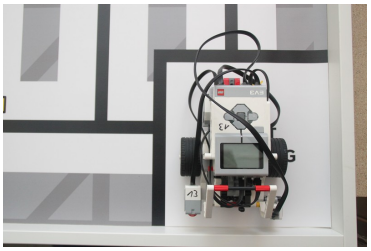
Black (old) bulb **standing or not standing <u>partly</u> inside the Trash Area** ➔ 5 points



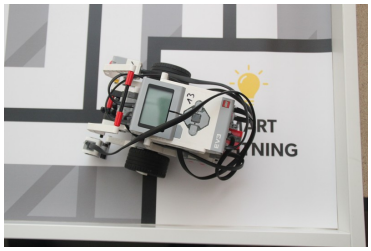
Robot completely stops within the Start & Finish Area. ➔ 10 points
(only if other points are assigned)



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



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



<u>No points</u> if the projection of the robot is not in the start/finish area.

Robot damages or displaces a wall from its initial position ➔ **-15 points (per wall)**

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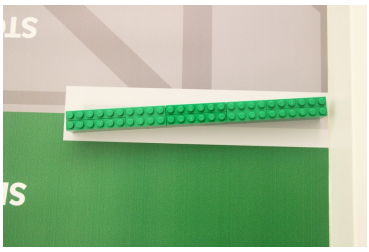
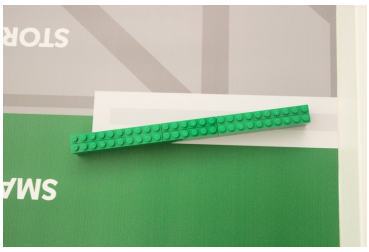


It is OK if the wall is moved inside the light grey area.



Penalty points if the wall is outside the grey area.

Penalty points if the wall is outside the grey area.

Penalty points if the wall is damaged.

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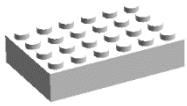
7. Assembly of Game Objects

Assembly of the bulbs / smart lights

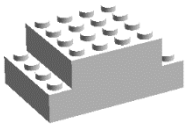
There are 2 black (old) bulbs and 8 smart lights: 2 red ones, 2 yellow ones, 2 green ones, and 2 blue ones.

For one bulb / smart light you need the following bricks:

- 9 2x4 bricks
- 2 2x2 bricks



Step 1



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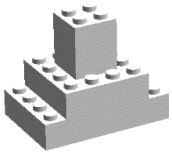

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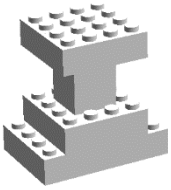

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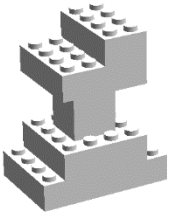

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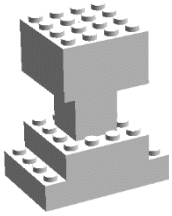

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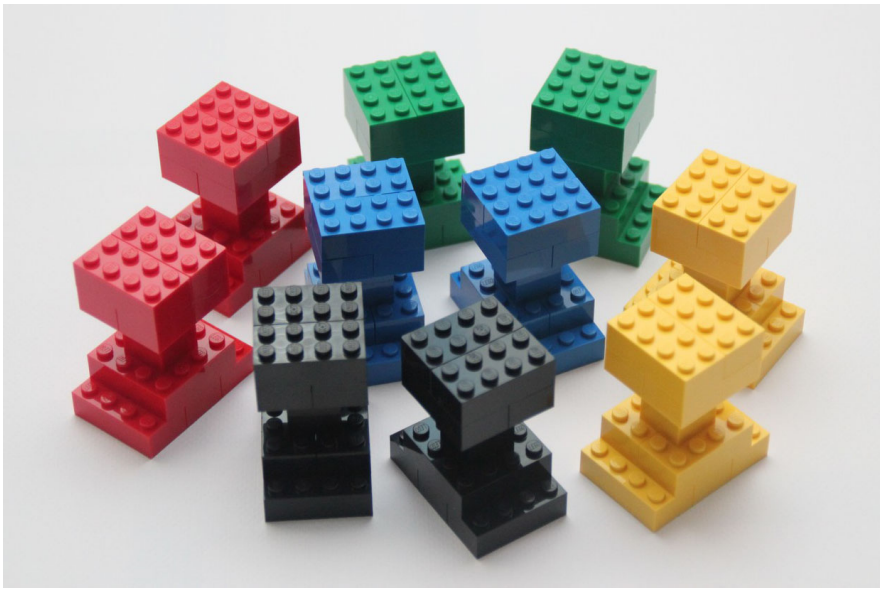

Assembly of the walls

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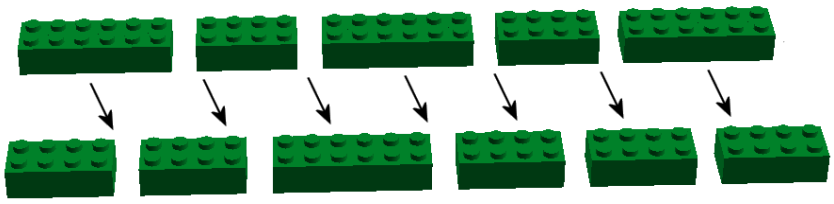
There are 3 walls on the field.

1) Wall at the right side of the green area

For this wall you need the following green bricks:

- 7 green 2x4 bricks
- 8 green 1x6 bricks



step 1

step 2

2) Wall between the blue and red areas

For this wall you need the following bricks:

Red Part:

- 6 red 2x4 bricks
- 14 red 1x6 bricks

Blue Part:

- 6 blue 2x4 bricks
- 14 blue 1x6 bricks

White Connection

- 8 white 2x4 bricks
- 10 white 1x6 bricks
- 1 red 1x6 brick
- 1 blue 1x6 brick

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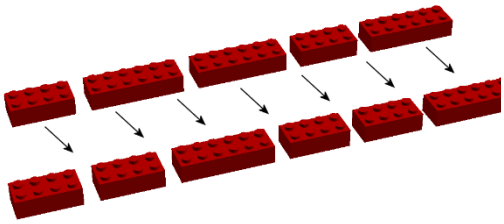

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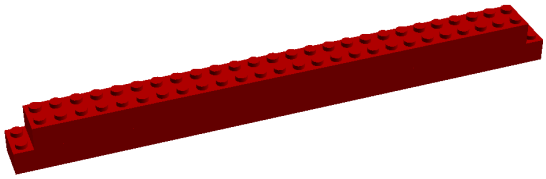

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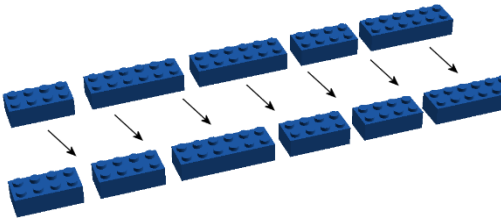

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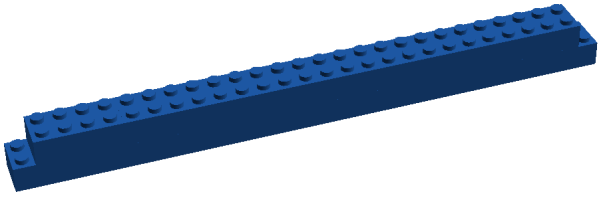
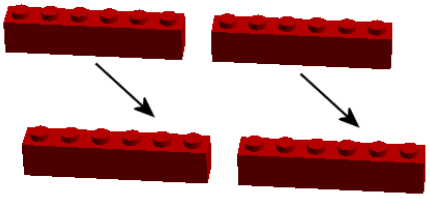


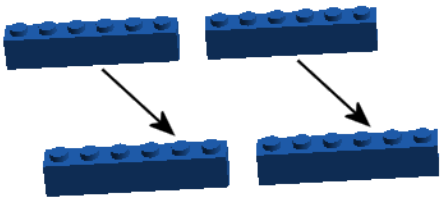
step 4

step 5



step 6

step 7



step 8

step 9

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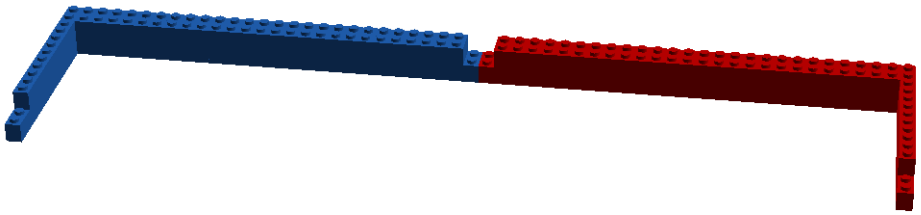

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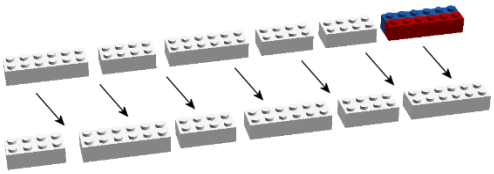

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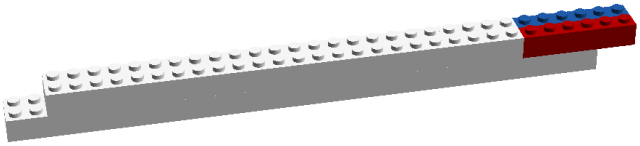

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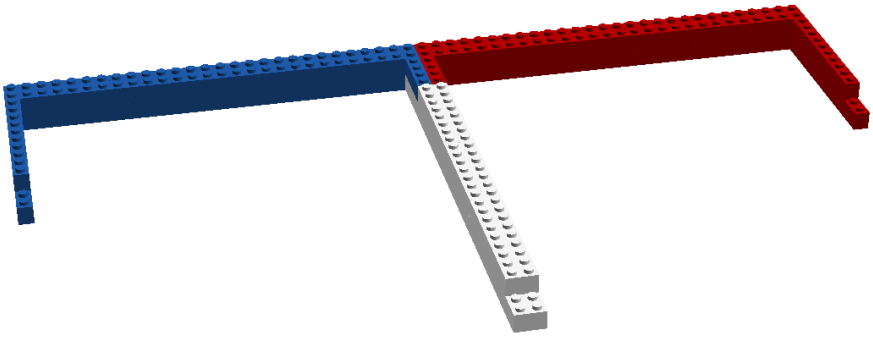

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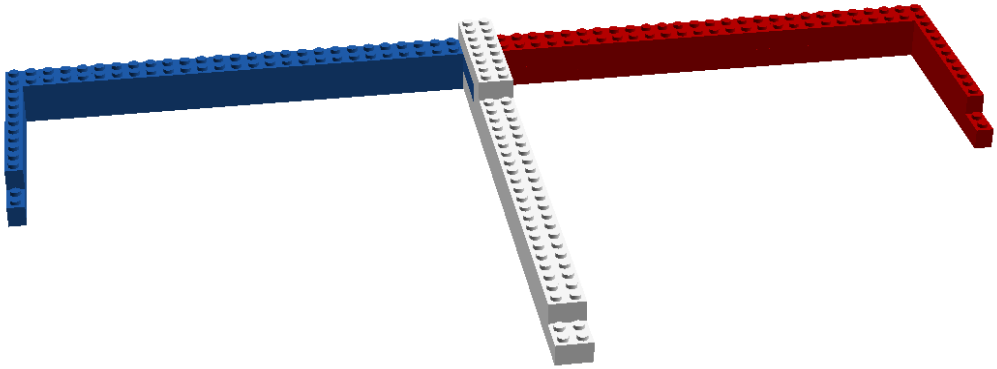

step 14

3) Wall between yellow and green area:

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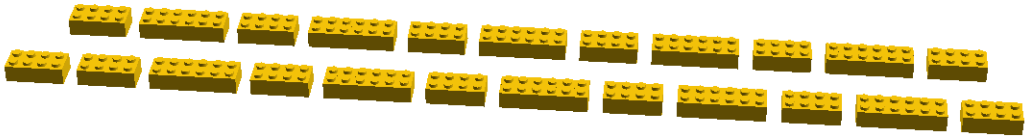
For this wall you need the following bricks:

Long yellow part:
- 13 yellow 2x4 bricks
- 20 yellow 1x6 bricks

White connection between green and yellow rectangle:
- 6 white 2x4 bricks
- 2 white 1x6 bricks

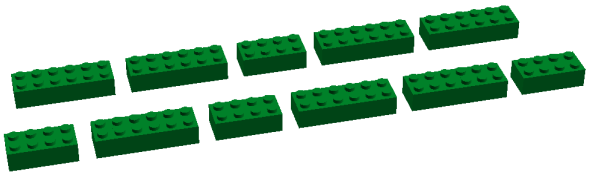
Green rectangle:
- 11 green 2x4 bricks
- 31 green 1x6 bricks

Yellow rectangle:
- 13 yellow 2x4 bricks
- 29 yellow 1x6 bricks



step 1

step 2



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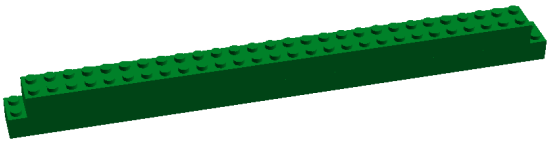

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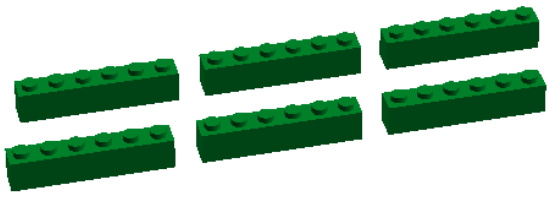

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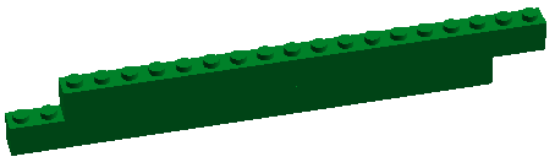

step 6

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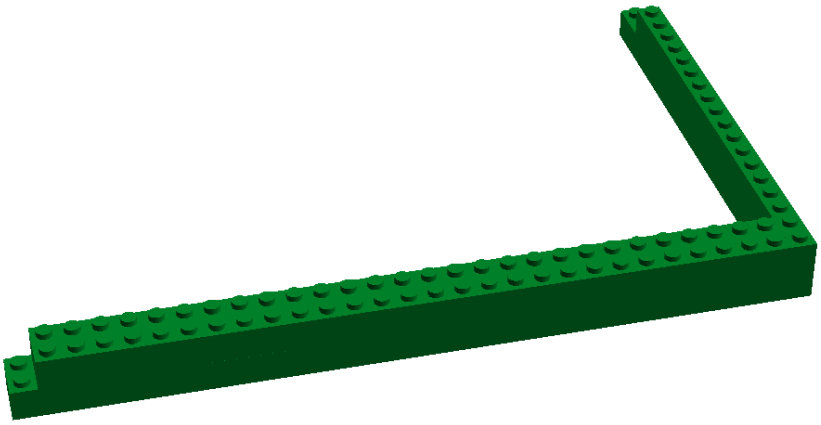

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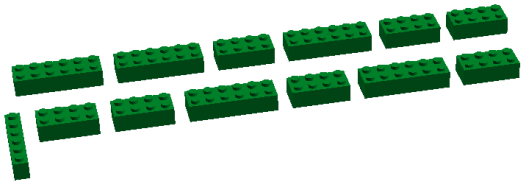

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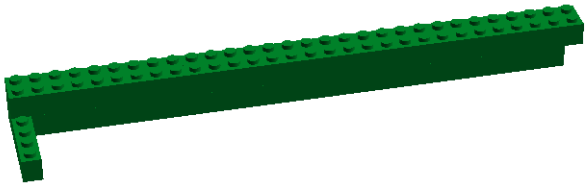

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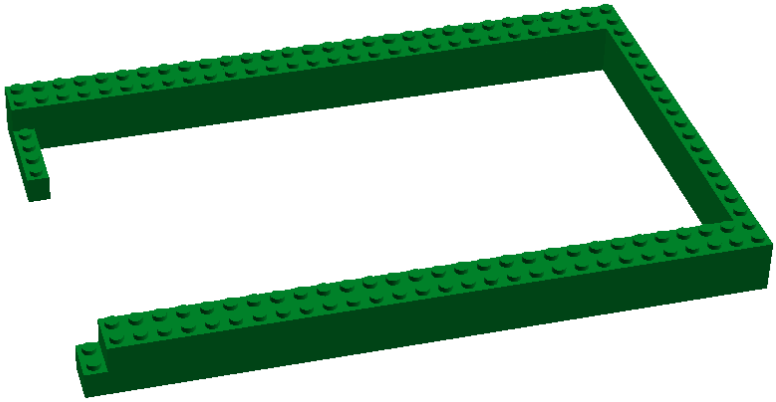

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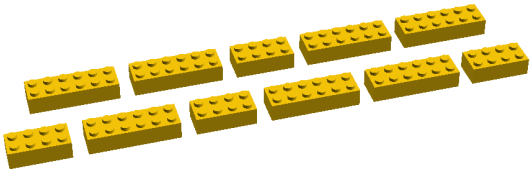

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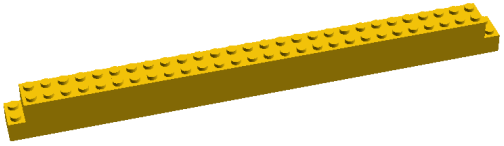

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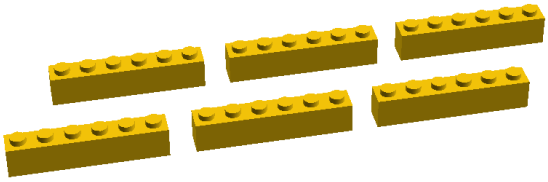

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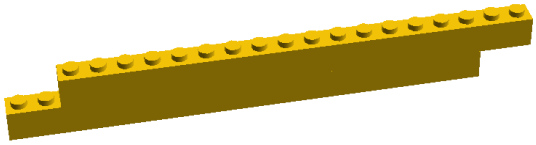

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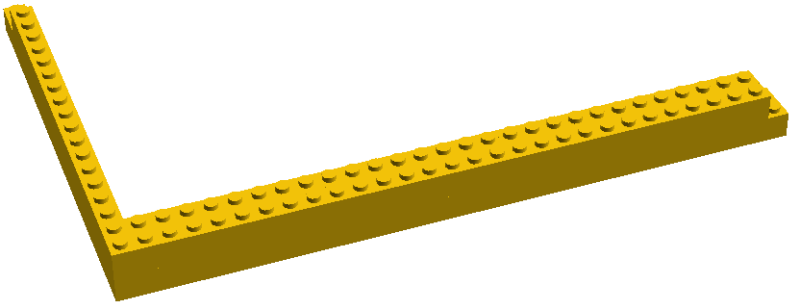

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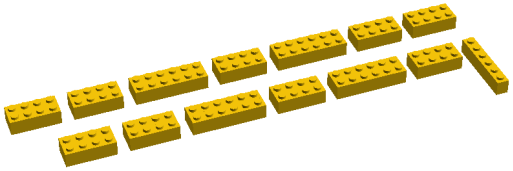

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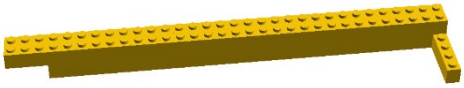

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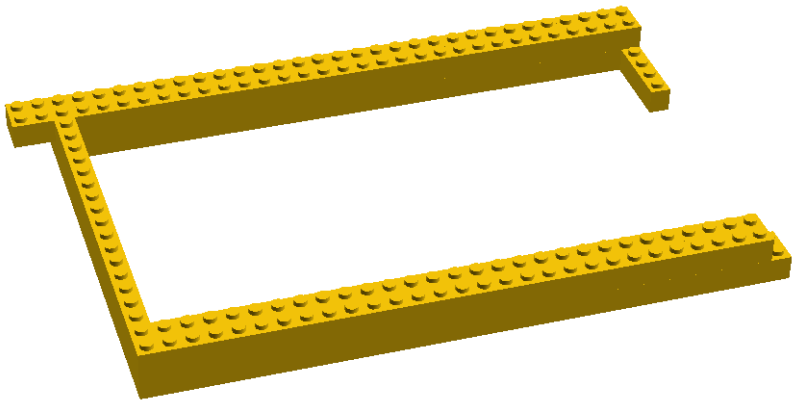

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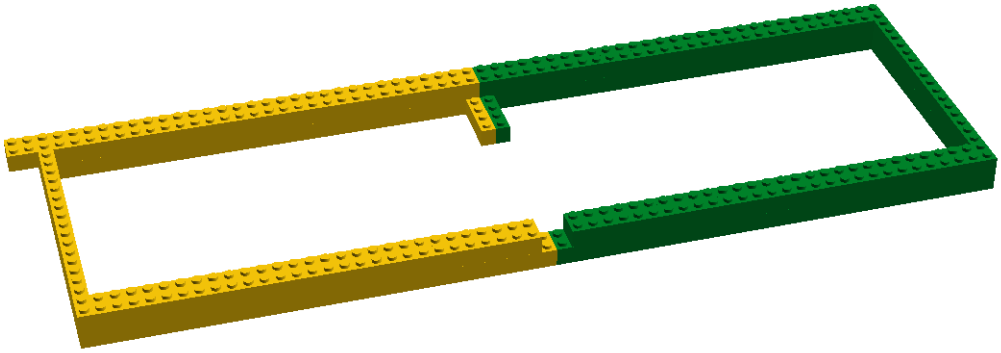

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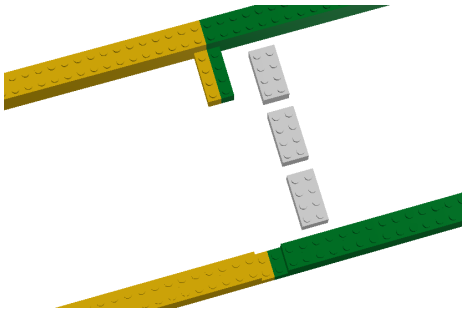

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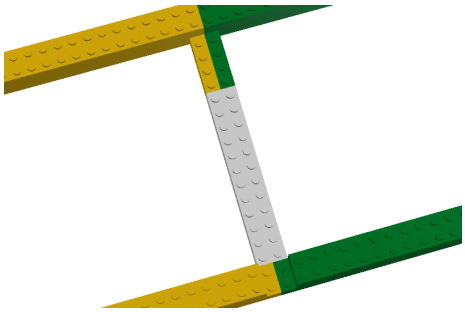

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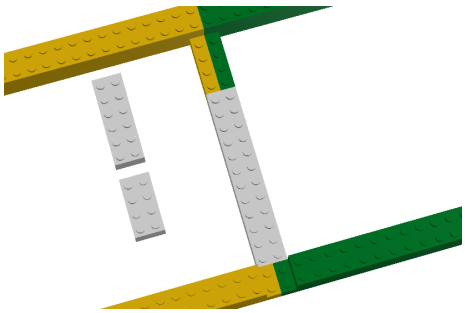

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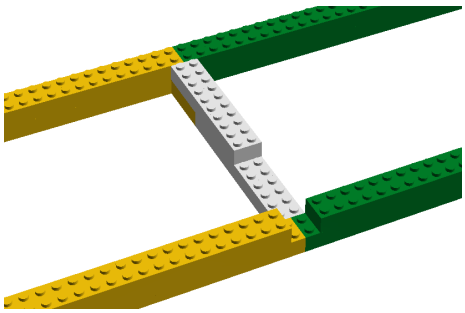

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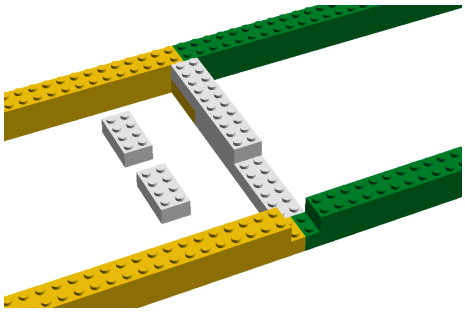

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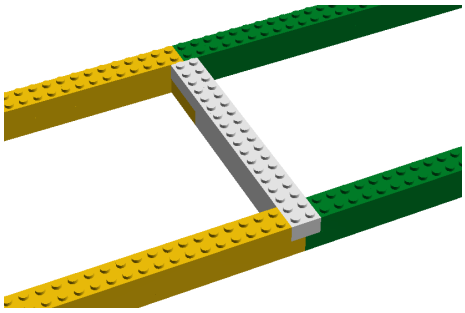

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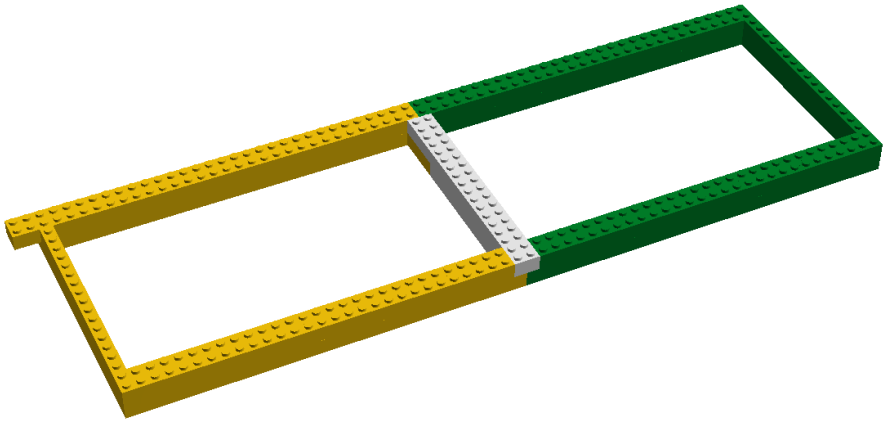

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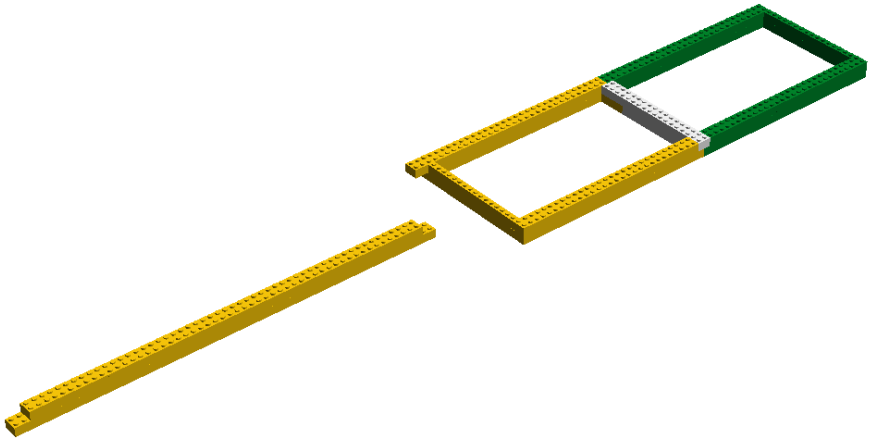

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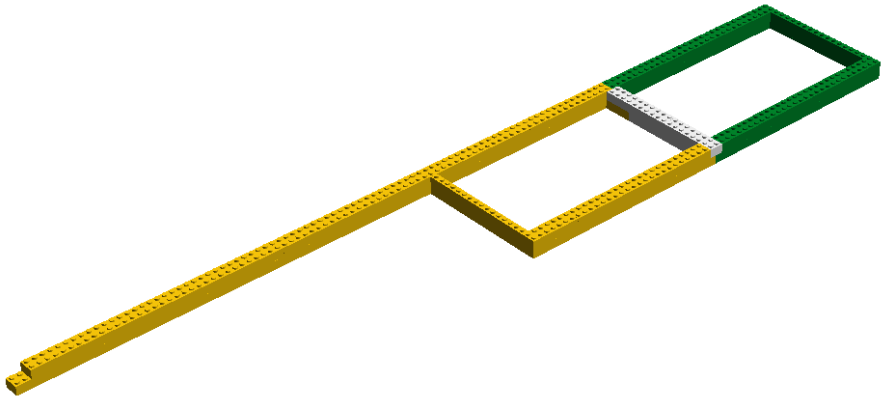

step 28

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