



BIOLINKER MANUAL

Materials

Rods

Grey	58
Red	20
Yellow	42
Blue	37
White	31
Green	19

Connectors

White	19
Yellow	20
Red	34
Orange	4
Purple	82
Blue	23

Clips

Gray	49
Beige/tan	20
Blue	3
Arm blue	2
Arm black	2

Mini

Pink transition	10
Green transistor	2
Orange stick	6
Yellow connector	8
Blue connector	4
Purple connector	2

Special

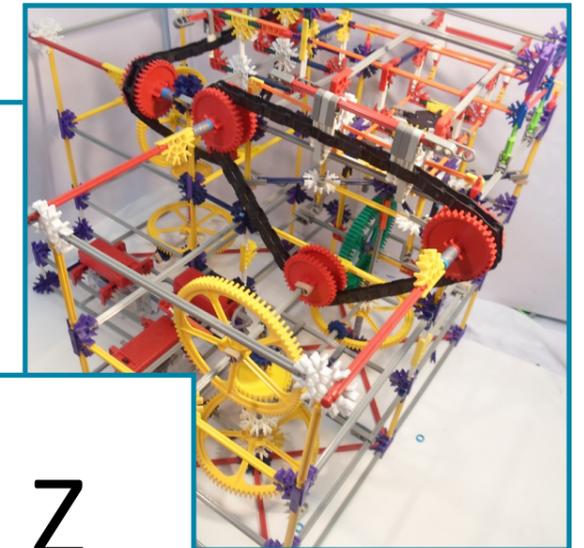
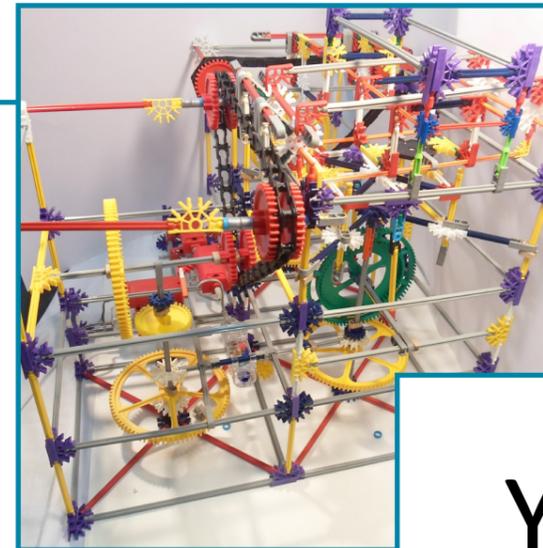
Motor	3
XL gear	6
M yellow gear	2
M red gear	12
S gear	6
Black track	60
Black platform	1
TOTAL	587



BIOLINKER MANUAL

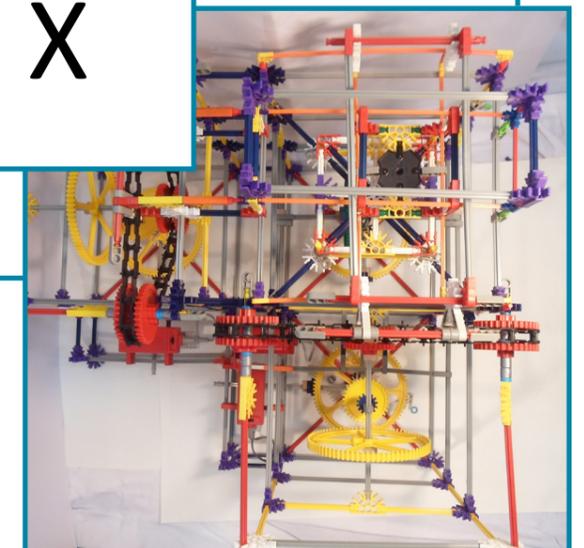
The iGEM 2015 of Delft University of Technology. BIOLINK, has strived to find a way to create a structured biofilm. The solution they came up with is BIOLINKER, a 3D printer made of K'NEX. After trying out several designs, the model you're about to build turned out to be the best suitable for their cause.

This final construction consists of 4 areas, called x, y, z, and control panel. Each area has its own main function, since the printer can move in three directions. The areas x, y, and z indicate a certain direction of movement. The control panel is where the movements can be controlled, because this is where the motors and on/off switches will be located. Throughout the manual, we will refer to these directions so the middle figure shown below is useful to keep in mind.



Y

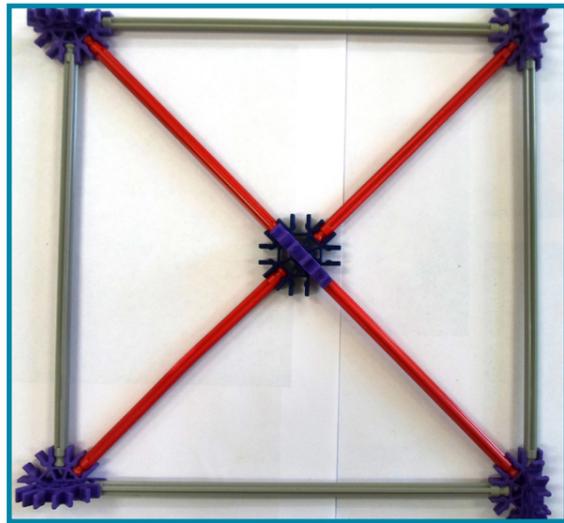
Z



Control
Panel

X

Bottom layer

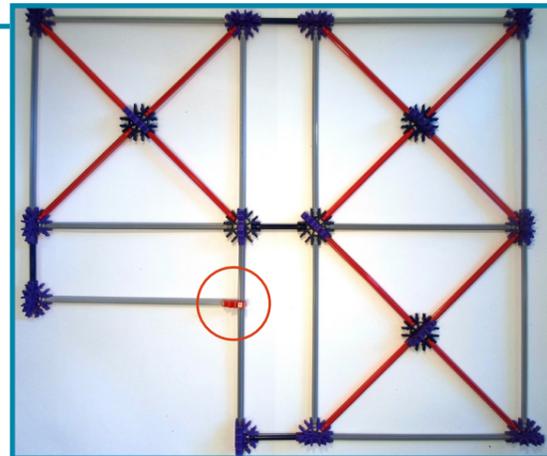


1

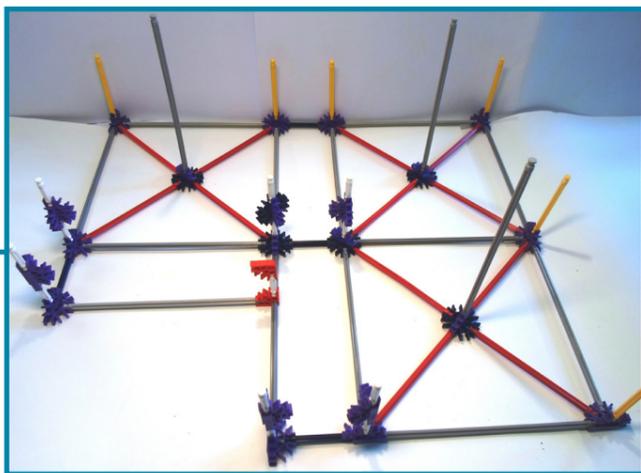
Make a square as seen in figure 1, by connecting four gray rods to each other, with four purple-purple connector. Connect four red rods to this square and connect them at the centre with a blue-purple connector.

2

Make three of these squares to form the x, y and z plane. Connect the left part to the right part with the blue rods. Also connect a red connector to the x-square by putting the eyehole of this part through the gray rod (red circle). This will become the control square. The corners are combination of blue/purple connection parts and purple/purple connector parts.

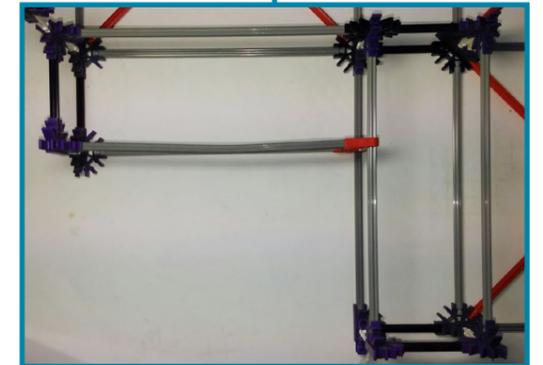
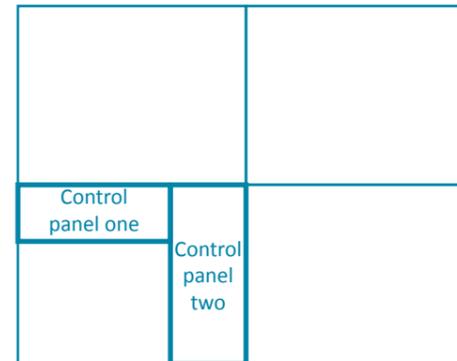


3



You have to place a rod on every edge as you can see in the figure. In total you have to place four yellow rods on the outside of the printer on the side of the moving squares. On the edges of the control center, you have to place a combination of two white rods with a combination of purple/blue and purple/purple. On the red edge you place a white rod on top with another red connection part. Place in the center of the x, y and z squares a gray rod on the purple/blue combination.

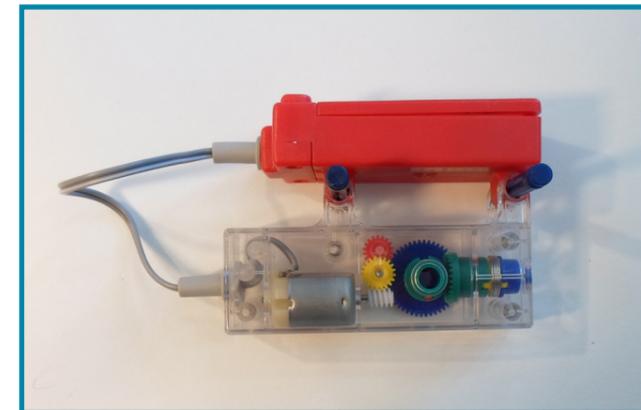
Control Panel



4

Connect the parts with the purple/blue and purple/purple connectors to each other with blue and gray rods.

In this section building the control panels will be specified. As can be seen above, there are two different control panels that will be constructed.



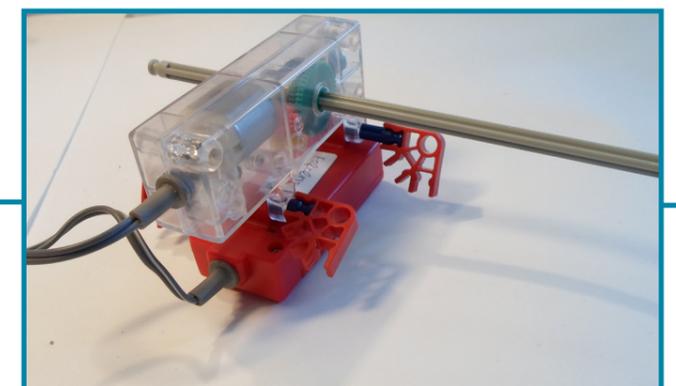
5

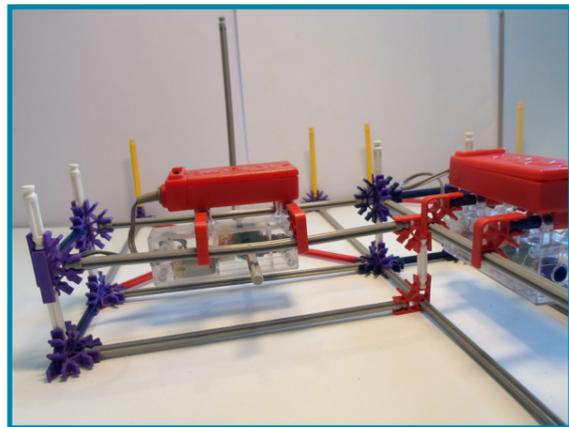
Place the control panel on top of the motor. You can stick them together by putting two blue rods through the holes on top of the motor. Enclose this motor by putting the red connection part to on the ends of the rods.



6

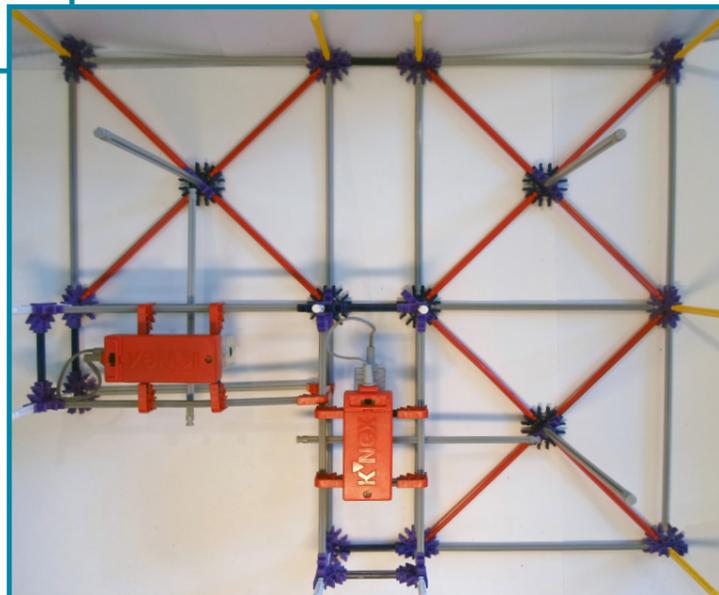
Put a gray rod through the motor part of the printer





7

Place the motor combination on top the two control panels by clicking the red connection parts on the gray rods.



6

X & Y direction

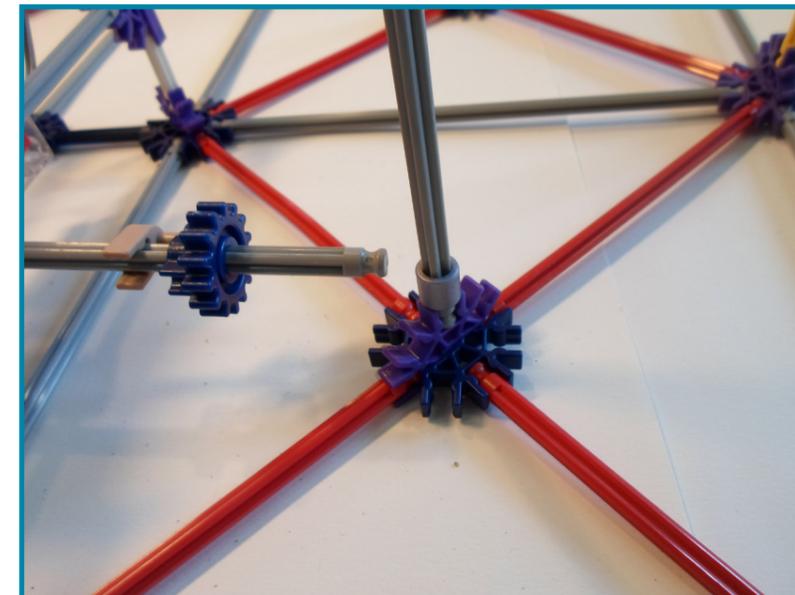
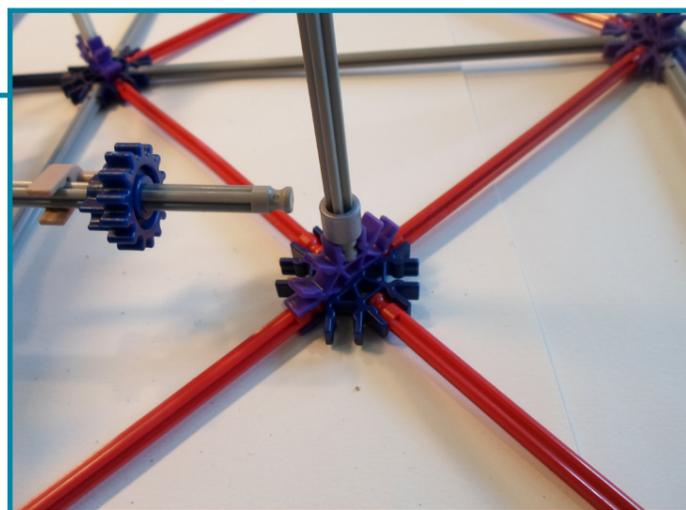


9

Add a gray ring in both the x and y square on the central gray rod.

8

Take a blue small gear and put them on the gray rod through the motors. Let them stick to the gear by putting a sand colored end on the gray rod. Slide the gear and the end together. Do this in both the x and the y square.

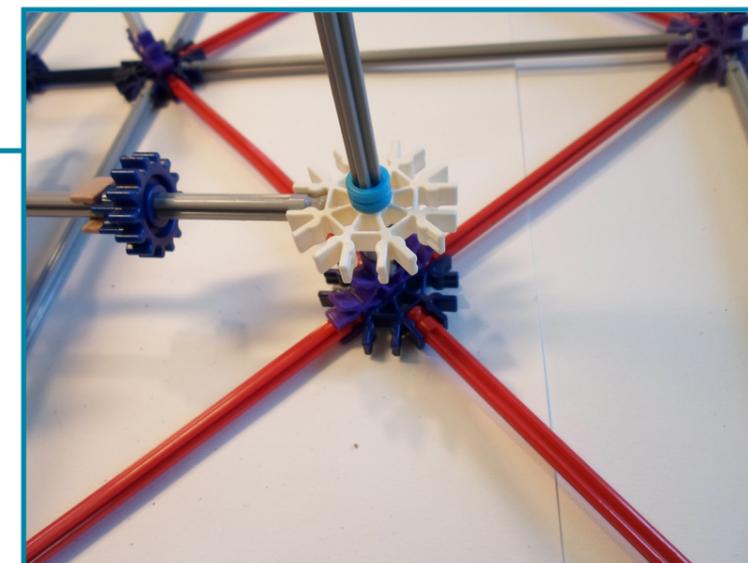


10

Put on the same gray rods a white connection part, so that these are on top of the gray rings. Connect the gray rods in the motors to this white connection part.

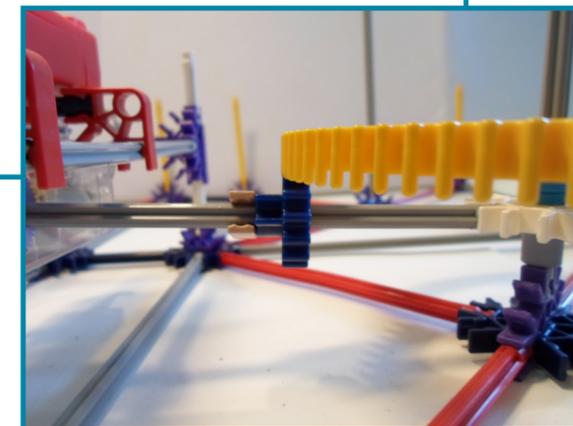
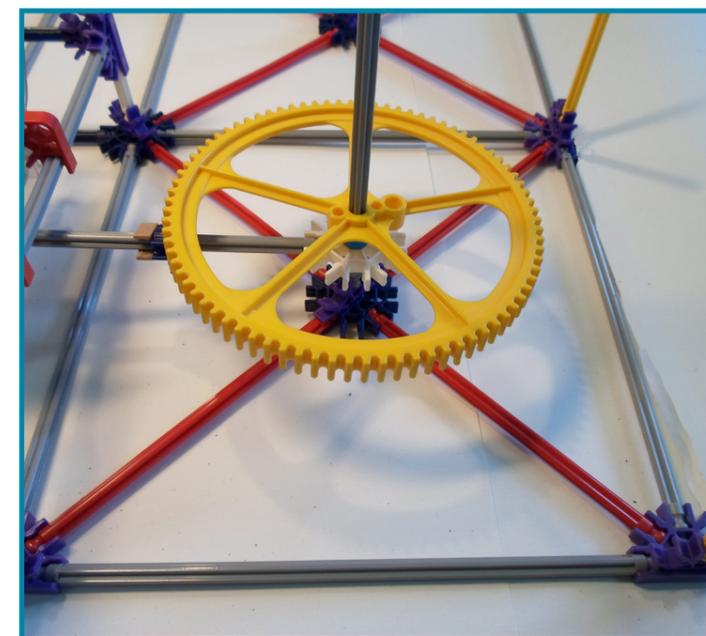
11

Add two blue rings on the top of the white connection parts.

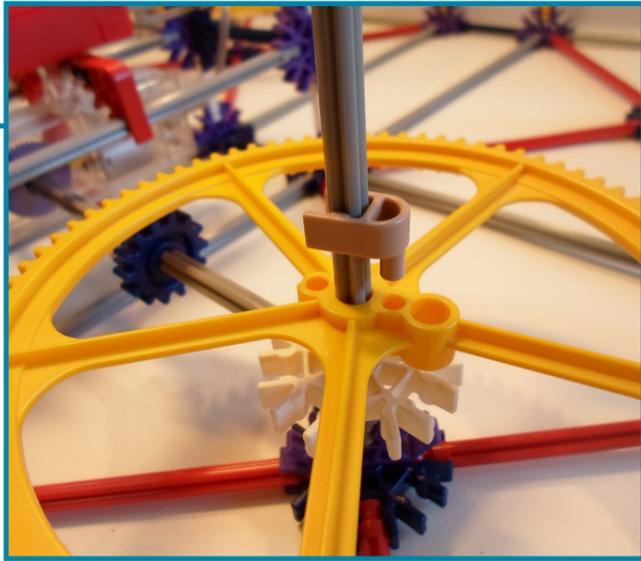


12

Put a big yellow gear on top. Make sure that this horizontal gear is in contact with the blue vertical small gear.



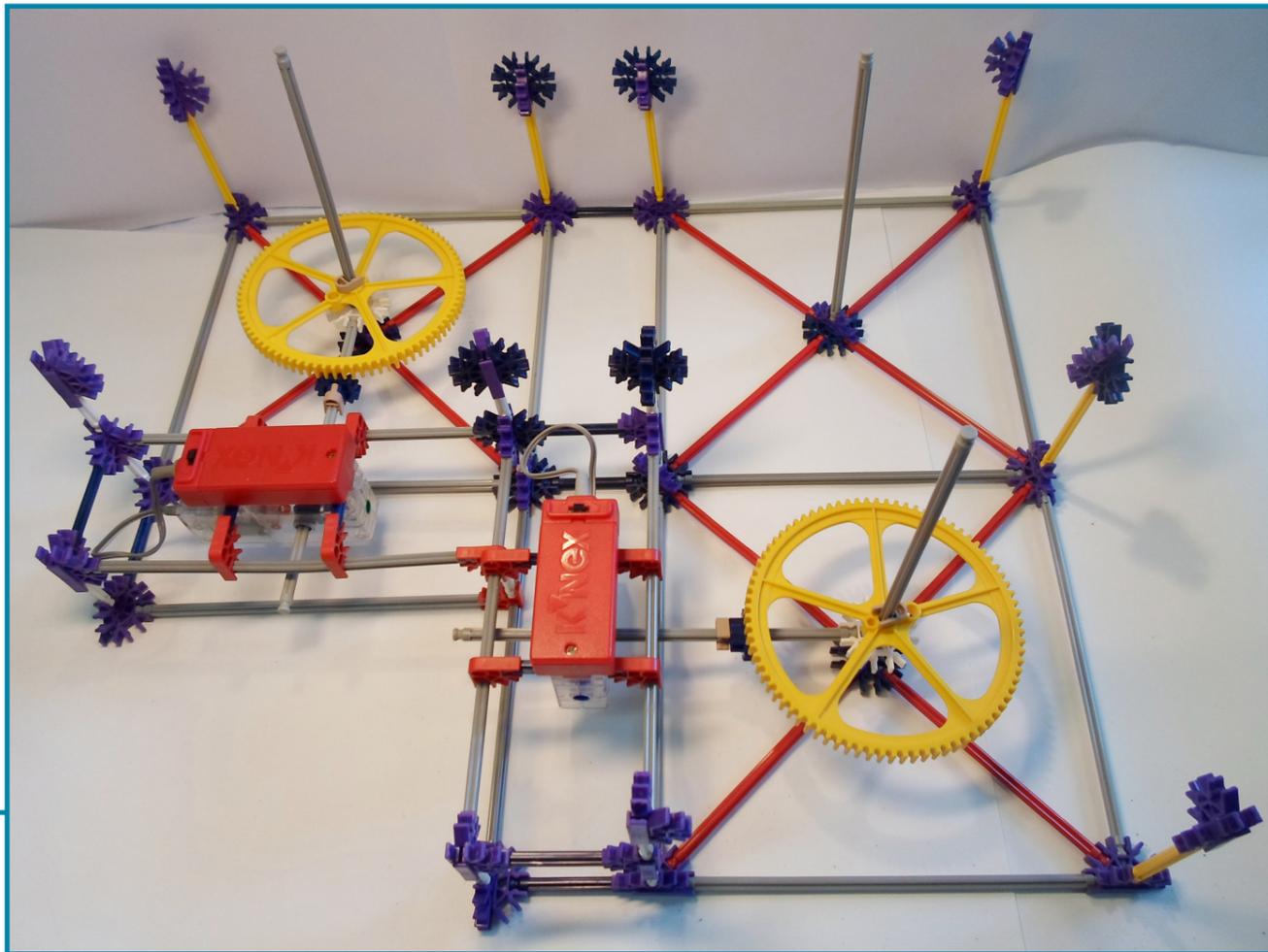
7



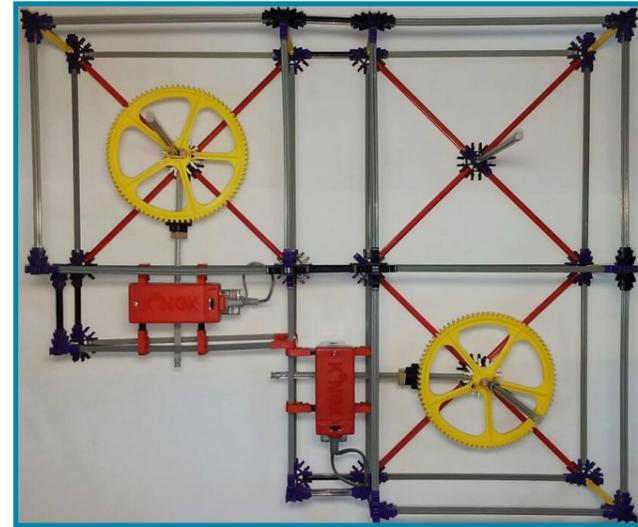
13

Click the sand colored end on the gray rod above the yellow gear, and slide them together. This causes the yellow gear to stay in a fixed position relative to the gray rod. Add in the x square two gray rings extra on top

OVERVIEW



Control panel Z-axis

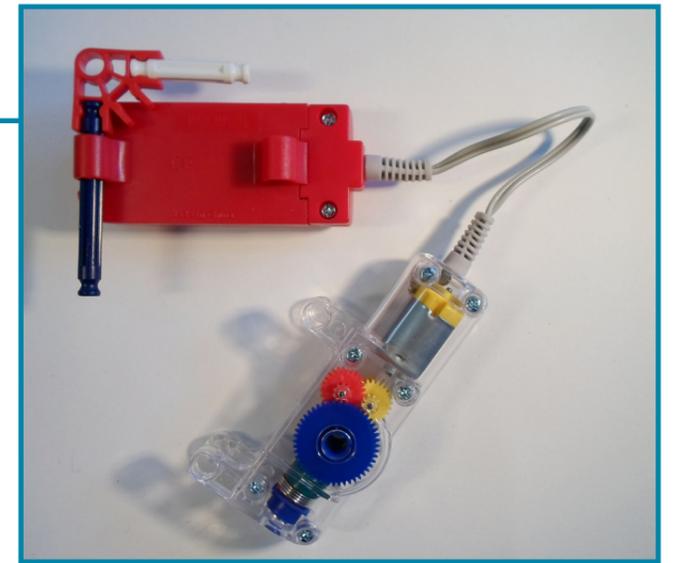


14

Add horizontal layer on top of the whole K'NEX printer. Therefore you have to connect all the purple-purple/blue-purple edges with gray or blue rods. Put 9 gray rods around the squares that are for movement, and one gray stick in the control panel. Connect the y square with the z-square with two blue rods.

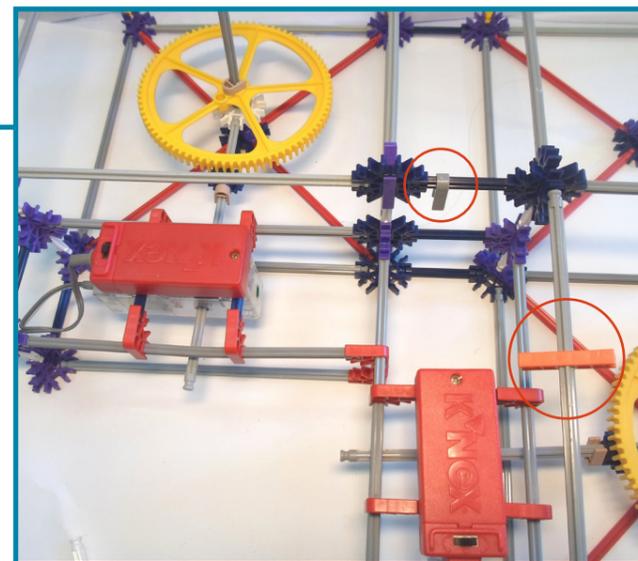
15

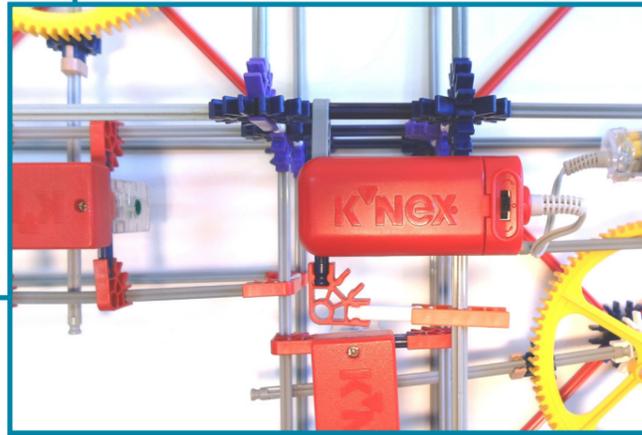
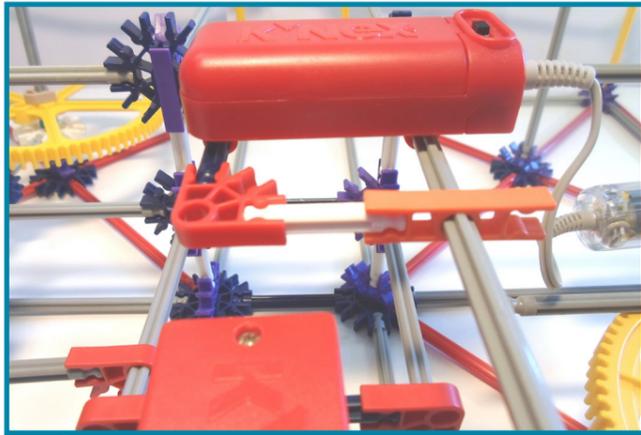
In panel don't place the motor on top of the remote, but keep them separately. First we place the control on the printer. Put the control upside down and put a blue rod trough the most left attachment hole. Connect one red connection part on it. Connect also a white rod to this red connection part, that will be parallel to the control.



16

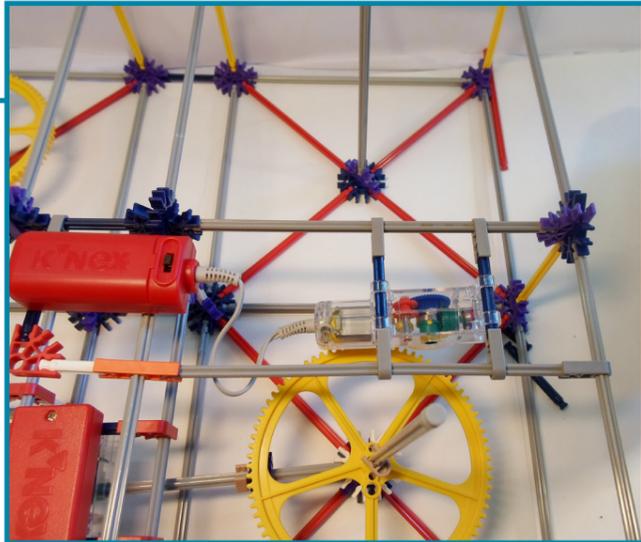
Connect a orange and gray connection part to control panel two in the way you can see on the figure on the left. So put the gray rod that's on the left side of the x direction to the center of the orange connection part. Put the blue rod in the center of the printer trough the center of the gray connection part.





17

Put the control panel left of the y direction control, and behind the x direction control, and one level higher. Therefore connect the white connection rod that's attached to your z-control to the orange connection part, and connect the blue rod in your control to the gray connection part. See that hole that's left on the bottom side of the control, you can put the gray rod in the control panel square through that hole. In this way the z-control is connected.



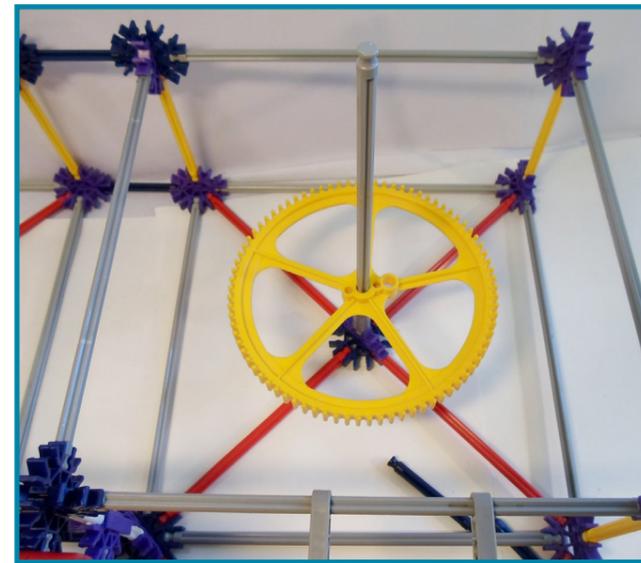
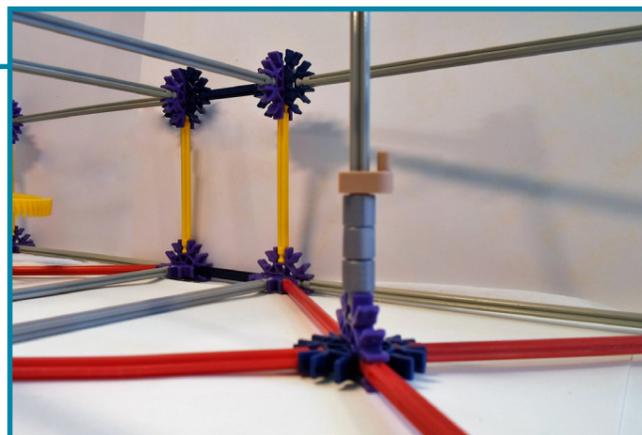
18

Now its time to connect the actual z-motor to the printer. Therefore you put it upside down, and put two blue rods through the holes, and close them both with gray connection parts. Add a gray rod in between the orange connection part of step 16, and the right side of the x-square. Therefore you can use again a gray connection part as you can see in the figure.

Z-direction

19

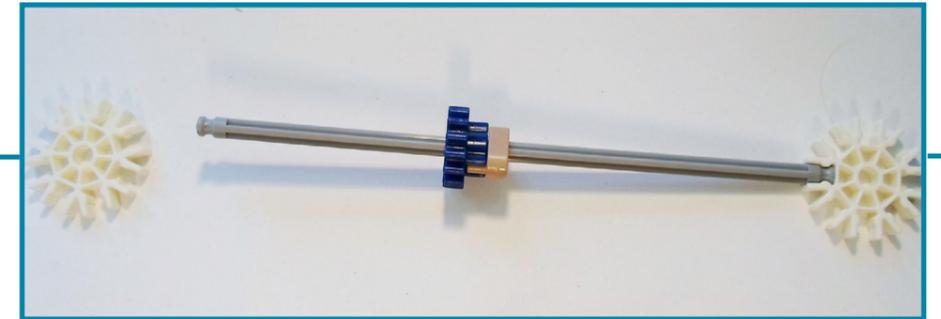
We start building on the z-direction. Add 3 gray rings on the central rod of the z-square. Add on the top a sand colored end.



20

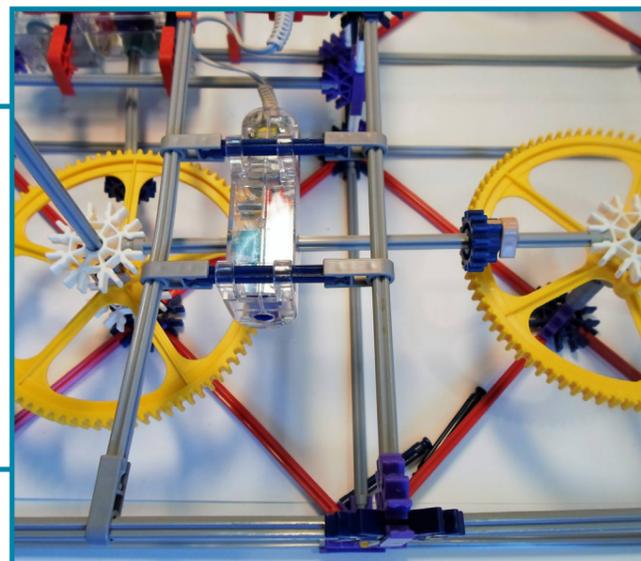
Put a big yellow ear on top of it. Let it stick to the gray rod by putting it together with the sand colored end below. Add one gray ring on top of it

21



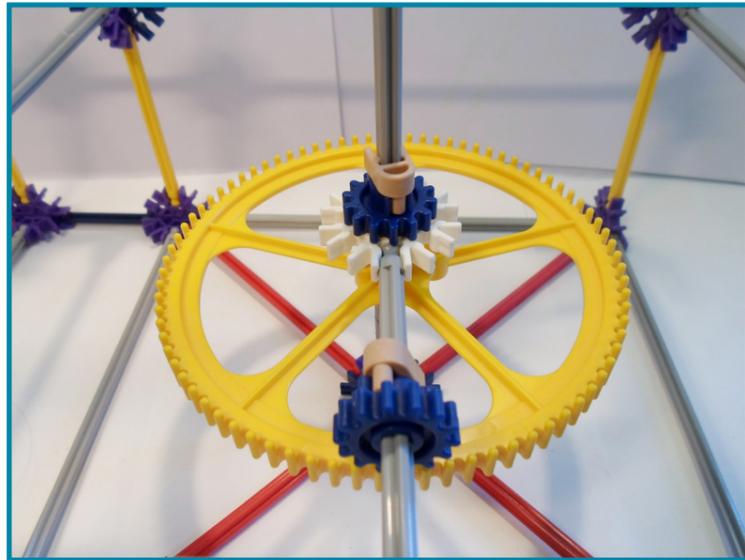
To give a circular movement to this yellow wheel we have to connect it to the z-motor.

Therefore take a gray rod and put a blue small gear on it, in combination again with the sand colored end. On the outside of the gray rods add two white connection parts. Don't connect the right side yet. First continue to step 22.



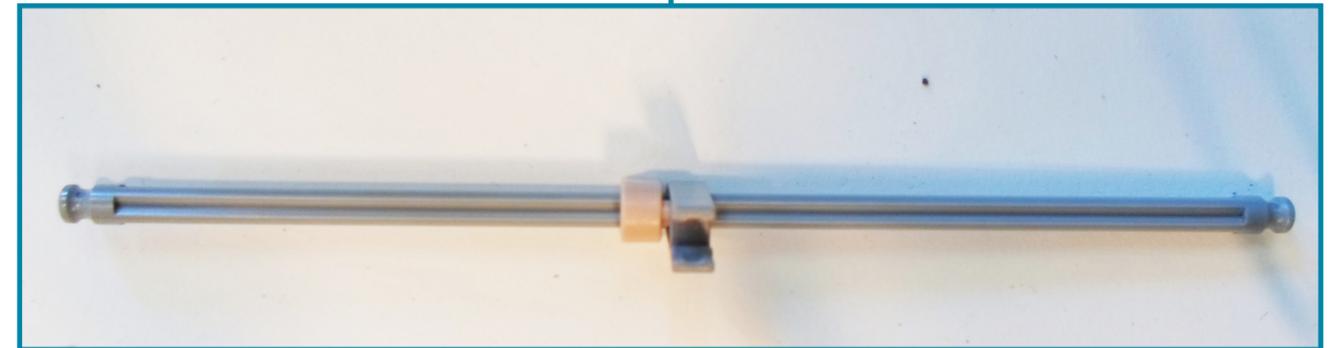
22

Put the rod you made in step 22 through the z-motor, in a way that the blue gear is connected to the big yellow z-gear. Slide the two white connection parts with the center on the center gray rod in the x and z-square.



23

We continue with the z-direction tower. Add on top of the white connection part in the center a blue ring, on top of that a blue small gear, and on top of that a sand colored end that sticks the gear on the gray vertical rod.

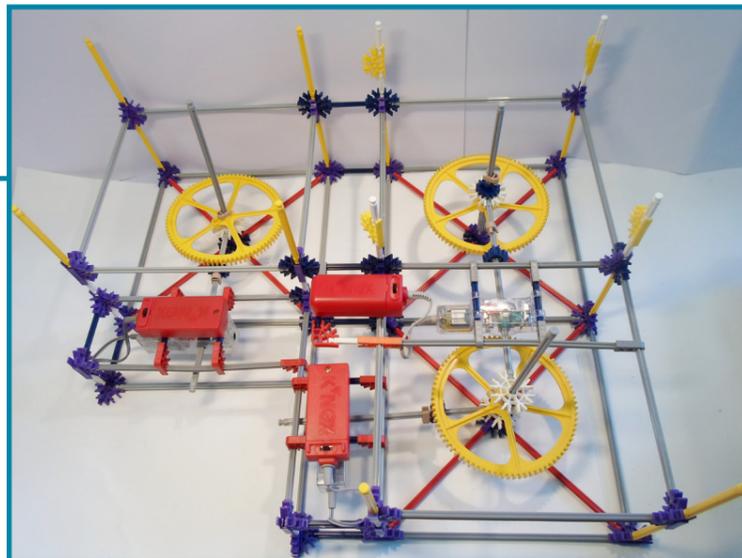


26

Grab a gray rod, and add a gray connection part to it and stick it to the rod with a sand colored end. Make two of this constructions.

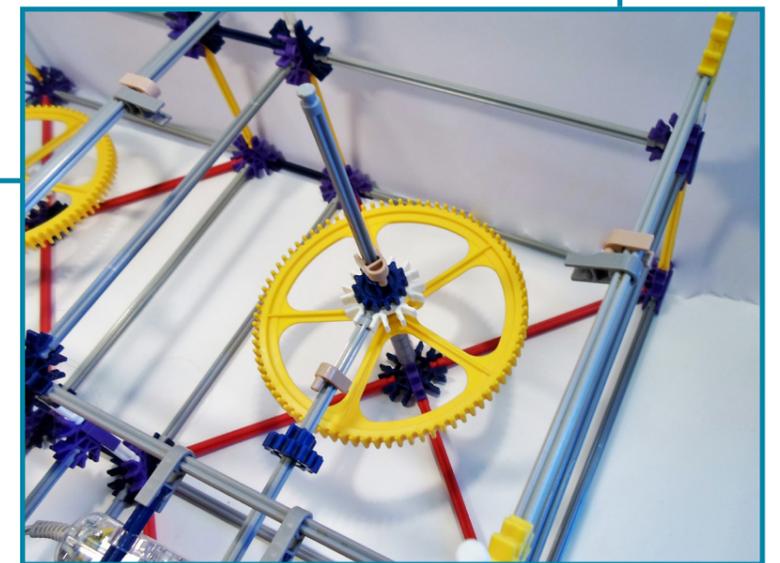
24

We start to build on the next layer. Put on every edge (purple-blue/purple-purple connection part) a yellow rod (6 in total), or a white-yellow-white rod (4 in total, placed around z-tower)



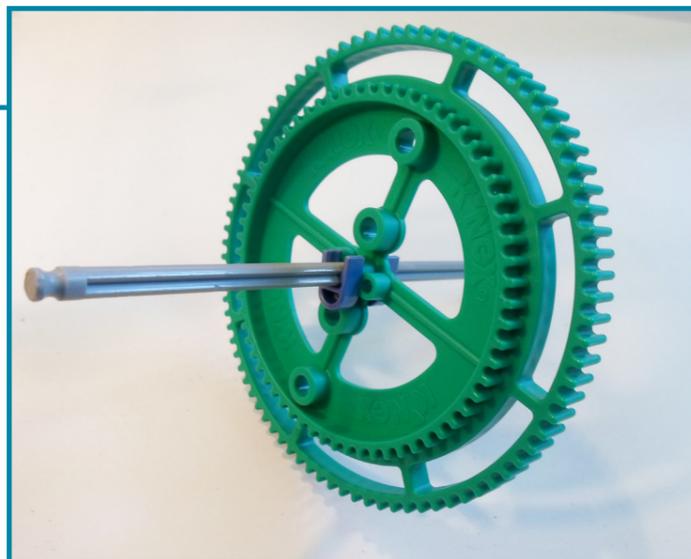
27

Add the rods you made in step 27 on the left and the right side of the z-tower, to the yellow connection parts that are vertical.



25

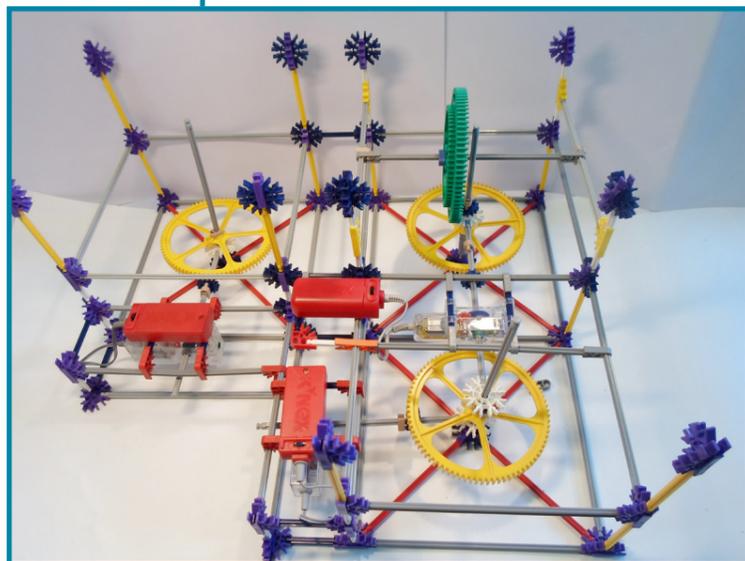
Take the green gear. Put a gray rod through the center of it. To let it stay at the same place put blue small ends on the rod. Be careful it is a blue and, that you don't stick the gear on the gray rod (so use the blue ends instead of the sand colored).



28

Place the stick with the gear you made in step 26 in between the gray connection parts on the left and the right side of the z-tower. Make sure that the green vertical gear has contact with the blue horizontal small gear.



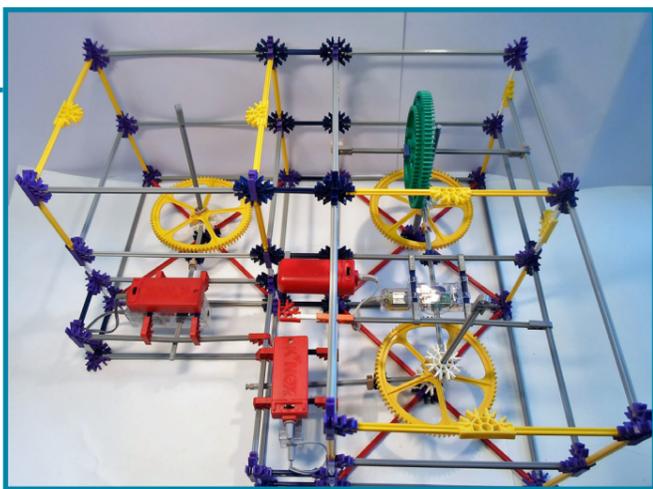


29

Put on every yellow rod again a purple-purple/purple-blue/blue-blue connection part.
 Amount:
 5 purple-purple
 4 purple-blue
 1 blue-blue

X & Y-direction

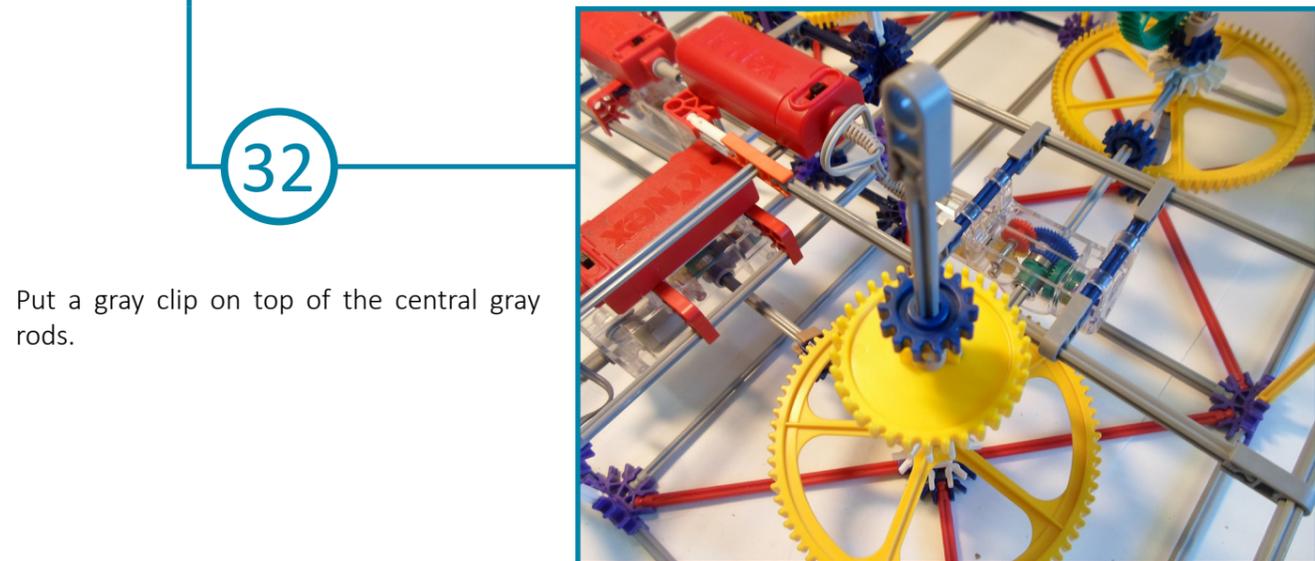
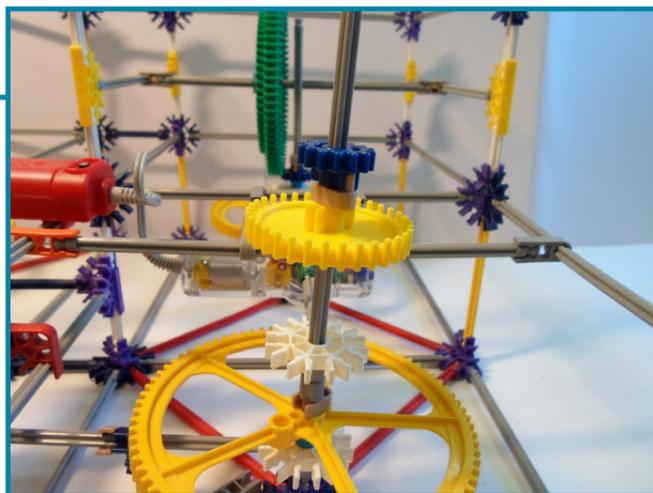
30



Connect all the added corners with gray sticks (6) or combinations of yellow stick - yellow connection part - yellow stick (4). This last combination you added in:
 - Left and right side of the y square,
 - Front and back side of the x square.

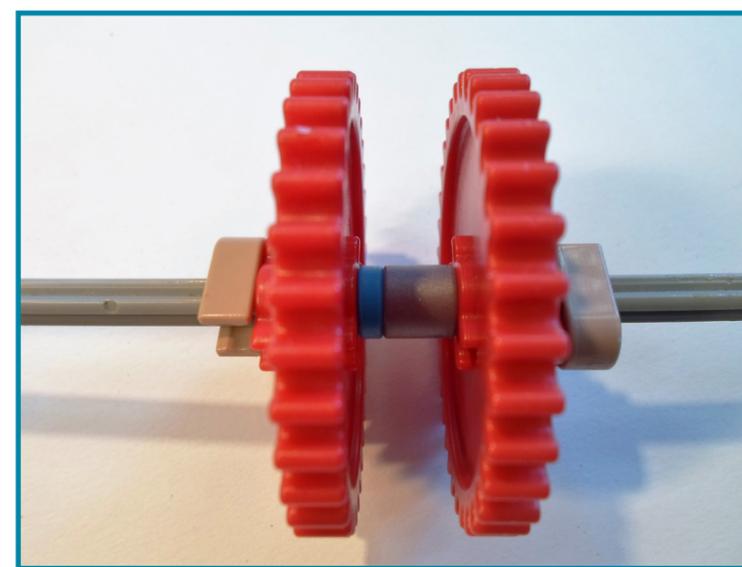
31

We continue with the x and y direction. The following steps counts for both towers. In this step we place first a sand colored end to the gray central rod's. Then add a small yellow gear to it. Attach another sand colored end to the gray rod, and place on top of that a small blue gear. This are the two acceleration types this printer has in each direction.



32

Put a gray clip on top of the central gray rods.

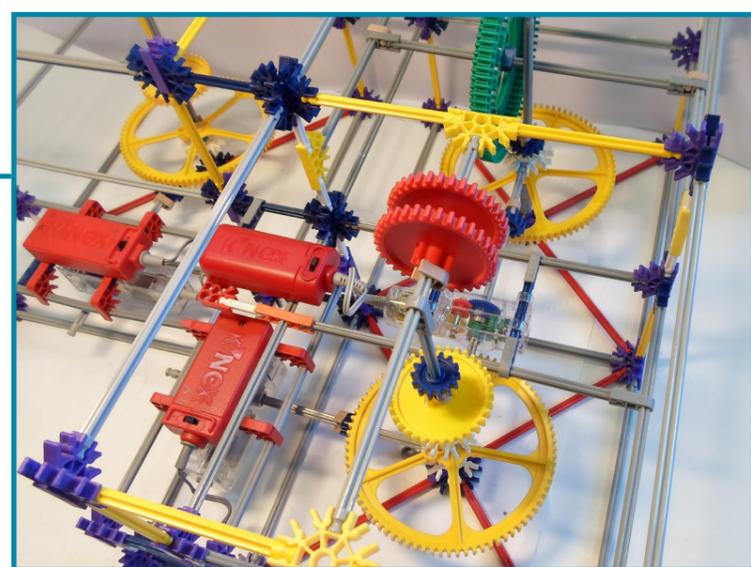


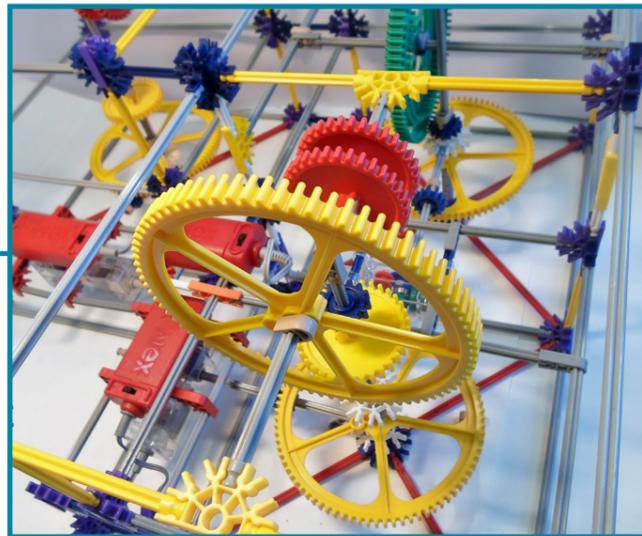
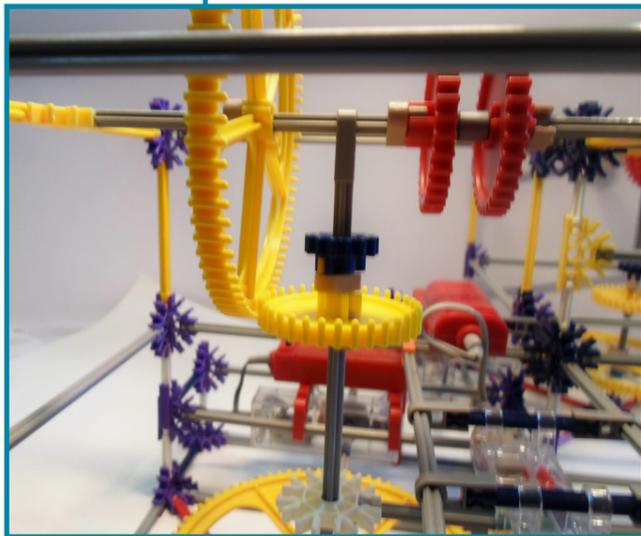
33

Make in total two of these constructs:
 Add two red gears on a gray rod, with in between a gray and a blue ring. Let them stick to the rod by making use of the beige clips again.

34

Add this construct to the x and y tower by putting them in between the yellow connection parts. Let the gray rod go through the central gray clip.



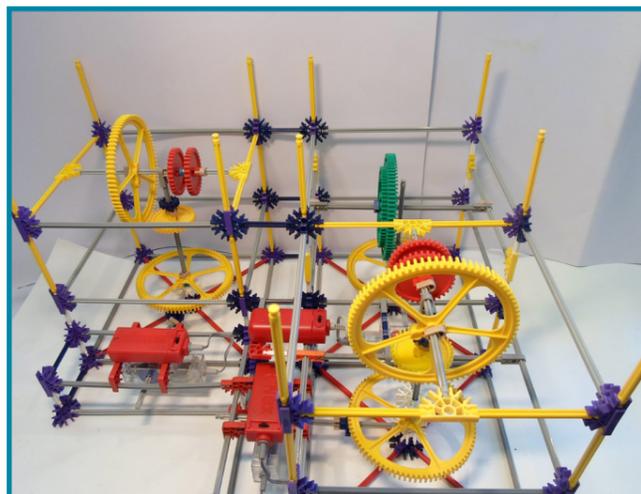


35

Add a big yellow gear on this same horizontal gray rod on the other side of the center point. Let this gear make contact with one of the small horizontal gears you added in step 31. If you make contact with the (small) yellow gear the printer head will go eventually in the fast mode. If you let this gear make contact with the small blue gear the printer head will eventually go in the slow mode.

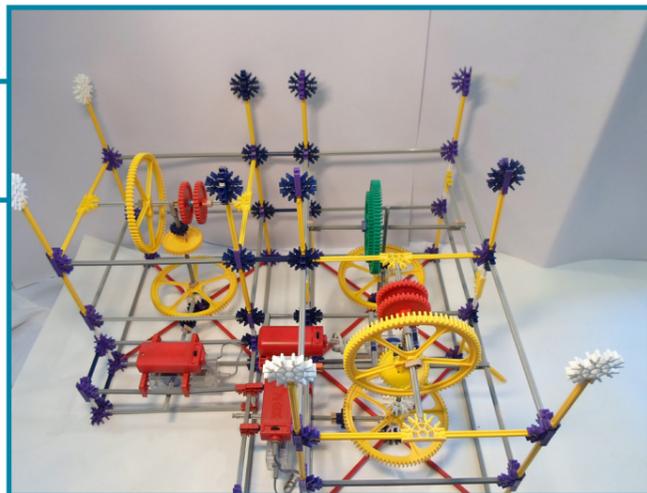
Pssst... Be sure that you did step 31 till 35 for both the x and the y tower!

Top layer



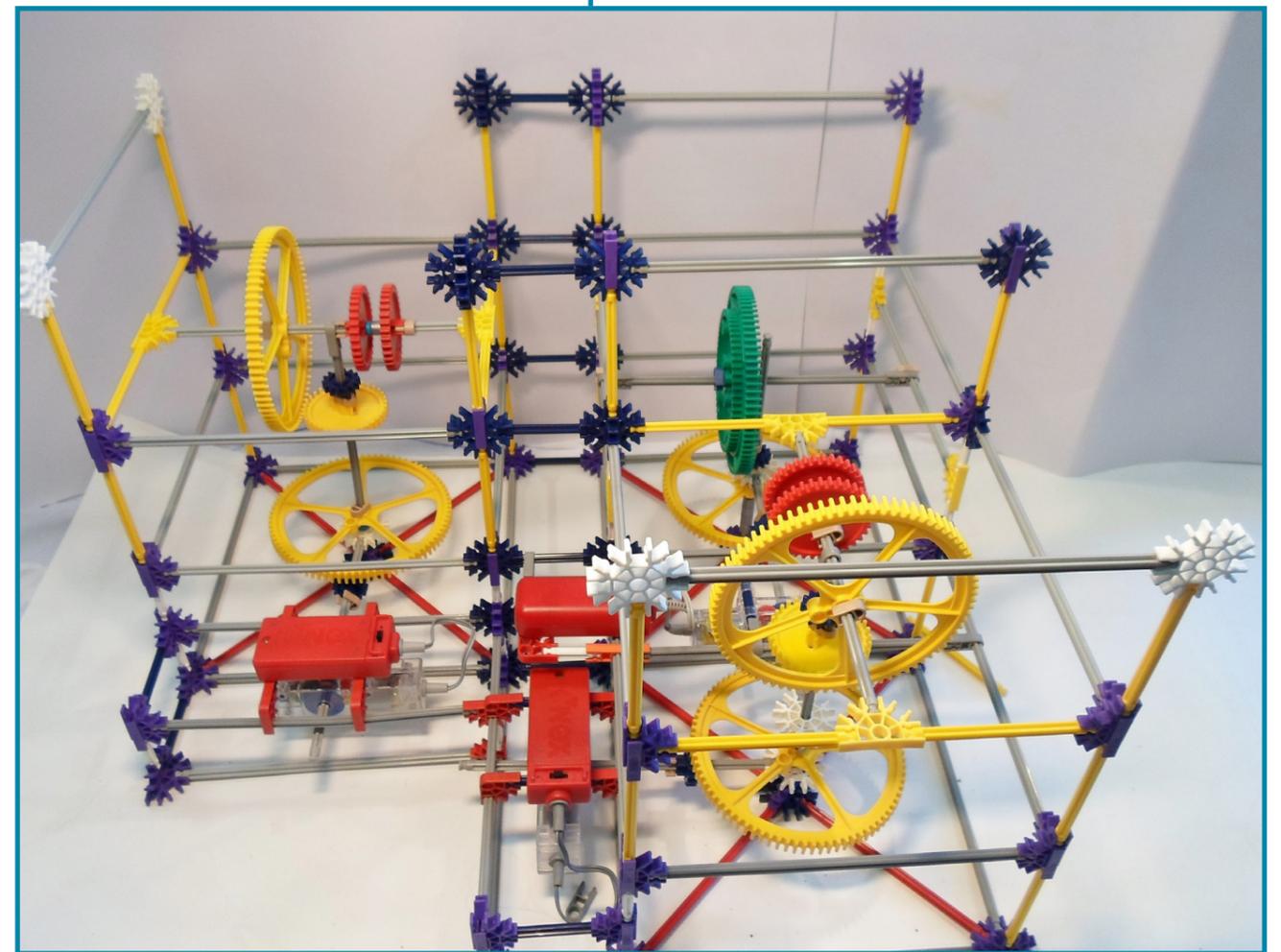
36

We start to build the next layer. Add on all the corners a yellow rod, in a total amount of 10.



37

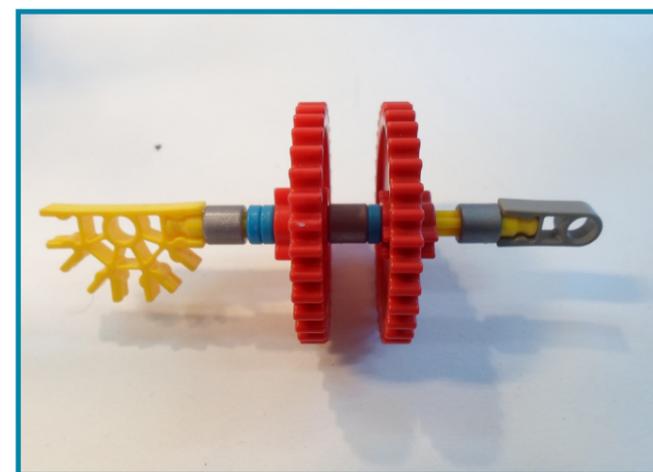
Add on every rod a connector. Add on the front/left side of respectively x and y tower a white connector. Further add combinations of purple-purple (1) / blue-purple (3) /blue-blue (2) to every yellow rod according to the photo.



38

Add new gray rods (4) and blue rods (2) on top of the printer. Make sure that the sides of the x and y towers stay empty

X/Y tower



39

Make 4 of this constructs as you can see in the figure. One construct consist of:

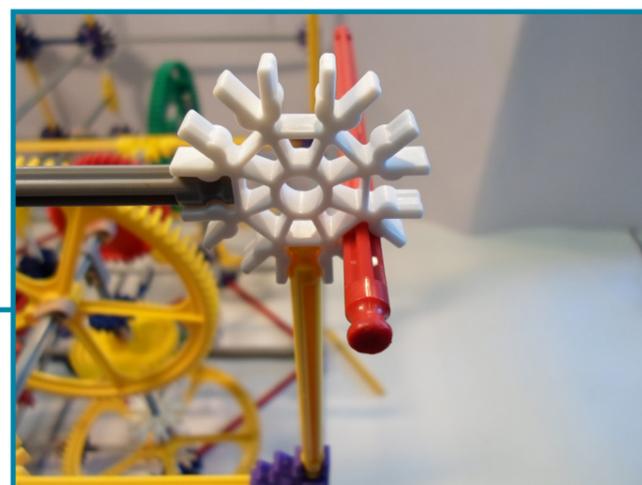
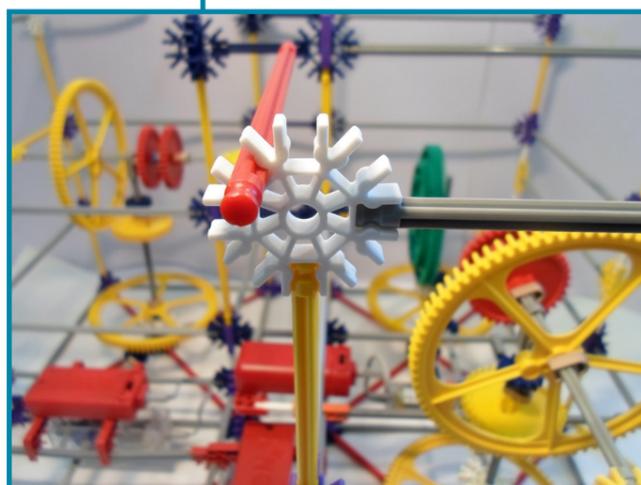
- One yellow rod
- Two red gears
- Three gray rings
- Three blue rings
- One gray clip
- One yellow connector

Do them in the order that you can see in the photo.



40

Click on every white connector a red rod. On every white connector there are 4 positions. It also depends of you look at the right of the tower of at the left side of the tower. It doesn't care that much on which position you put them for now. Later we use this to span the black chain. See 4 examples above and below.



41

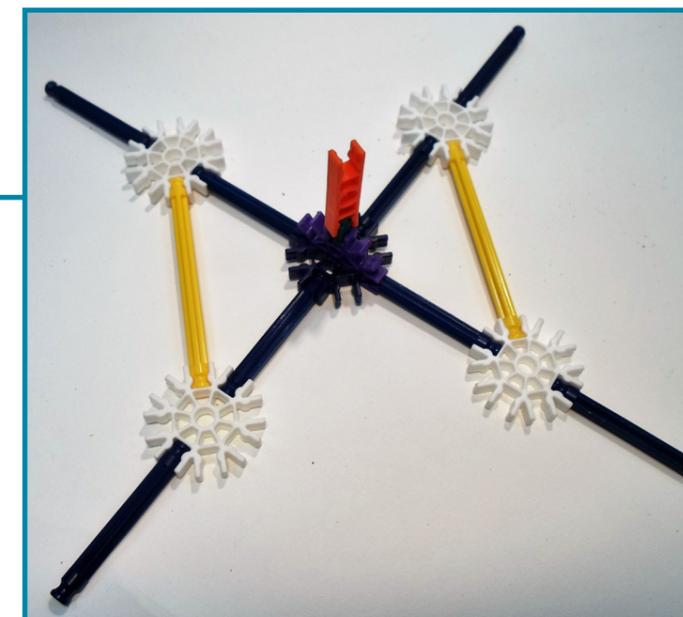
Click one end of the yellow rods you made in step 39 on the blue connectors on the right and the front side of the z-tower, on the sides of the x and de y tower. Connect the other side of the construct (the side of the yellow connector) to the red rod. Make sure that you connect the construct on the same position as you positioned the red rod on the white connector.
z-direction



42

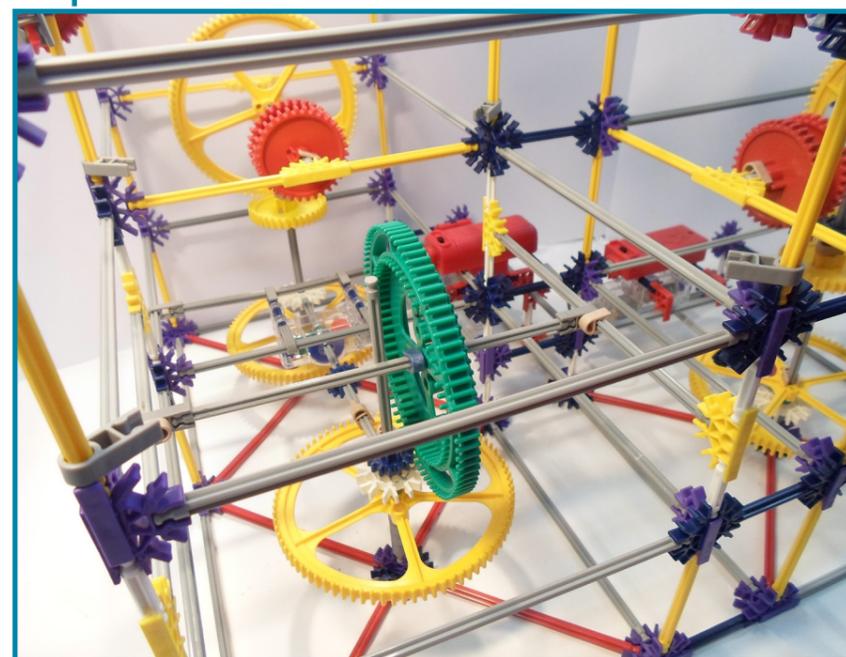
Add on the gray rods the following connectors:
 - Two white connectors on the upper gray rod of the x tower
 - Two red connectors on the lower gray rod of the z-tower
 - Two gray clips on the upper gray rod of the z-tower

(Photo taken from the other side)



43

We are going to build a platform. Take 4 white connectors and one purple-blue connector combination, and make a cross with 8 blue rods of it. Connect two sides of the cross with each other by a yellow rod. Add a orange connector on top of the purple-blue connector combination with a small green rod.

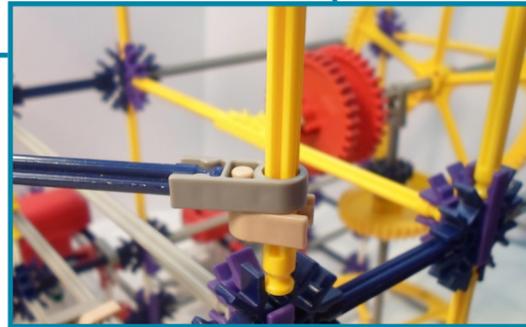


44

Add gray clips on the yellow rods on the corners of the z-tower.

45

Connect the platform you make in step 43 to these gray clips. Let the platform be in the right position by adding beige clips on the gray stick below the gray clips.



46

Connect the orange connection part on the central gray rod of the z-direction.

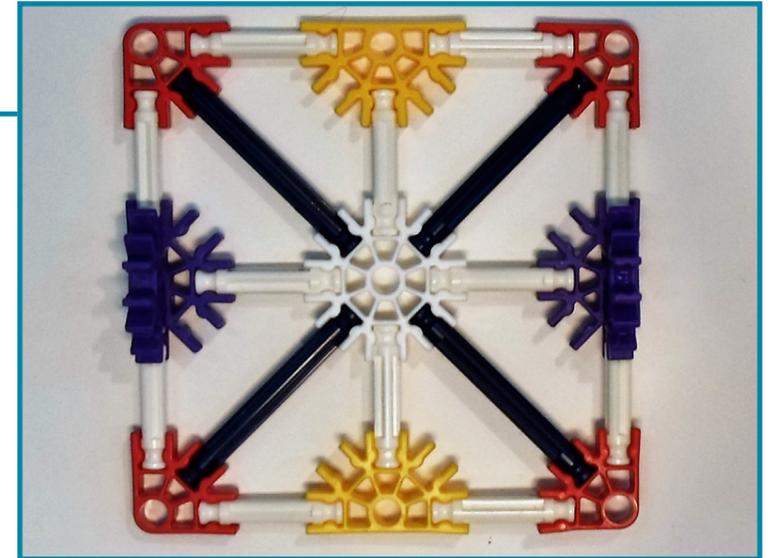


47

Now we came to the two different acceleration modes of the z-direction: we connect a yellow rod to an out of centered hole. For the fastest acceleration, choose the hole furthest from the center (upper figure), and for the slowest acceleration, choose the hole closest to the center (lower figure). Close the yellow rod by two red connectors.

48

Make another but smaller platform. This platform will be for the petridish (the paper we print on). The corners must be red connectors. In the center there is a white connector. The rods that connect these connectors are the white rods. In the top and bottom place the yellow connectors, and on the left and right place the purple-purple combination connectors.



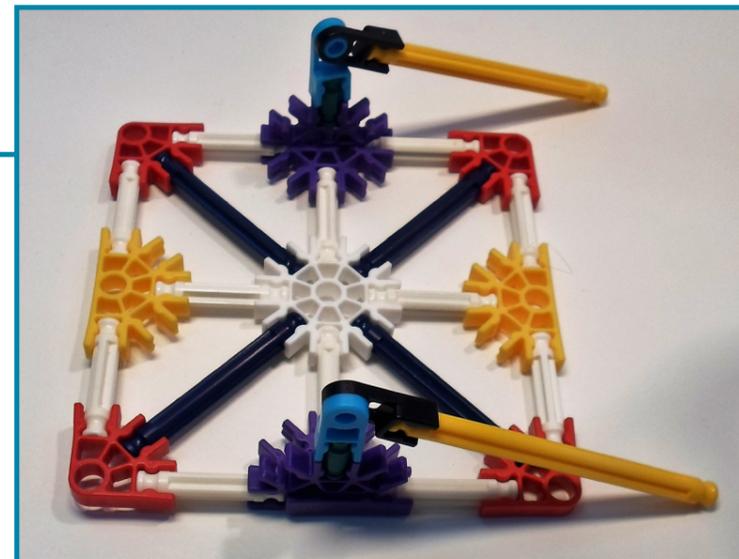
49

Add a moveable arm with a green small rod to purple connectors on the platform.



50

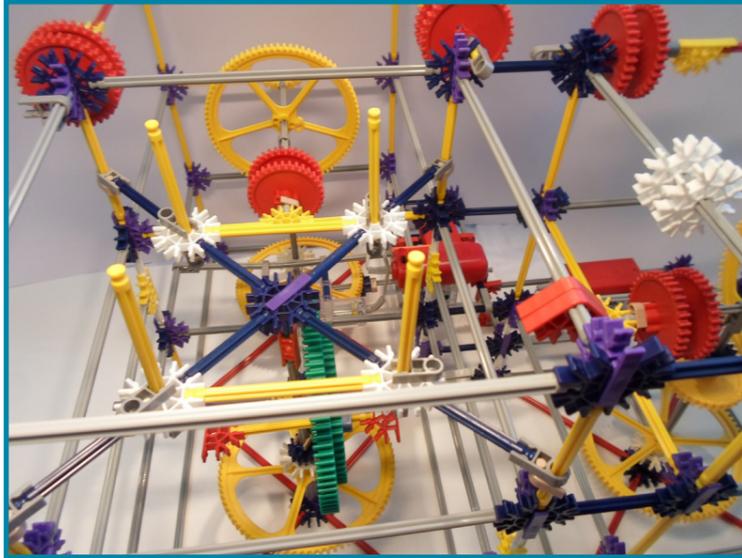
Add yellow rods to these arms.



51

Take another yellow rod. Stick one gray clip 0.5 cm from the side to the rod, and take another gray clip.



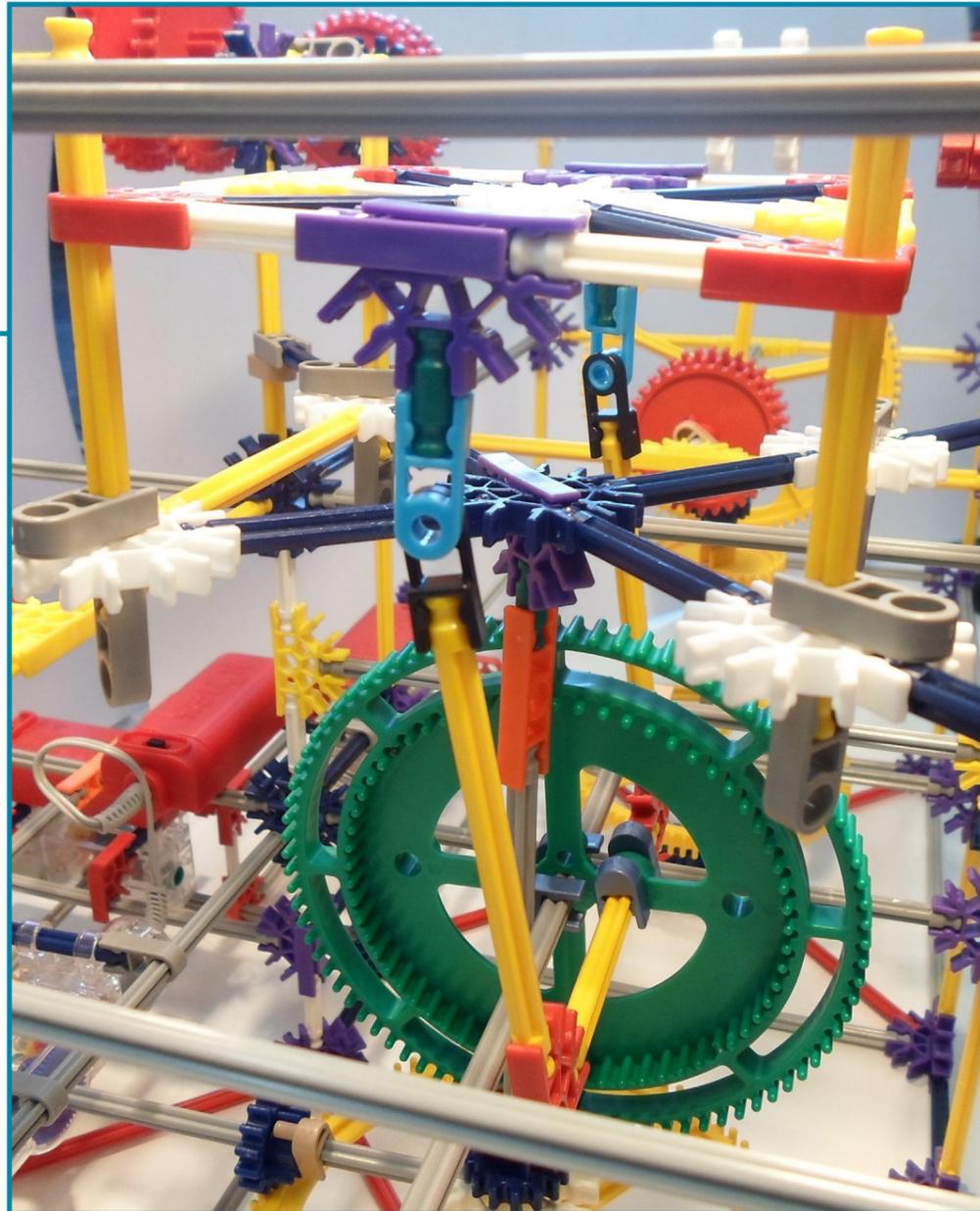


52

Add this rod to the platform you made in step 43, by putting it through the white connector, and close it by that other gray clip. Do this 4 times, for every white connector.

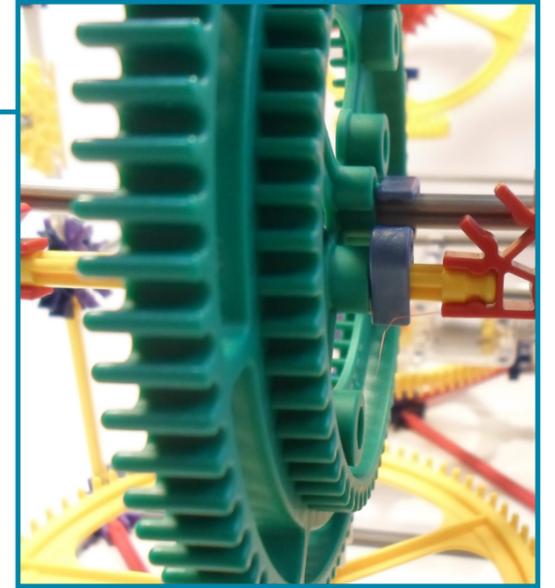
53

Now it is time to connect the second platform you made in step 48 on top of the big platform. Slide therefore the red connectors of the small platform on the yellow rods you just added. Connect the yellow rods of the that attached to this platform to the red connectors in the green gear.



54

Make sure that the yellow rod that sticks trough the green gear stays at the same place by the blue clips. That's the same for the gear itself. The green gear should be connected with the lower blue gear.



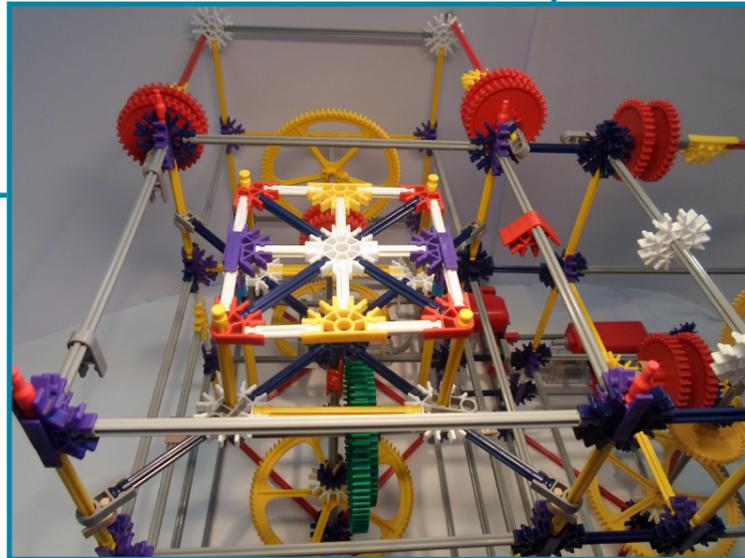
TOP VIEW



Moving parts

55

Add the pink small to big rod on every corner of the z-tower.



56

Remember the gray, red and white connectors you added in step 42? Add to the gray the green big to small rods. Add to the red connectors a white rod on the top.



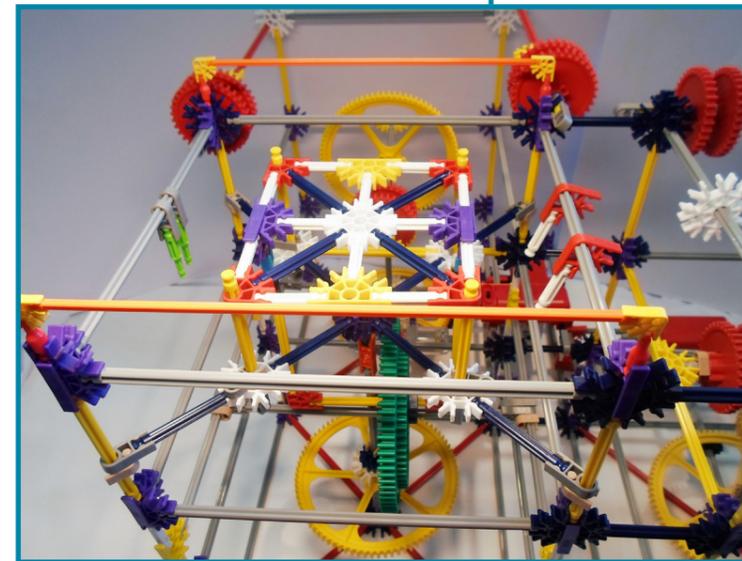
57

Take a small orange rod, and connect to that two yellow small connectors. Make two of them.



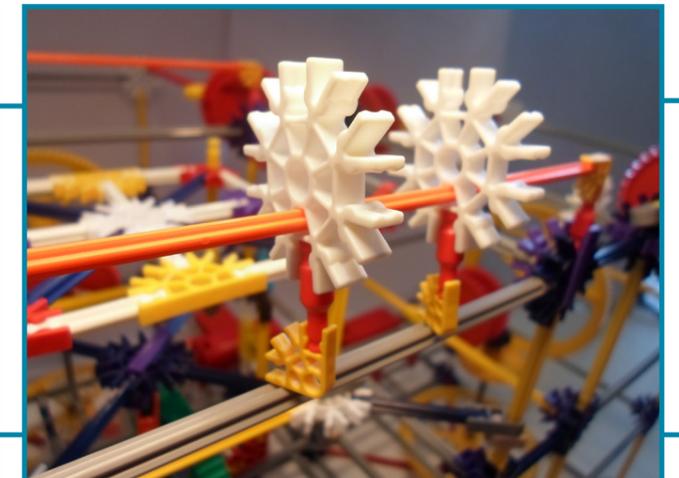
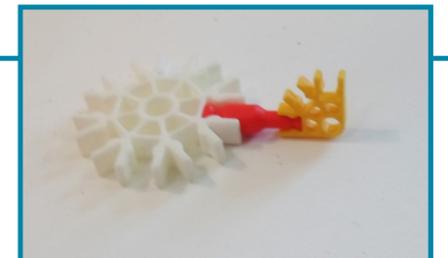
58

Place this small rods with the connectors on the pink rods that stick out on the top. Do this on the top and the bottom side of the z-tower.



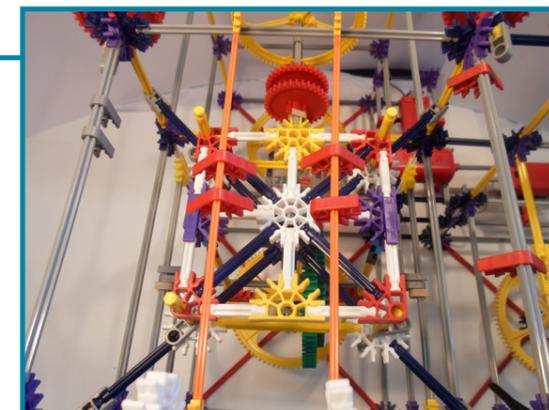
59

Take a white connector, and add a pink big to small rod, with a small yellow connector on it. Make four of them.



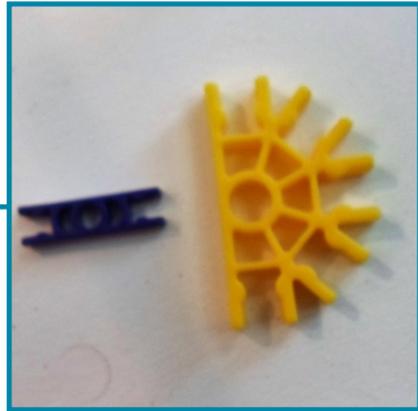
60

Slide two of these on one of the small orange rod's. Slide the others on the other orange rod.

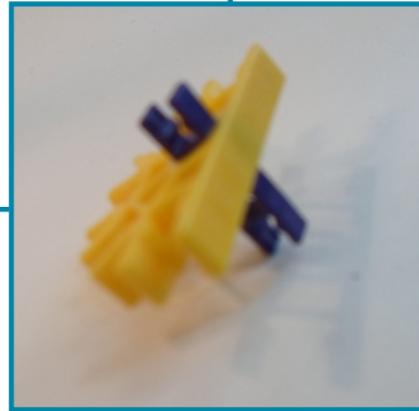


61

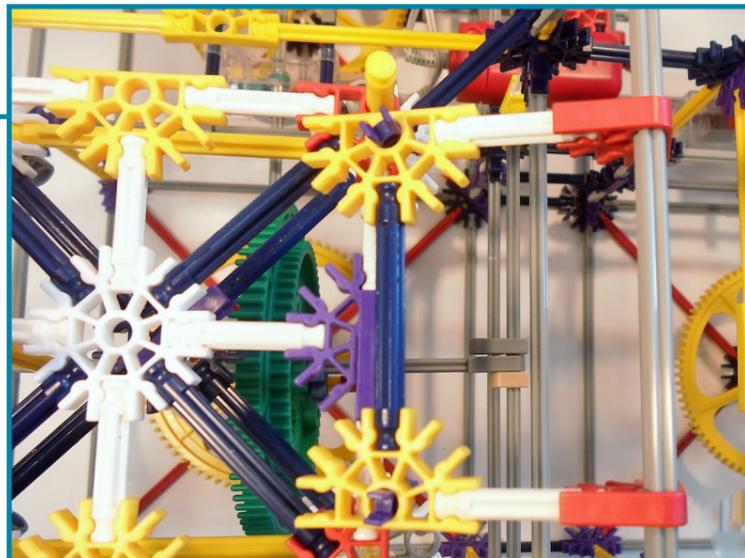
Slide two of these on one of the small orange rod's. Slide the others on the other orange rod.



62



In this step we make a combination of a small and a big connector. Take the small blue connector, and put it through the center of the big yellow connector. Don't be afraid to apply some force.

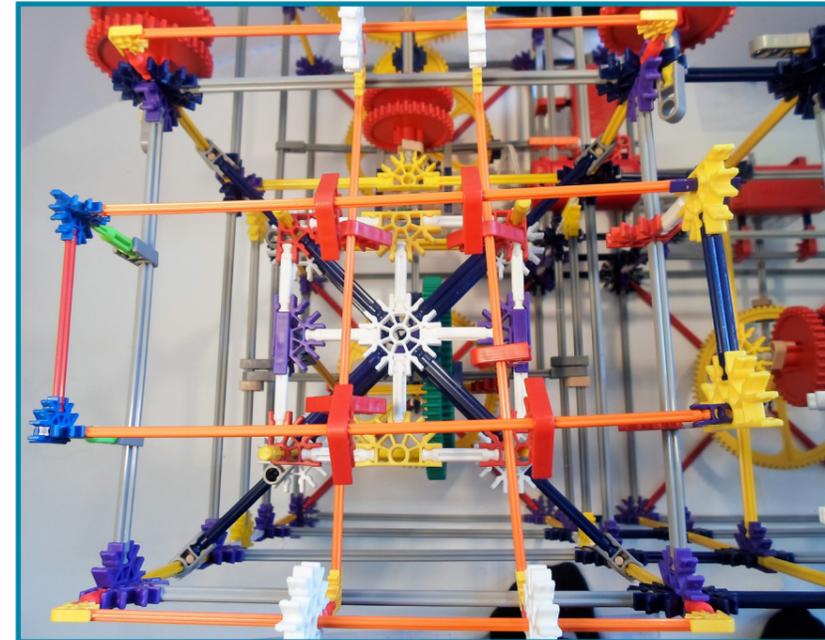
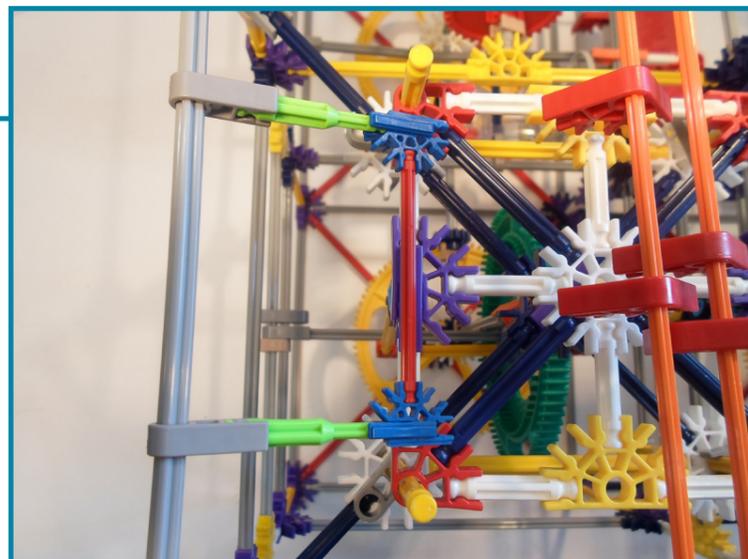


63

Add these to the red connectors with the white rod on it you made in step 56. Put a blue rod in between the yellow connectors.

64

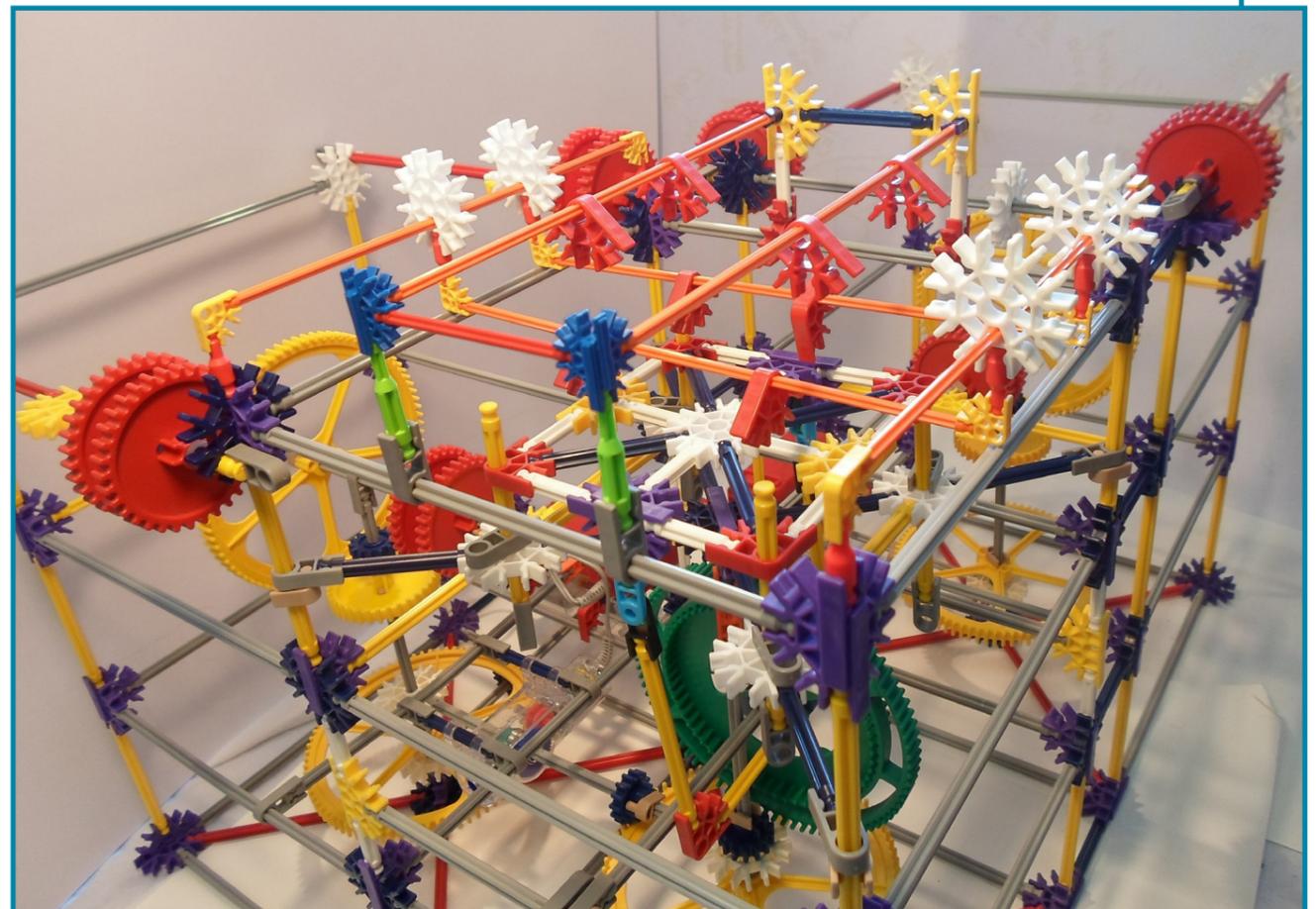
On the other side of the z-tower there are still the gray clips with the green sticks (you made in step 56). Put a small blue-blue connector combination on top of the green rods.

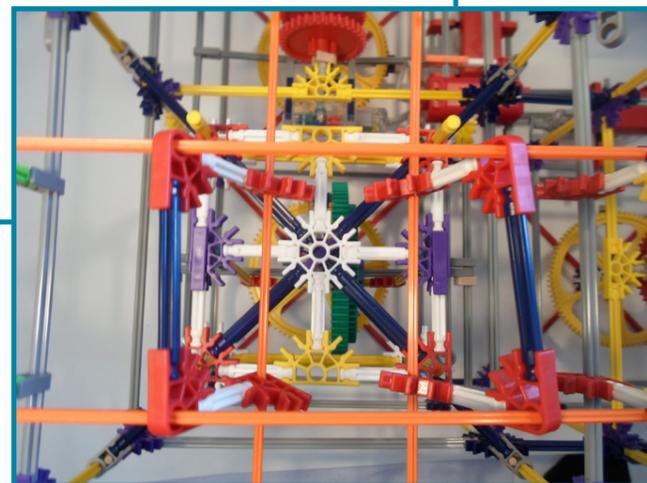


65

Connect now again with thin orange rods the blue small connectors in the left with the blue-blue small connectors on the right with each other. So this is the third layer of orange of orange rods on top of each other. Again slide two red connectors to both of the rod's.

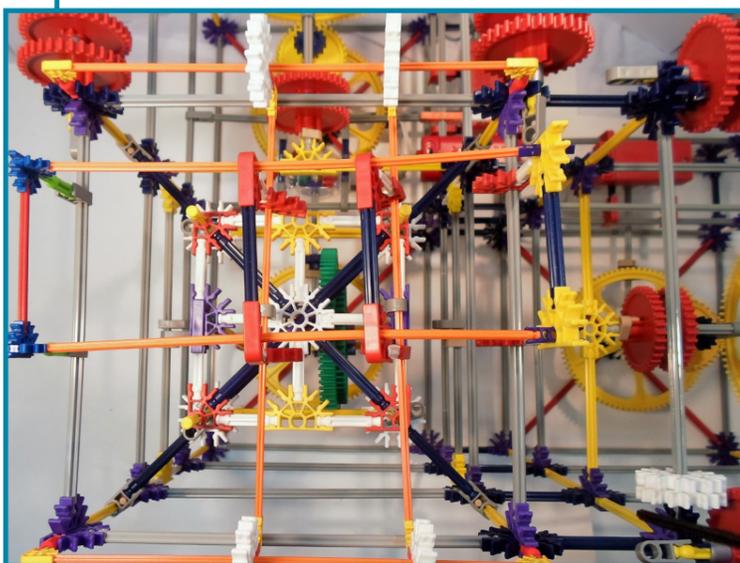
OVERVIEW





66

Now we are going to connect the red connectors you put on the orange rods. Place them more or less on top of each other, and connect them vertical with a white rod (four in total). add them horizontal with a blue rod (two in total).

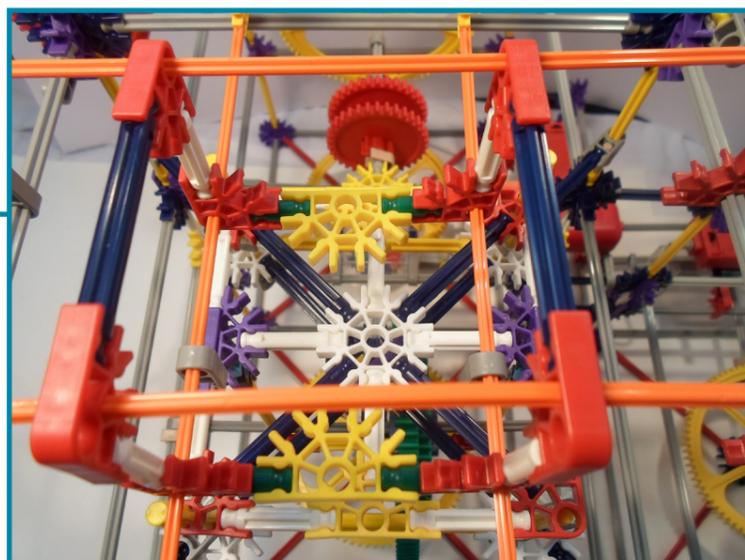


67

Add two gray clips on the lowest orange rods in between the red connectors

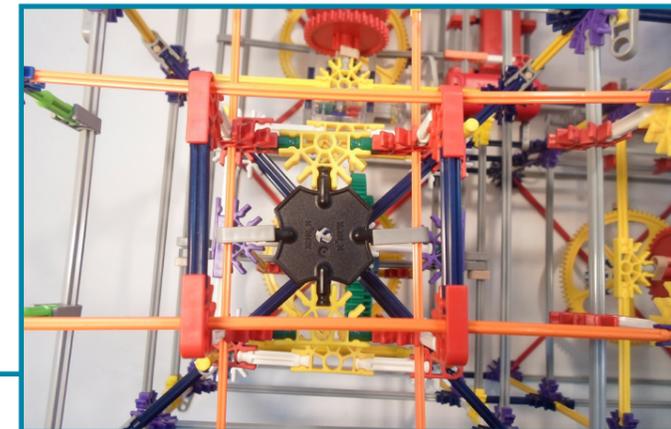
68

Add two gray clips on the lowest orange rods in between the red connectors



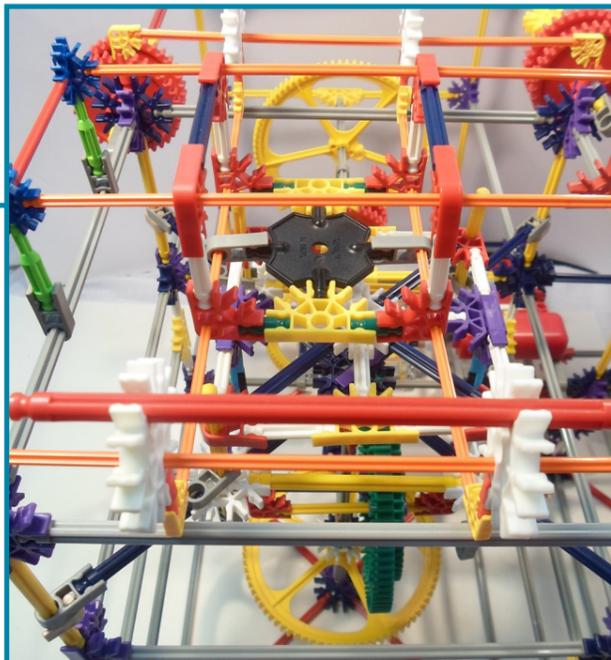
69

To finish the needle holder connect a black platform to the yellow connectors and the gray clips



71

Connect a gray rod to two red connectors

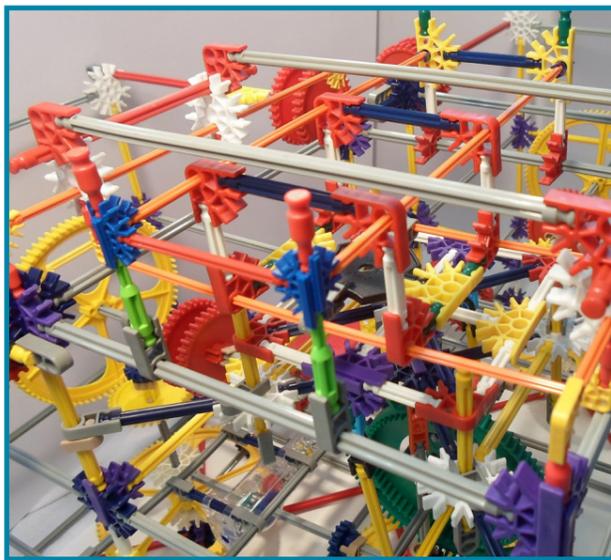


70

To support the movable structure, click a red rod on the white connectors that are attached to the orange rods, located on the upper and the down side of the z-tower.

72

Click two of these on the red rods from step 71, in a way that you connect the one side to another





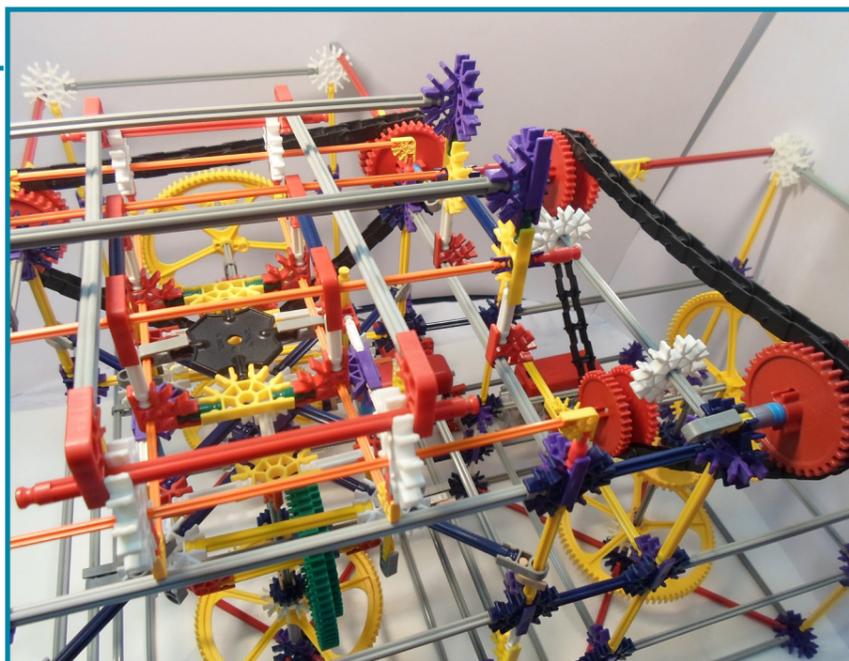
73

Go to the other direction movement, and add there also a supportive layer. Do this by placing pink small to big rods on the blue-blue connectors, and on top of that the big purple-purple connectors. On the other side put the also the big purple-purple connectors on top, but there on the yellow connectors and a green rod. Connect both sides with a gray rod. You can also support it more by placing a blue rod between the other sides.

Finishing steps

74

Put now a black chain in between all the red parallel gears in the x and the y tower. Try different lengths of the chain by adding and removing parts of it. The chain has to fall with the small protuberances into the indentations of the gears. You can also fit the chain by put the rods with the gears on different positions on the connector (see step 40).



Y-direction

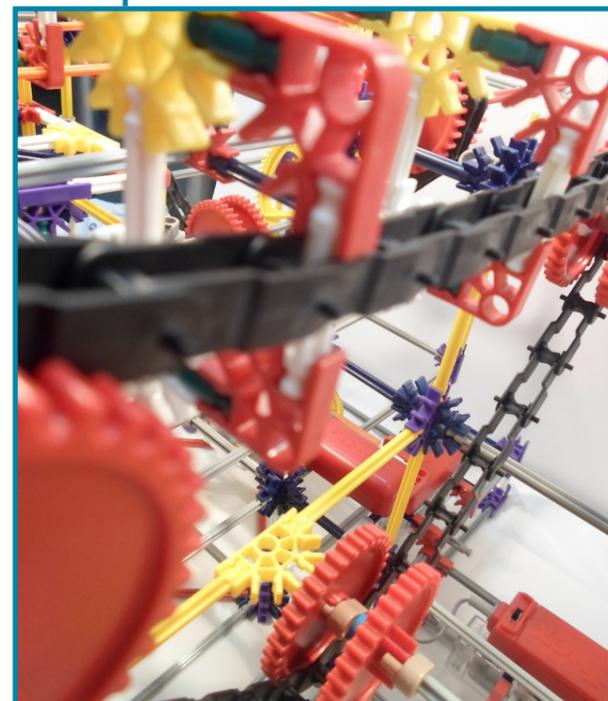
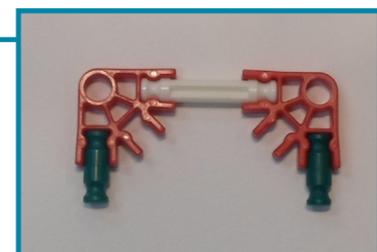


75

We are going to connect the movable parts to the chain. Therefore we go first to y-direction. On the small purple connector you put through the yellow connector, you attach to the other side a pink big to small rod. Add on that an orange connector with a green rod, to a yellow connector. That yellow connector is again attached to the white connector you added in step 42. Connect the white connector with the red connector to close the square.

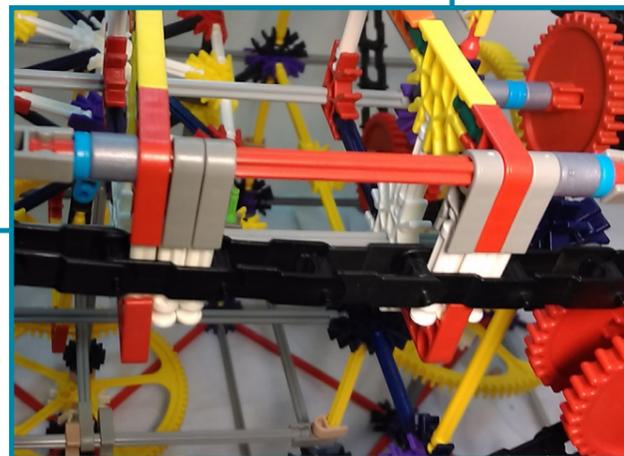
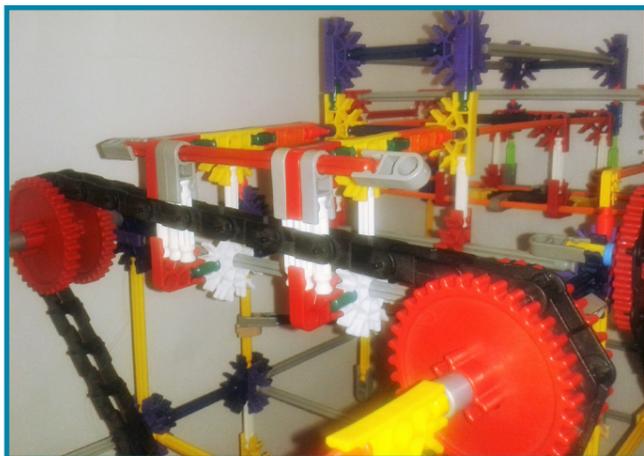
76

Make a hook of the combination of two red connectors, one white rod in between and two green rods on the sides.



77

Connect with this the chain to the moving part. Make sure that the white rod is going trough the chain. The green ones need to be connected to the yellow connectors



78

Take a gray rod and put it through the center of the red connectors. Add combinations of gray clips and white rods to fill up the empty space between in the chain. This make sure the printer reacts accurate. Close the red rod also by two gray clips.

X-direction

Connect two green rods to a gray link each. Connect the gray links with a white rod. Repeat this so that you have two.

79

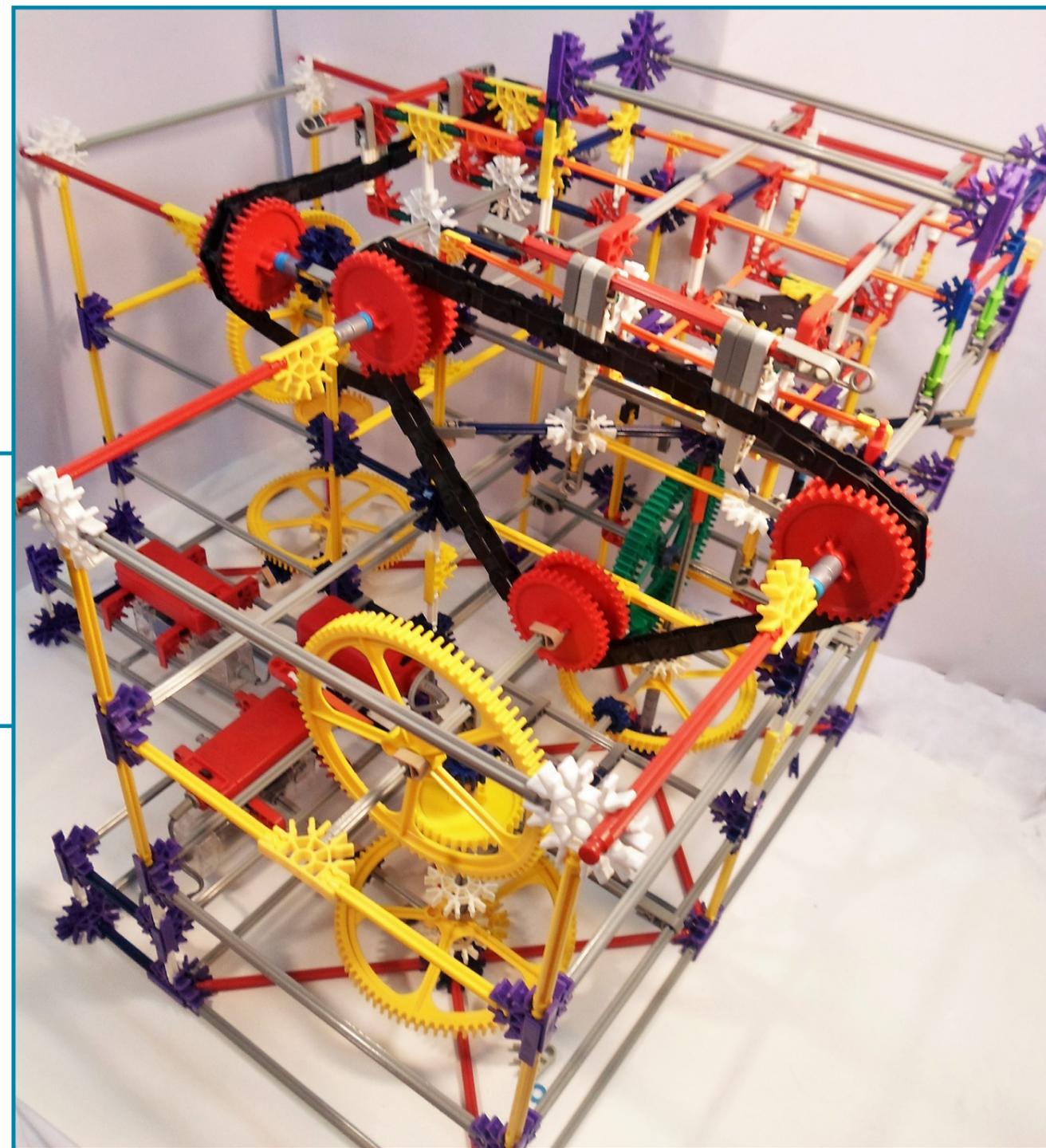


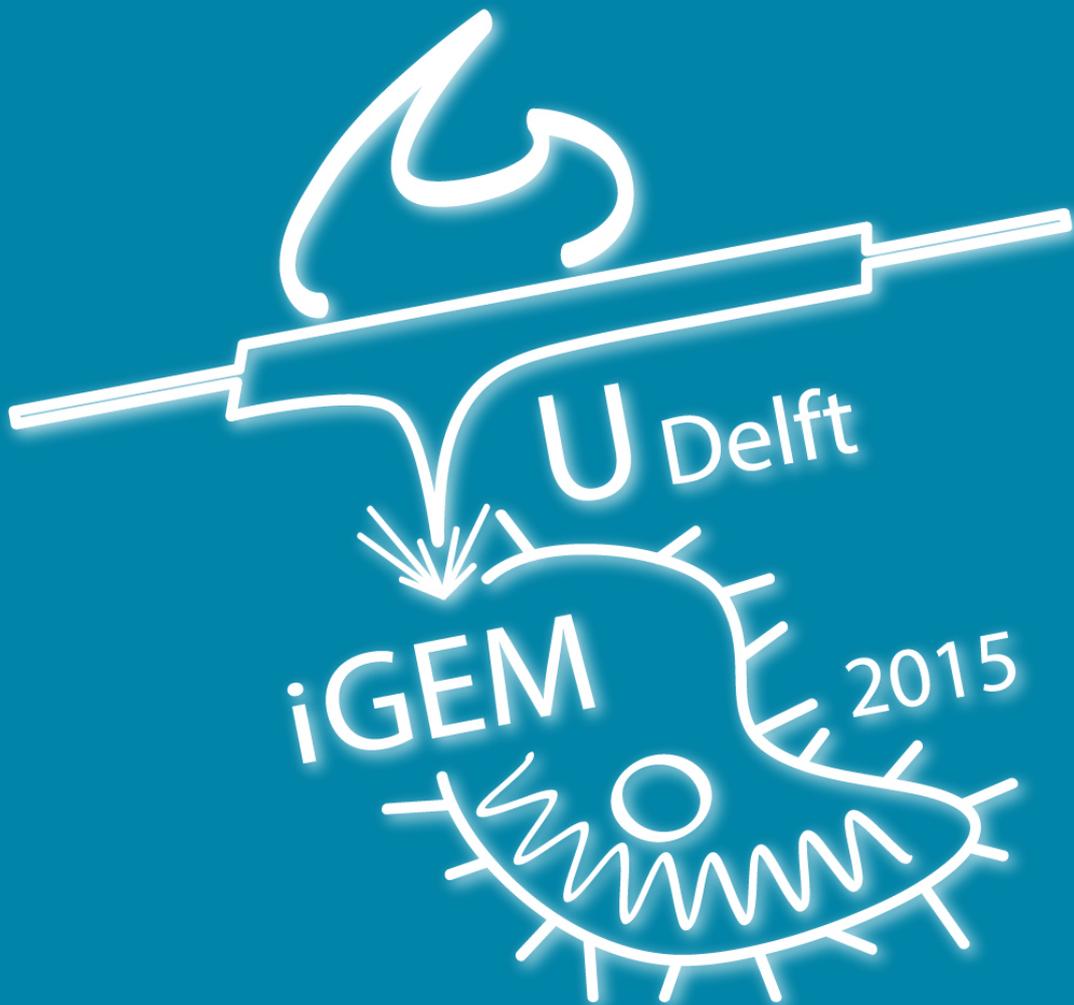
80

Connect this construct in the same way to the x-direction chain as you did on the y direction chain. Only here attach the green rods to the white connector. Also do step 78 to this side.



RESULT





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