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Plastic Tectonics for a Hanging Indoor Food Garden

Björn Vestlund

Chalmers School of Architecture
Examiner: Daniel Norell
Tutor: Jonas Lundberg

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CHALMERS
UNIVERSITY OF TECHNOLOGY

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ABSTRACT

In the design of a grow space located inside the main public library in Gothenburg, this thesis searches for a new or developed typology where production, education and perception intersect. Relations between artificial and natural, in space, structure and plant display, is investigated in the format of a plastic sheet and framing structure housing a hanging food garden. Traditional aspects of greenhouse architecture such as transparency, plant arrangement, viewing angles and organic aesthetics has been reinterpreted to make sense in an indoor context.

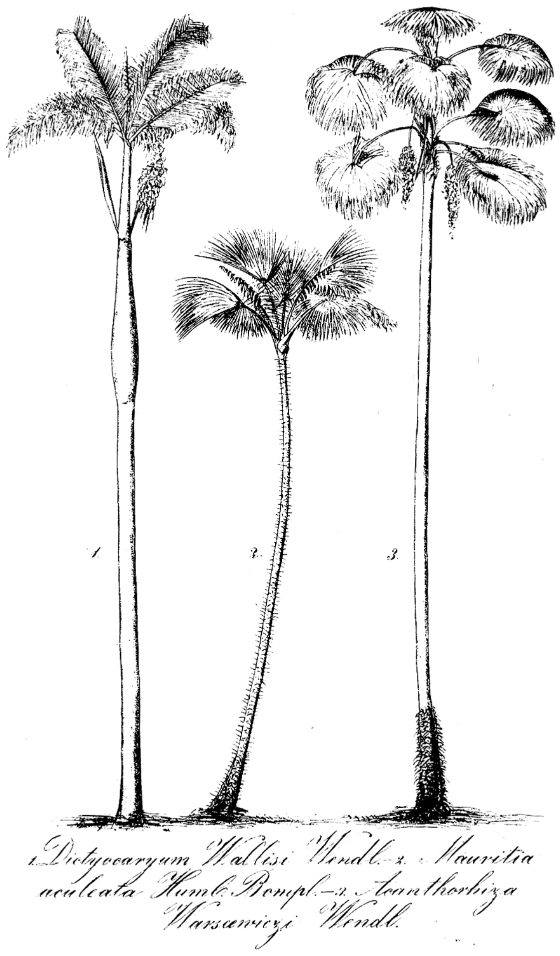
Historically, progress in agriculture and horticulture has partially been driven by architecture and technology. This also goes the other way around, like in the development of 19th century glass- and iron structures that was primarily associated with the emergence of greenhouses.

Today, the decreasing predictability of our climate and the demand for locally produced fresh food might soon accelerate the trend of indoor farming in urban centers. Hydroponic vertical farms are using less land and water, and with a fast development of grow lights, indoor farming might in some cases be the more sustainable alternative for cold and dark countries.

If food production is moving into urban areas, can this add values beyond the actual yield? Can growing of edible plants in artificial environments be elevated to an architectural level and offer attractive spaces for plants and people?

By searching to answer the questions: How can indoor production of edible plants be utilized to create a spatially interesting experience?

What are the fundamental spatial differences of a grow room and a green house? What are the challenges and what are the potentials in those differences? What can an indoor grow space add to the larger space in which it is placed? How can plants and growing equipment, such as pots, lights, reflectors and irrigation systems be part of an overall design concept? What approaches have been used earlier, in botanical greenhouses and other plant-related architecture, for the relation between architectural details and plants? What could be a relevant approach for an indoor grow space? How can the ritual of planting, supervision and harvesting indoor grown plants be simple and combined with an architectural experience? How can a hydroponic system be transparent in the way it functions and increase knowledge and interest among visitors about this branch of food production?



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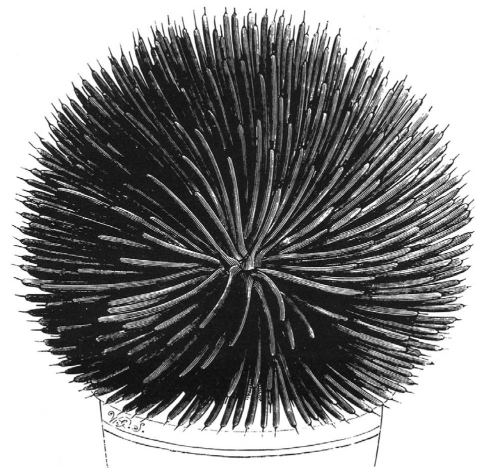

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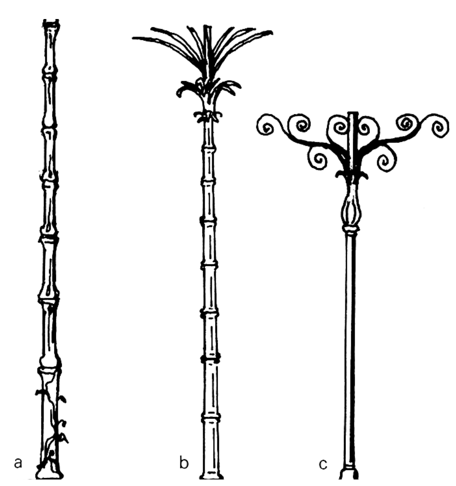

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1–3. Plant illustrations
4. Columns with plant motifs: Winter garden Lichtenstein Castle, 1845; Winter garden, Grimston Park, Yorkshire, 1830-1840; Richard Turner, palm house, Botanic Garden, Belfast, 1839-40
(Kohlmeier, G., von Sartory, B., 1986)


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ARTIFICIAL NATURE

Beginning of indoor growing

Throughout history, our desire to enjoy the prescience of plants and our ideas about their needs, has influenced the design of greenhouses, orangeries and conservatories. When plants from the East, such as citrus trees, first reached the center of the Roman Empire, primitive structures were built to help them survive the winter. Architects made plans according to theories that gardeners and botanists had on heat and light.

In the middle of the seventeenth century the typical Orangery was a plain masonry house with large windows facing south. Plants and trees where growing in large pots that were moved outside in the sun during the summer when the weather allowed. (Woods, M., Warren A., 1988)

Iron and glass

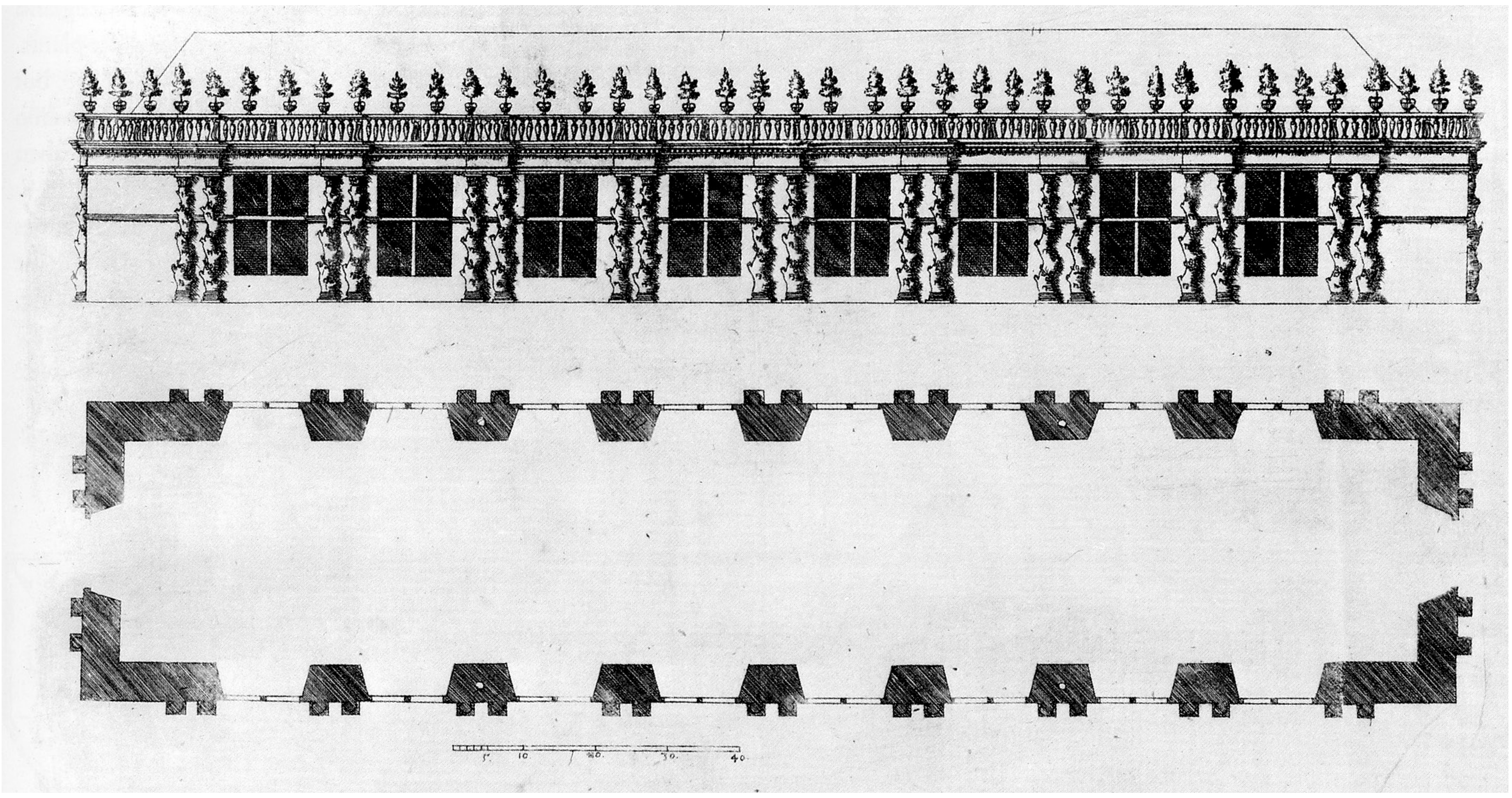
In western Europe during the early nineteenth century, when industrial growth was destroying nature and greenery became sparse in the cities, a period of fast development took place. In order to keep the vision of paradise alive, there was a need to symbolically conserve nature by putting plants under glass in private palm houses and public winter gardens.

Those were often designed by engineers who didn't build in the conventional style of stone architecture. Thin iron structures and glass enabled the first historic example of an interior that was completely flooded with light. All the structural members in a glass house were visible and, like the plants, put on display. (Kohlmeier, G., von Sartory, B., 1986)

New grow environments

In industrial vertical farms of today, common practice is to grow plants in vertically stacked layers in a racking system. These facilities utilize artificial control of light, humidity, temperature, gases and fertilization. The arrangement is of course compact and efficient, but made with the exposure of plants to grow light in mind, and not on the display of plants for an observer.

Recently, examples of projects and products have been realized where architecture and interior design are utilizing indoor growing both spatially and for food. In modern urban societies, almost completely detached from nature, even the presence of images of plants can lower stress levels. And a setting for growing where everything but the plant itself is artificial is still helping people reconnect with the origin of their food.



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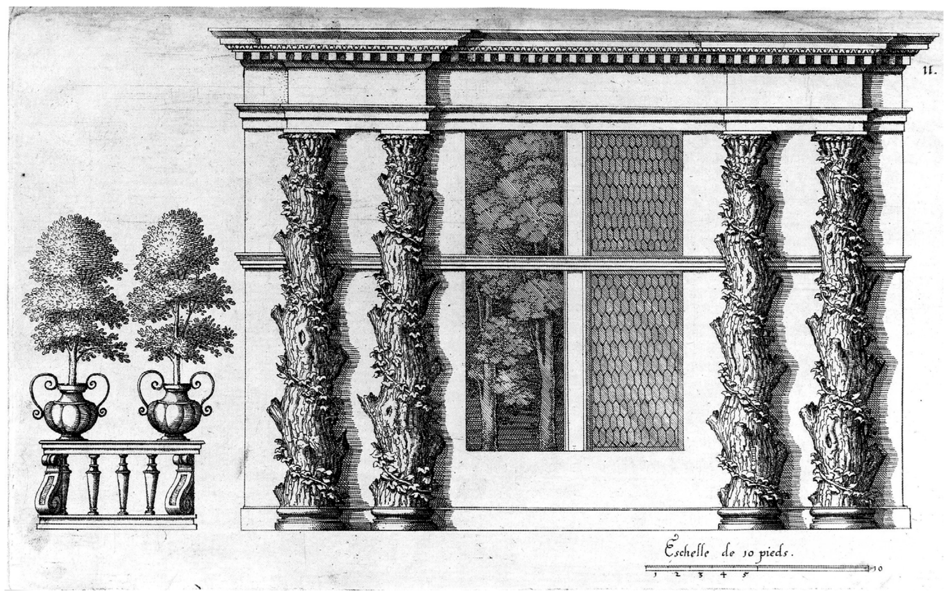

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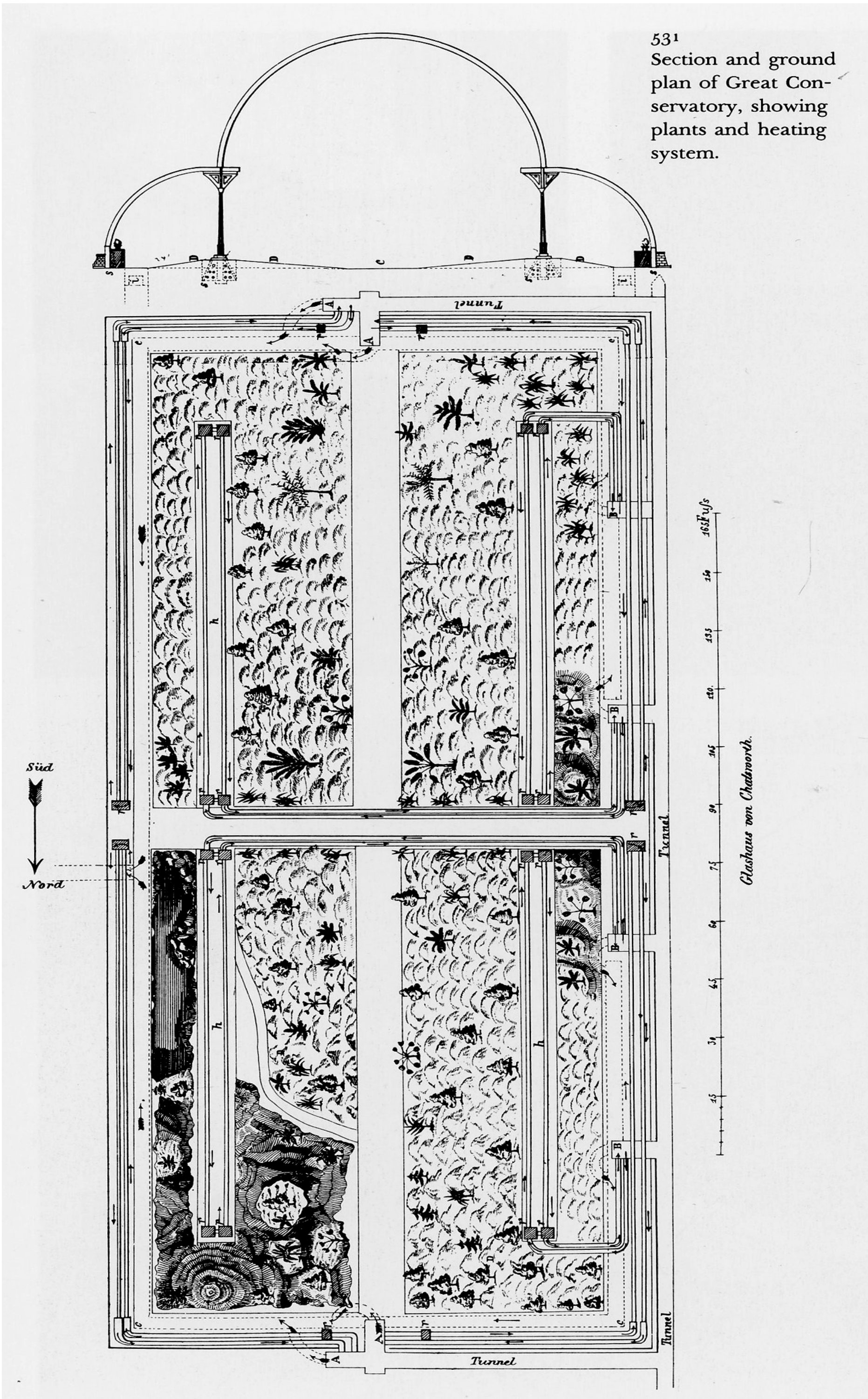

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5-6. Orangery at Heidelberg. Salomon de Caus. Windows facing both south and north showed not to cover in light for their heat losses. The Ivy-twined rustic columns is an example of how structural details relate to the plant world by decorative imitation. (Woods, M., Warren A., 1988)

7-8. Great Conservatory, Chatsworth, 1840, Joseph Paxton. The large glass envelope enabled plants to be freely arranged around the pathways. (Kohlmeier, G., von Sartory, B., 1986)

9


10


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12


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9-10. Japanese vertical farm
11-12. Refurbished office in Tokyo by Kono Designs. Has now 4000sm of dedicated of green space where over 200 species are grown. The food is prepared and served in the on-site cafeteria. Beyond ideas about the office environment, the architect and client both have an intention to also renew interest in farming among urban communities by visual intervention and by educational programs.
13-15. “Trees of the City” by photographer Florian Rexroth. Trees are isolated from their urban surroundings with white cloth. The backdrop enables a new gaze of a tree, an additional layer to the already artificial context.
(Ladner, P. 2011)

AN INDOOR GREENHOUSE

Type

If the old greenhouses were about using available sunlight while creating an artificial warm climate, this project is about using available indoor climate while creating artificial light. The logic of the transparent tight skin is replaced, now there is a need for a skin that traps and reflects light back. Pathways around an artificial landscape would be inefficient light-wise and a vertical racking system does not fulfill the spatial potential of the plants as displayed objects.

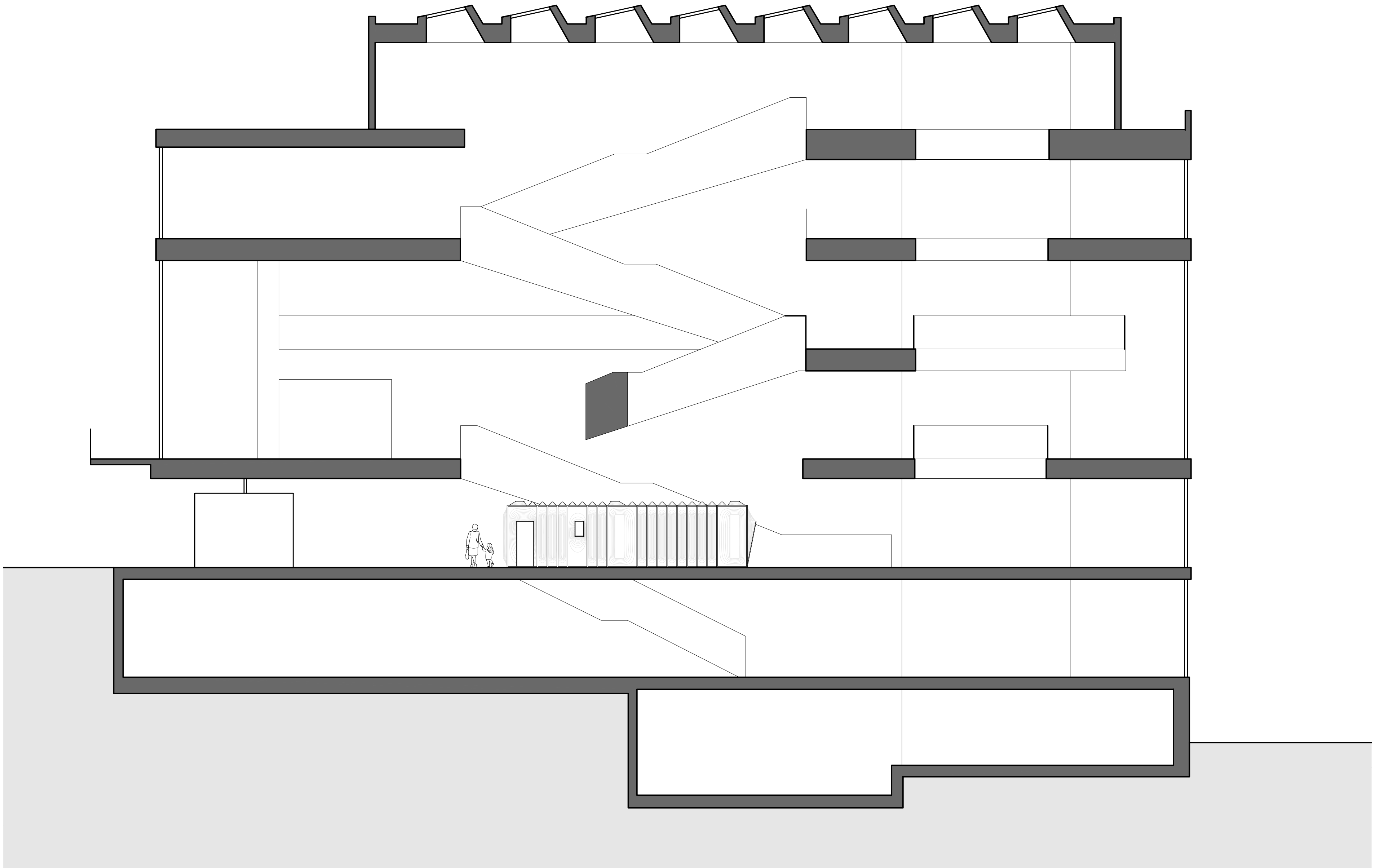
Site

The site which constitutes the context for the design part of this thesis is the main public library in Gothenburg. On a small area near the main entrance that is currently being used as exhibition space. The library is chosen because of its relatively large public indoor spaces, and because it´s housing a local cafeteria where the plants could be prepared.

Concept

The long and narrow plot is reflected in a long and narrow grow space, where pots and plants are hanging in chains from rails and are pushed forward along the rail as new seedlings are started and full grown plants harvested.

Plants and people are separated but within the same space. Light is distributed from the sides and from above to the plants as they pass through the grow space. An effect of a three dimensional deep space with hanging back-lit plants is created for the perspective of the observers who can enter the pavilion or peek through the openings on the side.



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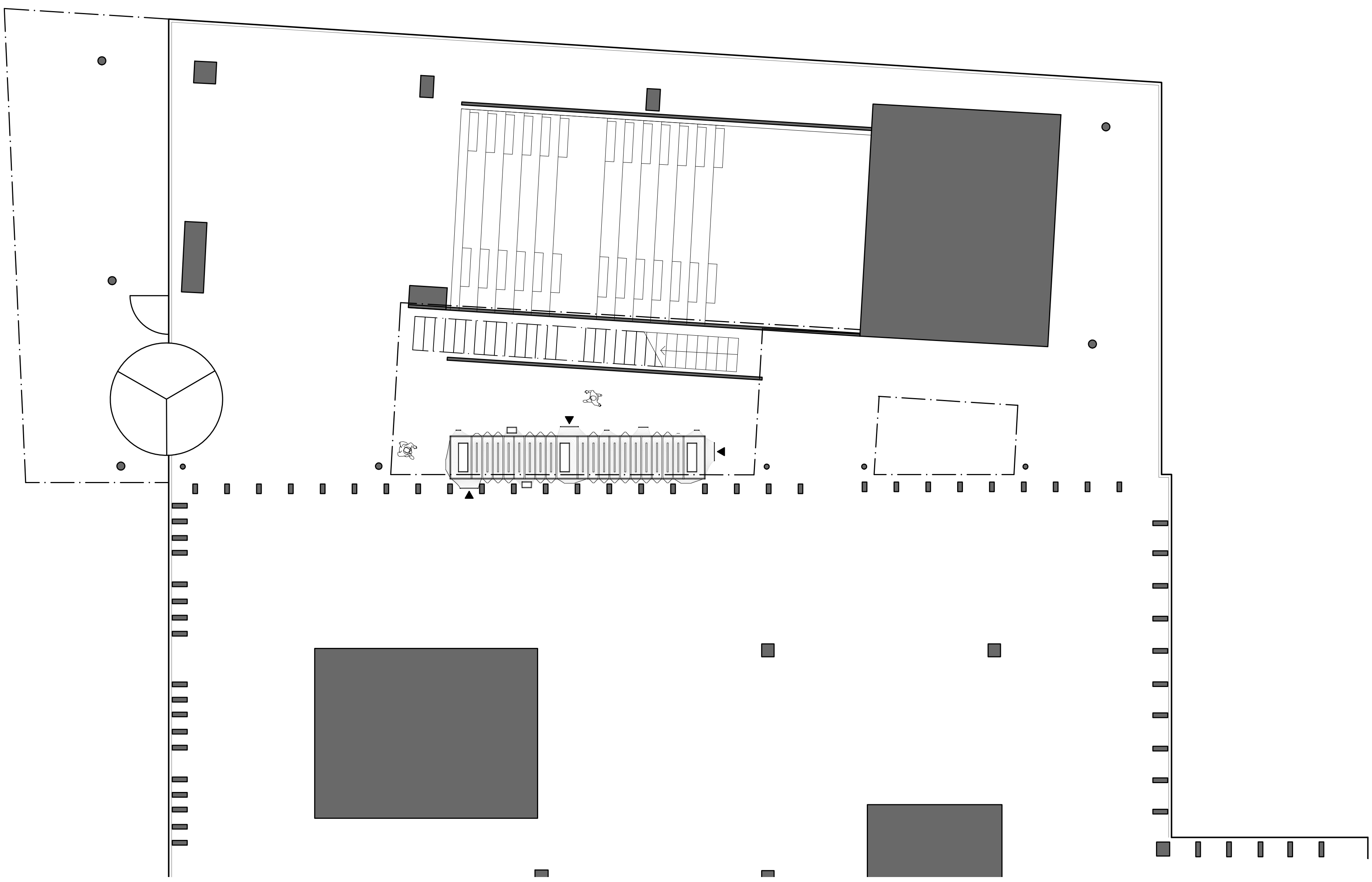

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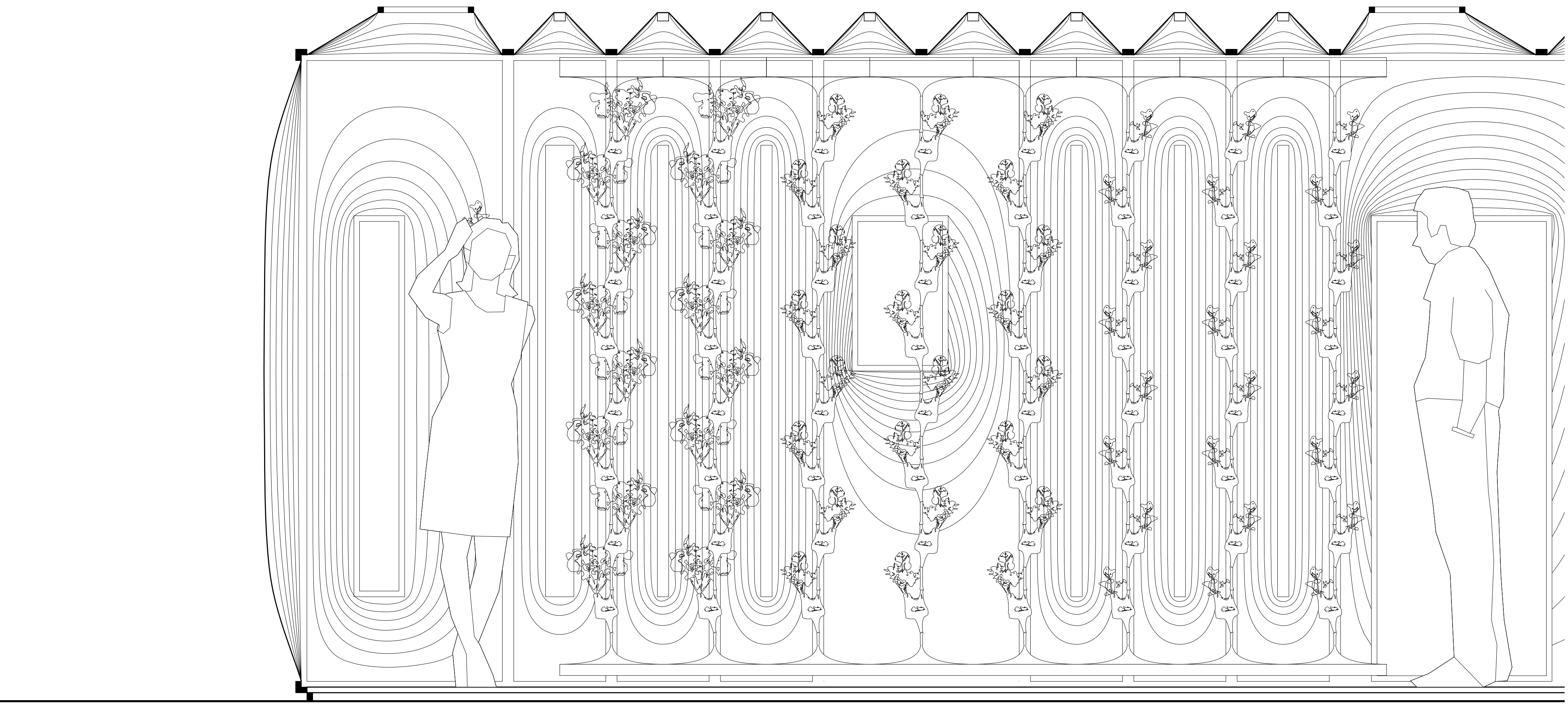

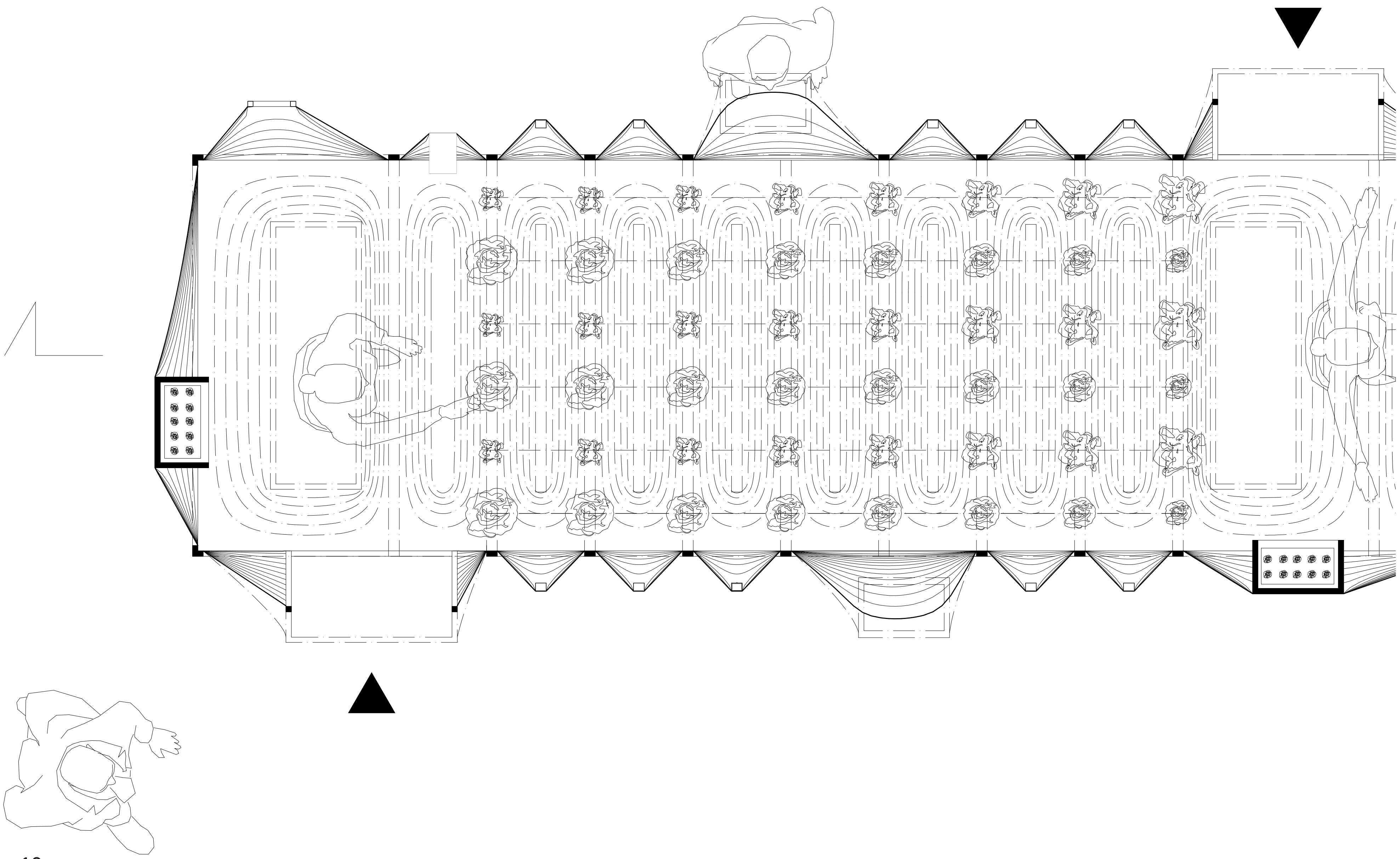

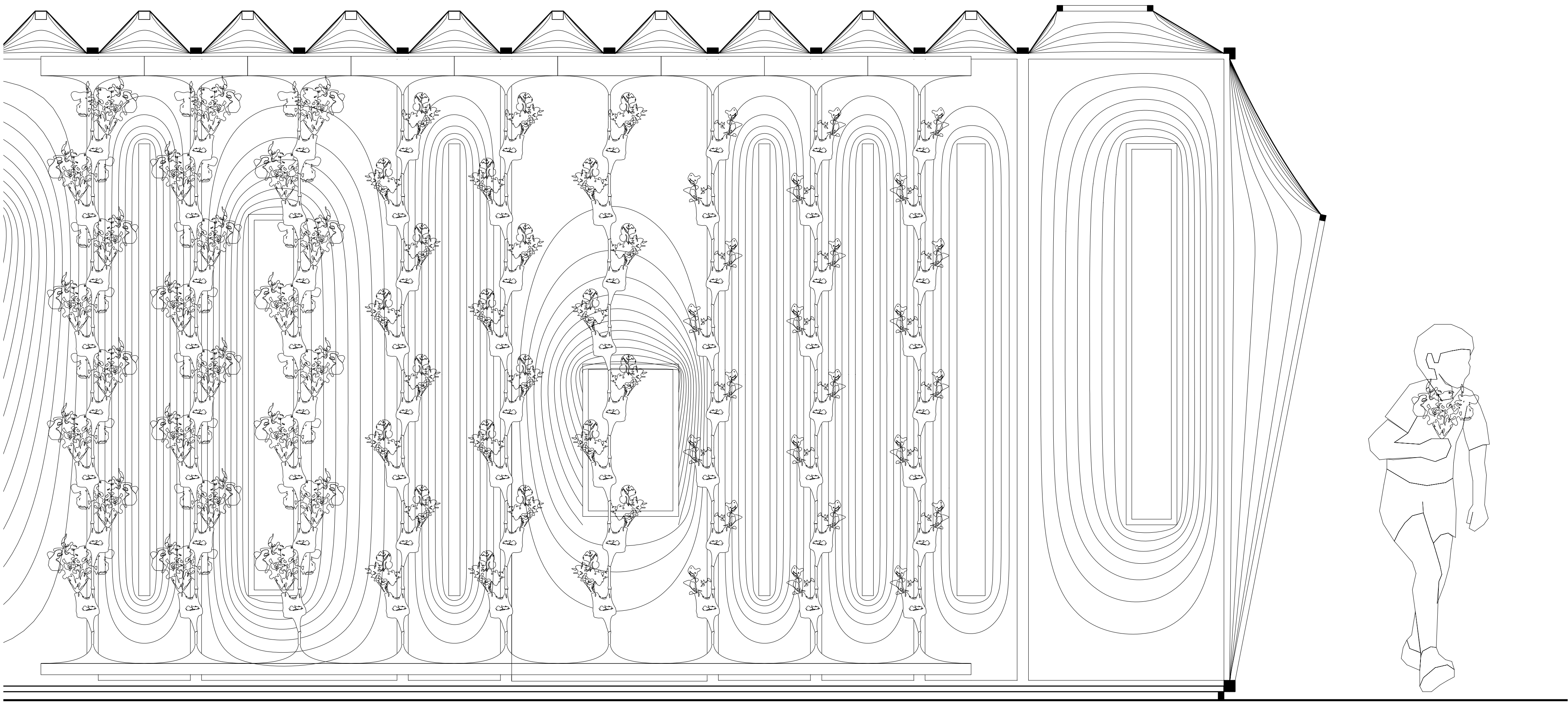

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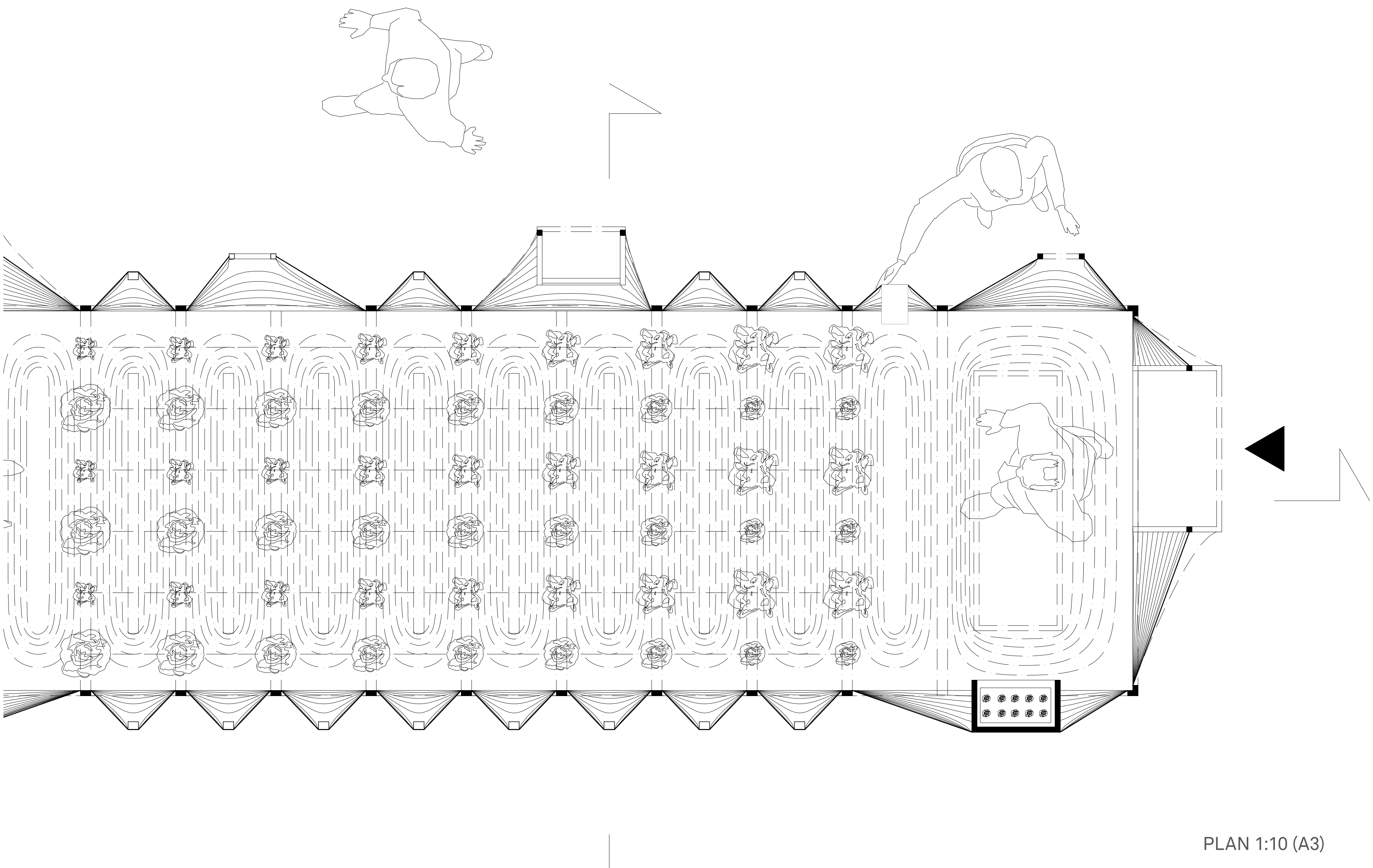

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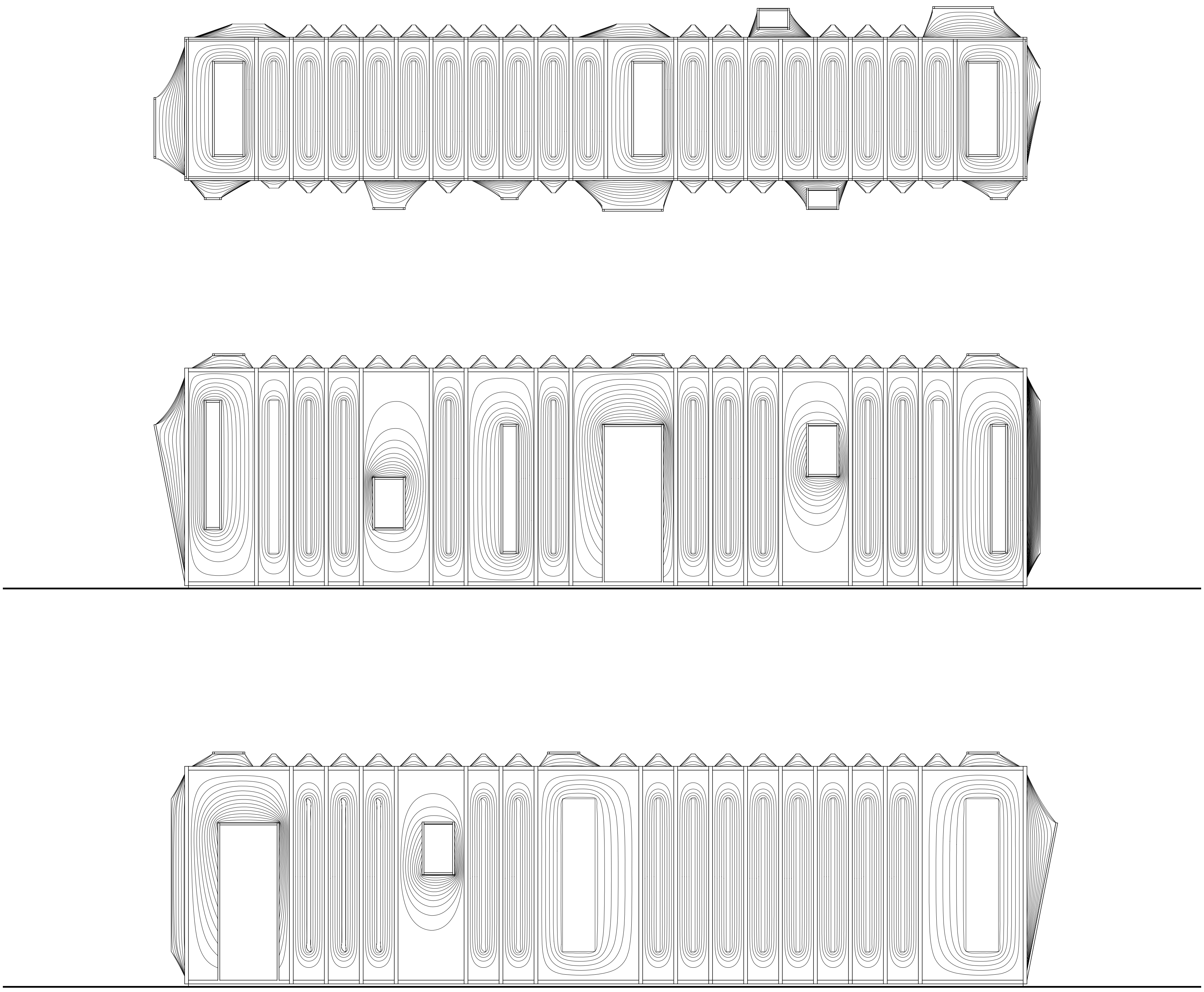
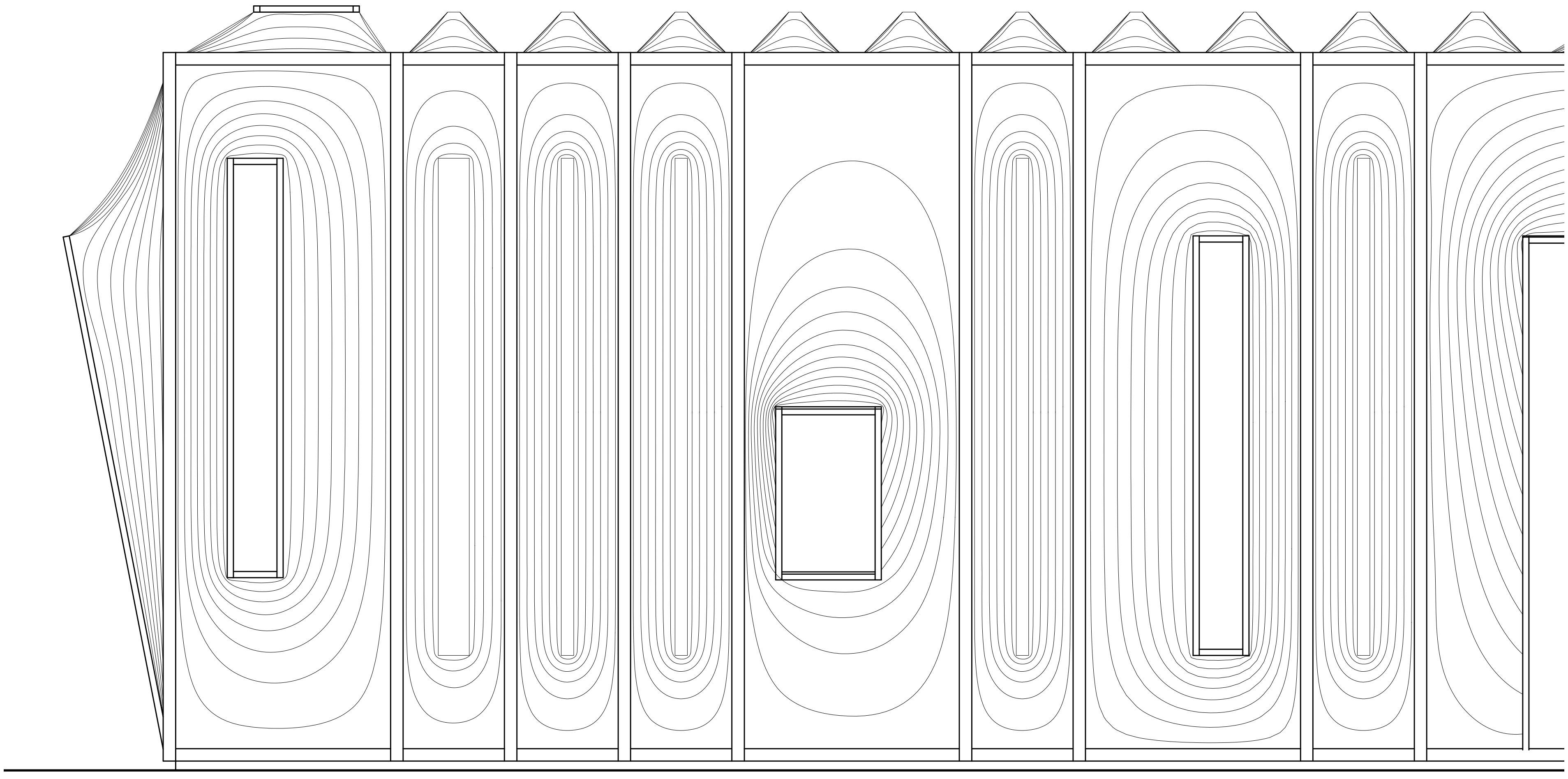


ELEVATIONS 1:20 (A3)



ELEVATION 1:10 (A3)

THEATRE OF PLANTS

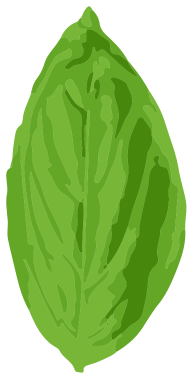
Circulations

Plants are arranged in a top drip system where chains of pots are being fed from above with nutrition solution. The solution is kept in a tank and distributed to all pot chains by a pump in a branched hose. At the bottom of each pot chain, the solution is dripping into a gutter from where it is pumped back to the tank. The pot chains are hanging in rails and are moving parallel as the plants are harvested and as a new chain are fed into the rail. A system is invented for the transfer of nutrient solution from the fixed branched hose to the moving hanging pot chains.

Seedlings are started in propagation trays near the entrances and then planted in hanging pots. The number of pots in the system is constant, for new seedlings to be started, an equal number of plants need to be harvested. The nutrition pump runs on a schedule and feeds the plant a few times each day. In between, a small amount of water is stored in the growing media and rock wool cylinder.

Growing picture

The pot chains constitute the three dimensional matrix in which hundreds of side and back-lit plants grow. This deep groundless abstract space causes a visitor to perceive it as small universe or a three dimensional growing picture. A number of different species are used as palette of dots with varying color and size. Those can be arranged freely in the matrix to achieve a variation of spatial motifs.

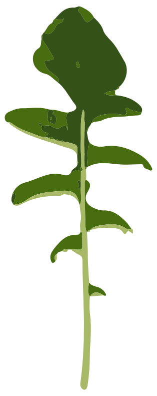


Basil *Ocimum basilicum*

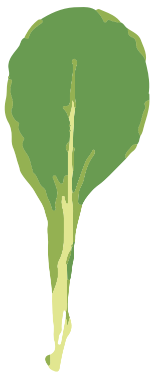
Tat Soi *Brassica rapa subsp. narinosa*

Coriander *Coriandrum sativum*

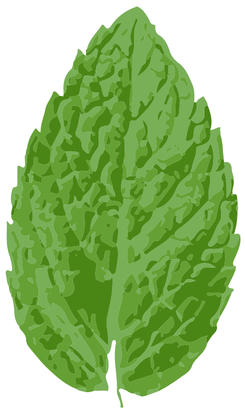
Lacinato Kale *Brassica oleracea*



Arugula *Eruca sativa*

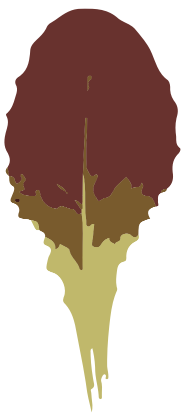


Mache *Valerianella locusta*

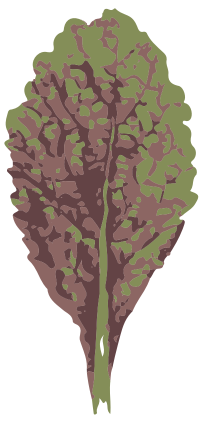


Mint *Mentha*

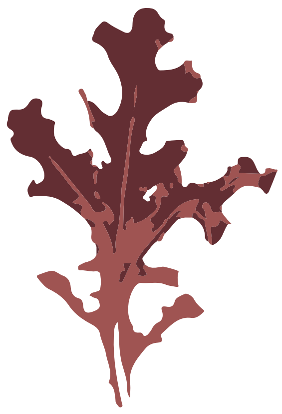
Mizuna *Brassica rapa nipponosica*



Red Romaine *Lactuca sativa var. longifolia.*

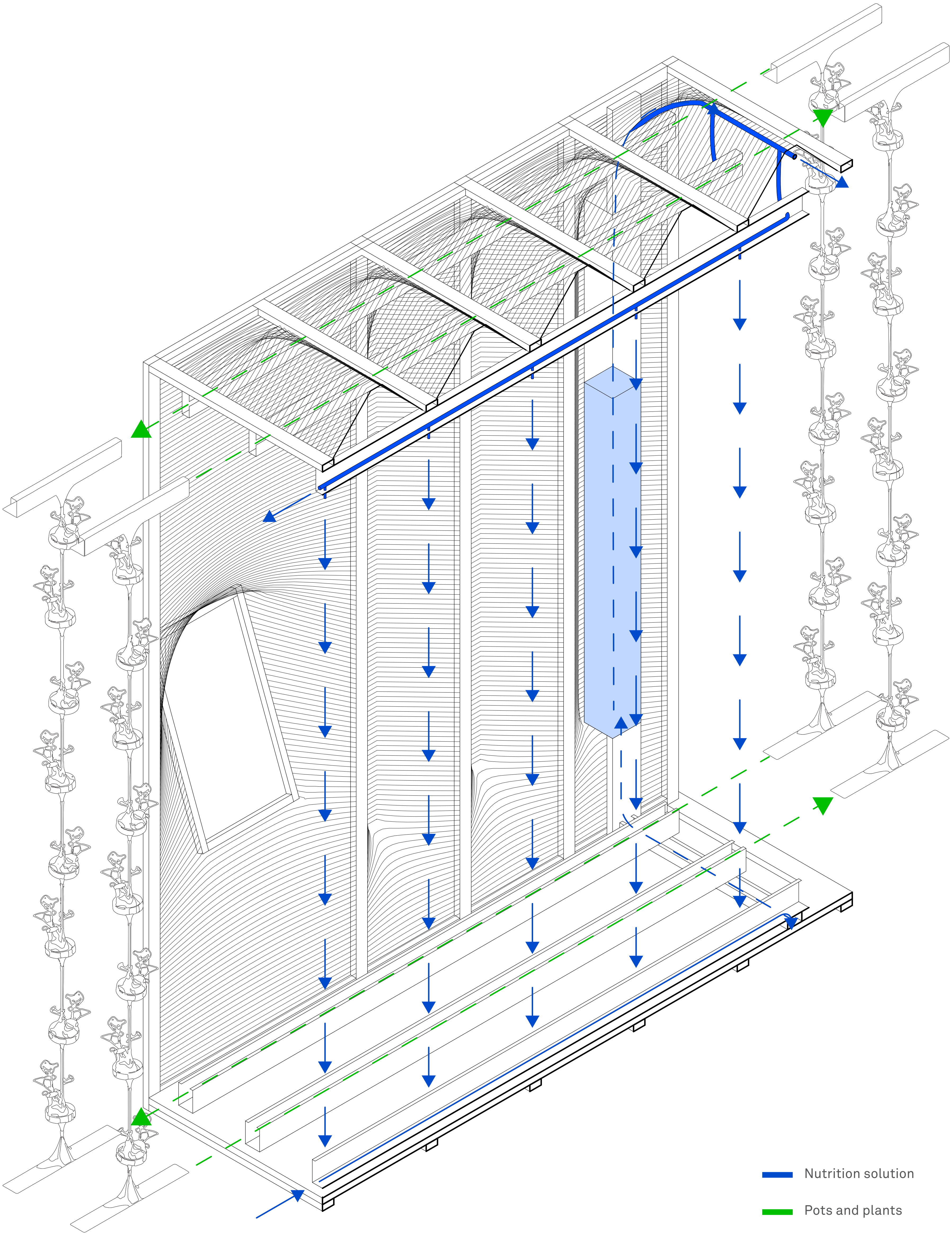


Red Mustard *Brassica juncea*



Red Tango *Lactuca sativa*

Lollo Rosso *Lactuca sativa var. crispa L.*


Nutrition solution
Pots and plants

SECTION 1:10

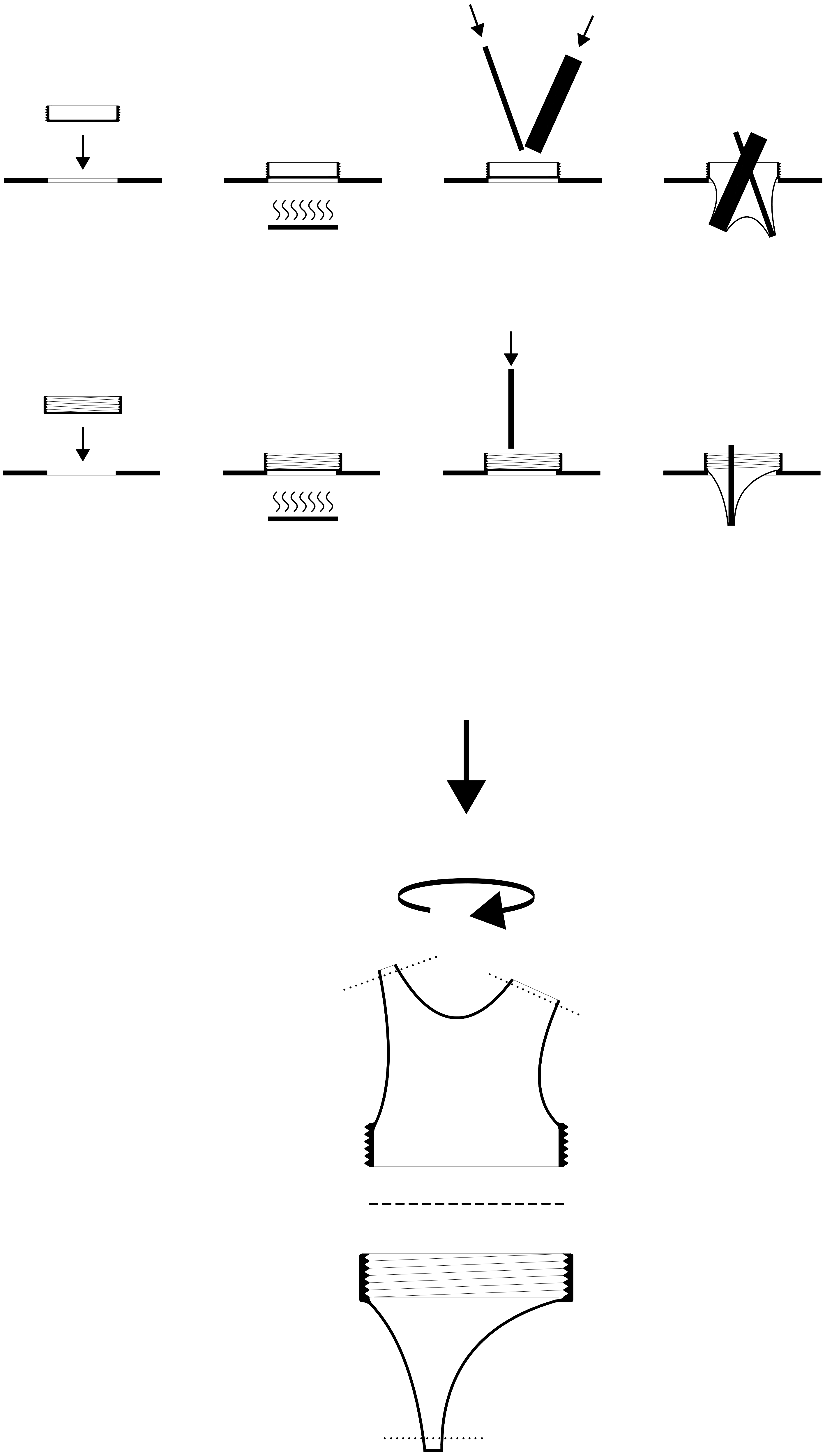
PLASTIC AND FRAMING

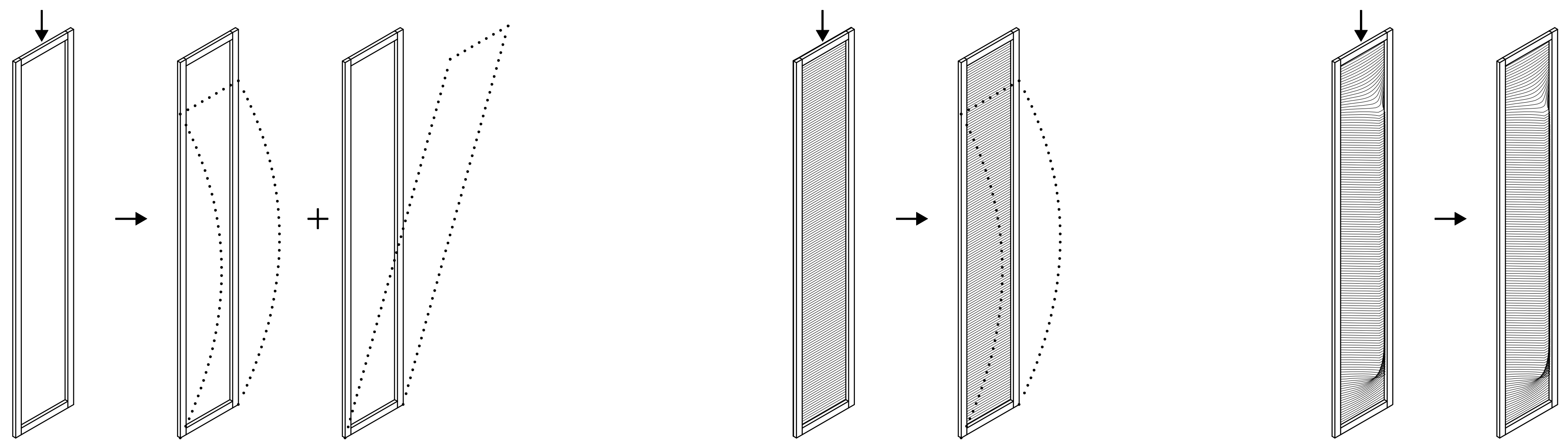
Structure

Plastic reflector sheets are deformed to hide the grow lights from the view of an observer. The deformation is also altering the cross section of the sheet and hence increasing its structural stiffness. The deformed plastic panels are screwed to a slender wooden framing system that stiffens loose panel edges and functions together with the plastic. As the composite elements are joined together as a box the structure becomes stable.

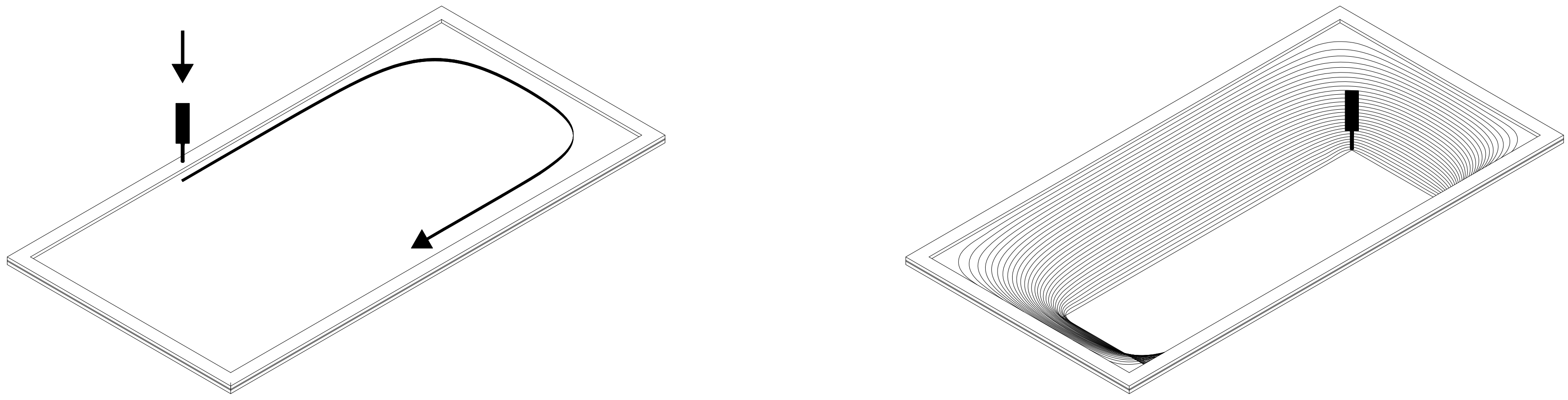
Manufacturing

Models are manufactured using a custom built form to shape heated plastic sheets. A sheet is placed in-between lid and bottom and the lid is pressed down against the bottom, causing the plastic to stretch into its desired shape, until the plastic has hardened. The same principle is used for both reflectors and pots. An alternative method to manufacture reflector panels is by single point incremental forming using a robotic arm. This would give a different surface texture.

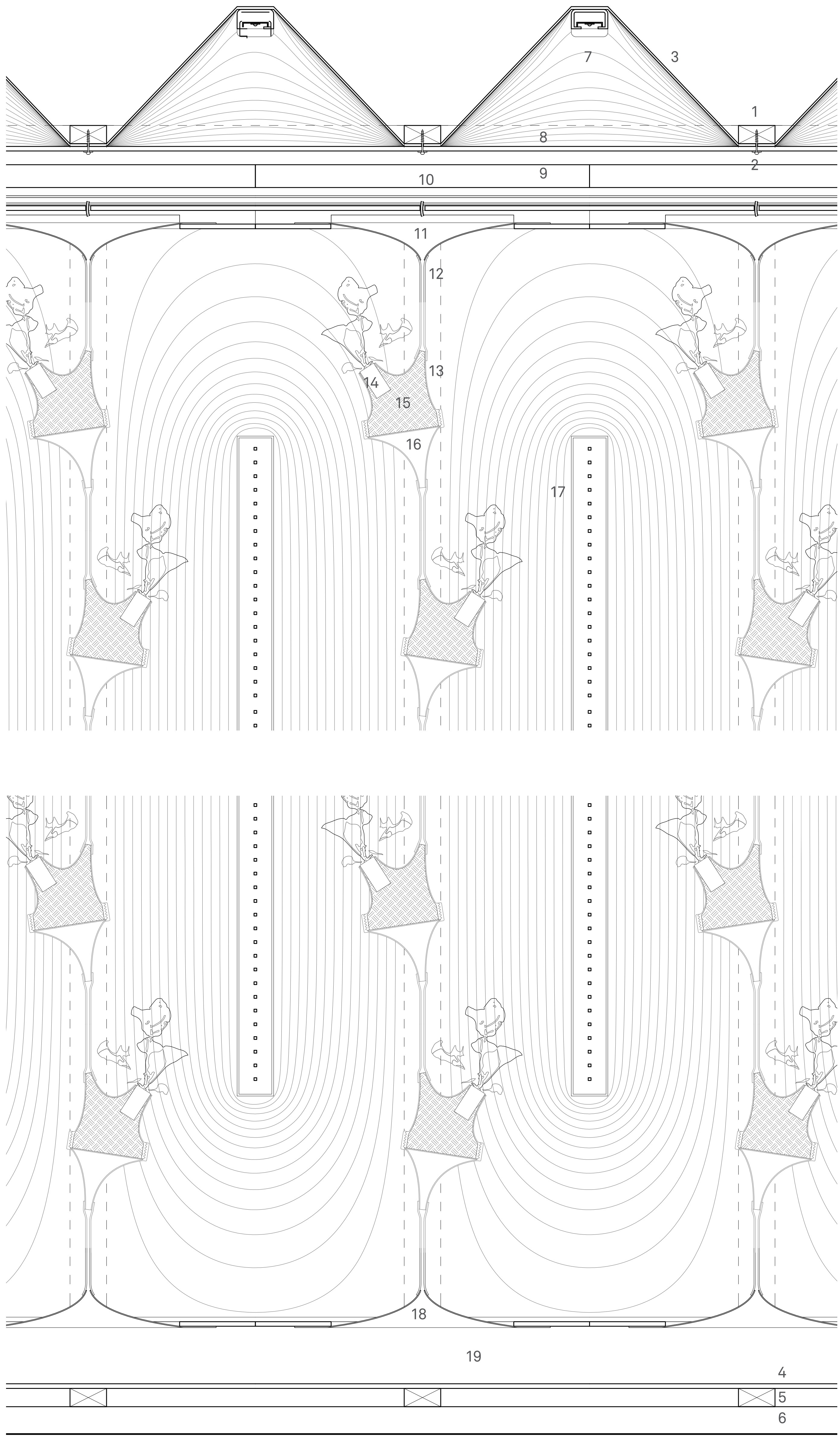




STRUCTURAL PRINCIPLE



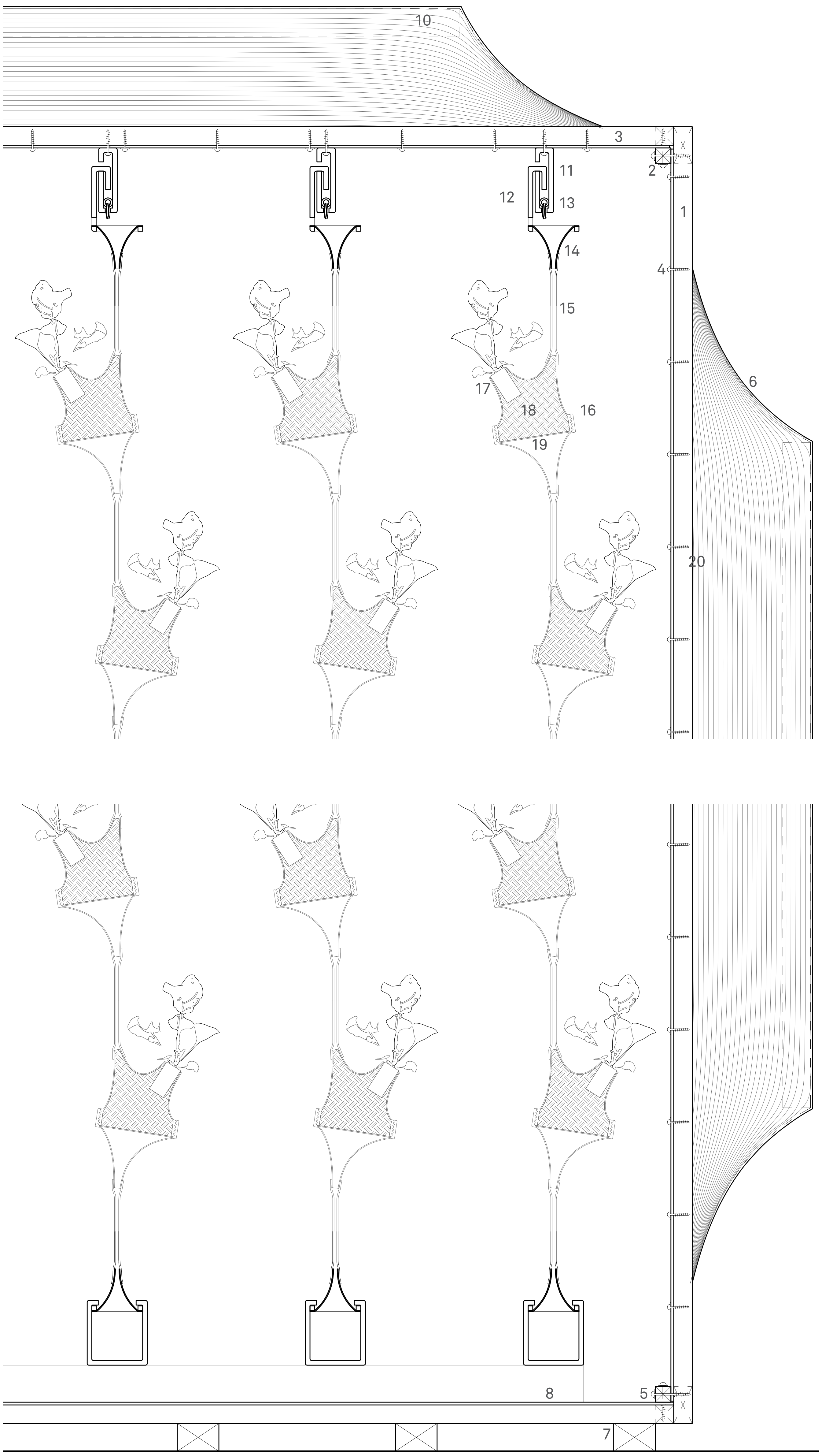
MANUFACTURING REFLECTORS



Structure
1 Wooden batten 20x40mm
2 Screw 20mm
3 White PET plastic 3mm
4 Board 5mm
5 Wooden batten 20x40mm
6 Wooden batten 30x45mm

Hydroponic system
7 LED Light bar, white light, 1000mm
8 Folded acrylic rail, transparent 5mm
9 Folded acrylic, transparent 5x366mm
10 Rubber hoses, ø 10/6mm, ø 5/3mm
11 PET drip catcher
12 Rubber hose, ø 6/8mm
13 PET openable screw pot
14 Rock wool cylinder ø 20mm
15 Coconut fibre, growing medium
16 Perforated acrylic plate 1mm
17 LED Light bar, white light, 800mm x2
18 PET and acrylic drip catcher
19 Folded acrylic gutter

DETAIL 1:5 (A3)



Structure
1 Wooden batten 20x40mm
2 Wooden batten 17x17mm
3 Wooden batten 20x40mm
4 Screws 20mm
5 Screws 40mm
6 White PET plastic 3mm
7 Wooden batten 30x45mm
8 Board 5mm
9 Wooden batten 20x40mm

Hydroponic system
10 LED Light bar, white light, 1000mm
11 Folded acrylic rail, transparent 5mm
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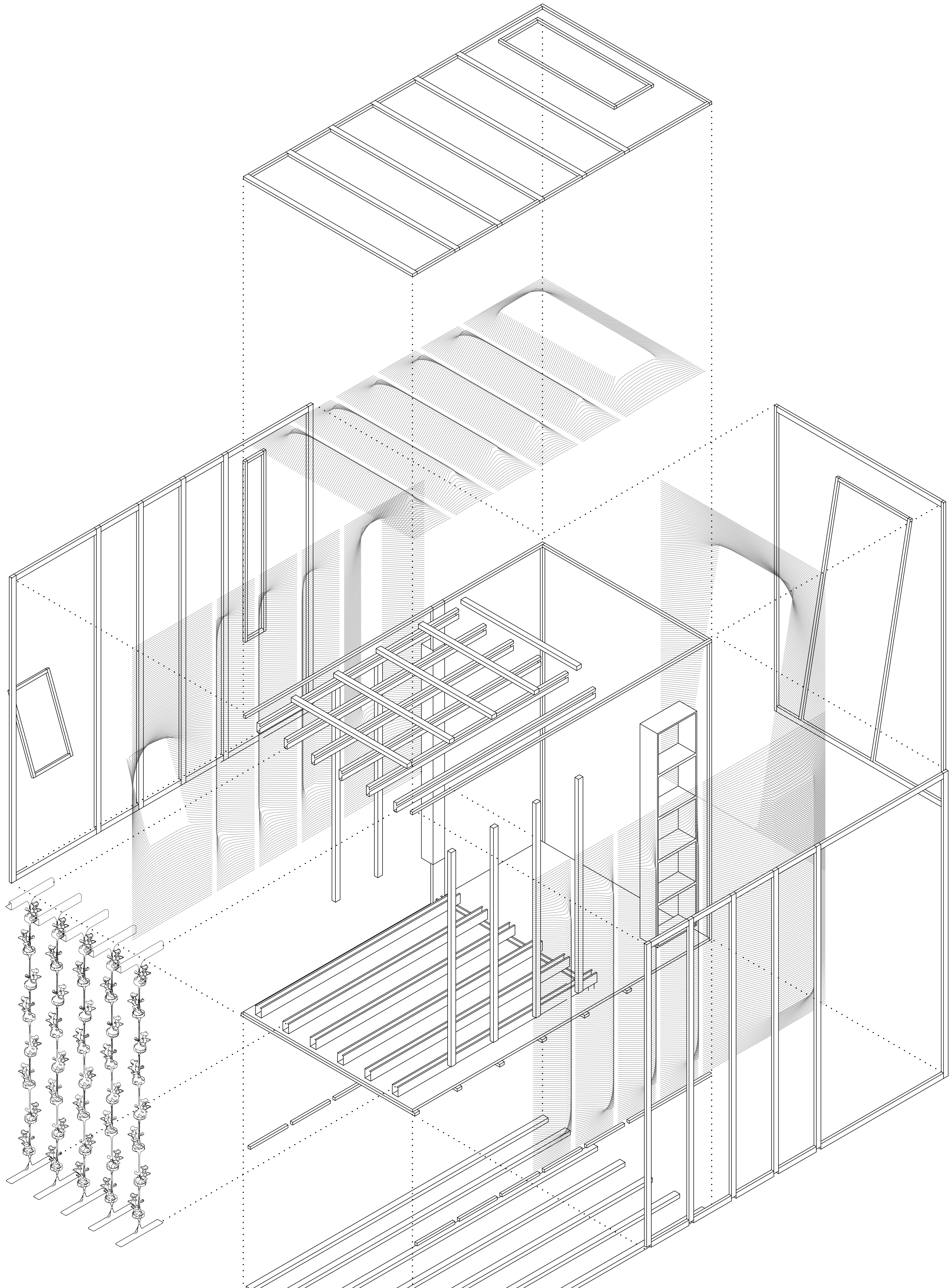

EXPLODED VIEW

MODEL OF GROW POD IN PETG PLASTIC AND CARDBOARD

MODEL OF POT IN PETG PLASTIC AND RUBBER

LIST OF REFERENCES

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