Inhalt

Preface

Mindstorms Robot Inventor Set 51515 continues the successful history of the Mindstorms series. The new generation is compatible with the electronic components of Boost 17101, Spike Prime and Powered-Up.

As the decisive difference to Boost and Powered-Up, Mindstorms is not generally “remote controlled” by a PC or Handeheld but the programs can run independently on the Hub. Unfortunately, the official set only comes with models that are remote controlled. Whereas the Egg Inventor can be used independently from a PC, as soon as the program is uploaded to the hub.

The Document has three segments:

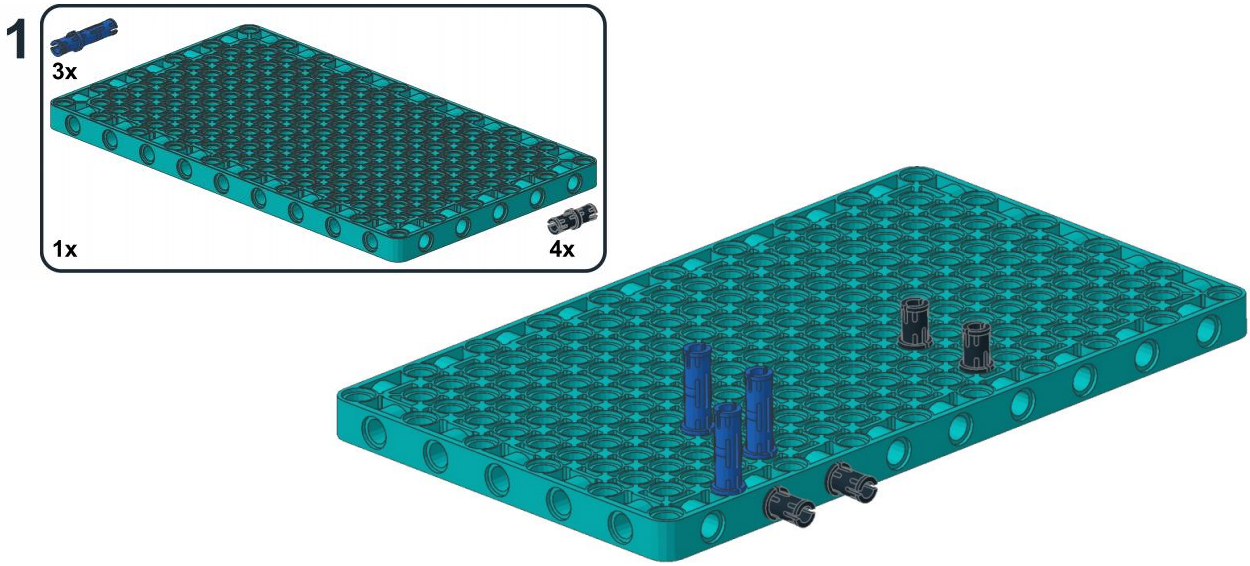
- BUILD – Build instructions for the Egg-Inventor
- CODE – Programming the Hub
- Play - Operate and customize

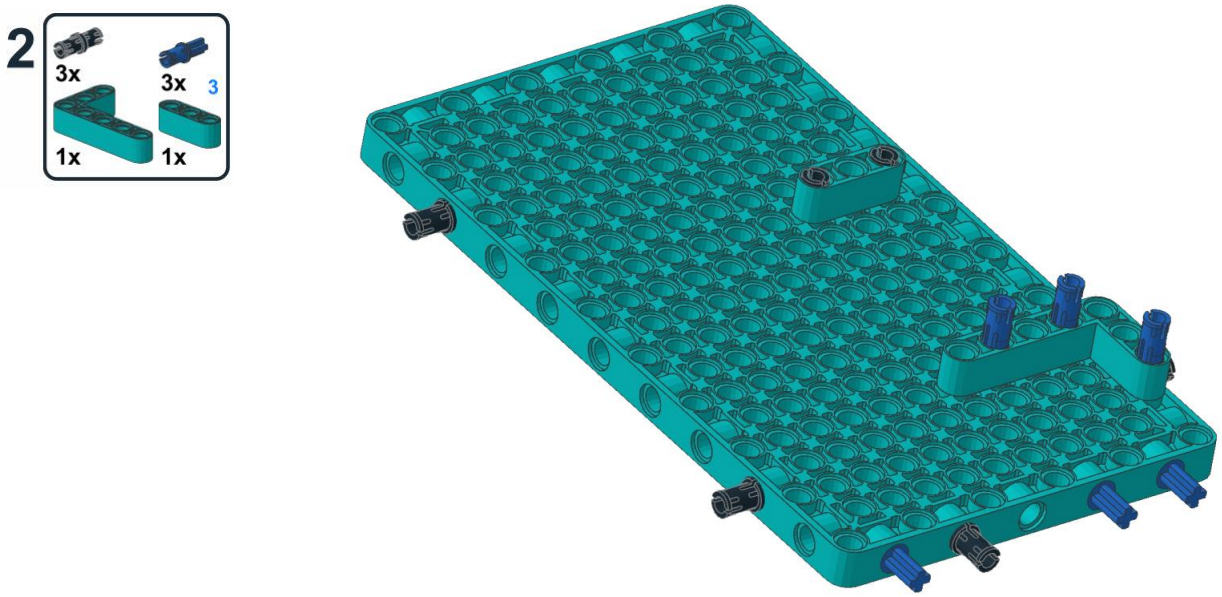
Egg-Inventor – Draw and Write

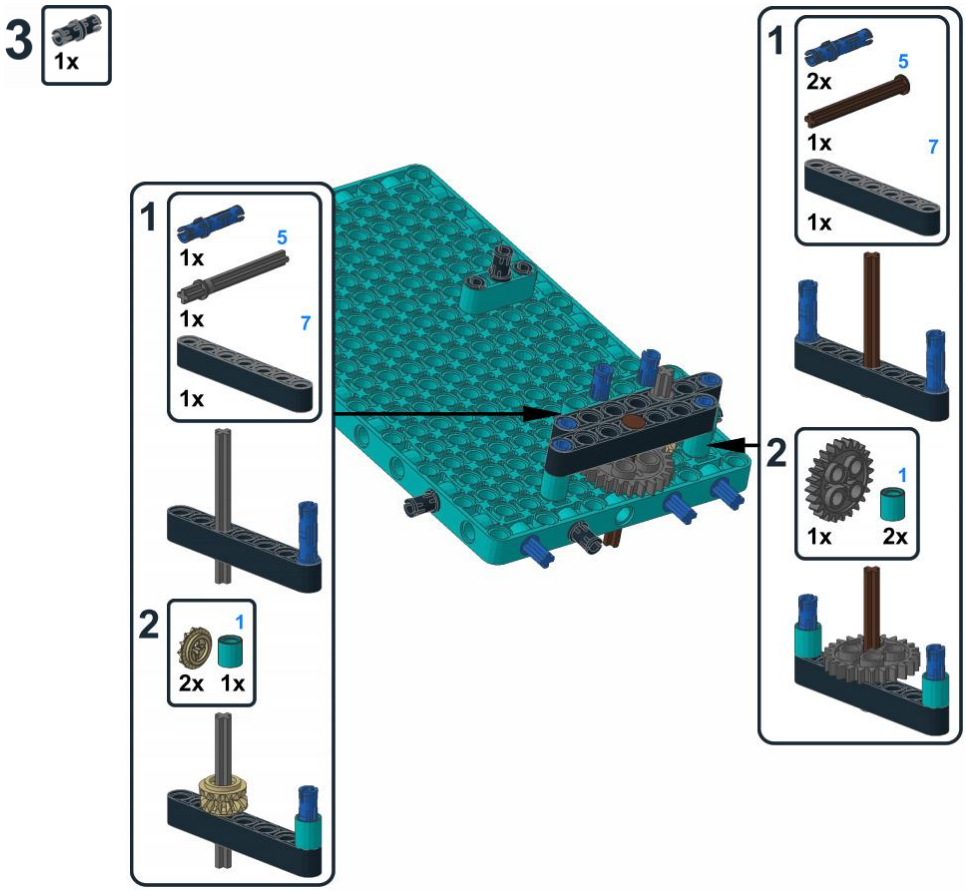
The Egg-Inventor can use marker pens to draw or write on chicken eggs. Using household rubber bands, you can attach up to three pens to the pen holder. The pens should be firmly attached to the pen holder to enable exact positioning of the pen tip. The white rubber bands contained in the original set are used for the lever at the distance sensor and to pull back the pen sled.

Building Instructions

The Egg-Inventor can be built with the standard content of the Mindstorms Robot Inventor set 51515 alone. Apart from pens, rubber bands and a PC, no additional components are needed.



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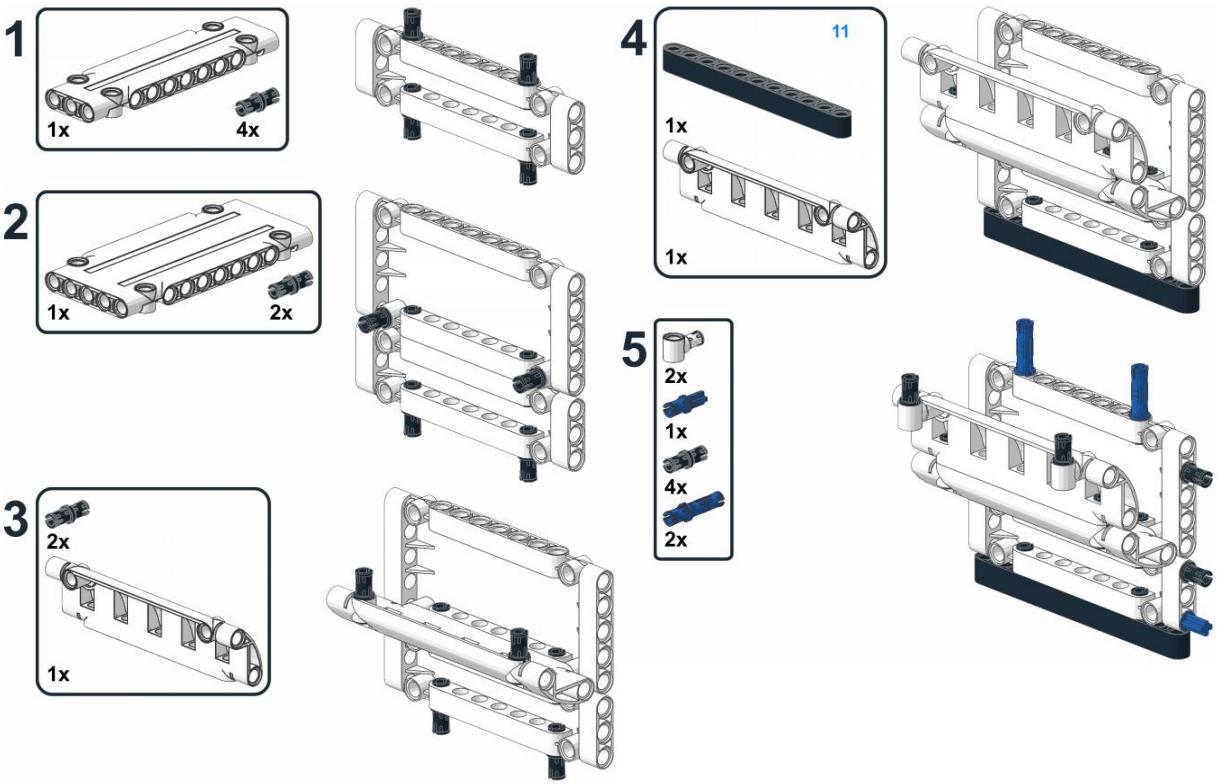
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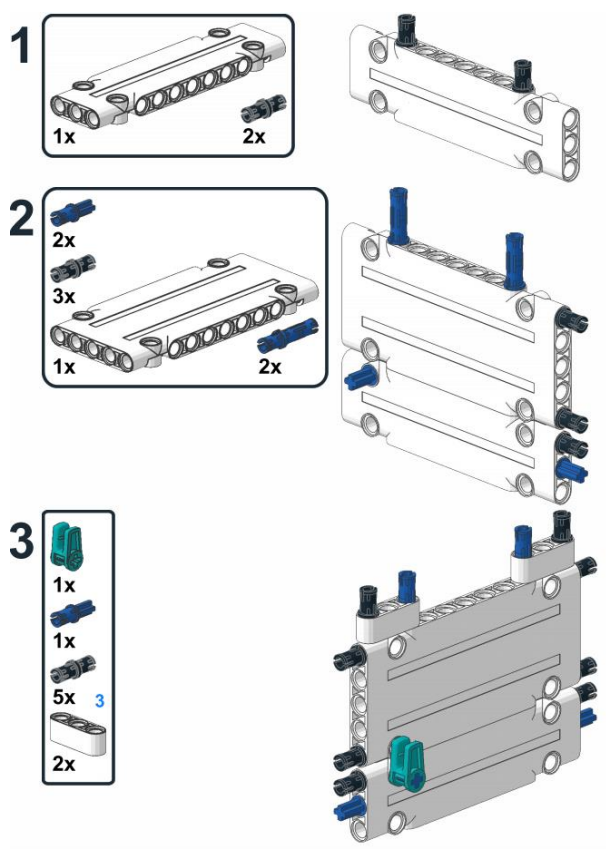
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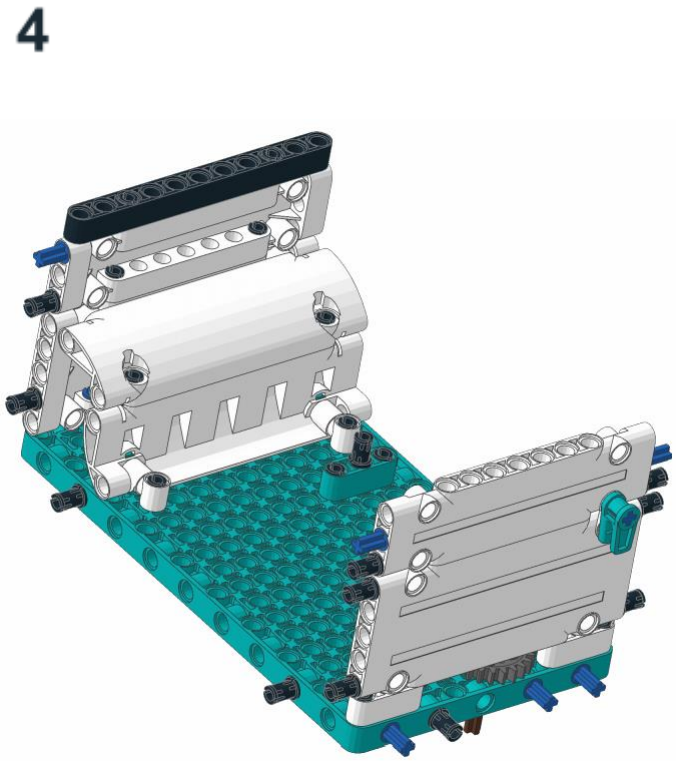
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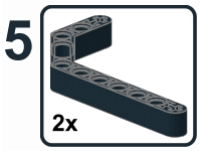
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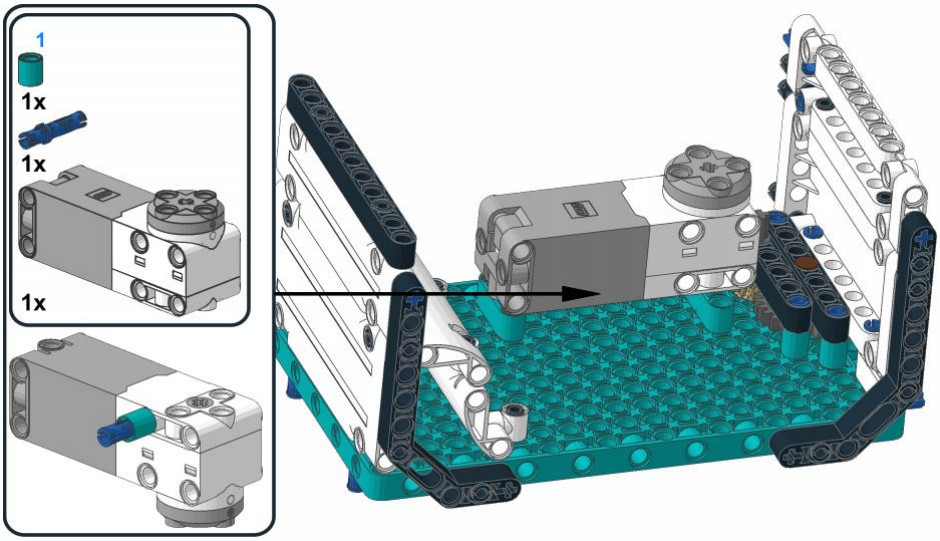
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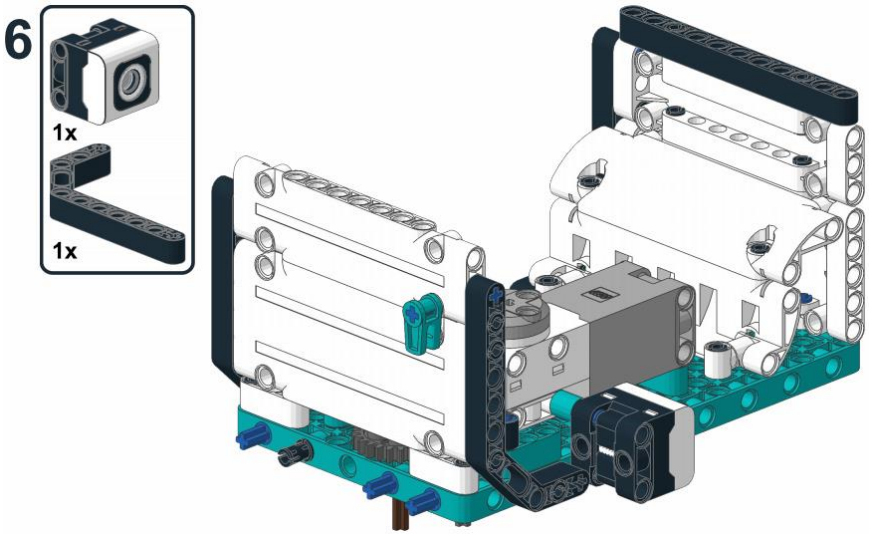
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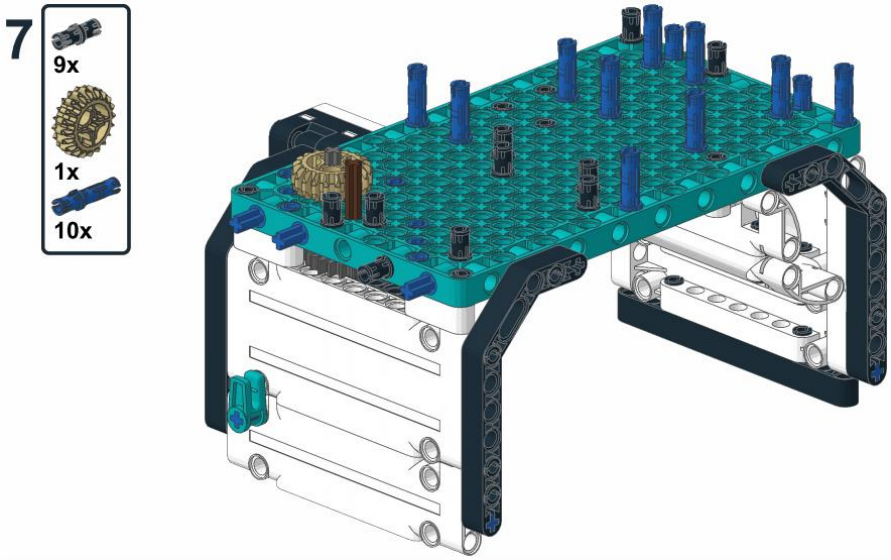
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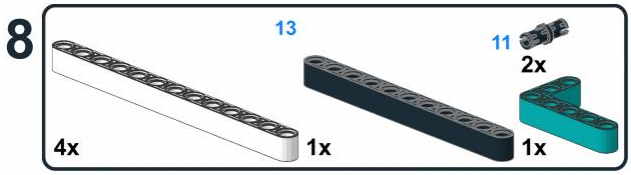
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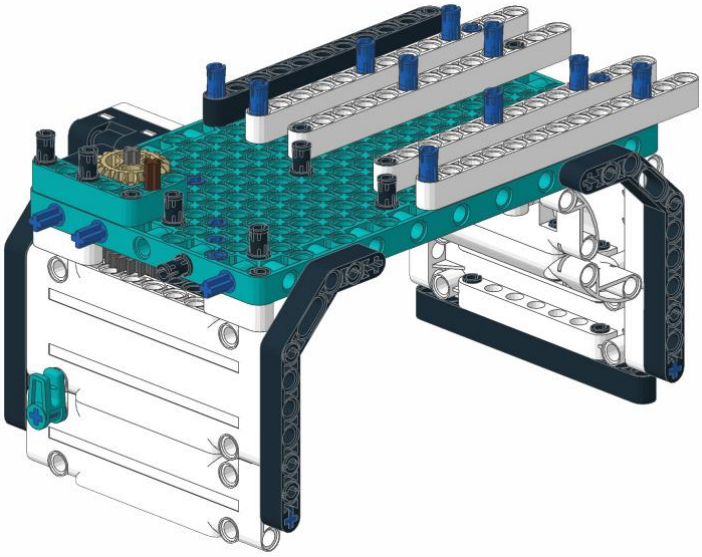

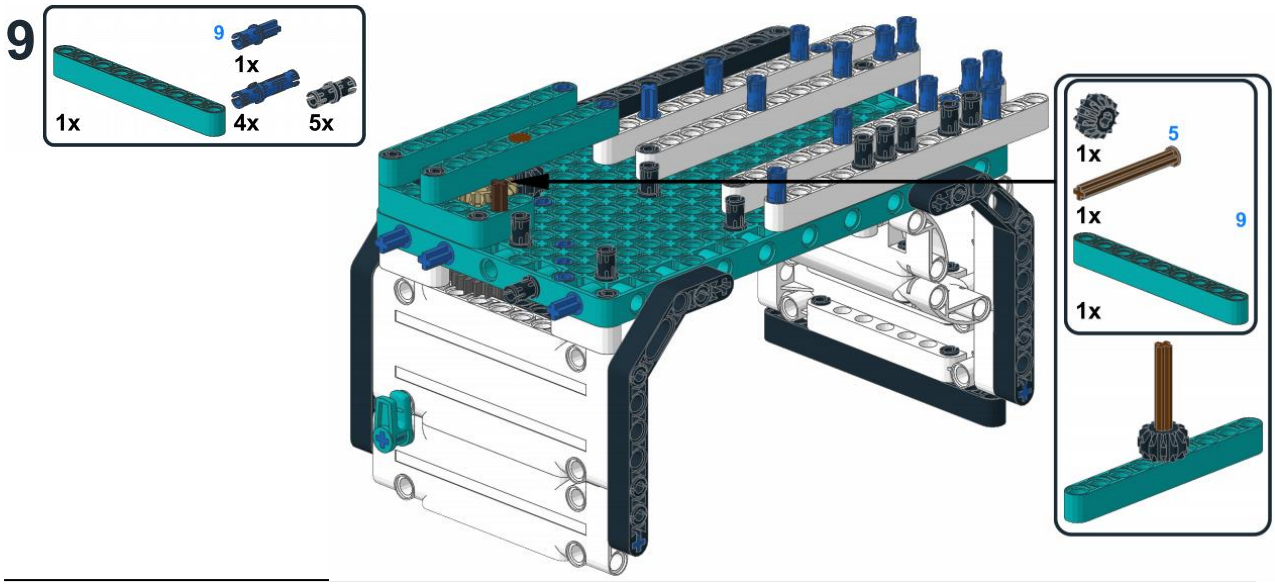
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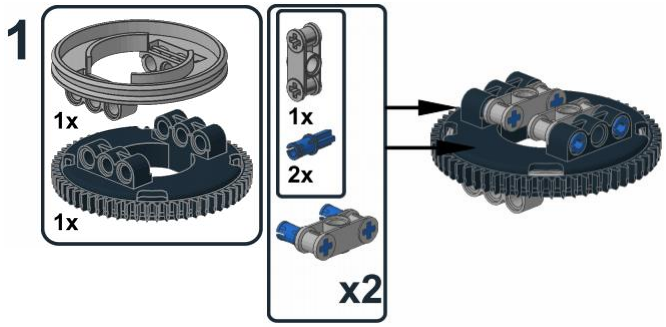
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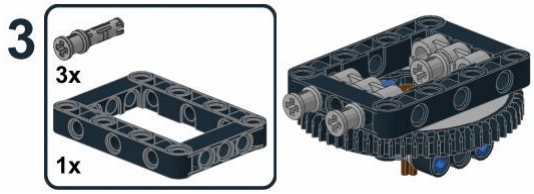
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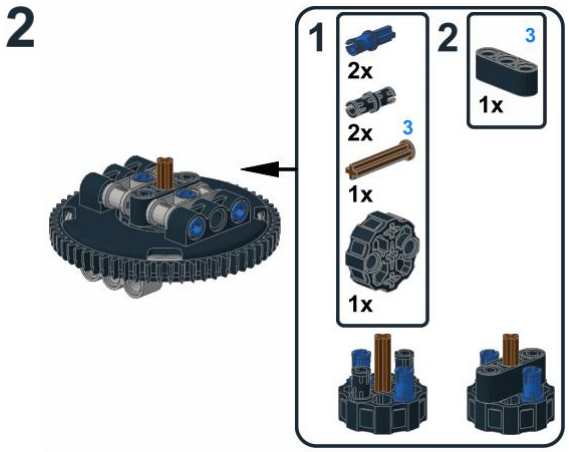
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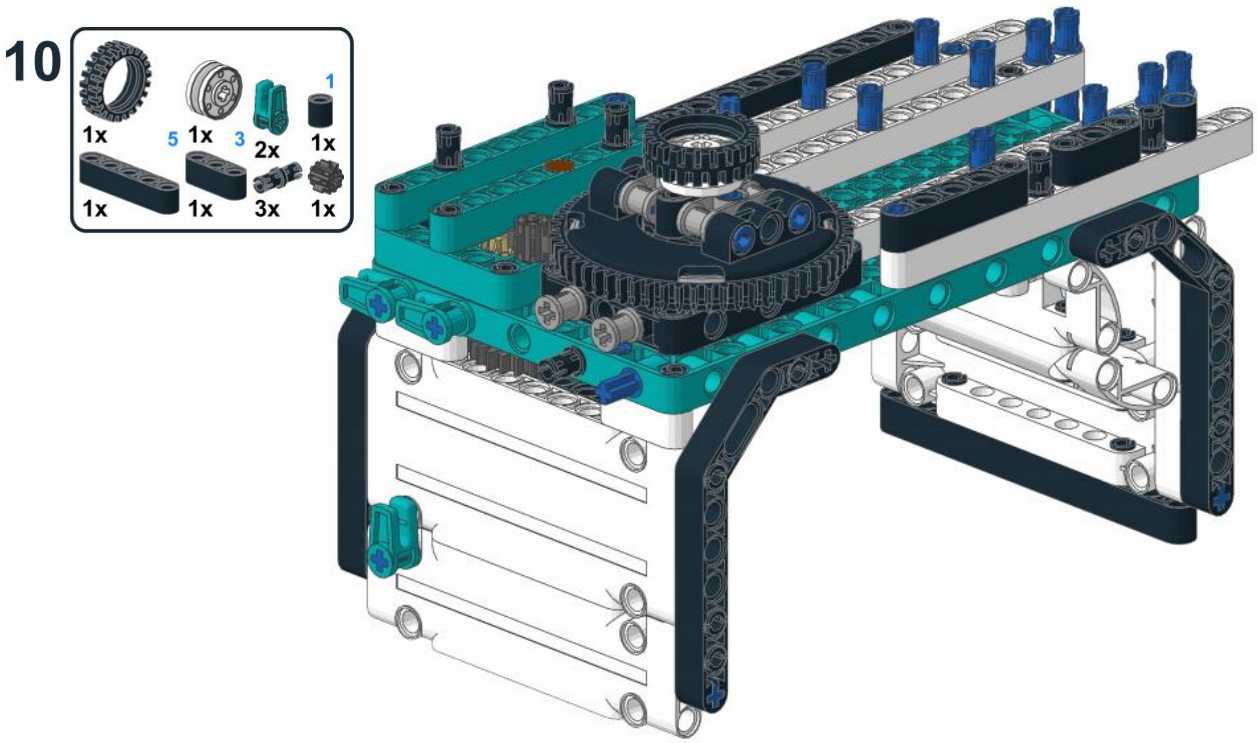
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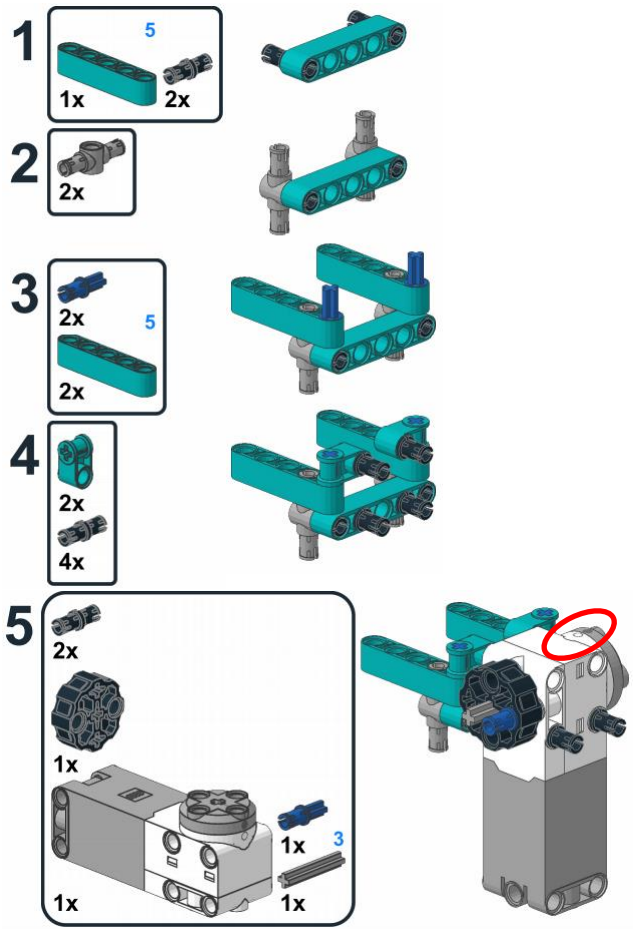
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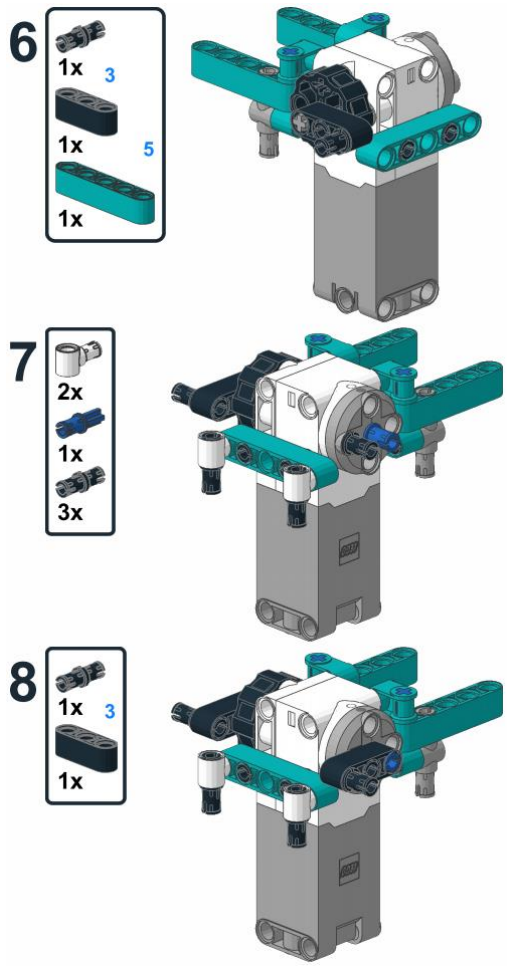
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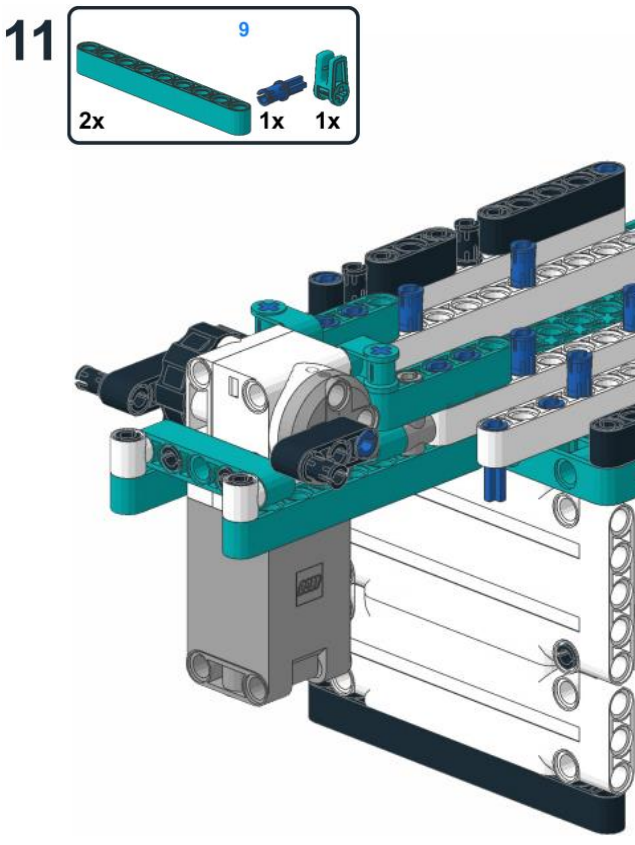
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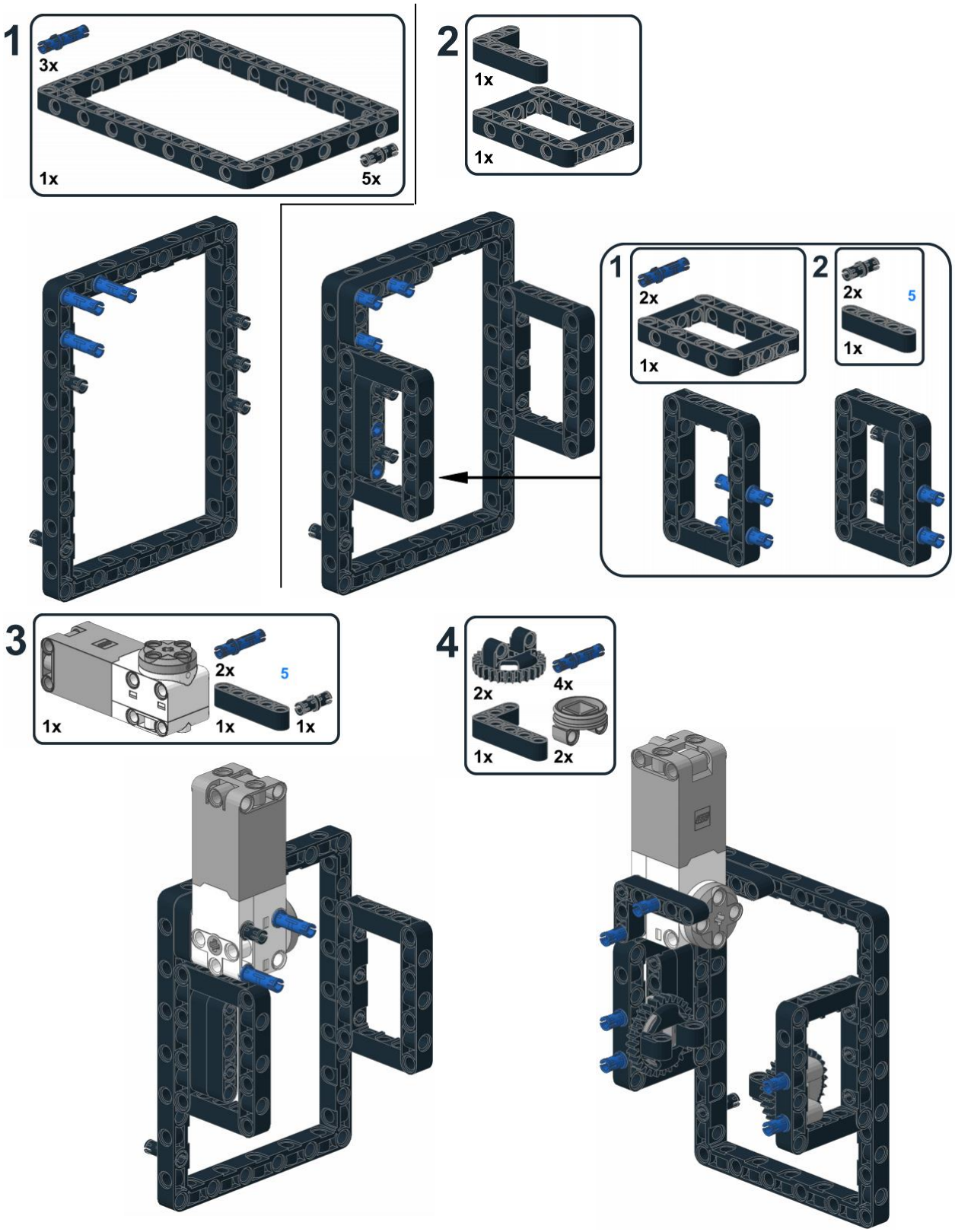
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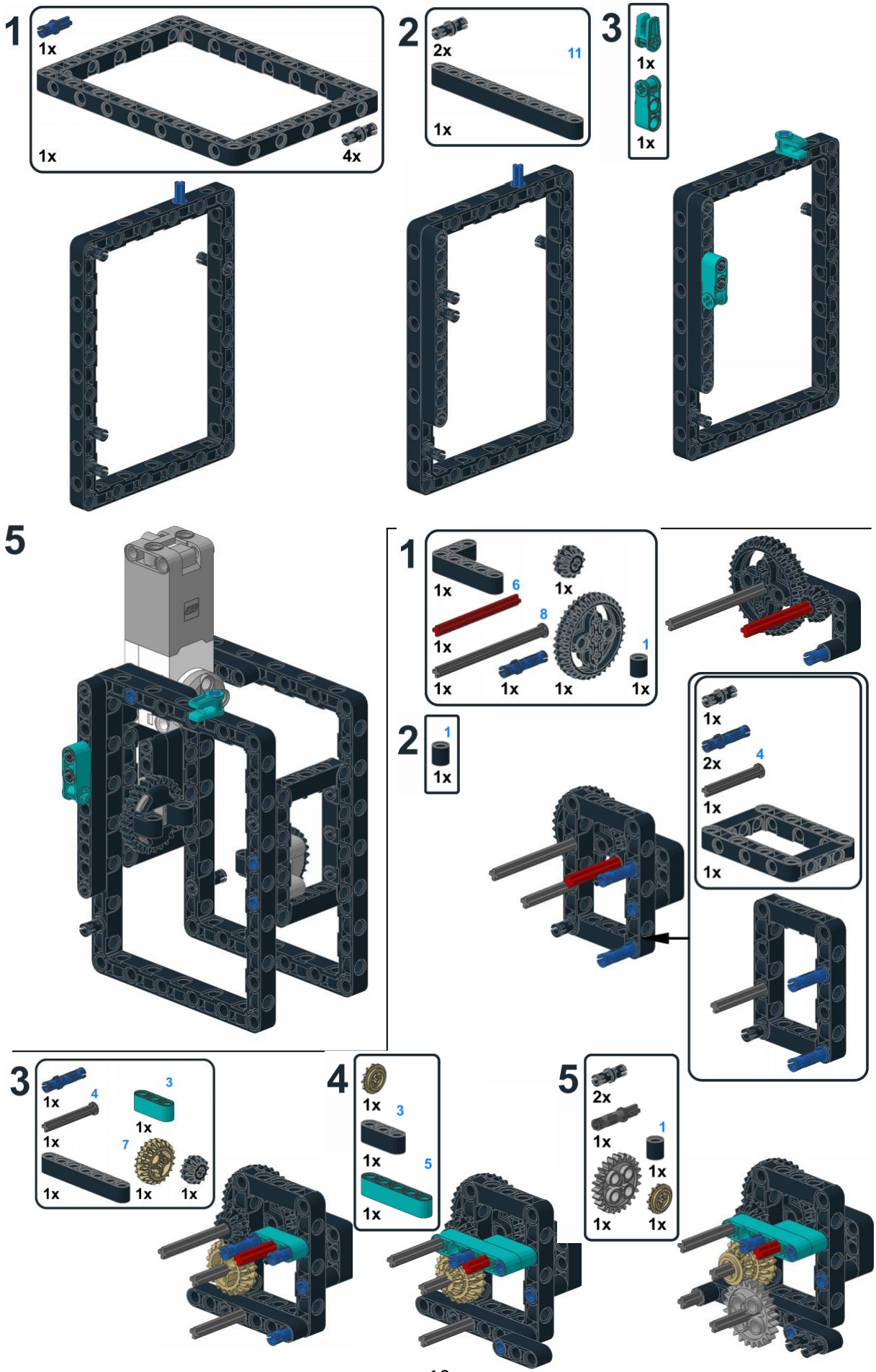
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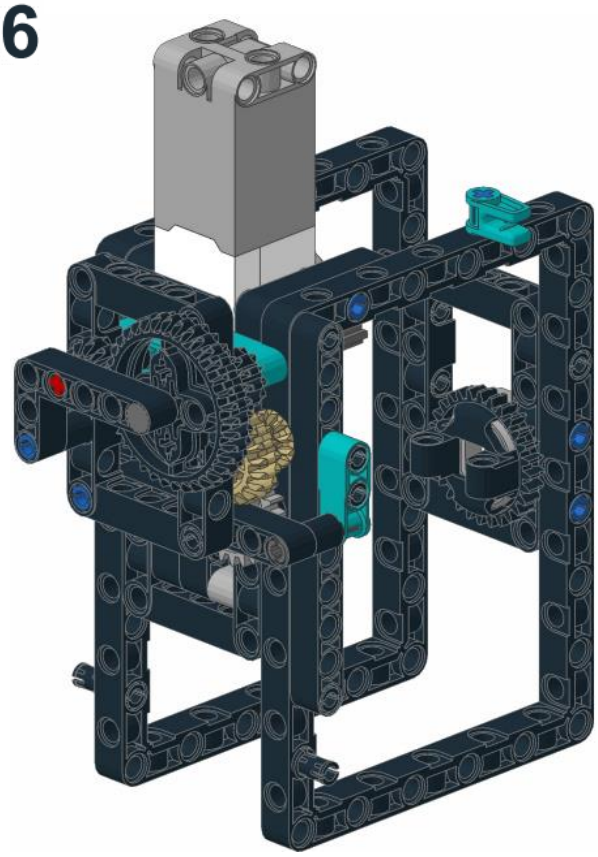

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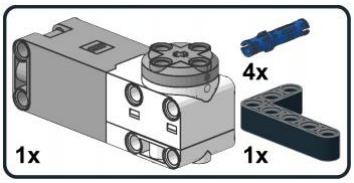

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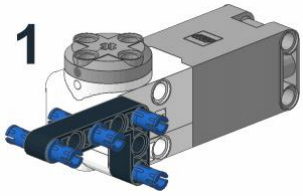

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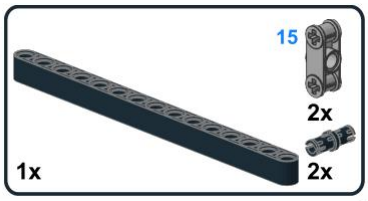

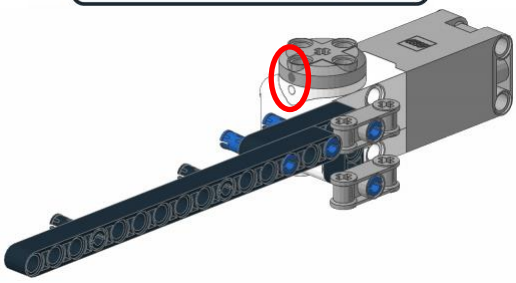

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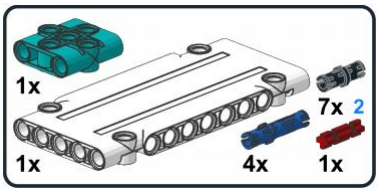

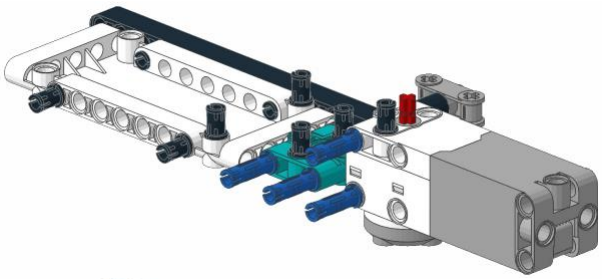

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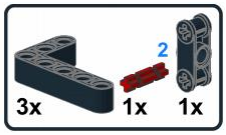

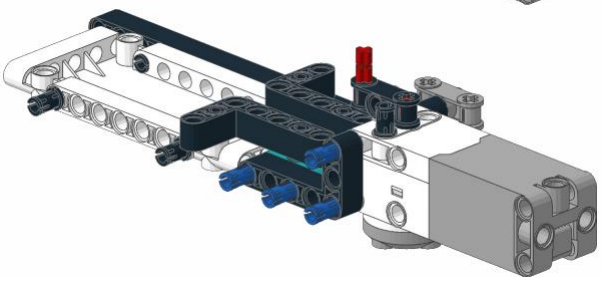

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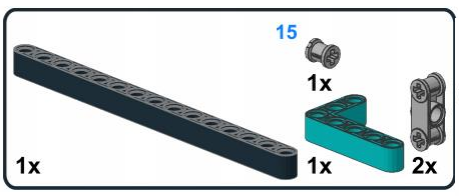

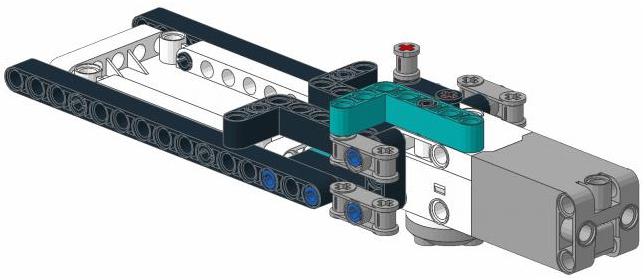

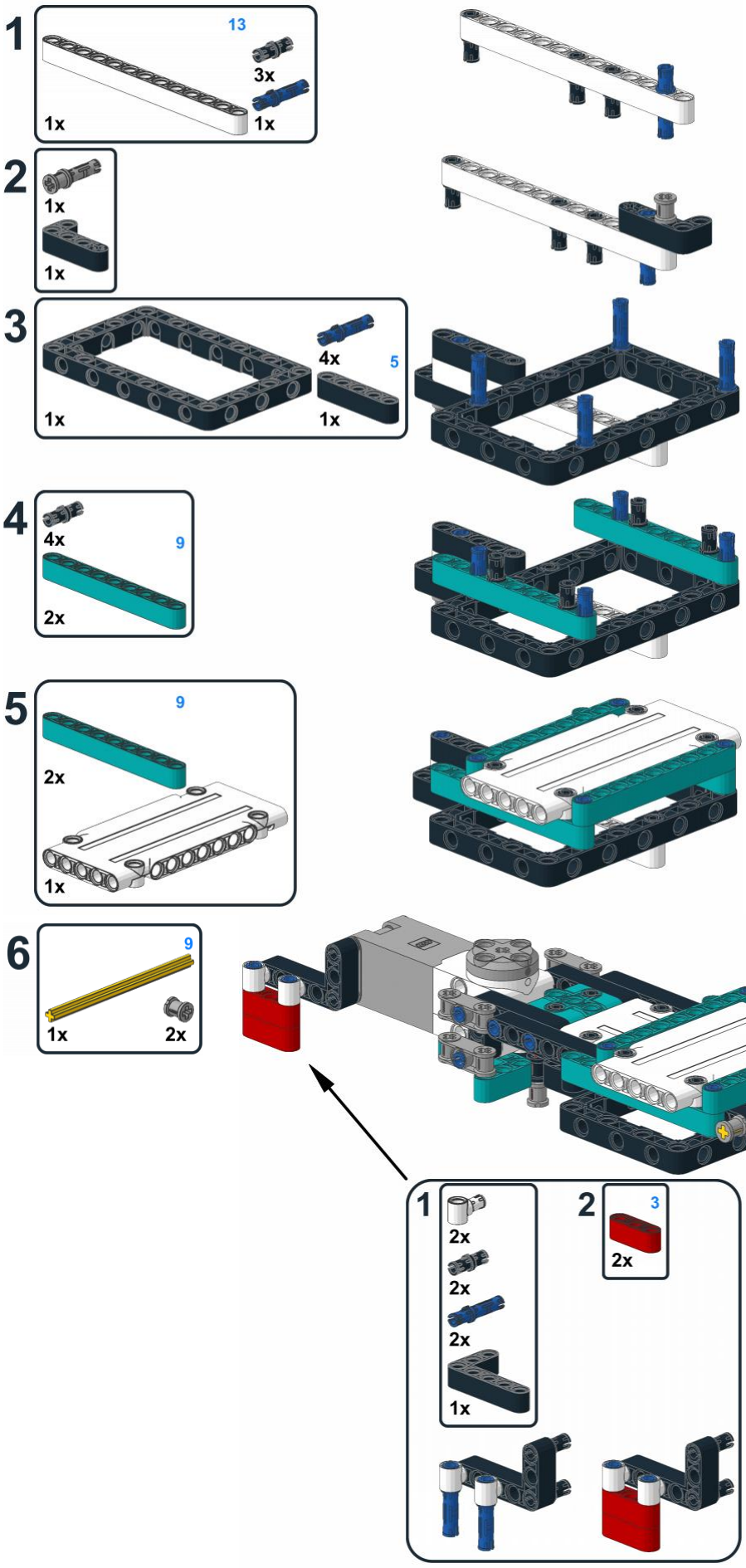
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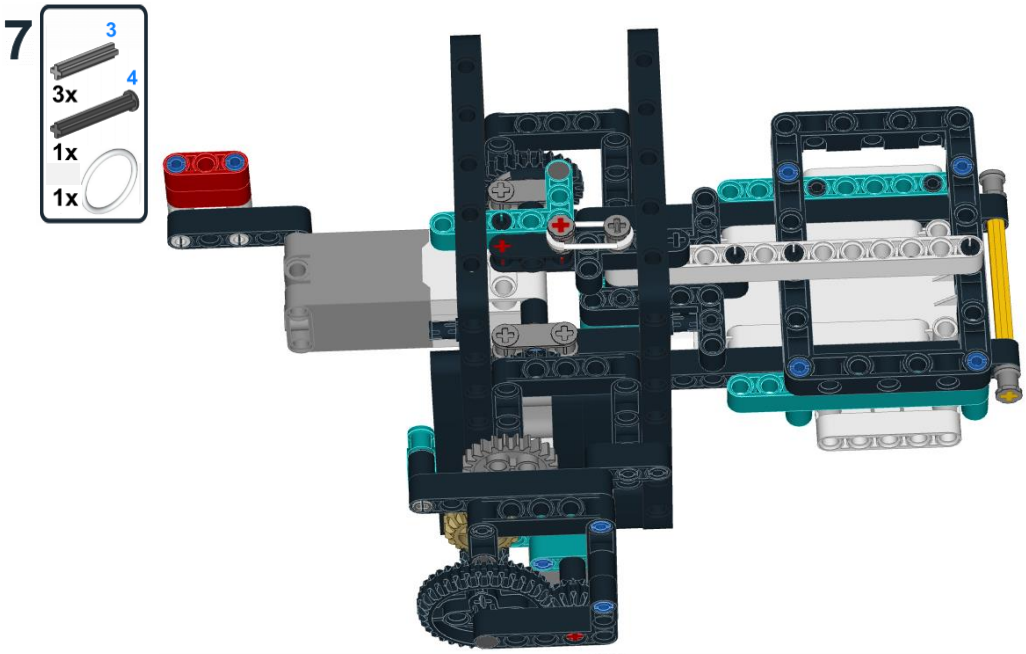
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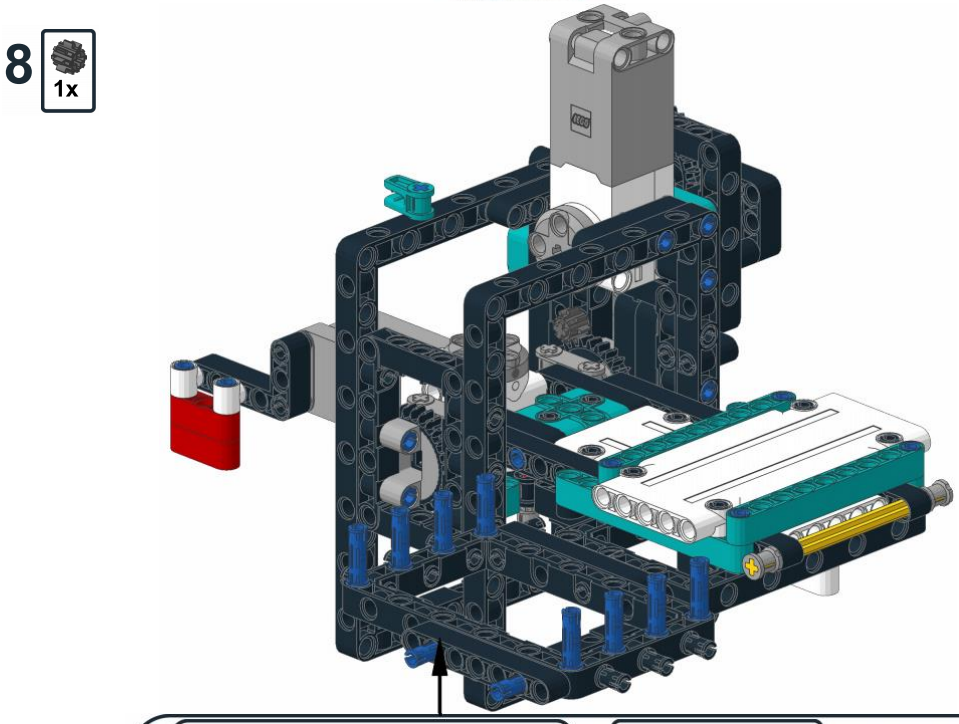
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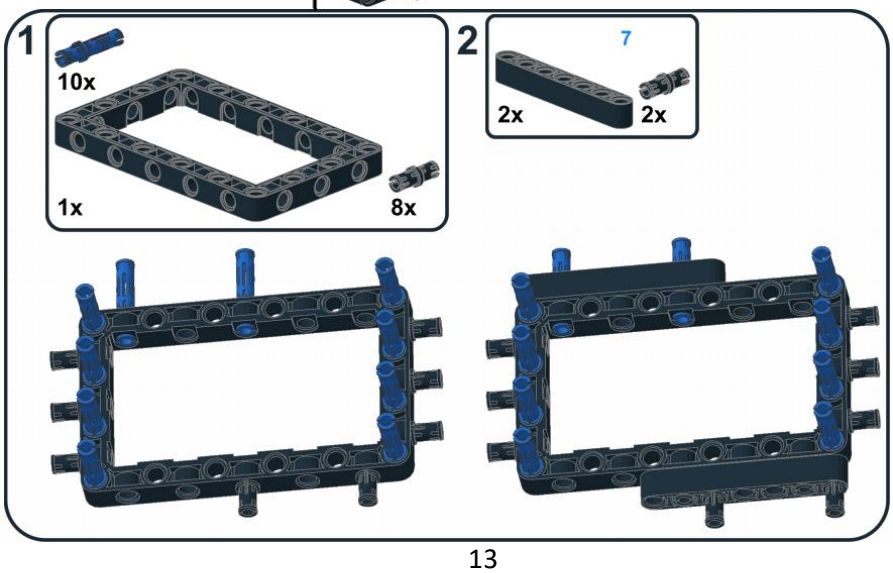
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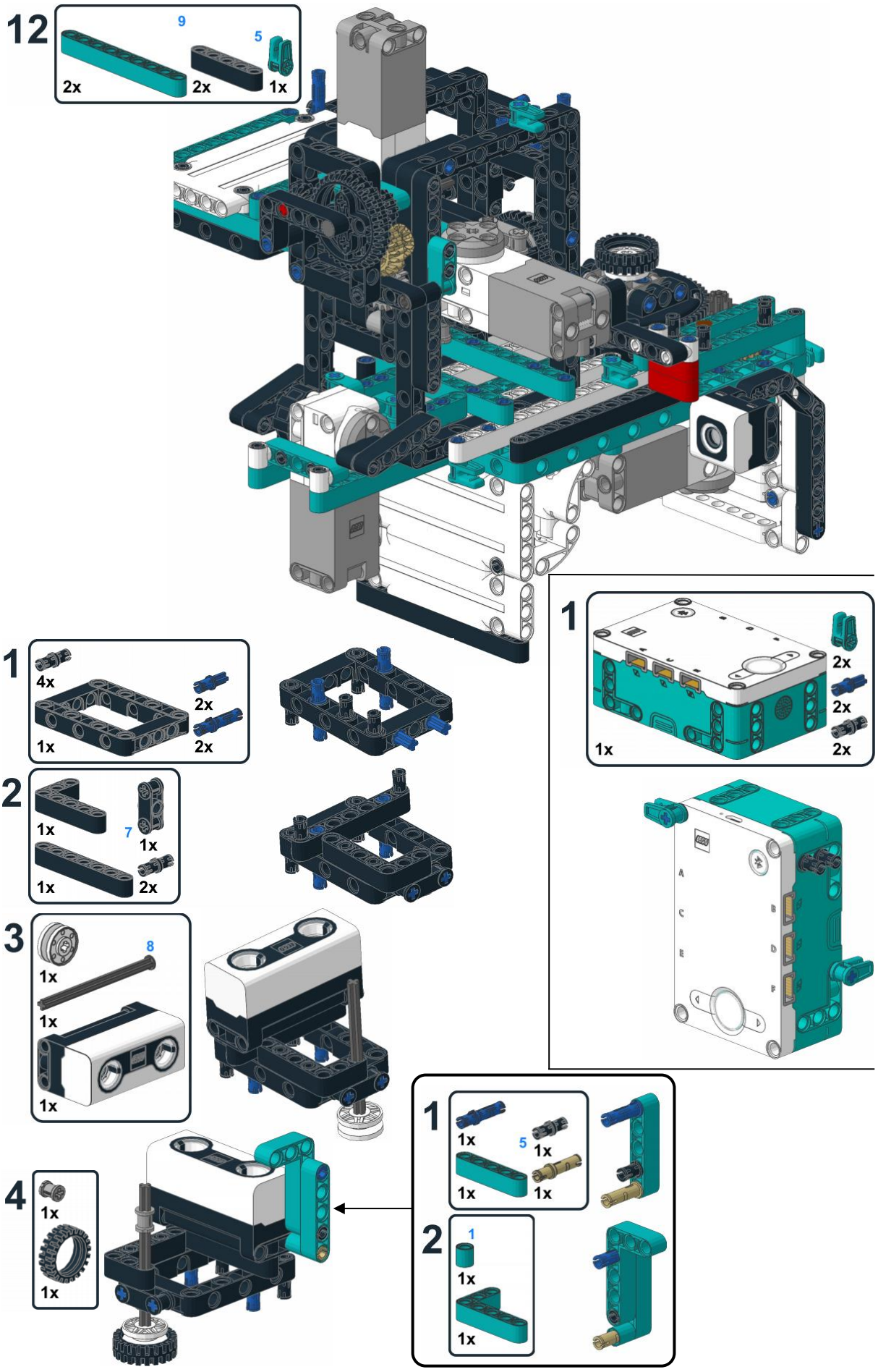
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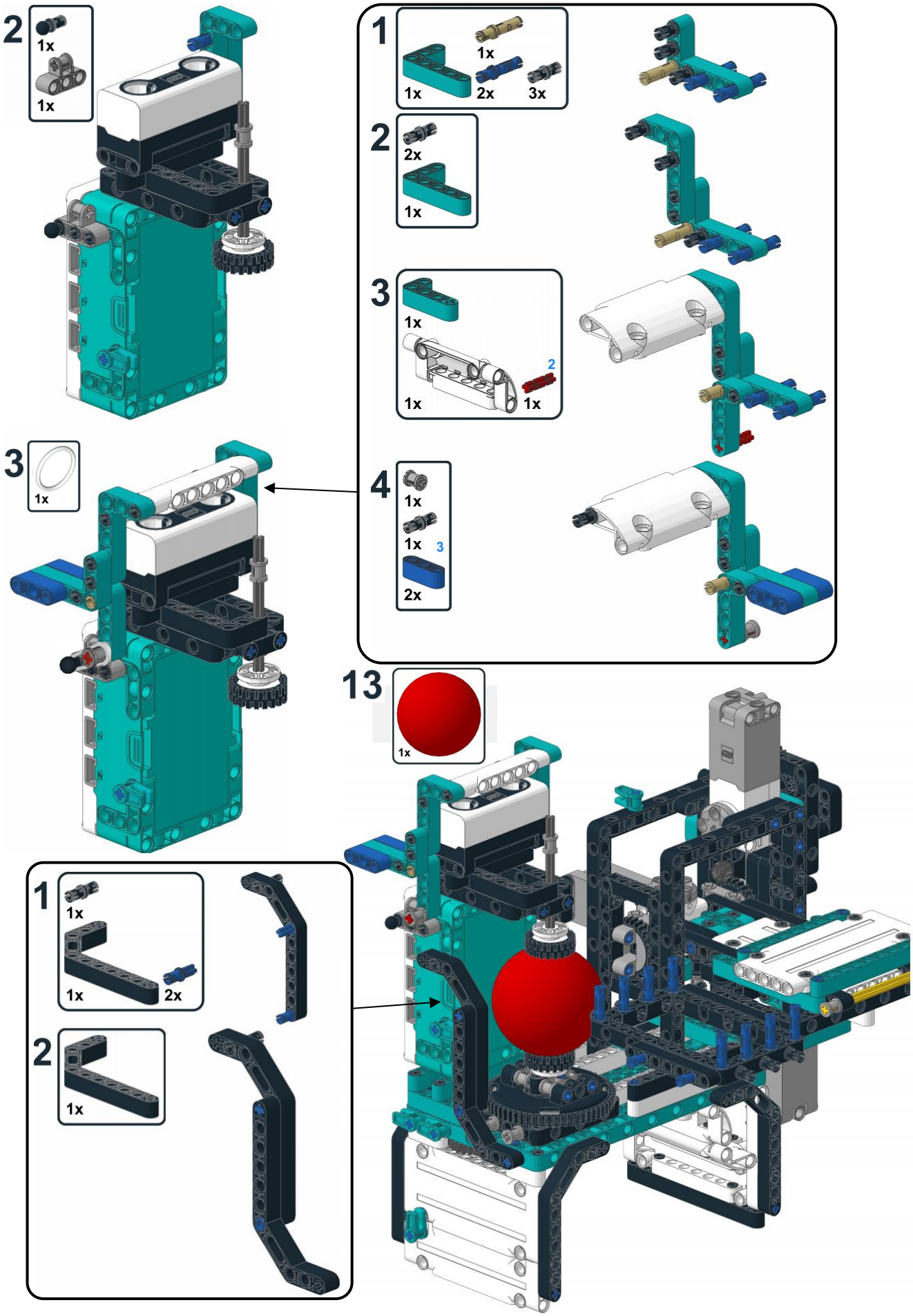
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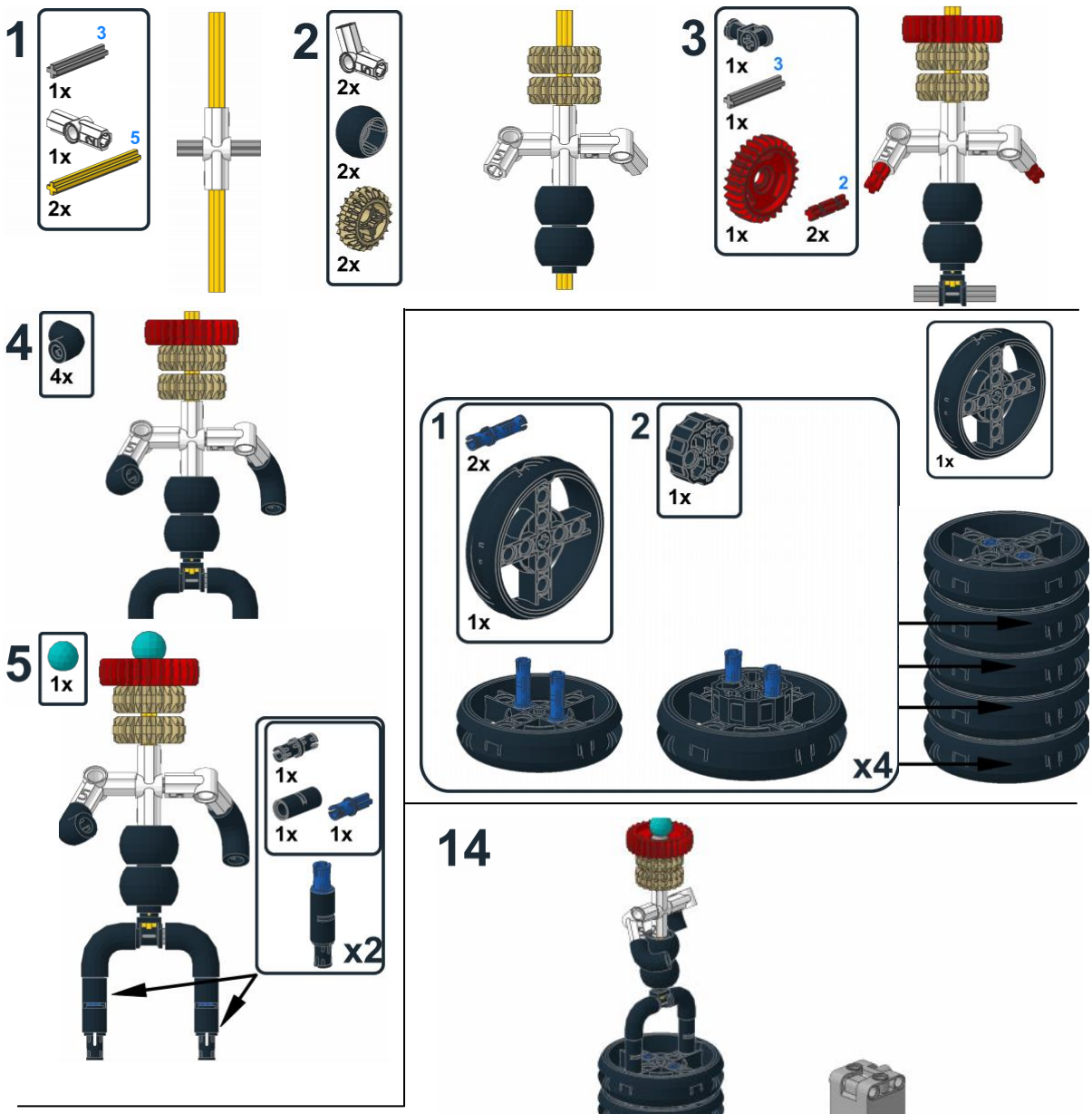
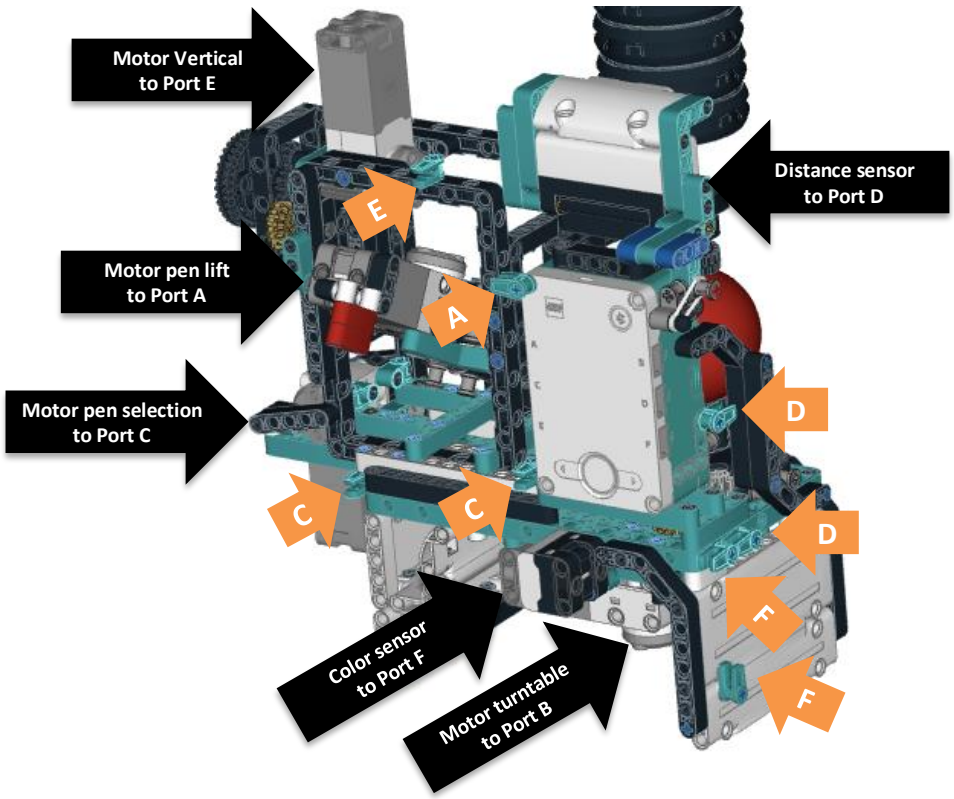
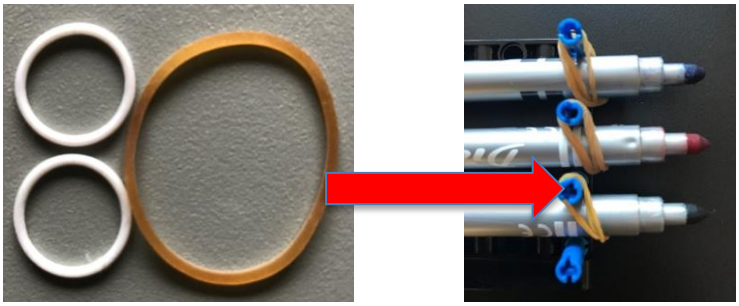


Any time no egg is put into the holder, you should insert the large red ball. This prevents the rubber rings from falling off when transporting the Egg-Inventor.

To prevent the cables from interfering with the movements of the swing or the main sled, the cable routing should closely follow the plan.



The pens should glide smoothly over the surface oft he egg. The height of the pen tip should be adjusted, that it touches the egg with little force, when the pen holder is pulled towards the egg. If the pen is pulled with too much force or is sitting too loose on the pen holder, your drawings or writing might get distorted. For easier pen adjustment, you can attach the pen holder in two different distancers to the egg by turning it 180° and using either the black or blue pins to attach it to the swing



You can use any type of marker pen that fits into the holder. If you still want to eat the egg after tit was painted, you should take care to use pens with edible ink as the ink of most pens will seep through the shell. Alternatively, you can blow out the egg before painting on it.

In case the egg slips on the rubber tires, you can increase the friction by adding some weight to the tire stack. To do so, remove the painter figure from the tire stack and put something heavy (e.g. a small mug) on top instead.

Program the Egg-Inventor

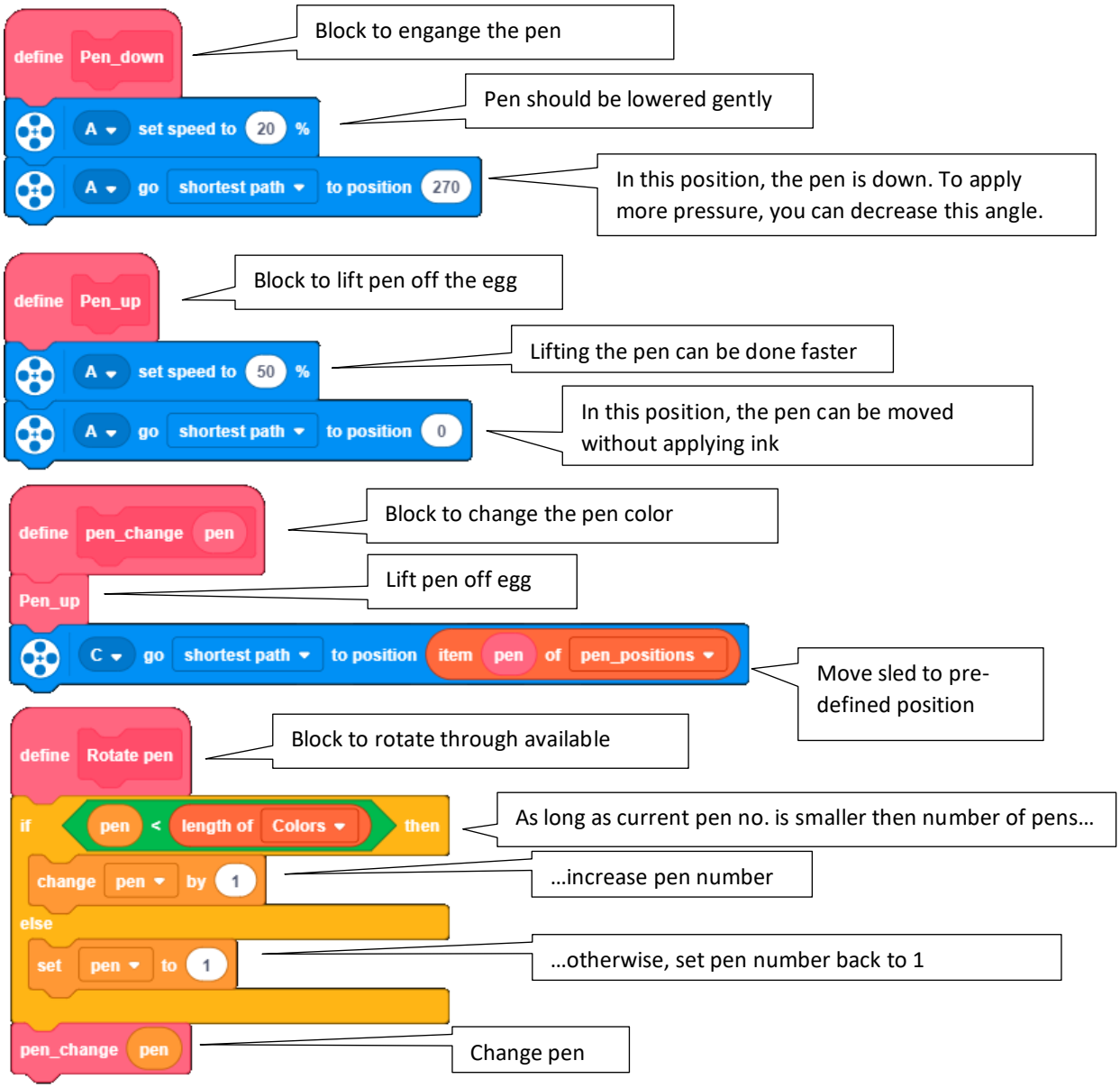
To run the Egg-Inventor, there are several programs are provided online. Some are based on WordBlocks, others use Micropython. The general operation and structure of subroutines is similar in both programming languages.

WordBlock programs on the hub

The following paragraphs describe some programs in detail. For the best learning experience, you can create them yourself on your tablet or PC without the need of an internet connection.

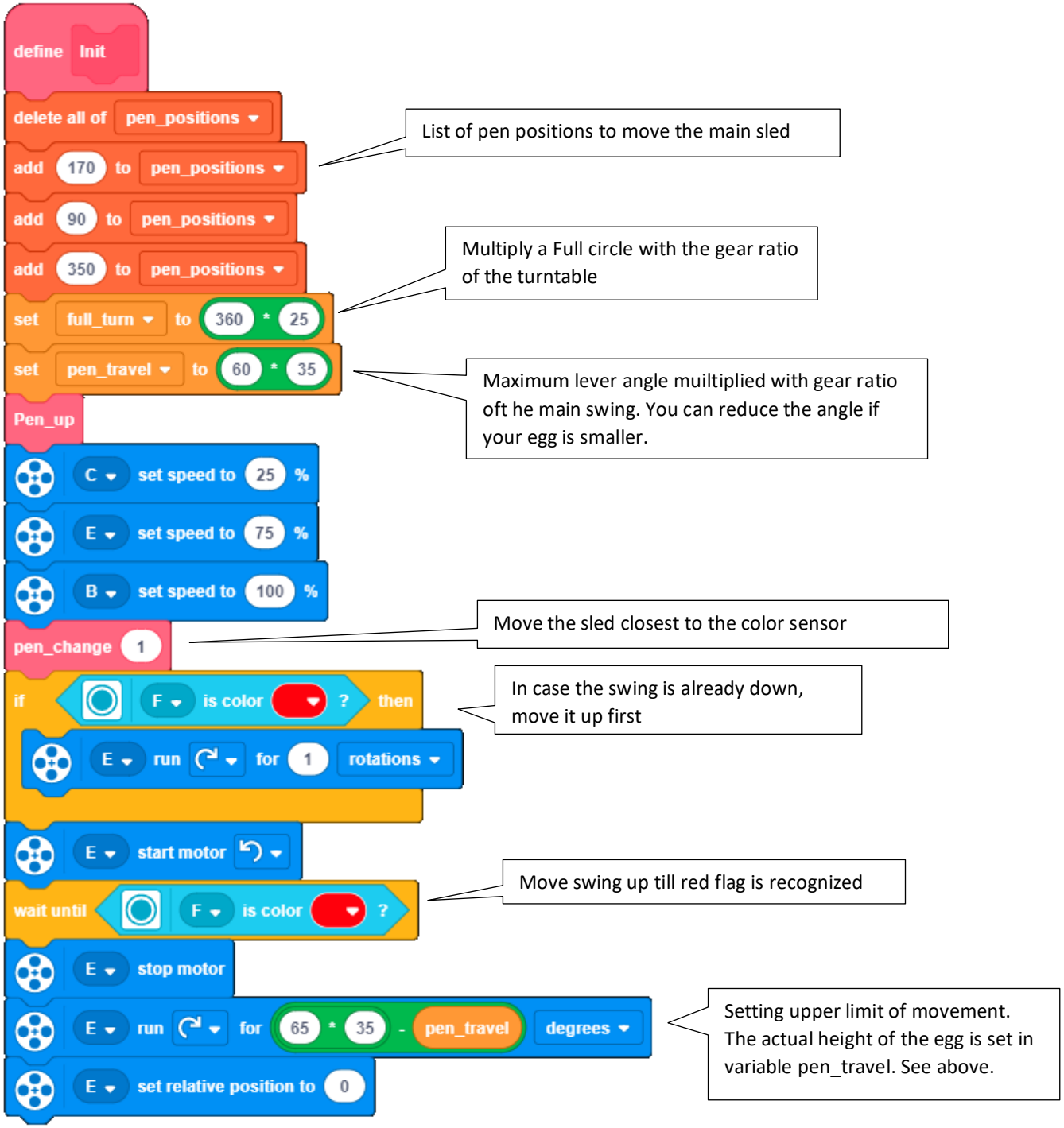
Controlling the pen

Only very few blocks are needed to control the selecting and engaging the pen.



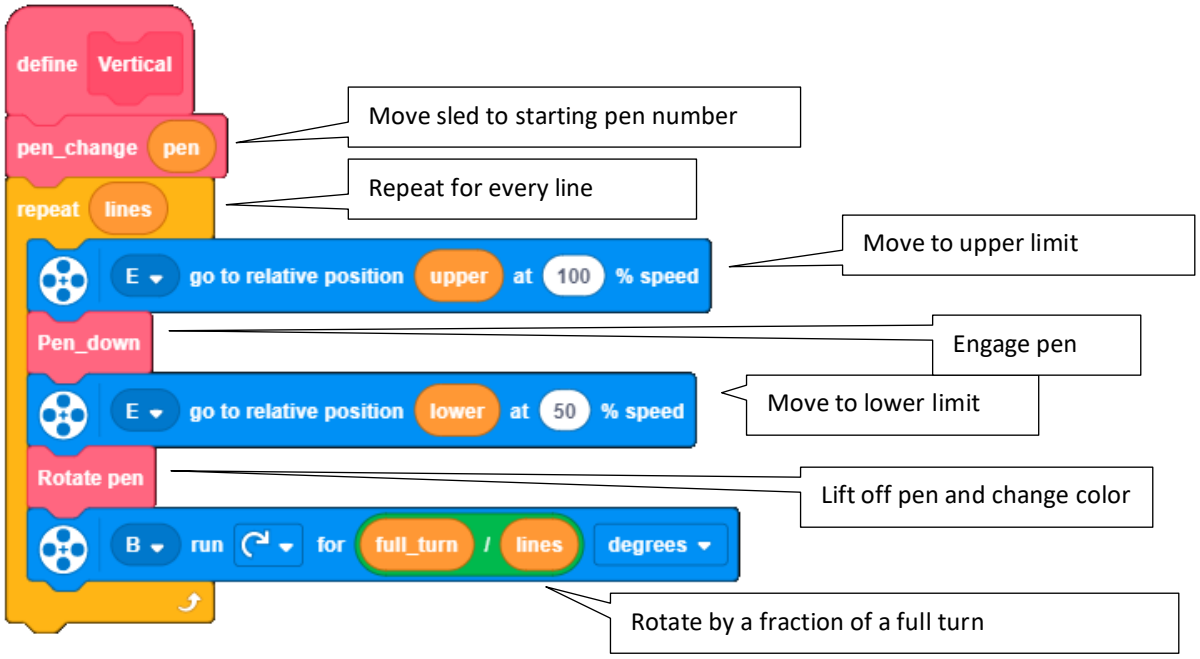
Initializing

After starting the Egg-Inventor, all parts move to their starting position. This is especially important for the main swing as its motor can not provide the current angle of the swing due to its high gear ratio. Therefore, following self-defined block must be included in every program of the Egg-Inventor.



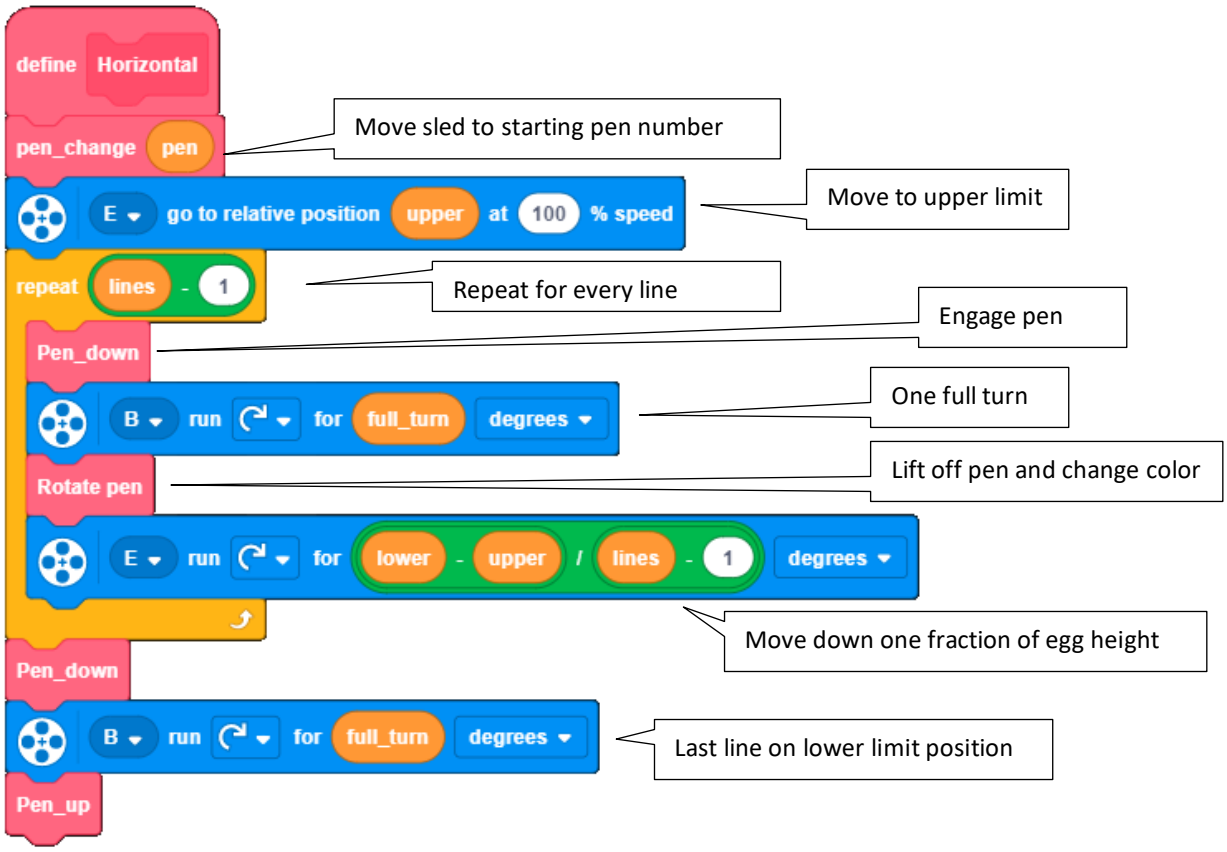
Vertical Lines

Vertical lines are very easy to generate. We can create a dedicated block for this type of line.



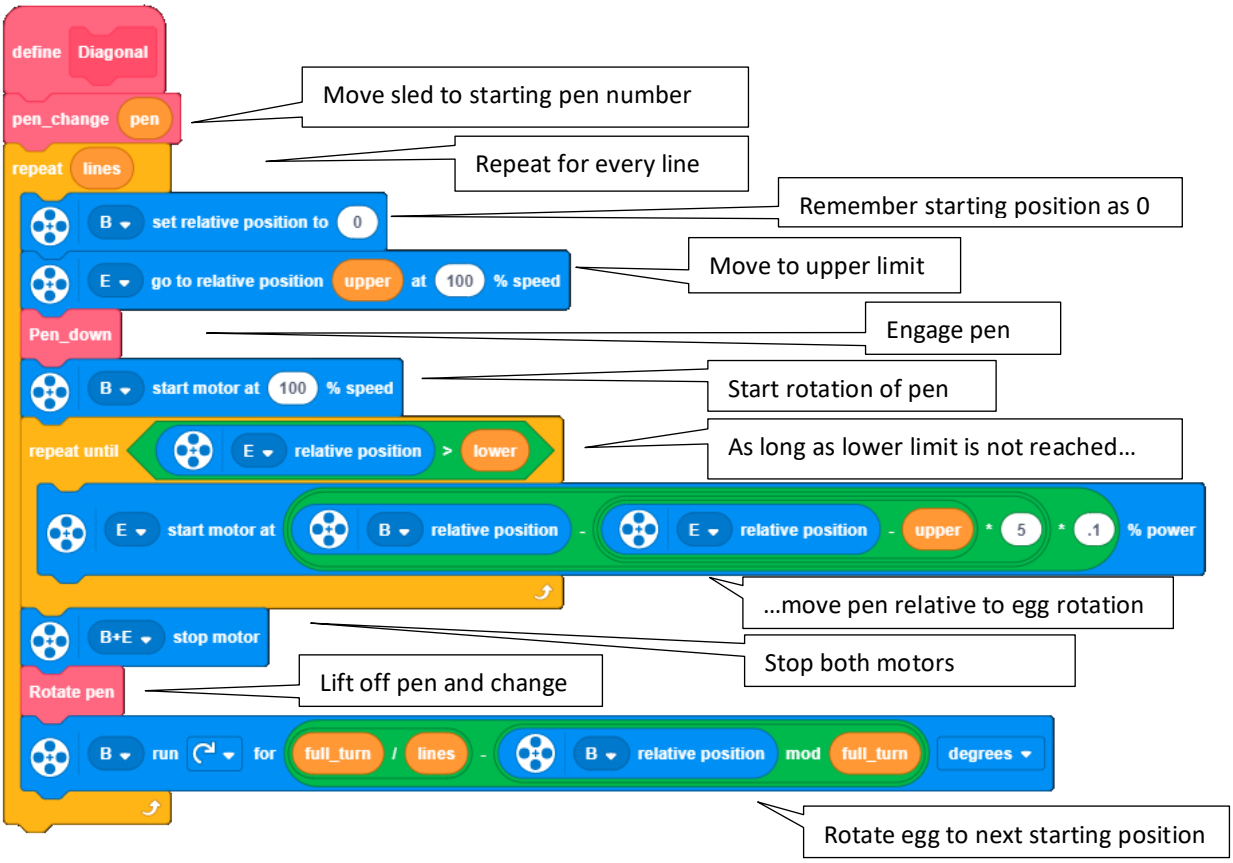
Horizontal Lines

The program for horizontal lines is similar.



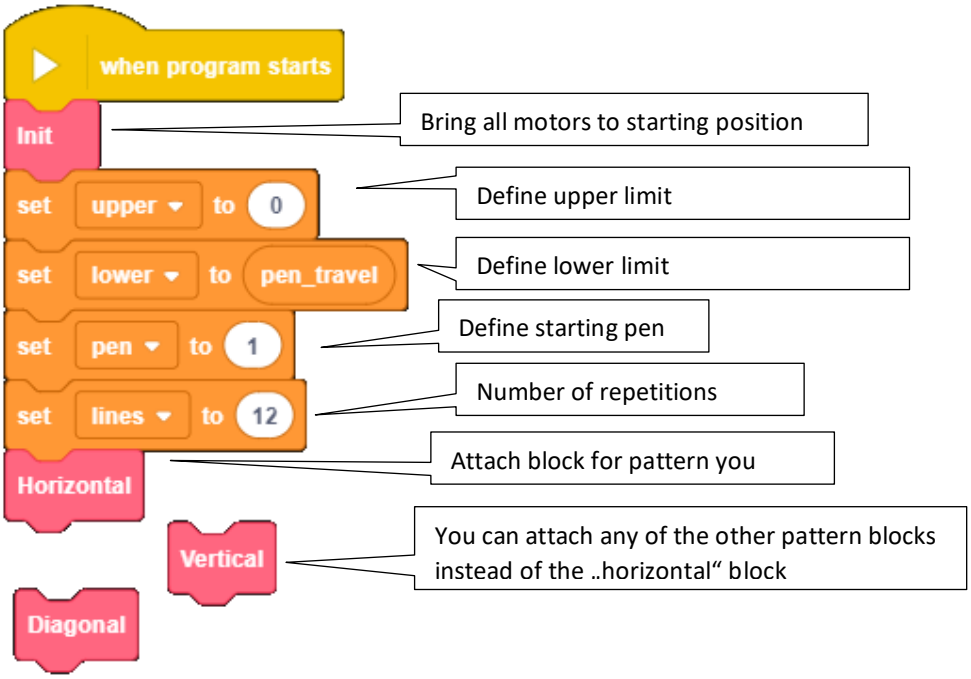
Diagonal Lines for spiral pattern

To draw diagonal lines, the motors need to be synchronized. Therefore, the code is a little more complex. Drawing circles or sinus patterns will follow a similar logic.



Main program

The downloadable programs have several menus to select and configure different patterns. In the code below, we limit ourselves to configuring the patterns within the code. You may want to save different configurations to separate program numbers on the hub.



Installation of downloadable programs

As am alternative to self-programming, you can donload three programs:

`Egg-design.lms` - Word-Block program for several different patterns

`Egg-writer.lms` - Python-program to write texts

`Egg-draw.lms` - Python-program to draw pre-defined symbols

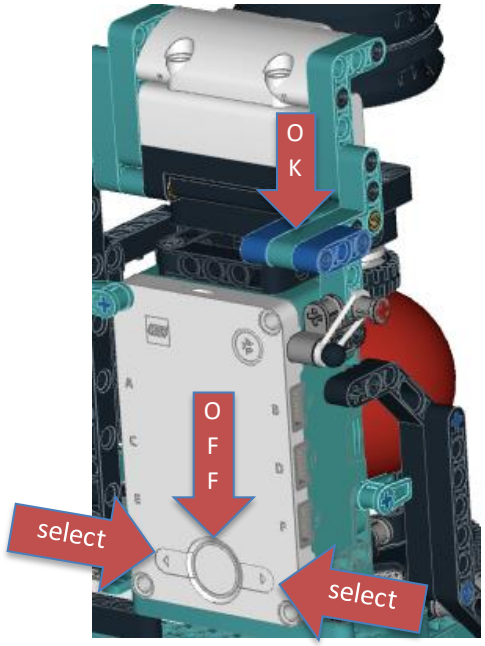
All listed programs can be uploaded to the hub using the standard LEGO Mindstorms APP.

Open your Mindstorms-APP on a PC. Via the menu „File“ and „Open...“ you can load any `.lms` file into the APP. The program can then be uploaded to the hub the same way you upload any other program to the hub..

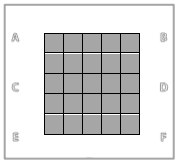
The code of the python programs is documented in detail.

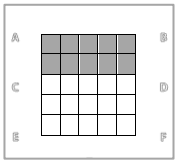
Using the programs

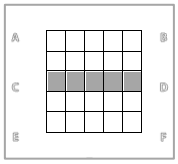
After starting the downloadable programs, you can use the arrow buttons on the hub to select a pattern, text or drawing. You confirm your selection by pushing down the lever next to the distance sensor. Within the egg-write program you need to confirm your selection again after the text has scrolled. Pushing the arrow keys again brings you back to the main selection menu.

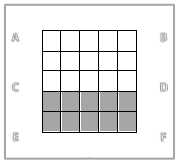


The programs for patterns and texts guides you through additional sub menus. You can define if the pattern or text should be drawn on the full height, the upper, middle or lower third of the egg.

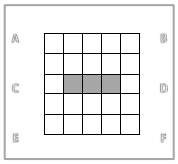

Full height

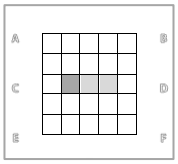

Upper third

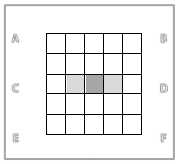

Middle third

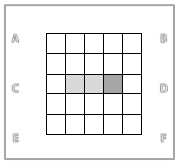

Lower third

The following menu lets you select if you want to rotate through all pen color or if only one of the pens should be used.


All pens


Left pen


Middle pen


Right pen

Finally, the last menu in the pattern program lets you define the number of repetitions (number of lines) of the pattern on the egg.

You confirm each selection by pushing the distance sensor lever. Pushing the center button on the hub end the program as usual. This is particularly useful in case of errors.

Own texts

The provided program `egg-write.lms` lets you select from the four texts `„LEGO“`, `„MINDSTORMS“`, `„ROBOT“` and `„INVENTOR”`. For additional, self defined texts, you have to add them as a string to the list variable texts. Every list entry is to be made within quotation marks and must be separated from other strings by a comma.

Own drawings and characters

The first few rows of the code in `egg-draw.lms` describe the basic command syntax for the drawing definition. This syntax is also used for the definition of characters in `egg-write.lms`.

Every drawing is defined as a list of basic commands in a list variable. Commands are defined by a letter followed by one or several numeric parameters.

„M“ = Move: move to x, y coordinate without drawing (pen up)

„L“ = Line: Draw a line from current position to x y position

„C“ = Curve: sub-circle defined by starting angle, circle angle, radius and rotating direction

The exact syntax and some examples are described in the first few lines of the program code.

The variable names of the drawings are listed in the variable `drawings` as a Python list.

```
drawings = [heart, smiley, teddy]
```

For the selection menu, a symbol is defined for each drawing in the variable `draw_symbols`.

```
draw_symbols    = ['HEART', 'HAPPY', 'COW']
```

You can add additional characters to `egg-write.lms` using the basic commands above. Every character is defined in the python dictionary variable `letters` like defining a drawing. The provided characters are 4 units wide and 6 units high. The scale of the letters I set to about one third of the egg height.

To adjust the scale for letters or drawings, you can change the values for `scale_turntable` and `scale_vertical`.