
SPINETEC
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4340
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Vision:

To be able to create more environmental friendly buildings by making the internal concrete structure stronger, lighter and cheaper by using less material.

How:

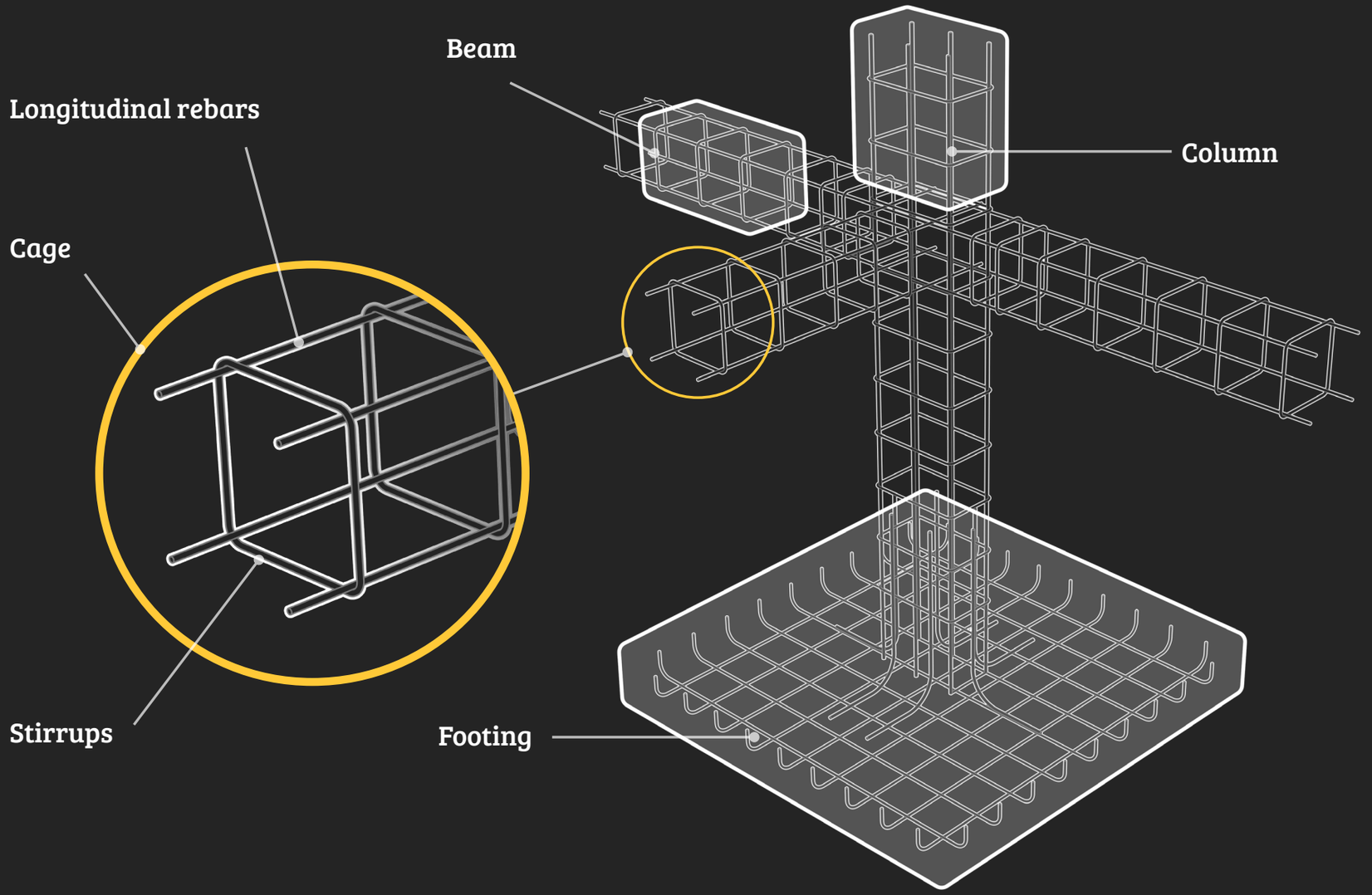
Automated manufacturing of rebar cages inspired by biomimicry. Each cage element will be custom build on site to get the maximum strength abilities and to be optimized for its placement in the building.

Benefits:

- Up to 30% less concrete and iron is needed.
- Decreased CO2 emissions: no shipping of pre-fabricated cages.
- Custom-designed reinforcing cages made on-site.
- Curved cages with optimized design for maximum strength.
- Less manual handling and heavy lifting of rebars.

Background

Rebar cages is a very common reinforcing element in concrete buildings, and they can be found in columns, beams, and footings. These cages are still made by hand, which is time-consuming, expensive, and labour-intensive. There are advantages to ordering prefabricated cages, but the shipping cost and environmental impact negate these advantages.



Background

Today, metal reinforcement for concrete buildings is either made on-site or prefabricated. In most parts of the world, the building industry is moving towards a scenario where the internal structures are pre-made in a factory, which has a lot of benefits. So there is a design opportunity to combine the good things from the two production methods.

Production at site

- No shipping of bulky cages (less environmental impact)
- Possibility to customize cages (shape and size)

Production at pre-fab

- Cheaper
- More precise
- Controlled environment
- Less waste material
- Drawings direct from 3D
- Less labor intense work (lifting heavy rebars)

Biomimicry

By rethinking and taking inspiration from nature (the human femur) offers new possibilities for the design of internal structures for concrete buildings by redistributing the existing forces in a more effective way. This results in a much lighter structure with the same strength, while using less concrete and iron.

1100 kg

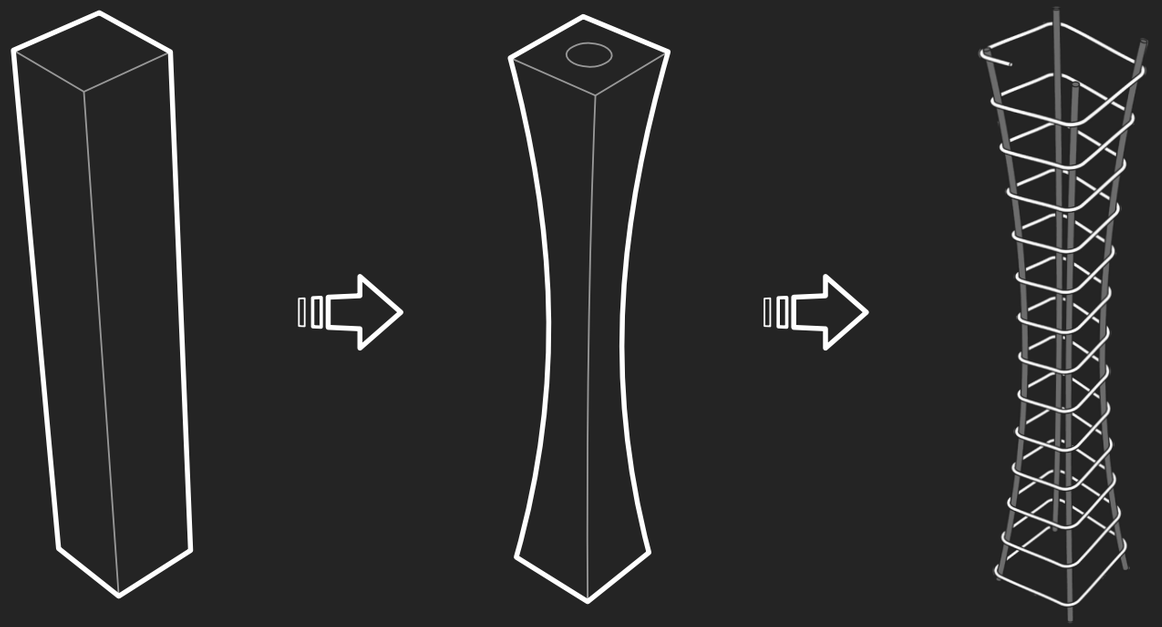
Conventional structural column

750 kg

Hollow Biotectonic column

Rebar

How the internal structure could look like

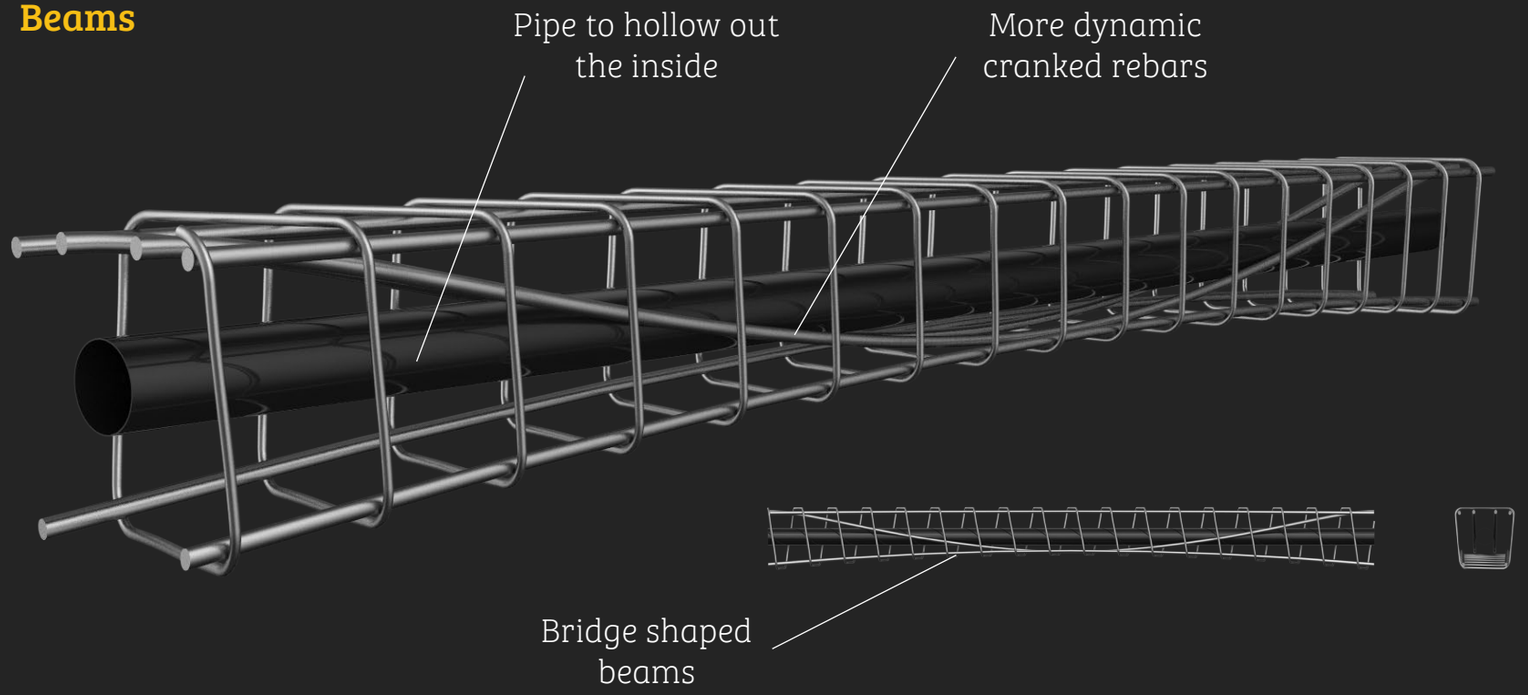


“ The femur’s hollow shaft design provides maximum strength with minimum weight “

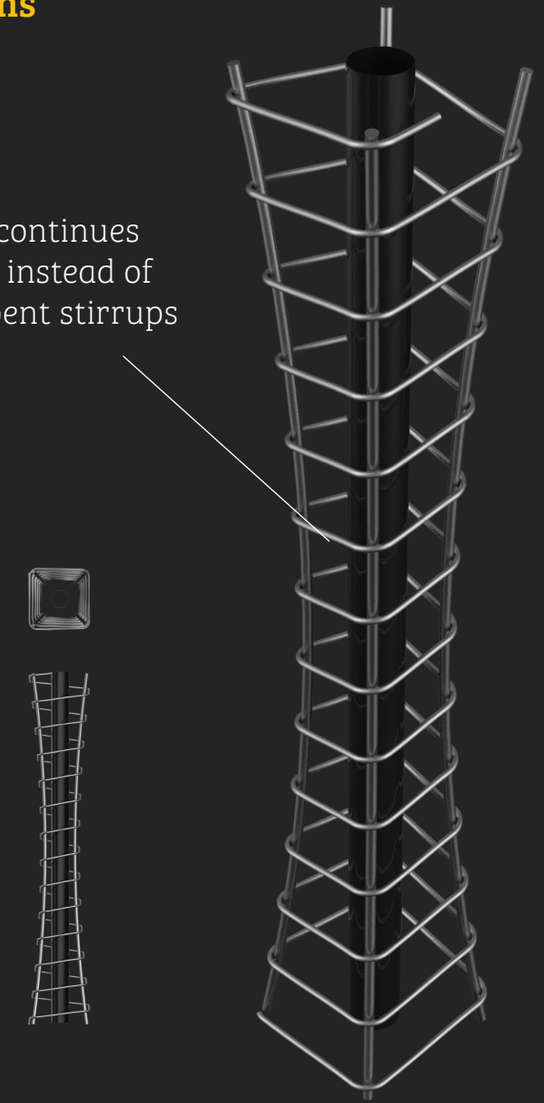
Wilfredo Mendez Vázquez, Biotectonica R&Design Studio
http://www.cienciapr.org/blogs/biotectonica

“ This proposed structure will reduce the use of concrete which is responsible for 7-10% of the global carbon dioxide emissions “

Beams



Columns



Biomimicry cages

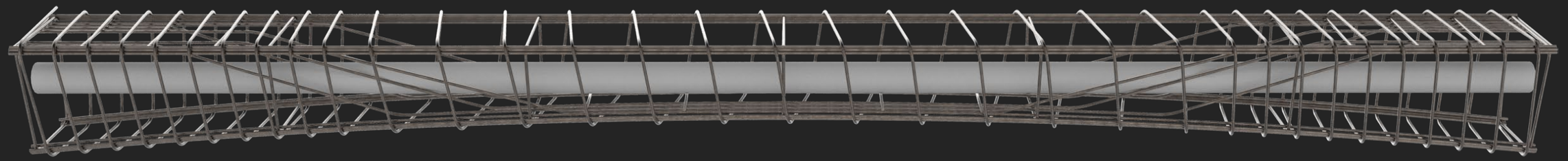
To be able to discuss these new idea how to make biomimicry cages, I made one set up of a beam and a column where I've applied the dynamics of biomimicry and the response from the structural engineers I talked to was very promising.

" This is a very good idea! "

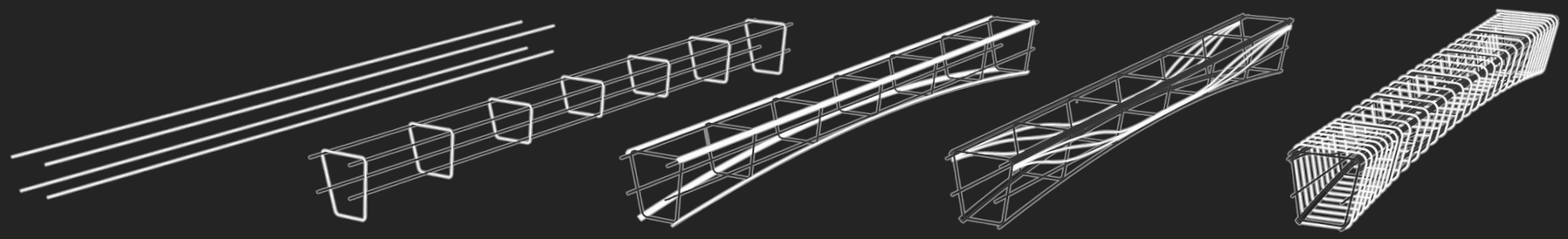
" ...and we don't really need all the concrete inside the beams "

Johan Jeppsson, Structural Engineer, SWECO
http://www.sweco.se/en

Final beam design



Production steps



1. Longitudinal attaching rebars

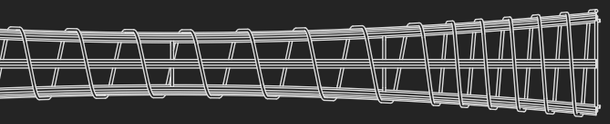
2. Support sections to control the shape

3. Main strengthening of the cage

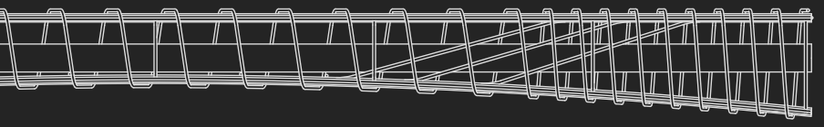
4. Cranked rebars

5. Winding the spiral stirrup

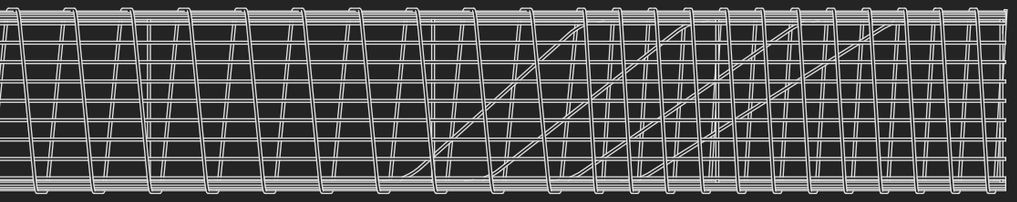
This is one example of the different steps, how to manufacture a simple beam.



Columns



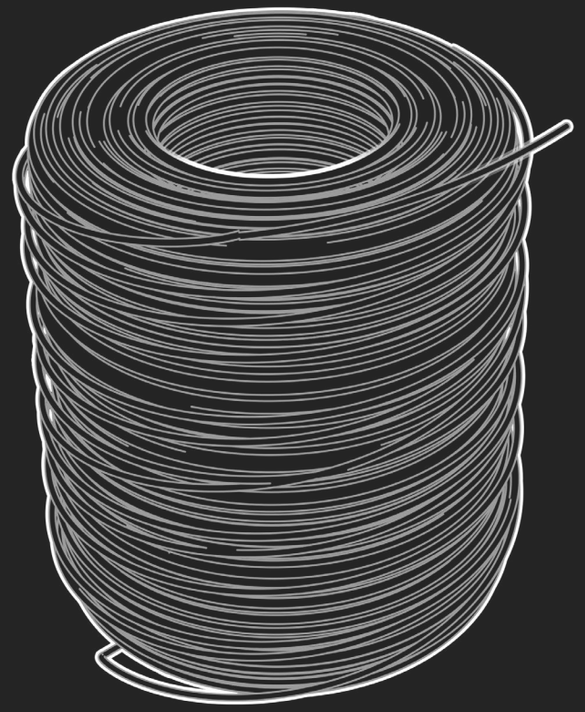
Beams



Footings

Spinetec can create cages that are non-uniformly shaped and curved in multiple directions. The machine is highly accurate, which makes it possible to position rebar in exactly the right spot where reinforcement is needed. This also opens up new design opportunities for engineers and architects.

Rebar spool:
Ø10mm
2418 kg
3000 m



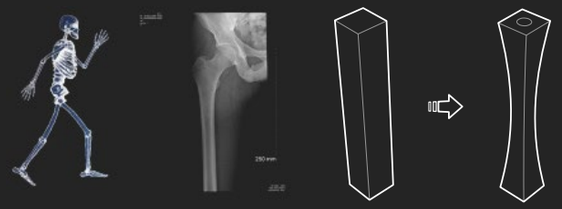
Using the most common size of rebar (10mm) on a spool reduces heavy lifting and handling of multiple rebar sizes on site, and also minimizes material waste.

1. User studies & observations

2. Interviews companies

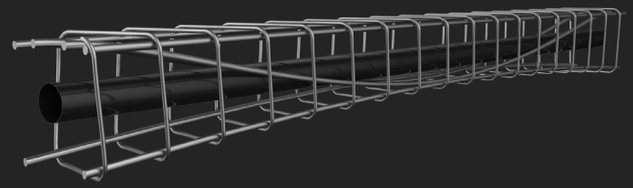
SKANSKA selbergs NCC OF BYGGSERVICE REKAB ENTREPRENAD AB CELSA GROUP

3. Problem finding



4. Potential solutions

5. Communicating ideas with experts



6. Feedback from engineers

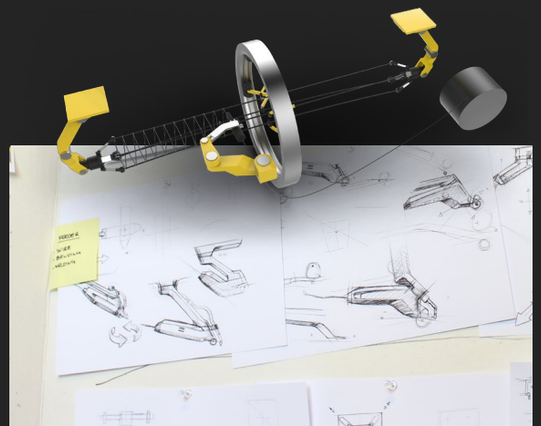
akt II CELSA GROUP SWECO

" This is a very good idea! "

Johan Jeppsson, Structural Engineer, SWECO
http://www.sweco.se/en

7. Ideation workshops,
How could this machine work?

8. 4 Concept directions



9. Feedback from collaboration partner & engineers

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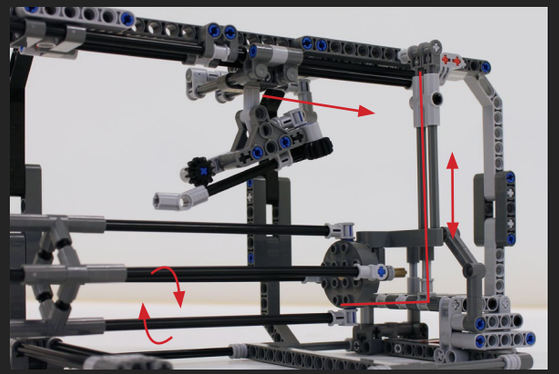
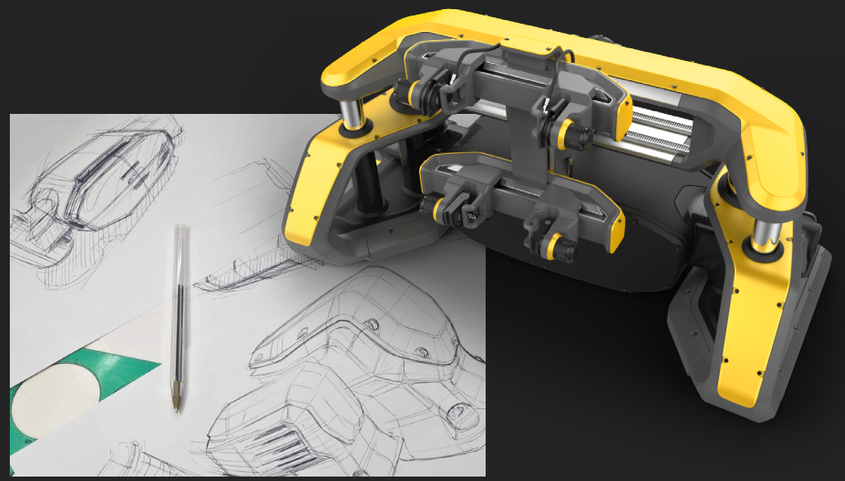
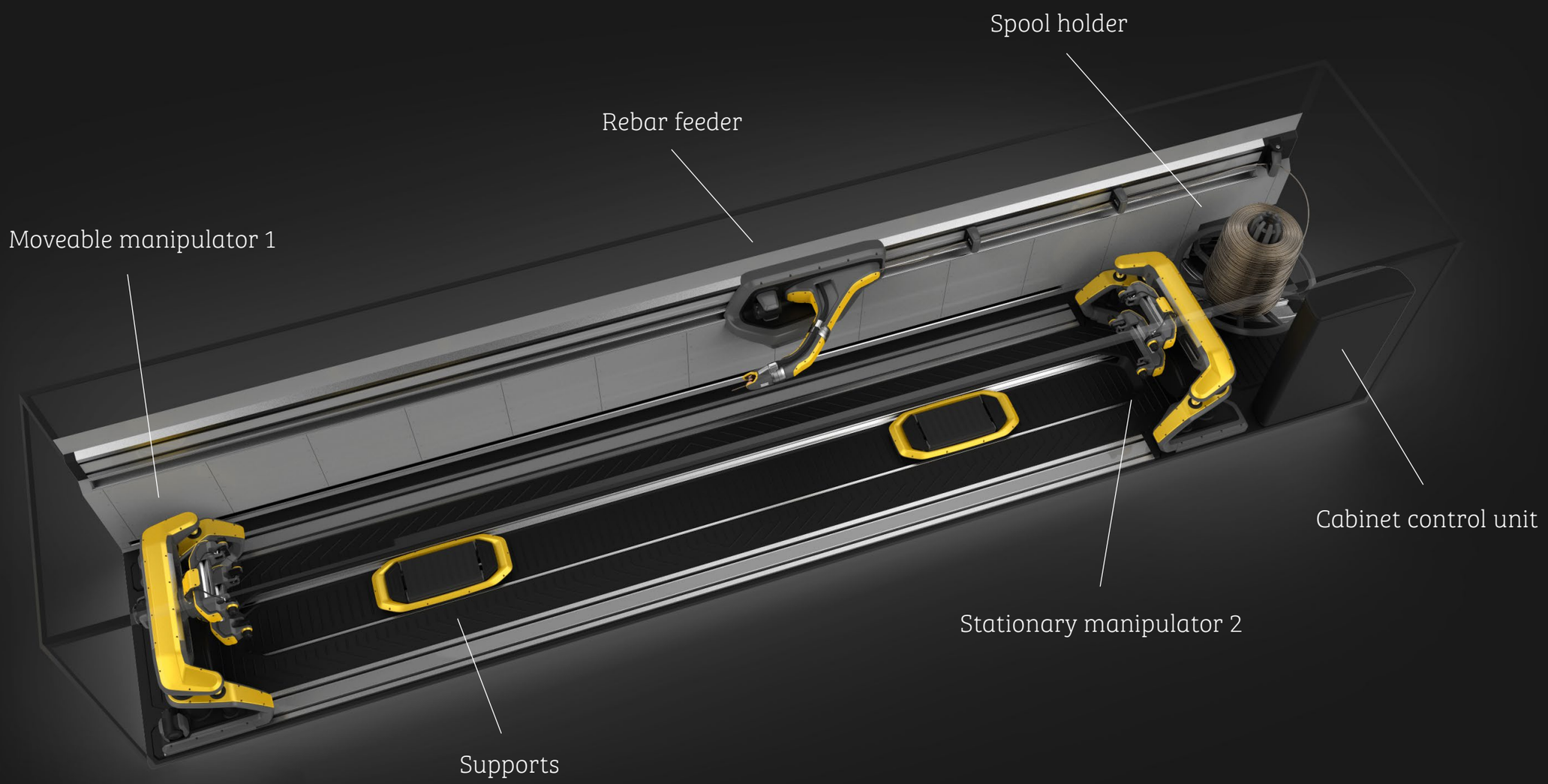
10. Exploration of technical solutions in LEGO





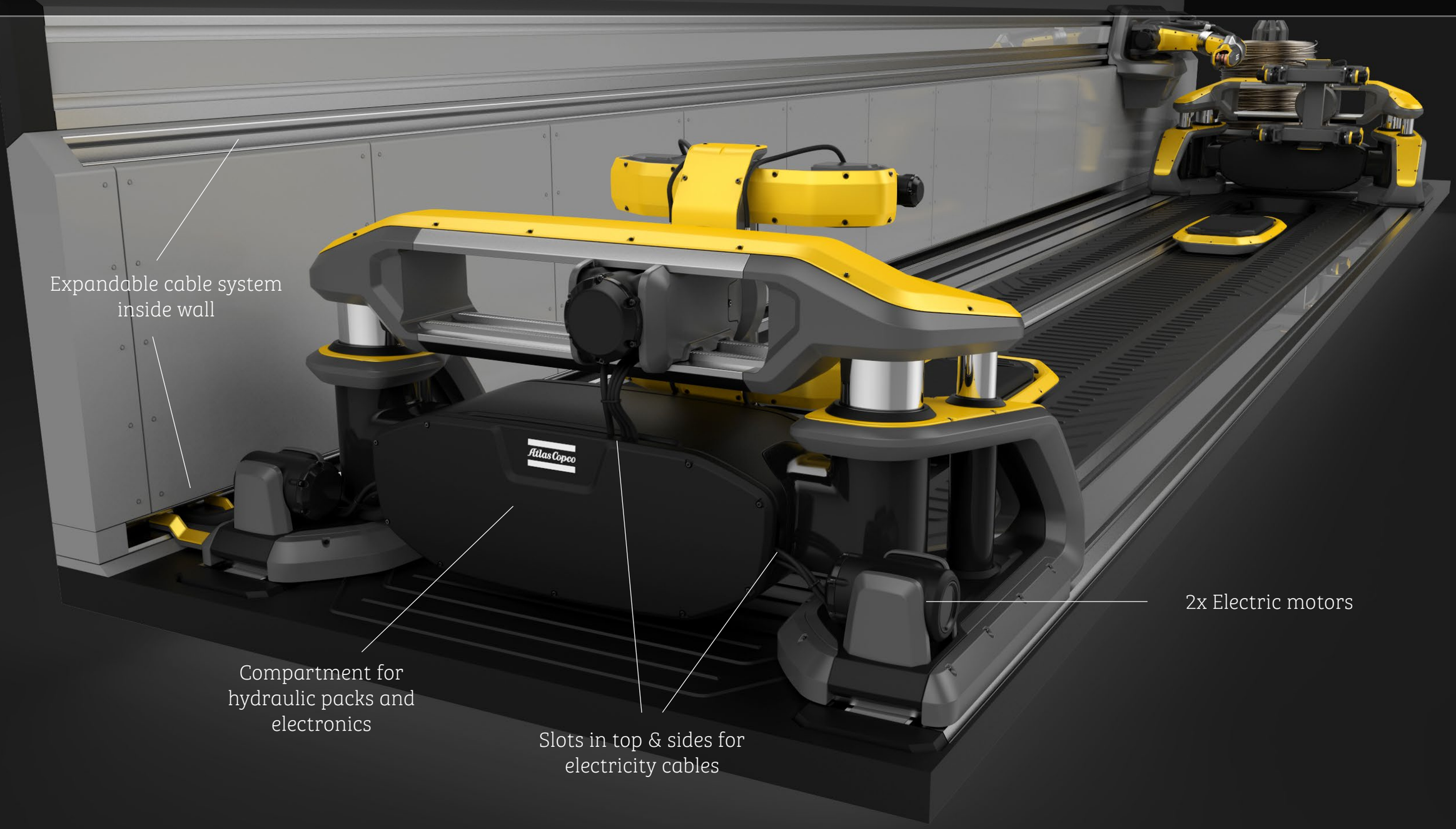
11. Sketching form development

12. Final CAD & detailing


Spool holder
Rebar feeder
Moveable manipulator 1
Cabinet control unit
Stationary manipulator 2
Supports

12 000mm fits in a 40’ feet container

Produce cages up to 8 500mm, 27’ feet


Expandable cable system inside wall
Compartment for hydraulic packs and electronics
Slots in top & sides for electricity cables
2x Electric motors
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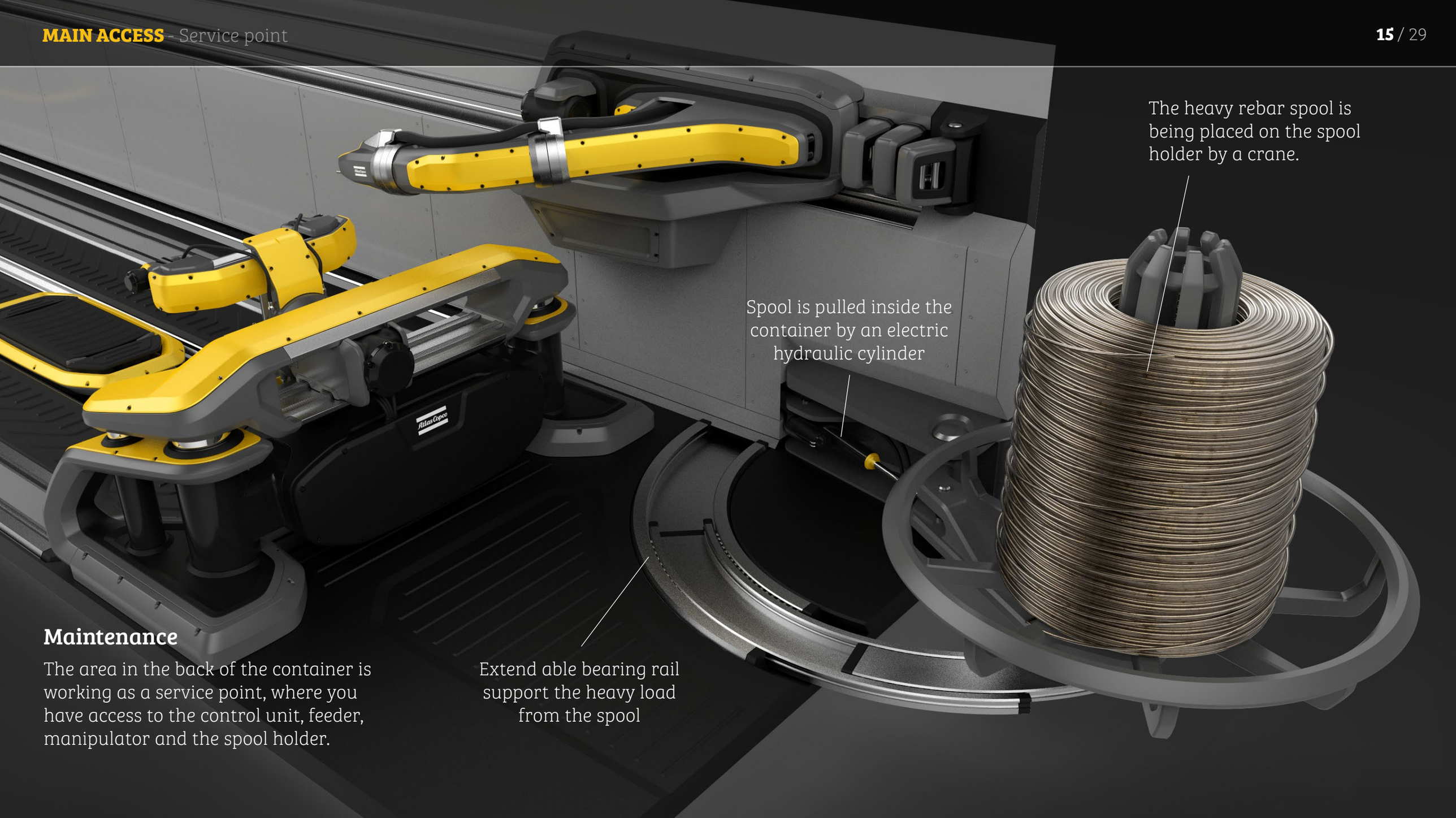
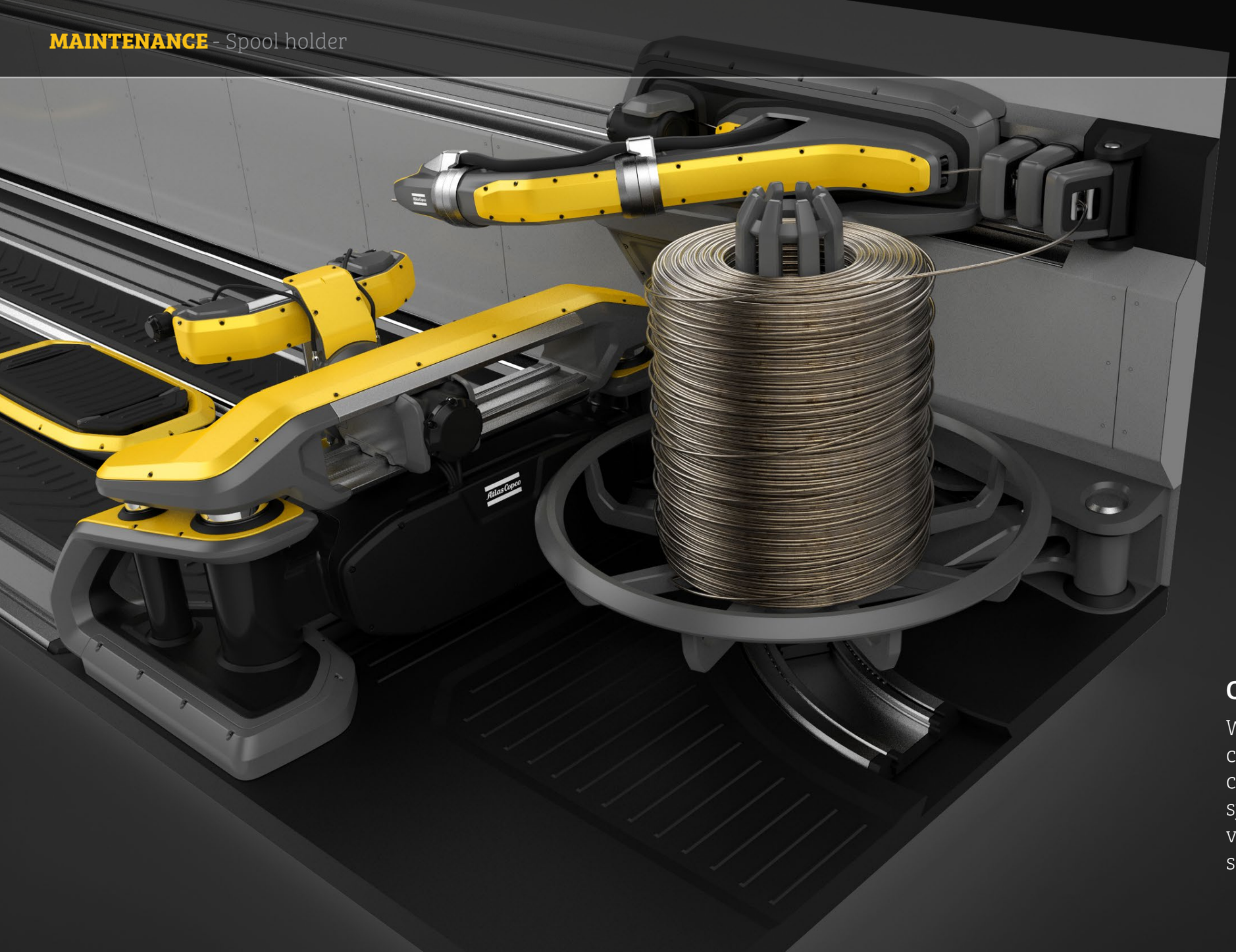
3. Y-axis
2. Z-axis
4. X-axis rotation
1. X-axis


5.
2x Upper/Lower
Z-axis
6.
4x Endeffectors
Y-axis



Maintenance

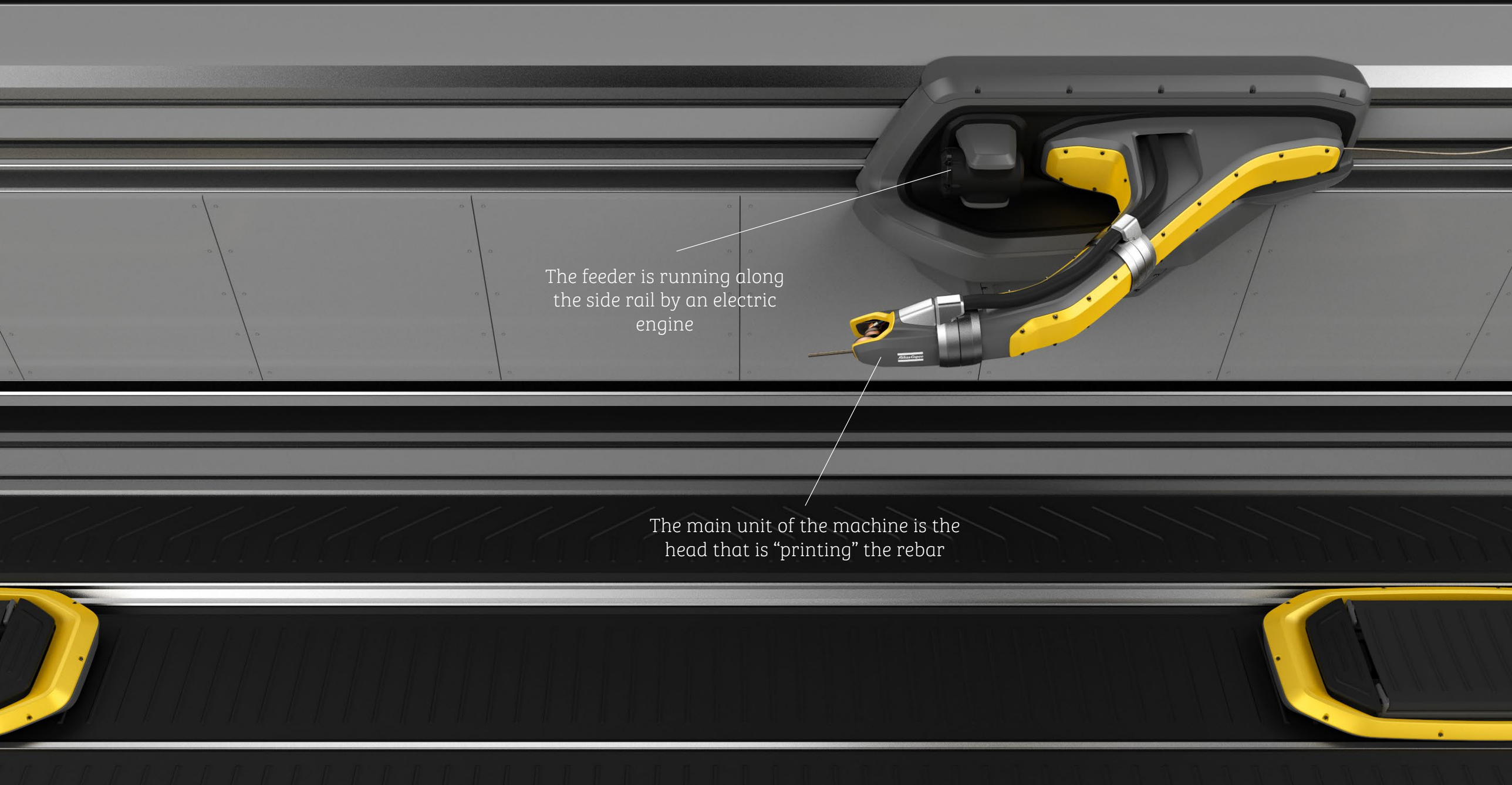
The area in the back of the container is working as a service point, where you have access to the control unit, feeder, manipulator and the spool holder.

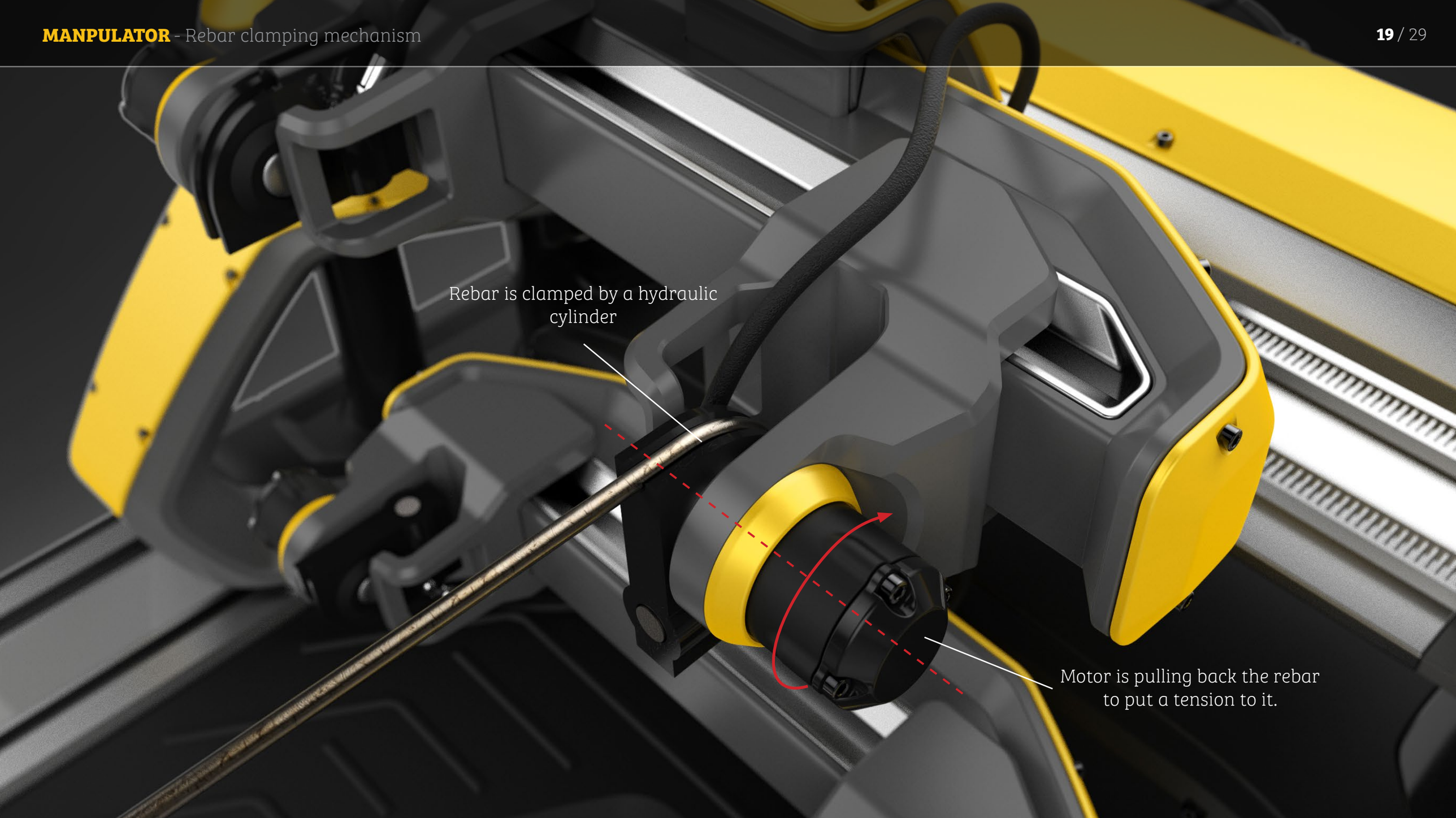


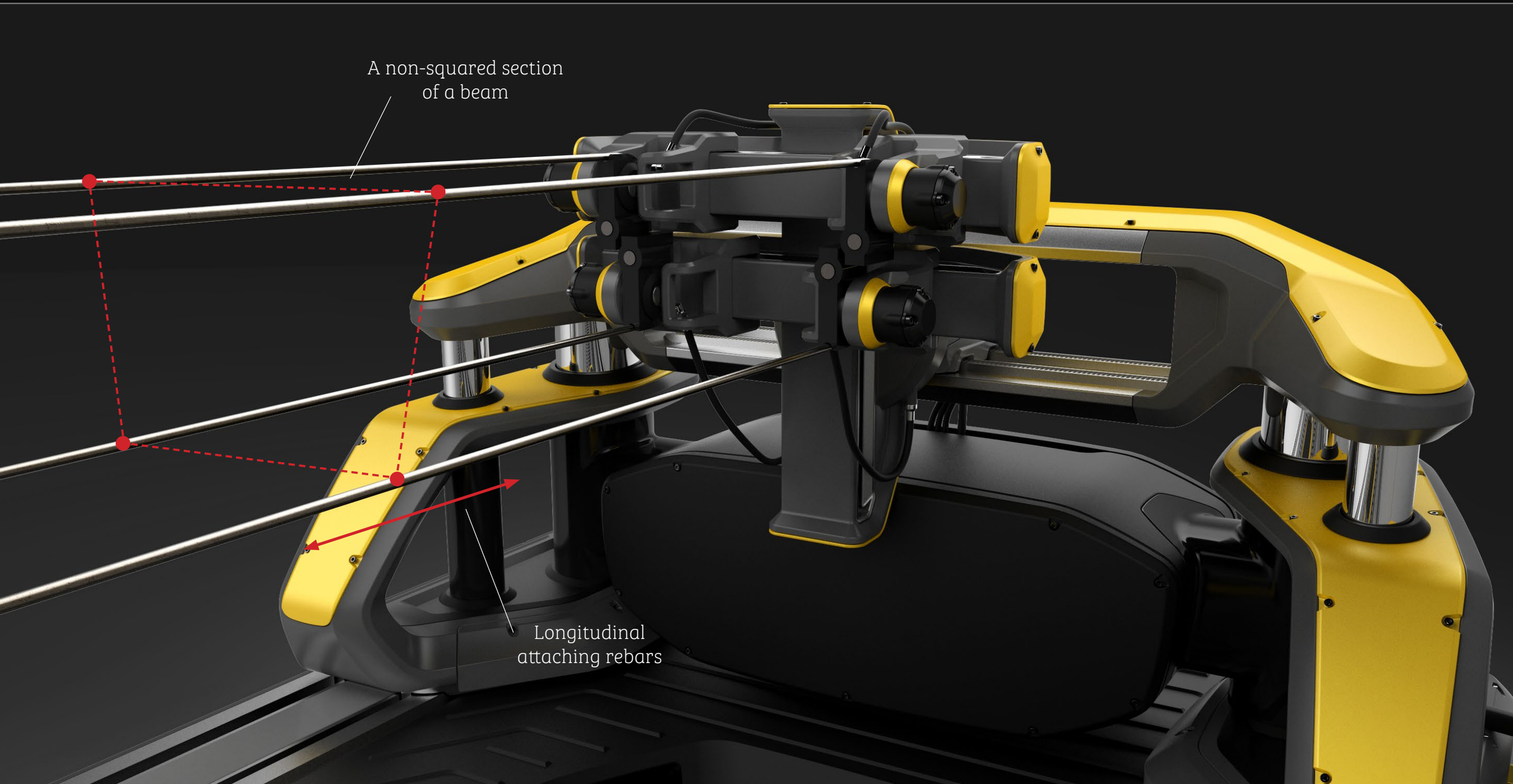
Compact system

When the machine is not in use or if it's cold outside the spool is pulled inside the container. This makes the whole Spinetec system to one closed unit which comes very handy when transported from one site to another.


Support roller along the side rail is transporting the rebar to the feeder


The feeder is running along the side rail by an electric engine
The main unit of the machine is the head that is “printing” the rebar


Rebar is clamped by a hydraulic cylinder
Motor is pulling back the rebar to put a tension to it.


A non-squared section
of a beam
Longitudinal
attaching rebars

Swivel

The feeder arm have the possibility to turn 90° degrees, by swivel around the mid axis. This is to be able to print both the longitudinal rebars and the stirrups.

This is also why the arm got its S-shape, to minimize the bending of the rebar that is feed inside the arm to the end effector.

Procedure

The main unit of the Spinetec machine is the printing head that makes it possible to produces these new improved curved cages.

The 10mm rebar is stored on a spool and is straightened out and feed to the printer head. Here it's being bent, cut and welded into place by a spot-welding unit.

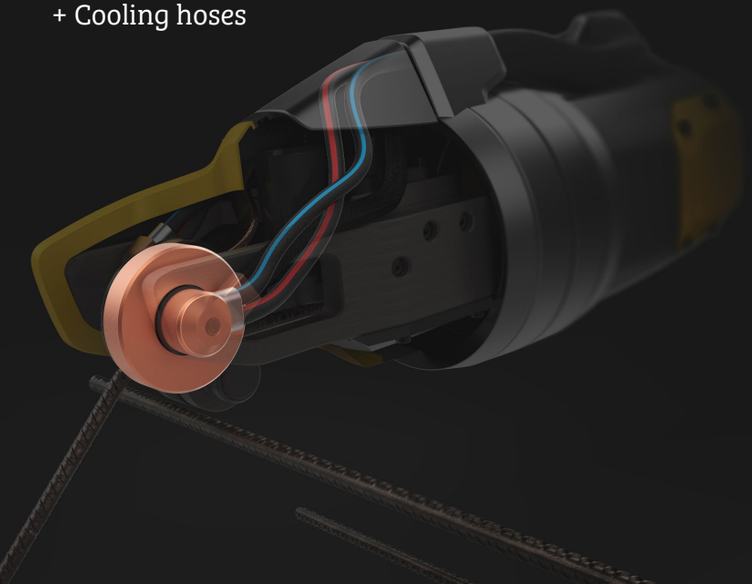
1. Feeding unit

2. Bending unit

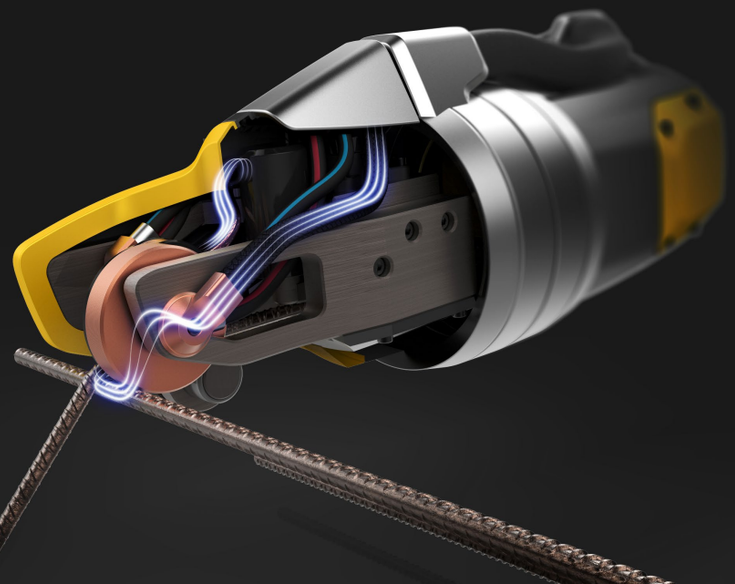
3. Cutting unit

4. Bending/Welding (-) wheel #1
+ Cooling hoses

5. Welding (+) wheel #2
+ Cooling hoses



6. Spot welding



1. Bending

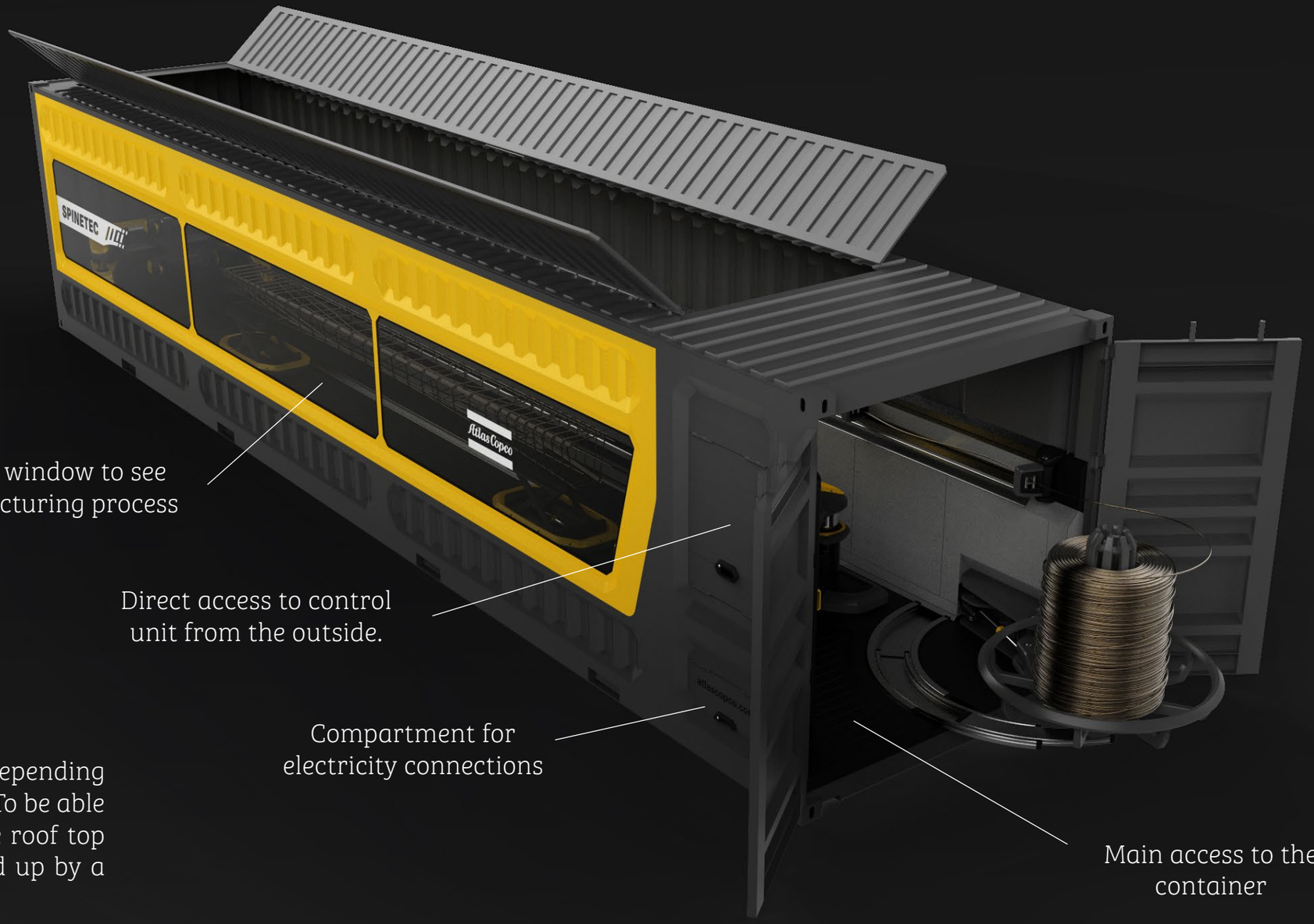
2. Welding

3. Cutting

Cage is ready

When the production of the cage is done. The clamping mechanism is released and the cages is resting on the supports ready to be picked up.

Take a look at my video to see how the cage is manufactured



Container

The final made cage can be very heavy depending on where in the building it's being used. To be able to get the cage out of the container the roof top will open up and the cages can be lifted up by a crane standing on the construction site.

- Custom-designed reinforcing cages made on-site.
- Less manual handling and heavy lifting of rebars.
- More environmental friendly building, up to 30% less concrete and iron is needed.

- Curved cages with optimized design for maximum strength.
- The possibility to hollow out beams and columns make the overall weight of the build lighter.

- Rebar on spool decreases waste material.
- Decreased manufacturing time of cages.
- Decreased CO2 emissions: no shipping of pre-fabricated cages.