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BioDwelling

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BioDwelling – A Participatory Approach to Living with Living Material

Abstract:

BioDwelling is an arts-led research project that brings ethical concerns of culture, gender and multispecies relationality from the feminist technosciences into direct conversation with the emerging field of biotechnological architecture (bio-architecture). Working within a multi-disciplinary bio-architecture research group, we develop a practice-led methodology to facilitate the exploration of questions that arise when we begin to engineer more-than-human dwelling spaces. In this paper we give a brief overview of the work of the Hub for Biotechnology in the Built Environment (HBBE), and the Responsible Interactions research theme, which outlines the project context. We go on to describe the BioDwelling methodology and introduce three arts-led interventions that draw on feminist science and cultural theory to invite reflections on the ethical implications of working with living materials to build (or grow?) spaces in which humans intend to live. We conclude with a summary of the project to date, reflections on methods and possible next steps.

Keywords: Interdisciplinary, participatory art, methodology, bio-architecture, bio-design, biotechnology, more-than-human

BioDwelling – A Participatory Approach to Living with Living Material

The concept of a biodwelling brings to mind science fiction; the living buildings of China Mieville's **Embassytown** or the womb-like structures of Octavia Butler's **Dawn** (Mieville 2011; Butler 1987). Yet the idea of self-healing, breathing walls and living scaffolds are oozing into our present and are closer to home than we may think. The Hub for Biotechnology in the Built Environment (HBBE) is a multi-disciplinary bio-architecture group based in the North East of England that spans the fields of architecture, design, molecular biology and biochemistry to research and develop biotechnologies that can exist beyond the laboratory in the built environment, supported through real-world testing in an experimental home studio, The OME (OME, 2019). BioDwelling is an arts-led project that brings knowledge and experience from local communities and artists into relationship with the work of the HBBE to explore the questions that arise when we begin to engineer dwelling spaces with more than humans in mind. In this paper we give some examples of the work of the HBBE, and then introduce three arts-led interventions that draw on feminist science and philosophy to invite reflections on the ethical and moral implications of working with living materials, particularly when being developed for use in spaces where humans live.

Biotechnology in the Built Environment

HBBE is a UK Research and Innovation (UKRI) funded research group led by Newcastle and Northumbria Universities in the North East of England. The group focuses on how biotechnologies can be brought out of the lab and into the public environment through architectural practice, deliberately blurring the boundary between lab-based biotechnology, architecture and biological processes that have been in use for thousands of years. Responsible Interactions (RI) is a practice-driven research strand within HBBE which creates spaces for cross-sector reflection on the implementation of new and largely unexplored biotechnologies at the building scale. RI supports and explores interactions between researchers, stakeholders and

end-users of biotechnologies in order to capture and understand how novel research collaborations and practices are required to develop a responsible application of biotechnologies for the built environment. Exploring themes of human co-habitation with microbes, the research addresses the wider ecological context of our human relationship with microbial communities.

Within RI, interdisciplinary research teams have developed prototypes that explore the possibilities for living materials in the built environment. The prototypes include: kombucha-based exterior building cladding; dwelling-sized constructions made from mycelium and knitted wool; masonry that can heal itself through Microbially Induced Calcite Precipitation (MICP); bio-receptive concrete panels made from waste and organic materials; a conceptual home-system that explores circularity across domestic food production, waste and energy systems; and two materials libraries that a) allow observation of microbial community development over time and b) invite tactile interaction and response from public audiences (Morrow, Bridgens and Mackenzie 2023). These prototypes are housed in The OME; an experimental building that consists of a lab, an exhibition space and a living studio. The OME is intended as a space where HBBE researchers can come together to test and demonstrate emerging technologies outside of the lab at architectural scale. It provides a space where the HBBE can engage with external partners and the public to shape and co-produce knowledge about how biotechnologies operate and are understood in the world, in ways that can guide future research.

BioDwelling is an artist-led project operating within the framework of Responsible Interactions. The aim of the BioDwelling project is to engage and provoke public consciousness on the concept of the home as a more-than-human living environment. Through arts-led activities with public audiences, the project explores both existing and contemporary biotechnological relationships to living materials (that is, materials composed of non-human elements such as bacteria, algae and fungi), and in doing so, produces new knowledge on the ways in which we might co-exist with biotechnological non-humans in the home. A key debate in feminist science and technology studies (STS) regards the accessibility of novel technologies, and how they can facilitate more ethical modes of relational living (Haraway 1988; Harding 1991; Wajcman 2000). In inviting diverse and (usually) non-scientific communities into this debate, the project is negotiating the tricky but important work of bringing the public with us on biotechnology research to broaden conversations around the implementation and ethics of bio-architectures.

Hosting the Other - The Contextual Framework for BioDwelling

The typical ecology of the late modern urban apartment is considered to be the fastest growing biome, and represents a microcosm ‘of virtually every ecosystem on Earth—the driest, the most acidic, the hottest, the coldest and wettest’ yet our built environments often exclude the microbes with which we originally co-evolved, ‘those that reside in soil, plants, rivers and other animals’ (Wakefield-Rann 2021:3). Human bodies are composed of microbial and human cells, our bodily microbiomes are not discrete but porous, in constant metabolic interplay with their environments. As such this new domestic microbiome is mutually constituting our own bodily microbiomes in ways that are rapidly changing what it means to be human. The idea of sharing our homes with invisible others is complicated by our rapidly developing knowledge of microbial life over the last century: the ability of microorganisms to communicate socially (Bassler 2009) and to form relationships with other species (as evidenced through the crisis of antimicrobial resistance (O’Neill (Chair) 2015), the COVID-19 pandemic and even through our pets (Karolinska Institute 2012)). Today we understand our entanglement with microbial and molecular matter as

symbiotic, uncontainable and relational (Margulis 1998, Radomska 2016, Barad 2007). The BioDwelling project thus positions human-microbial entanglement as spatial and relational, where microorganisms are a complex and constant dynamic in our lives.

We set out the BioDwelling methodology and approach as an arts-led participatory model for engaging wider publics in biotechnological research. The projects that emerge from the research exemplify a relational approach towards biotechnological innovation that brings tacit and practical knowledge into close engagement with biotechnological knowledge in ways that share and therefore inform research. Rather than the materialisation of a resolved artwork or series of works that engages with the (multiple) scientific projects being undertaken within the HBBE, the focus of the BioDwelling Project (and hence this paper) is the development of a methodology designed to gauge public readiness to accept biotechnological concepts and to test the idea of establishing a BioDwelling network; a cross-sector research group, working with public audiences in local communities to build knowledge on the implementation of biotechnology in the built environment through participatory arts research. We describe some early findings as well as the challenges that are beginning to emerge from this approach.



Figure 1. BioDwelling Network Launch event, The NewBridge Project, Newcastle, UK

BioDwelling Methodology

BioDwelling brings together theoretical approaches of dwelling (Ingold 2005), hospitality (Derrida 2000) and *whānau* or extended family (Walker 2011) with the concept of sharing generative space (Aristarkhova 2012) to shape a participatory practice-led methodology that focuses on the relationships between a multi-disciplinary research group, lay publics and microorganisms. In questioning whether dwelling can be ‘the foundation for a genuinely political ecology’, Tim Ingold reminds us that ‘all creatures, human and non-human, are fellow passengers [that] through their activities continually create the conditions for each other's existence’ (Ingold 2005:503). It is this sociopolitical and mutually interactive quality of dwelling that drives the methodology of the BioDwelling project. As a research group with over 50 researchers, the HBBE dwells in three locations: the Department of Applied Science at Northumbria University, the School of Architecture at Newcastle University and a shared experimental home/lab space, The OME. BioDwelling makes use of this third location and

further off-campus venues to create dwelling spaces that can engender the conditions for collaborative and cross-sectoral research.

The New Zealand Maori language word *whānau* encapsulates a complex network of relationships (physical, emotional, spiritual) between family members. Acknowledging the complexity inherent in human relationships, human/microbial relations and biomolecular exchange, the BioDwelling project introduces the concept of the extended family or *whānau* to navigate the relationships that exist across the HBBE research community, a wider public community and non-human actors. Viewing this broader BioDwelling research community as an extended family allows the sociopolitical complexities inherent in the concept of unconditional hospitality to pervade the research. It encourages researchers to build relationships with lay publics and with their research subjects (organisms such as fungi and bacteria). In expanding unconditional hospitality to include the microbial, the research considers how (or if) we are prepared to give the microbial ‘all of one’s home and oneself’ (Derrida 2000:77). Thus, BioDwelling extends participatory arts models of co-production and collaboration to encourage active and ongoing engagement with research through familial notions of kinship and responsibility.



Figure 2. Participants observe bacterial cellulose cladding during a tour of the OME as part of BioDwelling Network Launch Event – Amplifying the Other in collaboration with the Great North Museum, Newcastle, UK. Image: Kaajal Modi

The concepts of dwelling, hospitality and extended family are woven through a participatory arts model that attempts to form relations across not only disciplines but also sectors and species. Primarily it considers the relationship between the various disciplines within the HBBE and encourages relationships with wider public audiences through participatory art projects. It combines an ethnographic approach to social dynamics characteristic of Artist Placement Group (Slater 2000) with an approach to interdisciplinarity where unexpected meetings or locations provide opportunities for generative knowledge production across distinct groups (Crisp et al. 2022). Without pre-planned outcomes, the work of BioDwelling unfolds through the conversations that arise between extended family members (the BioDwelling community) in dwelling spaces that include The OME, the gallery, the lab and the home. Drawing from ideas that arose during initial interviews with the HBBE research group, artist Louise Mackenzie enlisted the support of HBBE researchers to develop a series of public-facing arts-led events and workshops that bring bio-science and bio-architecture researchers into dialogue with lay publics and with microorganisms. During these workshops, conversations were recorded, exploring both the concepts at play in the research of the HBBE and public readiness to accept these concepts.

Microorganisms were a central component of the workshops, giving lay publics a visceral and tangible access to biotechnology research through the materials and mediums of biology, including bacterial cellulose, mycelium and bacteria that consume household waste. Further, through the gifting of microorganisms in forms such as bacterial cellulose, kombucha and beer, the workshops provided an opportunity for microbial life to become an active and considered member of participants' home dwelling spaces, probing the question of how one's home can be hospitable to more-than-humans.

BioDwelling is a pilot project in cross-sectoral participatory arts, with initial funding during 2021-22. To date, the BioDwelling community has over 70 members in the UK and over 300 followers on social media (BioDwelling 2023), galvanised through a series of introductory network launch events (Figures 1 and 2) and workshops. Early activities focused on gauging public interest in the topics of research under exploration within the HBBE, whilst providing researchers with an opportunity to see their research from the perspective of other disciplines and wider publics. Employing a participatory framework helps to bring to the fore the potential for research to have unintended consequences and to raise questions and ethical dilemmas in relation to established social norms and conventions. The most challenging aspect of developing this community has been nurturing the engagement of researchers, busy with their own projects. Nonetheless, three projects have emerged from (and been shaped by) these early interactions: **Listen with Mother?** which explores relationships of care regarding biological materials through the provocative metaphor of interspecies mothering; **Shit Happens!** which questions public readiness and acceptance of human waste as a circular source of energy; and **OME Brew** which uses myth, ritual and brewing practices to provoke discussion around the differences between institutional science and lay expertise. We go on to describe the most fully developed of the three projects, **Listen with Mother?** in detail below, whilst introducing the others as examples of how generative interdisciplinary projects can grow from BioDwelling's extended family methodology.

Listen with Mother?



Figure 3. *Listen with Mother?* 2022. Mackenzie and Modi. Installation at Newcastle Contemporary Arts, Newcastle, UK. Image: Louise Mackenzie

Listen with Mother? is an arts-led participatory installation for galleries and other public settings that operates in dialogue with bio-architectural research on bacterial cellulose (Figure 3). It centres around a glass vessel which contains a Symbiotic Colony of Bacteria and Yeast (SCOBY), brought from the HBBE's experimental home/studio, The OME. The installation includes shelving with bottles of SCOBY (to be offered as gifts), two swan-neck microphones and a 1950s Formica kitchen table, adapted to house a waterproof speaker. The evolving microbial life in the gallery is mirrored by evolving stories, recorded over the course of the exhibition and broadcast through the speaker directly beneath the SCOBY, entangling cultures of bacteria, yeast and human in the situated context of the exhibition. Conversations around the table (that float on breath through the muslin atop the glass vessel and into the body of the SCOBY), along with the recorded conversations that vibrate through the glass vessel, evocatively and speculatively contribute to the formation and evolution of the biological material present in the gallery space.

Listen with Mother? emerged from discussions between artist Louise Mackenzie, designer Kaajal Modi and Professor of Biological Architecture, Ruth Morrow. In the HBBE, architect-led projects have developed a bacterial cellulose cladding for the exterior of the OME using SCOBY. Yet other projects led by scientists and biodesigners explore how we might enhance the properties of cellulose producing bacteria through genetic modification in the lab. Lab-based single strain bacterial cellulose is sensitive to contamination by yeasts and other fungal particles. In comparison, SCOBY-based cellulose grows readily in varying environmental conditions and is more resistant to external contamination. This creates an interesting tension between laboratory practice and building-scale architectural practice, which **Listen with Mother?** probes in discussing how we might bring bacterial cellulose out of the lab and into wider public environments.

The participatory context for **Listen with Mother?** employs the concept of the matrix as generative space (Aristarkhova 2012:26-28). Irina Aristarkhova considers the origin of the term matrix as womb, reconstituting the term beyond the maternal in the context of what the matrix *does* (a generative space), rather than what the matrix *is* (a receptacle). This active and relational figuring of the matrix as a generative space is helpful in considering what new practices and hence knowledge might arise when one's home and one's body become generative spaces for microbial others. The matrix thus becomes both a conceptual and an aesthetic framing for the creation of generative dialogue when research communities, publics and microbes meet. The question mark in the project title ambiguously plays on meanings of the word *mother*. The term mother is used colloquially to describe a SCOBY. It also features in the title of the UK radio programme, *Listen with Mother*, which premiered on BBC radio in 1950 as a first-of-its-kind programme dedicated to mothers and young children. Whilst considered progressive at the time, the concept of a radio show dedicated to women as primary caregivers is symptomatic of a cultural paradigm which continues to exist more than 70s years on and hence seemed fitting as a contextual backdrop to explore the relationships that exist around the maintenance (care) of living material in the comparatively nascent field of biotechnology.

Listen with Mother? is designed as a participatory installation. Visitors to the gallery are invited to sit at the kitchen table, listen to a public broadcast and drink sweetened tea, emulating the concept of the original radio programme while creating a generative space for public

dialogue. The same sweet tea is fed to a liquid SCOBY (brought from a culture used in research projects at the HBBE) that sits in a glass vessel on the table. Referencing both the matrix as receptacle and the matrix as generative space the ambiguous shape of the vessel is suggestive of sites of reproduction (a scientific flask, a womb, a scrotum, a breast, a round belly, a phallus). The vessel containing the SCOBY remains in place for the duration of the exhibition. As the liquid culture in the vessel matures a cellulose mat grows at the surface which can be used as a biomaterial. At stages throughout the exhibition, liquid is poured from the central vessel into milk bottles, where new cellulose mats begin to form.

Gallery visitors are gifted milk bottles containing a SCOBY mother to care for and work with as a generative biomaterial on the proviso that they will return and join us in dialogue at the kitchen table. At scheduled events, visitors who took up this offer, along with bio-scientists, architects, artists and other makers, are invited to use the microphones at the table to share how they work with non-human organisms. By asking the provocative question, ‘how do you relate to your mother?’, we intentionally open up the question of care beyond the scientific domain of bacterial cellulose, and the domestic environment of the SCOBY, to include extended forms of familial bonds and consider what is meant by a mothering relationship more broadly, inviting diverse perspectives on more-than-human care, control, kinship, nurture and culture from the lab, the gallery and the home. Thus the work explores what happens when we juxtapose relationships of care between the macro and the micro, when we think of bio-materials as living organisms which require care and controlled conditions in order to survive (and thrive), rather than simply as resources to be extracted from our environments.

Listen with Mother? was first introduced to public audiences as part of the exhibition **How we Live Now** at Newcastle Contemporary Art in May 2022 and has since been exhibited at **Habit Ability!** at The NewBridge Project, Newcastle and **Tendrils, with no way of knowing**, at The OME, Newcastle. These overlapping exhibitions, held between May 2022 and March 2023, have allowed multiple SCOBYs, or mothers, to proliferate. Each **Listen with Mother?** conversation is recorded, edited and added to the ‘playlist’ for the speaker that sits underneath the vessel. Each of these SCOBYs is therefore imbued with the rich and varied dialogue gathered around the table at each location. The interviews are also available online as part of the wider BioDwelling project (BioDwelling 2022). It is the intention of the project to allow the vessel to move from context to context, gathering stories, which can be relayed in each new location, adding to the qualitative discussion around how we care and who we care for in the context of biotechnology in the built environment.

Listen with Mother? - Discussion

Exhibiting a SCOBY for an extended period required all of those involved with the project to contend with the pragmatics of feeding and caring for living organisms. For example, at The NewBridge Project, where **Listen with Mother?** was exhibited close to a kitchen at the height of a particularly hot summer, our mother attracted fruit flies, which had entered the vessel unnoticed (through one of the – usually covered – apertures, possibly during a workshop) and began to colonise on the cellulose mat. This multispecies interaction highlights the constant and fluid environmental context of biological material and raises questions around how we prioritise who and what we care for. Whilst the curator was sympathetic to the evolving state of the work, our initial desire to leave the fruit flies was ended by mutual decision after the flies continued to breed, raising concerns around health, safety and the public perception of seeing flies in the

vessel. Notably, this incident mirrored similar conversations taking place in the HBBE where again, at the height of summer, fruit flies were attracted to bacterial cellulose grown using the SCOBY method in the OME, stimulating often polarised discussion amongst researchers around whether this meant that the work had become contaminated. This suggests further consideration is required of the relationship between lab culture and kitchen culture and how we manage cultural biases when these two spaces begin to collide in the context of bio-architecture.

The work of **Listen with Mother?** takes its cue from Haraway's SF – Science Fiction, Science Fact, Speculative Fabulation, String Figures, So Far (Haraway 2011), as a way to tell stories about interspecies and intergenerational care in and beyond the lab. This is a technoscientific feminist arts-led approach, that works across multiple valences of the word mother to elicit diverse perspectives on what constitutes mothering. On the surface this may read as gendered, but the complexity that lies beneath complicates this notion in ways that contest this reading. SCOBY is often referred to as a mother, and bacterial cell division can be described using terms such as daughter cells, yet SCOBY is not a single organism, or even a single colony and bacteria divide asexually. Nuances of language may reveal nuances in care which can be reflected upon in the context of biotechnological research as it moves from lab to architectural scale. Topics generated around the kitchen table included: the use of mothering as verb and how this genders care relationships; contextualising this alongside other gendered terms used in biological forms of care, such as husbandry and midwifery; mothering as a biological but not reproductive act; care as a burden, duty or responsibility; care as an action that engenders wanted and unwanted control (in both giver and receiver of care); shifts in behaviour that value sustainably grown materials as a positive form of compostable fast fashion and shifts of scale that favour the local and the cyclical (for example, ethically sourced waste from fruit factories as nutrient medium for kombucha) as an act of planetary care. The topics often aligned with, but also extended out from an ethical framework for matters of care (Puig de la Bellacasa 2017) that require further analysis beyond this paper.

In a related project by Kaajal Modi, **Crafting Cultures**, architecture and fine art students working with crafting practices were gifted our mother along with instructions on how to grow their own bacterial cellulose. Initially the aim was to build up tacit know-how in ways that could be incorporated into prototype designs, but the project came into its own as a way for emerging bio-architects and artists to relate differently to their materials. Important points made by researchers, visitors to the gallery and people who engaged with the cellulose included concerns about the aesthetics, with some calling it skin-like or leathery (see Figure 4) and raising concerns about the vinegary smell. Others raised issues to do with production: how do we grow this material at scale in ways that don't become extractive, especially when the standard mode of production is heavily reliant on importing monoculture crops such as tea and sugar that are destructive to biodiversity.

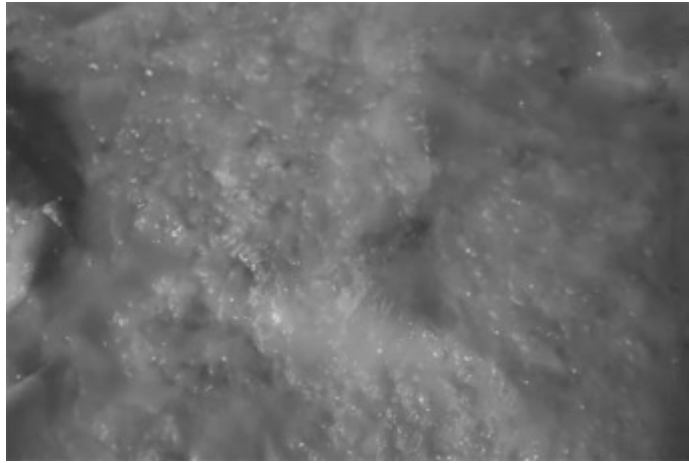


Figure 4. Bacterial cellulose grown for the Crafting Cultures project. Image: Tim Stein

Material acts such as feeding and creating conditions in which the mother can thrive, in the home and at scale, highlight the labour and ethics of biological care, and begin to draw attention to the challenges of bringing biotechnological material into architectural contexts. By bringing the concept of mothering (and reactions to this term) into dialogue with biotechnology, we have found new ways of describing our relationship with biological material and process. Mammalian amniotic fluid is a mixture of electrolytes and sugar and ‘scraps of vagrant DNA, fats, proteins, piss and shit’ (Lewis 2021:228). This fluid harbours a ‘potential of watery gestationality’ (Neimanis 2017:68-69), that we might use to extend our praxes of care beyond the human womb and into more-than-human generative spaces. Like the *whānau*, Lewis’ call for queer kinships speaks to complex networks of physical, emotional and spiritual family-making that can work beyond biological binaries. **Listen with Mother?** similarly seeks dialogue around how we reconsider hospitality beyond the family, and the human. We intentionally refer to the metabolic microbial process that comprises the act of fermentation as gestational, converting sugars and nutrients into new life in a liquid container, as a political provocation. In doing so, we suggest interspecies kinships can inform a generative mutuality in how we consider future biotechnological homes, in ways that respond to context and are responsive to uncertainty.

Shit Happens!

Shit Happens! is a project by artist Louise Mackenzie, that aligns with the work of HBBE researchers who are investigating circularity in the home through sustainable use of domestic waste (McLeod-Brown et al 2023). It is a collaborative arts project supported by the HBBE and two artist studio collectives, East Street Arts (Leeds) and The NewBridge Project (Newcastle) in the UK that explores our readiness to accept sustainable waste facilities in homes and buildings. The project comments on the growing socio-political divide between consumer culture and the circular (bio) economy, proposing that the root of the problem lies with that which we cannot see nor understand. Since we first understood germs as capable of transmitting disease, the microbial has been considered abject and we have increasingly distanced ourselves from the visceral – the handling of flesh and bodily substances. **Shit Happens!** hosts interviews and workshops to invite stories on our phobias and philiias in relation to human waste and to explore why, in the 21st century, when our understanding of the importance and significance of microbial materials is so

much greater, we are still so reluctant to embrace their relationship to our bodily functions. It further highlights that waste and waste management technologies are deliberately hidden from view and addresses this through developing a deeper cultural understanding of natural bodily functions.

Initially conceived as an exploration into how a sustainable toilet facility might be introduced to a public art hostel in Leeds, the project references the research of Rose George and Joseph Jenkins to consider the issues at stake in how we approach household sanitation in the 21st century (Jenkins 2005; George 2008). It draws from research within the HBBE that explores how aspects of household and human waste can be metabolised to generate sustainable sources of heating, light, fuel and fertiliser (McLeod-Brown et al 2023). Taking the idea of the toilet as a location for self-expression, Mackenzie conducted interviews across a wide range of individuals: from waste management workers and toilet cleaners to artists and academics who are researching circular forms of waste management, as well as the BioDwelling community and the community base around The NewBridge Project and East Street Arts. These interviews are the source material for the development of an audio work that can be played in public toilet facilities, supported by a printed publication, in the form of flushable toilet paper, developed in collaboration with researchers and members of the BioDwelling community.

The interviews, combined with toilet paper zine making workshops (Figure 5), provide the context for generating knowledge through participatory methods, prompted by questions such as:

‘How do you think we should dispose of household and human waste? Do you have, or have you used, a composting toilet? What are the barriers to generating sustainable toilet solutions in the home? Why is talking about toilets (and what goes into them) so difficult? Where does all the crap go?’



Figure 5. Details from *Shit Happens!* Toilet Making Zine workshop. Image credit: George Stewart

Although at an early stage, themes emerging include the challenges of developing composting toilets and other sustainable waste solutions in urban areas; how dealing with human waste is bound up in matters of care, duty and responsibility; the biopolitics of sustainable waste (for example how we deal with the excretion of medication) and inclusivity, safety and accessibility of sustainable toilet facilities; the perceived limits of human waste as re-usable material; and cultural differences in approaches to domestic waste. By collating and exhibiting these thematic outputs in the form of audio to be played in a public toilet and on an accompanying flushable

zine, the work brings together the collective voices of a diverse community (the BioDwelling extended family) in the generation of works that comment on practices of sustainability.

OME Brew



Figure 6. Documentation from OME Brew Workshops. 2022. The NewBridge Project and Northumbria University. Image Credits: Greg Young, Louise Mackenzie

Intended as a lighthearted way to introduce audiences to the work of the HBBE and the BioDwelling project, **OME Brew** originated from a question that arose in conversation between artist Louise Mackenzie and HBBE biotechnology researcher John Allan on the potential for converting household waste to energy through microbial processes (Allan 2022). What if we could brew beer made from bacteria that can metabolise wastepaper into sugars? Introducing the concept of the Tiny Urban Bioreactor, Allen's research challenges the logic of substitution (Rudge and Ehrenstein 2023) inherent in large-scale microbial green energy production by asking what forms of biotechnology might be possible in the community or within the home. **OME Brew** thus became a way to explore with public audiences the human appropriation of biological processes through participation in beer making rituals.

Conceived as a launch event for the BioDwelling network, the concepts explored through **OME Brew** with researchers and members of the public focused on the uses and protocols of biotechnology, through comparison to historic accounts of ale wives and ritual practices of *saining*. Within the HBBE, researchers are isolating strains of bacteria that might have useful properties to be synthesised or cultivated for human use. One such example is a strain of bacteria that can convert wastepaper to cellulose, which in turn is considered a useful biomass from which to create sources of energy. The search for renewable sources of energy is a key goal of biotechnological research. The challenge is identifying ways in which to generate energy from novel sources that do not incur consequential environmental damage, for example through intensive forms of labour production (Allan 2022).

Saining is a Scots term indicating a ritual form of blessing or protective charm. In Scottish folklore, to forspeak is to extravagantly commend a good property (e.g. 'what a clever bairn'), which is considered unlucky. To cure the forespoken individual, they are washed in water to great ceremony. Mackenzie, born in Scotland, chose to weave the concept of this *saining* ritual together with brewing (and ultimately with the multispecies community of audience, researchers and organisms), through the playful aim of ridding biotechnology of hype and over-promise. Working with scientist John Allan from the Department of Engineering Science at Oxford

University and Greg Young from Newcastle and Northumbria University's Hub for Biotechnology in the Built Environment, we rewrote the process for brewing beer with the bacteria from Allen's research as an easy to follow 'spell' (Figure 7) and Mackenzie prepared a *saining* incantation to 'cure' the bacteria used of any biotechnological forespeaking (see Figure 9).



Figure 7. Bacterial Beer Brewing Process, Reconceived for OME Brew Workshop.

We developed two ritual-based performative workshops (Figure 6) that playfully divine biotechnology fact from fiction. In the first workshop, audiences were invited to read biotechnology headlines, which they could choose to shred or keep, depending upon whether they felt that they agreed with the premise in the headline. Then, following a process that uses both scientific protocol and beer brewing - described for a public audience in terms of the species that participate in the process (see Figure 7) - the shredded headlines were fed to bacteria which Allan had isolated from wastepaper and cultivated in the laboratory. Once the bacteria had processed the paper into sugars, this mix was added to water, yeast and hops and brewed into beer. The process was enacted with the support of HBBE colleague, evolutionary microbiologist and DIY brewer, Greg Young. At a second public event, participants helped to bottle the beer and collaged custom-labels from a combination of biotechnology headlines and images, excerpts of text from feminist theorists including Lynn Margulis, Jane Bennett and Jane Ellen Harrison, and excerpts of text and images on the practice of *saining* and on the history of the ale wives (Fig 8).

As an example of the collective sharing of knowledge across researchers and audiences, the ale wives' story was introduced to the **OME Brew** team by a local brewer and member of the

BioDwelling extended family at an earlier BioDwelling event. Ale wives were traditional brewers of beer. It was a role historically associated with women in the home, who became skilled technicians in the production of beer. One of the earliest known records of beer brewing practices is that of Benedictine abbess and polymath, Hildegard of Bingen (1098-1179), who wrote extensive texts on the natural world, the creative arts and theology, leading to her description as the founder of scientific natural history in Germany and to her ultimate canonisation in 2012 (Jöckle 1995; The Editors of Encyclopaedia Britannica n.d.). In the late mediaeval period, women's autonomy as brewers was withdrawn through a professionalisation of the trade, with fines issued to brewers who were not part of guilds. Often women had no financial recourse to pay the fines and, in any case, were not admitted to guilds. Public depictions at this time frequently characterised ale wives as untrustworthy or unsafe (Vaughan 2011). This standardisation of cultural methods and practices altered the course of history. The ale wives' story is therefore a useful tool with which to critically question biotechnological procedure and practice through challenging the broader concepts at play in biotechnology (progress towards sustainability).



Figure 8. Beer bottles with collaged labels designed by participants of the OME Brew Workshop.

Protocols in science can be considered similar to recipes (a definition most scientists would be more comfortable with than spells) - they set out the steps by which a process ought to be undertaken to receive an expected set of results. Often, scientific protocols become habitualised as part of a larger project of work and as such, challenging an established protocol would waste time. Using artistic practice as a tool to reflect upon and re-imagine a protocol affords reflection on each step in the process: what is the intention of the action to be taken, what materials are required to enable this action, what will result from the action and, perhaps most significantly, whose intention does the action serve. This final question brings in the situated perspective of the living organisms that protocols are developed around, as well as the users of protocols and the audiences that they ultimately reach. Through raising these questions as part of a participatory dialogue therefore, researchers and lay audiences were able to discuss together how (or if) biotechnology impacts wider society and how (or if) it can help to sustain planetary resources. During the workshops, conversations included discussion of whether crops generated for biofuel would be better diverted to crops for food; whether methods used to engineer bacteria to generate energy for domestic use are preferable to methods that rely on naturally occurring bacteria; and the sustainability of laboratory practices that are reliant on single-use plastic for sterility. The

workshop format provided a space for a generative sharing of knowledge between researchers and wider audiences that permitted the holding of diverse opinions on these topics.

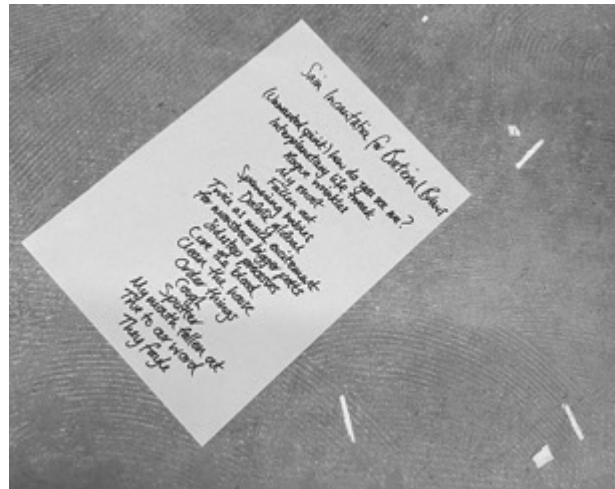


Figure 9. *Saining* Incantation for Bacterial Brews. 2022. Louise Mackenzie

Conclusions

BioDwelling aimed to establish a methodology that crossed disciplines, sectors and species boundaries. In doing so, it recognises, as Tim Ingold suggests in his use of the word dwelling, that ‘home is not necessarily a comfortable or pleasant place to be, nor are we alone there’ (Ingold, 2005:503). Across such a wide group, the voluntary nature of participation means that engagement is limited to those who have the time and resources to join what might be termed extra-curricular activities. This may be addressed through providing incentives to participate in interdisciplinary research (for both researchers and wider communities) although incentivisation aligns with the wider question of how to present unbiased research. The experimental and intuitive nature of BioDwelling’s extended family methodology helped to establish project teams that were invested in the work of the projects through mutual interest. It provided opportunities for researchers and members of the public to choose how they shape research outcomes and perhaps most significantly, it provided space for diverse opinions to dwell together. What became clear through the BioDwelling project was that, whilst a core of – often more junior – researchers were willing to embrace interdisciplinary methods, individual researchers are generally still trained in one discipline and incentivised from within that discipline, which limits their capacity to engage fully in interdisciplinary research. Just as gestation requires care and attention, interdisciplinarity takes time to establish and thus requires substantial investment. The BioDwelling project has made some significant but small first steps.

Embedding arts-led activities into emerging technoscientific research encourages ongoing reflection on the potential environmental, ethical and societal implications of work as it is being developed. Through ‘embrace[ing] the experimental and unexpected nature of collaborations with artists and designers’ (Calvert and Schyfter 2017:195), less obvious outcomes and themes

emerge from creative opportunities for collaboration. Further, inviting both academic researchers and external communities to engage in the project in a participatory manner enables skills and confidence and - through sharing a stake in the process and outcome - increases levels of engagement overall, building validation, a sense of achievement and a commitment to sharing project outcomes (Dix and Gregory 2010:20). To further the legacy of the work, the BioDwelling project has developed a repository of audio recordings from which sound-based artworks and an online interview series can be created. The opinions collated vary widely and thus the project provides a generative space in which such diverse perspectives can be considered and reflected upon. These form the basis of qualitative outputs for the ongoing research of HBBE and act as inspiration for the development of new projects. The emergent project themes generated through the BioDwelling methodology are examples of co-creation between artists, researchers and publics, where the concepts and the process to generate work could not be determined without the input of all three groups. All projects are led by public-facing participatory activities that co-produce critical knowledge around how we interact with biotechnology and biotechnological organisms as part of a longer-term approach to knowledge sharing amongst a broad cross-sectoral group.

The projects described in this paper were exhibited, along with works by artists who had engaged with the BioDwelling community, at the exhibition **Tendrils, with no way of knowing** at The OME in March 2023, offering an opportunity for further dialogue between researchers and public audiences. A second phase would invite both researchers and members of the public to delve deeper into the material practices and questions raised in these early stages through new sharing and making sessions, leading to arts-led outputs that can be collaboratively developed. What is key to the *whānau* extended family approach is that it is process, not outcome, oriented. This allows time and space for engagement with materials and concepts, from both the public and researchers, providing a means for knowledge shared to be absorbed over time, and to resonate back into their daily home and working lives. In the BioDwelling community, as with any large family group, unconditional hospitality does not come easily. There are relationships that blossom naturally and others that need work, amongst both human and microbial family members. BioDwelling's process-led approach and relies on a sense of familial duty, which inevitably breeds its own discomforts, obligations and boundary-crossing behaviours, as revealed through our audio recordings. These practices of care, control and negotiation are the heart of what BioDwelling seeks to discover about multispecies relations in diverse contexts.

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