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FUNGI IN ART

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Declaration

I declare that I have elaborated the Bachelor's thesis entitled Fungi in Art independently, under the expert supervision of my thesis supervisor, and using only the literature and sources cited therein, and that the thesis was not used within the scope of a different university programme of study or to obtain the same degree or a different degree. I consent to the publication of the thesis in accordance with legislation and with AMU internal regulations.

Prague,

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Eva Palčíč

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Fungi in Art

Abstract

This thesis discusses the role of fungi in art, both historically and in contemporary times, and emphasises the creative possibilities and distinct qualities of these complex organisms. The thesis highlights the growing field of bio art and the potential of collaboration between scientists and artists, specifically in the field of fungal biotechnology. Overall, this paper celebrates the diverse ways in which fungi can be incorporated into artistic practices and the potential for these organisms to inspire new forms of creative expression.

Key words: bio art, fungi in art, bio artists, science and art, fungi in Anthropocene

Abstrakt textu

Tato práce pojednává o roli hub v umění, a to jak v historii, tak v současnosti, přičemž zdůrazňuje odlišné vlastnosti těchto složitých organismů a jejich potenciál podporovat tvůrčí uměleckou činnost. Práce upozorňuje na rozvíjející se oblast bio umění a na možnosti spolupráce mezi vědci a umělci zejména v oblasti nových myceliálních biotechnologií. Celkově tato práce oslavuje rozmanité způsoby, jakými mohou být houby začleněny do uměleckých postupů, stejně jako jejich potenciál inspirovat nové formy tvůrčího vyjádření.

Klíčová slova: bio umění, houby v umění, bio umělci, věda a umění, houby v Antropocénu

Introduction

Throughout the thesis, I will investigate the emerging field of bio art and its potential in the intersection of science and art that offers a unique space for interdisciplinary collaborations among artists, scientists, and engineers. A particular area of my interest is the use of fungi in contemporary artistic practice. My focus will be on collaborations that use fungi as a means of exploring environmental issues, particularly those related to climate change and the Anthropocene. I will explore how artists use various organisms from the fungi kingdom as a tool to raise awareness and bring attention to ecological challenges. After lengthy research of this branch of bio art, I have selected eight prominent contemporary artists that actively contribute to addressing the importance and potential of fungi to remediate environmental damage caused by human activities. I will explore how they develop creative solutions to ecological challenges and the role of environmental sustainability in contemporary art production. I will provide an overview of their projects and artworks, analysing how they use different organic materials such as living fungi, mycelium and bacterial cultures as a medium. Fungi are fascinating organisms that offer a rich source of inspiration for artists working in a variety of media. From painting and sculpture to installation and performance art, fungi have been utilised in many ways. They have been used in artistic practice as a sustainable building material for producing sculptural work,

furniture, biodegradable packaging, textiles, pigments and many others. The versatile properties of fungi make them ideal for creative explorations that can help spark up conversations, develop solutions to environmental challenges and inspire action around pressing ecological concerns. The thesis will be organised into segments in which each will focus on a particular artist or group of authors. The chapters will provide insight into their artistic practices through research and excerpts from interviews of artist and scientist, artist statements and selected literature. The passage of the body will provide an overview of the work of contemporary artists Xiaojing Yan, Robbie Jenkins, Jae Rhim Lee, Neri Oxman, Suzanne Anker, Diana Scherer, Seana Gavin, Theresa Schubert, Anicka Yi and Studio The Living. Yan's work incorporates fungi in multiple ways: as a sculptural material, as an inspiration for casting bronze sculptures, and as a symbolic element in her virtual reality experiences. Fungi also play an important role in the history and heritage of ancient China, appearing in folk tales and mythology. Yan draws on these cultural connections in her work. Followed by a similar approach to material of fungal sculptures, Robbie Jenkins utilises fungi's mycelium forming organic sculptures inspired by the construction of classical Greek architectural styles. Followed by Jae Rhim Lee with an Infinity Burial Project, a mycelium burial suit that seeks alternative solutions for traditional burial methods using fungi to sustainably break down human bodies. Next up I will continue with a presentation of extensive research work Aguahoja, developed by Neri Oxman and her team at MIT media laboratory, where they seek to create alternative organic materials from biopolymers derived from fungi. Next, I will discuss the work of mixed media bio artist Suzanne Anker, focusing on her project Vanitas in a Petri Dish where she is combining natural and manmade materials creating hybrid environments within the petri dishes. Diana Scherer's fascination with underground root systems and her technique of growing roots in textile like materials will be presented after. ¹⁵ Next, Seana Gavin's multi-layered collages in which images of ancient civilisations met with speculation of future of the planet. Followed with sensory hybrid ecosystem, Inside an Inside Forest- an experimental techno-organic installation that inspects the micro processes that happen in tress by Theresa Schubert. Next to last is Anicka Yi's agar vitrine where she developed fungi and bacteria swabbed from hundred women. Last work will be Hy-Fi architectural structure by The Living studio, a building made from mycelium bricks. The first chapter On bio art will serve as an introduction to what bio art is, how it intersects with biological sciences, and how artists can use their skills to convey complex scientific ideas. Additionally, it will discuss the critical ethical considerations that arise from the use of living materials in bio art. Following chapter On Anthropocene will discuss the concept of the Anthropocene and its importance in the current environmental discourse. Specifically, it explores the pivotal role of fungi in revealing the extent of climate challenges and the potential for remediation. The section Bio artist using fungi will serve as rationale for the selection of the presented artists. By exploring the potential of fungi in bio art, I hope to contribute to the ongoing conversation about the role of art in addressing climate change, underlining fungi as remarkable organisms with characteristics that make them both fascinating and versatile as a medium for artistic expression that challenges our perceptions of life. The conclusion will summarise and revise all the main ideas and statements of the thesis.

On Bio art

Bio art represents a novel trajectory in contemporary art that involves the manipulation of biological processes.¹ It is an interdisciplinary field that integrates the arts with biological sciences, and frequently entails close collaboration between bio artists and scientists. This intersection facilitates the dissemination of scientific knowledge to the public, as scientific concepts are often complex and challenging to convey. Artists, equipped with their distinctive sensitivity and technical abilities, employ diverse visual, auditory, and creative approaches to present scientific concepts in a more accessible manner, thereby increasing public engagement with scientific research. This symbiotic relationship between seemingly disparate disciplines not only informs one's perception of an object, but also offers novel ways of presenting it to the public.

As a discipline, bio art involves the use of living organisms such as plants, fungi, bacteria, animals and even the human body to explore the relation to science and technology. It typically does so by using non-invasive or non-harmful methods for creative expression. However, the use of the living matter to create living or semi-living works of art raises important ethical questions. To which extent can humans be involved in the environment? Do artists have the right to manipulate nature and its processes? To address these ethical concerns, bio artists often closely collaborate with scientists and other experts to ensure that their work is conducted in an ethical and responsible manner. In addition, some bio artists use their work to engage with ethical issues, raising questions about the relationship between humans and other living organisms, the impact of human activity on the environment, and the ethics of genetic modification and other forms of biotechnology. By engaging with these issues, bio artists contribute to a broader ethical discourse around the use of living organisms in art and science.

Fungi have been a popular subject in art, some of the earliest of examples date back to Palaeolithic age where they were depicted on various cave paintings, where they had religious or ritualistic significance, perhaps representing fertility or the cycles of life and death. Since art has been a part of human culture artists take inspiration from nature, its shapes, harmony of forms and patterns. Fungi are a fascinating organism with unique biological properties, ecological significance, and cultural importance serving as a source of food, medicine, and inspiration for art and literature. Fungi play a vital role in many ecosystems, serving as decomposers, symbionts, and pathogens. They help to break down dead organic matter, recycle nutrients, and support the growth of other organisms. This makes them a part of various processes of growth, decay, and transformation. There are over a million different species of fungi, they are found virtually in every habitat on earth, from water and soil to plants and animals, ranging from microscopic

¹ Bödeker, T. (2020). W/K- between Science & Art. <https://between-science-and-art.com/merging-science-and-art-through-fungi/meyer-fbb-2019/>

single-celled organisms to fruiting bodies that we see above ground and vast underground mycelium networks. These networks have communication and information sharing capabilities; they communicate through a variety of mechanisms, including chemical signalling, electrical signalling, and physical interactions.

Bio art provides a platform for artists and scientists to collaborate and explore these complex organisms and their interconnection in relationship between humans and the natural world. By incorporating living organisms and ecological systems into their work, bio artists can highlight the fragility and interconnectedness of our ecosystems and draw attention to the urgent need for environmental conservation and sustainability. Bio art can help us to see the natural world in a new light, and to appreciate the complex relationships between different species and the environment. Moreover, bio art can also help to shed light on the negative impacts of human activities in the Anthropocene, such as pollution, habitat destruction, and climate change. Through their work, bio artists can encourage us to think critically about our own actions and the impact they have on the planet, and to consider how we might change our behaviour to reduce our environmental footprint. Finally, bio art can also raise important ethical questions about the use of biotechnology and the manipulation of living organisms for human purposes. By exploring these questions through their artistic projects, bio artists can stimulate debate and encourage a more nuanced and thoughtful approach to the development of new biotechnologies.

On Anthropocene

For thousands of years, human activity has brought about observable and quantifiable transformations to the Earth's natural systems. Such alterations have had a lasting impact on the environment, leading to the disruption and malfunctioning of ecosystems, a marked reduction in the variety of life forms, and the extinction of numerous species. "Anthropogenic effects, including, but certainly not limited to the rise of agriculture and attendant deforestation; the extraction of coal, oil, and gas, and their atmospheric consequences; the combustion of carbon-based fuels and emissions; coral reef loss; ocean acidification; soil degradation; an explosion of the population; a rate of life-form extinction occurring at thousands of times higher than throughout most of the last half-billion years".² The world's climate is going haywire, and industrial progress has proved much more deadly to life on earth than anyone imagined a century ago. In the context of the Anthropocene, bio artists are particularly interested in the ways in which human activity is affecting the natural world, and they use their work to raise awareness about the environmental challenges we face. Through their explorations of living matter, they seek to remind us of the interconnectedness and interplay of all living things and their lively activities, to encourage us to think critically about our impact on the planet. Interspecies entanglements that once seemed the concern of fables and fairy tales are now becoming materials for a serious tool of understanding nature's work in the order to offer the best abilities for rejuvenation. Currently, society lacks strong unifying principles, the degree of unity which the vague term modern civilization implies is in many ways unity of disunity the peoples involved being given a superficial coherence by the spread of technology and by common acceptance of certain ways of thought whose very nature is to create further disintegration.³

The world's climate is going haywire, and industrial progress has proved much more deadly to life on earth than anyone imagined a century ago. In the context of the Anthropocene, bio artists are particularly interested in the ways in which human activity is affecting the natural world, and they use their work to raise awareness about the environmental challenges we face. Through their explorations of living matter, they seek to remind us of the interconnectedness of all living things and to encourage us to think critically about our impact on the planet. The selected art projects bring together a multitude of disciplinary conversations concerned with art and aesthetics that are emerging around the Anthropocene, drawing together artists, curators, scientists, theorists, and activists to address the geological reformation of the human species.

² Kolbert, E. (2014). *The Sixth Extinction*. Henry Holt and Company.

³ Kuhn, T. S. (1962). *The Structure of Scientific Revolutions*.

Bio artist using fungi

The following chapter "Bio artist using fungi" showcases the work of ten artists who utilise fungi in their artistic practice, each with their own unique approach and style. The selection process for this project was based on extensive research and thoughtful consideration. The aim was to showcase a range of approaches, diverse mediums, and technical skills. Originality and creativity were also fundamental, along with the ability of the artwork to address the complex relationship between humans and nature, and to contextualise this within the Anthropocene. The impact of each artwork was also carefully evaluated, in order to create a cohesive and thought-provoking collection. The cultural significance of the artist and their work was also taken into consideration, along with their cultural values, providing insight into the historical and social context in which they were created. The purpose of this chapter is to illustrate the diversity of approaches that can be taken when incorporating fungi into art. The mediums utilised by these artists range from traditional sculptural forms to more experimental materials and techniques. From installation, collages, alternative packaging, building materials, textiles, design, 3D printing to interactive audio-visual pieces and VR. The inspirations for their work are equally diverse, encompassing physical beauty, medicinal properties, mythology, and the unique qualities of fungi as a growing material. Each artist in this collection brings their own perspective to the use of fungi in their work, highlighting different properties and characteristics of mushrooms. Some focus on the sculptural potential of fungi, creating intricate and beautiful forms that are both organic and otherworldly. Others explore the medicinal properties of fungi, using their art to raise awareness of the potential benefits of these organisms for human health. Still, others draw on the mythology and cultural significance of fungi, exploring their symbolic and spiritual importance in various cultures around the world. Ultimately, the works presented in the following chapters demonstrate the relevance of fungi to contemporary art and culture, particularly in the context of the Anthropocene. By incorporating fungi into their art, these artists are creating powerful statements about our relationship with the natural world and the urgent need for greater sustainability and ecological awareness in our society.

Xiaojing Yan

Xiaojing Yan is a contemporary visual artist of Chinese Canadian descent whose artistic practice spans several mediums, including sculpture, installation, painting, video, and sound. Yan's work is characterised by her profound fascination with the natural world, which she explores by using a variety of materials, including wax, wood, wire, plexiglass, paper, reed, metal pearls, silk, ceramics, and mushrooms. Notably, Yan frequently employs living fungi in her projects, particularly Lingzhi mushrooms, a species renowned in traditional ancient Chinese, Japanese, and Korean medicine due to their purported health benefits. By creating living sculptures using mycelium, the vegetative part of a fungus, Yan's works transform and evolve over time in response to their environment, resulting in dynamic and ever-changing creations.



Figure 1 Lingzhi Girl, mycelium, cultivated lingzhi mushrooms and wood chips, 2015-2017

She described her workflow with fungi: “When I create my lingzhi sculptures, I first put wood chips and lingzhi spore mixtures into the mould I created. With the control of humidity, temperature and light, lingzhi mycelium starts to grow. Once the lingzhi mycelium had bound the wood chips into the mould’s shape, I removed the mould and put the bonded mixture into a small greenhouse to let it keep growing. After a few weeks, the body of the roots began to grow and created their own transformative sculpture. These new mushrooms, in turn, dropped more spores, thereby providing the delicate brown powder that now covers the sculptures.”⁴ Fungi-based materials are eco-friendly

as they are biodegradable and compostable, decomposing naturally over time without releasing harmful pollutants into the environment. This can help reduce the environmental impact of art installations, which often use materials that are not biodegradable and end up in landfills or contribute to pollution. The use of mushrooms as a sculpting material in art has the potential to be an environmentally friendly alternative to traditional materials and can help promote a more sustainable and responsible approach to art creation and art production. Lingzhi mushrooms have been used to treat various ailments in traditional medicine, including insomnia, anxiety, high blood pressure, and liver disease, and are believed to have immune-boosting properties and anti-inflammatory effects. She symbolically includes these medicinal properties as well as Lingzi’s position and role in ancient mythology where it is believed that all living things have spirit and possess magical powers. “I have experimented to produce sculptures that integrate the natural growth cycle of this mushroom and highlight its amazing properties, such as adaptation, self-organisation, self-healing, and regeneration. While evoking traditional Chinese medicine,

⁴ *Lingzhi Girl* | XIAOJING YAN. (n.d.). https://yanxiaojing.com/portfolio_pages/lingzhi-girl/

mythology and religion, the lingzhi mushroom, as an innovative green material, also speaks to the role of environmental sustainability in contemporary art production,” she writes.⁵

Mythology has been an inseparable part of humanity since the beginning of human civilization. Through history, mythology has helped people make sense of the mysteries of the natural world, explore the human experience, teach important lessons, convert cultural values etc. Fables often contain archetypal patterns of human experience, symbols and motifs that are intertwined in the mythological figures and their relationships. Across different cultures, mythologies have emerged that reflect a deep and enduring fascination with the natural environment. They often involve the personification of natural elements such as trees, animals, and weather phenomena, as well as the use of symbolic imagery to represent natural processes. “In Chinese mythology, it is believed that all things have spirit and are capable of acquiring human forms, magical powers, and immortality when they absorb the nimbus of the universe and the prime of the sun and moon. When there is a lack of energy during the transformation, they may still keep some of their animal or plant traits. These busts can be seen as lingzhi in the process of acquiring the human form as the wood chips are bonded by mycelium to create a human form. However, the work shows the reverse process by presenting the mycelium sculpture of a human form transforming into a hybrid lingzhi and human form. This is a deeper view of the symbiotic relationship between humans and nature.”²



Figure 2 Lingzhi, cast bronze with patina, 2020

In her work *Lingzhi*, 2014 Xiaojing works with fungi through their presence in ancient mythology – a Chinese legend of the lingzhi mushroom and its promise of eternal life. She created a series of bronze cast sculptures with turquoise patina. “I arranged them onto the wall in the way that bracket mushrooms would grow in steps in nature. Against the white wall, these hoary objects appear to float in space. Bronze is often associated with monuments, images of power, or eternity and creates tension with lingzhi's delicate nature and mythology. As an organism, lingzhi has a fragile and ephemeral life.” she wrote.⁶

In the work "Fairy Ring," Yan creates a circular wall installation of mushroom-shaped iron cast sculptures. Inspired by naturally occurring rings of mushrooms that grow in such shapes in nature. This phenomenon is caused by the underground mycelium of the

⁵ *Far from where you divined* | XIAOJING YAN. (n.d.). https://yanxiaojing.com/portfolio_pages/far-from-where-you-divined/

⁶ *Lingzhi* | XIAOJING YAN. (n.d.). Retrieved April 10, 2023, from https://yanxiaojing.com/portfolio_pages/ling-zhi/

mushrooms, which grows outward in a circular pattern as it searches for nutrients in the soil. Over time, this growth pattern creates a visible ring of mushrooms on the surface.



Figure 3 Fairy Ring, cast bronze with patina, 2020

The fairy ring has a long history in folklore and mythology and has been associated with magical and supernatural properties.

Yan's artwork may also be seen as an inclination to these traditions and a celebration of the mysterious and awe-inspiring aspects of nature. Her work draws attention to the beauty and mystery of nature, the sense of unity and interconnectedness among all living things, emphasising our role in preserving and protecting the natural world.

Her latest work is a virtual reality experience.

The immersive experience transports the viewer into an imaginative virtual landscape, ecosystem teeming with animals, plants, fungi and underground mycelial networks. In the imaginative forest environment, the audience can coexist with mystical creatures. These creatures are overgrown with mushrooms and fungus. Mycelium has been recognised as the largest living organism on earth, due to its symbiotic relationship with materials that support its growth, resulting in its networks being able to spread underground for metres or even kilometres. Mycelia connects with other plants and fungi, facilitating nutrient exchange and communication between them. In *Whispers of the Mountain Spirits* the underground world are connected with mycelium networks that symbolise the interconnectedness and independence of the natural world. The work is



Figure 4 *Whispers of the Mountain Spirits*, still from VR, 2021-2023

inspired by the ancient Chinese legend of the mountain goddess. The figures symbolise the spiritual power of nature and suggest a deeper dimension of the forest. "The VR work offers an insight into the mystical and spiritual realm and invites the audience to reflect on the connections

between nature, culture, technology, and spirituality.”⁷

Whispers of the Mountain Spirits" is an example of how VR technology can be utilised to create highly engaging and thought-provoking environments that offer insight into the beauty and complexity of the natural world.

Robbie Jenkins



Robbie Jenkins is a British 3d artist who is based in London. He has also been involved in several projects that explore the use of mycelia in art.

Figure 5 Mycelium columns, mycelium substrate with wood chips

Fungi, especially mycelia, have become vital agents in some outstanding artistic experiments, installation projects, and ongoing art interventions in recent years. ⁸ Artists have used fungi to create living sculptures, installations that grow and change over time its unique properties, such as their ability to grow, decompose, and interact with other materials. Examples of such art interventions include using fungi as a sculptural material to create living fungal sculptures. Robbie Jenkins combines his knowledge from his practices as a 3D artist to 3d print resin moulds. Afterwards he uses it to cast different types of mycelium substrate mixed with wood chips. He lets it grow and bind into a homogeneous mixture. After removing the mould, he leaves the mycelium to incubate and develop growing mushrooms. This results in living sculptures of various columns inspired by Classical Greek architecture and its distinctive features such as its focus on harmony, proportion, and balance and its use of three distinctive styles - Doric, Ionic and Corinthian.⁹

⁷ *Whispers of the Mountain Spirits* | XIAOJING YAN. (n.d.). https://yanxiaojing.com/portfolio_pages/whispers-of-the-mountain-spirits/

⁸ Rapp, R. (2019). *On mycohuman performances: fungi in current artistic research*. *Fungal Biology and Biotechnology*, 6(1). <https://doi.org/10.1186/s40694-019-0085-6>

⁹ *Robbie Jenkins: building organic sculptures using mycelium*. (2019). *Myminifactory.com*. <https://www.myminifactory.com/stories/robbie-jenkins-building-organic-sculptures-using-mycelium>

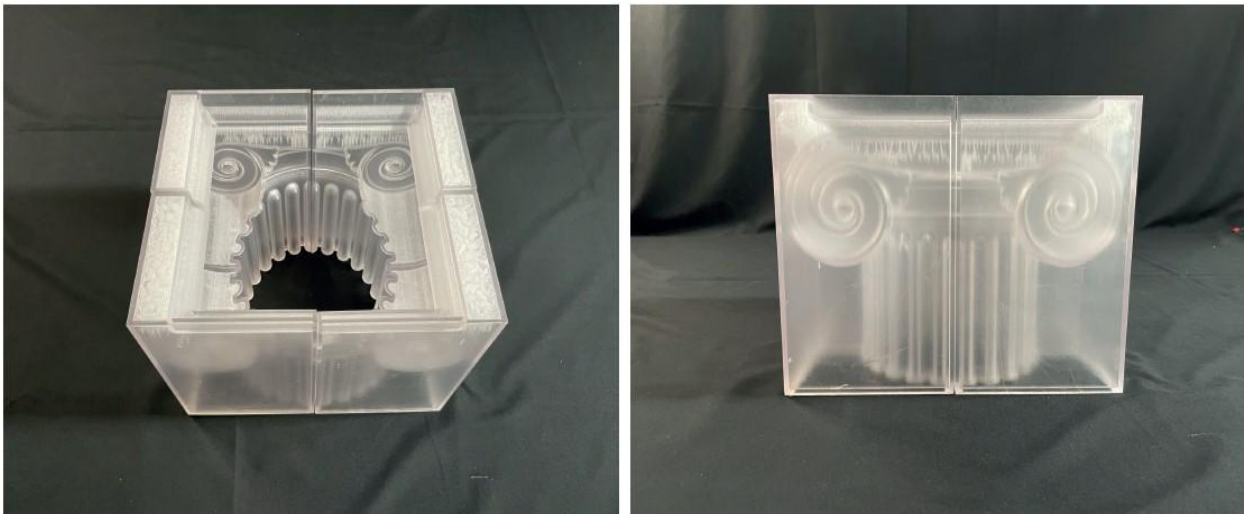


Figure 6 printed moulds for casting, SLA resin

“There is an enjoyable sense of freedom when working between the digital and physical environment. With this flexibility, Robbie combines contrasting and contradictory themes. With his Mycelium columns, he has created ancient relics using modern technology and cast them in a very temporary, natural material. Working digitally helps to expand the design process by offering a variety of methods to communicate ideas in very efficient and convincing ways but for now, the most realistic and authentic way to experience sculpture is to do so physically.”⁷

“This idea of pedestals, support and elevating what we believe in, led to architectural columns - as they provide physical, structural support. “⁷

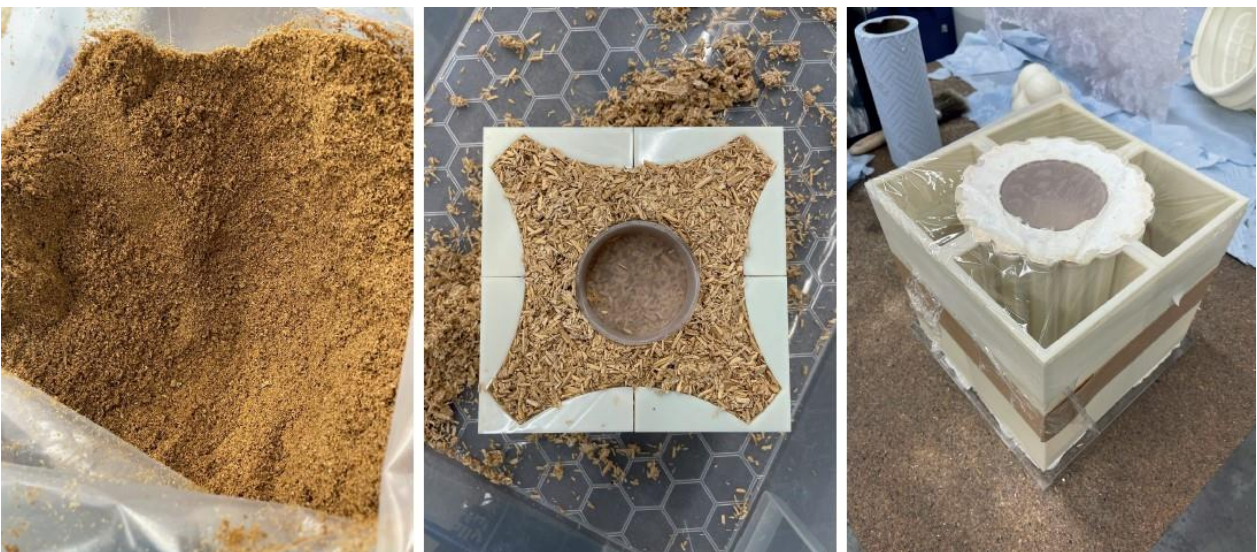


Figure 7 Mycelium columns, from work process

Jae Rhim Lee



Figure 8 Infinity Burial Suit, cotton with a mushroom spore- infused biomaterial, 2011

Jae Rhim Lee is a South Korean contemporary artist who works across a variety of media, including sculpture, performance, and video. She is best known for her work exploring the intersection of art, ecology, and the human body, and for her project, the Infinity Burial Suit. Lee's "Infinity Burial Project" is a multi-disciplinary project that explores the idea of using mushrooms to break down human bodies after death. Fungi are essential components of ecosystems, and their involvement in the cycle of life

is critical for maintaining ecosystem health and equilibrium. Specifically, fungi play a crucial role in decomposing organic matter, including dead plants and animals, as well as other organic materials such as wood and leaves. By breaking down these materials, fungi recycle nutrients and organic matter back into the ecosystem, making them available for use by other living organisms. This process of nutrient recycling is essential for the continued functioning of ecosystems, as it supports the growth and survival of a wide range of organisms. As such, fungi are the fundamental element for the maintenance of ecosystem health and balance. The project's goal is to create a more sustainable and environmentally friendly approach to burial, as traditional burial methods involve using toxic embalming fluids and caskets that do not decompose for hundreds of years. Lee also wants to challenge the traditional perception of death and the commonly practised burial ceremonies. Questioning this Lee created a special suit called the "Mushroom Death Suit," which is infused with mushroom spores and other microorganisms that help break down the body after death. The suit is designed to accelerate decomposition and create a natural and ecological process for decomposition. Using the specialised suit, the nutrients from the body are absorbed by the mushrooms, which can then be used to nourish the soil. The project also includes an educational component, with workshops and presentations on eco-friendly burial practices with which Lee hopes to promote sustainable burial practices and warn of the environmental impact of death. In terms of mycoremediation, a type of bioremediation that uses mushrooms to clean up contaminated environment, fungi are highly adaptable and can break down a wide range of pollutants, including organic compounds, heavy metals, and radionuclides, making them ideal candidates for bioremediation. They have the ability to break down complex molecules, such as hydrocarbons, and convert them into simpler and less harmful substances. They can be applied to water, soil, industrial wastelands, oil spills and others. This has significant implications for urban areas, which often have high levels of pollution.

Neri Oxman

Neri Oxman is an American Israeli architect, designer, and researcher who has made significant contributions to the fields of biomaterials, biologically inspired design, and digital fabrication. She is the founder and director of the Mediated Matter group at the MIT Media Lab, which focuses on developing new materials, tools, and methods for design and fabrication that are inspired by and integrated with nature. Oxman has a background in architecture and design, having earned a bachelor's degree in arts and sciences from the Hebrew University of Jerusalem and a master's degree in architecture from the Architectural Association in London. Her work at the Mediated Matter group has been recognized with numerous awards and honours, including the Cooper Hewitt National Design Award in 2018 and the Vilcek Prize in Design in 2021. Oxman's research and design practice is characterised by a deep engagement with the natural world, and a belief in the power of design and technology to create more sustainable and adaptive systems. She has developed a range of innovative projects that explore the potential of biologically inspired design and fabrication techniques, from 3D printed objects made from biological materials to adaptive clothing that responds to changes in the environment.



Figure 9 Aguahoja, plant-based fibres, 2014-2020

"Aguahoja" is a project by Neri Oxman and her team at the Mediated Matter group at the MIT Media Lab, which aims to explore the potential for using natural materials and digital fabrication technologies to create sustainable, adaptive structures that respond to changes in the environment. The project takes inspiration from the structure and behaviour of water-based organisms, such as coral and diatoms, which are able to adapt and respond to changes in their surroundings. The team has developed a new material system called "Fungal Architecture," which combines biopolymers derived from fungi with plant-based fibres to create a lightweight, durable material that is also biodegradable and recyclable. The material is created using a 3D printing process that involves depositing layers of the biopolymer mixture onto a scaffold made of plant-based fibres. The resulting structure is then allowed to dry and solidify, creating a lightweight, porous material that can be shaped and moulded into a variety of forms. One of the main

objectives of the Aguahoja project is to develop a new paradigm for architecture and design that is more responsive to changes in the environment and can adapt to new conditions over time. To achieve this goal, the team has developed a series of computational tools and design strategies that allow them to simulate and optimise the growth and behaviour of the material.



Figure 10 Parametric chemistry: a scientific design framework for 3D printing biocompatible multifunctional material combinations

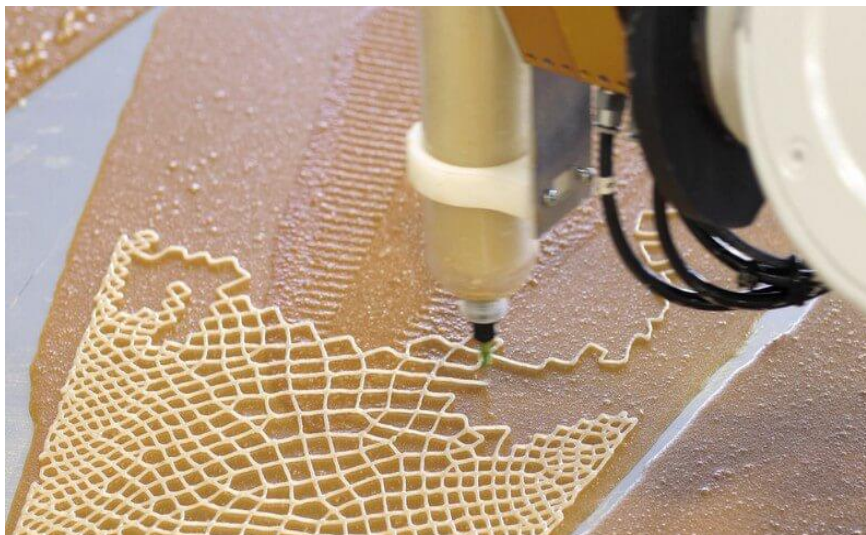


Figure 11 3D printing of cellulose, a plant derivative

The team has also collaborated with experts in robotics and sensing technologies to develop a series of prototypes that demonstrate the potential for the material to be used in a variety of applications, such as environmental sensors, air purifiers, and lightweight, flexible structures and alternatives for biodegradable packaging.

Only a small fraction, less than 10%, of this material is reused, recycled, or repurposed, leaving most of it to be discarded as waste in landfills and oceans. Meanwhile, materials based on plastic utilise natural resources at a rate that exceeds replenishment, and the process of obtaining and processing these materials has a negative impact on the environment.¹⁰ “There is another way. Organic structures embody more efficient and adaptable material properties compared with human-made ones and leave no environmental marks. From a limited palette of molecular components, including cellulose, chitin, and pectin—the very same materials found in trees, crustaceans and apple skins—natural systems construct an extensive array of functional materials with no synthetic parallels. Chitin, for instance, manifests in the form of thin, transparent dragonfly wings, as well as in the soft tissue of fungi. Cellulose makes up more than half of plant matter planet wide. These materials, and the living systems they inhabit, outperform human engineering not only through their diversity of functions but also through their resilience, sustainability, and adaptability. The Aguahoja collection (pronounced: agua-hocha) offers a material alternative to plastic subverting the toxic waste cycle through the creation of biopolymer composites that exhibit tuneable properties with varied mechanical, optical, olfactory and even gustatory properties. These renewable and biocompatible polymers leverage the power of natural resource cycles and can be materially ‘programmed’ to decay as they return to the earth, for purposes of fuelling new growth.” (1)



Figure 12 Aguahoja pavilion, 2020

The name "Aguahoja" is a combination of the Spanish words "agua" (water) and "hoja" (leaf), reflecting the project's focus on water as a crucial element in the design process. The project involves the development of a novel material called "hybrid hydrogel-fibres," which combines the structural properties of natural fibres with the water-absorbing properties of hydrogels. Using this material, the team at Mediated Matter has created a series of architectural structures, including a large-scale pavilion that was exhibited at the Museum of Modern Art (MoMA) in New York in 2019. The pavilion features a series of interconnected chambers that are designed to respond to changes in humidity and temperature, creating a dynamic and responsive environment for visitors. The Aguahoja project represents a significant contribution to the field of biologically inspired design and fabrication, demonstrating the potential for natural materials and processes to be integrated with advanced fabrication techniques to create novel and innovative structures.

¹⁰ Oxman, N. (n.d.). Aguahoja. <https://oxman.com/projects/aguahoja>

Suzanne Anker

Suzanne Anker is a contemporary artist, considered a pioneer of multimedia in bio art. “Her practice investigates the transformation and altering of the natural world in the 21st century, focusing on genetics, climate change, species extinction and toxic degradation. Anker's work brings to light the beauty of life and the need for enlightened thinking about the tangled web of nature.”¹¹ With several decades of experience in the field of bio art, Anker has experimented with a diverse range of mediums and themes. She is particularly interested in the ways in which fungi can serve as a metaphor for the cycle of life, growth, death, decay. One of Anker’s most significant works, *Vanitas (in a Petri dish)* involves the creation of miniature ecosystems within circular petri dishes. She combined various live and dead natural materials such as mushrooms, moss, lichen, insects, flowers, seeds, shells, and stones with man-made materials such as plastic glitter, wraps, and rubber to create hybrid landscapes that challenge the viewer's perception of the natural world. Her contemporary interpretation of vanitas explores how natural materials can be combined with artificial ones and can coexist. She explores the concept of vanitas, a type of still life, that has been a recurring theme in art and literature throughout history, from the 16th and 17th centuries to contemporary art.



Figure 13 Vanitas in a Petri Dish, mixed media in petri dish, 2016

The philosophy of vanitas draws attention to human mortality, temporarily of human endeavours and passage of time. Anker's *Vanitas (in a Petri dish)* serves as a powerful metaphor for these concepts, as the organic materials in her work inevitably begin to rot and decay over time. The decay can be seen as a reminder of mortality, fragility of nature and fleeting nature of physical beauty. Anker presented the petri dishes as physical objects in the gallery and captured them and presented them in the form of large prints further emphasising the ephemeral nature of the works.

In her work Anker often explores the concept of what is considered natural in the Anthropocene era, where the environment is already highly manipulated, lines between natural and urban environments are blurring and can as well be looked at as some kind of homogeneous hybrid landscapes. She challenges viewers to re-

¹¹ *Bio Art: Suzanne Anker - Contemporary Visual artist and theorist. (n.d.). Suzanne Anker. <http://suzanneanker.com/>*

examine their assumptions about what is "natural" in a world where human activities have had such a significant impact on the environment.



Figure 14 Vanitas in a Petri Dish, mixed media in petri dish,2016



Figure 15 Vanitas in a Petri Dish, mixed media in petri dish

Diana Scherer



Figure 16 *Hyper Rhizome, seeds, soil, roots, 2022*

Beneath 90% plants lies an invisible support system—subterranean fungal partners that form a network of filaments connecting plants and bringing nutrients and water to their roots. In return, the plants provide a steady supply of carbon to the fungi. Researchers are learning that these hidden partners can shape how ecosystems respond to climate change.¹² Diana Scherer is a Netherlands based artist fascinated with these hidden underground root systems. In her works she creates artificial biotopes, using soil, seeds, light and moulds from both natural and man-made patterns to grow roots in various shapes.¹³ Fascinated by the intelligence and behaviour of the roots, she explores their ability of growth and weaves textile-like materials.

Her craft involves the manipulation and controlling of natural processes in order to create a desired effect, altering the roots to form specific patterns. She considers the ambiguous tendency of man to cherish nature, while simultaneously recklessly manipulating it. Is biotechnology an innovative signal of progress, or does it signify the domination of the natural world by humans? How does biotech manifest as an art practice and how can bio art help with understanding these complex relations.

“For the project I developed a technique to guide the growth of the plant root. With the help of underground templates, I control the root system. During the growing process, the roots conform to underground templates and the textile weaves or braids itself. In this project I apply the strength of nature to weave a textile.”¹² “A root navigates, knows what is up and down, perceives gravity and can locate moisture and chemicals. Roots are incredibly strong. In their search for food and space they fight for every space they can find. I use this strength to create my work. I expose the subterranean life and the natural network turns into a textile-like material. The dynamism of the plant makes it seem as if the work is making itself.”¹⁴

¹² Pennisi, E., & Cornwall, W. (2020). *Hidden web of fungi could shape the future of forests*. *Science*, 369(6507), 1042–1043. <https://doi.org/10.1126/science.369.6507.1042>

¹³ *Interview with Diana Scherer*. (2022, August 29). Berlin Art Link.

<https://www.berlinartlink.com/2022/08/29/growing-sculptures-interview-with-diana-scherer/>

¹⁴ Diana Scherer. (n.d.). *Dianascherer.nl*. <https://dianascherer.nl>

“I have learned that an enormous amount of communication takes place underground. The rhizosphere forms a very dynamic environment in which the plant roots and many organisms are located. Plants communicate with each other and collaborate with other organisms for example fungi and bacteria.”¹⁵

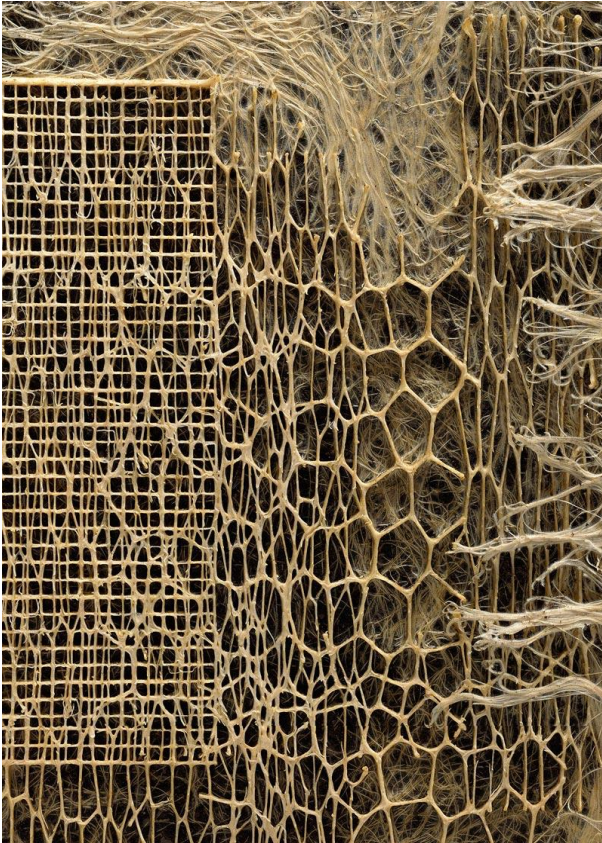


Figure 17 *Interwoven, seeds, soil, roots, 2020*

We are starting to understand that fungi, mycelium, plants, and roots form huge, complex networks through which they support and feed one another. Roots work together with fungi somehow, and the information can also be transmitted through the leaves and air.¹¹

“I didn’t have the experience to design my own, so I looked to the natural world, which is so full of geometric order, such as honeycomb and cells.”¹⁶ she continues. What appealed to Diana was not only the pleasing nature of geometry but the strength in these formations, which are often used by scientists, architects and designers alike.

“The most fascinating thing for me is the strength of the roots, this enormous energy and the way they interweave below ground—I can’t see it when it grows so it’s always a surprise.”¹⁴

Exposing roots can create visually stunning images and sculptures, highlighting the beauty and complexity of the natural world. It can serve as a metaphor for the interconnectedness of all living things and the hidden systems that sustain life on Earth. The concept of interconnectedness among all living beings carries significant implications for environmental management and necessitates a systemic and holistic approach. This approach acknowledges the intricate relationships and interdependencies that exist between diverse species and systems. Preservation of biodiversity is of most importance, and efforts must be made to safeguard the entire spectrum of species and ecosystems that constitute the natural world.

¹⁵ *Antennae Magazine # 52 – Diana Scherer.* (n.d.). *Dianascherer.nl*. Retrieved April 19, 2023, from <https://dianascherer.nl/photography/antennae-magazine-52/>

¹⁶ *Transforming Roots into Weavings with Visual Artist Diana Scherer.* (n.d.). *TOAST*. <https://www.toa.st/blogs/magazine/diana-scherer>

Seana Gavin



Figure 18 *Times gone by*, collage



Figure 19 *Galactic mushroom highway*, collage

Gavin's artistic output is focused on the concept of the Anthropocene, dealing with the geological era characterised by the human impact on the natural environment. She delves into multi-layered complex interactions between humanity and the natural world, she also explores the potential pathways to remediate the damage that has been inflicted. Her intricate collages often feature images of mushrooms, plants, animals and other natural elements, which she combines with photographs and found materials to create surreal and dreamlike landscapes. Through her work, Gavin is inspired by the concept of "rewilding," which involves restoring ecosystems to their natural state and reintroducing native species. She sees the use of mushrooms and other natural elements in her collages to imagine what the world could look like if we were to embrace a more sustainable and ecologically minded way of living. In her collages she uses motives and symbolism from ancient civilizations and merges them to create dystopian landscapes. She uses the juxtaposition of the imagery from past, present and speculative future.

"When I try to visualize future environments, even if half of the natural world was wiped out, I imagine there will be residues or structures from the current or ancient world. Maybe, when I combine these different eras, the landscapes become timeless." Fascinated with the concept of time and its abstract qualities, Gavin explores ancient theories from varying civilizations. Drawing on these principles of living, she creates portals into uncharted universes where the dystopian and utopian worlds meet. In one of her series, "Wilderness Studies," Gavin creates collages that explore the ways in which nature can be both a source of wonder and beauty and a place of destruction and decay. She juxtaposes images of pristine landscapes with those of urban decay and environmental destruction, highlighting the contrast between the natural and built environments. Overall, Seana Gavin's work often addresses the Anthropocene by inviting viewers to reflect on our relationship with the natural world and the ways in which we can work to restore balance and harmony to the planet. Her collages are a reminder of the fragility and resilience of nature and the importance of protecting it for future generations.

Theresa Schubert



Figure 18 *Inside an inside forest*, 2019

In 2019, Theresa Schubert's "Inside an Inside Forest" project was exhibited at Errant Sound Berlin. This audio-visual spatial installation explores the hidden connections and entanglements within forests, particularly the processes that occur between trees and fungi that are invisible to the human eye. The installation features circular monitors that display algorithmically morphed photo stills of macro views of fallen trees, inspired by the movement of fluids inside trees. Through this innovative use of technology and imagery, Schubert invites viewers to consider the complexity and interconnectedness of natural systems that often go unnoticed.

As part of her "Inside an Inside Forest" project, Theresa Schubert installed the circular monitors inside the tree barks that she had collected from a forest near by Berlin. Her aim was to create a connection between the materials and their micro-life, including fungi, bugs, and bacteria, and to bring them into the gallery space. This

innovative approach brings the hidden complexities of the forest ecosystem to light, highlighting the intricate relationships that exist between living organisms and their environment.

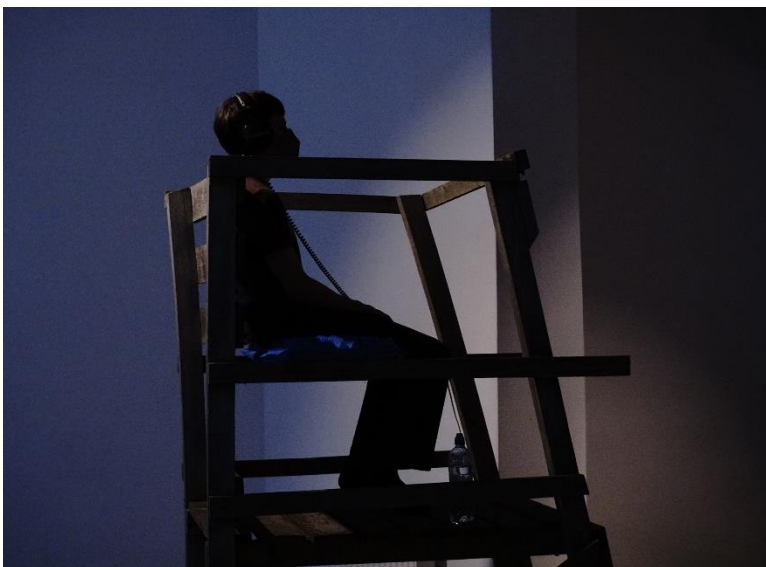


Figure 19 *Inside an inside forest, hunting observatory*, 2019

In contrast she also put emphasis on the destructive traces that humans leave in the forest.¹⁷ Strong chainsaw cuts in the barks and floor covered in wood chips depict human intervention and exploitation of natural resources of forest. As a part of installation Schubert included an original elevated hunting observatory seat from which the visitors can observe the room from an elevated position.

¹⁷ *inside an inside forest*. (n.d.). Theresa Schubert. <https://www.theresaschubert.com/works/inside-an-inside-forest/>



Figure 20 Inside an inside forest, still from two channel video

The calm atmosphere of the work masters to illustrate the movement of fluids in the trees, the process known as transpiration. It brings emphasis on the nature's always running systems that exist outside of our attention. Transpiration is the evaporation of water from the leaves of a plant, which creates a negative pressure or tension that pulls water from the roots and up through the plant's xylem tissue. Xylem tissue is made up of tiny tubes called vessels, which act like straws to transport water and nutrients from the roots to the rest of the plant. As water evaporates from the leaves, it creates a pull that draws more water up through the plant, and this cycle continues if the plant has enough water. This process also helps to cool the plant and transport nutrients from the roots to the rest of the plant. Inside an Inside Forest is a reminder of that all organisms have their own unique beauty, distinctive processes and biological characteristics. Even the smallest actions are a part of an intricate and complex web of relationships that sustain the life on earth. In her installation Schubert invites the viewer to slow down, observe and meditate on this idea.

"Thousands of plants and trees cannot absorb water or nutrients without mycelium intertwined with their roots. Mushrooms are a metaphor for our need to live symbiotically in tandem with nature. They point to a new way of structuring society, not as individuals but as a network that needs to live in collaboration."¹⁸

¹⁸ Gavin, F. (2020, March 20). *GOLDEN TEACHERS: Can Mushrooms Save the World? 032c*. <https://032c.com/magazine/golden-teachers>

Anicka Yi

Anicka Yi is a Korean conceptual artist known for her unorthodox approach to bio art, using unconventional materials, often including fungi as a medium or subject matter. She creates installations and sculptures that incorporate living fungi cultures, bacteria and scent molecules. Yi's artistic process typically involves working with a team of biologists and scientists to grow and cultivate the fungi cultures she uses in her artwork. Her work " You Can Call Me F" is a multi-



Figure 21 *You Can Call Me F*, plexiglass, agar, bacteria, fungus, 2015

sensory artwork that combines sculpture, scent, and sound to explore the relationship between humans and the microbial world. The work was first exhibited at the Kitchen Gallery in New York in 2015.

The centre piece of exhibition was a backlit display box. The platform behind glass was covered in agar gel formed a large petri dish like space. It

was used as a nutrient medium for growth of bacteria, microorganisms and fungi. For this project Yi asked one hundred women from her close circle to get their body swabbed and let their samples cultivate in the large bacterium. She gathered their biological information to cultivate the idea of the living always transforming female sculpture. Visually the work projected different shapes, forms and colours of the developed colonies of organisms, the main formed shape was the outlined text "YOU CAN CALL ME F" .

An interesting element of the work is the scent that this bacterium produced. The smells were let to coexist in the gallery space and after the unpleasant odours filled the room. With this Yi brought attention to body smells that refuse to smell pure and clean. It is also emphasises that fungi live withing human body and are a part of our microbiome. Grabbing At Newer Vegetables reminds us of the insistent materiality of bodies within a network- society's growing paranoia around contagion and hygiene (both public and private) with the enduring patriarchal fear of feminism and potency of female networks.¹⁹

¹⁹ *The Kitchen: Anicka Yi: You Can Call Me F*. (n.d.). Thekitchen.org. <https://thekitchen.org/event/anicka-yi-you-can-call-me-f>

Studio The Living

The sculpture "Hy-Fi", developed in 2014, by a New York based design studio The Living in collaboration with Ecovative Design company. It represents a response to the growing concerns about the sustainability of urban environments. As cities continue to expand at an unprecedented rate, there is an urgent need for alternative building materials that are environmentally friendly and sustainable. Traditional building materials such as concrete and steel are energy-intensive and contribute to climate change. To address this issue, scientists are exploring alternative materials for building construction, such as mycelium bricks. Mycelium is the main body of fungi and can be used to create self-growing, fibrous, natural composite materials with controlled physical properties that can be produced in large quantities and over wide areas. The possibility of tailoring mycelium materials' properties by properly choosing their nutrient substrates paves the way for their use in various scale applications. Currently the world finds itself in the midst of a dilemma, as the population continues to grow at an unprecedented rate, and the need for sustainable solutions for climate-friendly building is intensively sought. Human needs for solitude and enjoyment of the natural surroundings are competing with the needs of industrialization, creating a web of interactions between settlements of all sizes and all the components needed to maintain urban life. With these pressing issues it is essential to treat nature as a system that



Figure 22 Hy-Fi at MoMa PS1, 2014

requires constant maintenance, or it will expire. The cities not only pollute themselves but also create toxic situations that upset natural cycles. Thus, the world must apply its intellect to the task of rectifying this balance if the earth is to support life effectively and survive as a habitable planet.

²⁰

The sculpture "Hy-Fi" represents a glimpse of hope for the future of sustainable architecture. The building was constructed from mycelium bricks, consisting of a mass of branching, thread-like hyphae. To create the bricks, Ecovative grows mycelium in a substrate of agricultural waste such as corn stalks or sawdust. The mycelium grows around and binds the waste material together, creating a solid, lightweight and biodegradable material that can be shaped and moulded into various forms. Once the mycelium has fully colonised the substrate, the material is heat-

²⁰ Bell, G., Tyrwhitt, J., & Internet Archive. (1972). Human identity in the urban environment. In *Internet Archive*. [Harmondsworth, Eng.] Penguin Books. <https://archive.org/details/humanidentityinu00bell/page/50/mode/2up>

treated to stop further growth of the fungus and to give the bricks their final shape and consistency. There are several advantages to using mycelium bricks, they are lightweight, strong and biodegradable, making them an environmentally friendly alternative to traditional building material. They can be easily shaped and moulded into various forms, allowing for greater design flexibility in architecture and construction. However, the material does have its limitations, as it is not as strong as traditional construction materials and is more susceptible to damage from moisture and other environmental factors. Additionally, mycelium bricks are not yet widely available or cost-effective to produce at scale, which may limit their adoption in mainstream construction projects. The Hy-Fi tower was built as an experimental structure for the MoMA PS1 Young Architects Program in New York.²¹ The shape was designed as a singular tower that divides into three interconnected tower openings at the top of the construction. It was designed as a cooling area with ventilation and shade on the courtyard, providing a congregation point for visitors of MoMa. The Hy-Fi tower was a popular attraction and hosted a variety of cultural events during the summer of 2014, including music performances, film screenings, and dance parties. After the summer season, the tower was dismantled and the mycelium bricks were composted, in keeping with the sustainable ethos of the project. The sculptural building is a testament to the potential of mycelium materials as a sustainable building material for functional structures that are both environmentally friendly and aesthetically pleasing.



Figure 23 Hy-fi at Moma close up



Figure 23 Mycelium brick

²¹ Stott, R. (2014, June 27). *Hy-Fi, The Organic Mushroom-Brick Tower Opens At MoMA's PS1 Courtyard*. ArchDaily. <https://www.archdaily.com/521266/hy-fi-the-organic-mushroom-brick-tower-opens-at-moma-s-ps1-courtyard>

Conclusion

The use of fungi in contemporary art has emerged as a powerful tool for raising awareness about environmental issues and promoting innovative solutions for conservation and remediation. Through their creative practices, artists showcase the potential of fungi in restoring damaged ecosystems and inspiring us to explore new approaches to ecological challenges. The integration of art, science, and environmental studies through bio art has become a vital interdisciplinary platform for exploring the severity of anthropogenic effects, such as extreme weather events, temperature increase, and rising sea levels. Bio art challenges our assumptions, provokes critical thinking, and inspires new ways of understanding and engaging with the world around us. Bio art also has enormous potential in education, providing a unique opportunity for students to explore complex environmental issues in a creative and engaging way. Through bio art, students can develop critical thinking, problem-solving, and interdisciplinary collaboration skills, essential in addressing environmental issues from a multidisciplinary perspective. The strength of imagery and narratives in art can activate neural networks associated with empathy and social cognition, promoting greater emotional resonance and understanding of the perspectives and experiences of others. By using compelling imagery and storytelling, bio artists can create a powerful emotional connection between their audience and the natural world, inspiring action and positive impact. The challenges we face in the 21st century require a collaborative, interdisciplinary, and innovative approach to problem-solving that considers the complex interrelationships between the environment, society, and the economy. Bio art provides a powerful tool for exploring these relationships and developing new solutions, allowing us to harness the unique abilities of fungi and other organisms to create a more sustainable and resilient future. However, while art is an invaluable tool, it is essential to recognize its limitations and the need for more significant structural shifts in our understanding and care for nature to ensure its preservation.

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