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The way we build our homes & cities today is irresponsible, a strain on our planet and unsustainable. The building sector stands for about 40% of the world’s entire carbon footprint, and many of the materials are used on a cradle to grave concept, ending up in landfills or burnt after use.

Rather than implementing new materials and techniques we keep developing the ones that we are familiar with even though their affect on our environment is clearly negative. We simply can’t continue building the way that we are used to and alternative materials and methods need to be evaluated, tested and implemented, the sooner the better.

Looking at future materials, Bio-materials seems promising from a carbon footprint point of view, but are these materials and methods sustainable from an economical, social and aesthetic point of view as well?

During this project I am going to explore alternative ways of constructing architecture, to enable a more sustainable approach in the creation of our built environment. Analysing different materials and construction methods that are under development or already in use. Materials that are grown or made by biological processes. This will end up in a better understanding of the possibilities that the chosen materials/methods hold. How well they answers to the need of social, ecological and economical sustainability and how the use of these materials/methods will affect the built environment and how people interact with it.

Is it possible to produce buildings entirely made from cultivated bio-materials?

Is it possible to work with Living bio-materials as structural elements in buildings?

How well do these materials perform in comparison with traditional materials?

How well suited are these materials & techniques for a subarctic/temperate climate?

For what purpose are the different materials best suited? Structural, insulating, protecting etc.?

What are the impacts on our built environment when using cultivated materials & techniques rather than traditional?
Material Research

To Answer my questions I Started the project by looking into research regarding materials that fit my criteria; made by either biological processes or cultivated & preferably biologically degradable. I focused my efforts on 3 materials, Mycelium based, Bacteria based & living trees. I looked at these materials closer by conducting short case studies of existing structures where they have been used. And after analysing my findings I Did a small study of my own, a 40 sqm, free standing structure, made mainly from one of the materials at a time.

**Mycelium** (my·ce·li·um

The mass of interwoven filamentous hyphae that forms Especially the vegetative portion of the thallus of a fungus and is often submerged in another body (as of soil or organic matter or the tissues of a host)

A.K.A. — Mushroom roots

Due to the mycelium’s natural properties & the way it grows in every direction, if packed dense enough you can produce a material that is both insulating and “solid”. This can be achieved by controlling the growth both regarding shape and the material that are “Fed” to the mycelium.

Starting by creating a mould of the required shape & fill that with some kind of cleaned agricultural waste mixed with mycelium. Then keeping the mixture in a humid environment for about 1 week, the mycelium will grow through & around the particles of agricultural waste and bind them together. When the growth process is done, the material needs to be thoroughly dried, killing the mycelium and preventing further growth and sprouting of mushrooms.

**Bacteria**

consist of a large domain of prokaryotic microorganisms. Typically a few micrometers in length, bacteria have a number of shapes, ranging from spheres to rods and spirals. Bacteria were among the first life forms to appear on Earth, and are present in most of its habitats.

If treated right, this bacteria produces calcite that can glue sand grains together, the process is referred to as microbial-induced calcite precipitation, or MICP.

Treating the bacteria right requires feeding them urea \((\text{NH}_2\text{H}_2\text{CO})\) which can be made synthetically or from urine, and provides nutrition for the bacteria. Water is also necessary, as is calcium chloride. The bacteria are non-pathogenic and die in the process of solidifying the sand.

The amount of carbon emissions that can be saved from using this process in contrast to traditional brick making is enormous.

However, sand is not a renewable resource & there are some concerns regarding the bi-products (mostly ammonia) of the process.

**Living Structures**

This technique uses living trees and other woody plants as the medium to create structures and art. There are a few different methods used by the various artists to shape their trees. Most artists use grafting to deliberately induce the inosculation of living trunks, branches, and roots, into artistic designs or functional structures.

Living structures & tree shaping has been practiced for at least several hundred years, as demonstrated by the living root bridges built and maintained by the Khasi people of India.

Early 20th century practitioners and artisans included banker John Krubsack, Axel Erlandson with his famous circus trees, and landscape engineer Arthur Wiechula. Contemporary designers include “Roots” artist Peter Cook and Beaky Norbury, “arboresculpte” artist Richard Reames, and furniture designer Dr Chris Cattle, who grows “grown up furniture”.

Living grown structures have a number of structural mechanical advantages over those constructed of lumber and are more resistant to decay.
The Hy-Fi tower by The Living is a structure made from 100% degradable materials. The structure is a circular tower made from both Mycelium bricks & reflective bricks made with daylight mirror film. The reflective bricks are used as the mould for growing the mycelium bricks before being incorporated into the structure.

The mycelium bricks are both load bearing & insulating but receive extra support from a re-claimed wood structure. The bricks are laid out in a traditional stretch bond, but the bricks are slightly rotated the further up in the structure you get, creating a thin wall at ground level and a thicker one at the top.

The structure was the 2014 YAP Winner and stood at the MoMa during the summer of 2014 as part of an exhibition, after this it was dismantled.

The Beetles Pavilion

This pavilion was raised by Beetles 3.3 (Indian & Italian Architects) in the south west of India for the Kochi Muziris Biennale 2016. The aim is to promote the use of mycelium for temporary structures used for events etc.

This structure is an attempt to grow the structure in-situ and it is made from a tray like wooden framework that over time will be consumed and encapsulated by the mycelium.

The pavilion stood for about 3 months, unprotected but for palm leaves to shield the mycelium trays for the sun, and over time the mycelium took hold. Eventually starting to disintegrate due to the mycelium not being protected or properly dried out. It would have been interesting to see the results for a similar project intended for a more permanent structure.

MycoTree

MycoTree is a spatial branching structure made from Load bearing Mycelium elements. The shape of the structure is designed using 3d modeling & analysing software to make sure that the Mycelium elements are kept in constant compression.

Due to the material being weak in both tensile & bending situations. The idea is to create stability through geometry rather than material strength.

The structure was made for the Seoul Biennale 2017 by the Block research group & Dirk Hebel, according to whom a mycelium structure could support a 2 story building if designed with the right geometries.

Bamboo & Steele dowels are connecting the mycelium elements but the mycelium carries all of the loads.
When attempting to create my own (super quick) case studies I set up some rules; the structure should be made as much as possible from Mycelium materials & it should be a domestic building of 40 m². This was to get a better understanding of how the material operate & can be applied in the most effective way.

Starting with the mycelium brick I have decided to work with regular brick modules to keep the exercise manageable. Working with a material that is strong in compression the problematic elements in a building is floors & roof. The way to get around this is to work with vaults or domes. In this case I decided to work with a traditional rectangular floor plan and using a Roman vault for the roof.

My conclusion is that using prefabricated mycelium elements can result in quite traditional structures, but it is not well suited for constructing an entire building. Complementing the structure with other materials would make for a much more efficient building and a more inspiring aesthetic.
The main issues with an in situ structure made from only mycelium is the support structure needed & the issue of drying out the material. The possibilities for the support structure is either using a material that will be consumed by the mycelium in time or using a removable & re-usable support structure. In this case I have been looking at the construction method used by Wallace Neff in his bubble houses. Where the support structure for the concrete is an inflated rubber “Balloon”, I think that this method could both with the support during growth & drying out the material. The material needed for the balloon is quite small & the balloon can be reused many times. Also when the mycelium growth is done, warm air can be put inside the balloon helping to dry out the material from the inside.

My conclusion from this investigation is that when working with mycelium In-Situ the support structure is the key, and this needs to be further investigated. If you were to construct a building from only mycelium I would recommend this over the prefabricated elements due to the lack of transport to site.

Wallace Neff: in 1946 he designed the bubble house, a distinctive house of inexpensive housing, in dome-shaped construction made from reinforced concretes that was sent in position over a inflatable balloon. It has been used for large housing projects in Egypt, Brazil & West Africa during the 1940s & 50s.
The Dune

The Dune is a project proposal from 2008, by Magnus Larsson that was developed in co-operation with the Green Wall Sahara Initiative. It is a 6000km long stretch of solidified sand dunes, crossing the Sahara desert from Mauritania to Djibouti. Proposed in 2008 the project is an attempt to reduce spreading of the dessert & at the same time create an inhabitable and plant-able wall, that can house thousands of refugees in the area.

The construction process of the Dune is acting like a gigantic 3d printer. Sporosarcina Pasteurii bacteria is flushed directly into the desert dunes. The bacteria cause a biological reaction turning the sand into sandstone, the initial reaction takes about 24 h but it will take up to one week to saturate the sand enough to make it inhabitable & structurally sound.

Bio-Brick

BioMason is a North Carolina start up, growing bricks from bacteria & sand, on a industrial scale. The company was founded in 2012 by Ginger Klug Dosier, Architect & biologist. The company is focusing on perfecting their zero emission, zero waste production techniques and the products are not yet available to the market.

The bricks are made from altering layers of sand mixed with bacteria, urea & calcium chloride to trigger a chemical reaction that produce mineral growth. This growth binds the layers of natural materials to form a brick, mimicking the process of coral growth. One brick can be grown in 2-3 days without any carbon emissions, in comparison to a traditional brick, that needs to cure for 3-5 days under very high temperatures, this process generates around 800 million tons of carbon emissions every year.

According to BioMason the bricks are equal to traditional bricks both in strength and durability, and they can be programmed to absorb pollution and change their colour when wet.

The first structure to be built with this product is a pedestrian walkway made in 2017/2018.

Self healing concrete

The most promising areas of use for this bacteria is in Self healing concrete. Researchers at delft university has created a brand of concrete, that can repair itself when needed. The concrete is infused with "a lime-stone creating bacteria". This bacteria is cultured & patches up damaged areas in the concrete, once it comes in contact with rainwater.

A typical durability related phenomenon in many concrete constructions is crack formation. Larger cracks hamper structural integrity, but even small cracks may result in problems. Ingress water and chemicals can cause premature matrix degradation and corrosion of embedded steel reinforcement. Therefore a self-healing repair mechanism would be highly beneficial as it could both reduce maintenance and increase material durability.

Since concrete is one of the most used materials in construction today, increasing the material durability could help when looking at the overall carbon emissions of the concrete sector, due to a reduction of casting new concrete for maintenance.
In this study I created a small structure with both curved walls & a roof made from Gaussian vaults. The base form is a rectangle but the experience of the structure both from interior & exterior would be something out of the ordinary. The shape of the walls is purely decorative whilst the shape of the roof is allowing for a smaller volume than if you were to use for example an Roman vault, a thinner structure and skylights.

Looking at Diestes work opened up a new way of looking at brick for me, and the possibilities of the traditionally shaped brick was evident. Though the walls are interesting aesthetically they might not be suited for such a small structure. However, this was a study to understand how the material can be applied, and I decided to draw the structural theme as far as possible.
The Baubotanik tower is a demo building, exemplifying new possibilities of engineering with living plants. It visualises the architectural & ecological potential of Baubotanik as a technique. The building has a 8m² footprint & stands almost 9m tall, containing 3 walkable levels.

The structure is made from 100 young silver willows, only the first layer of plants are placed in the natural ground, the rest is planted in special containers attached to the structure. Trusses are made out of two plants arranged in form of a rhombus, creating a stable structure once the plants have merged together.

The construction is supported by a temporary steel scaffolding, that will be removed once the structure is strong enough to stand on its own. This was approximated to happen within 5-10 years. It was built in 2009 so the time for removal is now very close.

This Hollowed out Oak is between 800 & 1200 years old, 15 m tall with a 1.6 m circumference at the base. The hollow trunk holds 2 chapels that were built in 1669 & they are still in use today.

The tree was hit by lightning which caused a slow burning fire through the core of the tree, hollowing it out will still keeping most of the tree alive. The local abbot at the time saw the fire as a sign from God and ordered the chapel to be built in the tree.

Since the tree was burnt out such a long time ago, several measures have been taken to counteract the problems that have risen over time. Poles help supporting the weight of some of the branches & wooden shingles cover parts of the tree where the bark is missing.

Buildings like this exist all over the world.

The Auerworld palace is known as the mother of all willow palaces. It was erected in 1998 by Marcel Kalberer & Sanfte Strukturen. It is inspired by the old Sumerian reed houses of Mesopotamia, constructed by tightly bound reeds. In this case however, the reeds are replaced by small young living trees.

Weaving the live saplings together to form a domed cathedral space, took the 300 volunteers about one month to finish. It was the first large scale example of botanic architecture in the world & the structure is massive, with a 320m² footprint & 7 m tall.

Since this project was realised, 1000's of small willow palaces have been erected around Europe.
When I was looking at different willow palaces & BauboBauk structures, the most of them had two things in common: they worked with rhomboids in the walls/domes and they have a circular footprint. I decided to make my structure a domed one, with one outer circle creating the walls & an inner circle creating a room & at the same time helps to support the point where the branches meet.

Working with this type of igloo-like structure might not be the best for a smaller building like this since you get a large volume but not as much usable floor area. This is different from the willow palaces I've looked at since I work with single saplings and inosculate them where they meet each other. Rather than working with several saplings that are bound together but not grown together.
When working with existing trees & bending the branches you have to consider the fact that you are not going to be able to get an exact result. Rather you have to adjust the rest of the built structure to the trees original geometry. To keep it simple i decided to work with one single tree, which limits the possibilities even further, since you need to keep the entire construction balanced.

This structure is built in two stories to achieve the 40 m² that i set up as a goal before i started the studies. The Walls, floors & roofs are connected to the branches and help to shape them gradually even after the structure is in place. To create a successful structure this way, i think that you need more than one tree as part of the structure, to make it stable and of a usable size.
Material experiments

Living structures

Test Cardboard - living structures
Test steel wire - living structures
Test papier mache - living structures
Test branches - living structures

Mycelium

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Brick test 1

a mixture of 30% straw, 30% feeding pellets, 27% mycelium mixed on oat pellets & 3% water. The molds were wrapped in plastic foil, to reduce exposure to air.

The cultures began to mold after a few days & mycelium growth stopped.

Brick test 2

a mixture of 49% feeding pellets, 50% mycelium mixed on oat pellets & 1% water. The molds were wrapped in plastic foil, to reduce exposure to air.

In the beginning it seemed to be a success, mycelium grew but mould took over and killed the mycelium.

Brick test 3

a mixture of 49% feeding pellets, 50% mycelium mixed on oat pellets & 1% water. The molds were wrapped in plastic foil & pressed close together to reduce exposure to air even more.

First successful experiment, however the mixture was too dense for the filaments to spread & instead created a dense layer in the top half of the brick.

Brick test 4

99% mycelium mixed on oat pellets & 1% water. The molds were wrapped in plastic foil & pressed close together to reduce exposure to air even more.

Mixture worked well and the mycelium spread through the entire brick. I did however stop the growth a bit to soon and the dried bricks are not perfect.

<Brick test 3

<Brick test 3, brick test 4
Brick test 5 & 6:

5 70% straw & 29% mycelium mixed with oat pellets, 1% water. Same sealing techniques as previous.

6 80% coffee grounds, 19% mycelium mixed with oat pellets, 1% water. Same sealing techniques as previous.

I lets the samples sit for about 1 month, the coffee samples were almost entirely covered in mould. The straw worked better but became very porous.

Trees:
I started to bend lilac trees during the fall, unfortunately, there were still not enough time for any result to be achieved.
Material properties comparison

- **Mycelium**
  - 100% Bio-degradable
  - 1,188 MPa -bend strength
  - Co2 emitted 1m3 - 31Kg
  - Energy consumed 1m3 - information missing
  - Thermal conductivity - (at 10°) W/mK 0,39
  - Density 112Kg/m³

- **Bacteria brick**
  - 0 waste 0 emissions
  - 7 MPa compression
  - 0,35 MPa tension
  - Co2 emitted 1m3 - 0Kg
  - Energy consumed 1m3 - information missing
  - Thermal conductivity - (at 10°) W/mK 0,5-0,8
  - Density 1845Kg/m³

- **Living structure (Willow)**
  - 0 waste 0 emissions
  - 18-28 MPa compression
  - 70 MPa tension
  - Co2 emitted 1m3 - 0Kg
  - Energy consumed 1m3 - information missing
  - Thermal conductivity - (at 10°) W/mK 0,12
  - Density 330 kg/m³

- **Concrete**
  - 30 MPa compression
  - 1,8 MPa tension
  - Co2 emitted 1m3 - 2400Kg
  - Energy consumed 1m3 - 4500Mj
  - Thermal conductivity - (at 10°) W/mK 0,4-0,7
  - Density 2400 kg/m³
Looking at the Case Studies it is clear that the material is in an experimental phase and that the attempts are temporary pavilions. None of the projects have been left up for more than 4 months so it is difficult to understand the lifecycle of the materials. Also, none of the structures are made totally out of mycelium but are all made to be biodegradable (except the steel rods used in the Mycotree).

Looking at the Material, no projects have yet to be realised and you can only look at the theory. The first structure to be built with a product like this is a pedestrian walkway made in 2017/2018. However the material is comparable to lime-stone & traditional clay bricks. The Company BioMason states that they can produce bricks that absorb pollution & changes colour when wet.

- Mycelium materials are strong in compression but weak in tension & bending. Making geometry key for structural elements.
- Treatment of the surface is needed to prevent deterioration of the material when exposed to humidity.
- Mycelium have both structural & insulatory properties.
- Prefabrication of smaller elements is much more developed & researched than In-Situ use, though both options are viable.
- The mycelium can be moulded into any shape.
- The growth medium & mold surface material affect the outcome of the mycelium element.

- Bacteria materials are strong in compression but weak in tension & bending.
- Bacteria bricks have a better insulatory property than regular bricks.
- Prefabrication of smaller elements is much more developed & researched than In-Situ use, though both options are viable.
- The bacteria can be moulded into any shape.
- The bi-products of the growth process & the use of sand as the main material makes the material questionable in some respects & has made the process of industrial use long and slow.
- The strength & durability can be compared to traditional bricks.

100% Bio-degradable
Rapidly renewable
Naturally fire resistant

0% waste material
0% emissions
Not derived from petroleum or food

Consumes Co²
Strong in compression & tension
Grown on site

Living structures & tree shaping has been practiced for at least several hundred years. And when looking at the Case studies, the variety of use is clear. The most interesting part of the technique is how it develops over time until killed. Since plants eat Co² The structure would be practically carbon negative & the possibilities for reuse of the wood after the lifetime of the building is endless.

- Living structures are strong in compression, tension & bending.
- Insulation create interesting patterns & stable structures, even solid walls.
- Saplings can be grown on site and planted when mature enough.
- Shaping of trees is possible, even in mature trees.
- Agroponics can be used to both grow & shape trees before planted at the final location.
- The process takes several years.
- When the structure is demolished, wood from the structure might be recycled & made into furniture etc.

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Living Struc tures

Conclusions

Mycelium materials

Bacteria materials
In the beginning of this project, I set out to investigate what alternative materials and techniques are out there, how well they perform and how they could be applied within a built structure.

My criteria for the materials was that they should be either made from biological processes or cultivated, that they would be renewable, recyclable or biodegradable. I chose 3 materials & looked into existing research, possible existing structures & did some case studies using each material. I did this to really get to know the materials and understand how they behave, their strengths & weaknesses.

After looking at the materials one by one I then started to mix the together into larger structures.

The Chimney:
This is a 1 family building in 3 stories, made with a living structure & a skin made from mycelium panels.

The Mycelium panels & floor slabs are gradually encapsulated by the living structure, holding them in place. A support structure is in place until the structure is strong enough.

The Blob:
This is a smaller structure that focus more on shaping than merging the trees, the skin is made from mycelium.

The MycoCave:
This structure is made from mycelium, grown on the site. A rubber balloon is inflated and the growth medium & mycelium mix is put on top of it and left until the growth process is complete. A technique inspired by Wallace Neff & his bubble houses.
The Chimney

2m Sapling are planted in a circle and bound together with each other to create the structure of the external wall.

A Support structure is raised & floor slabs are attached to this. The trees have now grown together at the lower layers and shaping continues higher up in the structure.

The Living structure has now grown enough to attach a roof. The support structure is kept in place until the structure has grown attached to the floor slabs & are strong enough to carry the loads. Prefab modules of mycelium (or windows) are also placed between the trees.

At this point the support structure has been removed and the Living structure carries the floorslabs. The trees have grown around the mycelium modules and windows, holding them in place. Moving into the building is possible. This has taken between 8-12 years.

The trees will keep growing over time shaped around the floor slabs and facade modules, changing the appearance over time.
Young trees are planted in a small circle. They are being bent down with the help of ropes that are attached to the ground.

Bending of the trees are being bent into the required shape, gradually. This is a slow process and are started whilst the trees are young and softer and kept until the tree has become stiff enough to stay in the right position.

The trees are grown together at the top to stabilise the structure. Prefabricated mycelium modules are placed between the trees, creating a building skin.

Ready to move in! This process takes between 6-10 years since you start with older trees.

The Blob
A rubber-balloon is attached to the site and inflated. Positive shapes of the doors and windows are put into place to create the necessary holes later on.

The inflated balloon is covered with mycelium mixed with growth medium and are left to be taken over by 100% mycelium. This would take between 1-2 months.

When the growth process is completed, the mycelium is dried out and killed. The balloon is deflated and removed. Doors and windows are put into place. And now it is ready to move in.
From my investigations I have come closer to answering the questions that I asked in the beginning of the project. But more questions have popped up, mainly the question of time!

Both the bacteria & the mycelium is suitable for industrial scale production and are made quickly. But living trees is a different story, sure you can grow them on an industrial scale but time is still the main factor in the production of structures like these. And I found the concept of time very intriguing & the place that time holds in our society and building processes and it raised a lot of questions.

Is it justifiable to wait 10 years for one house to grow? Is it for a neighbourhood or a city?

What if you plan the structure to change it's function over the cultivation time?

I decided to work with time as one of the main factors of the design process. And started thinking of what activities and functions could be housed during different points of time within the cultivation of the structures. at the same time, looking at what the architectural experience would be like during these points in time. Jumping back and forth in time to see the effect of each decision in each point in time.
1. Columns inside a larger structure

A wall would have to be raised around the entire housing area, fencing it off and claiming a big area as private land. The roof is a traditional flat roof which would make the building into a very traditional structure, just a big wall in the landscape. Too traditional, unsuitable for the concept, needs a more organic appearance.

2. Mesh with stems & domes

The mesh gives the structure a bit more variation & a more organic appearance. Weird meetings with the much lower domes.

3. Mesh with only stems

Too uniform & the structure would still be very 2-dimensional in the landscape, the roof holds the same height almost everywhere and the variation would only be seen from the rooftop patios.
4. Mesh with different shapes & heights

The volume is more diverse in appearance both from the exterior & interior. The domes are redundant, simply creates weird meetings & the thinner stems would be unusable except in the final stage. If you add floor slabs between the stems, the structure is still too heavy.

5. Mesh with stems in different heights

The volume is more diverse in appearance both from the exterior & interior. But the structure is still too heavy & monolithic.

6. Smaller units

I like the size of these better than the previous large structures, but the building is much smaller and would take up more land. Somehow I would like one larger structure so that you can move between the spaces without leaving the structure.
7. Canopies & crowns

The crowns solved most of my concerns, like monotony in the exterior, heaviness & variation in internal & external spaces. Also you are able to move all through the building without going outside. The crowns also frames the outdoor spaces, almost making them a part of the building.
Saplings have been cultivated in nurseries and was planted on site when between 1.5 & 2 m tall. Some of the saplings have been here for almost 5 years and have continuously been shaped and bound together with their neighbour, merging over time just like kissing trees and have started to create wall like structures. Others are newly planted & yet others are grown on site, together creating a landscape in various stages of growth.

This is a park of framed circular spaces, framed by stems, walls, difference in materiality & temporary shelters. The framed spaces allows for a feeling of privacy, and hints of the existence of an inside & outside. A totally public space, changing in appearance from season to season and as the living structures develop.

On Grafting

Grafting is a horticultural technique whereby tissues of plants are joined so as to continue their growth together. The upper part of the combined plant is called the scion while the lower part is called the rootstock. The success of this joining requires that the vascular tissue grow together and such joining is called inosculation.

For successful grafting to take place, the vascular cambium tissues of the stock and scion plants must be placed in contact with each other. Both tissues must be kept alive until the graft has "taken", usually a period of a few weeks.

Successful grafting only requires that a vascular connection take place between the grafted tissues.
Salix Babylonica
Weeping willow

Betula Pendula
Silver birch

Prunus Padus
Bird cherry tree

Grafting

Inosculuation

Baubotanik

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By now, what used to be a park have become buildings, 2-3 stories high stems inhabited by students. The first students moved in about 10 years ago, when the structures were tall enough to house one story. As the buildings have grown taller, more people have moved in. And it is now fully inhabited, full with the activities of a small community.

The building skin is made primarily from mycelium & placed on the inside of and attached to the living structure. The mycelium needs to be shielded from the environments and there are several techniques possible to use for this. One is to use some kind of gore-tex-like fabric or maybe use future lexxar made from wood cells.

During the growth process, a ring made from a strong material (steel) have been merged into the structure to which the floor slabs of the building will be attached. The living structure supports the floor slabs and the mycelium walls helps as well.

When the first floor is completed, there is a possibility to place a temporary structure on the roof of this, allowing for a tenant to move in and take the responsibility of the continual growth of the living structure until the second story is complete and so on.

Inhabiting the structures as soon as possible & making the inhabitants into a part of the construction process can prevent damage & squatting during the growth period. And create a sense of pride in the inhabitants.

Walking around the area, will be like walking in a forest of gigantic trees, huge stems reaching towards the sky, smaller trees and shrubs growing at their feet. But the stems are inhabited by humans instead of birds & bugs, you can see them trough the rhombiod windows or sitting in the tree crowns.

Hanging gardens with leaves falling around the top of the buildings like waterfalls. Light & shadows playing on the ground, and buzzing from insects swarming around you. The clearings inbetween the stems have been filled with flower beds and fairy lights, informal meeting spaces, where the habitation bleeds out of the structures into nature.

And from the roof patio of one of the taller structures, you get a birds-eye view of the inhabited park trees.
What used to be individual buildings have now become building elements in a large structure. The stems have grown into either a traditional tree crown, or into a canopy like in a weeping willow. Generating different types of spaces and connections.

Standing in the courtyard, surrounded by the canopies but open to the sky, you are shielded, embraced by the structure, outdoors, but in a clearly defined space. It feels like a natural part of the structure even though it is an in between.

Walking on the pathway, closing in on the structure, like an arch over your head, framing the backdrop of forests and fields and the winding of the road. Standing under the crown, covered from the sky, but not encapsulated by a structure, not inside, but not outside.

From a far, the building will appear like a cluster of tree-like organisms, but as you come closer, you can see the neatly shaped patterns of the stems and the unformed crossings of the crowns.

The canopies are large open courtyards but indoors, varying in size in all directions, within this large hall, the stems are placed, like oversized columns. Creating nooks and “corners” that are more intimate, feels more private even though they are just a part of the bigger hall.

Light shines in through openings, placed in between the living structure, a combination between skylights and openings in walls, there are not many, but they are big.

The curvation of the building skin in combination with the stems placed inside of it will generate a varied daylight climate, enhancing the mentioned smaller & larger spaces within.

The crowns are connecting the three clusters contained within the canopies, raised up in the sky, to break up and create a lighter appearance to the building volume.

The spaces are large open halls, with curved surfaces all around, making the differentiation between floor and wall & wall and ceiling blurred.

They are made for larger event such as lectures or art exhibitions or similar activities and they only have one, large window, to make the daylight intake easy to control.

The ceiling height is vast, and you enter from the floor, which is also the roof of the stems. A spacious organic structure, almost flying above the ground.

The sapling has made the journey from a single plant, into a building element, in a building that in time has grown into a building element in a larger building.

This is as far as I have travelled, so who can say what comes next, but I imagine that these structures have started to pop up all over. Growing in what used to be parking lots or roads, biological structures taking back what we once took and making the city a more healthy & sustainable place, both for our planet and for us.
Isometric drawing
not to scale
In the Crown halls you have large open spaces, where lectures, exhibitions and other large gatherings can be held.

In the Canopies you have a combination of open spaces with generous ceiling height, more intimate corners. These can be used for studying, workshops & parties or other medium sized group activities.

In the Stems, the rooms are smaller, more intimate & are used for vertical communication. The stems can be used for offices and smaller meetings.

A few of the stems are wet buildings, meaning that all facilities in need of plumbing will be placed here.

During the early stages of the growth process, shaping the stems & creating the main shape of the crowns and canopies, the trees will be strictly kept, not allowing for the tree to branch out, cutting of new buds to allow for maximum growth of the main stem.

But when the main shape of the building has started to take form, the trees will be allowed to grow branches, these will help to create a mesh and enhance the strength of the structure, at least this is the case in the crown & canopies. The stems will be kept clean since they will be in an indoor environment.

This will create, in time, a mesh of branches covering the structure, almost like a birds nest.