## **INOCULATING ARCHITECTURE**

by

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## ABSTRACT

Inoculating Architecture manifests itself as a series of interventions designed to recalibrate human society's relationship with nature in an effort to promote the mediation of environmental damage using Vancouver Landfill as a test site. These interventions are constructed with the aid of waste consuming fungus to convert humanity's discarded materials into organic building components capable of curtailing the demand on extracted natural resources within the construction industry. The site's public amenities are focused on bringing human society closer to the natural processes that support our everyday life by creating opportunities for the public to engage and interact with this remediative process facilitated by mycelium production.

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"Collaborating with the remediative qualities of mycelium as a conduit for producing organically derived architectural systems that are capable of constructing our built societies can remediate environmental damage and recalibrate human society's relationship with nature."



This project holds its significance as an aid to the increasingly deteriorating state of our planet as global warming and the effects of climate change begin to seep into our everyday lives. This project focuses on the planetary flow of waste and, specifically, how the local flows of waste have contributed to these global inventories. For context, it was noted in 2019 that 38.5% of globally extracted resources was associated with the construction, renovation and demolition of buildings and other built structures, with almost one third of this material ending up in landfills.<sup>1</sup> Finding alternative methods to resource extraction to build our societies is vital for our combined effort as a species to curb global waste inventories and the effects of climate change.

Thinking of waste reminded me that these discarded objects were once understood with purpose and value but have become obsolete within our existing systems. It is simply a matter of re-purposing these materials to re-frame their existence as valuable within our society even after their original, intended purpose has been fulfilled. Mycelium also exists in the same manner, as nature's recycler. This organism takes matter that the rest of the ecosystem has no use for and converts it into something useful for the surrounding fauna and flora. By consuming toxins in the soil, it creates mushrooms, which can be eaten by wildlife, clearly supporting the ecosystem. This shared experience creates a clear dialog between the fungus and the waste as both seek purpose in an ever changing human society.



With a clear identification of the issues the project is looking to tackle combined with an avenue for potential solutions, researching the existing conditions of the industry responsible for this waste epidemic becomes vital. Wood and plastic building materials make up the vast majority of our construction waste inventories and are the focus of this exercise. First, each material is extracted from its natural environment, reaching deep underground to extract crude oil or extracting old growth trees from our forests.<sup>2</sup>

Both materials are then shipped to a processing factory where their physical properties are altered through heating, diluting, cutting and more, in order for the material to be deemed useful for the impending construction and eventual demolition of a project and then discarded in landfills to fester until natural processes can return them to their natural state- which in some cases can take decades if not centuries to occur.<sup>3</sup>

The issue with this system is two-fold: the abundance of unused waste materials created during the production process and the product that only spends a fraction of its lifetime actually executing the task it was intended for. A redefinition of purpose is required in order to expand the functionality of the products we create for our built societies.











Understanding how to manage these waste inventories is not the only task at hand, however. If mycelium is the conduit for converting these waste inventories into organic building materials, an understanding of humanity's relationship with mushrooms is equally important for this endeavor.

Mycelium is the root system of all variations of fungi and varies across thousands of species capable of connecting a forest's population of trees and plants through a subterranean root structure called the Common Mycorrhizal Network, or the CMN, or the Wood Wide Web.<sup>4</sup> This is achieved via microscopic hyphae capable of transferring nutrients or warnings of invasive species from flourishing to struggling plants.<sup>5</sup>

Historically, humanity only knew of mushrooms as a food source, and eventually discovered its medicinal and recreational properties as well. In modern times, we have politicized mushrooms as a delicacy or a health hazard, but never both at the same time.<sup>6</sup> We have also expanded our medicinal applications as our intelligence and technologies expand, yet we only discovered the CMN in 1997 in British Columbia and only in the past several years have we even attempted to create an inhabitable structure out of this multifaceted living being.<sup>7</sup>







With an understanding of how society views waste systems pertaining to our built environment and mycelium within the landscape, their intersection culminated in the form of a self conducted brick growing exercise. These mycelium bricks were grown in containers accompanied by four different types of waste. The first of which is agricultural waste represented by coffee grounds and orange peels. Next is organic waste in the form of hemp shavings. The third waste brick holds plastic waste in the form of single use plastics used in food and product packaging and finally, construction waste in the form of sawdust from SALA's wood shop.

## $\mathbf{o}$ | Waste Brick Experiment



WASTE BRICKS

## Agricultural Waste



## Plastic Waste



#### Organic Waste



## Construction Waste



Once I became familiar with the growth process of waste consuming mycelium and the pertaining spatial requirements seen from my own experiment, the next study performed sought to upscale the individual actions performed throughout the growth of mycelium in order to create a series of functional built interventions. This was done by elaborating on the processes of each action and defining the floor space requirements of each activity in order to better understand the size and proximity needs of these spaces.



In tandem with spatial explorations, each defined space of the waste processing center is organized on a scale of public interaction determined by the need for controlled environmental conditions. Activities like old packing and product drying are examples of programs the public can participate in while spore propagation and mycelium growth remain passive, observatory experiences as the need for controlled environmental conditions rise.





A local site abundant in waste is Vancouver Landfill. The landfill will serve as a site of investigation for the capacities of mycelium growth pertaining to waste consumption, human interactions with nature and the construction of built environments that facilitate these relationships.

Located along Highway 99 in Delta, BC, the site is only accessible from a single southbound exit. The project will need to manage the existing waste inventories on site while also dealing with incoming waste from the surrounding area. Burn's Bog Ecological Conservancy Area to the North, Boundary Bay Airport to the South, a range of agricultural fields and small congregations of residential areas make up the surrounding context of waste flows that the site's interventions will be managing.

The project will be completed in seven phases that divide the construction of temporary and permanent amenity nodes relative to a central, unwavering waste wall. These amenities are stitched together by weaving path systems that tether the nodes of program to the central circulation wall and takes users through the newly established Burn's Bog forest extension. The final set of interventions are strewn throughout this expanded green fabric as a grid of artifacts that allow all living users of the site to interact with the remediative capacities of mycelium and by extension, the healing qualities of nature.




















The first site intervention manifests as a rammed waste wall focused on managing the existing waste inventories that plague our ecosystems in an actively productive way to create spaces for the public to interact with each other and the natural realm that envelops our everyday activities. Spanning the majority of the site, the linear waste wall cuts through the center of the site as it is slowly constructed with the aid of a series of rolling greenhouses that enclose temporary work spaces for landfill workers as they mediate the relationship between waste and fungi.





34 / The Walls

Beginning with the sanitation of existing waste inventories, the waste processing station houses industrial pressure sterilization autoclaves on rolling steel platforms that move with the encasing structure. The surrounding area is used to sort the existing waste into viable categories like wood, plastic, food and agricultural waste to ensure the inoculated spore is capable of consuming the entire batch. Once sanitized, the waste passes through an airtight accordion passage to neutralize any chance of exposure during the inoculation process.



Next, in the spore storage station, petri dishes of a variety of fungal spores are stored at precise temperatures also upon a rolling steel platform. Adjacent to the exterior walls of this greenhouse is a modest potato garden which will be used to provide starch as sustenance to the growing fungal spores prior to inoculation. These gardens will be used to sustain local communities once the project has reached completion.



In the next space, mycelium growth occurs in light controlled boxes and continues to consume the waste for several months until there is no trace of garbage left. At this point, any failed growth resulting in non-structural capacities will be removed and placed into a gabion basket adjacent to the site's circulation paths. Any growth failures due to contamination will be placed in isolation pods throughout the site. Once the mycelium has successfully consumed the waste within the container, it is removed and used in the construction of the waste wall.



In the soil excavation greenhouse, a six meter wide trench is dug out and a series of steel floor plates are installed as a foundation for the rammed earth waste wall. Vertical steel members are screwed into the base and will be used to align the top compression plate when the waste has reached capacity and requires crushing to increase its structural integrity and to neutralize the spores. A central steel grate walkway is installed for workers to access the wall from below to ensure feeding from above occurs smoothly as the next greenhouse rolls by to compress the waste and repeat a process similar to traditional rammed earth wall construction.



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In the final greenhouse, the construction of the rammed earth waste wall ensues. Once a portion is complete, its compression plate is welded to the top of the steel columns to signal to the public that this next phase of the wall is ready to be explored. The open nature of this installation process allows visitors to follow along the completed wall and review the construction process through the translucent nature of the greenhouse's facade.







Simultaneously to the waste wall, a series of circular public amenity nodes are constructed using three unique waste encapsulating strategies. Each strategy varies in structural feasibility and therefore, varying life spans that provide an array of temporal experiences gauged at framing user interactions to accountability of mistreatment of natural elements and the environment. These interventions intend to manage the current influx of new waste produced from other industries' practices still indifferent towards climate change and the global efforts to mediate environmental damage.

The first set of constructed elements are made of rammed earth, just like the main waste wall and will be the permanent stakeholders on site as they are only constructed once and are intended to stand the tests of time and human interaction. Retaining walls and foundations encase waste into the compressed soil mixture and employ traditional, recycled wood form work to complete the forms, potentially soliciting the public for help with this huge endeavor.

A total of four programmatic elements are constructed with this strategy on their first, and only, iteration. An amphitheater, a sport's field, an art gallery and a restaurant/café find themselves throughout the site and will serve as a tethering point for the less permanent constructions adjacent to them.





49 / The Nodes

The circular form creates a juxtaposition from oldest to newest construction as the amenities begin to establish themselves in the landscape. These sites will allow visitors to create long lasting memories and personal connections with the entire site as the constructed elements resist time and maintain form and structural integrity.



The next set of programmatic elements are constructed by filling gabion baskets with inoculated waste bordered by a layer of repurposed masonry elements, separated by a layer of landscape fabric. The baskets are used in a modular fashion to construct retaining walls and foundations that come together to form public amenities like fire pits, greenhouses, an outdoor gym and a children's playground.

The gabion baskets are a static form filled with a growing, living medium that will eventually grow past its confining form. Upon the failure of the structural elements a new site will adopt the existing form and program but this time, out of rammed earth. The intention is to allow users a safe place to interact with natural elements that respond to how they are treated by humanity. The worse a site is treated the sooner it will fall into disrepair to be reclaimed by nature.





With traditional architecture, this process of degradation and decay often takes decades to occur, removing the immediate users from the consequences of their actions, which perpetuates the misuse of our built environment as any expressions of mistreatment remains unrecognized by the inflicter. Nature is trying to tell us something yet we rarely have the tools to comprehend the message. Perhaps refining the temporal aspects of these interactions will aid in facilitating a successful conversation between humanity and nature.



Finally, the third and most temporary of constructed elements are a series of programs constructed from live stake enclosures that retain inoculated waste with wooden stakes hammered into the ground. From this strategy, a dog park, mushroom farm, and community garden will emerge.





59 / The Nodes

These amenities will be the first to fail as all structural elements used are easily manipulated by public interaction and remain consumable by the mycelium once it has finished with the waste within. These sites will be the most effective in portraying reactions to human interactions as tampered elements quickly decompose or topple over when mistreated, altering the form and intended use of the space.

The reconstruction as a gabion system will provide users a second chance to learn the necessary lessons of mutual reciprocity and respect prior to the construction of a permanent, final structure that, once spent, will not be reconstructed for fear of emotional dissociation from the landscape.





A series of pathways connect the project together and create a variety of access points that tie the site to its surrounding context. These circulation strategies aim to secure the success of built forms despite the many uncertainties of working with autonomous, living building materials by incorporating failed structural growth into the construction of the site's circulatory systems.

The main strategy consists of modular gabion baskets that form walls of varying heights. A combination of failed mycelium structural elements and recycled aggregate from demolition projects are placed in illuminated gabion cages alongside a pathway made from compacting recycled aggregates into steel grate walkways.





These pathways remain linear and only curve around the amenity nodes allowing the modular strategy to continue throughout the site. As time passes, the failed structural growth will overtake the baskets and surrounding landscape, establishing the circulation path into the form of the landscape itself.


In the Burn's Bog extension that consumes the non-active areas of the site, live stake trails weave throughout the site, creating a multiplicity of circulation routes to traverse the site. With no regard to the formality of the constructed elements, these trails remind us of the interconnecting system of mycelium living beneath our forests and cities and creates a sense of wonder and discovery previously unattainable at a landfill park.





Stakes inoculated with bioluminescent fungus hold loosely compacted soil in place and light the way for visitors at night. These paths weave between the trees of the Burn's Bog forest extension and connect the pedestrian access adjacent to Highway 99 at the southern edge of the site to the rest of the green fabric to the North. Spent logs glowing from the accumulation of fruiting fungus are placed adjacent to the pathways and extend into the landscape as inventories rise and a freshly inoculated stake is installed in its place.





The final series of site interventions organize themselves on a gridded system spanning the entire site. These elements intend to express this developing organic construction system's ability to form our societies while facilitating a mutually reciprocal relationship with each other and with nature. These constructed elements provide a series of discoverable experiences only accessible from meandering the illuminated trails, enticing visitors to explore the site and discover new interactions with the natural realm.

The first intervention is a series of enclosed waste capsules intended to store toxic waste that the landfill was previously managing as well as any new waste from surrounding industrial sites. Contained in a steel alloy tube with an angled screw top punctured by a small viewing window to allow light and precipitation, this unit becomes a place of congregation and exploration as users discuss what they are seeing deep below the ground, safe from the dangers of man's most toxic creations.





7**6** / The Grid

These capsules are placed furthest away from programmatic elements and site circulation and as time passes, the connections between the steel alloy elements will decompose. Moving at a rate much slower than any of the toxins within, these capsules will eventually reveal the living ecosystem they contain only when safe to do so, finally re-establishing these century old materials with the ground they were once extracted from.



78 / The Grid

Finally, placed in clusters around programmatic elements and circulation routes, are a series of tubular steel cages that house hanging bags of inoculated agricultural waste for edible mushroom growth and consumption. The steel cages are enclosed with strips of landscape fabric to contain moisture and darkness during the fruiting process. These interventions stand as a means to educate the public through personal explorations and organized site tours that allow visitors to take the lessons learned on site forward into their daily lives.





Over time, the bags will fail and fall off of their hanging supports to be reincorporated into the surrounding landscape as they make their way through the steel mesh without compromising the health of the mushrooms, ensuring consistent access to food for all who visit the site.

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83 / The Grid



In conclusion, the concepts within these organic construction assemblies expand and spread beyond the constrains of the landfill and can be implemented at local, regional and global scales enacted by individuals, corporations and even the governing bodies that form our cities. This project aims to illustrate a future for humanity where mediation and communication outweigh imposition and exploitation. As time continues to pass, we see fragments of a bigger picture throughout our daily lives, yet our disconnection from the temporal aspects of growth and decay make it impossible for society to understand the ramifications of our consumptive behaviors.



We share this planet with an inconceivable array of fauna and flora that already understand and embrace the ever-changing ecosystems of our globe and, through this understanding, are able to define a sense of purpose within this 'bigger picture'.



Perhaps we are simply afraid that our true purpose is too large for our individual or collective capacities as a species. But more likely, is that we have rejected our humble beginnings in a thirst for more, so much in fact that there is nearly nothing left for the remaining living beings of the globe.



If humanity could learn to coexist with the natural processes that form the human experience, then we might be able to embrace the decaying wasteland we have constructed for ourselves and finally learn to only take what we need to survive.



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