Queering Nature After Death, Giving Back to the Non/living:

Materiality, Mediality, and Agency of the Mycelium Material in the Loop Living Cocoon™ Coffin

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Abstract

This thesis provides a New Materialist analysis of the Loop Living Cocoon™ coffin, which is made of living fungal mycelium material. More specifically, it leads to a trans-corporeal understanding of the relationship between the living mycelium material and the (dead) human body. Hereby the materialities, medialities, and agencies of the material and the human body are considered. The chapters follow four phases in the 'life' of the coffin: the production process, the phase when the dead body has been placed in the coffin, the event of the burial, and the phase after the burial. Using the concepts of 'remediation', 'non/living', and 'performativity', this thesis highlights the increasing reciprocity between fungi and humans, as the life phases progress. The understanding of the relationship as trans-corporeal assemblage thereby queers the anthropocentric dualisms of death/life, human/nonhuman, and nature/culture. This offers space for ethical reflection on the socio-political perspective on fungi, and leads to a reimagination of the ontologies of death and life, which might cause more environmental awareness.

Keywords

Posthumanism; new materialism; bodies; medium; performativity; Queer Death Studies; fungi; mushroom; mycelium; biodesign; anthropocentrism; ethnography; remediation.

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Introduction

What happens to your body after you die? The answer to this question varies depending on the perspective and cultural context of the person you ask. Across all cultures, funeral rituals play a central role in the disposal of the deceased body. These rituals often involve ceremonies that serve as a way to mourn the deceased and celebrate their life. The ceremony frequently affirms cultural and sometimes religious practices.[1] When it comes to the disposal of human remains, there are several options. Cremation, traditional burial (in a casket, coffin, or shroud; with or without embalming), water burial, composting, sky burial, and donating the body to science are among the possibilities. The choice of a specific disposal option is frequently influenced by the cultural background and geographical location of the deceased person or their loved ones. One of the arguments for a certain method can be the environmental sustainability of the method.

As a woman from Northwestern Europe, I am most acquainted with burial and cremation as common funeral practices. In these practices, the deceased's body is typically placed within a coffin or casket. If the state of the body allows for it and the loved ones decide for it, the body may be displayed before the funeral service takes place. During the service, the body is obscured from view by a lid before it is disposed of. In the case of burial, the body undergoes natural decomposition in the ground, while cremation involves subjecting the body to high temperatures until only ashes remain. These longstanding Western customs have evolved over centuries, yet they are not the most environmentally sustainable methods for handling the deceased. According to a report by the Netherlands Organization for Applied Scientific Research (TNO), one of the methods with minimal environmental impact is alkaline hydrolysis.[2] While alkaline hydrolysis is legal in many countries, it remains relatively uncommon. Similarly, human composting, another eco-friendly option, is not frequently chosen despite its potential for reducing the carbon footprint associated with traditional practices. These instances highlight the diverse array of choices available for the disposal of human remains within

[1] William G. Hoy, *Do Funerals Matter? Purposes and Practices of Death Rituals in Global Perspective* (New York & London: Routledge, 2013), 1–3.
[2] E.E. Keijzer, H. ten Broeke, and A.M.M. Ansems, "Milieueffecten van verschillende uitvaarttechnieken – update van eerder TNO-onderzoek," *TNO innovation for life* (2014): 26.

the contemporary Western context, each carrying its own environmental implications and prevalence.[3]

Burial and cremation are not exclusive to Western cultures; they are also common practices for the disposal of human remains in cultures around the world. In certain regions of Papua New Guinea, Indigenous people bury their deceased in materials such as pandan leaves, clay, and/or the bark of a tree.[4] In India, Hindu communities often perform wood-fuelled, open-air cremations known as pyres.[5] Meanwhile, in Tibet, a practice called sky burial involves exposing human corpses to carrion birds as a culturally accepted way of disposal.[6] Distinctive variations can be observed in the ceremonies and rituals associated with funerals across cultures, as well as in the materials used to surround the body during burial or cremation. This latter aspect holds particular interest in terms of sustainability and design.

This thesis centres on an innovative and sustainable burial method where the human body is buried in a coffin that is not made of *dead* materials such as wood, but of *living* mycelium: the underground fungal network of fungi. This unique mycelium coffin, called the Loop Living Cocoon™, has been developed and produced by the Dutch company Loop Biotech B.V.[7] After burial in the Loop Living Cocoon™, the human corpse can decompose more quickly. During this process, the mycelium material actively integrates into the environment, potentially even aiding in the decomposition of the human body and accelerating the overall process of decomposition.[8] My research is directed towards exploring the relationship between the living mycelium material and the deceased human body. This study may offer insights into the Western perspective on fungi and provide a new understandings on how fungi influence human life and death and the relationship between humans and fungi.

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[3] While I specifically focus on methods of disposal, other factors also influence sustainability, such as the clothes the dead person wears and whether it has been embalmed.

[4] Pawel P. Gorecki, "Disposal of Human Remains in the New Guinea Highlands," *Archaeology & Physical Anthropology in Oceania* 14, no. 2 (1979): 107–117.

[5] David Arnold, "Burning Issues: Cremation and Incineration in Modern India," *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin* 24, no. 4 (2016): 393–394.

[6] Dan Martin, "On the Cultural Ecology of Sky Burial on the Himalayan Plateau," *East and West* 45, no. 3/4 (1996): 353.

[7] "Product," Loop Biotech B.V., accessed February 21, 2023, https://www.loop-of-life.com/product.

[8] Unfortunately, not much research has been done on what happens after the human body is buried in a living mycelium coffin.

In this study, my aim is to comprehend the relationship between mycelium material and the human body through the lens of mediality. I position the mycelium as a non-anthropocentric biomedium that queers established dualisms like human/nonhuman, nature/culture, and life/death. In the context of this thesis, 'queer' implies a mode of inquiry that questions, challenges, and systematically disrupts anthropocentric and essentialist perceptions of nature.[9] This perspective aligns with the principles of Queer Ecology, a discourse I will delve into further. This proposition is built up in relation to the growth of the mycelium material and the performative aspects of the life of the Loop Living Cocoon™. The analysis revolves around the ecologies, materialities, and agencies inherent to both the dead human body and the mycelium material. By examining these concepts and related phenomena, I offer an understanding of the dynamic relationship between the human body and the mycelium at various stages in the life of the coffin.

In this introductory section, I begin by situating the Loop Living Cocoon™ within the broader context of both eco-grief and environmentalism. This urgent and acute context of thinking about and designing for burial with an eye for environmental impact provides clarity on the importance and relevance of the interaction between the living mycelium and the dead human body. Subsequently, I introduce the primary research question and the supporting sub-questions that guide this study. To conclude, I provide an overview of the four chapters that constitute the structure of this thesis.

Green Funerals

Grieving the death of a human being is undoubtedly vital within the context of the Loop Living Cocoon™. However, this study delves into a broader yet interconnected form of sorrow: ‘eco-grief’. This kind of grief extends beyond the personal and encompasses environmental concerns. Climate change and health researcher Ashlee Cunsolo and interdisciplinary social scientist Neville R. Ellis define eco-grief as “the grief felt in relation to experienced or anticipated ecological losses, including the loss of species, ecosystems

[9] Caitlin Marie Doak, “Queering Nature: The Liberatory Effects of Queer Ecology” (Honour’s Thesis, Dickinson College, 2016), 2.

and meaningful landscapes due to acute or chronic environmental change."[10] In these times of significant ecological decline, many individuals experience strong mental and emotional responses. While eco-grief has not been examined thoroughly yet, it is clear that there is a strong desire for restoration of the environment and a halt of climate change in those who experience eco-grief.[11] A sustainable approach to the disposal of deceased human bodies can contribute to this restoration. Upon their passing, individuals or their loved ones may opt for what is often referred to as a 'green funeral.'[12]

Just like environmentalism has been getting urgent and acute in Western society at large, green funerals have been getting more popular in recent years. At a green funeral, the body of a deceased person is processed in a sustainable manner, avoiding the use of chemically preservative measures.[13] The body can, for example, be wrapped in a linen shroud and the coffin can be made from biodegradable and sustainable materials, such as cardboard.

When a conventional wooden coffin is buried, it contributes to environmental pollution in multiple ways. Firstly, the materials frequently used to produce the coffin (metal, glue, etc.) reduce the soil quality.[14] Furthermore, the body is encapsulated in a sealed container and sometimes even embalmed. This isolation prevents direct contact between the body and the organic elements in the environment. The disconnection promotes internal rot of the body, which could cause harmful substances to leak into the environment. In contrast, the decomposition process of an unencapsulated body is immediately connected to the surrounding environment, which prevents internal decay.[15]

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[10] Ashlee Cunsolo and Neville R. Ellis, "Ecological grief as a mental health response to climate change-related loss," *Nature Climate Change* 8 (2018): 275.
[11] Émilie Crossley, "Ecological grief generates desire for environmental healing in tourism after COVID-19," *Tourism Geographies* 22, no. 3 (2020): 537–538.
[12] The term 'green funeral' refers to all aspects of a funeral ceremony. In this study, the focus is on the processing of the dead human body, mainly through burial.
[13] A. A. Bouverette, "Green Burials: The Deinstitutionalization of Death," *The Hilltop Review* 10, no. 1 (2017): 50.
[14] Amuno Solomon Aruomero and Oluwajana Afolabi, "Comparative assessment of trace metals in soils associated with casket burials: Towards implementing green burials," *Eurasian Journal of Soil Science* 3 (2014): 73.
[15] Marisa Gonzales, "The Green Burial Movement: Reworking the Relationship between Death and Society" (Master's thesis, Texas Woman's University, 2009), 18.

There are numerous reasons to decide for a green funeral. While research into individuals' personal motivations is limited, sociologists Nick MacMurray and Robert Futrell have identified several arguments put forth by Ecological Death Advocates (EDAs) in favour of green funerals. These EDAs are "driven by environmental attitudes, economic pressures and desires to better connect families and communities with nature through death."[16] Additionally, arguments in favour of green funerals are rooted in the historical context. Green funeral practices are not new; they have existed before contemporary Western burial customs and continue to be prevalent in many non-Western cultures. Re-adopting these practices could lead to more awareness on environmentalism, besides the obvious reduction of environmental impact.[17] However, it is worth noting that previous practices might not have been that sustainable, as embalming and cremations were not uncommon in the old days.

The contemporary Loop Living Cocoon™ takes green burial practises a step further. Loop Biotech B.V. points its view towards the future, by inventing new technologies. The additional affordance of active decomposition is a recent invention that is more environmentally friendly than traditional and still common Western burial practices.[18] A mycelium coffin does not only enhance the process of decomposing the body, but some fungi species even have the ability to degrade toxic substances such as drug residues, a plastic hairpiece or synthetic clothes.[19] This extends beyond the conventional notion of 'green burial', because the Loop Living Cocoon™ contributes to the decomposition process. The mycelium plays a pivotal role in this process as a living material that is intricately connected with the deceased body. In the context of the Loop Living Cocoon™, the buried body becomes a source of regeneration and life.

The idea that the deceased human body (re)generates life is also evident in other (post) funeral practices. An example is the Bios Urn, a capsule designed to house cremated remains, from which a tree can sprout and grow.[20] Cremations are often not

[16] Nick MacMurray and Robert Futrell, "Ecological Death Reform and Death System Change," *OMEGA—Journal of Death and Dying* 83, no. 4 (2021): 863.
[17] MacMurray and Futrell, "Ecological Death Reform," 869.
[18] Keijzer, et al. "Milieueffecten," 26.
[19] Jeroen Junte, "Een kist van schimmel: een groen laatste huis," *Trouw*, 15 January 2023, https://www.trouw.nl/nieuws/een-kist-van-schimmel-een-groen-laatste-huis~b46ac4b7/.
[20] "Urn," Bios Urn, accessed March 20, 2023, https://urnabios.com/urn/.

considered 'green' though, as they use much energy and generate CO_2.[21] A more environmentally conscious funeral approach, which takes the notion of the body generating life even further, is human composting. This method is "the practice of placing a dead body in a reusable vessel with biodegradable materials that foster the transformation into nutrient-dense soil that can be returned to loved ones or donated to conservation land."[22] Human composting offers an interesting alternative to the traditional practice of placing ashes in an urn, as it involves returning the body to the deceased's loved ones as nutrient-rich soil.

In her book *Matters of Care*, Feminist Science and Technology Studies researcher María Puig de la Bellacasa underscores the significance of human-soil relationships. She delves into their intricate fusion of material necessities, affective intensities, and ethico-political complexities in the context of care.[23] As the Loop Living Cocoon™ is buried in soil, this *triadic* connection of the dead human body, the mycelium and the soil goes beyond the *dyadic* human-soil connection of human composting. While human composting also involves intriguing interactions between humans, nonhumans, and materials, the mycelium's pivotal role within the Loop Living Cocoon™ appears to disrupt conventional Western dualisms.

Anthropologist Anna Lowenhaupt Tsing argues in her book *The Mushroom at the End of the World* that mushrooms have agency because of their specificities. Her study primarily offers an ethnographic and economic exploration of the matsutake mushroom – a culturally and financially valued commodity in Japan. Tsing also delves into the inherent agency of the mushroom itself. For the matsutake mushroom, this agency lies in aspects like its smell, and its encounters and relations with various kinds of tree species and soil types.[24] Within Western culture and science, fungi are often perceived either as their fruiting bodies: mushrooms, or as a pest (mould growing in the bathroom or on

[21] Keijzer, et al., "Milieueffecten," 26.
[22] Kristen Rogers, "How human composting could reduce death's carbon footprint," *CNN*, November 7, 2022, https://edition.cnn.com/2022/11/07/world/human-composting-natural-organic-reduction-scn-lbg/index.html.
[23] María Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: University of Minnesota Press, 2017), 172.
[24] Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton, NJ and Oxfordshire, UK: Princeton University Press, 2015), 46–51.

food). Fungi are largely unknown, harder to grasp than animals or plants. They are unimaginably different from humans in the cultural imaginary, yet, as Tsing points out, they also bear surprising similarities:

> Many people think fungi are plants, but they are actually closer to animals. Fungi do not make their food from sunlight, as plants do. Like animals, fungi must find something to eat. Yet fungal eating is often generous: It makes worlds for others.[25]

My study of the mycelium in the Loop Living Cocoon™ contributes to a more profound comprehension of fungi and their interconnectedness to humans and nonhumans, as the mycelium material directly interacts with the dead human body: how fungi make worlds within this interaction.

Performativity, Power, and Anthropocentrism

What interests me about the Loop Living Cocoon™ as a case study for Environmental Humanities is the paradox that the *dead* human body is buried in a *living* coffin that, furthermore, 'consumes' thus *incorporates* the body instead of keeping it 'above' or 'outside' nature. What is at stake here is the queering of some anthropocentric assumptions on what the human body is and on what nature is. These assumptions are primarily rooted in Western cultural (linguistic and classificatory) foundations, as well as physical principles. I explore both the cultural roots of these assumptions and their transformation through the concept of 'performativity'. Feminist and queer philosopher Judith Butler describes performativity as "the reiterative and citational practice by which discourse produces the effects that it names."[26] Performativity serves as a useful core to understand the cultural aspects of the relationship between living mycelium and dead human body and the assumed dualisms connected to that.

Situating the Loop Living Cocoon™ within the discourse around performativity provides the foundation for an exploration for a study on the materiality, mediality and agency of the mycelium material of the Loop Living Cocoon™ in relation to the dead

[25] Tsing, *The Mushroom*, 137.
[26] Judith Butler, *Bodies that matter: On the discursive limits of sex* (New York: Routledge, 1993), xii.

human body. In this study, I propose an understanding of mycelium and the dead human body as biomedia that queer the Western dualisms of human/nonhuman and nature/culture. This understanding is examined in relation to the performative remediation of the dead human body and the mycelium material. The materiality and agency of the dead human body and the mycelium are therefore central elements in the analysis.

The *linguistic* challenge posed by the interaction between living mycelium and the deceased human body significantly impacts the Western dualistic framework. A prime example is the word 'consumption', which carries inherent power and agency.[27] The connotation of consumption with power acknowledges agency within the mycelium in relation to the human body, in the case of the Loop Living Cocoon™. Analogical is the coinciding *classificatory* fact that nature is often considered as separate and less valuable than culture, which is part of the 'human realm'. A common phrase used in relation to green burials is that the body is 'returned' to nature. This phrase implies that the human body is cultural and separated from nature when it is considered alive. It implies that the human body was nature at some point before birth and becomes nature again when it is just about the materiality of the dead human body. Hereby also a strong distinction between life and death is made. The coffin is considered natural *because* it is alive, but at the same time mycelium would never naturally grow into the shape of a coffin: the Loop Living Cocoon™ is designed by humans, for humans.

The *physical* relationship between the dead human body and the living mycelium influences our conception of the relationship between humans and the fungi. The lifelessness of the human body adds a layer of complexity to this relationship, as dead and alive are often strongly differentiated. In the context of the Loop Living Cocoon™, these dualisms – such as death/life, nature/culture, and human/nonhuman – are intricately interwoven, leading to a blurring of their boundaries through the interaction between mycelium and the deceased human body.[28] Moreover, the coffin plays a role in

[27] Ron Broglio, *Surface Encounters: Thinking with Animals and Art* (Minneapolis: University of Minnesota Press, 2011), 2–3.

[28] Important to consider is that the human body is dead and the case study is related to burial of that body. Therefore the Loop Living Cocoon™ also raises questions on grief. While I do not engage with this in a psychological manner, it is taken into account in the argumentation.

the performative and cultural event of a burial. This *performative* aspect should be considered when studying the Loop Living Cocoon™, as it is the actual purpose of the object. 'Performativity' can refer to the rather abstract concept of reiterative practices such as repeatedly growing mycelium in the shape of the coffin. However, it is also, maybe even particularly, present in connecting cultural practices that are performed at a funeral. As Butler pointed out in relation to the human body, sex, and gender, performativity shows that there is no body prior to cultural inscription.[29] This underscores that also the relationship between the dead human body and living nature (and the connected dualisms) can be reinscribed.

Research Question, Sub-Questions, and Outline of the Thesis

In sum, the cultural-analytical issue I engage with in this study is the 'remediation' of the dead human body and the living mycelium that supports the decomposition the body. Based on insights by media theorist Marshall McLuhan, media theorists Jay David Bolter and Richard Grusin introduced the concept of remediation as a process in which media form and interact with each other, thus generating new connections between the media and new understandings of what those media mean.[30] While they mainly refer to technological media, remediation as a conceptual tool makes in this thesis the interactions visible between the dead human body and the mycelium material, without losing the contextual picture in which these interactions take place. The central question is therefore: 'how does the relationship between humans and fungi in the mycelium of the Loop Living Cocoon™ remediate our Western anthropocentric conception of death, multispecies, and environmentalism?'

The sub-questions that help answer the research question are connected to multiple phases in the 'life' of the Loop Living Cocoon™.[31] The first phase is that of producing and growing the coffin; while the coffin is not in use yet. The mycelium material is being grown and shaped like a coffin, but there is no human body inside of it yet. Of

[29] Judith Butler, *Gender Trouble: Feminism and the Subversion of Identity* (New York: Routledge, 1999), 25.
[30] Jay David Bolter and Richard Grusin*, Remediation: Understanding new media* (Cambridge: MIT Press, 2000), 21.
[31] While I argue for a non-linear manner of thinking, the linear structure that inspires the chapters as phases serves as one of the anchor points. The linearity is not absolute.

this phase, I study the relationship between the mycelium and the human in terms of *biodesign*. The first sub-question is: 'how can the practice of growing mycelium material offer an understanding of the relationship between human and fungus (within biodesign)?' Multiple visits to mycelium-growing facilities and an analysis of multiple patents on the production of mycelium material lead to the conclusion that the interaction between living human and growing mycelium is reciprocal, but that humans are clearly powerful in this relationship.

In the second phase, the human body is in the coffin, but it is not buried yet. From this phase, I study the *medialities, materialities* and *agencies* of the mycelium and the dead human body. The second sub-question is: 'how can mycelium material and the dead human body be approached as media, materials and agents?' The separate medialities and affordances of the mycelium material and the dead human body offer the foundation for the analysis of the relationship between them in the third phase.

Between the second and the fourth phase, there is a transitional phase that distinguishes the visible and sensible from the invisible and mostly unknown. This phase consists of my abstract visual interpretation of a burial with a living mycelium coffin. I include this phase for multiple reasons. The visual interpretation of the transitional phase forms a tribute to the mycelium. In addition, it is a manner to reflect on what is not visible to the human eye and what has not been studied extensively yet: the process of decomposition. Even though this thesis does not focus on grief, the transitional phase is one that is often full of grief (as well as phase 2 and 4, but in those phases it is more distant). I attend to these emotions, that are elsewhere within the thesis unrepresented, by incorporating them into the visualisation.

In the fourth phase, the dead human body is buried in the coffin and is participating in its decomposition. As stated before, this is the only phase of the four phases that is not visible to the human eye. Here I study the combination of the Loop Living Cocoon™ and the dead human body and the queering of the opposition of death and life. The third sub-question is: 'how is the binary opposition between life and death queered by the performativity of the relationship between the mycelium material and the dead human body?' Exposing life as the 'non/living', from an 'ecological occult' position,

the remediation that is present in phase 4 deconstructs the socio-political understandings of each medium.

All in all, this leads to a non/living understanding of the remediated relationship between the mycelium material and the (dead) human body as media, in which the reciprocity between human and fungus increases with each phase. A space is created in which dominant Western dualisms, such as life/death, nature/culture and human/nonhuman, are queered. This establishes the opportunity to rethink their socio-political implications and leads to increased environmental awareness.

Theoretical Framework

There is a growing interest in fungal materials within the design industry. Biotechnologist Vera Meyer and art historian Regine Rapp predict that "in the not so distant future, we will live in houses built with the power of fungi, in which there will be furniture made out of fungi and where we will wrap ourselves in fungal clothing, since textiles as well as leather are made of them."[32] This emerging generation of fungal-based products and technologies possesses the potential to significantly reshape our lifestyle and work, as well as our journey through death, burial, and decomposition, as exemplified by the Loop Living Cocoon™.

After a human corpse is placed in the Loop Living Cocoon™, there is a direct connection between the fungus and the human body. Because of this multispecies contact, the broad and interdisciplinary field of Posthumanism offers a relevant framework to position the Loop Living Cocoon™. Within the Posthumanist perspective, the humanist ideal of 'Man' as universal embodiment of humanity is criticised.[33] Rooted in Western colonial perspectives, this humanist ideal distinguishes man from woman, nonhuman from human, culture from nature, mind from body, and life from death, among other binary divisions. Consequently, such an ideal establishes a power dynamic between the opposing facets of these dualisms, leading them to serve as markers of what is deemed human and as determinants of access to rights and privileges associated with human status.[34] Posthumanism as a critical theory is therefore not basically about the level beyond the human, like transhumanism, but encompasses Environmental Humanities and Ecofeminist thinking about human-nonhuman entanglement. Those aspects of Posthumanism that mainly engage with the nonhuman, nature, and life lie at the heart of this thesis.

The goal of the Loop Living Cocoon™ is to offer a sustainable form of burial of a human body, and therefore fits within the environmental pillar of Posthumanism. Environmental Studies scholar Stacy Alaimo defines environmentalism as: "a practice that

[32] Vera Meyer and Regine Rapp, *Mind the Fungi* (Berlin: Universitätsverlag der TU Berlin, 2020), 7.
[33] Rosi Braidotti and Maria Hlavajová, "Introduction," in *Posthuman Glossary* (London: Bloomsbury Academic, 2018), 1.
[34] Braidotti and Hlavajová, *Posthuman Glossary*, 2.

entails grappling with how one's own bodily existence is ontologically entangled with the well-being of both local and quite distant places, peoples, animals, and ecosystems."[35] The Loop Living Cocoon™, which serves as the main case study in this thesis, focuses on the (deceased) human body, nonhumans, and environmentalism. This aligns with environmental discourse within Posthumanism, and its critique on the human/nonhuman dualism. In addition, the Loop Living Cocoon™ questions the binary opposition between death and life, which is also commonly criticised within Posthumanism. The *nonhuman* fungus is *alive* and the *human* body that is buried in it is *dead*. Nevertheless, the human body plays an active role in its own decomposition, in conjunction with the fungi and other (micro)organisms that are present in the soil. Within this study, the main focus is therefore on the interplay of the relationships between the human/nonhuman and life/death within the Loop Living Cocoon™.

Within Posthumanism, the individual dualisms of human/nonhuman and life/death have been studied extensively, but their combination, as present in the Loop Living Cocoon™, has rarely been discussed. The upcoming section offers an overview of the components within the Posthumanist discourse that frame the context of this study. Queer Ecology provides a starting point that reveals an explicit questioning of ecological humanist dualisms. While introducing New Materialism as an umbrella term, I also critically visit sub-fields such as Animal and Plant Studies, that leads to an understanding of how to engage with fungi within Posthumanism. Furthermore, as I introduce Queer Death Studies, I clarify the connections between the theoretical framework and the Loop Living Cocoon™, integrating the concepts of bioart and biodesign. This leads to a combination of sub-fields and sub-perspectives of Posthumanism that shapes a common interdisciplinary lens that accounts for all facets of the phenomenon and topic.

In efforts to undermine the human/nonhuman binary, an interdisciplinary strand of research on the relationship between humans and animals, Animal Studies, has emerged recently. One could say that Animal Studies draws from, and in turn contributes to, New Materialism and Posthumanism. The narrowness of the singular focus on animals spurred the emergence of Plant Studies as a response. However, Plant Studies is guilty of

[35] Stacy Alaimo, *Exposed: Environmental Politics and Pleasures in Posthuman Times* (Minneapolis & London: University of Minnesota Press, 2016), 131.

the same flaw that it tries to criticise: a narrow focus on a specific 'kingdom' of species, referred to as 'kingdomism'. Hence, I advocate for a 'multispecies' approach, that also includes humans. This multispecies approach is relevant within thinking about multispecies relations in death, as multiple species are involved in decomposing dead bodies. This approach brings on an exploration of the field of Queer Death Studies and, related to that, biodesign. An understanding of the Loop Living Cocoon™ as biodesign leads to the recognition that the ethical assumptions as proposed by biodesign urgently need to be questioned.

Posthumanism & New Materialism

Within this study, I adopt an understanding of matter as entangled with meaning and with other matter – a New Materialist perspective. This view is informed by the theories of Karen Barad on intra-action and posthuman performativity, Jane Bennett on vibrant matter, and Alaimo on trans-corporeality. This leads to a notion of agency that is beyond the agency of human consciousness. Within humanism, agency was considered to be confined to the mind of man. The definition of agency I deploy here is based on Bennett's broad definition: "the capacity to inflect the direction of events and to make a difference to outcomes."[36] Crucially, this definition does not limit agency to the mind of man. Posthumanist researchers Christine Daigle and Ilaria Santoemma provide a clear statement on the intertwinement of matter and agency:

> The world is an entanglement of beings and their agentic capacity, which creates a vibrant and dynamic network of relations that is always shifting. [...] As such, the agentic capacity of a tiny being [...] is extensive and causes the whole entangled network to be affected and to change.[37]

Within New Materialism, this agency of matter within a network of relations is central. As Cultural Studies theorists Rick Dolphijn and Iris van der Tuin state: "New Materialism is a

[36] Jane Bennett, "Vibrant Matter," in *Posthuman Glossary*, eds. Rosi Braidotti and Maria Hlavajová (London: Bloomsbury Academic, 2018), 447.
[37] Christine Daigle, and Ilaria Santoemma, "Pandemicity and Subjectivity: the posthumanist vulnerability of the zoe/geo/techno framed subject," *Journal of New Materialist Research* 3, no. 2 (2022): 88.

cultural theory that does not privilege matter over meaning or culture over nature."[38] This offers a way to approach (bio) design as a "material-discursive"[39] process that emerges from tangled relationalities. This means that the boundaries of the subject are never clear-cut and that they emerge within entanglements within the environment.[40] This notion of fluid boundaries extends to the materiality of the dead human body. Feminist philosopher Rosi Braidotti has identified a shift toward 'life itself'. With the notion of 'life itself' she refers to the centredness of the living matter of the body as subject, but also to the changing status of death in contemporary society. If the body is considered *zoē* ("life itself" or "life as absolute vitality"[41]), then we can adopt a non-anthropocentric view, whereby death is just part of a generative process.[42] A generative process in which nonhumans and humans are equally subjects and therefore have agentic capacity.

Humanism denies agency to everything that is not considered 'human'. Barad challenges this idea with her notion of intra-action. Drawing inspiration from Niels Bohr's theoretical physics, Barad argues that all matter is intra-active, established through relational networks.[43] Also humans are entangled in these intra-actions with nonhuman actors, and thereby become posthuman.[44] Phenomena are constituted in reconfigurings and entanglements between matter and only exist as material-discursive practices. These discursive practices are "material (re)configurings of the world through which local determinations of boundaries, properties, and meanings are differentially enacted."[45] Matter is created in its intra-active becoming: matter is not a thing, but a doing. It has agency. Barad combines this to shape the idea of material-discursive practices that are performative: they are phenomena of iterative intra-activity.[46] Barad's theory lays the

[38] Rick Dolphijn and Iris van der Tuin. *New Materialism; Interviews and Cartographies.* (Ann Arbor: Open Humanities Press/University of Michigan Press, 2012), 85.
[39] Karen Barad, "Posthumanist Performativity. Toward an Understanding of how Matter Comes to Matter," *Signs: Journal of Women in Culture and Society* 28, no. 3 (2003): 810.
[40] Dorota Golanska, "Geoart As A New Materialist Practice. Intra-Active Becomings And Artistic (Knowledge) Production," *RUUKKU - Studies in Artistic Research* 9 (2018): 2.
[41] Rosi Braidotti, "The Politics of 'Life Itself' and New Ways of Dying," in *New Materialisms: Ontology, Agency, and Politics*, eds. Diana Coole and Samantha Frost (Durham & London: Duke University Press, 2010), 210.
[42] Braidotti, "The Politics of 'Life Itself'," 212.
[43] Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham and London: Duke University Press, 2007), 33.
[44] Alaimo, *Exposed*, 115.
[45] Barad, "Posthumanist Performativity," 828.
[46] Barad, "Posthumanist Performativity," 828.

basis for the New Materialist framework and serves as a cornerstone for the development of related theories that build upon its principles.

In her book *Vibrant Matter*, Bennett aims to enhance our awareness of agency in nonhuman entities while still accommodating intentionality.[47] Any human agency is, according to Bennett, composed of multiple agencies. Also nonhumans and things have agency in this sense. While objects do not have a will, they can have power in operation with others. As a result, agency always arises from the interplay between the human and the nonhuman.[48] This perspective moves away from the idea that humans are central or "the ultimate wellspring of agency."[49] To this point, Bennett agrees with Barad. However, vibrant matter offers an understanding of agency that is not devoid of intentionality, which could erase moral responsibility. Barad seems to erase this aspect, when allowing for relativist interpretations.[50] The solution Bennett offers for this is that of distributive agency. Intention *does* exist, also within the human, but it is less definitive of the outcomes: "it vibrates and merges with other currents, to affect and be affected."[51]

Another pertinent concept linked to intra-action is 'trans-corporeality', a term introduced by Alaimo. The concept of trans-corporeality offers a strong focus on 'nature', climate change, the nonhuman, feminism, and ecologies. Alaimo defines trans-corporeality as: "that all creatures, as embodied beings, are intermeshed with the dynamic, material world, which crosses through them, transforms them, and is transformed by them."[52] This notion incorporates 'nature' as an active participant, engaging, interacting, and intra-acting within, around, and through the human body. Trans-corporeality offers a way of thinking that traces how the humans have been part of intra-active networks and systems. These systems include the material, discursive, economic, ecological, and biopolitical contexts as well.[53] Trans-corporeality thereby offers a more ecological perspective on New Materialism, responding to, and building upon

[47] Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham & London: Duke University Press, 2010), ix.
[48] Bennett, *Vibrant Matter*, xvii.
[49] Bennett, *Vibrant Matter*, 30.
[50] Barad, "Posthumanist Performativity," 826–827.
[51] Bennett, *Vibrant Matter*, 32.
[52] Stacy Alaimo, "Trans-corporeality," in *Posthuman Glossary*, eds. Rosi Braidotti and Maria Hlavajová (London: Bloomsbury Academic, 2018), 435.
[53] Alaimo, *Exposed*, 131.

previously mentioned New Materialist theories and concepts. Thereby, it offers a way of including the contextual factors of a case study, instead of the narrower structuralist positions Barad and Bennett propose. In the next section, I engage with sub-fields of Posthumanism and New Materialism that support the contextual aspects that are present the analysis.

Queer Ecology

One of the more specific sub-fields of Posthumanism is Queer Ecology. Through the discourse on Queer Ecology, I explain the queering of dualisms such as human/nonhuman, nature/culture, and death/life. Environmental Humanities scholar Catriona Sandilands describes Queer Ecology as a broad and interdisciplinary field of study concerned with disrupting the prevailing heterosexual discourse around gender, sexuality and nature.[54] Within this field, one applies Queer Theory to queer the environment and the dualisms involved in ecological thought.[55] This is how Queer Ecology reinterprets evolutionary processes, ecological interactions, and environmental politics.[56] Although this thesis does not directly revolve around queer themes, the anti-essentialism and disruption of humanist dualisms prove to be suitable to the analysis on how the relationship between the mycelium material and the dead human body remediates Western interpretations of death, life, and nature.

To better interpret Queer Ecology, it is important to first define 'queer'. Traditionally, the term queer means to ruin or spoil something, but the meaning has evolved in recent years into a term that serves as an umbrella term for non-heterosexual and non-gendered identities. The term can be used as a noun, adjective, verb, and adverb.[57]

Women's Studies scholars Noreen Giffney and Myra J. Hird emphasise more on what queer 'does' than on what it is. The verb queer prompts individuals to reflect on boundaries of dualisms, leading to leading to a deliberate disruption or subversion of

[54] Catriona Sandilands, "Queer Ecology," in *Keywords for Environmental Studies* (New York: New York University Press, 2016), 169–171.
[55] Doak, "Queering Nature," 2.
[56] Sandilands, "Queer Ecology," 169–171.
[57] Doak, "Queering Nature," 4.

established norms and conventions. Queer rejects essentialist perspectives. Queer can thus be seen on the one hand as an identity and on the other as a performative effect.[58] The performative effect holds a central role in the analysis of the performative aspect of the Loop Living Cocoon™. At the same time, Queer Ecology provides a lens that rejects categorisation and understands prevalent (aforementioned) dualisms as continua. This rejection is mainly in relation to the environment and thereby Queer Ecology aims to position the human as integral part of the environment: connected and entwined. This perspective relates to the environmental aspect of the phenomenon. The aspect relating to death is discussed in the section on Queer Death Studies. First, I dive deeper into the environmental discourse through Animal Studies and Plant Studies, to make sense of the position of fungi within this theoretical framework.

Animal Studies

Drawing upon Posthumanist thought, Comparative Literature scholar Cary Wolfe has been instrumental in shaping the field of (critical) Animal Studies, arguing against "speciesism" and for "a ceaseless examination of culturally encoded and oppressively maintained divisions across different species."[59] This is one of the main useful aspects of Animal Studies, offering a critique on the Anthropocene, because the specificity of organisms matters when we talk about how the biosphere shapes the climate. However, delving deeper into this field reveals the field's inherent limitations. Animal studies is limited to, as its name suggests, animals. Other beings are not considered, which means that Animal Studies omits the majority of the biosphere. The animal-centredness seems to be a result of the easy connection between animals and humans. Animals are more relatable to humans than plants, bacteria, fungi, or other life forms. Multispecies embodiment, worlding, and relation can take us away from abstract planetary systems

[58] Noreen Giffney and Myra J. Hird, "Introduction," in *Queering the Non/Human* (Abingdon & New York: Routledge, 2016), 4–7.
[59] Dana Medoro and Alison Calder, "Ethics, Activism, and the Rise of Interdisciplinary Animal Studies: An Interview with Cary Wolfe," *Topia: Canadian Journal of Cultural Studies* 10 (2003): 39–40.

language.[60] Despite its broad implications due to the ubiquitous presence of animals,[61] the field itself remains limited in scope.

Jacques Derrida's *The Animal That Therefore I Am*, and Donna Haraway's *The Companion Species Manifesto*, have contributed to the emergence of the field of Animal Studies. Derrida contemplated the gaze of his cat encountering him naked.[62] Haraway elaborated on her concept of natureculture in relation to historical and domestic dog-human relationships.[63] These very influential texts partly influenced Animal Studies' popularity. Especially the concept of natureculture is relevant. Nicholas Malone and Kathryn Ovenden explain: "natureculture is a synthesis of nature and culture that recognizes their inseparability in ecological relationships that are both biophysically and socially formed."[64] In her book *When Species Meet*, Haraway continues from her previous works on animals, focusing on the concept of 'becoming with' in relation to different animals. She tells us that "[i]f we appreciate the foolishness of human exceptionalism then we know that becoming is always becoming with, in a contact zone where the outcome, where who is in the world, is at stake."[65] Haraway argues that our becoming is intertwined with all kinds of nonhumans and objects: an idea that also appears in thinking of the human body as hosting approximately one nonhuman cell for every human cell.[66] Even though this argument is valid and relevant, practically it is primarily focused on animals, despite potentially encompassing organisms beyond the animal kingdom.

Multiple texts within Animal Studies have dealt with expectations regarding homosexuality as unnatural and animals as natural. This demonstrates the close relationship and, sometimes, overlap between Animal Studies and Queer Ecology. Also in Animal Studies, dualisms are queered. However, the perspective is still much human-

[60] Cary Wolfe, "What 'the Animal' Can Teach 'the Anthropocene'," *Angelaki* 25, no. 3 (2020): 134.
[61] Cary Wolfe, "Human, All Too Human: "Animal Studies" and the Humanities," PMLA: Publications of the Modern Language Association 124, no. 2 (2009): 564.
[62] Jacques Derrida, "The Animal That Therefore I Am (More to Follow)," trans. David Willis, *Critical Inquiry* 28, no. 2 (2002): 372–373.
[63] Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm, 2003), 12.
[64] Nicholas Malone and Kathryn Ovenden, "Natureculture," in *The International Encyclopedia of Primatology*, ed. Agustin Fuentes (West Sussex, UK: John Wiley & Sons, 2017), 848.
[65] Donna Haraway, *When Species Meet* (Minneapolis and London: University of Minnesota Press, 2008), 244.
[66] William Myers, *Bio Design: Nature, Science, Creativity* (London: Thames & Hudson, 2018 [2012]), 13.

centred. The anthropocentrism mainly becomes clear when animals get assigned or are connected to human-like qualities. In the chapter "Lessons From a Starfish," Eva Hayward reflects on a song about a starfish's ability to regrow limbs, in relation to transsexuality.[67] Another perspective on the connection between sexuality and animals is offered by Alaimo. She argues against the human/nonhuman and nature/culture oppositions, through evidence of the sexuality of queer nonhuman animals.[68] Hird does something similar, reflecting on how "nonhuman animals supposedly exemplify human animal qualities like the family, fidelity, selfless care for young and [...] sex complementarity."[69] She states this in relation to the two female macaques raising a young. It disrupts the idea of homosexuality as unnatural. The supposedly human-animal qualities also show a certain kinship/relationality towards animals. For humans it is easier to imagine some connection to nonhuman animals than to other nonhumans.

Humans easily assign animals human-like qualities, whereas it becomes more challenging with non-animal organisms due to their increasingly distinct anatomies. As Climate lawyer Bronwyn Lay states: "while animals and humans have bodies recognisable to judicial eyes, fungi run wild under earth, above ground, mesh with plants, and other organisms. Their shape slips away."[70] The easy connection between humans and animals might be a reason for the animal-centredness within the nonhuman discourse. When nonhumans are mentioned, this often relates specifically to animal nonhumans – or a specification is lacking. Of course, there are also texts specifically on other nonhumans than animals, but the bulk of the discourse on nonhumans is on *animal* nonhumans. Alaimo mentions that domestication of pet animals means dominating them, while other nonhumans are to be kept at bay.[71] This section of her book makes the focus on the animal as 'main nonhuman' very clear. While she intends to reveal something about all nonhumans, the actual point she makes is limited to the realm of nonhuman animals.

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[67] Eva Hayward, "Lessons From a Starfish," in *Queering the Non/Human*, eds. Noreen Giffney and Myra J. Hird (London: Ashgate, 2008), 249–264.
[68] Stacy Alaimo, "Eluding Capture: The Science, Culture, and Pleasure of "Queer" Animals," in *Queer Ecologies: Sex, Nature, Politics, Desire*, eds. Catriona Mortimer-Sandilands and Bruce Erickson (Bloomington: Indiana University Press, 2010), 51–72.
[69] Myra Hird, "Animal Transex," *Australian Feminist Studies* 21, no. 49 (March 2006): 36.
[70] Bronwyn Lay, "Fungus Sacer or Radical Outlaws?" *PAN: Philosophy, Activism, Nature*, no. 10 (2013): 47.
[71] Alaimo, *Exposed*, 19.

A useful concept to avoid the spotlight on nonhuman animals is 'multispecies'. The notion of multispecies emerged as a critique on the nonhuman, as the 'non' carries connotations of lacking 'humanness'.[72] Multispecies means that a broader range of nonhuman critters can be engaged with, such as fungi and plants, without assuming a specific resemblance or connection to humans. This approach prompts inquiries such as, who is involved in domestication? And for what purpose?[73] Multispecies therefore offers a framework that attends to the agency of the fungus that constitutes the mycelium of the Loop Living Cocoon™. It does not position the fungus as distant from or a 'non' human, but as an equally important actant and subject – explicitly not anthropocentric. The situation in which the dead human body is 'consumed' by the fungus can then be considered a 'becoming with'. While the term 'nonhuman' is still employed in this thesis, the multispecies framework is at the core of thinking about organisms. A practical effort made to include multispecies into the nonhuman discourse is made by Plant Studies, which I delve into in the following section.

Plant Studies

In his critique on Animal Studies, English Language scholar Jeffrey Nealon argues that the kingdom of plants offers an alternative to the centrality of the human/animal. Thereby the political, theoretical, and cultural formations at the basis of biopower can be questioned.[74] The Platonic idea that plants are passive, sessile, lacking any motion, communication, or awareness positions them as lower than animals, "within the human-animal-vegetable hierarchy of things that are alive."[75] Plant Studies challenges this perspective by highlighting research into 'plant intelligence'. The field aims to re-enter the presence of plants into Western thinking.

Nealon's theorisation fits within a general response to Animal Studies, in the shape of Plant Studies. The field of Plant Studies emerged recently as the 'New Animal Studies',

[72] Eben Kirksey and Sophie Cao, *The Promise of Multispecies Justice* (Durham: Duke University Press, 2022), 2.
[73] Eben Kirksey, "Multispecies," in *Posthuman Glossary*, eds. Rosi Braidotti and Maria Hlavajová (London: Bloomsbury Academic, 2018), 265.
[74] Jeffrey Nealon, *Plant Theory: Biopower & Vegetable Life* (Stanford, CA: Stanford University Press, 2015), 27.
[75] Nealon, *Plant Theory,* 30.

accounting for the intelligence and agency of plants.[76] While Nealon's critique on Animal Studies rests on an accusation of 'kingdomism', he does the same by introducing plant theory. Plants also exist within their own by humans categorised kingdom. And even though plants can certainly offer interesting insights, animals should not be forgotten, and one should account for other beings, such as fungi. It is relevant to think from a multispecies perspective in which understandings from Animal Studies and Plant Studies come together with thoughts on fungi and other beings. Therefore I do not argue for a field of 'Fungi Studies'. Individual species or a categorised group of organisms might be central to a certain study, but one should not be limited to that viewpoint. Interspecies relationships are at the base of human, or better: all, nature.[77]

Fungi Taking the Stage

We now get to a space within Posthumanism and New Materialism where the human finally is not central anymore, the animal is not favoured anymore, the plant is not hyped anymore, and the fungus can take the stage.[78] Although the relationship between fungi and humans that is so central to this study has not been studied as often as the relationship between animals and humans, there are some relevant studies. The most renowned book on the fungi-human topic might be *The Mushroom at the End of the World* by Tsing. In this book, Tsing explores the cultural and economic agency and value of the matsutake mushroom in relation to pickers in different forests and several layers of mushroom trade. The international trade and human impact on forests is influenced by the value and agency of the mushroom.[79] A very inspiring humanities text on the topic

[76] Wendy Woodward and Erika Lemmer, "Introduction: Critical Plant Studies," *Journal of Literary Studies* 35, no. 4 (2019): 23.
[77] Anna Tsing, "Unruly Edges: Mushrooms as Companion Species," *Environmental Humanities* 1, no. 1 (2012): 141.
[78] This does not erase the question whether a study written by a human being, within a human culture, in a human language and for a human audience, is not actually entirely anthropocentric. While this is of course a very central and important question, it exceeds the scope of this thesis. This thesis is for sure a project that is for humans in the sense of language, audience, and the academic educational system within which it is written. However, when thinking with Barad's intra-actions and Bennett's vibrant matter, the human is constituted through intra-actions. This not only includes humans and, through a multispecies lens, means that this project is not only for humans. It aims to contribute to an erasure of the dominant and sometimes harmful Western traditional dualisms of human/nonhuman, nature/culture and life/death. Sometimes such an effort cannot be done outside of current mainstream structures of knowledge production.
[79] Tsing, *The Mushroom*, 37–52.

is “Pulpy Fiction,” written by English Literature scholar Ella Mershon. Starting from Victorian times, and based partially on Victorian literature, she draws out a history of fungi and how they were seen in relation to humans. Until the first half of the nineteenth century, it was not clear how fungi could be classified within the taxonomic system of organisms. Fungi are not plants, as they cannot produce their own nutrition, but they are also not animals.[80] Lichens have only recently been lifted from obscurity and are not being mistaken for moss anymore.[81] This history makes clear that fungi are indeed harder to relate to than animals or plants.

Even after fungi were classified in their own realm, they were still considered as ‘quasi-animals’, because commonly, they need consumption of living or dead organic matter. This need put fungi in a negative light, as most of the to-humans-noticeable actions of fungi are annoying, harmful or even deadly. Because fungi are so different and hard to classify, “fungi are fecund allies for occult interpretations of language-making, self-making, and world-making.”[82] Occult refers here to the ubiquity but invisibility of fungi, mostly underground or microscopic. Based on these notions, Mershon developed a theory of the ‘ecological occult’: “A strand of environmental thinking interested in the cryptological, subterranean secrets concealed beneath the earth.”[83] While this history shows, once again, that fungi are hard to grasp, Mershon’s notion of ecological occult offers a useful concept to understand the socio-political relationships between self and world that are present when a dead human body is buried in the Loop Living Cocoon™. This concept will, therefore, return in the analysis.

Queer Death Studies

Where Queer Ecology offered a starting point to the discourse around ecological topics, to interpret multispecies relations (mainly the human-fungus relation), Queer Death Studies offers a starting point for the discourse on death and life. The relationship between fungi and dead *human* bodies has not been studied yet within Environmental Humanities, or within other fields. The decomposition, partially by fungi, of nonhuman

[80] Ella Mershon, “Pulpy Fiction,” *Victorian Literature and Culture* 48, no. 1 (2020): 272.
[81] Derek Woods, “Prosthetic Symbiosis,” *CR: The New Centennial Review* 22, no. 1 (2022): 162.
[82] Mershon, “Pulpy Fiction,” 274.
[83] Mershon, “Pulpy Fiction,” 269.

animal carcasses or parts is often overlooked, and dead human bodies are not considered at all in this regard – not even within biomolecular sciences.[84] An entrance point for engaging with this obscure(d) combination of dead human body and living fungi is the relatively recent field of Queer Death Studies (QDS), which is inspired by Posthumanist thought.

QDS offers a useful framework to make sense of elements relating to death, necropolitics, and grief. These are topics that are central when thinking of a coffin and the performative practice of a burial, but also of the dead human body as a biomedium that can be remediated. QDS theorists critically, (self-)reflexively, and affirmatively investigate and challenge conventional normativities, assumptions, expectations, and regimes of truths that are brought to life and made evident by current planetary scale necropolitics and its framing of death, dying, and mourning in the contemporary world. The concept of non/living provides and understanding of both a processual entwinement between the living and the non-living, but also of the continuum between life and death.

The 'Queer' in QDS relates to topics of feminism, Posthumanism, and otherwise-subversive aspects brought up in analyses.[85] Within the field, both the deaths of humans and nonhumans are considered. QDS, therefore, also relates to the relationship of human and nonhuman, and to ecological themes. One of the principles adopted here, in line with earlier mentioned discourses, is that dead matter is agential.[86] As it fosters life (e.g. fungi, bacteria, and small critters), it blurs socially constructed boundaries between life and death.[87]

Important to clarify in this sense are different understandings of death. Gender Studies scholar Nina Lykke understands life and death as a continuum, rather than a dualism. Lykke's understanding is based on a Bennettian understanding of matter and its vibrancy. However, she also mentions a humanist social perspective: death as a moment

[84] M. E. Benbow, et al., "Necrobiome framework for bridging decomposition ecology of autotrophically and heterotrophically derived organic matter," *Ecological Monographs* 89, no. 1 (2019): 2.
[85] Marietta Radomska, Tara Mehrabi & Nina Lykke, "Queer Death Studies: Death, Dying and Mourning from a Queerfeminist Perspective," *Australian Feminist Studies* 35, no. 104 (2020): 81–96.
[86] Marietta Radomska, *Uncontainable Life: A Biophilosophy of Bioart* (Linköping: TEMA – the Department of Thematic Studies, 2016), 38.
[87] Tara Mehrabi, "Queer Ecologies of Death in the Lab: Rethinking Waste, Decomposition and Death through a Queerfeminist Lens," *Australian Feminist Studies* 35, no. 104 (2020): 140.

of ending; when a person is not a living embodied subject anymore.[88] The concept of the non/living proves to be useful in navigating different understandings of death. Feminist philosopher Marietta Radomska introduced the concept as follows: "the concept of the non/living draws attention to the ambivalent entwinement of living and dying."[89] Radomska defines the non/living as the enmeshment between the living and the non-living, and the entwinement of life and death and the organic and inorganic. Those conceptual pairs should not be considered as referring to distinct components of uncontainable life and the slash exposes the enmeshment of these processes. This theoretical use of the slash is based on Barad's argument that a slash invites an active rethinking of a binary opposition and a destabilisation of prefixes.[90] The slash is an example of the 'both/and' logic that offers the possibility to produce "a multiplicity of relations, interpretations, and implications."[91]

Through non/living, Radomska argues for an ontology of uncontainable life as non-anthropocentric and non-speciesist. This theory is based on an analysis of bioart. Bioart "manifests processes that are intrinsically uncontainable, extend across materialities and processes, show life and death entanglements, and thus exceed singularities and frames."[92] In other texts, non/living is also deployed in analyses of bioart works. In a text where she reflected on bioart works and monstrosity, Radomska offers an affirmative understanding of the non/living to argue for an ontology of life as uncontainable.[93] In another text, she focuses rather on death, reframing the ethico-ontology of death as material and processual ecologies of the non/living. This is done through a study of a series of works by new-media and bioartist Svenja Kratz.[94]

[88] Nina Lykke, *Vibrant Death: A Posthuman Phenomenology of Mourning* (London: Bloomsbury Publishing Plc, 2022), 8–9.
[89] Marietta Radomska, *Uncontainable Life*, 35.
[90] Adam Searle, "Spectral ecologies: De/extinction in the Pyrenees," *Transactions of the Institute of British Geographers* 47, no. 1 (2022): 171.
[91] Iris van der Tuin and Nanna Verhoeff, "Both/And," in *Critical Concepts for the Creative Humanities* (Lanham, MD: Rowman & Littlefield, 2022), 36.
[92] Margherita Pevere, "Arts of Vulnerability" (PhD diss., Aalto University, 2023), 19.
[93] Marietta Radomska, "Promises of Non/Living Monsters and Uncontainable Life," *Somatechnics* 8, no. 2 (2018): 215.
[94] Marietta Radomska, "Deterritorialising Death: Queerfeminist Biophilosophy and Ecologies of the Non/Living in Contemporary Art," *Australian Feminist Studies* 35, no. 104 (2020): 116.

Margherita Pevere offers a reading of her own bioart works as non/living, to introduce the concepts arts of vulnerability and poetics of uncontainability.[95]

As bioart is a practice that often deliberately undermines dualisms as sloppy analytical tools for the position of humans in relation to each other and in relation to the environment, non/living is not limited to the realm of bioart. Radomska and Åsberg reflect on the non/living specifically in relation to the corpse. They consider the corpse as a lively site that is overtaken by (micro)organisms. These organisms flourish by decomposing the dead body. Because of this liveliness, the corpse is often perceived as "repulsive, too 'alive' and too 'dead' at the same time."[96] All these interactions and intra-actions between life and death, and between living and non-living, or dying, show that there is liminality in the corpse. A corpse is not 'just' dead: it participates in its decomposition. Therefore, our approaches to the 'dead' body needs to be revisited.[97] In sum, the concept of non/living leads to an approach that redirects our attention from dualistic norms that are based in Western cultural imaginaries, but is also a means to question the extent of this reciprocity and vibrancy of matter between corpse and 'consuming' organisms.

The concept of 'non/living' works as a biophilosophical tool that addresses relationalities, processes, and modulations. This tool offers a space for examining the entanglements between living and dying, and between growth and decay.[98] The non/living is made useful as a concept for the analysis of vibrant matter. The living and the dead are not distinguishable and therefore must not be distinguished before any scholarly analysis takes off. The very conceptual tool as well as the realisation to start an analysis in a 'blurry' zone is relevant to understanding bioart works and other case studies in their biopolitical, necropolitical, ecological and symbiotic workings. This processual intertwinement between living and non-living is importantly affirmed within this thesis in case of the Loop Living Cocoon™. However, the non/living can also be deployed as a concept that functions more obviously as a continuum, when looking at multiple levels of

[95] Pevere, "Arts of Vulnerability," 203–210.
[96] Marietta Radomska and Cecilia Åsberg, "Doing Away with Life – On Biophilosophy, the Non/Living, Toxic Embodiment, and Reimagining Ethics," in *Art as We Don't Know It*, eds. Erich Berger, et al. (Tallinn, Estonia: Printon, 2020), 59.
[97] Radomska and Åsberg, "Doing Away with Life," 57–58.
[98] Radomska, *Uncontainable Life*, 189.

non/living processes. Thereby multiple arguments can be made about scalability and relationality.

Biodesign

The Loop Living Cocoon™ is an instance of the new *Growing Design* practice where biological, living materials are shaped in a certain aesthetic way.[99] Within QDS, some researchers have focused on bioart as an art form that often operates at the boundary of life and death, and that therefore is suitable for critically reflecting on Western dualisms. Radomska argues that "thinking through bioart is a biophilosophical practice that may contribute to a more attentive and nuanced conceptualisation of life than we encounter in mainstream academic discourse."[100] While the Loop Living Cocoon™ is not a bioartwork, it is, as biodesign, situated within the realms of biotechnology and artscience. This does not mean that the differences between biodesign and bioart can be nullified, but it does mean that they are two sides of the same coin, within the realm of biotechnology.

Biotechnology is predicted to be the foremost driver of change in the current century as a synthetic biology field in which life is manipulated.[101] Artscience is a field in which the advantages and knowledges of the sciences with those of the arts and humanities are combined.[102] Bioart and biodesign are part of this field, as biotechnological materials are used for art and design projects.[103] There are many overlaps between bioart and biodesign, but also some important differences. While bioart is more likely to actively and intentionally question humanist presumptions, biodesign rather works based on modification of organic tissues with biotechnology for a certain (often anthropocentric) purpose. Manipulating the plasticity of life has been around for thousands of years, but it used to be form-driven, with metaphorical,

[99] Elvin Karana, et al. "When the Material Grows: A Case Study on Designing (with) Mycelium-based Materials," *International Journal of Design* 12, no. 2 (2018): 119.
[100] Radomska, *Uncontainable Life,* 189.
[101] Alexandra Daisy Ginsberg, et al., eds. *Synthetic Aesthetics: Investigating Synthetic Biology's Designs on Nature* (Cambridge & London: MIT Press, 2014), x.
[102] Nora Sørensen Vaage, "On Cultures and Artscience: Interdisciplinarity and discourses of 'twos' and 'threes' after Snow's Two Cultures," *Nordic Journal of Science and Technology Studies* 3, no. 1 (2015): 3.
[103] Robert Zwijnenberg, "Art, the Life Sciences, and the Humanities: In Search of a Relationship," in *Art in the Age of Technoscience. Genetic Engineering, Robotics, and Artificial Life in Contemporary Art*, ed. I. Reichle (Wien: Springer-Verlag, 2009), xviii.

symbolic, or decorative effects.[104] The increasingly complex biotechnological design has become very popular in the 20th century as an artistic and design practice and as such it has been studied more within the humanities.[105]

The interest in biodesign stems at least partially from conflicting ideas on ethics and from utopic images of a biotechnological future. Biodesign is often portrayed as a solution to issues caused by our current globalised capitalist economy which harms the earth's ecosystem extraordinarily. However, there is a certain hubris in thinking humans can modify nature in order for it to fit an ever-increasing demand for more. Biodesigners are initiators in shaping opinions on this, by offering reflection on the design processes and production processes. The design object should not be considered as a thing or an end in itself, but as a system.[106] On the one hand, the Loop Living Cocoon™ contributes to the biotechnological revolution, as it is a product of biotechnology. The mycelium is shaped in a certain manner that is preferred for human use. On the other hand, that human use is the sustainable burial of human remains. Burial is a practice that has been around for a long time and has become unsustainable in the last few centuries in the Western context. This means that Loop Biotech B.V. does not pretend to have created a completely new practice of dealing with the dead, but offers a small sustainable modification to an ancient practice. The Loop Living Cocoon™ is made of mycelium, a natural material that accelerates decomposition of the corpse and even might dissolve plastics that could be present in or on the body itself. The design of the Loop Living Cocoon™ itself is therefore not as invasive and ethically controversial as some other biodesign projects, for example those that use DNA modification.

Ginsberg et al. recognise that "this focus on design allows us to question, challenge, and reconsider the assumptions made about the future of this developing technology, one normally rendered through contradicting visions of utopian green salvation or dystopian bio-apocalypse."[107] As the Loop Living Cocoon™ and other

[104] Myers, *Bio Design*, 11.
[105] Eduardo Kac, "Introduction. Art that Looks You in the Eye: Hybrids, Clones, Mutants, Synthetics, and Transgenics," in *Signs of Life: Bio Art and Beyond*, ed. Eduardo Kac (Cambridge, MA: MIT Press, 2007), 6–18.
[106] Myers, *Bio Design*, 13.
[107] Ginsberg, et al., *Synthetic Aesthetics*, xiv.

biotechnological design products and processes already exist and are in use, challenging their assumptions only becomes more urgent.

Methodology and Glossary of Concepts

The connection between the mycelium and the human body does not happen in a vacuum. In fact, numerous factors contribute to their interconnectedness. In the context of the Loop Living Cocoon™, there are broader elements at play, such as the burial ritual, the experience of grief, the design and creation process of the coffin, the local actualisations of the Anthropocene, and many more elements, processes, and critters. Even though this study is limited to theorising the implications of the connection between the living mycelium material and the dead human body, navigating a combination of close reading, a broader cultural analysis, and real-life engagements with mycelium and the people who grow the material offers several benefits. By taking into account transdisciplinary factors, the analysis can uncover several intra-actions that brought socio-political implications of fungi-human connections to life.

The diverse range of factors involved leads to the adaptation of several methods to perform the analysis. For the analysis of the first phase, I propose an ethnographic method that aids in understanding fungus-human relations when growing the mycelium material. The ethnographic analysis is enriched by a cultural analysis of five patents on specific methods of creating mycelium material. The methodology of cultural analysis is also taken to the second and fourth phase, specifically based on the concepts of performativity and remediation. In the second phase, I introduce my interpretation on the methodology on remediation as theorised by Comparative Media scholar Lars Elleström. While Elleström's methodology is approach is rooted in semiotics and phenomenology and is inspired by technological media, it also – as this thesis demonstrates – proves to be useful when dealing with the human body as a medium and with the mycelium material as medium from a New Materialist frame. In the upcoming section, I offer an overview and explanation of the methods used and a glossary of the concepts used in the analyses.

Ethnography

Humans deliberately produce and shape the mycelium material in a certain manner. Although fungi possess agency, the interaction between humans and fungi during the

production process seems to be less reciprocal than the relationship that forms after burial. The emphasis in this thesis is on the connection between the living mycelium material and the *dead* human body. However, contextual factors such as the production process are taken into account for a more encompassing picture of the Loop Living Cocoon™ and its environmentalist stance. To achieve this broader perspective, phase 1 engages specifically with the production process of mycelium material and the relationship between growing mycelium material and living humans. The method used for the analysis is ethnographical. Ethnography means that a culture's relational practices and shared experiences are studied. This leads to an understanding of a culture for both insiders and outsiders.[108] It provides the opportunity to explore a range of practices and artifacts within a culture, such as clothes, spaces, texts, or manners of speaking. This can be done through recordings of members of the culture or through interviews.[109]

This ethnographic method allows for an analysis of the ways in which people engaged in growing mycelium material for various purposes operate within their cultural context. The analysis in phase 1 is based on the space, production process, and informal conversations with the producers of mycelium material. The data has been gathered during two visits of mycelium material growing facilities: the mycobiological research laboratories at Utrecht University (UU) and a small Urban Mushroom Farm (UMF) that cooperates with artists and designers.

The physical visits are complemented by an online visit to the Loop Biotech B.V. website, to assess the comparability of production processes.[110] The diversity of the visited mycelium growing settings aligns with the general scope of the first sub-question, dealing with the general practice of humans growing mycelium and biodesign. Thus, the focus is on the spaces and practices themselves, rather than solely on the personal opinions and manners of speaking of the producers. Conversations do offer a clarification of what is visible and otherwise sensible in the space and of the actual practices, possibilities, and limitations of growing mycelium (material). The ethnographic

[108] Ilja Maso, "Phenomenology and ethnography," in *Handbook of Ethnography*, eds. Paul Atkinson, Amanda Coffey, Sara Delamont, John Lofland & Lyn Lofland (Thousand Oaks, CA: Sage, 2001), 136–137.
[109] Carolyn Ellis, Tony E. Adams, and Arthur P. Bochner, "Autoethnography: An Overview," *Historical Social Research* 36, no. 4 (2011): 273–275.
[110] I also visited the Loop Biotech B.V. factory but I am contractually obliged to omit insights gained there from my thesis.

methodology, as carried out in the described manner, leads to a deeper understanding of the microbiological processes and the mycelium material-growers culture. Thereby ethnography contributes to a transdisciplinary approach in which (micro)biology also plays an important part.

Cultural analysis

In addition to the production process, another crucial context for studying the Loop Living Cocoon™ is the current era of the Anthropocene.[111] In the Anthropocene, human activity occupies a central role due to its transformative impact on Earth's geophysical aspects. According to Kim Fortun, the Anthropocene calls out new relationships between the political and the empirical.[112] Currently, new technologies are developed to deal with the environmental impact of the Anthropocene, exemplified by the Loop Biotech B.V.'s objective to provide a more ecologically sustainable burial method. Fortun argues that cultural analysis can provide insights into the Anthropocene sciences as cultural phenomena, the individuals that live during the Anthropocene, and how they are shaped, differentiated, and interconnected by Anthropocene science. In this context, cultural analysis takes its place within the realm of science.[113] This is relevant to this study of the Loop Living Cocoon™ as a scientific *anthropological* project. Such an anthropological project sheds light on the relationship between humans and, in this case, fungi in the domain of design.

In the second and fourth phases, the methodology employed is cultural analysis. Cultural theorist Mieke Bal proposed this "concept-based methodology"[114] as a fitting method for a transdisciplinary study, like this one. Bal explains this methodology as a broad, but also and simultaneously deep, analysis of a certain cultural object, based on specific philosophical concepts. These scholarly ingredients lead to an approach that is not necessarily tied to a single discipline, or to a single object, for that matter, but can

[111] While I am aware of the discourse and discussion around naming the current era, the term Anthropocene, as describing human exceptionalism, is the main point here.
[112] Kim Fortun, "Cultural Analysis in/of the Anthropocene," *Hamburger Journal Für Kulturanthropologie* 13 (2021): 15–24.
[113] Fortun, "Cultural Analysis," 18–24.
[114] Mieke Bal, *Travelling Concepts in the Humanities: A Rough Guide* (Toronto: University of Toronto Press, 2002), 5.

explore the meaning of certain concepts in different practices. Where the first phase forms the base of a transdisciplinary approach, the second and fourth phases build upon an understanding of the relationship between the living human and the growing mycelium. This combination leads to an analysis of the materiality, mediality, agency, and interconnections between the shaped living mycelium and the dead human body. Therefore, the main concepts adopted in this study are performativity and remediation. To be able to make sense of remediation in relation to the phenomenon, I also explain the concepts of the body as medium, modality, and mediality. In the following section I clarify the reasons for using these concepts and why they are useful in relation to this study, in addition to a short outline of the discourse surrounding the concepts.

Performativity

Performativity has been discussed earlier in the theoretical framework as a concept that reiteratively produces reality, but also as a concept that signifies cultural practices.[115] This concept aligns well with the New Materialist framework that I have put forth as the central theoretical underpinning of this thesis. As one of its main concepts within the analysis, performativity is a rather broad concept, but suitable to the aspects of the phenomenon that I focus on. Performativity provides an understanding of the relationship between the living mycelium material and the dead human body as a context-dependent construction of meaning. The context includes the cultural relations present in the dead human body and the living mycelium, but also the new relations to the biodesign, the materiality of the medium, and its performativity and queering potential in relation to the common views of mycelium within Western culture.

Remediation

Remediation has widely differing meanings in different contexts. Within a cultural analysis as described by Bal, tracing the travels of a concept offers an interdisciplinary approach.[116] Therefore, I map the two important meanings of remediation and how these are useful in relation to the case study: an environmental notion and a Media Studies

[115] Butler, *Gender Trouble*, 25.
[116] Bal, *Travelling Concepts*, 3–13.

notion. As this thesis has a strong ecological connection, the environmentalist notion is important to mention, even though I utilise the Media Studies notion in the analysis.

In the first place there is an environmentalist notion of remediation. The environmentalist notion seems to be one of the better known definitions of remediation. Within biology and Environmental Studies, remediation refers to restoring sites (mainly referring to the soils and sediments) that have been polluted and contaminated by human waste products such as chemicals and heavy metals.[117] A reason to remediate these sites is that a degradation of the environment can lead to a serious threat to mankind.[118] A variety of ways exist to remediate a polluted area. Common traditional methods are excavation of the site and thermal decontamination. These remediation methods are highly expensive.[119] A less common, but often equally effective method is bioremediation. Bioscientist Molly Leung describes bioremediation as "the transformation or degradation of contaminants into non-hazardous or less hazardous chemicals. Bacteria are generally used for bioremediation, but fungi, algae and plants have also been used."[120] Remediation done specifically with fungi is called mycoremediation.[121] The biological definition of remediation is very different from a Media Studies understanding of remediation.

A well-known definition of remediation within Media Studies is the representation of one medium in another medium.[122] Even though this definition is based on technological media, I argue in this thesis that the body can be seen as a medium as well and take part in remediation in that sense. In this section, I elaborate on both meanings of remediation. Bolter and Grusin proposed the concept of remediation as a tool to grasp multiple 'traditional' media that come together and are represented in new digital

[117] FAO, et al., *State of knowledge of soil biodiversity - Status, challenges and potentialities, Report 2020* (Rome: FAO, 2020), 3–327, https://doi.org/10.4060/cb1928en.
[118] Y.Y. Babanyara, H.A. Usman, and U.F. Saleh, "An overview of urban poverty and environmental problems in Nigeria," *Journal of Human Ecology* 31, no. 2 (2010): 138–143.
[119] Ashutosh Agarwal, and Yu Liu, "Remediation technologies for oil-contaminated sediments," *Marine Pollution Bulletin* 101 (2015): 483–490.
[120] Molly Leung, "Bioremediation: techniques for cleaning up a mess," *BioTeach Online Journal* 2 (2004): 18–22.
[121] Paul Stamets, *Mycelium running: How Mushrooms Can Help Save the World* (New York: Ten Speed Press, 2005), 86.
[122] Jay David Bolter and Richard Grusin, "Remediation," *Configurations* 4, no. 3 (1996): 339.

media.[123] In a posthuman sense, remediation can also be effective in relation to the human body and its connections with the Loop Living Cocoon™ as a medium. As will become clear in phase 2, digital media are not necessary for remediation. To be able to consider remediation, it is necessary to first understand the notion of mediality.

Mediality and Modality

Elleström's theory on mediality and modality encompasses a meeting of the physical aspects of mediality and the social construction of media conceptions. Elleström aims to dissolve media borders by offering a combination of three complementary types of media: "*Basic media* are simply defined by their modal properties whereas *qualified media* are also characterized by historical, cultural, social, aesthetic and communicative facets. *Technical media* are any objects, or bodies, that 'realize', 'mediate' or 'display' basic and qualified media."[124] Elleström approaches these media and intermedial relations from the lens of modality: a way of being or doing things. He differentiates medium/intermediality and mode/multimodality.[125] Multimodality means that linguistic meaning making is extended with non-linguistic modes. This includes more traditional sensible modes such as the visual, tactile, and olfactory; the affective, and spatial; but also the 'multisensory', such as the kinaesthetic and the proprioceptive.[126] In practice, the differentiation between the medium/intermedial and the mode/multimodal means that the material of the medium and the perception of the medium are separated theoretically. To do that, Elleström proposes the *material modality*, the *sensorial modality*, the *spatiotemporal modality*, and the *semiotic modality* as analytical tools. According to Elleström, these modalities are interconnected, as the material modalities influence sensory inputs, which in turn generate perceptions structured in space and time, ultimately conveying meaning.[127]

The four modalities proposed by Elleström seem to limit the account for considering contextual factors. Elleström's modalities are clearly based on semiotic and

[123] Bolter and Grusin, *Remediation*, 44–46.
[124] Lars Elleström, "The Modalities of Media: A Model for Understanding Intermedial Relations," in *Media Borders, Multimodality and Intermediality,* ed. Lars Elleström (London: Palgrave Macmillan UK, 2010), 5.
[125] Elleström, "The Modalities of Media," 14.
[126] Van der Tuin and Verhoeff, "Mode, Modality, Multimodality," in *Critical Concepts for the Creative Humanities* (Lanham, MD: Rowman & Littlefield, 2022), 134.
[127] Elleström, "The Modalities of Media," 17–24.

phenomenological thought and thereby limit the possibility of agentiality in the mycelium material and the dead human body. I engage with Elleström's theory from a New Materialist perspective. Therefore, a different approach to modality is needed. Creative Media Arts theorist Felicity Colman mapped almost 30 modalities that discern how the ethical aspects of material worlds influenced by technology and aesthetics are brought into play by different processes and methods. This also involves considering the types of objects, things created, and traces they leave behind.[128] Colman's approach to modality accounts for the agency of matter and is therefore more fit to the New Materialist lens of this thesis than Elleström's approach. Colman's use of the modal puts a stronger emphasis on the agentiality of matter, which enables reflection on the manner in which knowledge is produced, while being able to engage with the ethical aspects of that.[129] However, the combination of mediality and the four modalities that Elleström proposes stay useful for defining the mycelium material and the dead human body as media, while attending to their multispecies relations when considering their interactions.

The Body as Medium

The human body is often referred to as the 'oldest medium'. The concept of the body as medium mostly refers to the idea that the human body can be used as a tool or channel for communication, expression, or artistic creation.[130] In some contexts, the body as a medium refers to performance art or dance, where the body is used to convey a message, emotion, or story to an audience. Here, the body is seen as a canvas or instrument that artists can use to express themselves in a unique and powerful way.[131] In other contexts, the body as a medium refers to how our physical presence and actions can communicate information or influence others.[132] For instance our facial expressions, body language, and tone of voice communicate our thoughts and feelings to others, even without words. Overall, the concept of the body as a medium emphasises the importance of the physical body in our experiences and interactions with the world around us.

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[128] Felicity Colman, "Modality," *Philosophy Today* 63, no. 4 (2019): 987.
[129] Colman, "Modality," 993.
[130] Marwan Kraidy, "The Body As Medium in the Digital Age: Challenges and Opportunities," *Communication and Critical/Cultural Studies* 10, no. 2–3 (2013): 282.
[131] Mamiko Sakata, et al., "Human Body as the Medium in Dance Movement," *International Journal of Human-Computer Interaction* 17, no. 3 (2004): 428.
[132] Kraidy, "The Body As Medium," 282.

Art historian Lucy Willington mapped a part of the media studies discourse in which not only the human body, but all tissue is considered medial. Tissue in general can then be considered the oldest medium. Tissue as a medium is both complex and ambiguous due to the liminal nature of its life status and categorisation.[133] However, when returning to biology, tissue in itself was already considered a medium. This understanding is often based on the definition of medium as the material in a petri-dish in which fungi or bacteria can grow. In the current debate, the body as medium is often understood in relation to 'new' or digital media.[134] When working with the Media Studies definition of remediation, its workings are dependent on the specific understanding of the body as medium. The body as medium does not refer to the singular *human* body then, but to multispecies bodies. This offers a challenge for two reasons: firstly, the boundaries of the multispecies body are explicitly porous. Secondly, multispecies bodies often lack the cultural significance of, for example, decoration through clothing that humans do possess. Nonhumans that are not animals are even harder to relate to, as mentioned earlier. In phase 2 and 4, I reflect on how we can understand human and multispecies bodies as media.

[133] Lucy Winnington, "A Mirror of Flesh: An Exploration of Materiality in Living Bioengineered Art" (PhD diss., University of Auckland, 2021), 173.
[134] Joanna Zylinska, *Bioethics in the Age of New Media* (Cambridge & London: The MIT Press, 2009), xii.

Phase 1: Growing Mycelium Material

Growing mycelium for its affordances as a material is a relatively new technology that is still being explored. This exploration is done at commercial companies, such as Loop Biotech B.V. A research endeavour for growing mycelium material is done at Utrecht University, where a research group at the Faculty of Science carries out research on how mycelium material can be produced and its affordances. There are also efforts to create mycelium material that do not have an academic or commercial research ambition: at a small urban mushroom farm (UMF), for example, where they support bioartistic research.

Prior to writing this thesis, I had very few experiences and encounters with mushrooms and fungi, besides the occasional mushrooms for dinner. My first introduction to mycelium material for design purposes was at an artistic exhibition that was organised by an UMF. I later revisited the UMF's laboratory for this thesis.[135] While the main purpose of the UMF is growing edible mushrooms, they also cooperate with designers and artists who are interested in working with mycelium material. This leads to experiments with different species of fungi, different substrates,[136] different moulds for shaping the material, and different drying techniques. I learnt that mycelium is very versatile, but a lot is still unknown about its possibilities.[137]

This chapter serves as an introduction to the process of growing mycelium material. The sub-question that is answered in this chapter is: 'how can the practice of growing mycelium material offer an understanding of the relationship between human and fungus (within biodesign)?' To answer this question, I analyse the production process of the material based on ethnographic accounts of visits to the UMF, and a microbiological laboratory at UU. An online visit to the website of Loop Biotech B.V. supports the analysis. The ethnographic analysis is supplemented by a short conceptual analysis of a patent for the production of mycelium material, that offers an understanding of a Western cultural-judicial relationship with mycelium. The analyses are informed by the discourse on biodesign and by the environmentalist objective of the Loop Living

[135] The farm has been pseudonymised for patent-reasons.
[136] Substrate means the base material on which the mycelium grows. This can be, for example, sawdust, hemp, or coffee beans.
[137] Stamets, *Mycelium Running*, 12.

Cocoon™. This connection between the practice of growing, researching, and handling mycelium (material) and the judicial practice of 'owning' a method for growing mycelium material aims to convey embodied knowledge of the relationship between the growing mycelium and the living human. In this chapter I argue that the practice of growing mycelium material shows that there is little reciprocity between human and fungus, while the process of growing mycelium material requires embodiment and care to create a medium that can be used for multiple purposes. This is used as a basis for the further exploration of living mycelium and dead human, which will be covered in phases 2 and 4.

Visits

The ethnographic analysis in this chapter is based on several sources. In the first place, the interviews at and visits to mycelium growing facilities. At the UMF the founder explained to me how they grow their mycelium. She also showed me how the mycelium material can be made and I got to touch a piece of the material. A few weeks later, I visited the mycobiological research facilities at UU. There, I saw the process from a different perspective. Researchers at UU also study the possibilities of mycelium material and how to grow it in the lab. However, the setting was also intended for educational purposes, and it was much more advanced and extensive. In the second place, the analysis is based on public information on the production process of the Loop Living Cocoon™. This information is relevant in relation to what I learnt at the UMF and the mycobiological laboratories at UU. The aim is to get a picture of the relationship between the human and the fungi within the production process of mycelium material, and in this case specifically the Loop Living Cocoon™. As most of the information is sourced from the website of Loop Biotech B.V., this can be considered an online visit.

The biological aspects of producing mycelium material are important for an understanding of the factual elements and the possibilities. In addition to the biological aspects of producing mycelium material, ethnography offers insight into the process from a different perspective that leads to an understanding of the embodied encounter between the human producer and the growing mycelium that is being shaped. Therefore, I engaged not only with the conversations with the persons I spoke with at the mycelium growing facilities, but also with the space, the materials, the smells, the manner of

handling the mycelium (material), and other aspects in the spaces. Before the actual analysis, I will briefly describe the UMF and the UU research facilities and my visit to their laboratories.

Urban Mushroom Farm

The main aim of the UMF I visited is to grow edible mushrooms in the city. The farm is located in a building of a cultural and creative centre in a city in Central Europe. On their website, they write: "We are a bunch of friends interested in the applications of mycelium and the use of mushrooms in urban and artistic environments."[138] Besides selling the mushrooms they grow, they also experiment with mycelium material. Often these experiments are carried out in cooperation with local design and art students. The connections that are the result of these experiments go hand in hand with an effort of community building, following the metaphor of the wood wide web: based on the fact that mycorrhizal fungi can communicate within vast, complex, and collaborative systems of shared networks.[139]

The farm was rather a laboratory in a space at the cultural centre. The floors were tiled and the tables were made of steel. Everything has to be sterile when you grow mycelium. In the main room, most of the work is being done. Someone was preparing petri dishes to make the mycelium start growing. Someone else was picking the mushrooms, as they were ready to eat. In a smaller room, the mycelium gets the time to grow. Upon entering this smaller space, it immediately smelt musty. But that is not that strange in a room where many plastic bags with mycelium are stacked in shelving units. The room was mainly filled with these plastic bags. In one corner was a shelving unit with glass pots in which 'young' mycelium grows. Another corner was for experimentation. It had a shelf with mycelium design and art experiments.

The founder of the UMF explained to me how growing mushroom material practically works. She showed me the different stages of growth of mycelium. It was mostly hard to fathom. A rather slowly growing white organism that attaches to a (for them) nutritious substrate. It reminded me of the moulds I knew: those growing on food

[138] My translation. I do not provide the reference for anonymity reasons.
[139] Merlin Sheldrake, *Entangled Life: How Fungi Make Our Worlds, Change Our Minds, and Shape Our Futures* (New York: Random House, 2020), 154–155.

or in the bathroom. At the first sight and smell, these repulsive connotations influenced me. I got used to it very quickly, though. At the end of the visit, I held a block of mycelium material that they produced. It was very soft, sturdy and surprisingly light. This was a completely different expression of mycelium than the bathroom mould. The piece was already a few weeks old, and it has been dried at a temperature that the mycelium does not survive. However, the colour of the block was still very well shaped and very white, with a few darker spots where the substrate was more visible. I could almost not believe that I was holding a dead organism that had been shaped in this way and dried to stay like this. It felt to me like a taxidermy done to a mould. It makes the mould visible and tangible in a different way than its fruiting bodies for which they are known best, but it is also very different from the mycelium during the growing process. As I did not know much yet about the production process of mycelium, most of the conversation consisted of an explanation and showing the different stages of the process. The conversation is therefore one of the sources of information for the general process of growing mycelium material, which can be found later in this chapter.

Utrecht University Microbiological Research Facilities

I met Jeroen van den Brandhof at his office at the Utrecht University microbiology facilities. We first talked about my thesis project and about his research and background. After studying Biology and Bio Inspired Innovation, he started a PhD project at UU in mycobiology and mycelium materials. The laboratory where he works is part of the general microbiology section, but he showed me the parts where they mainly work with fungi. He works with 16 colleagues and about 30 students on different research projects that are carried out in this fungi lab. There are two labs with each having multiple rooms where researchers and students deal with mycelium materials: one where they study growing the materials and the other where they mainly examine (the characteristics of) the materials.

Van den Brandhof guided me through the first lab, where they do research on growing mycelium materials. Some bachelor students were working on their projects. At the lab they have access to a very wide range of fungi, substrates, technologies, tools, and knowledge. When I visited the students were working on creating a kind of mycelium

‘leather’. They test different methods, species and manners of manipulating the material for different qualities of the material. This process is done without a solid substance, but on a liquid medium, such as glucose or agar. An Erlenmeyer flask with the material is shaken in a machine and the material grows stably like that. Depending on the temperature at which the mycelium is dried and which chemicals have been used to manipulate the material, the material can be dead or still alive. The result is a thin layer of solid mycelium material, from which the liquid medium has evaporated.

The process used to grow the mycelium material is very similar to what I saw at the UMF. The mycelium material itself was very similar as well. Depending on the mould, the species, and the substrate, the qualities will vary, and this is exactly what the students and researchers experiment with. However, the material I saw at the lab was all relatively similar and the process of creating it (based on a substrate) is also largely the same, except for certain parameters, such as species, temperature, or substrate.

In the second lab area, the focus was more on technological appliances. In several rooms were climate cabinets, in which the mushrooms and mycelia are grown at a certain stable temperature. There was a room with freezers at -80°C. At this temperature fungi do not metabolise, so they can be stored for a longer time. In another room, a student did research on the growth of mycelium. In a special scanner, she scanned plastic dishes with twelve different kinds of fungi every day, to see which ones grow better on a certain substrate and in a certain environment. Yet another room contained a machine with a large Erlenmeyer shaker. The mycelium grows on a liquid substrate - like I saw in the first area - and is shaken 200 times per minute. The result looks like a liquid with small transparent tapioca balls. Jeroen commented on the shaking process that this manner of growth is not natural and rather stressful for the fungi. However, the researchers grow the mycelium like this, as it seems to be the most productive manner of growing mycelium in a lab setting. It was clear that Jeroen is very aware of the liveness of the mycelium and possibly ethical considerations that connect to that. However, the lab as a place to grow mycelium seems to be a parallel reality; in vitro has different ‘rules’ than in vivo. This difference between in vivo and in vitro also became clear from his concern about introducing a fungus species into an environment. The ethically concerned

questions he proposed were more focused on in vivo: for example, how does introducing a fungus through a living coffin influence the environment?

As I already expected from reading multiple sources on mycobiological research, it became clear that we do not know much yet about fungi. Many fungal species have not even been described yet.[140] There is a large research gap on the interactions of fungi with their environment. Not only specifically when a human body is buried in mycelium material, but also when a fungus is introduced without encapsulating a dead body. I learnt that it is not clear (yet) how the mycelium material physically and biologically interacts with the dead human body and its surroundings after burial.

Online visit to Loop Biotech

A clear description of the production of the Loop Living Cocoon™ is not available. Therefore, the website of Loop Biotech B.V. and their presence in the online press provide just tiny snippets of information that confirm that the production process used for the Loop Living Cocoon™ is similar to the production processes used at the UMF and at UU. The online visit offers some insights into more specific aspects of the production process of the coffin.

The information on the website is mainly aimed at the funeral industry. Several pages describe the products they offer in relation to practicalities that arise when organising a funeral. However, there are some descriptions that provide information about the production process. On the "Loop Living Cocoon™" page, they write that the coffin is grown from local mushroom-species and upcycled hemp fibres. These fibres are sourced locally as waste materials. They grow the coffin in seven days, which implies that they already have the substrate on which the mycelium has been growing. This is also confirmed in an article about Loop Biotech B.V. that has been published in the magazine Constructeur.[141] The coffin is biodegradable and after burial it "becomes one with nature

[140] Sheldrake, *Entangled Life*, 182–183.
[141] Erik Tempelman, "'Thinking about the Box': ontwerp en productie van mycelium producten - de baanbrekende doodskisten van Loop," *Constructeur*, June 14, 2021, https://issuu.com/online-mbm/docs/cst3_ezine.

in 45 days."[142] What this means is unclear, but it implies that the coffin – according to its makers – is something separate from nature at the time of the burial.

A relevant part of the Loop Biotech B.V. website is a published press kit.[143] This press kit includes a flyer and a brochure with the same information as can be found on the website's pages, and a folder with photos. Some of these photos have been taken during the growing process. One of the photos shows petri dishes in which the moulds grow on a medium and substrate. The labels name multiple species: grey oyster, king oyster, and Ganoderma, a genus of fungi the reishi mushroom is part of. This does not mean that the coffin is made of those species. These species are, however, suitable for creating mycelium material in the manner described by the UMF and Van den Brandhof. The other photos include a shelf with plastic bags with mycelium, from which mushrooms grow, similar to the shelves at the UMF. Another included picture shows several items that have to do with growing mycelium: a mushroom, a piece of mycelium material, a glass jar with mycelium, a plastic tube with mycelium in a liquid, and a flat dried piece of mycelium. The details of the production process are not relevant to this study, as mycelium material is mostly grown in roughly the same manner. However, these photos do show that it is plausible that the Loop Living Cocoon™ is created with similar techniques as the UMF and the researchers at UU use to grow their mycelium material.

The Production Process of Mycelium

The visits to the UMF and the lab at UU, and the description of mycologist Paul Stamets in his book *Mycelium Running*[144] lead to the following general description of the process of growing mycelium material.[145] The process described here is for sure not the only method to produce mycelium material, but it is a description that applies to the production processes at both the UMF, the lab at UU, and it seems to apply to the production of the Loop Living Cocoon™.

[142] Loop Biotech B.V., "Loop Living Cocoon™," accessed June 22, 2023, https://loop-biotech.com/living-cocoon/.
[143] Loop Biotech B.V., "Press & Media," accessed June 22, 2023, https://loop-biotech.com/press/.
[144] Stamets, *Running Mycelium*, 134–143.
[145] While the production process is also described in the Ecovative patent, I did not engage with that when writing this production process.

Step 1: inoculation

Inoculation is a technique to start growing the mycelium from spores, spawn or stem butts of a fungus. In a petri dish, on a growing medium such as nutrient-enriched agar, the spores can germinate or the spawn can expand.[146]

Step 2: colonisation[147] of substrate, base medium

When the mycelium has grown in the petri dish, it can be transferred to a pot with a nutrient-rich substrate that is quickly colonised, such as rice, grains, or sawdust.[148] The mycelium colonises the substrate and this can be kept for a longer time in the refrigerator, as the cold slows down the metabolism of the mould.

Step 3: colonisation of substrate needed for material

The mycelium that has grown in the pot can be mixed with a larger amount of substrate: the volume that is needed to create the needed amount of material. The mixture can then be place in a large plastic bag. The substrate used here will determine the weight of the final mycelium material. Sawdust will lead to a heavier material than hemp fibres, for example. In the plastic bag, the mycelium can grow much larger, to be able to get to about the size of a coffin.

Step 4: transfer of the mould to the mould

When the mycelium has spread throughout the substrate in the shape of the bag, it has to be transferred into a mould in the shape of the coffin. This can be done as soon as the mycelium starts to produce sclerotium; hardened fungal mycelium containing food reserves. Mycelium produces this protective layer when the environment changes or when nutrients in the surroundings are lacking. Like this, the organism rests and it can survive in a dry environment for years. When the conditions get more favourable, the mycelium can start growing again. The mould in which the mycelium is shaped is often made of plastic. This is one of the few materials that would not get consumed by the

[146] Stamets, *Running Mycelium*, 134–143.
[147] Colonisation in this context refers to the fungus spreading itself through the substrate. The term has no connection to colonialism here.
[148] Another technique is to grow the mycelium submerged in liquid. For the material I write about, the liquid-based technique is not relevant.

mould and that can be shaped easily. After the mould is transferred to the mould, it takes a few days before the mycelium produces the sclerotium.

Step 5: drying the mycelium material

When the mycelium has filled the mould and produced the sclerotium, the material can be taken from the mould and has to be dried. Drying it hardens the material and makes it rest properly. When the material is dried at a high temperature (for most species about 60 degrees Celsius), the mycelium dies. This means that the material can decompose, but it cannot grow anymore. For building materials this is often done, as one does not want a living fungus in their building. However, the Loop Living Cocoon™ is supposed to stay alive. Therefore it is probably dried at a lower temperature than 60 degrees Celsius. At this lower temperature the mycelium stays alive, in a resting state. When the material is exposed to a humid environment, the mycelium will start growing again.

What can be gleaned from this production process is that it is very structured. Humans have the agency to decide what shape and weight the material will be, but also the agency to decide about the life and metabolism of the fungi. Even though the fungi have the agency to grow, which is something that humans cannot influence, humans *can* influence the speed of the growth and whether the metabolism is paused or the fungi is killed. The process of growing mycelium material is done completely without soil: the main natural habitat of the mycelium. Everything about the process is visible and sensible to the human, which negates the notion of the 'ecological occult'. The fungi are microbiologically extracted from the occult environment in which they can reveal "an exilic, fugitive form of belonging that offers new possibilities for reimagining socio-political relations."[149] As such, the relation between the human that grows mycelium and the fungi is limited to the in vitro environment of the laboratory. This shows that the fungi have agency to carry out their metabolism, but the agency to reimagine socio-political relations is limited. I elaborate on this limit in reciprocity between humans and fungi in the next sections.

[149] Mershon, "Pulpy Fiction," 269.

Awareness of Fungi and Speaking about Mycelium

In his book *Entangled Life*, biologist Merlin Sheldrake reflects on his own experiences with researching fungi and mycelium. He refers to the small amount of knowledge the layperson has on fungi, but notes that even experts do not know much yet about fungi: "a mere six percent of all fungal species have been described. We are only just beginning to understand the intricacies and sophistications of fungal lives."[150] Within Western culture, fungi have always played a role in some way, but awareness of it is minimal. The manner of referring to fungi and handling them offers a reflection of the general attitude of humans in relation to fungi. This section offers an understanding of these referrals to fungi that were part of my visits, in order to understand the power relationship between human and fungus. *The approach to fungi shows the power fungi have to affect the lives of people*: "The ways that we try to make sense of fungi often tell us as much about ourselves as the fungi that we try to understand."[151] How can we understand ourselves (humans) in relation to the production of mycelium material, then?

In this analysis, I move from formal to informal research ambitions of the analysed sources. The UU laboratory is a very formal research institution, where certain rules apply. The UMF lab is an informal institution. As the founder is a researcher in microbiology, the approach is similar, but the space is different. Sheldrake's book encompasses a wide range of potential interactions between humans and fungi, including 'radical mycologists': grassroots fungal enthusiasts that work with mycelium on a DIY basis.[152] Even though Sheldrake did not interview an 'amateur' radical mycologist, he does describe the movement. This also contributes to an understanding of the relationship between human and fungus. The online visit to Loop Biotech B.V. provides the least academic and reliable sources, but it does offer a view of how the target audience of the Loop Living Cocoon™ is approached in their communication about the production process. The objective of this visit is to confirm the similarities between the production processes and the relevance to the Loop Living Cocoon™.

[150] Sheldrake, *Entangled Life*, 16.
[151] Sheldrake, *Entangled Life*, 213.
[152] Sheldrake, *Entangled Life*, 183.

As I mentioned earlier, the lab environment is one that seems to be divided from the 'real' world. Sheldrake reflects as follows on his experience as a field biologist in opposition to lab biologists:

> Lab biologists spend most of their time in charge of the pieces of life they study. Their own human lives are lived outside the flasks that contain their subject matter. Field biologists rarely have so much control. The world is the flask and they're inside it. The balance of power is different. Storms wash away the flags that mark their experiments. Trees fall on their plots. Sloths die where they planned to measure the nutrients in the soil. Bullet ants sting them as they crash past. The forest and its inhabitants dispel any illusions that scientists are in charge. Humility quickly sets in.[153]

Both the UMF and the UU researchers grow mycelium material in a laboratory environment – an environment controlled by humans. At the UMF, the focus was mainly on artistic experimentation: how can we shape/grow/adapt the material in such a way that it fulfils the aim of the artist? At the UU lab, the researchers and students explore the behaviour and possibilities of the mycelium material. Also here, the research is partly aimed at design purposes. At Loop Biotech B.V., the environment and aim are similar, but more specifically on characteristics and requirements for a coffin. The most ideal environment for growing mycelium material with a biodesign purpose is a laboratory. This means that the production of mycelium material is also a human-controlled environment where the human has the power to make the mycelium grow in a certain way.

A human-controlled environment does not mean that the human has the ultimate power over the fungi in this situation. Humans found out about certain characteristics of mycelium, in terms of how they grow, but also in terms of how they can be made useful for human purposes. However, the fungi do require specific circumstances to be able to grow them. The fungus has the power to make humans act in a particular way and to influence the space in which they are grown. It could be considered an example of mutual

[153] Sheldrake, *Entangled Life*, 18.

domestication.[154] The human domesticated the fungus to grow in a certain way that benefits them, and the fungus, in turn, domesticated the human to create an atmosphere in which the fungus thrives.[155] Most spaces in which mycelium is grown have shelving units with plastic bags filled with mycelium. Care is needed: the grower needs to pay attention to the temperature, humidity, substrate, materials, and very importantly: hygiene. However, the power of the fungus gets increasingly minimised when production becomes more standardised.

Both the founder of the UMF and Van den Brandhof seemed to be aware of the reciprocity between human and growing mycelium material. The founder of the UMF explained that the work with mycelium is very intensive. The UMF staff monitors the mycelium daily and sometimes all the factors seem right, but the mycelium still does not behave in the expected and wanted manner. This dependency on the tendencies of the mycelium is also present in the Loop Living Cocoon™. Aesthetically the coffin is expected to be – and marketed to be – 'clean' white. However, in practice the coffins are often not completely white. The substrate is sometimes faintly visible and the mycelium itself is not always completely white.[156] Van den Brandhof acknowledges the difficulty to get the mycelium to grow in the desired manner. One of his students was working with closed, plastic dishes that hold a substrate and a fungus. In one of those dishes, the fungus only grew on the sides of the dish and actually tried to 'escape' from it. Mycelium does not always do what the human wants or expects it to do. This also leads to an awareness of the liveness and power of the mycelium. An example of this is when van den Brandhof told me that the growth while shaking is rather stressful for the fungus. It is not a natural way of growing. However, it mostly works well for what the human wants.

Whatever 'works for what the human wants' is the main characteristic of growing mycelium material and experimenting with it. The ultimate goal is to inhibit the natural and unpredictable behaviour of the fungi. So when the most productive manner of

[154] Sheldrake, *Entangled Life*, 207.
[155] As the fungus is sometimes killed for the sake of the mycelium material, one of the issues here is a rigid Darwinian manner of thinking: that the ultimate goal is to reproduce and produce fertile offspring in order for the species to survive. Especially when thinking of fungi, this framework proves to be problematic. Fungi are very hard to categorise as 'species' in the traditional sense, based on DNA, because each organism can have different genome characteristics, even if they are considered to be the same 'species'.
[156] Loop Biotech B.V., "Loop Living Cocoon™," accessed June 22, 2023, https://loop-biotech.com/living-cocoon/.

growing mycelium is found, whether this means shaking or mass-producing mycelium coffins, the reciprocity diminishes. This also leads to a strong focus on what the mushrooms can do for humans on a personal level. While the ecological factor was present in all visits, it seems to be approached as ungraspable – almost like the fungi themselves. The idea of having power over fungi is reinforced by the cultural-juridical possibility of patenting a mycelium production process. In the following section I analyse five patents of Ecovative Design LLC (Ecovative) that protect that company's rights to the growth of mycelium material.

Power Relations Between Humans and Growing Mycelium

In an overview article, Biotechnologist Kustrim Cerimi et al. described 47 granted and pending patents on mycelium material. The company Ecovative Design, LLC (Ecovative) is leading with a share of 45% of all patents found.[157] Both the UMF employees and Van den Brandhof referred to Ecovative as a company that holds many influential patents within the field of growing mycelium material for construction, art, and design. Therefore, I selected five of Ecovative's patents on the mycelium material production process on a solid substrate to analyse in this section. The existence of patents on the mycelium-growing process, but also the language within these patents reflect an understanding of how companies that mass-produce mycelium consider their relationship with the fungi. The patents analysed are:

[157] Kustrim Cerimi et al., "Fungi as source for new bio-based materials: a patent review," *Fungal Biology and Biotechnology* 6, no. 17 (2019): 2.

Index	Title	Patent number	Current assignee	Date of patent
1	Method for producing grown materials and products made thereby	US9485917	Ecovative Design, LLC	2016
2	Method for making dehydrated mycelium elements and product made thereby	US9803171	Ecovative Design, LLC	2017
3	Tissue morphology produced with the fungus pycnoporus cinnabarinus	US9085763	Ecovative Design, LLC	2015
4	Method for growing mycological materials	US9394512	Ecovative Design, LLC	2016
5	Stiff mycelium bound part and method of producing stiff mycelium bound parts	US10144149	Ecovative Design, LLC	2018

Table 1: Overview of analysed patents.

Ecovative's Patents

All analysed patents deal with creating mycelium material in one way or another. They explain a process in which the fungus or fungi are positioned in a human-created environment. It leads to a set-up where the fungi grow in a certain manner that creates a mycelium material that is beneficial for human use. The benefits are, for example, about the shape and about the characteristics of the material.

In terms of structure, all the examined patents share similar components. The primary purpose of the patents is to protect the rights of the 'inventor' and to explain the actual invention along with instructions for its replication.[158] The first page presents comprehensive patent details. This includes specific juridical information, as well as information on the inventors, applicant, application and publication data, and an abstract. The subsequent page or pages contain images and schemes of the invention. Following this, one finds a detailed text with the explanation of the invention. While the

[158] In itself, the possibility of getting a patent on a semi-natural process is disputable. However, the possibility leads to the practice that if anyone can apply for a patent and earn money, at least someone will do it. The ethical response is then related to how the assignee deals with the patent in practice (e.g. making others pay for using the process).

texts are the main source of this analysis, the metadata, images, and schemes are taken into account as well.

The most extensive patent is number 1. This particular patent is also the most interesting in relation to the Loop Living Cocoon™, as it is the patent that describes the most basic manner of creating mycelium material. The process is very similar to the steps described earlier in this chapter. Even though the other patents might not be as relevant in relation to the Loop Living Cocoon™, they do offer insights in the relationship between human and growing fungi. Accordingly, they are considered here in a less thorough manner as patent 1.

All the patents hold a narrative structure to some extent. There is an awareness of the world outside the processes described and therefore they are not considered in a vacuum. The narrative often underlines the importance and relevance of the patent. The rising demand for raw materials such as minerals and fossil fuels is described, for example, and its environmental downsides. The alternative of typical grown materials, such as trees, plants, and animals is dismissed as requiring sunlight and land (Patent 1). It is remarkable that living beings are referred to as materials. Also the comparison between plants and fungi is made here. Earlier we saw that it is a common comparison, as plants are easier to understand and relate to than fungi. Only patent 3 does not have a narrative. While it also acknowledges environmental advantages, it is mainly focused on how the fungus that is central to the patent has been known as a producer of several enzymes.

The narrative structure makes the patents accessible to read, although there are also more complicated, technical parts. The narrativity can be found in the explanation of biological processes and in the images. While the images clarify the invention, they are drawn in black and white. The images can be considered as vague schemes of what the processes could look like. The vagueness can also be found in the texts. It seems like a balance is to be maintained between describing the process as clearly as possible and describing it as broad as possible so a variety of manners of carrying out the process can be included. In all the patents, the inventors outline a broad variety of possibilities. In patent 2, for example, they write: “the mycelium may be a variety of fungi species or strain and may be natural, hybridised and/or a genetically modified organism (gmo) or a

combination thereof." In patent 1, they write: "Other embodiments may use an entirely different set of particles from either agricultural or industrial sources in ratios sufficient to support the growing of filamentous fungi through their mass." And in patent 5, they write: "Liquids and gases can be applied during the compression to enhance end material properties." These descriptions can refer to anything within the mentioned categories, for example the fungi species that could be used within the described processes. Sometimes a group of species is mentioned (patent 1), sometimes the patent is about a certain species (patent 3), but sometimes the only reference is that the species should, for example, be able to produce mushrooms (patent 4). The latter is hard to repeat, as it is not certain which species have the right characteristics.

On the one hand, patents can be very broad and vague. On the other hand, the patents also include very detailed 'recipes'. Patent 1 first describes a step-by-step method for creating mycelium material. Following that, it describes 16 examples of how these steps could be understood in different situations and for different purposes. To make the patent very clear, Ecovative sometimes describes all the steps several times, except for one or two details that are different in the process.

The other four patents also offer step-by-step plans for executing the patented production process. These recipes provide a very clear description, but it also makes it unclear what exactly is included in the patent. Is it the entire process, exactly as described? Or is the invention still protected when one of the steps is not followed, for example? The section "what is claimed is…" could provide a more tangible explanation of what is claimed in the patent. This section is included at the end of each patent. Often the "what is claimed is…" section lists a few main claims that are patented. Patent 2 only has one claim: "a method of growing a fruiting body comprising the steps of […] and to initiate the growth of at least one fruiting body." While there is clearly a strong focus on the fruiting body, the actual patented claim is the process of dehydrating mycelium and rehydrating it so a mushroom will grow. Patent 4 has 18 claims. The first one is a method of growing mycelium of a mushroom-producing fungus in certain conditions that do *not* lead to the production of a fruiting body. The other 17 claims specify certain conditions in terms of temperature, humidity, carbon dioxide levels, and substrate composition.

As mentioned before, the result of the process described by the patent is considered to have certain advantages. The advantages are only mentioned very briefly in each patent, but are clearly described from a certain perspective that focuses on advantages for humans. Patent 2 mainly emphasises the economical aspect of growing mushrooms from dehydrated mycelium: it is simple, cheap and can be transported easily. This economical factor returns in other patents as well. Patent 5 compares the production of mycelium material with post-processing of wood-based materials. The wood-based process is much more expensive, time-consuming and wasteful as the mycelium-based process. Patent 3 describes its invention as an ideal material for packaging, because of its cushioning surface. It is also beneficial for shipping products. Only patent 1 explicitly refers to environmental benefits, besides the economic benefits. The production of mycelium material is compared with petroleum-based foams that produce downsides in the form of pollution, energy consumption, and a long post use lifespan. However, the rising costs associated with a rising demand is mentioned as well and the material will be used for human purposes. Therefore, the advantages mentioned in the patents are mainly aimed at human benefit. From an environmental humanities perspective, this means that the dualism of human/nonhuman is very present and not questioned in the Western cultural-judicial context on fungi and mycelium materials.

Production Process: Fungus x Human

The advantages of the inventions are aimed at humans, and the production process is carried out by humans. *And fungi*. This interaction between human agency and fungus agency is complicated in terms of which is considered to have agency in certain situations and the human awareness of the liveness of the fungi. I argue that, based on the language used in the patents, the fungi and other actants within the processes have agency based on their 'natural' behaviour. Humans have a certain goal in mind that can be reached by placing the fungi in a certain environment in which the fungi do something that the human can benefit from. This leads to a situation in which the human is required to care for the fungus, but the reciprocity between fungus and human is low.

In the first place there is a distinction between the fungi as growing and the fungi as being grown. Both versions are mentioned in the patents. Mostly 'being grown' is used

in relation to the final material. The 'growth cycle' of the fungi is being used to produce materials comprised of the cellular body of fungi (patent 1). However, one of the steps described in patent 1 is: "growing the desired fungi strain [...]." This is an approach that is more aimed towards the human as having agency. Even within sentences, the struggle to describe the agency of fungi arises: "As such, the fungi, *Plearotus* [sic] *ostreatus*, a cellulosic decomposer, being grown through the enclosure, was able to naturally bond itself to the top portion of the panel by growing along and into the surface of the material." The fungus is described as 'being grown', but also has agency in the sense that it is able to bond itself. An important word here is 'naturally', as it distinguishes the human agency and the fungus agency. The human creates the circumstances and makes the fungus do something. The fungus still has the agency to demonstrate its natural behaviour – only until it has a useful shape and it is killed, dehydrated, and/or mechanically processed. The fungus/human agency is a little blurry when the patents describe fruiting bodies. Mushrooms are often considered to be 'produced', as they grow or do not grow based on the circumstances created by the human. Finally, the fungus is the organism that actually does the growing and consuming and creating a network of mycelia. Both influence the process so the human-desired material and shape emerges.

The observation of the fungus still having agency shows that there is an awareness of the liveness of the organism. It is able to 'do' things, as long as it is 'natural' behaviour. The organism is described as a body. Different set-ups and examples of the inventions are described as embodiments. An embodiment includes the entire product, including the substrate, fungi, and shape. It becomes especially clear in patent 3, where different products are described based on the characteristics of the specific species of fungus used. When the mycelium is exposed to light, it will become orange and it can be used as a buoy. When it is not exposed to light and when it grows in an open mould, it will be white and it grows to be soft. This embodiment of the fungus is suitable as packaging material. Embodiment, therefore, refers to the entire final product and its unique characteristics. This is an interesting approach from the perspective of trans-corporeality, as the patent accounts for the liveness and agency of not only the fungus, but also the materials used, the mould, the substrate, and the human agency. The process is influenced by the requirements of the fungi and other materials that are used. This leads

to the very specific step-by-step plans for what the human should do to make the fungus create the desired product. Even the temperature, humidity, and mix of substrates is to be exactly as the fungus prefers. The human, then, has to put a lot of care into creating the most ideal environment. The final product is an embodiment of all those agencies that have come together and that form an entanglement which manifests itself as something that is useful for humans.

A very interesting indication of awareness of liveness is the killability of the fungus. In patent 1, the inventors write the following: "The preferred method [...] for killing the growing organism, i.e. a fungi [sic], in order to stop further growth is by heating above 110 degrees Fahrenheit, there are a number of other ways that this same task can be accomplished." This killability can be seen as comparable to the killability of animals. Environmental Humanities scholar Christina Fredengren argues that: "A major relationship between humans and animals is acted out in violence and killing practices – as animals have economic value and are used as food or in the making of things for humans."[159] The relationship between humans and fungi is a very different one compared to the relationship between humans and animals. However, within the processes described by the patents the fungus-human relationship is also one of growing the fungus for a certain purpose and then killing it. In line with Derrida, this shows that fungi are not capable of a (human-recognised) response, so they are considered as separate from humans.[160]

This makes us return to the goal of the patents: what is useful for humans? Is it useful to kill the fungus, so the material can be used in the - for humans - most convenient manner? Or is the goal that the fungus stays alive for the purpose of its human use? Growing a fungus in a certain shape for a human purpose complicates the common aspect of 'human domination of nature' and anthropocentrism, in relation to an environmentalist objective of production. There is a clear interaction between the growing mycelium material and the human producer of the material. The ideal environmental factors are created with care by humans, so the fungus thrives. However,

[159] Christina Fredengren, "Beyond Entanglement," *Current Swedish Archaeology* 29, no. 1 (2021): 22.
[160] Jacques Derrida, *The Animal That Therefore I Am*, ed. Marie-Louise Mallet, trans. David Willis (New York: Fordham University Press, 2008), 25.

this human expectation of the characteristics of the material can also lead to killing the fungus. This shows that the interaction is reciprocal, but that humans are clearly powerful in the relationship: in terms of creating a certain atmosphere and in terms of creating this atmosphere so the fungus does something that is beneficial for human use.

Conclusion

The first phase of the life of the mycelium material in the Loop Living Cocoon™ is the production process. I studied this process through an ethnographic analysis of visits to mycelium growing facilities and an online visit to Loop Biotech B.V. The process of growing mycelium showed that there is little reciprocity between human and fungus in phase 1. Even though the humans who grow the mycelium are aware of its liveness, the lab environment offers a bubble in which humans are powerful over the fungus.

An analysis of five patents assigned to Ecovative reaffirmed this conclusion. These patents protect the rights of Ecovative regarding inventions of the production process of mycelium material. What became clear is that the mycelium has power and agency as well. The human needs to give care and should provide the perfect environment for the fungus to do what the human wants it to do. The process leads to killing or dehydrating the fungus and the product is then for human (commercial) benefit. The human is in a powerful position here, in which the fungus is powerful up until its 'natural' behaviour and the human can kill the fungus when it did its part. Therefore, the process of producing mycelium material requires embodiment and care, while the practice is low in reciprocity between human and growing mycelium.

In terms of biodesign, the growing and shaping of mycelium is a promising tool. The material is useful for many uses and it is an environmentally friendly alternative to materials such as plastic. The interesting aspect of the Loop Living Cocoon™ is that it is *not* killed. The mushrooms are kept alive and, together with the dead human body, placed in a grave in the environment of a burial site. Hereby the concept of the 'ecological occult' becomes more relevant in relation to the soil and the invisibility of the fourth phase. Therefore, the second and fourth chapters engage with the Loop Living Cocoon™ in relation to the dead human body and their interactions as media.

Phase 2: Between Death and Funeral

During the second phase of the life of the Loop Living Cocoon™, the human corpse is in the mycelium coffin, but it is not buried yet. This phase often lasts from less than 24 hours[161] to up to three weeks.[162] Against this background, the materiality, mediality, and agency of the mycelium material and the dead human body are analysed. The sub-question therefore is: 'how can mycelium material and the dead human body be approached as media, materials and agents?' To answer that question, I engage with the theory of mediality as proposed by Elleström. This section thereby underscores the relevance of mediality in relation to the (dead) human body and the mycelium material. I analyse the materiality, mediality and agency of the mycelium material and the dead human body. To do that, I consider the mycelium material and the (dead) human body as an example of the notion of 'body as medium'.

In a broad sense, recognising nonhuman and multispecies bodies as media involves considering their capacity to convey information, meaning, and significance in various contexts. This acknowledgement attends to their discursive and performative power, in addition to their power to ignite physical change. These different forms of power also complicate our understanding of mediality. I argue that all those forms of power shape and are shaped by the agency of corpora; by their vibrant mattering. As media, they are not only physical matterings, but also discursive. This frame offers the possibility of understanding trans-corporeality in a manner that accounts for the human-centred departure point of thinking about actants. Media are clearly and obviously known to have an impact. Remediation, then, is about when the representative value of a medium becomes changed through recontextualisation.[163] In this thesis, I follow an ecological approach that accounts for those recontextualisations.

To answer the sub-question, I draw upon Elleström's theory of mediality to position the mycelium material and the deceased human body as forms of media and to

[161] Jewish law, for example, commands that the deceased are ideally buried before dusk of the same day. However, the deceased are often buried in *tachrichim*, the traditional clothing for burying the dead.
[162] In Western communities – where the Loop Living Cocoon™ is mainly used.
[163] Elisabetta Adami, "Retwitting, Reposting, Repinning; Reshaping Identities Online: Towards a Social Semiotic Multimodal Analysis of Digital Remediation," *LEA - Lingue e letterature d'Oriente e d'Occidente* 3 (2014): 224.

analyse the affordances of these media. Elleström's theory provides a broad and interdisciplinary tool to define media, based on their modalities. However, this framework, though encompassing, falls short when viewed through the lens of New Materialism. To deal with this, I engage with Elleström's distinction of four modalities through the New Materialist modal concept as described by Colman. I add to Elleström's theory while making his work productive. This is in line with cultural analysis that – in Bal's terms – allows for the object (or phenomenon) to "speak back".[164]

The human body as a medium has been studied extensively, but the *dead* human body as a medium cannot be understood in the same manner. Also here, Elleström's theory offers a way to analyse the affordances of the medium. The physical characteristics of the dead human body are taken into account as well as the emotional situation that shapes the context of the death of a person.

This chapter contributes to an understanding of the mycelium material as a networked medium that cannot just be approached in a semiotic and phenomenological manner. Both the mycelium material and the dead human body have to be considered within their common intra-actions. The mediality of the dead human body creates an extra complexity because of cultural and emotional influences. Reflecting on the 'non/living' differences between the living body and the dead body as media, the dead body as medium can be defined as very similar to the living human body in terms of materiality and trans-corporeality. The analysis leads to a New Materialist understanding of the human body as an non/living intra-active constellation that performs and reifies its cultural meaning.

I follow an approach that does not individualise and separate entities, as they are intra-acting and thereby boundaries are blurry. Considering the media individually seems counterproductive. However, in the fourth phase, the media come together in their remediation. To be able to consider remediation, it is necessary to first define the characteristics of the entities involved. I stay aware of the vagueness of boundaries,

[164] Mieke Bal, "From Cultural Studies to Cultural Analysis: 'A Controlled Reflection on the Formation of Method'," in *Interrogating Cultural Studies: Theory, Politics and Practice*, ed. Paul Bowman (London & Sterling, VA: Pluto Press, 2003), 37.

although Elleström's model accounts for contextual factors as well, within the qualified type of medium.

The Mycelium Material as Medium

In his theory, Elleström proposes to start with the modalities, to be able to identify the materiality and mediality of media. My perception of the mycelium is informed by my visits to the UMF and the UU laboratory, and by the understanding of the (low) reciprocity between human and fungus in the production process as described in phase 1. This perception relates to objective aspects of the mycelium material, such as its colour. While these aspects can differ, depending on the fungus, the substrate, and the environment, the Loop Living Cocoon™ stays central.

The *material modality* is the latent corporeal interface of the medium.[165] In the case of mycelium, the actual materiality of the hyphae (cells) and the substrate on which it grows can be considered part of this modality. A mycelium network communicates within itself and potentially with associated plants, with the actual molecules of the messages falling within the realm of the material modality. The biological mechanics of this system are not known yet. If this would be known, it would be very interesting to study the molecules that would be part of physical contact with a dead human body. For now, it is hard to engage with the actual workings of the material modality. Therefore, this study mainly focuses on the material modality on a macro level. What characterises the mycelium material is the three-dimensional surface that is solid. Its strength depends on the manner in which it is processed. The mycelium material is generally very strong when it is completely dry. Whenever it gets humid, the material gets less solid.

From a human perspective, the latent corporeal interface consists of the substrate used (that is often not recognisable anymore) and the physical body of the fungus. Especially the body of the fungus is relevant here. In the first place, it is hard to recognise that the white material consists of a living being (or one that used to live). This is because of the temporal aspect that fungi do not grow very fast (I will come back to this later). When one does recognise that it consists of fungi, it is near impossible to know which

[165] Elleström, "The Modalities of Media," 23.

species and its characteristics. Van den Brandhof explained that the only manner for humans to be sure about the species is through DNA-sequencing of the genome of the fungus.

The *sensorial modality* refers to the cognitive and physical processes involved in perceiving the immediate interface of the medium through our sense faculties. Elleström distinguishes three levels within the sensorial modality: *sense-data* that originate from the medium, but that can never be captured in isolation; *receptors*, the cells in our nervous system; and *sensation*, the experienced effect of the stimulation. In the current phase, this means for example the musty smell of growing mycelium, the visual shape and colour of the coffin, and the soft and light feeling when you touch the material. However, Elleström's depiction of this modality is notably from a human perspective. Colman describes that modal conceptualisation is twofold: of speculation and of rationalism.[166] The latter is relevant to the manner in which Elleström describes the sensorial modality: humans can rationally reflect on what they sense. The notion of speculation is an interesting addition: how could this modality be described from a multispecies perspective?

Sense-data include the aspects of the mycelium material that can be sensed. It refers to 'traditional' human senses: vision, smell, touch, taste, and hearing. The material reflects light that is on the spectrum as humans sense it as white-grey and a little brown from the substrate. The mycelium emits molecules that human olfactory receptors translate to something that our sensation has learnt us to understand as mushy. The material has a certain weight, because it is attracted by gravity. I consider it light. The sturdiness of the material is created by the different kinds of connections that hold molecules together. The spatial aspect of the Loop Living Cocoon™ is rather specific as a 2-metre long rectangular box, with a lid.[167] Then there are the less traditional senses, such as kinaesthetic, haptic, and proprioceptive, which have to do with (self-)movement. In this case, these are not as relevant as the 'traditional' senses. These aspects can all be sensed by humans and their sensation is considered from a human perspective. However, for another being the weight might be heavy, the material might not be sturdy and the smell

[166] Colman, "Modality," 984.
[167] The new design of the Loop Living Cocoon™ has rounded corners and is therefore not rectangular.

might be much more attractive than the rather negative value of 'mushy'. Then there are aspects that humans cannot sense. The material is inedible to humans, but might be a tasty treat to other beings. The sense-data provokes a certain sensation. This sensation and its influences create a performative effect that leads to a certain understanding of the materiality.

Because the sense-data cannot be perceived as sensation without form, "the *spatiotemporal modality* of media covers the structuring of the sensorial perception of sense-data."[168] There is a link with the material modality and the sensorial modality, as the spatiotemporal modality exists on the level of perception, but also as physical phenomena. The spatiotemporal modality consists of four dimensions: width, height, depth, and time. This modality is already at a macro level very unstable when thinking of the Loop Living Cocoon™. When the material grows, the width, height, and depth change over time. The mycelium material can be shaped in many ways, but in terms of biodesign and the final product of the Loop Living Cocoon™ the shape of each coffin is the same. On a microlevel it is different for each coffin, of course. But humans cannot sense that. Time seems to go rather slowly. It takes about seven days to grow the Loop Living Cocoon™ – the growing of the mycelium is hard to sense. A human does not miss part of the growth when they close their eyes for a few seconds, although the material does change over time. The understanding of time is for humans culturally specific. Some might say that seven days to grow a coffin is quick. For the fungus itself, it is just a part of its own growth. When the material is dehydrated, the three dimensional shape is maintained, but the temporal dimension does not play a role anymore. At least to humans, the shape stays the same. The spatial change is reignited in the phase after burial, when the material comes to life again.

Meaning primarily belongs to the *semiotic modality*. This is the modality that is furthest from the New Materialist lens that this thesis follows. Elleström states that: "all meaning is the result of an interpreting mind attributing significance to states of affairs, actions, occurrences and artefacts."[169] I argue that meaning is produced in the intra-actions that lead to a certain situation and that corpora are not as distinct as Elleström

[168] Elleström, "The Modalities of Media," 18, my italics.
[169] Elleström, "The Modalities of Media," 21.

considers them. The semiotic modality is still relevant in the sense that meaning is produced in some way. When an object like the Loop Living Cocoon™ is considered performative, it has to be considered in relation to other cultural-discursive practices. The actual influence that is produced only becomes clear in phase 4, when the coffin is buried, together with the human corpse.

The mycelium material as a network can be considered a medium. This means that it is a body, constituted of the hyphae of fungi that form the mycelium. The modalities shape an understanding of the mycelium material from a multispecies perspective. To be able to understand its actual working within the Loop Living Cocoon™, remediation is used as the main concept in phase 4.

The Dead Human Body as Medium

As stated in the theoretical framework, the human body as medium is often explicitly positioned within discourses around digital and technological media. For example, Donna Haraway's cyborg.[170] In this thesis the living human body and the dead human body are considered as closer in mediality than is often assumed. The body is considered an intra-action, similar to the bodies of all organisms. This understanding is based on the concept of 'trans-corporeality' by Alaimo: all creatures are enmeshed in intra-active networks and systems.[171]

The human body as a medium consists of tissue (cells). This tissue is non/human[172] and is interpreted as a trans-corporeal expression. While it might seem to go beyond the rational, also the speculative aspect is part of the constellation. The tissue impacts the rational and the other way around. When the human is dead, the rational and subjective aspects of that human body are not accessible anymore to the environment. While it is considered one marker of liveness, the discussion about the cells not being fed or rotting is not relevant in the context of the living body versus the dead human body, as the cells are still part of the constellation. This means that the speculative has an important part.

[170] Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century," in *Manifestly Haraway*, eds. Donna Haraway and Cary Wolfe (Minneapolis: University of Minnesota Press, 2016), 5.
[171] Alaimo, *Exposed*, 131.
[172] Meaning: the human as consisting of human and nonhuman tissue.

In addition, the human body does not only consist of cells with human DNA, but also of fungi, bacteria and viruses that are part of the constellation. When the human is considered dead, these organisms might live on and contribute to the decaying body. Furthermore, the human body participates in its own decay. This shows the enmeshment between the living and the non-living, and the entwinement of life and death and the organic and inorganic, described by Radomska as the 'non/living'.[173] Accordingly, the dead human body is considered the same constellation as the living human body, with different medial expressions. These different medial expressions lie in the ontology of death. The lack subjective availability is often considered a main affirmation of life.[174] Another mainstream view of death is "the irreversible cessation of functioning of the entire brain, including the brainstem."[175] The non/living provides a perspective that avoids the necessity to dive into the wide range of understandings of death, as multiple understandings of death can fall under the non/living.

When the dead human body is seen as a complicated non/living trans-corporeality, this influences the understanding of the dead human body as a medium. Considering the framework offered by Elleström, the material modality of the dead human body consists of the cells that are part of the constellation and the molecules that are part of the communication between them. The cells are human cells, but also those of bacteria, viruses, and fungi that are part of the system. Similar to the mycelium material, the actual shape of the system differs on a microlevel. In the case of the human body, it also differs on the macrolevel. It can still be recognised by humans as a dead human body.[176] In addition, the body can be decorated or positioned in a certain manner. These aspects are part of the realm of the living human. It does communicate something, but what it communicates is different in every case. The specific decoration and identity of the body is in this thesis considered of marginal importance, as it is different for every

[173] Marietta Radomska, *Uncontainable Life*, 35–38.
[174] Lykke, *Vibrant Death*, 8–9.
[175] David DeGrazia, "The Definition of Death," in *The Stanford encyclopedia of philosophy* (Spring 2017 Edition), ed. Edward N. Zalta, accessed August 14, 2023, https://plato.stanford.edu/archives/spr2017/entries/death-definition/.
[176] In some cases a dead human body might not be recognisable, but considering a general Western funeral, it can be considered that the dead human body is recognisable.

body and every funeral. The material modality therefore mainly consists of the cells that are part of the trans-corporeal constellation the dead human body.

The sensorial modality of the dead human body is more complex, as this modality is for humans rather influenced by emotions. In general, a dead human body is not pleasant to sense for humans. In the first place, because of the sadness connected to the loss and the – of course – negative connotations with death. Besides these emotional aspects, the distinctive features of the body are the coldness and stiffness of the body, the unpleasant smell, and – if the body has a light skin colour – the paleness of the skin and the blue or grey lips. For other organisms, sensing a dead human body might not have such negative connotations. A dead human body serves as nutrition to some organisms, for example.

The spatiotemporal modality is also not easy to consider. In relation to this specific phase, the people who engage with the corpse as relatives often experience a distorted sense of time. This is mainly because of the situation of the loss of a loved one. When thinking in a more objective manner, the spatiotemporal modality can be seen as similar to that of the mycelium material. The body is still. It does not visibly move. It does not grow or shrink. It does change, but very slowly. The concrete sensible spatial aspect stays the same during the time that passes between death and burial. The spatiotemporal modality is – again – very different to other organisms. A lot changes within the body, already a short time after the heart stops beating.

The meaning that the medium conveys is for sure connected to the semiotics of the dead human body. However, also here the intra-actions play an important role. The physicality of the body is connected to its identity. Therefore, the meaning differs per dead body and per sensing body. The meaning also depends on one's cultural connection to death. In Western culture, a dead body is considered lifeless. But, as Radomska argues, one can also consider the dead human body as an example of the non/living. Within this thesis, the meaning is considered in relation to the mycelium (material). Therefore, I return to that in phase 4.

As became clear in this section, the dead human body is a complicated medium to define in terms of the four modalities. A human perspective on the dead human body is often emotionally charged. It is heavily dependent on personal connections to the

identity of the person and to cultural background. Furthermore, this thesis focuses on Western cultural connections to death and the dead human body. This is a perspective that considers the dead human body as only dead. It is an anthropocentric and individualist perspective on the human being of the body. At the same time, this analysis shows that a deep understanding of the mediality of the dead human body can only be about the intra-active, non/living, and the performativity of the body. Therefore, a multispecies perspective might even be more productive within the context of this thesis. This does not mean that the emotional aspects of the death of a human do not influence the phase, but that the dead human body is mainly considered in its materiality. In relation to the mycelium material, this leads to a New Materialist view on the body as an intra-acting medium that is a constellation within the constellation of its environment.

Conclusion

When the deceased body rests in the Loop Living Cocoon™ before burial, it is still possible to contemplate the distinct nature of the mediality of the coffin and of the body. In phase 2, these separate medialities have been considered, so the interactions of the media can be studied in phase 4. The analysis made clear that there are significant limits to an exclusively human perspective. The mycelium material should be considered a networked medium that cannot just be approached in a semiotic and phenomenological manner. Through the non/living, it became clear the dead human body can be considered a networked medium as well. This means that the exclusively human perspective also does not offer productive means in this situation. The mycelium material and the dead human body have to be considered within their trans-corporeal matterings.

Within the context that starts at phase 2, it is necessary to consider the capacity of media to convey information, meaning, or significance in relation to each other. In this case: the (dead) human body and the mycelium material. This relationship attends to the discursive and performative power, in addition to the power to ignite physical change. This understanding shapes the foundation for a deeper analysis on the fourth phase. During phase 2, I made an artificial differentiation between the material and the human body, but as will become clear in the fourth phase, the media influence each other in their

remediation. The ‘ecological occult’ in phase 4 complicates the dualisms of human/nonhuman and death/life even more.

Phase 3 (Transitional Phase): Burial

The third phase is the phase in which the human body, placed within the Loop Living Cocoon™, is buried in the soil. This is a transitional phase on several levels. The burial is an event that marks the final farewell to the human that is buried. This features the transition from a stage where the dead human body and the mycelium coffin can be sensed by humans to a stage where they are invisible and insensible in general to human. The transition also divides the known from the unknown and the 'rational' from the speculative.

As an emotionally charged ritual and as a volatile, but important moment of transition in knowledge (production), phase 3 is hard to grasp within the context of this thesis. This difficulty lies not only in the subject matter of this thesis, but also in its textual form. Therefore, I propose a non-textual manner of grasping this phase. The aim is to challenge traditional manners of factual, textual, and linear writing, by offering an example of an evocative representation.[177] The representative form chosen for that is a visual interpretation of phase 3. This is how I understand a wordless transition as a transformative creative encounter.

The third phase is one in which the mycelium material presents itself in a manner that affects more deeply than through plain text. The fungus can in this sense be considered an example of the 'subaltern', as described by feminist scholar Gayatri Chakravorty Spivak. The subaltern is a term for individuals who are marginalised and oppressed within certain cultures. This refers to the silencing of certain voices by larger power structures.[178] Fungi (and for that matter, nature in general) can be considered a subaltern. Fungi are not considered agential or powerful in Western culture. Within environmentalism, fungi are considered marginal and are not explicitly protected. Within biodesign, as we saw earlier, fungi are considered resources.

Human language is powerful. It is a constitutive force.[179] However, fungi do not have language. To raise them from the subaltern, we need to shift to a multispecies

[177] Laurel Richardson, "New Writing Practices in Qualitative Research," *Sociology of Sport Journal* 17 (2000): 5.
[178] Gayatri Chakravorty Spivak, "Can the subaltern speak?" in *Marxism and the interpretation of culture*, eds. Cary Nelson and Lawrence Grossberg (Chicago, IL: University of Illinois Press, 1988), 271–316.
[179] Richardson, New Writing Practices," 5.

framework of understanding. This premise led to the following visual interpretation of phase 3, in which I aim to highlight both the linearity and emotional tension of the human perspective and the multispecies, non-linear, trans-corporeal, and speculative perspective of the fungus:

Phase 4: After Burial

By now, the human body, encapsulated by the Loop Living Cocoon™, has been buried in the ground. Even though the decomposition process of the body already started before the burial, this is the phase where the body and the coffin decompose and become part of the soil. The Loop Living Cocoon™ and the dead human body become part of each other and of the environment. As this phase is not visible to the human eye, the conceptual and performative aspects of the relationship are studied, based on their mediality as determined in phase 2. The sub-question is: 'how is the binary opposition between life and death queered by the performativity of the relationship between the mycelium material and the dead human body?'

To answer this sub-question, the Loop Living Cocoon™ and the dead human body are studied as a trans-corporeal constellation. Continuing on the understanding that the dead human body and the mycelium material can be considered as media from a multispecies perspective, the theory on (inter)mediality is addressed and questioned. Consequently, the notion of remediation is introduced regarding the interactions of the media (and their environment). Two other concepts are important in this phase. The 'non/living' aids in the interpretation of the subversion of the binary of death and life. The 'ecological occult' offers an environmental perspective on the subterranean and how we can (re)imagine socio-political relationships through what is not visible.

The analysis leads to a twofold conclusion. Firstly, I argue that the ecological occult relation between the coffin and the dead human body can be seen as a non/living relationship at multiple levels. This is how it queers the dualism of death/life. Secondly, the interaction of the Loop Living Cocoon™ and the dead human body lead to a remediation of both 'parts', fading the boundaries of each. Even though these processes happen simultaneously and are non-linear, the linear form of this thesis forces me to consider them apart from each other.

Remediation

Continuing on the chapter on phase 2, it makes sense to dive deeper into Elleström's theory of intermediality. This is because, except for offering an understanding of media

based on modalities, he mainly offers a model for understanding intermedial relations. Elleström defines intermediality as the result of constructed media borders being trespassed. Borders can be considered absolute, as the physical borders of the coffin and of the human body. In this case, the borders are also connected to the other modalities, as defined in the chapter on phase 2. Elleström also distinguishes qualifying aspects of media. This has to do with semiotic understandings. Those qualifying aspects are, therefore, cultural and aesthetic conventions. As became clear in the previous chapter, this theory does not account for intra-active matterings that are at the core of trans-corporeality. Within the theory of Elleström the agencies of the media are not specified. In this chapter, the medial understandings as described in the chapter on phase 2 are kept in place. However, an alternative is needed for intermediality, to be able to fully grasp the workings of the relation between coffin and human body. Therefore, I propose the concept of remediation as one that considers trans-corporeality within and between the two media.

Remediation means that the representative value of a medium becomes changed through recontextualisation.[180] This happens when two (or more) media come together and the one medium is represented in the other. Their discursive and performative powers influence each other's power to ignite physical change. The recontextualisation that is present within the case study of the Loop Living Cocoon™ is multiple. In the first place, the mycelium is recontextualised as mycelium material. Following that, the mycelium material is recontextualised as a coffin. Most important here is the recontextualisation of the Loop Living Cocoon™ in relation to the dead human body. Even though the coffin can theoretically hold a dead human body that can be buried in it, only when it actually happens, its agency in that sense emerges. The same counts for the dead human body. It is a manifestation of 'the human body'. One that holds many facets of meaning. When buried in the Loop Living Cocoon™, the meanings of both media change under the influence of trans-corporeality. Accordingly, remediation is considered the core concept through which the relation between the Loop Living Cocoon™ and the dead human body is analysed in this phase. In the following section I elaborate on the

[180] Adami, "Retwitting, Reposting, Repinning," 224.

non/living and how remediation can lead to an understanding of the Loop Living Cocoon™ as queering the binary between death and life.

Queering the Binary Between Death and Life

I consider the relation between the mycelium material and the dead human body as a non/living relationship. Radomska describes the non/living as "the processual enmeshment of the organic and inorganic, living and non-living, and growth and decay."[181] As described in the methodology of this thesis, the non/living means that life is considered as a continuous process of growth and decay. Often the value of the non/living in analyses leads to the affirmation of the ontology of life as the non/living in relation to a specific phenomenon, such as bioart.[182] Here, I assess whether and how the non/living is also relevant for a phenomenon that consists of a multiplied and complicated relation between the mycelium and the human body.

The 'non/living' analysis is complicated by the fact that this phase is not visible to humans. The non/living is mostly considered in relation to physico- and biochemical processes. These processes are, in this case, unknown. The concept of the 'ecological occult' offers a manner to consider this invisibility and insensibility as something that contributes to understanding how the fungi influence human perception from the occult. To recompose our view on life and death, nature and culture, and human and nonhuman, we need to consider the decomposition of the human body, together with the mycelium material.

As suggested earlier in this thesis, the dead human body in itself is already a very clear instance of the non/living. When alive, the human body consists of both dead matter and living matter, and of both human cells and the cells of microorganisms. These organisms help dealing with the dead cells that are part of the human body. As soon as the human body dies, it does not mean that all processes suddenly stop. Cells live on, microorganisms keep on processing, the body participates in its own decomposition and thereby offers nutrition to other organisms. These processes are simultaneous and

[181] Marietta Radomska, "Non/living Matter, Bioscientific Imaginaries and Feminist Technoecologies of Bioart," *Australian Feminist Studies* 32, no. 94 (2017): 377.
[182] Radomska, "Non/living Matter," 377.

interrelated, but in this case, they are also influence by the mycelium material of the coffin.

When the corpse gets buried in the Loop Living Cocoon™, these processes have already been ongoing. After the burial has finished, the process of decomposition is intensified. The humidity of the soil 'wakes' the fungi that shape the mycelium material. The material gets soft and the fungi start to metabolise again. They spread their hyphae and find nutrients in the soil and in the dead human body. The human body continues participating in its own decomposition. Slowly, the matter gets intertwined with each other and with the environment.

The departure point of the Loop Living Cocoon™ is a strong dichotomy between the *living* mycelium coffin and the *dead* human body. However, life and death are always intertwined. In the living, in the dying, but most of all in their combination. Thereby, the combination of the Loop Living Cocoon™ and the dead human body resists the idea that death and life are separate. This is how phase 4 exposes life as the non/living. But how does this understanding contribute to a remediation of their affordances and agencies? In the next section, I discuss the agencies of the media and how multiple anthropocentric dualisms are queered in phase 4.

Queering Anthropocentric Binaries

Phase 2 demonstrated that the mycelium material coffin and the dead human body can individually be considered as media with each their specific affordances and agencies. The previous section revealed that the processes of phase 4 can be considered as examples of the non/living. Based on these notions, I propose the concept of 'remediation' as a tool that displays the performative queering of anthropocentric dualisms. Understanding this leads to an ethical reflection on the ontology of life.

Remediation in the Media Studies sense is defined as one medium being represented in another medium.[183] However, in a New Materialist sense, I consider recontextualisation instead of representation, as representation is rooted in semiotics. As we saw earlier, the semiotic tradition is useful to some extent, but it does not account

[183] Bolter and Grusin, "Remediation," 339.

for the agency of matter. When phase 4 is considered as a recontextualisation of the Loop Living Cocoon™ and the dead human body – from the context of phases 1, 2, and 3 – this notion accounts for the trans-corporeal entwinement of matter that is present in this phase. Here, remediation reveals a change in affordances, but within the mutual relationship. The fungi do not 'consume' the human and the human is not 'decomposed'.

Phase 3 destabilises the consensus of how fungi and a human corpse are to be understood. This happens because a common corporeality emerges that creates a common agency, while the awareness of the previous agencies still works through. This process is reinforced by the ecological occult. Mershon notes that a mouldering home is often considered to be "invading, colonizing, and establishing its dominion over the home and thus emulating the appropriative logic of settler colonialism."[184] However, as she argues, the mouldering home deconstructs the notion of home and, in turn, ecology, from conventional social and political ideas of belonging.[185] When we consider the body as a home, this means that the mouldering home can be seen as an analogy for the relation between the coffin and the corpse. While Mershon notes the refuge one wants to take from such a home, the human corpse as a mouldering home in the current phase is considered as a positive, sustainable process. This might be because it is not a home to the subjectively available person anymore, but to multispecies intra-actions. And because of the ecological occult, as a cryptological relation that reconfigures socio-political relationships between self and world. The deconstruction of the notion of home is therefore not different, as one does not consider it a home anymore. This means that the relation between the fungi that shape the coffin and the dead human body as 'mouldering home' creates space for reimagination of social and political ideas of what this relation means instead.

The deconstruction of the perspective on the human body leads to a performative shift that destabilises the anthropocentric view on life. The two media should be considered as one multiple entity that does something different than those entities separately: this new entity is full of non/living and trans-corporeal agencies. This shows that the reciprocity between the human and the fungi has reached a peak point: they are

[184] Mershon, "Pulpy Fiction," 290.
[185] Mershon, "Pulpy Fiction," 290.

part of each other. The notion that the human body is dead, could lead to the argument that there is a distinction between the relation when the human is alive and when it is dead, getting buried, less human. However, posthumanist thought offers a perspective on the human body as inherently non/living. As death and life can be seen as a continuum, that also counts in this situation. The interactions in phase 1 are more on the 'life' side and the interactions in phase 4 are more on the 'death' side of the human body – besides, of course, the lack of trans-corporeality in phase 1.

Conclusion

This chapter made clear that in phase 4, the mycelium material of the Loop Living Cocoon™ and the dead human body cannot be considered separately anymore – they are to be considered as a multispecies constellation. Together, they expose life as the non/living. As an example of the ecological occult, the relationship deconstructs socio-political understandings of each medium. This creates space for a reimagination of social and political ideas of what the result of the remediation means instead. The remediation leads to a new understanding of the world and the of the human itself. The realisation of the close ecological relationship to nature after burial, leads to a closer relationship to the environment, not only after death, but also while alive. The soil is considered as alive and nature is something that humans are part of and that is part of us. Graveyards may disrupt this notion, as they fence an area, an almost alternate reality, where human remains *may* be buried. However, the Loop Living Cocoon™ is often used at natural burial sites. These are legally graveyards, but practically forests in which human remains are buried. There are no gravestones or any kind of marking about the site where a human is buried. Within the Western legal system, this is the close to 'nature' a burial can get. Through the relationship between the Loop Living Cocoon™ and the dead human body in phase 4, conventional approaches to life, death, nonhuman, human, and nature are queered. This gives space for ethical reflection on what can be considered as those concepts and could lead to a reimagination of how we approach life.

Conclusion

At the beginning of this thesis, I posed the research question: 'how does the relationship between humans and fungi in the mycelium of the Loop Living Cocoon™ remediate our Western anthropocentric conception of death, multispecies, and environmentalism?' I have addressed this question by following four phases in the 'life' of the Loop Living Cocoon™. This led to a study of the materiality, mediality, and agency of the mycelium material, in trans-corporeal relationality with the materiality, mediality, and agency of the dead human body. The result is a non/living understanding of the remediated relationship between those media, in which the reciprocity between human and fungus increases with each phase. A space is created in which dominant Western dualisms are queered, such as life/death, nature/culture and human/nonhuman, which establishes the opportunity to rethink their socio-political implications. This effect is reinforced by the ecological occult positionality of the *buried* coffin and body in phase 4.

The first phase revealed an inequal power relation between the growing fungi and the humans that create the conditions for the fungi to grow in a desired manner. This is typical to the dominant Western cultural framework towards fungi. Fungi are remote, hard to comprehend, and when they are known better: handled as a resource. However, the fungi also challenge the Western assumption by 'claiming' their agency. They grow, metabolise, and sometimes do not do what the human wants or expects them to do. This leads to a situation in which humans have to create the most ideal growing conditions for the fungi and care for them. This process is even described in patents. From these patents, also the reciprocity, although limited, becomes apparent. The writers clearly have an anthropocentric objective in mind with their processes, but struggle to deal with the agency of the fungi. Therefore, while the reciprocity in phase 1 is limited, it already exemplifies the agency of the mycelium material.

From phase 2, there is a stronger focus on the *dead* human body. The human at the 'life' side of the spectrum is generally considered more powerful as the human on the 'death' side. However, the relationship between the living mycelium material and the dead human body queers the dualisms of life/death and human/nonhuman, and thereby blurs the strong distinction between phases 1 and 2. After the burial, this effect only

intensifies. As a performative effect, queering the human/nonhuman dualism in phase 2 also influences the perception of nonhumans, specifically fungi, in phase 1.

Additionally, I reflected on semiotic and phenomenological theories and concepts as proposed by Bolter and Grusin and by Elleström, from a New Materialist perspective. Even though their intended application seemed limited within this frame, I showed that semiotic and phenomenological theories and concepts can be made productive for New Materialist methodologies and discourses.

Within the ecological occult of the fourth phase as a cryptological and subterranean place, the media effectively become a trans-corporeal constellation, thereby remediating their meaning. This leads to a further reimagination and queering of the dualisms of death/life, nature/culture, and human/nonhuman. A multispecies perspective performatively reinforces itself in that manner.

The modalities that influence the perception of the relationship between the mycelium material and the dead human body, offer a space for ethical reflection on socio-political understandings of human's relations with fungi. This leads to a rethinking of the ontology of death, but also of life. It might lead to more environmental awareness.

Limitations and Suggestions for Future Research

This thesis has been limited to an enquiry into the relationship between human (corpse) and the mycelium materiality of the Loop Living Cocoon™. Therefore, it applies only to rather specific circumstances. Even though several phases in the life of the coffin have been considered, the scope is narrow. While more general conclusions about the connection between living mycelium and the dead human body are drawn from this study, like Tsing did in her study on the matsutake mushrooms,[186] applicability to other situations could be further substantiated in future studies.

The narrow scope also counts for some of the research directions in direct relation to the connections between fungi and the dead human body in relation to the Loop Living Cocoon™ that I have hinted at in this thesis. One of the directions could be in relation to race. Who is to be buried in the Loop Living Cocoon™? Does a neocolonialist frame imply

[186] Tsing, *The Mushroom,* 37–52.

that sustainable burials are only for white people? Also the whiteness of the coffin prompts questions on this. As Mershon describes, a fungus's blackness creates a racialised marking of being more distant to humanness.[187] According a racialised assemblage, the whiteness of the fungus could lead to insights into the perception of the coffin. Furthermore, the production process of phase 1 raises questions on the exploitation of fungi and whether the growing of mycelium material creates a neocolonialist framework. In terms of ecology, the phenomenon inserts a new assemblage into a certain environment. As the biological and environmental consequences of this are unknown, it raises questions on whether it is ethical to potentially disrupt an environment. These speculations lie beyond the scope of this thesis, but they invite for further research to consider.

[187] Mershon, "Pulpy Fiction," 272.

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