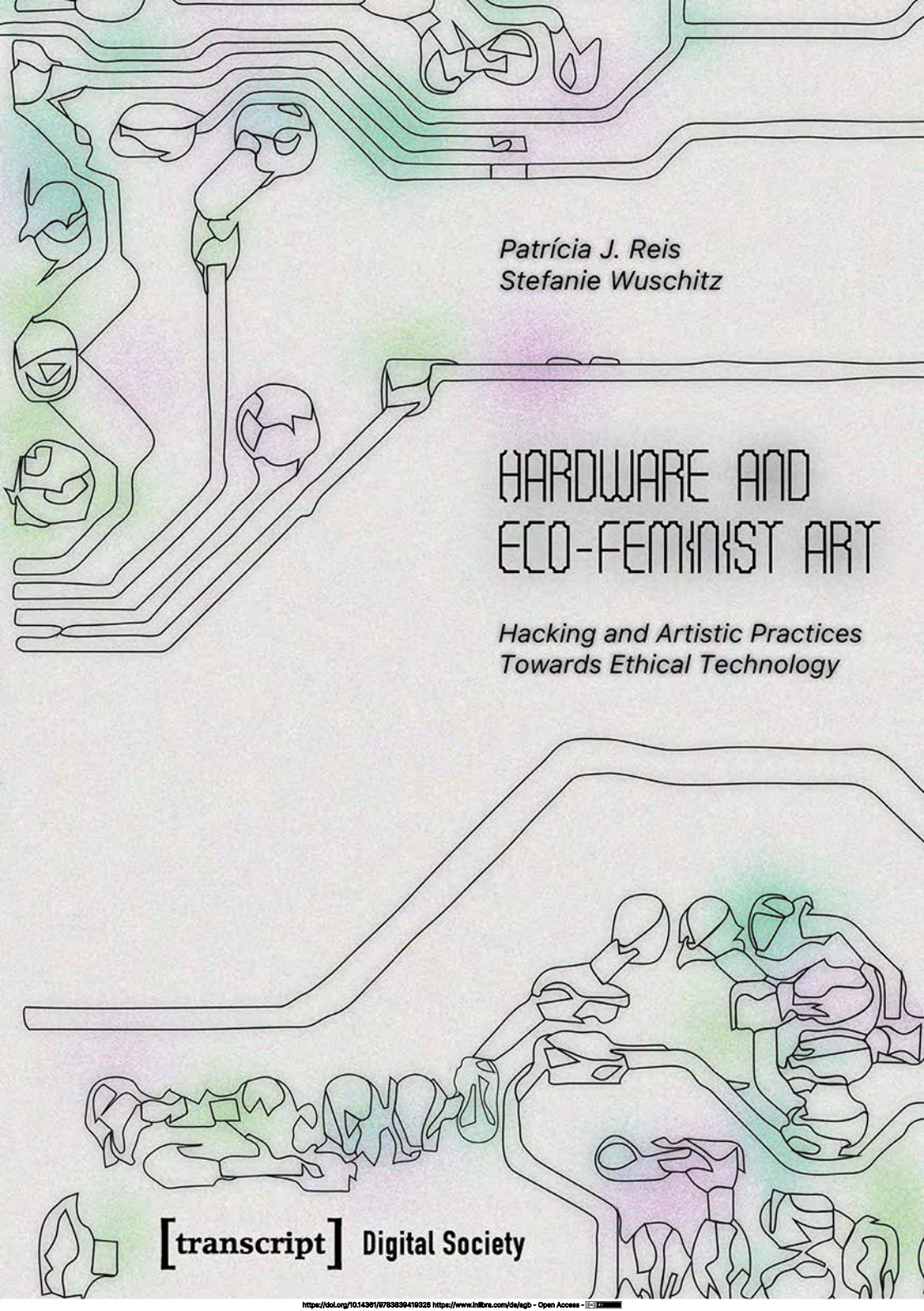

Patrícia J. Reis
Stefanie Wuschitz

HARDWARE AND ECO-FEMINIST ART

Hacking and Artistic Practices Towards Ethical Technology

[transcript] Digital Society

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Patrícia J. Reis
Stefanie Wuschitz

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Introduction

This book calls for new standards through a more ethical, eco-sentient and anti-racist use of technology in the field of art (Mohanty, 2003; Tsing, 2015; Vergès, 2021; Tungstall, 2023). It builds upon an artistic research project with the title Feminist Hacking: Building Circuits as an Artistic Practice (PEEK AR580), an international and art-based research project that ran from March 2020 to November 2023. Feminist hacking is here understood as a method involving an intensive knowledge-sharing process, through workshops and other forms of exchange, which encourages peer-to-peer learning. Drawing upon the experience of queering technology through feminist hacking, an artistic research team set out to decolonise technology using feminist hacking. Our peers are mainly 'women', meaning cisgender and transgender women, as well as non-binary individuals who are marginalised in the technology and art field. Furthermore, feminist hacking was used in this project to gather knowledge on mining, extraction, contamination, conflict and exploitation. Speculative methodologies were employed to promote more sustainable hardware production methods within the realm of art.

In this way, the Feminist Hacking project – hosted at the Academy of Fine Arts Vienna by Patrícia J. Reis, Taguhi Torosyan and Stefanie Wuschitz – wanted to challenge the normalising extractivist narratives prevalent in technology. For this reason, the research team worked with activists, critical makers and artists to produce hardware, rather than producing hardware with professionals from the hardware manufacturing industry. One of our strongest partners in this project was the feminist hackerspace and art collective Mz* Baltazar's Laboratory, based

in Vienna, Austria. All members of the research team were part of the feminist hackerspace collective, and their previous experience with the community positively informed and shaped this project.

After producing this 'feminist hardware', the team organised workshops to teach participants how to create the hardware themselves, using circuit building as a core methodology for artistic practice. During the workshops, participants were asked to unpack, question and subvert traditional power structures within the field of technology through speculative prototypes inspired by the notion of feminist hardware (Wuschitz, 2020). The project also provided different platforms (artist and citizen science workshops, online conferences, GOSH and GitHub contributions and a Feminist Hardware Festival) for participants to share their unique perspectives, ideas and experiences. Ultimately, the project goal was to raise awareness of alternative commodity chains and more decentralised, ethical, sustainable and thought-through forms of manufacturing electronics. In short, forms that align with values of de-growth.

De-growth prioritises global, social and environmental justice over the overconsumption-based profit maximisation of a few. In practice, de-growth stands for a transformation from extractivist economic models to circular economic models that consider ecological limits (Heron & Eastwood, 2024).

Through circuit building as an artistic practice, participants questioned and subverted the status quo of technology production and expressed their unique visions through their choice of materials and sources. These materials encompass alternatives that are biodegradable, including those derived from plants, upcycled resources and urban-mined materials, which are not typically used in hardware manufacturing processes. Through our

Ethical Hardware Kit: action in the forest by Patrícia J. Reis and Stefanie Wuschitz, 2023
Photo © Janine Schranz

Concept and design: Patrícia J. Reis and Stefanie Wuschitz, in collaboration with Media Design students (Hackerspace Cultures) of the University of Arts in Linz, Austria – Melanie Steinhuber, Petra Francesca Weixelbraun, Florian Winkler, Alba
Curatorial work: Patrícia J. Reis
Textile design: Erika Farina
Contributors/experts: Gameli Adzaho, Seyram Avle, Milton Raggi, Mariá Antonia González Valerio, Saad Chinoy, Ira Agrivina, Hannah Perner-Wilson, Rajina Shresta

practice and feminist hardware workshops, we also addressed a prevailing gender bias within the maker community and a lack of representation of non-binary and female-identified tech developers (Abbate, 2012; Wuschitz, 2014; D'Ignazio & Klein, 2020; Kohei, 2024). The Salon of Open Secrets interview and workshop series (presented in Part 2 of this book) is an example of how the project addressed this gender imbalance and the under-represented groups. To foster community building and facilitate knowledge transfer in this domain, we extended invitations to various non-binary and female-identified media artists and researchers. They were invited to discuss their work, career challenges and struggles, and to impart insights by sharing some of their 'secrets'.

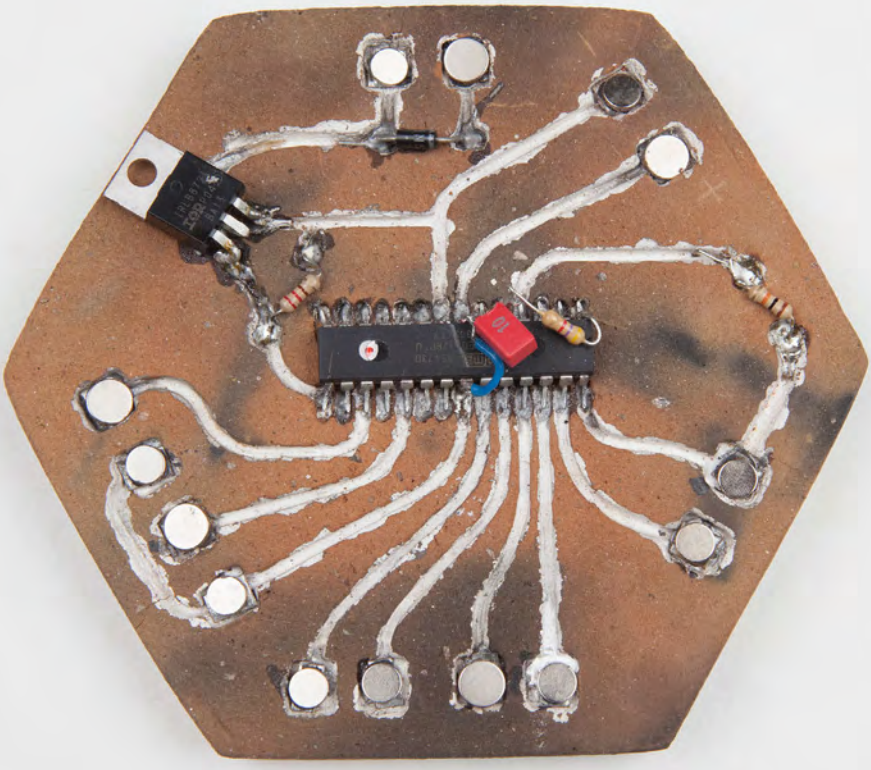
Giulia Tomasello and Arianna Forte, in conversation with Patrícia J. Reis and Stefanie Wuschitz, 2022

Through the workshop series, the project aim was to create a safer and more inclusive space for makers of FLINTA (women, lesbians, intersex, non-binary, trans and agender) genders to share their approach to the intersection between art, technology and material science. By bringing together a diverse range of voices and perspectives from different age groups, the project sought to inspire more people to speak up and become active, and to forge a shared vision of green, economically just and decolonial de-growth. The project uses the practices of local communities of feminist artists, activists, technologists and feminist hackers around the world. In particular, we invited and worked with Hannah Perner-Wilson, Ira Agrivina, Erika Farina, Rajina Shresta, María Antonia González Valerio and Seyram Avle, and our allies Saad Chinoy, Milton Raggi and Gameli Adzaho, Julian Chollet, Heinz Lackinger and Daniel Schatzmayr, among others. The three-year research project at the Academy of Fine Arts Vienna embraced different tactics to create a more inclusive, critical and diverse tech community and to speculate on the future production of ethical hardware.

The aim of this book is to provide a comprehensive overview of several projects that apply trans-feminist hacking in ethical computing.

Firing the natural clay during the workshop with Heinz Lackinger at Donnerskirchen, Burgenland, Austria, November 2022
Photo © Patrícia J. Reis

The book is divided into three parts: Part 1 introduces the methodology and literature review underpinning our project, including an exploration of key concepts such as feminist hardware and trans-feminist hacking. Part 2 presents the practical outcomes of the artistic research, from the preliminary research phase to the final results. We look in detail at the Ethical Hardware Kit, Clay PCB and Coffee Table. These projects emerged within the framework of the arts-based research project Feminist Hacking: Building Circuits as an Artistic Practice. Part 3 introduces the network of contributing allies, who are part of an interdisciplinary and international community of activists, artists and trans-feminist hackers. It introduces the interactive storytelling game Salon of Open Secrets, its citizen science aspect and the Feminist Hardware Festival.



Patrícia J. Reis and Stefanie Wuschitz,
Clay PCB, 10x10 cm, natural clay fired in
wood fire, silver, electronics
© Patrícia J. Reis

FEMINIST HACKING AS ARTISTIC PRACTICE

PART 1

Methodology

Building Circuits as an Artistic Practice

This research draws upon feminist hacking methodologies (Reis & Wuschitz, 2021) and diffractive methods (Barad, 2007, p. 28) within artistic practice. Specifically, it employs diffractive analysis, which integrates diverse methodologies from various disciplines, to position the research within multiple perspectives (Tsing, 2015). Through this approach, the project aims to examine the material effects of difference within these entanglements. This implies embracing technological challenges from a demystification and hacking perspective based on open hardware and DIY[1] techniques, and also looking into the materials used from the perspective of their matter and agency (Bennet, 2010), using non-toxic and recycled hardware where possible.

By questioning the techno-capitalist system, reverse engineering, advocating for access and openism, repairing and de-growing, we employ a top-down approach, using deconstruction as a method to create art. We question what drives the tech industries and the impact of technology in the current neoliberal market.

1 The DIY (do-it-yourself) ethic is rooted in craft and artisanal traditions and is seen as a dimension of punk culture, allowing mainstream culture to become more accessible (George, 2002). The riot grrrl feminist movement, which draws on the experiences of marginalised women, used music, art and writing to create a sense of solidarity and protest against various social issues (Higgs, 2013; Klein, 2019). The DIY principle encourages individuals to create and consume within their own communities by building, changing or repairing objects without the help of experts (Ferguson, 2016). This has been described as using raw or semi-raw materials to produce, transform or reconstruct objects.

Instead of consuming commodities off the shelf, we recycle materials; instead of accepting the toxic afterlife of dysfunctional devices, we analyse the genesis to demystify the actors that benefit from their blackboxing, application and licensing – those who profit from opacity and designed obsolescence. As artists and researchers, we believe in the power of art as a critical impetus for social and political change (Nijhuis, 2019, p.128). We embrace hacking strategies, both as research methodologies and potential instruments for self-articulation (Laczko, 2021). We work in collaboration with allies who are grounded in intersectional and eco-feminist values and who operate within the realms of science, art and technology – an approach that we refer to as feminist hacking.

Feminist Hardware: Making Printed Circuit Boards with Natural Clay by Patrícia J. Reis and Stefanie Wuschitz, Hangar-Visual Arts Research and Production Centre, Barcelona, Spain, 18 and 19 October 2023

Feminist hacking

Feminist hacking is a movement that challenges traditional gender norms and encourages greater participation of under-represented groups, including women*, in the technology field. It often pursues a trans-species approach, finding kinship with other sentient beings (Haraway, 2016; Albrechtsen & Helms, 2019; Gillespie, 2020). It involves the deconstruction and reassembly of electronic devices to create something new, with the goal of learning and understanding how these devices work and their impact on sentient beings on a global scale. Feminist hacking values are making use of existing, recycled and/or self-made DIY hardware; the process is driven by a desire to create technology from unique and nomadic perspectives (Braidotti, 2002, 2019). By breaking with feminine gender scripts and embracing technological challenges, feminist hacking pushes the boundaries of what is considered 'technology' in the first place (Criado Perez, 2019).

Many feminist hackers work with the situated experience of their own body, skin, hormones or body fluids to generate embodied technological assemblages.[2] This experimental approach to technology is informed by critical making, human–computer interaction, media art and feminist theory, but it remains anti-disciplinary. Other than critical making, the main intention is not critical pedagogy but the deconstruction of non-legitimate authorities. We should point out the importance of open hardware for our endeavour. We understand open hardware as main We see it as a basic requirement to hold developers accountable

2 See Part 2 Acupuncture sonification, My Fair Acupuncture Songs as an example of how we developed an interface that works with the body as 'matter'.

and to grant wider access to knowledge and means of production and self-expression.[3] taining commons that provide the public with transparent data sheets or tutorials on how a particular technology works and can be used or modified.

***Note: The use of 'women*' in this context refers to cisgender and transgender women, as well as non-binary individuals who are marginalised in the technology field.**

Agential cuts

How should scientific or artistic inquiry approach ever-transforming entangled worlds? Feminist physicist Karen Barad proposes enacting *agential cuts* (Barad, 2020), through which we produce boundaries and properties of *entities* where there are none. We enact agential cuts by intervening in the world, by defining a beginning and an end of an observation, for example through an apparatus and experimental setting, but also an art piece. The entity that we create through our agential cuts is shaped dynamically by the properties of our intervention (e.g. the temperature measure changes the temperature of the measured water). The reciprocal quality of the intervention makes us transform while we investigate an entity, which is itself transformed. To Barad, science is a practice of making boundaries and cuts that help us to look at this transformation. Phenomena come to matter through the dynamics of this mutual transformation that Barad calls *intra-activity*.

3 Open hardware refers to hardware designed so that the schematics are openly available for everyone to see, modify and distribute. This means the hardware design is not proprietary and people can use it for their own purposes, commercial or non-commercial. Open hardware projects are often built and developed feminist hardware through collaborative efforts and can range from single boards to complete systems. Open hardware is important for the development of ethical hardware because it increases transparency and visibility within the design and manufacturing process of hardware products, which can help to identify and address ethical concerns such as

Mz* Baltazar's Lab, outdoor view during the performative event Riot im Riot. On Reclaiming Space, curated by Olivia Jaques and Anna Watzinger, July 2023
Photo © Patrícia J. Reis

For this project, the feminist hacklab Mz* Baltazar's Laboratory in Vienna, Austria, provided the experimental framework and apparatus. Its properties and boundaries were enacted through a theoretical agential cut, mediated the research process and became the site of extensive intra-active mutual transformation. Donna Haraway calls the future epoch – following the Anthropocene – the Chthulucene. It signifies a future world in which humans and non-humans co-exist and understand the extent to which they co-create one another as kin in intra-activity. How can we develop tech for the Chthulucene?

the use of conflict minerals, environmentally damaging production methods or privacy-infringing data collection (Free Software Foundation, 2019), encouraging collaboration and community involvement, which can lead to faster innovation and a wider range of perspectives and solutions to ethical and technical issues (OpenSource.com, 2018). This can help to promote digital rights and freedom of expression (Free Software Foundation, 2019). Allowing for the reuse and repurposing of hardware components reduces the need for new products to be manufactured (OpenSource.com, 2018).

Chthulucene is a simple word. It is a compound of two Greek roots (khthôn and kainos) that together name a kind of [sic] timeplace for learning to stay with the trouble of living and dying in response-ability on a damaged earth.

(Haraway, 2016, p. 2)

Haraway, a trained biologist, also coined the term 'natureculture', which refers to the idea that the natural world and culture influence each other (Haraway, 2003). This idea draws attention to the body as a biological being shaped by cultural beliefs and practices. New materialist theories argue that the traditional separation of nature and culture into separate academic disciplines is artificial and that they are two sides of the same coin.

Feminist new materialisms: (re)turns to matter

The term 'new materialism' was first introduced by feminist scholar Rosi Braidotti in the 1990s in the field of gender studies (Braidotti, 1996). This cultural theory has emerged in response to the cultural turn, a focus in the social sciences on cultural and textual approaches to understanding society. New materialism aims to create a more holistic understanding of the world by breaking down dualisms.[4] It makes affirmative connections between seemingly opposing theoretical traditions. The new materialist approach involves re-reading classic and marginal texts from various disciplines and paradigms to find shared characteristics and unexpected theorisations (Coole & Frost, 2010).

4 New materialism is transversal rather than dialectic and seeks to create 'transversal cartographies'.

Karen Barad unexpectedly brings together perspectives from physics, including recent research in quantum mechanics, and cultural and social theories (Barad, 2003, 2020). The result is a post-humanist, performative account that highlights the inter-dependence and mutual constitution of matter, meaning and agency. Materiality, or the physical things of the world, is seen as a complex and self-organising process that is active and has agency. This means that things, including non-human agents, are able to shape and interact with the social environment.

This approach differs dramatically from traditional cultural theories that view the matter as passive and lacking agency (Bennett, 2010; Alaimo & Hekman, 2008). Additionally, new materialists focus on what they call 'material realism', meaning they aim to understand theories about life's non-discursive aspects through an examination of lived experience, physical practice and biological substance (Coole & Frost, 2010). The new materialist perspective is political and ethical, taking a stand on issues such as climate change and biotechnological engineering (van der Tuin & Dolphijn, 2012). To do so, they embrace an interdisciplinary approach that includes the non-human universe, which has historically been the domain of natural sciences.

Finally, new materialists reject the idea that science should only consider falsifiable hypotheses and instead seek to understand the impact of technological advancements on the natural world. They believe that modern science, with its focus on calculability and measurability, has led to the degradation of the environment (Barad, 2007). A perspective that really resonated with our practice.

With the rise of artificial intelligence and its potential to replace human values, technoscience is becoming more powerful (Sinders 2019; Crawford, 2021). According to philosopher Bruno

Latour, we must choose between modernisation and ecologising. And we should be aware that any change in our understanding of science could impact modernisation as a whole (Latour, 2013).

To address this challenge, we need to create a new system that incorporates a more diverse range of values and a deeper relationship with the natural world. The main driving forces behind new materialism are technoscience and climate change.[5] The theory seeks to find a balance between progress and ecology, and it encourages the creation of new organisations and networks that prioritise global wellbeing (Coole & Frost, 2010).

Indigenous philosophers have written about similar worldviews before new materialism or eco-Marxism (Kohei Saito, 2022). They have more eloquently revealed how violent dispossession of land and the ongoing praxis of displacement could be normalised through enforcing racial and material categories (Lorde, 2021; Yusoff, 2019, p. 3). Yet, we believe that new materialist theory has the potential to bring together a community of like-minded individuals who seek to create a more conscious and organised world (Tuck & Yang, 2012).

5 They also believe that certain things 'matter' because they are a matter of shared concern and emphasise the movement's political agenda (Latour, 2008).

Considering human and non-human persons

These theories resonate with scholars who integrate Indigenous knowledges into post-colonial critique. 'Human beings' existence is contingent on the lives of others, other non-human persons.' These non-human persons can form relationships, and their relationships can generate cultures — *naturecultures* — as stated by Puig de la Bellacasa (Haraway, 2003; Bellacasa, 2017). These naturecultures need to become the focus of our attention if we want to survive on a damaged planet (Tsing et al., 2017). This is what Indigenous resistance stands for: caretaking and creating just relations between human and other-than-human worlds on a planet that is thoroughly devoted to capitalism (Demos, 2016). Animistic syncretism grants personhood to plants, animals and stones. This leads to a critique of settler-colonialism, opposition to extracting natural resources and their capitalist commercialisation as commodities (Kimmerer, 2015). In that sense, new feminist materialism aligns with these values. Anna Tsing, one of the most important authors for our research, explains that this personhood of natural resources is not a belief or metaphor — even our own bodies contain more bacterial cells than human ones (see interview with Saad Chinoy in Part 3). Tsing shows how cross-species entanglement is real and requires our attention for collaborative survival (Tsing et al., 2017, p. M5, M75).

In the following chapters, we will provide an overview of the umbrella concepts that have inspired our research, and we will discuss their influence in our practical outcome.

Open technology culture: hacking/making

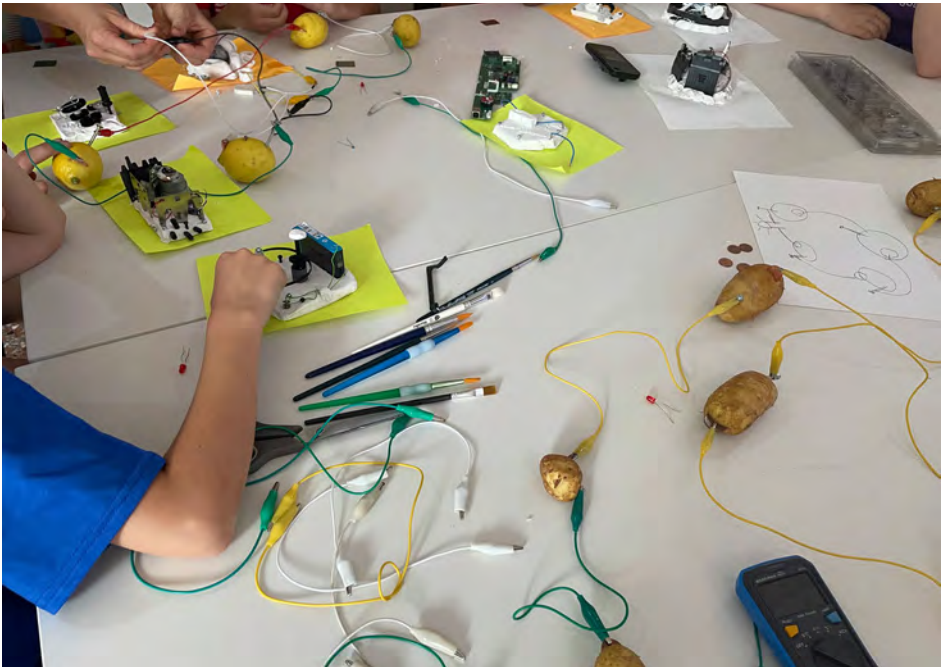
In recent years the impact of technology on society has become a major topic in mainstream culture, media and academic studies (Klein, 2020). Many people are now examining the colonial, environmental and political effects of disruptive technologies such as AI, big data, overconsumption or surveillance and are looking for alternatives (Noble, 2018; Vergès, 2021; Crawford, 2021; Kohei Saito, 2022).[6] While being critical of technology has the potential to make technology more ethical, there is a concern that critical individuals may feel excluded from the field to begin with, leading them to avoid developing technologies that align with their values (Criado Perez, 2019; Kuo et al., 2022).

Hacking is allowing those blocked out by techno-capitalism to start a creative process that involves experimenting, solving problems and finding new ways to use technology. The traditional view of hacking[7] is based on principles like unlimited access to information, distrust of authority and a focus on decentralisation. However, feminist perspectives have challenged this view and expanded the definition of hacking to include care, mutual self-help, embracing failure and promoting social jus-

6 According to recent statistics, only around 10% of people who identify as female are represented in STEM fields at universities in Austria (Statistics Austria, 2021).

7 While the definition of hacking can vary, it is generally understood as the application of knowledge in information technology through unconventional methods. Hacking can be seen as a way to bring about change in both technical and social systems and is viewed as a political and economic force by hacker communities (Jordan, 2008; Söderberg, 2008).

tice and equity (Söderberg & Delfanti, 2014; The Care Collective 2020; Bosold et al., 2021). Today, hacking and making are more popular than ever, and they are supported by governments, corporations and academic institutions. Hacking has been adopted as a pedagogical method for STEM learning, particularly in deprived communities, as a way to promote tech literacy and science skills among citizens, and it has attracted much attention as a method to encourage ideas that can be licensed under profitable patents (Lindtner, 2012; Tan & Barton, 2020). This has led to the growth of open source hardware hacking, DIY and DIWO (do-it-with-others) workshops and hacklabs, and seemingly ubiquitous urban and rural makerspaces. These movements are often referred to as the 'open technology culture', and around 10 years ago they were believed to enable a new Industrial Revolution (O'Reilly, 2007; Shirky, 2008; Anderson, 2010). Yet, most rapid prototyping tools still depend on fragile and toxic commodity chains. The so-called West experienced a new scarcity exposing the limits of maker culture's potential (Dunbar-Hester, 2020; Maly, 2016; Foster & Suwandi, 2020).



Workshop, citizen science project:
Salon of Open Secrets at Kinderuniversität
(Academy of Fine Arts in Vienna) with
Mir* Raggam-Alji, Patrícia J. Reis, Theresa
Schütz, Petra Weixelbraun and Stefanie
Wuschitz, 2023

In Armani et al.'s (2020) article 'Low-tech solutions for the COVID-19 supply chain crisis', the authors focus on the challenges faced by supply chains during the pandemic, and they propose low-tech solutions to address these challenges. The authors argue that while high-tech solutions such as 3D printing and automation have received much attention, low-tech solutions can be equally effective in addressing supply chain disruptions. A conclusion that encouraged the assumptions made in this project.

The authors highlight the critical role played by personal protective equipment (PPE) and medical supplies in the pandemic

response – and the challenges associated with their production and distribution. Armani et al. conclude that there is a real need for local and regional supply chains to reduce dependence on global supply chains.

In *Chip War*, Chris Miller considers not only the COVID crisis but also the crisis caused by the scarcity of conflict materials and transition minerals that was experienced. Miller sheds light on imperialist strategies to access semiconductors, produced only by the most precise high-tech chip-fabrication facilities (e.g. the Taiwanese semiconductor manufacturing industry), a critical technology for economic and military dominance (Miller, 2022).

In contrast to what drives high-tech 'chip wars', hacker/maker cultures are still seen as promoting the democratisation of technology, allowing for easier and low-tech access to tools and a worldwide community to create, experiment, test, produce and distribute new products, machines and artefacts. These movements are also viewed as contributing to the rapid transformation of identities, practices and cultures through organising community platforms, conferences and gatherings across different continents.

The study of hacker/maker cultures, their knowledge, practices and institutionalisation, is the subject of ongoing research in fields such as internet and communication technologies (Kelty, 2008; Ratto & Boler, 2014a, 2014b; Garnet Hertz, 2023), science and technology studies (Hess & Ostrom, 2007; Sipos, 2023) and human–computer interaction and education (Sipos, R. Åkerman et al., 2022; Gatz, 2023), among others.

We would like to point out that older structures (e.g. resistant education movements) in the so-called Global South have

aligned and often merged with today's maker culture, embracing some of its principles (Siagan, 2016; Nadia, 2020). Many local, deprived or Indigenous communities are celebrating them in entanglement with older autonomous approaches to sharing and collaborating in commons. Self-organised hacklabs on the margins offer precious platforms of hope by implementing science solutions to local needs and crises, enabling people on the ground to collaborate and learn in new ways (Kelty, 2008; GOSH, 2025).

Many times, these shared technologies are underestimated and overlooked by Western-centric hackers. Similarly, stories of people of colour within the IT industry have been left out of existing accounts of tech development (Nakamura, 2014). Fairchild, one of the most important semi-conductor corporations in the US, employed Navajo women to solder integrated circuits. Fairchild had opened a plant in the 1960s and 1970s at Shiprock, New Mexico, on a Navajo reservation (Nakamura, 2014). The plant was shut down in 1975 after protesters had demanded better working conditions for the impoverished Navajo employees (Nakamura, 2014). Nakamura shows in her book how outsourcing electronic manufacture to skilled female workers of colour in Asia was piloted within US borders, on a Navajo reservation in the 1960s and 70s. Today, Indigenous communities are more exposed to radiation, contamination and pollution. This is why strong movements have evolved at the intersection between education, environmentalism and open hardware (Shiva, 2012; Liboiron, 2021; Shiva & Mies, 2022; Demos, 2023). We stand in solidarity with these movements.

Who are the feminist hackers?

Traditionally, the fields of science and technology have been dominated by a fairly privileged, competitive, Euro-American, gender-biased, masculine culture. Innovation in science and technology is still driven mainly by the interests of big tech companies (O'Neil, 2019). We need to discuss 'how capitalism profits from the ongoing production of racialized difference, such as through the extraction, control, and dispossession of data, land, environment, and natural resources and exploitative labour and material conditions' (Yusoff, 2019; Margaret & Avle, 2021; Kuo et al., 2022). Feminist hackers, therefore, are dedicated to cultivating different values, with a focus on sharing, openness, decentralisation and free access as the keys to providing welcoming conditions for creating global change. They believe in the ethos of DIY, DIT[8] and DIWO, which allows for unblackboxing or making machines, technology and tools accessible to all (Chun, 2013; Coleman, 2013). Feminist hackers are challenging traditional Western tech narratives.[9] Many of them critically examine overconsumption and toxic power dynamics in technology by raising questions of de-growth and renewable energies in their art. Many aim to integrate Indigenous values for technology knowledge and reshape the accelerationist understanding

8 Do-it-together.

9 Even before feminist hacking became relevant, there was a divide between hacking and making, with hacking being associated with traditionally masculine ideals of transgression and competition, and making associated with care and 'femininity' (Nagbot, SSL, 2016; MAXIGAS, 2012). However, others argue that there is much overlap between the two and they should not be seen as two separate entities. Feminist hackers highlight the political implications of care and repair in the tech industry, particularly regarding gendered labour (Kumar, 2017a; Rosner & Ames, 2014; Rosner et al,. 2014).

of techno-solutionism. They also strive to develop alternative projects that shape the future. For example, Nicole L'Huillier, Caroline Sanders, Sarah Newman, Klau Kinky and Amelia Winger-Bearskin, among others (L'Huillier, 2018; Sanders, 2018; Newman, 2019; Winger-Bearskin, 2023).

Feminist hacking became more widely known through the Genderchangers network (Genderchangers Academy), which operated on an 'informal, ad hoc, DIY, hands-on basis in a non-purpose-driven, non-competitive atmosphere of mutual respect' with a 'focus on free and open source software as a political decision' (Genderchangers Manifesto, 2009). The yearly Eclectic Tech Carnival by the Genderchangers Collective was an exclusive safe space for marginalised communities to share tech skills and reveal the impact of hidden power structures on technological progress. These issues were addressed in the 1990s by sharing knowledge on open source technologies in spaces exclusively designated for female-identified persons.

These early cyberfeminist groups also fostered the idea of speculative fabulation inspired by science fiction (Haraway, 1988; Wajcman, 2004; Derieg, 2007). Even today, these speculative methods inspire our approach towards making technology. It is generally agreed among experts that making technology is about exploring the material, site-specific, bodily and intimate aspects of design, engineering and art (Ratto & Boler, 2014b). Extending this initial aim, feminist hackers are essentially speculating on more ethical future tech to unpack how technology keeps up the status quo. How it is instrumentalised to maintain violent hegemonic gender regimes globally. Feminist hackers instead perform and exercise alternative approaches to worlding (Ahmed, 2006; Jackson, 2014). Commoning, and caring for commons, is considered an alternative approach.

Care-based commoning is a process of becoming a commoner, an entangled subjectivity, through relationships among humans and with the environment. It is a response to individual circumstances and recognises the micro-political situations of each commons. Women*, especially, have traditionally created feminist counterspaces as a form of resistance against patriarchal oppression. These spaces allow for exaggerated and subversive gender performances and have been co-opted into broader feminist resistance movements (Federici, 2012). Feminist hacklabs such as Constant,[10] Deep Lab,[11] XXLab,[12] GynePunk,[13] Mz* Baltazar's Lab,[14] Radiona[15] and Heart of Code,[16] among others, have emphasised the importance of having a physical space as a place in which resistance can flourish, based on principles of commoning, sharing, openness, care, decentralisation, de-growing and free education (Toupin, 2014b; Wuschitz, 2014; Nagbot, SSL, 2016; Savic & Wuschitz, 2018).

Workshop, *ArduinA* at Constant with Mz* Baltazar's Lab (Lale Rodgarkia-Dara and Patrícia J. Reis), Brussels, 2013

10 https://constantvzw.org/site/
11 http://www.deeplab.net/
12 https://honf.org/category/project-spinoff/
13 https://hackteria.org/wiki/GynePUNK
14 https://www.mzbaltazarslaboratory.org/
15 https://radiona.org/
16 http://heartofcode.org/

Feminist hacking roots

Feminist technoscience and cyberfeminism

Feminist hacking draws upon the ideas and work of techno-feminists (Wajcman, 2004, 2006) and cyberfeminists (Braidotti, 1996; Hall, 1996; Sollfrank, 2002), including influential figures such as Donna Haraway, VNS Matrix, Linda Dement, Jill Scott, mez breeze and the Old Boys Network (OBN). This approach is rooted in the concept of 'situated knowledge', which challenges traditional opposites such as nature/culture, subject/object and man/woman, and examines the impact of computer technology on communication and power dynamics.

Feminist standpoint theory gives a voice to those who are subjected to a given mode of production. Donna Haraway's concept of 'situated knowledge' recognises that knowledge is complex and shaped by various factors, including personal experiences (Haraway, 1988). This idea was also formulated by Chandra Mohanty (1991, 2003), who believes that all perspectives should be open to critical examination, particularly to denounce racism in knowledge production. This mode of understanding subjectivity encompasses both a liberal perspective that sees technology as a liberating tool for fluid gender expression, and a separatist perspective that seeks to create (e.g. queer, black, writer, workers) women-only spaces in response to exploitation and harassment, both offline and online.

The rise of 'bodiless pragmatics', which revealed that virtual interactions were not free from gender biases and violence,

led to renewed interest in the material aspects of resistance through technology. Feminist hacking aims to extend the promises of cyberfeminism and reclaim technology for marginalised communities. It sees the body, gender and technology as intertwined and constantly shaping one another, and it views mutual knowledge exchange as a means of political action. Grounded in a new understanding of the relationship between the body and technology, feminist hacking empowers non-normative bodies, genders and sexualities to build their own identities and spaces in a liberating and autonomous manner (M. Dietze & Wuschitz, 2020). Claiming the right to decide over the body includes the uterus, reproductive rights and abortion. Ultimately, this perspective seeks to undo oppression and exploitation legitimated through illegitimate hierarchies.

Feminist hackers want to understand the fleeting, yet powerful, influence of matter in the present moment. This perspective rejects metaphysics and is closely connected to being present. Our perspectives are shaped by our interactions/intra-actions with others, including humans, species, environments and technologies.[17] It is important to consider the consent and intentions of others before taking action, fostering wokeness and solidarity. Both the DIY and trans-hack feminist movements strive to create a unique environment where participants can undo societal norms and hierarchies based on gender, race and class. This environment provides a space for people to explore their interests, find care and support, and heal from harmful experiences.

17 This is not limited to our experiences of using, creating, hacking and altering technology but extends to the exploitation of child labour in mining and e-waste recycling, as well as the impact of civil wars and displacement.

Autonomy and commoning

Autonomous feminist movements are often associated with first-wave feminists such as Emma Goldmann (1869–1940) and Clara Zetkin (1857–1933) or third-wave feminists such as Pussy Riot or the Xenofeminists. But autonomy[18] and commoning are rooted in prehistoric societies (Mies, 1986, 2014). As Maria Mies (2014) and Sophie Lewis (2022) pointed out, gender bias and the patriarchal nuclear family are products of early capitalism, protecting land ownership through establishing patrilineal heritage laws and implementing the ideology of state motherhood to control objects and subjects, particularly subjects labelled as 'women' (Suryakusuma, 1988). Commons, in contrast, were strategies of the landless to sustain a living (Federici, 2012). They were not limited to feminists: commons were crucial to the resistance of systematically discriminated groups.

Autonomy and commons are two key elements that bring together the post-1968 social–political movements in the Western world and the hacker movements. The convergence of contemporary political activism with the FLOSS (free/libre and open source software) movement, feminist hacking and critical artmaking is influenced by the DIY ethics of autonomous and anarchist punk, the individualist libertarian ethos and hacker ethics, the FLOSS ethics of decentralisation and freedom of information, hardware access and the feminist ethics of care (Kelty, 2008; Coleman, 2013; Kelty, 2014; Wajcman & Rose, 2015; Gandini, 2016).

18 Libertarianism, popularised by individualist anarchist Benjamin Tucker in the 1880s, has been adopted and co-opted by liberal thought. It has two main branches: laissez-faire capitalism; and anti-state and anti-proprietary socialist movements. Both branches reject the state and authority and advocate maximum autonomy, individual freedom

The political economy of community-based peer production, based on the hacker ethics, aims to build up commons and communities through peer-to-peer learning, prototyping, manufacturing and fixing, as a way to provide a dignified livelihood for all. This is a response to the increasing vulnerability and automation of the supply chain, which leads to decreasing wages and oppression of workers (Butollo & Nuss, 2022). And increasingly insecure conditions for racial, ethnic and sexual minorities, women, Indigenous people, migrants and peoples in the Global South (Precarity Lab, 2019). When needs cannot be met through capitalist markets, alternative forms of production and parallel economies are needed.

Care-full commoning

Feminist hackers really value sharing practices and coming together through technologies, spaces and rituals (Wuschitz, 2014). These are embodied in feminist hacklabs, such as Mz* Baltazar's Lab (Wuschitz, 2022). Feminist hacklab communities believe in care as a means of commoning, maintaining, repairing

and voluntary association (Mises, 1944; Guérin, 1965; Day, 2005). The autonomist movement in Europe was a response to the cultural shock of 1968 and the failure of workers' struggles in Italy. It was connected to the emergence of youth countercultures, such as anarchist punk. The anarcho-punk groups in the Autonomen reject the idea of a revolutionary state and focus on anti-corporatist and workers' rights struggles, as well as animal rights, anti-war, anti-nuclear, anti-racist, anti-colonial, feminist and LGBTQIA issues, all with a DIY approach (Cleaver, 1991; Toscano, 2006; Juris, 2008). In its original sense of anarchism, the libertarian ethos stands for individual freedom and anti-establishment principles, including non-conformity, anti-authoritarianism, anti-corporatism, anti-consumerism, anti-corporate greed and direct action. The punk DIY ethos is about not 'selling out' and solving new problems with available materials (Graeber, 2013a, 2013b; McRobbie, 2016).

and improving shared workshop and culture spaces (Reis & Wuschitz, 2021). These practices help to build local communities in a sustainable way, and they provide an alternative to the insecurity and precariousness of everyday life (Dombrowski et al., 2020).

Exhibition *Revier* by Julia Frank at Mz*
Baltazar's Lab, May 2021
Photo © Mz* Baltazar's Laboratory

Commons refer to the social practices involved in various forms of organisation, rather than a collection of objects. The focus is on the relationships between participants and their site-specific intra-active engagement, rather than the resource itself (Wuschitz, 2014). Some theorists, such as Elinor Ostrom, believe these relationships are governed by formal rules and regulations (Ostrom, 1990, 2002). However, Ostrom's approach to commons governance is seen as exclusionary and fails to account for local norms, values and interests (Calvillo et al., 2020).

The feminist hacking and making communities, such as Mz* Baltazar's Lab, emphasise the significance of understanding how different practices shape our beliefs and values. Accord-

ing to Calvillo, Farias and Bocchicchio (2020), these communities strive to create safer spaces where people can share their experiences and learn from one another. The use of free/libre open source technologies is a crucial element of this movement. Federici (2012) argues that understanding how the products and technologies we use are made and distributed is vital to understanding the exploitation and oppression faced by women and other marginalised groups.

The creation of open source technologies is community-driven, with the intention of providing everyone with a voice in the process of creation and distribution. Ostrom (1990) explains that community-driven technology development allows for democratic participation and the evolution of institutions for collective action. The use of the open source licence allows people to access knowledge and resources that are not controlled by corporations or governments (see interview with Rajina Shresta in Part 2). According to Haraway (2016), this aspect of open source technologies promotes the sharing of knowledge and resources, enabling communities to develop and grow collectively.

Exhibition *Resonation Sculptures & Radio Cyborg Transmitter RCT* by Reni Hofmüller at Mz* Baltazar's Lab, February 2023
Photo © Flavio Palasciano

Art hacking practice

Art hacking is a method and practice in the field of media arts, art, science and technology that redefines the relationship between hacking and making (Sjöholm, 2019). It is seen as a form of communication guerrilla or guerilla art that is influenced by the impact of technology on daily life, the cultural and economic surplus in society, and the politicisation of art. Art hacking is related to hacktivism, media hacking, tactical media and reality hacking, which involves using legally questionable digital tools for socially, politically or culturally subversive purposes (Coleman, 2014).[19]

Artists such as Pechblenda, Mary Maggic, Paula Pin and Hannah Perner-Wilson approach hardware as an organism and use it as a tool for empowerment and resistance (Braidotti & Hlavajova, 2018). Artists such as Ebru Kurbak and Irene Posch, Ioana Vreme Moser and Sarah Grant use unconventional materials like gold thread, water, air and slime to store information and tell stories (Ratto & Ree, 2012).

19 Art hacking has a long history dating back to the 1970s and the Fluxus movement and Happenings (Bishop, 2006). Today, artists and collectives such as subRosa, Ubermorgen, Geert Lovink, The Yes Men, Critical Art Ensemble, DoEAT Group and the Institute for Applied Autonomy use a range of tactics, from virtual sit-ins to mass protests, to raise awareness of social and political issues (Goriunova & Shulgin, 2013).

Exhibition *Genital (*) Panic* by Mary Maggic
at Mz* Baltazar's Lab, December 2019
Photo © Mz* Baltazar's Lab

Often, art or craft workshops are used to piggyback temporary safe spaces, allowing conversations that tackle taboo issues. Efe Franca Blange and the Needle and Bitch collective in Indonesia use sewing workshops to educate women about sexual health and harassment (Sen & Hill, 2019). These collectives and individuals are pushing the boundaries of what is possible within the realm of art and technology, and they are using their work to raise awareness and effect change simultaneously. Like, for example, the DIY menstruation pad movement in Indonesia (Biyung, 2025).

The project's theoretical backbone

ETHICO-ONTO-EPISTEM-OLOGY

According to Barad, we can no longer see ourselves as detached from the world, because we are part of it, transforming what we see in a constant state of becoming. This idea is similar to what feminist science studies scholar Donna Haraway referred to as the 'god trick', the false notion of a neutral and detached perspective. Nobody can claim to be distant and static while experiencing and investigating the world. When we are in the world, we are suddenly faced with the presence of others and are therefore ethically responsible for responding to their needs. Barad's idea of an 'ethics of entanglement' involves being aware of and responding to ethical demands, influenced by the concept of facing the Other, as put forward by philosopher Emmanuel Levinas.

Following Karen Barad, ethics, ontology and epistemology are inseparable in our interaction with the world and the creation of knowledge. In Barad's framework, our ethical obligation extends beyond human–human relationships to acknowledge the interdependence of all beings in the universe. This means that the concept of 'otherness' is not fixed but created through the intra-actions between beings and the universe. This creates a sense of shared responsibility between all beings, not just humans.

Barad refers to this as an 'ethics of worlding', which emphasises responding to the needs and demands of the world rather than simply following a set of obligations. In this sense, ethics, being and knowing are intertwined and cannot be separated. The focus is on a relational and embodied approach to (inter)subjectivity, highlighting the importance of considering the impact of our actions on the world and its inhabitants (Geerts, 2025).

Diffraction

The study of how we come to understand and interact with the complex world around us involves multiple interdisciplinary approaches. One of these is the sociology of knowledge, which considers the relationship between symbolic forms of knowledge and objective social structures.

The communicative turn in social philosophy, influenced by Hans Herbert Kögler (1997), moved away from the two-world theory proposed by Kant, which distinguished between a subjective epistemic viewpoint and an objective empirical viewpoint. Instead, this approach focuses on the specific patterns of meaning that connect individual actions with objective social factors.

Objectivity is not about transcending all limitations and responsibilities but about embracing the limitations and specific perspectives of our embodied experiences. Reflective and reflexive practices have been important in qualitative research since the cultural turn. Pierre Bourdieu (1993) advocated the use of epis-

temic reflexivity, which acknowledges the impact of the researcher's social position on the knowledge-making process. The constructivist paradigm recognises that the object of study is closely tied to the methods used to study it, and that it is important to be aware of the values and biases that shape our understanding of the world. Reflectivity is informed by ways of knowing that are influenced by values and attitudes, which in turn shape how evidence, data and narratives are created. In the field of feminist studies, there has been a criticism of using metaphors based on sight, such as reflection, to understand knowledge production. Donna Haraway, a prominent feminist scholar, suggested using the concept of diffraction as an alternative.

Diffraction, in physics, refers to the interference of waves as they interact with obstacles. Haraway believes that diffraction can serve as a metaphor for a different kind of critical consciousness, one focused on making a difference and not just repeating old ideas. In diffractive methods, knowledge is seen as being closely connected to its sociocultural and relational context, and its definition depends on the ongoing process of knowledge production. This approach suggests a shift from simply collecting and representing data to a more interactive relationship with research subjects and the world.

According to Karen Barad (2007), diffraction patterns can be seen as the building blocks of the world, and the concept of diffraction offers a way to understand the world in terms of its variations and differences. Quantum mechanics teaches us that waves and particles can behave differently under certain conditions. In feminist philosophy, this idea of 'diffraction' has been used to describe a more open and aware way of thinking that takes differences into account. The new materialist tradition views difference as important and influential.

According to Donna Haraway (1997), diffraction offers a 'more subtle vision' than traditional scientific thinking. It allows us to better understand how differences are produced and their effects on people and the world. Haraway uses diffraction as an optical metaphor for a more critical and conscious way of seeing and thinking.

Karen Barad extends this idea by suggesting that reading and theorising about texts and philosophies can be done in a more dialogical and inclusive way, rather than using a hierarchical approach. This is what she calls 'diffractive communication'. By reading texts 'through one another', we can gain new and unexpected insights while respecting the differences between them. This approach can also blur the boundaries between disciplines and theories, leading to a more inclusive and respectful engagement with various practices.

Diffractive art hacking practices

Rosi Braidotti believes it is possible to embrace the current challenges in theories. By viewing ourselves as a collective, we can work towards practices that promote mutual understanding instead of causing harm. Karen Barad (2007) includes the role of particles and molecules in her perspective, stating that the meaning and existence of matter are intertwined. Barad's approach views differences as a constantly changing and dynamic force, lacking a fixed essence. Conflict and growth cannot be easily judged, but by embracing the interconnectedness of everything we can gain a better understanding of the world. The work of Donna Haraway (1998) emphasises the importance of embracing difficulties in order to take a closer look at reality.

Feminist hacking practices from around the world, like those in Ghana, Mexico, Indonesia and Germany, are connected through resilience in the face of power and influence (Avle & Lindtner, 2016; Lindtner et al., 2015). For feminist hackers, this means staying open-minded and avoiding quick solutions, instead continuously making connections to better understand the world. Jane Prophet and Helen Pritchard are pioneers in the study of diffractive art practices. In two instances, they have explored the relationship between art and 'agency'. In the first instance, they questioned the use of the term 'agency' in artificial life art, favouring the more relational term 'agential'. This new term destabilised the traditional subject–object binary. In the second instance, they studied the connection between media art and contemporary art practices, looking at how these practices are intertwined and emerge from patterns that are sometimes revealed through artworks.

Belsunces et al. (2017) introduced the concept of 'diffractive interfaces' as a way to research the relationship between art and education. They believe that this approach allows for dynamic interaction by experimenting with different relational patterns. The framework they propose can help to destabilise systems of representation and encourage the development of new ways of understanding the world. The intra-actions that occur in a learning setting result in a condition of preindividuation, where the focus is on the process of becoming rather than the final form.[20]

20 Scurto et al. (2021) propose a diffractive methodology for design research in the field of machine learning and material-centred interaction design. The authors suggest this method as a way to reveal the computational materiality of machine learning and the role of embodiment in the creation of machine learning prototypes. They outline five interference conditions for art-based machine learning prototypes and describe how these can expand the design and engineering practices of machine learning. Through diffractive practice, the authors propose a process of intra-active machine learning that positions materiality as the starting point for machine learning design in human–computer interaction.

Towards new materialist circuits

Our goal of ‘hacking’ hardware involves looking closely at the origins and production processes behind the materials used in our technology. We want to explore and understand the impact of colonial and extractive practices on the mining and manufacturing of these materials. To do so, we use creative storytelling and speculative fiction to examine the entire life cycle of these materials, from mining and transportation to production, consumption and disposal.

Our aim is to create a model for a more equitable and sustainable future, where technology is produced and used in a way that is less harmful to people and the environment. As artists, our goal is to provide a vision of a future that is less extractive, colonial and exploitative. To create minimum standards for feminist hardware production, we took a closer look at hardware commodity chains and embraced the principle of ethical hardware.

ICT commodity / supply chains and gender

'Commodity chain'[21] is a term used to describe the entire process involved in creating a product, from design to manufacturing and marketing. Global commodity chains have long been analysed, but researchers have often overlooked the importance of gender in these chains. One such example is Gereffi and Korzeniewicz (1994), who did not consider the impact of gender on labour strategies and worker households within commodity chains. From 1965 to 1975, the Fairchild Semiconductor plant in New Mexico was the second-largest employer of American Indians. Almost all of the people working on the assembly line creating electronics were women (Precarity Lab, 2019, p. 83). However, today it is clear that women* play a crucial role in global commodity production, especially in the informal sector of developing countries. In fact, women make up a large portion of the global workforce, including one-third of the manufacturing labour force in developing countries and more than half of all industrial workers in Asia. Women are also heavily concentrated in service jobs that support global manufacturing supply chains, and they provide a significant amount of unpaid family labour to sustain household-based farms and enterprises.

21 There have been different approaches to studying commodity chains, with some focusing on the role of large manufacturers in producer-driven chains and others focusing on the role of retailers and advertisers in buyer-driven chains. In producer-driven chains, multinational manufacturers are the key players, and industries such as cars, computers and heavy machinery fall under this category. On the other hand, in buyer-driven chains, large retailers and advertisers play a central role in establishing decentralised manufacturing networks in many exporting countries in the Global South. This type of commodity chain is commonly seen in labour-intensive industries like clothing and consumer electronics. In these chains, the actual processing of the product is separated from the design and marketing stages, and profits are generated through unique research, design, sales, marketing and financial services that connect overseas

Women's contributions, however, are often overlooked and undervalued. Women are less likely to leave the workforce during childbearing years, because of the limited job opportunities for men and their involvement in the informal sector and unpaid contributions. This highlights the need for a more comprehensive understanding of the role of gender in commodity chains and for recognition of the significant contributions of women in this sphere. Women who work in informal conditions, and therefore lack unions, are more vulnerable to market forces and changing prices. We should consider the surplus that capitalism gains from two important contributions made by worker households: reproduction of the labour force; and the provision of low-wage jobs (Dunaway, 2014; Hopkins & Wallerstein, 1977).

Feminist analysis of commodity chains includes examining the gendered nature of globalised production and the ways in which capitalism benefits from externalising the costs of maintaining and reproducing the labour force. This means that the cost of caring for workers and their families shifts to households and communities, which is seen as a crucial aspect of value extraction and capital accumulation in the globalised economy (Bair, 2005; Dunaway, 2014; Bettio & Verashchagina, 2008; Wallerstein, 1995).[22]

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factories with product niches in consumer markets. In simpler terms, there are two types of commodity chain: producer-driven and buyer-driven. The main difference between these two types is the role played by the companies involved. In producer-driven chains, companies that make advanced products such as airplanes and computers play a big part in controlling the entire process, from production to distribution. These companies are usually large multinational corporations. On the other hand, in buyer-driven chains, companies that produce and sell brand-name goods have the power to decide how, when and where products are made and how much profit is made at each stage of the process. These companies are often led by retailers and marketers. The two types of commodity chain are different in terms of the type of company involved, the industries they are in, and how profits are made.

22 It's important to note that the term 'reproductive' goes beyond the biological aspect of reproduction to encompass maintaining and supporting both the labour force and the community. This is because the capitalist system also needs to be reproduced and sustained (Truong, 1996; Dunaway, 2014; Marx, 1976, vol. 1).

The information and communication technology (ICT) supply chain is responsible for numerous human and environmental rights violations, according to the Local Governments for Sustainability, European Secretariat (ICLEI) and Electronics Watch (2020), a watchdog organisation focused on defending the rights of electronics workers. These violations range from long working hours, low pay and temporary contracts to child labour, armed conflict and environmental disasters. The new '*supply chain act* (Lieferkettengesetz) *aims to protect the rights of people who produce goods*' for the European market and '*ensure better human rights protection*' (Bundesregierung Deutschland, 2021). As of February 2024, it had not been implemented by European Union member states.

In commerce and in production basic human rights are frequently violated within global supply chains, with child labour, exploitation, discrimination and inadequate labour law protection. Environmental destruction is also covered by the bill – illegal logging, inappropriate use of pesticides, the contamination of water resources and air pollution.

(Bundesregierung Deutschland, 2021, online)

Ethical hardware

The concept of ethical hardware has attracted much attention in recent years because of the increasing awareness of the negative impacts of technology production on workers and the environment. Ethical hardware refers to electronic devices manufactured responsibly and sustainably, with the wellbeing of workers and the environment taken into consideration.
One of the main benefits of ethical hardware is that it can improve working conditions and reduce environmental harm. For example, a study by the International Labour Organization (ILO)

found that the electronics industry was characterised by long working hours, low wages and hazardous working conditions, leading to serious health problems among workers (ILO, 2018). In contrast, ethical hardware production was characterised by decent working conditions, fair wages and environmental sustainability, providing positive impacts for both workers and the environment (Liboiron & Austic, 2025).

Several challenges are associated with promoting ethical hardware. One of the main challenges is the complexity of the electronic supply chain, which spans multiple countries and involves numerous actors (Electronics Watch & ICLEI, 2020). This makes it difficult to monitor and regulate working conditions and environmental practices throughout the entire supply chain. Additionally, the fast pace of technological innovation and the demand for low-cost electronics products puts pressure on manufacturers to cut corners, resulting in labour and environmental abuses (Ho & Jensen, 2018).

Despite these challenges, several initiatives are aimed at promoting ethical hardware production practices. For example, the Electronic Industry Citizenship Coalition (EICC) is a global network of electronics companies that seeks to improve working conditions and environmental sustainability in the electronics industry (EICC, 2020). The Fairphone initiative, launched in 2013, is pioneering ethical hardware production by creating smartphones made with conflict-free minerals under fair working conditions (Fairphone, 2020).

In conclusion, the concept of ethical hardware is increasingly important because of the negative impacts of traditional electronics production on workers and the environment. While challenges exist in promoting ethical hardware, various initiatives are aimed at improving working conditions and environmental

sustainability in the electronics industry. Further research is needed to understand the best practices for promoting ethical hardware production and to assess the impact of these initiatives on workers and the environment.

Conflict materials

In the midst of increasing geo-political and geo-economic tensions between the US and China, the mining industry is expanding. The demand for raw materials to produce decarbonisation technologies (e.g. batteries for e-cars) is propelling new (dirty) investments into mines in Africa, South America and South-East Asia (Hertanti, 2023). So-called transition minerals come with significant social and ecological costs (Hertanti, 2023). At the time of writing this book, Rwanda's M23 attack on DR Congo is causing unthinkable human suffering for the sake of gold and coltan looting (Schwarz-Stiglbauer, 2023; Zane, 2025).

Mines for rare earth are in unique geopolitical positions and do not permit fair-trade alternatives. On the contrary, they actively destroy the existing democratic syntax of nation states (Rodney, 1972). Their monopoly causes modern slavery, child labour and violations against human rights. The only alternative to industrial mining seems to be ASM, namely artisanal and small-scale mining. It is conducted by families, groups or cooperatives on a small scale and with little support from technologies. In many places this comes at a high cost; for example, on the island of Lombok (ID), which neighbours Bali, communities are suffering from severe mercury contamination, because ASM miners use mercury to extract gold (Hidayatin et al., 2009; Paddock, 2016; Ahyadi et al., 2022). They are managing to avoid intermediate purchasers but harming their own land and families.

Another aspect is the viability of ASM. Will the European market be able to meet the demand from ASM mining combined with recycled and upcycled substances? What impact will implementing this law have on global economies?

These questions cannot be answered within the scope of this research. From a new feminist materialist perspective, even the far-reaching and ambitious law proposed by the European Commission will not question the violent concept of extraction, and it will not stop the expanding development of public lands and oceans. Returning to the question of which phenomena could de-escalate mutual transformation, we investigated ancient iterative intra-action, such as transformation based on handicrafts and pre-industrial production. Our arts-based research, therefore, started to engage with different forms of crafting and making.

Applying ancient community-centred crafts enabled us to find enough conductive, resistive or insolating substances to build circuits that comply with the code of conduct for feminist hardware. We propose a new ethical standard for tech development: 'a code of conduct for hardware' that demands the exclusion of conflict materials from tech development to halt colonialist violence and inequalities created through today's tech industry (Hertanti, 2023).

Our feminist hacking contributions

The feminist hardware kit – Clay PCB

The feminist hardware kit demystifies high-tech electronics and encourages debates about sustainable technologies. It consists of electronic parts made from clay, thread, mud and other conductive, insolating and resistive widely accessible substances.

The current PCBs (printed circuit boards) in most electronic devices contain plastic, which is light and durable but toxic after decay. We tried to substitute plastic boards with clay boards retrieved from the forest around Vienna, which, after weathering, turn into clay. Clay is available ubiquitously and can be made durable by heating it to up to 750 degrees Celsius in a bonfire. After burning this ancient substance, it is still quite heavy, but it can be formed and manufactured without tools. The earliest civilisations, for example the Babylonians, applied clay tablets as their preferred medium for human knowledge transfer. For the feminist hardware kit, we applied clay tablets as a substitute for printed circuit boards (see Part 2 for a more detailed description of the Clay PCB project).

Patrícia J. Reis and Stefanie Wuschitz,
Clay PCB, 10x10 cm, natural clay fired in
wood fire, silver, electronics
© Patrícia J. Reis

Gold is an important metal for hardware manufacturing because it does not corrode and it is highly conductive. We were researching the Indonesian Grasberg mine on Papua (the world's largest gold mine), which is owned by Freeport-McMoRan: '*US-based Freeport-McMoRan Copper & Gold holds a large stake in Freeport Indonesia. Freeport Indonesia was established as a new legal entity in 1991, replacing Freeport Indonesia Incorporated which had operated the Grasberg mine since 1967.*'[23] We did not

23 At this time, a *coup d'état* had enabled the New Order regime to destroy Indonesian democracy for more than thirty years: 'Freeport's seizure, control, and despoliation of Kamoro and Amungme lands and natural resources has circumscribed or destroyed local communities' economies and livelihoods, and caused the internal displacement -- often forcibly -- of entire villages.'

want to become complicit in this form of neo-colonialism (Hartami, 2023). The stealing of land and colonialism of pollution need to end (Liboiron, 2021), because they ruin the basis of all living.

For feminist hardware, we therefore explored the use of other metals and upcycled old china porcelain decorated with gold (see Part 2, Coffee Table project), using a technique known as lustreware.[24] It is applied to the clay tablet and burned with the clay to merge into one entity.

Patrícia J. Reis and Stefanie Wuschitz, in collaboration with Mz* Baltazar's Laboratory, Coffee Table 1, 2022
Photo © Gabriele Krisch

24 A metallic glaze composed of metallic oxides, namely gold, applied in a last firing at the melting temperature of the metal.

Minimum standards for feminist hardware

In this project we put together a set of rules that we intended to follow. A set of rules that worked almost like an algorithm, which limited, but simultaneously facilitated, our creative process:

FEMINIST HARDWARE IS DEVELOPED:

- Without mining in harmful ways
- In an environmentally friendly way
- Under fair working conditions
- Manufactured from ubiquitously available materials
- Without generating e-waste

This set of rules served as a starting point to explore practices of resistance against current forms of exploitation and extraction for hardware production. The experiments conducted on alternative assemblages for future technologies instigated debates on fair-traded, ethical, biodegradable hardware for environmental justice. In this sense, building circuits that use ancient community-centred crafts as an artistic practice encourages colonial thinking to be unlearnt, market forces to be disobeyed, and future technologies for the Chthulucene to be imagined.

Using fairly traded, recycled or existing materials only, we intended to answer our research question: *What is feminist hardware?* Forcing ourselves to comply with our own rules generated a range of experiments, trial-and-error attempts, frustrations, hacks and narratives that eventually evolved into new artworks. In the following chapters, we will describe these new artworks: Salon of Open Secrets — a feminist online hacklab; Acupuncture sonification; Low-tech Paper Pulp Lab; the Coffee Table; Who has land to make a fire?; the mud battery workshop; Clay PCB; the Salon of Open Secrets citizen science project; and our main research output, the Ethical Hardware Kit.

During our arts-based research, we learned about the principles of de-growth and educated ourselves about our complicity in toxic global commodity chains. Decolonising hardware means making sharing your priority (Tungstall, 2023, p. 69). So, we initiated several platforms to put our approach up for debate, for example at the Feminist Hardware Festival, the Salon of Open Secrets or other conferences that we took part in (e.g. POM 2022, RIXC Art Science Festival 2022, re:publica 2022, Schmiede 2022). We shared our concepts in the form of articles, manuals and tutorials.

Patrícia J. Reis, Stefanie Wuschitz and
Anna Watzinger, Conference at
Schmiede, Hallein, Austria, 2022
Photo © Gabriele Krisch

These rules or standards for feminist hardware constitute a boycott of hardware that relies on extraction, exploitation and colonisation. And they enable a playful, speculative and hopeful approach towards alternative solutions.

As media artists, we usually work with hardware such as computers and other electrical devices. To decolonise our practice, we had to go beyond demystifying the black box of this hardware, as feminist hacking implies, and dive deeper into understanding the basic elements of these circuits and chips. This journey took us (virtually) to many places, from gold mines in Indonesia to upcycling workshops in Cuba and e-waste landfills in Ghana. The interviews with international experts that we encountered are printed in shortened form in Part 3. These interviews represent a small selection of the wide range of interviews conducted during the entire research period.

ARTISTIC RESEARCH

PART 2

SOS STANDS FOR SALON OF OPEN SECRETS

NOW WHAT DOES THAT MEAN?

We began our research project, Feminist Hacking: Building Circuits as an Artistic Practice, on 1 March 2020. Sixteen days later, the Austrian government announced several measures designed to contain the spread of coronavirus, including temporarily closing down all universities in the country. We, the core project members at the time (Patrícia J. Reis, Taguhi Torosyan and Stefanie Wuschitz), were terrified and clueless about the future, just like everybody else around the world. Before we could even settle into our beautiful new office at the Academy of Fine Arts in Vienna, we found ourselves swiftly moving our books, materials and instruments back home. We were incredulous, emotionally disturbed, confused and also busy making sure that our friends, family and community would be safe. However, we considered ourselves fortunate to be in good health and privileged to be able to stay at home, while others had to go outside to secure the essentials for survival during confinement. Today, at the beginning of 2024, it feels like a lifetime ago, but we still remember that 'time' back then had a totally different meaning.

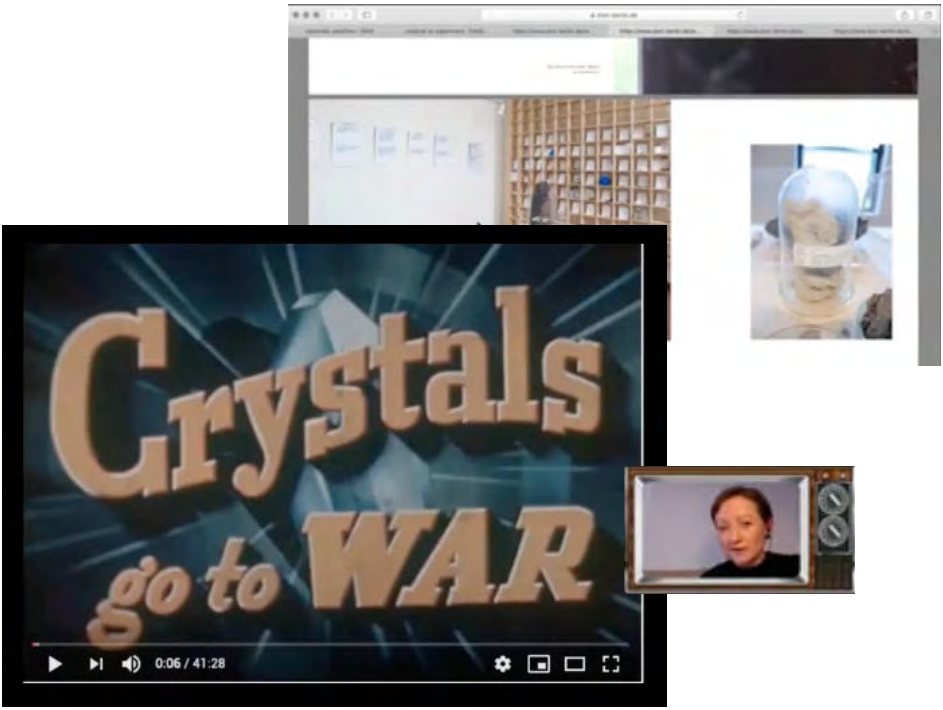
While trying to adjust to the future challenges, we made sure that we met online every day. Our first job was to identify national and international hardware manufacturers that could become partners in our project. We wanted to look at the whole hardware production cycle and commodity chain through critical and feminist lenses, decolonising by revealing the exploitative conditions of the processes (from mining to consuming) and also the labour conditions of its employees. One of our main hardware manufacturers was Seeed Studio, and our goal was to visit them in Shenzhen, China, to foster a closer collaboration between our feminist hardware open source project and their hardware production cycle. This didn't happen, because of the worldwide travel restrictions that were in place; and with that in mind, we had to adjust our research methodology to the new reality. We thought that, instead of reaching out to manufacturers (which were, in any case, shut down), we should reach out to peers, artists, researchers, feminist hackers, who, like us, were

confined to their home offices. And that is how the Salon of Open Secrets interviews began. From our own homes, we wanted to virtually re-enact our cosy hackerspace studio/gallery at Mz* Baltazar's Laboratory by creating a safer space, a conversation, a happening and a relationship with our peers around the world. Our Salon would reconnect everyone out there who was making and creating, succeeding and failing to do things and to think with things, managing to stay fascinated through the promise that technologies always held: to create a better and more liveable future for all.

What are open secrets? The elephants in the room? Gossip? Publicly censored and stigmatised topics? Everything at the same time, but not exclusively. We define open secrets as situated, niche and embodied experiences, know-how and fun — of being female*, of bending binaries with/through/in art, technologies, engineering and materials science, and of connecting in the most unexpected and life-affirming ways. Our basic format was an open online conversation with an artist, feminist, hacker, maker and scientist on the existing challenges and the solutions — weaving an interconnected web of materials, components, ecologies, economies, labour, hardware, geographies, ethics and politics of becoming in our more-than-human world. Later, when it was finally possible, we switched the format to our physical gallery space. The interviews were recorded in video and published openly on the Mz* Baltazar's Laboratory website. A summary of each episode follows.

Lilo Viehweg,
in conversation with Barbara Huber, Patrícia J. Reis, Taguhi Torosyan and Stefanie Wuschitz

What is a piezo? How can we read it historically and from a feminist viewpoint? We talk to Lilo Viehweg about the unknown history of piezo-electrics and her new materialist artistic practice with crystals.



Karin Reisinger,
in conversation with Patrícia J. Reis, Taguhi Torosyan and Stefanie Wuschitz

A mining town in the very north of Sweden, architecture, feminist and creative strategies and prolonged coloniality. We talk about feminist ecologies and mining from an architectural and community perspective, and the complex relationship between margins and the centre in terms of material flows and forced migration.

Cornelia Sollfrank,
in conversation with Patrícia J. Reis and Stefanie Wuschitz

We talk about Sollfrank's groundbreaking work, from cyberfeminism in the 1990s up until today. We discuss the dynamics of collaboration. What does it entail to share experiences and knowledge, and autonomous infrastructures – structures, spaces and platforms of visibility? How can we open up resources running on independent servers for common use? And other topics. What challenges does the digital represent for traditional aesthetics, what new forms of authorship, and what definitions of artwork emerge in the condition of reworking, modification, distribution and sharing? How can we define digital aesthetics today? How does the creation of artworks and collaborations play with these notions of the seemingly possible? We also discuss Sollfrank's research on net art, her work on the OBN and cyberfeminist international archives, and the ontological difference between cyberfeminist and techno-feminist phenomena and movements.

Paula Pin,

in conversation with Patrícia J. Reis, Taguhi Torosyan and Stefanie Wuschitz

Paula Pin talks to Mz* Baltazar's Laboratory about her pioneering work in the field of trans-feminism*biohacking. We talk about 'building' science fiction and hacking everything — incorporating technologies with bodies and biology — what Paula Pin terms the 'expanded body'.

Janne Kummer,

in conversation with Patrícia J. Reis, Taguhi Torosyan and Stefanie Wuschitz

We talk about Kummer's hacking practice in embodied interfaces. We discuss how, and which, bodies are represented and what that representation does to our bodies – both digital and analogue. What are the inscriptions of living in a neoliberal system as a female-read body?

Gaia Leandra and Ce Quimera,

in conversation with Patrícia J. Reis and Stefanie Wuschitz

We discuss the individual and collective definitions of trans-hack feminism. In particular, we talk about two distinct, but intertwined, approaches – that of hacking the sex, gender, sexuality, bodies, identities, bacteria and hacking; and the practice of transdisciplinarity and horizontal learning. In both cases, the questions of mutual care and building safer spaces for individuals with different sensibilities are important. Hence, the praxis of feminism is central to this particular fusion of art and science.

Giulia Tomasello and Arianna Forte,

in conversation with Patrícia J. Reis and Stefanie Wuschitz

We discuss speculative fiction breaking the taboos, stigmas and culture of shaming around female bodies, and we talk about methods of building self-empowerment and knowledge about intimacy through art, science and technologies.

ACUPUNCTURE SONIFICATION

MY FAIR ACUPUNCTURE SONGS

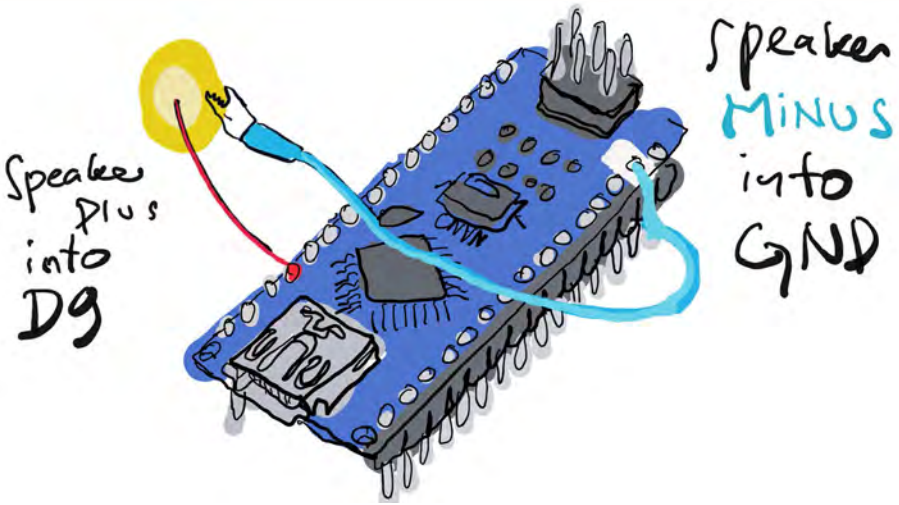
Are we hardware ourselves? Taking the body as input, perceiving it as a space to claim ownership over ('my body, my choice'), and as artistic material to explore and celebrate, is a relatively common approach among queer-feminist and trans-feminist artists and hackers. Resisting attempts to discipline, control, restrain and govern female-read bodies was a starting point for many legendary artists in the 1970s (Carolee Schneemann, Yoko Ono, Abramovic, etc..), who centred their artwork around their own bodies. Today, feminist hackers and biolab artists find inspiration in embodied technologies, embracing all of the fluids, phenomena and mysteries of the body.

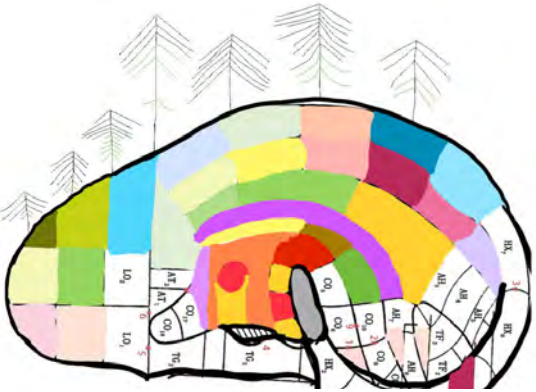
This particular project tackles the issue of technology as an extension of our bodies, and our bodies becoming an extension of technologies (McLuhan, 1964; Haraway, 2016). Even in their pre-technological form, our cells are sending and receiving signals, and tissue is organising around communicating neural networks connected to the brain. Our bodies are matter, matter that is sensitive to environmental changes and contamination. Our bodies are made of water (Neimanis, 2017) and therefore part of larger circles and entanglements. In traditional Chinese medicine (TCM), meridian networks are paths for chi — life energy — flowing through the body. Acupuncture points are located along these meridians and can be measured with devices called acupuncture locators. These electrical devices measure resistance on the skin and the capacity of the body to locate an acupuncture spot. We tried to imitate such a device in order to sonify its input. This DIY project uses a capacitor sensor to measure the skin's capacity and immediately translates it into sound frequencies. Our aim was to apply only fairly traded electronic components, as well as existing and recycled parts, to create this circuit. No acupuncture needles were involved in this project, not even recycled ones. Instead, we wanted to play with the notion of the body as a map of inner and outer sensa-

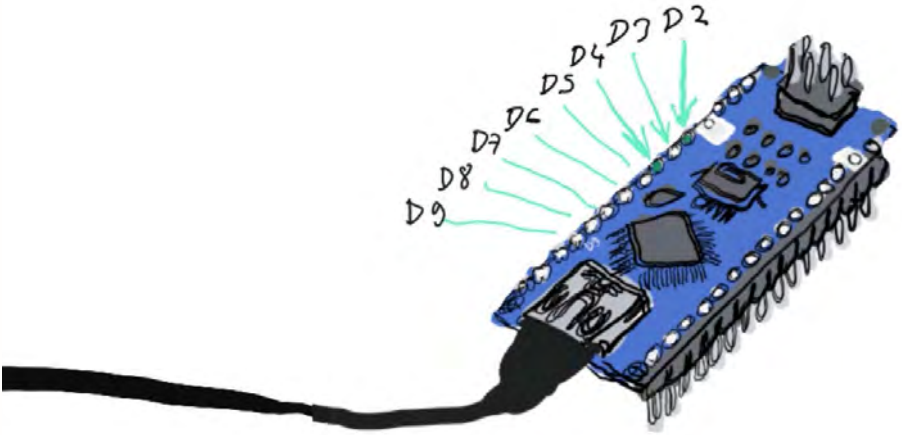
tions. The measurements can sonify acupuncture spots through differences in pitch (high or low sounds).

The open source microcontroller board Arduino compares the values coming in from two pins to see whether one of the electric fields is grounded (reaches equilibrium). The antenna of this capacitor sensor detects the body when the electric field around it gets close to the skin. The antenna that touches an acupuncture spot is grounded faster than it would be on a normal part of the skin. Based on this principle, we can measure different qualities of acupressure points and create music. In principle, we connect an antenna to our skin and listen. Depending on the capacity of the body using the Acupuncture sonification device, and depending on the resistance of the skin, the acupuncture points are translated into different sounds.

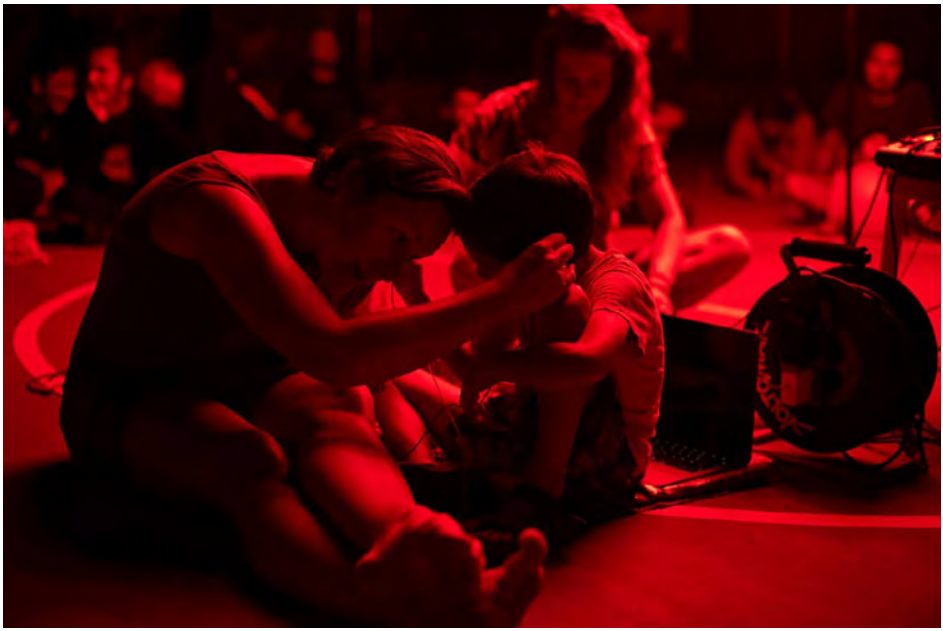
Illustrations by Stefanie Wuschitz, 2021







Performance by Stefanie Wuschitz with
her son Leo
Light installation by Janez Grošel,
2021
Photo at PIFcamp
Photo © Katja Goljat



Body Sonification Workshop at The Ludwig Foundation
by Patrícia J. Reis, Havana, Cuba, 2022
Photo © Patrícia J. Reis

LOW-TECH

PAPER PULP LAB

Recycling and upcycling have become increasingly important as we strive for a more sustainable future. In particular, the art world has played a crucial role in exploring creative ways to re-purpose waste materials.

The participatory installation Low-tech Paper Pulp Lab, a collaboration between artists Ana Rita António and Patrícia J. Reis, took place in 2022 in Havana, Cuba, as part of the Art Biennale. The goal was to gather individuals from diverse backgrounds and perspectives, encouraging collaboration with the artists in a happening/performance that enacted a commodity chain for recycling and upcycling paper. The four-week action began with an open call to participants to bring their own obsolete paper objects. The recycling laboratory was designed to resemble a 'kitchen studio', including various workstations for collecting, sorting, shredding, pulping, de-inking, drying and modelling the paper. Participants could choose which part of the chain they wanted to contribute to and participate in, as well as which object they wanted to create as the final outcome of their participation. Collaborators worked together in a close and intimate environment, fostering peer-to-peer and hands-on transfer of knowledge. The different stages of the production process were structured like a narrative, acting as a community laboratory that offered a temporary safer space for sharing, healing and contemplating future economic, ecological, social and affective sustainability.

Each object was thoroughly documented before and after the recycling process. We wanted to observe the process and artistic production in the specific context of Havana — a context in which recycling and upcycling are part of daily Cuban citizen routines, out of necessity because of the lack of materials and resources. In the end the workshop was more like an open working space in which we absorbed more knowledge than

we imparted. From collecting to modelling, there was always a moment of discussion, reflection and sharing knowledge. The most collected sources of paper were the national free distributed newspapers, such as *Gramma* and *Juventud Rebelde*, but also outdated books and flyers. Participants from all over Havana were happy to transform their newspapers into meaningful objects, often reflecting their thoughts on the current social, economic and political situation. In this book we present some of the outcomes, but, as the participants requested, their identity is kept confidential.

The Low-tech Paper Pulp Lab was designed by Ana Rita António and assembled through a modular system designed under an open source grid available on an online platform called Open Structures (https://www.openstructures.net/). Creatives from around the world contribute with the design of parts, allowing the structure to be organically rearranged and adapted for diverse purposes. What is a paper pulp lab today might be a greenhouse or shelter structure tomorrow.

The full schematics of the lab, including assembling instructions in English and Spanish, are available for download at https://anaritaantonio.com/.

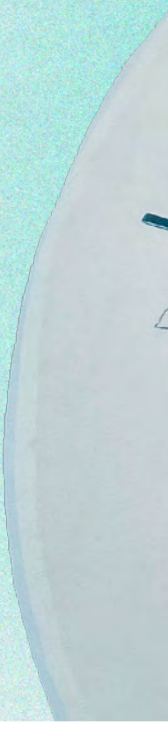
Ana Rita António and Patrícia J. Reis, Low-tech Paper Pulp Lab, 2022
Happening/Performance at the Havana Biennial, Havana, CU, dimensions variable

Photo credits
Workshop pictures: Kevin Sanchez
Lab: Ivo Oliveira Rodrigues

Schematics and drawings: Ana Rita António
This project has been further supported by: Norske Billedkunstnernes, Bergen Kommune, Norsk Kulturrådet, Vestland Fylkeskommune.

COFFEE TABLE

TABLECLOTX MZ* BALTAZAR'S LABORATORY



In the interactive installation Coffee Table (in German 'Kaffeekränzchen'), the legacy of gendered porcelain collecting, and the different functions and meaning of this in women's lives, was explored, while also engaging with themes of art, science and technology. The installation consisted of a set of porcelain vessels and plates arranged on a circular wooden table, surrounded by a series of interconnected circuits and wires. The vessels and plates were adorned with intricate floral patterns and delicate textures, showcasing the exquisite craftsmanship and aesthetic qualities of porcelain. The use of circuits and wires in the installation served as a metaphor for the interconnectedness of historical legacies, colonial histories (of gold mining) and contemporary technologies (which use gold in computer chips). And the use of porcelain vessels and plates alluded to the history of oppression and the global trade in luxury goods.

The installation represented an interactive circuit embroidered in a tablecloth with conductive textiles. The circuit used four open source hardware boards (Adafruit Audio FX Sound) that triggered sounds whenever a button was switched on. The buttons were triggered by old porcelain coffee cups with gold lustre. Gold has been urban mined as a conductive material that naturally establishes electric conductivity. The tablecloth worked as an instrument/performative tool: whenever one of the performers poured the coffee, 'drunk' the coffee or added sugar, a different sound was triggered. Sounds were collected from the natural coffee-drinking environment, but also from important texts that tackle the topic of coffee, gold and porcelain as precious materials mined in the Global South and brought to the Global North through colonialism and neo-colonialism.

The Coffee Table installation also addressed the legacy of gendered porcelain collecting, and the different functions and

meanings of this in women's lives. During the 17th century, the trend of decorating rooms with porcelain collections spread across Europe, with the chinoiserie cabinet being the most exclusive and ornate space. Women, in particular, collected porcelain, which was used not only as showpieces but also as suitable containers for hot drinks such as tea and coffee. The use of Asian porcelain for this purpose resulted in a significant rise in the amount of porcelain owned by women, and these items were legally counted as part of a woman's personal property and inherited by the female line. However, porcelain vessels were not always considered part of the female line of inheritance because they could be categorised as either tableware or ornamental items.

Collecting in general serves a deeper psychological and social need, and gendered collecting is a specific example of how humans use items to forge a sense of self. Women's ceramic collecting can be regarded as a form of both conspicuous consumption and social emulation, by which they imitated other women located higher on the social ladder. The gathering and exhibition of ceramics within the confines of individual women's lives was not just a reproduction of patriarchal norms but also a chance for them to actively create meaning for themselves and perform belonging to others. Porcelain was relegated from its practical purpose to an aesthetic one, valued for its tactile and visual features, and made accessible for the creation of adorning visual displays. When such pottery was used at all, it was often for ceremonial events like hosting significant visitors.

Like other works of art, they also assume extra importance as status symbols: they serve as a reflection of the owner's preferences and a platform for the display of taste and the application of specialised expertise. Since the capacity to enjoy them already constitutes a type of power, which was crucial for women,

they do not need to be possessed. At first, women collectors were rare, since they didn't have access to the financial means, education or freedom to pursue such activities. By the 1960s, however, the numbers had started to grow. It was also a way of constructing social networks through the gift economy between family and friends (Vincentelli, 2002).

Building on that legacy, we invited the participants to rethink the women's Coffee Table* gathering as a circulation of energies and potentialities that we exposed through the electric circuit, built with ecologically sentient methods and materials, reflecting on the colonial histories and presents of mining, import, consumption and performance (or faking) of belonging to a specific class or group.

The Coffee Table installation project is intricately connected to the principles of urban mining, upcycling and new materialism. Upcycling, a form of recycling, involves repurposing discarded or waste materials into new products that have higher value and functionality. The use of conductive gold porcelain cups in the installation is a prime example of upcycling and new materialism. Gold, a precious metal, is usually associated with jewellery or high-value financial transactions, as well as a safe investment. However, by repurposing it as a conductive material within an electric circuit, closed through fragile porcelain on a conductive tablecloth, the installation creates a unique blend of art, technology and sustainability.

Theoretical framework

New materialism is a framework that recognises the agency of matter, for example minerals and metals, in shaping human experience and culture, challenging the view that humans are the only agents of change. The Coffee Table installation project exemplified this perspective by repurposing gold porcelain cups, acknowledging the role of gold in shaping human technology and culture. The project denounces the human suffering caused by gold mining. It promotes sustainability by using upcycled gold on porcelain as a method. In this way, it acknowledges the tremendous social and environmental impact of mineral extraction as a global trade, speculating on ways of creating new relationships with natural resources that are more just and sustainable. The Coffee Table installation project took a decolonial perspective on the underlying social and environmental injustices of the computer chip industry. The use of upcycled materials to build an electric circuit challenged the dominant ideologies of economic growth enabled through exploitation of the peripheries, seeking to create awareness and a critical dialogue around imperialism and capitalism. The project instigated discussions to disrupt the silencing of witnesses of violent histories of resource extraction in the so-called Global South.

Performance

The installation was first presented in combination with a performative act during the Mz* Baltazar's Laboratory Salon of Open Secrets exhibition in 2022 at Kunstraum pro arte in Hallein, Austria; and then in 2023 at the Artistic Ceramics Bi-

ennial in Aveiro, Portugal. In the former, artists Patrícia J. Reis and Stefanie Wuschitz teamed up with artist–performers Anna Watzinger and Olivia Jaques (all active members of Mz* Baltazar's Laboratory collective) in a 15-minute performance, which started with all of the artists enacting coffee drinking as a female-connoted ritual while sitting in silence around the table. At minute 5, a shattering sound was triggered on the tablecloth as a clue for Watzinger and Jaques to take over and expand the performance to the audience, adding elements such as cleaning supplies, mirrors and, ultimately, a cake.

In the second performance – in Portugal – Reis and Wuschitz teamed up with local performers Ana Rita Carvalho and Silvia Amado in a 22-minute act, in which the interactive triggered sounds were added to a previously recorded main soundtrack containing the testimonies of our international project collaborators on the topic of ethical hardware, from their specific perspective.

Project collaborators: Gameli Adzaho and Seyram Avle from Ghana, Milton Raggi from Cuba, María Antonia González Valerio from México, Saad Chinoy from Singapore, Ira Agrivina from Indonesia, Hannah Perner-Wilson from Germany and Rajina Shresta from Nepal.

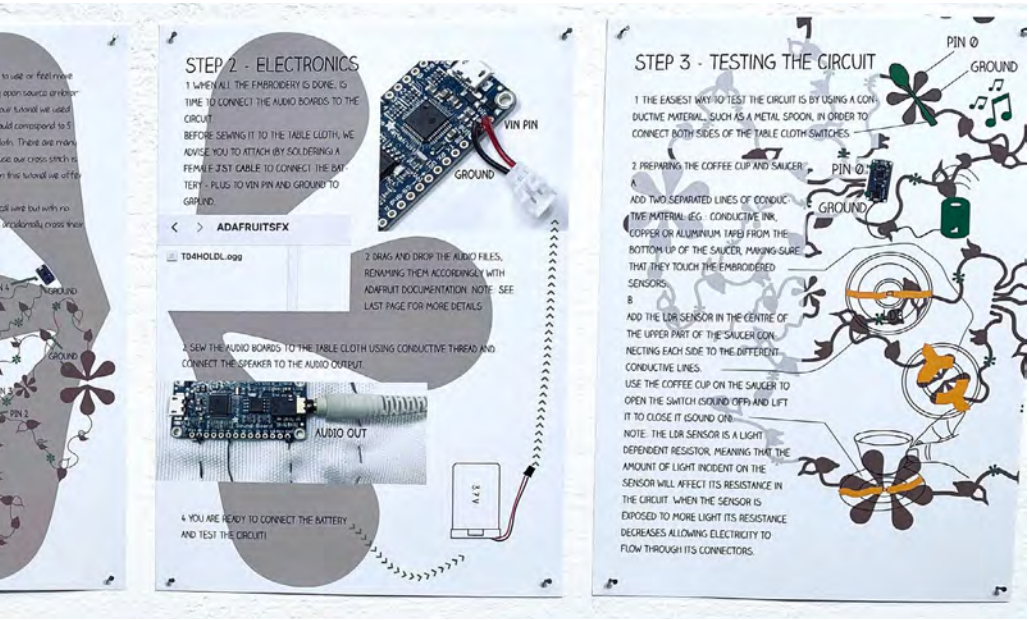
The installation is accompanied by a full manual describing, in detail, all of the necessary steps to make and program the tablecloth.

Patrícia J. Reis and Stefanie Wuschitz, in collaboration with Mz* Baltazar's Laboratory, Coffee Table 1, 2022

Interactive audio installation composed of embroidered circuit, four Adafruit Audio FX Sound Boards, conductive thread, modified lustred porcelain coffee set, metal spoons, transducer, mixing table, sound: stereo
Installation during the SOS 2.0_ Fürsorge ist die Schwester der Autonomie exhibition at the Medienwerkstatt in Vienna,
Austria, 2023–24
Photos © Janine Schranz

Patrícia J. Reis and Stefanie Wuschitz, in collaboration with Mz* Baltazar's Laboratory, Coffee Table 1, 2022
Interactive audio installation composed of embroidered circuit, four Adafruit Audio FX Sound Boards, conductive thread, modified lustred porcelain coffee set, metal spoons, four audio channels
Installation during the Salon of Open Secrets exhibition at Kunstraum pro arte in Hallein, Austria, 2022

Embroidery: Erika Farina
Photo © Gabriele Krisch
Photo © Patrícia Reis



Patrícia J. Reis and Stefanie Wuschitz, in collaboration with Mz* Baltazar's Laboratory, Coffee Table 2, 2023
Interactive audio installation composed of embroidered circuit, four Adafruit Audio FX Sound Boards, conductive thread, modified lustred porcelain coffee set, silver spoons, transducer, mixing table, sound: stereo, 22 min.

Installation during the Coffee Table exhibition at the Artistic Ceramics Biennial in Aveiro, Portugal, 2023

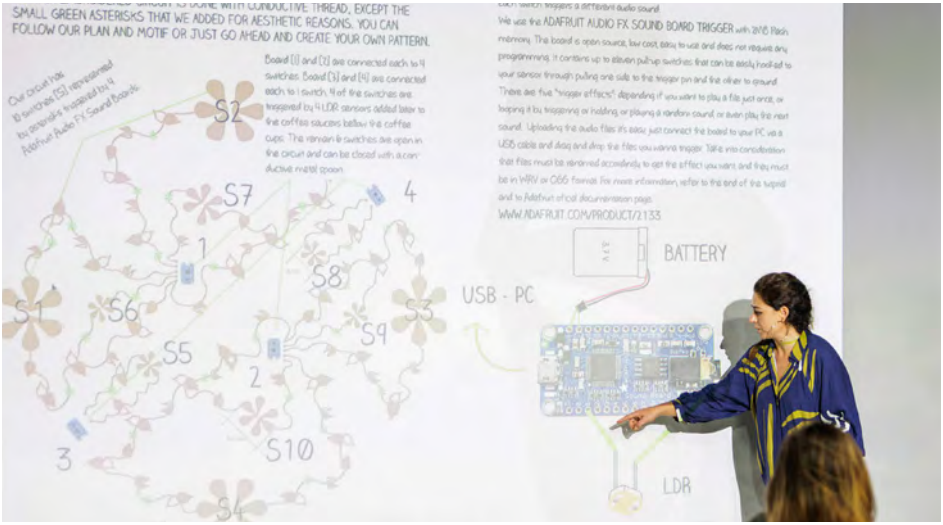
Embroidery: Erika Farina
Sound: José Lopes
Video: João Nunes

The installation features testimonies by: Gameli Adzaho, Seyram Avle, Milton Raggi, María Antonia González Valerio, Saad Chinoy, Ira Agrivina, Hannah Perner-Wilson, Rajina Shresta.
Still from video © João Nunes

Coffee Table workshop, Ljubljana

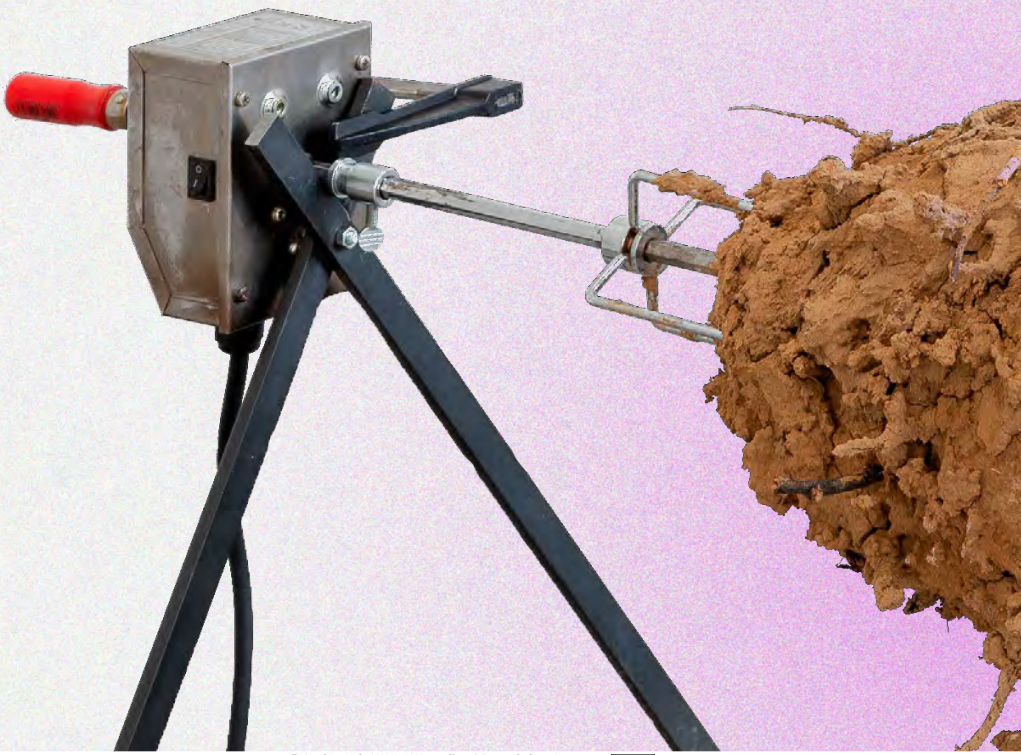
As a follow-up to the Coffee Table installation, we offered a workshop with the same name in Ljubljana, Slovenia, in 2022. Building on the legacy of the feminist salon culture of the 1920s, we invited participants to rethink the women's Coffee Table gathering as a circulation of energies and potentialities that we expose through the electric circuits. Forms of collective knowledge transfer that were believed to be outdated, such as a secret, a coffee party or a manual, are playfully reactivated.

Remembering these outdated forms, while also becoming aware of their colonial context, can inspire generative resistance. The workshop focused on the need to build these electric circuits using ecologically sentient methods and materials, reflecting on the colonial histories and presents of mining, import, consumption and appreciation of art and hardware. We asked participants to bring old cups with gold decoration (if they had any), which we implemented into DIY sensors.

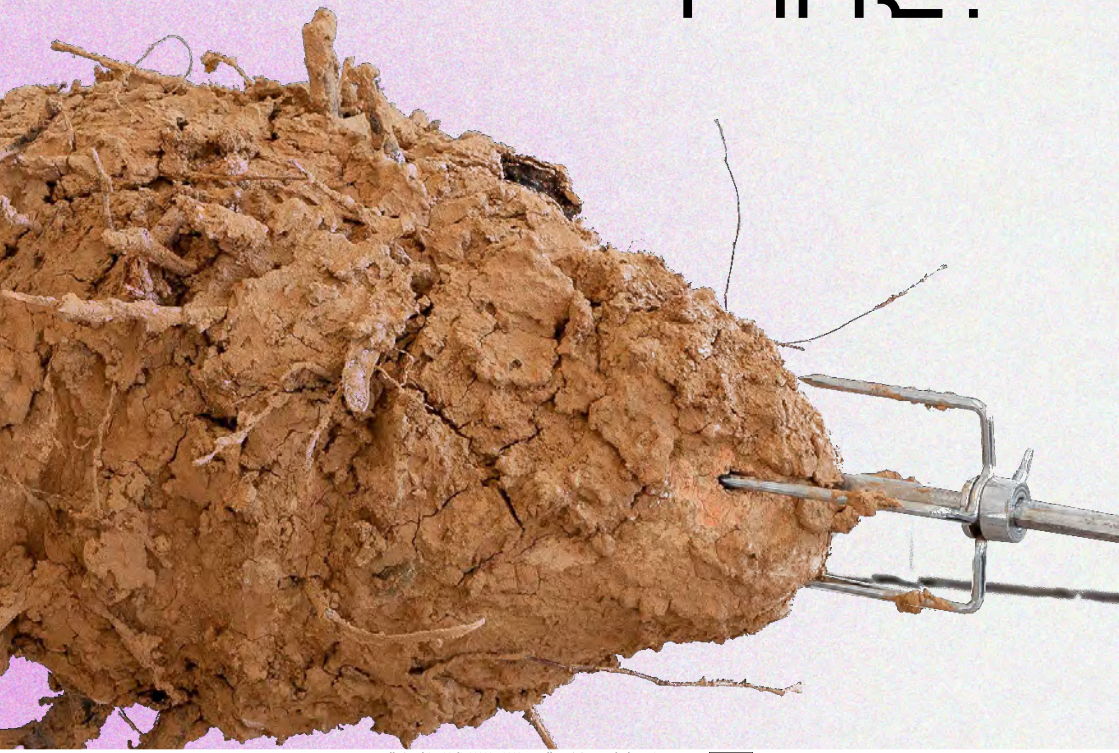


Coffee Table: workshop on ethical hardware, wearable tech and feminist hacking by Patrícia J. Reis and Stefanie Wuschitz, at project Atol, Ljubljana, Slovenia
19 October 2022
Photo © Matjaž Rušt

MUD-GROUP



WHO HAS LAND TO MAKE A FIRE?



The Mud-Group III exhibition, titled 'Who has land to make a fire?', served as preliminary research for the Clay PCB project (Clay PCB). The aim was twofold: first, to explore and experiment with ancient methods of firing locally sourced clay using an open wood fire, thereby reducing the carbon footprint of firing ceramics in an electric kiln; and, second, to highlight the challenges faced by artists and makers striving for autonomy and independence of shared resources, knowledge and space. This endeavour involved questioning the politics of ownership and claiming and hacking a public infrastructure within the city of Vienna: Donauinsel (Danube Island or 'Donau Island').

The project by Patrícia J. Reis, Céline Struger and Kristin Weissenberger was presented at Mz* Baltazar's Laboratory (2023), Vienna, in the form of an exhibition. It revolved around the group's collaborative and artistic process, using ceramics as their primary medium for exploration. The group's goal was to create a shared artistic process that encouraged reflection and discussion among the artists involved. Through this project, the artists also wanted to shed light on the emancipation history of female artists and to explore the relationship between ceramics, hacking and other fields of art (Vincentelli, 2002).

Ceramics have also increasingly been discussed as materials with agency within the discourse of new materialism, which emphasises the active role of materials in shaping, and being shaped by, social, cultural and historical contexts (Bennett, 2010). Ceramicists have long been aware of the agency of their materials, as the process of creating ceramics involves a dialogue between the artist and the material itself.

According to Jane Bennett (2010), 'vibrant matter' has its own agency and vitality — it is not merely a passive object to be acted upon by human agents. Ceramic materials, like other materi-

als, have their own properties and capacities; they can exert influence over the artist's process and the final outcome of the artwork. For instance, the way that clay responds to touch, the effects of heat on glazes, and the colours and textures of various clay bodies all contribute to the creative process and the final product.

For this project, the artists wanted to employ an ancient technique involving firing natural clay in a wood fire. Considering that lighting open fires in public spaces within the city of Vienna is restricted, except for designated areas for barbecues, the artists asked the question, 'Who has the land to make a fire?' This inquiry reflects a positive inclination towards embracing traditional, low-tech methods for warmth, light and community-building through fire, as well as a critical perspective. It not only signifies a desire to move away from the often-detached and impersonal experiences of contemporary urban lifestyles, but also expresses a yearning to establish more direct, embodied connections with nature and others. By raising this question, the artists were demonstrating their radical intent to challenge conventional understandings of ownership, property and resource access, while also exploring sustainable communal living and alternative models of resource use.

The Mud-Group's artistic journey began with a series of initial meetings where the members explored their shared interests in ceramics, particularly the cultural and feminist background. The group recognised the importance of using traditional techniques and materials as a way to resist capitalist production methods and to highlight the importance of sustainable and ethical hardware. As the group members developed their artistic practice, they began to experiment with ancient ceramic production techniques in a workshop located in the forest. The group members were able to learn about, and incorporate, sus-

tainable methods for producing ceramics, which furthered their commitment to anti-capitalist practices.

However, the Mud-Group's radical attitude did not stop there. They continued their exploration of autonomy by hacking/repurposing the city infrastructure and reclaiming a public space on Donau Island. Donau Island's public barbecue spots in Vienna, established in the 1970s following social–democratic reforms, are still in use today and attract visitors from all walks of life. While some upper/middle-class and privileged citizens view the spots as unsanitary and a nuisance, these areas serve as a vital social and cultural space embraced by many first- and second-generation families with migrant heritage, and new Austrians, celebrating their cultural traditions and communities. These differing attitudes towards the public barbecue areas are indicative of a larger issue of class and cultural segregation in Austrian society. Privileged citizens may not understand the importance of the barbecue spots for people who have struggled for representation in public space and to find areas to celebrate without being harassed.

During this exercise, the group members questioned the idea of public space and ownership, using their art to push boundaries and reclaim space for public use. Hacking urban infrastructure for autonomous living refers to the practice of using and repurposing existing urban infrastructure for self-sufficient and sustainable living. This practice has gained popularity in recent years as people seek alternative solutions to live off the grid and reduce their reliance on traditional forms of infrastructure, such as power grids and water supply systems. Ethical hardware and DIY approaches play a crucial role in this process, enabling individuals to build and maintain their own sustainable systems. By hacking and repurposing existing infrastructure, individuals can create their own networks of sustainable resources, allow-

ing for greater autonomy and resilience. This practice not only promotes self-sufficiency but also contributes to a more sustainable and ethical use of urban resources.

Artistic hacking is also becoming increasingly popular as a means of creating sustainable living solutions. By incorporating creative and artistic elements into the design and implementation of autonomous living systems, individuals and communities can create more engaging and aesthetically pleasing solutions that are also functional.

Through the exhibition, visitors were able to witness the Mud-Group's artistic journey and its members' commitment to sustainable and ethical hardware, autonomy and a DIY approach to ceramic production. The exhibition showcased the group's artwork, including ceramics produced using traditional techniques, as well as video documentation of their public space reclamation project on Donau Island.

Furthermore, this installation presented two unique pieces. First, a water fountain made entirely out of ceramic pieces that were fired at Donau Island, with ceramic plates holding cups collected from common spaces such as offices and artist ateliers. The cups, which carry advertisements, are intentionally covered with broken glass melted onto them. The second piece features a customised metal structure specifically built for barbecue place number 12, along with a hacked barbecue rod typically used for cooking chicken. This piece re-enacts the firing process and adds to the overall experience of the installation.

Céline Struger, Kristin Weissenberger and Patrícia J. Reis, Who has land to make a fire?

2023 Installation composed of water fountain made of natural clay collected in Austria (Burgenland) and fired in the public barbecue of Donau Island in Vienna

Industrial cups with diverse advertisements covered with melted waste glass, rounded barbecue metal structure with electrical rod customised and natural clay

Video with documentation of the action at Donau Island in Vienna, COLOUR, FULL-HD, MUTE, 43 min.

Photo © Flavio Palasciano

Céline Struger, Kristin Weissenberger and Patrícia J. Reis,
Who has land to make a fire?

2023, detail video with documentation of the action at Donau Island in Vienna, COLOUR, FULL-HD, MUTE, 43 min.

MUD BATTERY

Imagining feminist hardware as a more ethical technology made us look for renewable energy sources that could empower feminist hardware. In 2021 we invited Julian Chollet, a member of *Mikrobiomik*, to run a two-day online workshop on microbial fuel cells with our team (https://mikrobiomik.org/). He explained that the term 'microbiome' is used to describe the sum of all microorganisms that populate a specific ecosystem. The mud battery is therefore not a battery but a microbial fuel cell, which means it will never go empty like batteries do. Instead, it 'grows' electrons, as long as you regularly feed the microorganisms and keep the soil temperature stable. The way that microbacteria can generate an electric current was recently discovered by biologists and later implemented in a variety of applications, for example powering sensors on the ocean floor. The mud battery workshop conducted in 2022 was supposed to open up a discussion about how we will generate energy in the future, and whether it is okay to 'use' microorganisms to generate 'our' electricity?

After experimenting with many different forms, shapes and compositions for mud batteries and their potential applications in art projects, we held a mud battery workshop at Mz* Baltazar's Lab. It was early spring 2022 when we carried a table and some chairs to the park in front of the lab. The intention was to open up the hacklab to new workshop participants and (inspired by Anja Groten) make it intergenerational. Several children who played in that particular neighbourhood joined in. It was a dynamic situation that strengthened our ties with people living nearby — it was a densely populated public housing area, with people often living in precarious conditions. Our intention was to invite mums to hack with us, so we tried to provide workshop content that could be exciting for both adults and children. But we did not succeed in keeping participating mums interested in hacking, because they were mostly enjoying a short break from childcare. While their children were busy building mud batteries, they were enjoying some well-deserved 'me time'. For future workshops, we might need to provide a separate space for it.

What we learned from giving this workshop was that outdoor workshops are more inclusive. They attract people who would otherwise be hesitant to enter the hacklab/studio space and sign up for a workshop. We also found that the content of the workshop needs to be meaningful to different age groups. This can be accomplished by distributing tasks that are more or less challenging among children and caretakers. The caretakers who stayed and engaged in the workshop expressed their appreciation for being seen and heard with their challenges. As long as no shared language is required, workshops in urban public spaces of diverse neighbourhoods can provide platforms of exchange, and hands-on practices allow people with different mother tongues and from different age groups to join in and collaborate. Some parents later brought food, snacks and even fresh hot soup down to our table, turning the end of the workshop into a spontaneous picnic. Even weeks after the workshop, participants still came up to me on the street to say hello and share a smile.

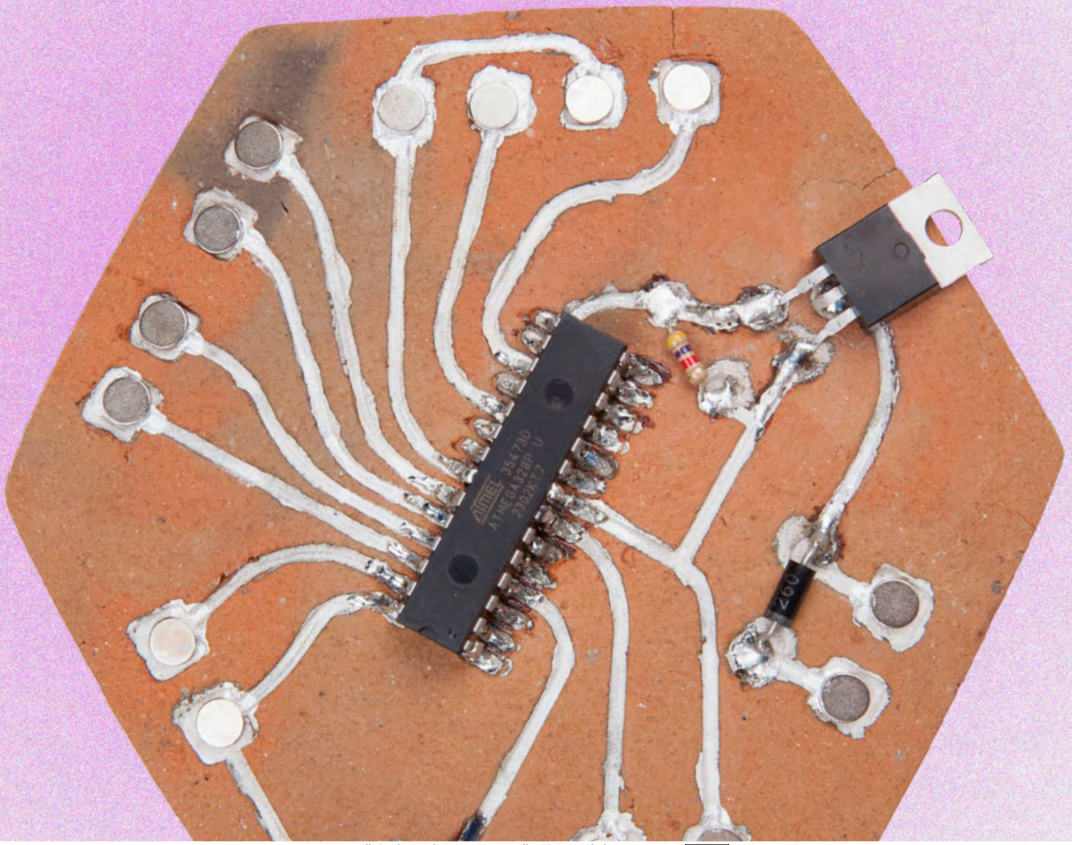
We later gave this workshop in Berlin at the re:publica 22 Conference. Here, the challenges were very different: it was difficult to find real mud on site. It was a key takeaway of the workshop in Berlin that stealing soil from plant pots is counter-productive, because plant fertilisers change the milieu for microbacteria within the soil. What was positive about this workshop was that Saad Chinoy dropped by, becoming an important collaborator and contributor to our citizen science project with an interview that was later used to create a Saad Chinoy avatar (Part 3).

Workshop with Julian Chollet via Zoom at Mz* Baltazar's Lab, Vienna, 2022
Photo © Patrícia J. Reis

Intergenerational workshop in urban public space, organised by Olivia Jaques and Stefanie Wuschitz, Vienna, 2022
Photo © Olivia Jaques

Feminist hardware workshop at re:publica 22 by Stefanie Wuschitz (with live interview in Deutschlandradio), Berlin, 2022
Photo © re:publica 22

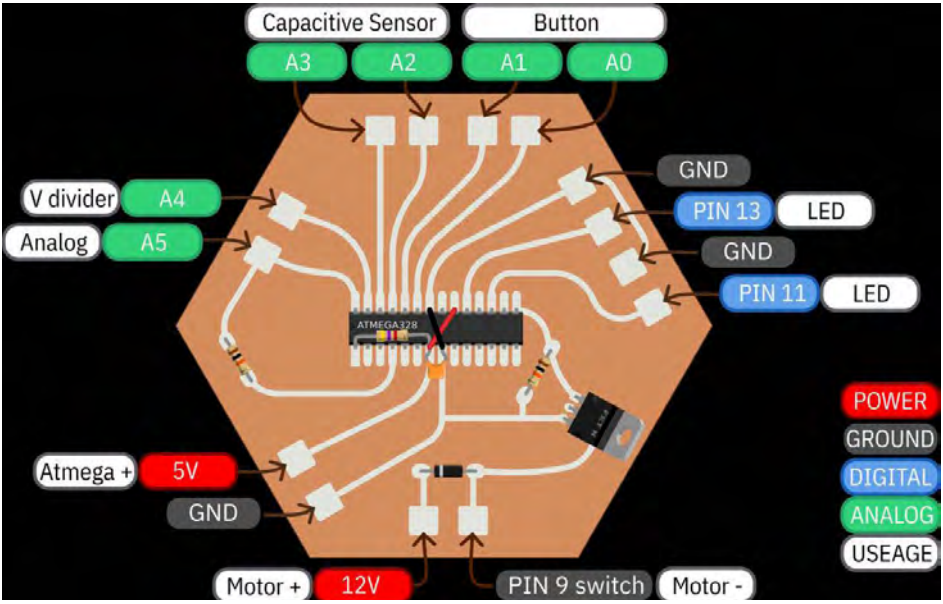
CLAY PCB



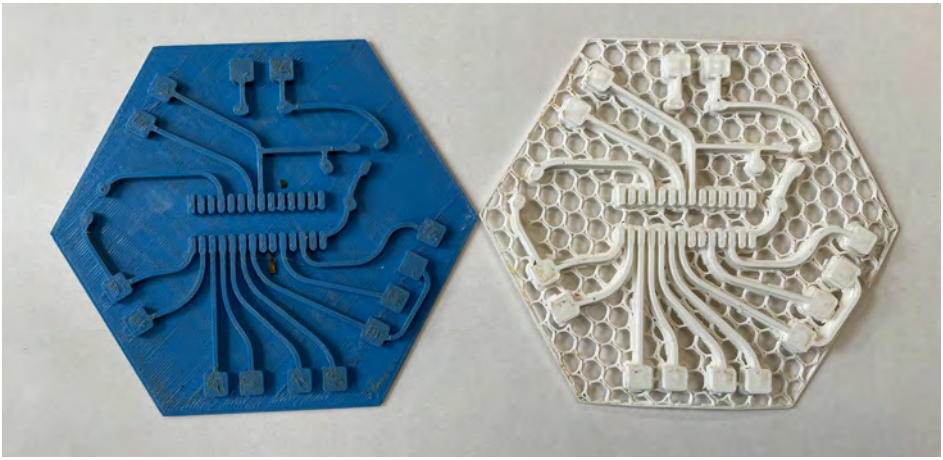
It is an open secret that the hardware in our smart devices contains not only plastics but also conflict minerals such as tungsten, tin, tantalum, silver and gold. We are investigating alternative hardware from locally sourced materials — so-called ethical hardware — to develop and speculate upon renewable practices for the benefit of both nature and humans. We are exploring different materials: sentient, low-impact, non-toxic, fairly traded, recycled and urban-mined means of production. We aim to challenge the common PCB (printed circuit board) economies in an artistic, creative, positive and responsible way, applying feminist hacking as an artistic methodology and critical framework.

Our initial idea was to develop a microcontroller PCB imprinted on clay that could work with the ATmega328P chip, commonly used in the famous Arduino Uno board (or Arduina board, as some feminists call it).

Why this chip? Because we are part of a community hackerspace — Mz* Baltazar's Lab (a feminist hacklab and artist-run off-space based in Vienna, Austria) — and the Arduino Uno has been our favourite microcontroller in the past 12 years. After using it in many prototypes, artworks and workshops, we had several malfunctioning Arduino boards left over. But their chips were still working, so the idea was to reuse them in our new project. The second challenge was to come up with an electric circuit that would allow us to receive several forms of input signal (analogue and digital sensors) and generate a variety of output signals (to control LEDs, motors and speakers), using the lowest amount of ATmega chip pins possible in order to simplify the circuit. We wanted to reduce the circuit to a single layer that could be imprinted in a piece of clay as a 'stamp'. We came up with a 3D-printed 'stamp' using a recycled polypropylene filament. This took a while, because we had to consider the clay's shrinkage rate after drying and firing.



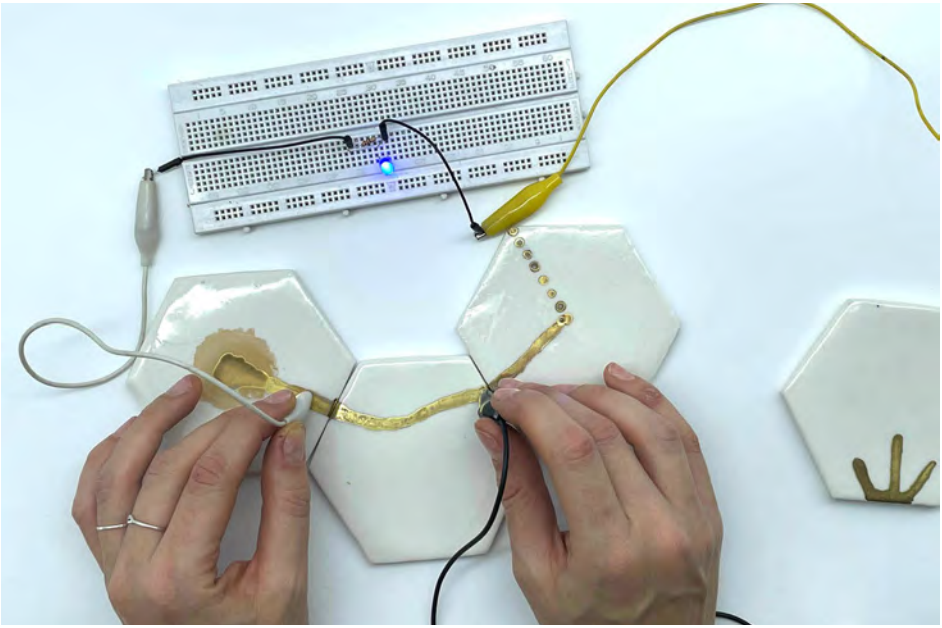
PCB Schematic of the circuit with input and output. Designed by Daniel Schatzmayer, Klemens Kohlweis and Patrícia J. Reis, Vienna, 2022



3D-printed circuit stamp, printed on recycled polypropylene filament, designed by Klemens Kohlweis, Vienna, 2022
Photo © Patrícia J. Reis

When we began the research into alternative materials for circuit building, we separated the materials into two categories: conducting and insulating. To build the base of our PCB, we needed insulating, sustainable and robust materials (eggshells? wood plates? wax? ceramics?). We immediately chose ceramics, specifically porcelain, as it plays an important role in electronic components, such as capacitors, piezo and resistors. Porcelain is an industrial-made material composed of kaolin (the main ingredient that makes it plastic and white) and stone pottery (the second ingredient that makes porcelain translucent and hard). Both are well-known commodities prospected and mined around the world, on a small scale in Europe and a larger scale in China, Brazil, South Africa and Vietnam (among others). In pottery, porcelain, also known as china clay, is a very delicate and sensitive material (we could say it has its own agency), more difficult to control than other industrial clays. Also, along with the other harder and resistant stoneware clays, it usually requires higher firing temperatures in two stages: a first firing known as ceramic bisque of around 1000 degrees Celsius; and a glazing firing of around 1200 degrees Celsius in an electric kiln. During our first experiments with porcelain, we quickly realised that the higher temperatures, and therefore electric consumption, were not compatible with our standards for ethical hardware.

Experiments with conductive material on porcelain by Patrícia J. Reis, Vienna, 2021
Photo © Patrícia J. Reis



Experiments with gold lustre conductivity
on porcelain by Patrícia J. Reis, Vienna, 2021
Photo © Patrícia J. Reis

It was when we were struggling with the question of how to manufacture clay in low-energy and low-impact ways that we came across the work of Heinz Lackinger, a pottery crafter from Donnerskirchen, Burgenland, Austria, who works with prehistoric techniques of firing clay in an open wood fire. Instead of sophisticated machines, he uses a simple hole in the ground of his 18th-century backyard. We had the privilege of spending two days with this skilled craftsman, learning how to identify and collect the clay, how to model it and fire it using old, dry branches collected from forest ground. If the clay is collected with an awareness of its many qualities, and in small quantities only, this process can be defined as 100% fair trade and congruent with locally sourced modes of hardware production. We owe the knowledge required for the following steps to Heinz Lackinger's generous knowledge transfer during his workshop, and to our own experiments with later applying this technique in the making of natural PCB clay boards.

Collecting clay during the workshop
with Heinz Lackinger at Donnerskirchen,
Burgenland, Austria, November 2022
Photo © Patrícia J. Reis

Firing the natural clay during the workshop
with Heinz Lackinger at Donnerskirchen,
Burgenland, Austria, November 2022
Photo © Patrícia J. Reis

We collected our wild clay at the beginning of autumn, when the weather was dry. The soil was mainly dry but did not consist of argil alone: we found little stones, plants, even small insects. When clay is that dry, the easiest way to clean it is using a net that retains the undesirable waste. The organic waste collected should be given back to earth, back to the ground. After cleaning, we ended up with a fine powder that requires water and much care, while mixing it until a consistency of solid and malleable clay is achieved. The natural clay is very fragile and less elastic than the industrial type, so patience and care are required.

Cleaning the natural clay at Donnerskirchen, Burgenland, Austria, October 2023
© Patrícia J. Reis

Clay after cleaning and adding water, Burgenland, Austria, October 2023
© Patrícia J. Reis

For the form of our PCB board, we chose a hexagon shape, hoping to assemble the boards as tiles next to one another, connecting them electronically. We ultimately abandoned this idea since it was very difficult (with this kind of clay) to obtain straight edges that lined up neatly next to one another. After cutting the shape, we pressed the 3D-printed stamp gently against the clay to imprint the circuit. The result was engraved circuit lines that serve as a guide for painting the circuit with a conductive material.

Cutting the hexagon shape using a tile cutter, Burgenland, Austria, October 2023
© Patrícia J. Reis

'Stamping' the circuit into the clay with the 3D-printed 'stamp', Burgenland, Austria, October 2023
© Patrícia J. Reis

While searching for conductive materials that can be used in ceramics, we came across a gold lustre (often used in gold details on porcelain) that, after firing, becomes conductive (the same kind was used in our Coffee Table project). The first problem we encountered was that this product is usually sold by ceramic shops that supply no information about its ingredients, especially on the sources of the gold and its complex commodity chain. The second problem was that it is not possible to solder directly on this gold lustre, so we had to add another precious metal to the equation. The challenge was to find within the solderable and readily available precious metals, such as tin, copper, brass and silver, one that could bear the firing process, which is around 700 degrees Celsius, and at the same time maintain its conductive properties. As we know, tin, mostly used for soldering, melts at a very low temperature, copper melts at approximately 1000 degrees Celsius, but the oxidation process happens so quickly in the fire that it loses its conductive properties. And the same thing happens with brass. We were left with silver, which, although it also oxidises with the fire, maintains its conductive properties. Also, silver is cheaper than gold and widely used by goldsmiths. We were able to find a silver paint, commercialised by a German company, made with waste silver powder collected by jewellery makers — a form of urban mining of silver dust.

To paint the circuit, a huge amount of patience and dedication are required, since the final circuit lines cannot be crossed. There would have been many other ways to print the circuit avoiding this time-consuming hand painting, for instance using a stencil mask and spraying on it or using another paint-transferring technique. The reason we chose this method is because it appears to be more economical and sustainable and generates almost no waste paint.

Painting the PCB circuit on the clay boards with silver ink, Burgenland, Austria, October 2023
© Patrícia J. Reis

Boards after painting during the drying process, Burgenland, Austria, October 2023
© Patrícia J. Reis

We fired the boards in our backyard, reusing a hole that had previously been dug for this purpose. The wood was collected *in situ* and consisted of dry wood sticks and old branches from our trees. We started a normal fire to generate some heat and placed all of the boards around it so they could finish drying. It is important to achieve a temperature of around 700 degrees Celsius, but this is obviously hard to control. Our experience tells us that 20 minutes is the average time the boards need to be in the fire. After this, we should be able to see the boards glow in the fire, which is when they are ready. Using tongs, we were able to quickly transfer them from the fire to a bucket of cold water and leave them there, holding them for a few seconds with the tongs.

This is usually the ultimate ‘proof’ test for the clay. If there are no air bubbles, stones or cracks, and if dried properly, it can resist the cold water.

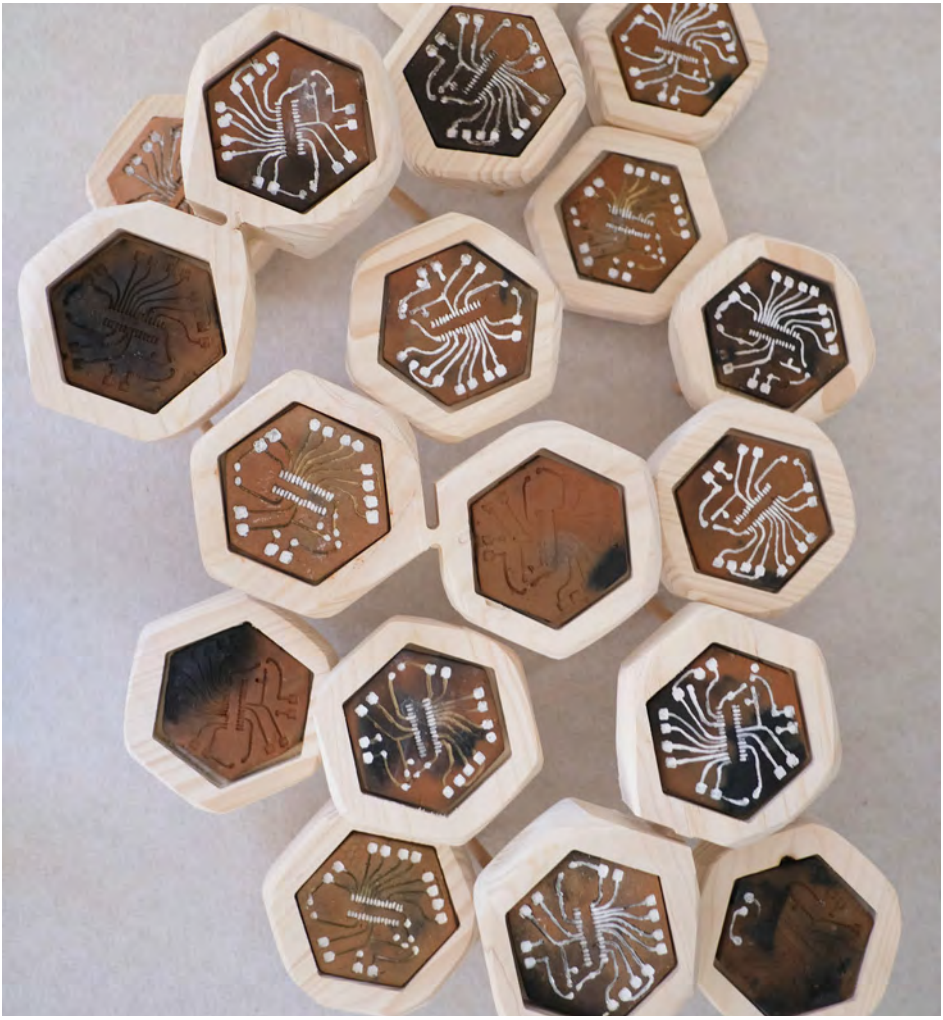
Placing the boards in the open fire,
Burgenland, Austria,
October 2023
© Patrícia J. Reis

Boards glowing in the fire after approx. 20
minutes, Burgenland, Austria, October 2023
© Patrícia J. Reis

Transferring the boards directly from the fire into a bucket of cold water, Burgenland, Austria, October 2023
© Patrícia J. Reis

Final boards after firing, Burgenland, Austria, October 2023
© Patrícia J. Reis

After this process, we bootloaded and programmed the chip and soldered all the electronic components. A full step-by-step guide of all the processes can be found on our repository page at Github:
https://github.com/FeministHardware/Making-PCBs-from-natural-clay



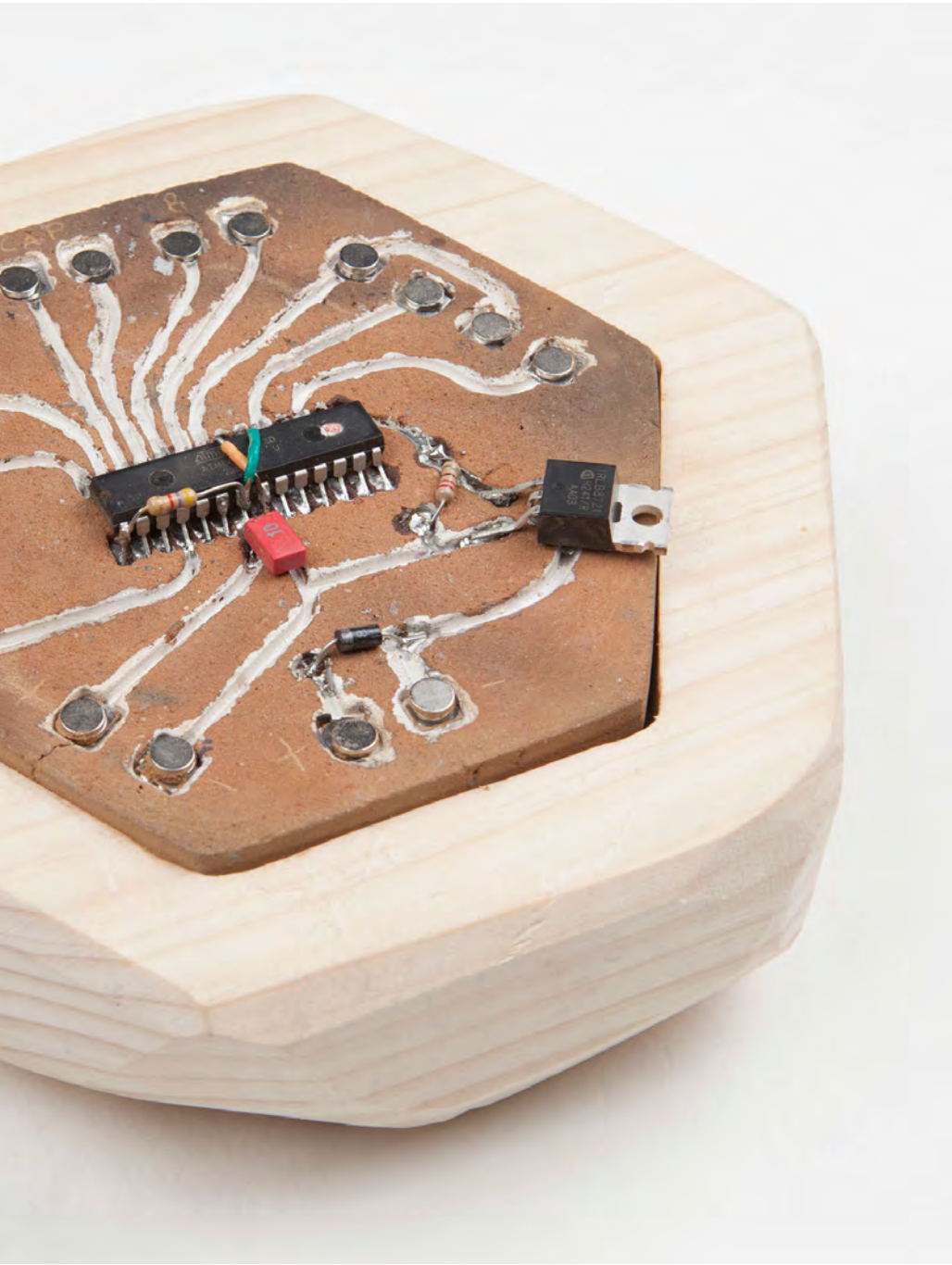
Boards after soldering all the components
© Janine Schranz

In October 2023 we had the privilege of being invited to give a two-day workshop on this topic by the Hangar, Visual Arts Research and Production Centre in Barcelona, Spain. For us, this was an opportunity to test the complexity of manufacturing the PCB using the process described while facing the challenges already mentioned in the 'Who has land to make a fire?' project (2023), namely how to make an open fire in a public infrastructure of a densely populated city. With the amazing help of our hosts, we were able to re-enact the barbecue scene and reuse an old metal pan and old wood that had already been cut and disposed of by the construction workers around the corner. The two-day workshop was intense and – one could say – a little stressful because of the short timeline. However, the participants were highly motivated and worked extra hours to finally complete their wild clay PCB boards.

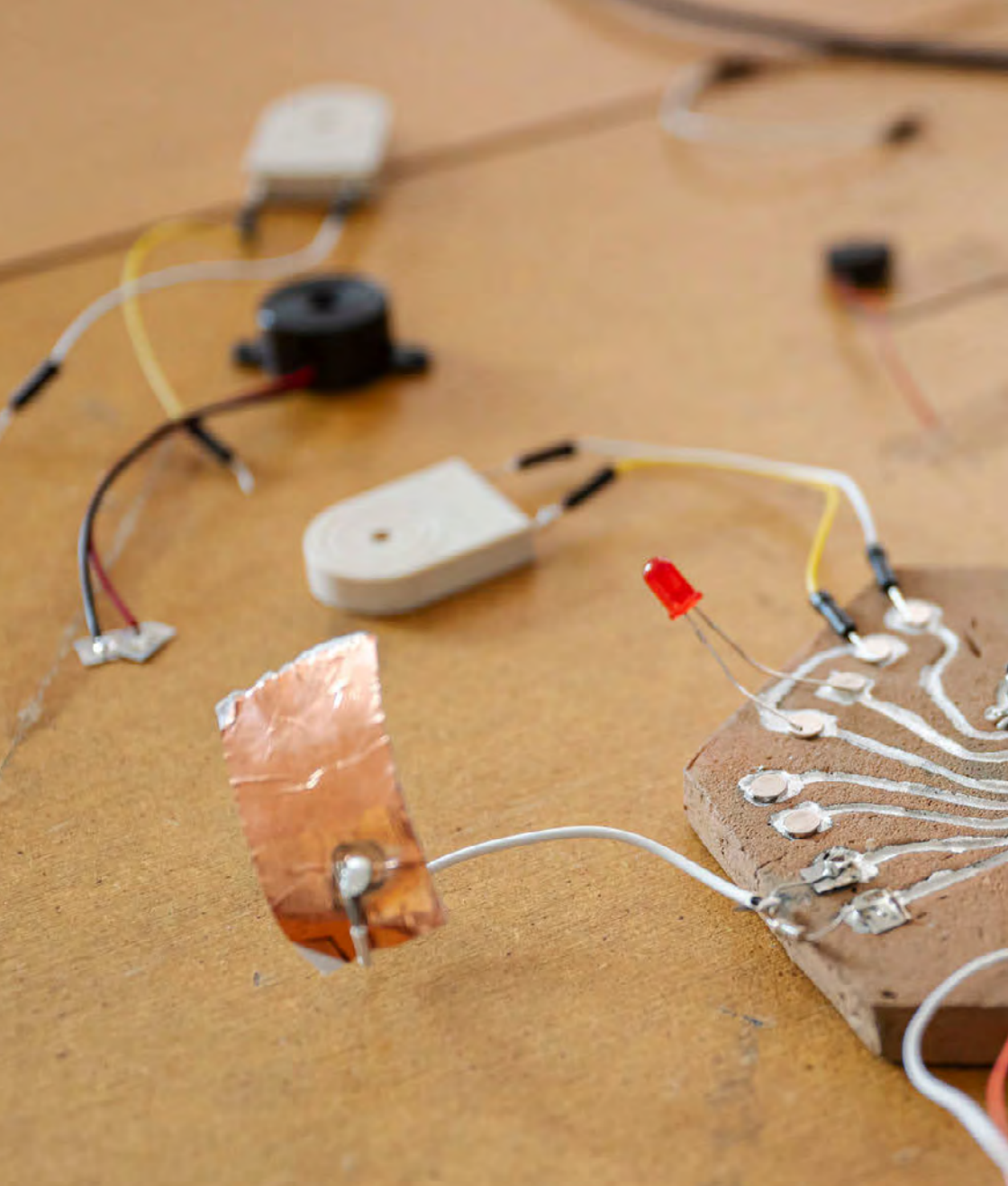
Feminist Hardware: Making Printed Circuit Boards with Natural Clay by Patrícia J. Reis and Stefanie Wuschitz, Hangar, Visual Arts Research and Production Centre, Barcelona, Spain, 18 and 19 October 2023

Patrícia J. Reis and Stefanie Wuschitz, Final Clay PCBs, 2023
Photo © Janine Schranz

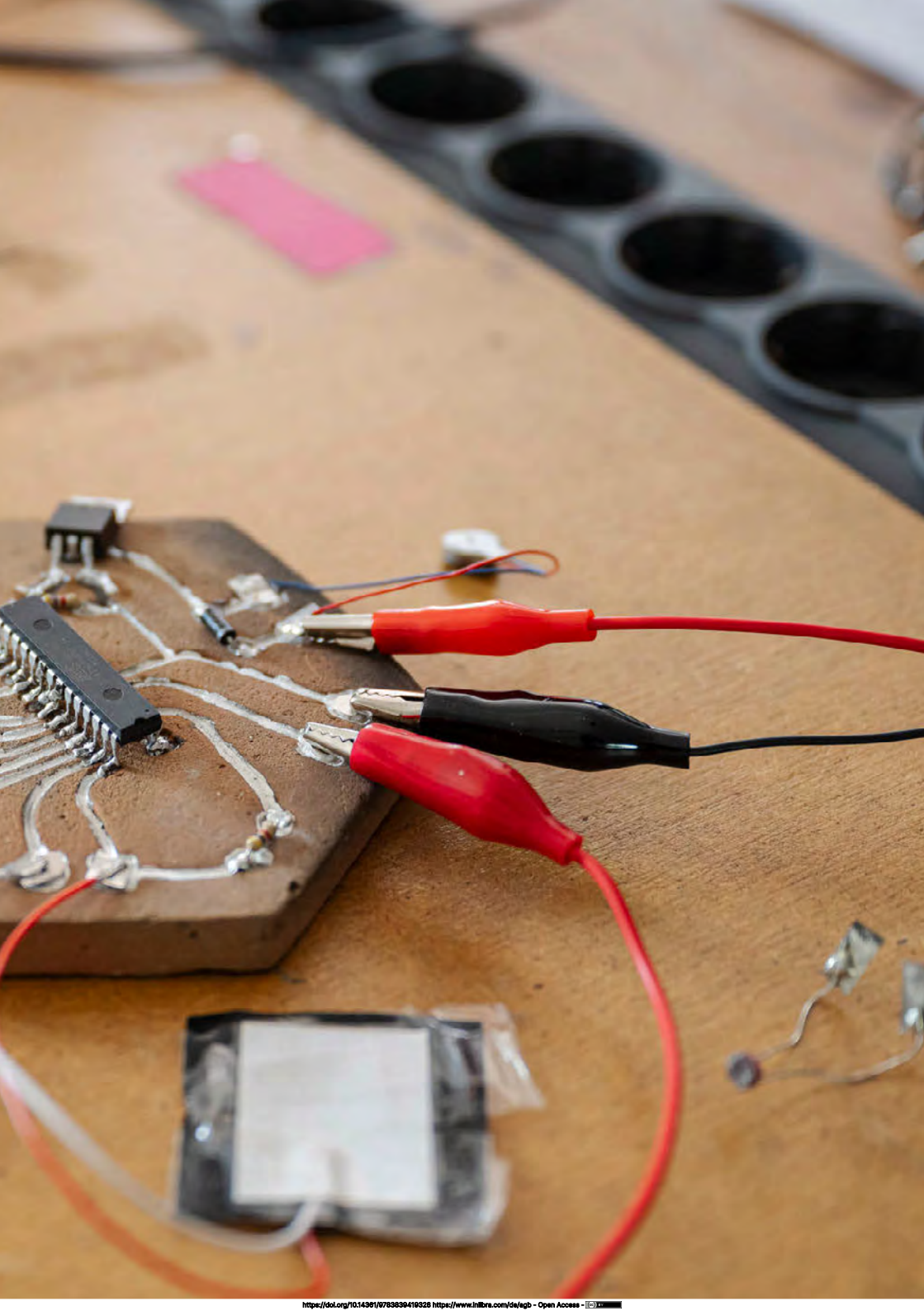
Board after soldering all the electronic components
© Janine Schranz



Boards after being fired, before soldering the electronic components
© Janine Schranz



Board in action at PIFcamp in Slovenia, 2024.
Photo © Violetta Wakol



ETHICAL HARDWARE KIT

Ethical Hardware Kit

How can hardware become more ethical, more decolonial, more sustainable? Maybe we need to get on our feet and become nomadic, get used to change. Nothing can stay the same if we take this seriously. The Ethical Hardware Kit is a fun way to take this seriously. It contains tools, materials and devices for building computational electric circuits from existing materials – stuff you can find locally. It even allows you, in a remote or rural area, to set up a tiny hacklab, as easily as you would set up a picnic somewhere. First, it requires you to move from metropolis to periphery. You take your backpack, walk to the place of your choice and unfold the three packages that come with the backpack on the ground. Each package unfolds into a hexagon-shaped piece of cloth inhabited by recycled, urban-mined, salvaged or self-made parts. Tutorials are stitched into textiles attached to the main cloth. These tutorials show you how to use these parts to make a loudspeaker (electronic kit), vegan leather out of kombucha (wetlab kit) or simply instructions to sit on a pillow and meditate (textile kit).

Ethical Hardware Kit: action in forest by Patrícia J. Reis and Stefanie Wuschitz, 2023
Photo © Janine Schranz

Concept and design: Patrícia J. Reis and Stefanie Wuschitz, in collaboration with Media Design students (Hackerspace Cultures) of the University of Arts in Linz, Austria – Melanie Steinhuber, Petra Francesca Weixelbraun, Florian Winkler, Alba
Curatorial work: Patrícia J. Reis
Textile design: Erika Farina

Contributors/experts: Gameli Adzaho, Seyram Avle, Milton Raggi, Mariá Antonia González Valerio, Saad Chinoy, Ira Agrivina, Hannah Perner-Wilson, Rajina Shresta

The hardware in the electronic kit can be used to measure electronic input (receiving a signal) and generate electric output (sending a signal). The tutorials also explain how to create materials that either allow or block electric current, known as conductive and non-conductive. Then, the core part of the Ethical Hardware Kit comes in: the Clay PCB board. A self-made circuit board, from clay and recycled silver, with an old microcontroller that takes care of the data-processing part. It is already programmed, so you can use the inputs and outputs for different purposes involving sound, light, motor movement or various measurements. With all these elements, you can assemble interactive circuits. You could, for example,

Ethical Hardware Kit: electronic kit by Patrícia J. Reis and Stefanie Wuschitz, 2023
Photo © Janine Schranz
Textile design: Erika Farina
Contributors/experts: Hannah Perner-Wilson

sonify your measurements: the embroidered tutorial by Hannah Perner-Wilson provides instructions on how to make a speaker out of forest leaves, wire and old magnets.

The second module is designed for wetlab practices, incorporating tools and materials that are essential for wet laboratory work. This includes items required for measuring, mixing and ingredients that are essential for accomplishing wetlab protocols, fostering a multidisciplinary approach within our kit. The embroidered tutorial by Saad Chinoy provides instructions on how to make vegan leather out of kombucha.

Ethical Hardware Kit: wetlab kit by Patrícia J. Reis and Stefanie Wuschitz, 2023
Photo © Janine Schranz
Textile design: Erika Farina
Contributors/experts: Saad Chinoy

The third module focuses on textile tools and materials, specifically curated not only for crafting textiles from naturally available materials but also for the reproduction of similar kits. This forward-thinking inclusion encourages sustainability and self-sufficiency by empowering users to replicate the kit, extending its impact and promoting a culture of collaborative making. The embroidered tutorial by María Antonia González Valerio offers instructions on how to use a pillow (the base of the textile-made backpack) for the practice of meditation and the state of being grounded.

Ethical Hardware Kit: textile kit by Patrícia J. Reis and Stefanie Wuschitz, 2023
Photo © Janine Schranz
Textile design: Erika Farina
Contributors/experts: Mariá Antonia González Valerio

Ethical Hardware Kit: wetlab kit (detail)
by Patrícia J. Reis and Stefanie Wuschitz,
2023
Textile design: Erika Farina
Contributors/experts: Saad Chinoy
Photo © Janine Schranz

Ethical Hardware Kit: wetlab kit (detail)
by Patrícia J. Reis and Stefanie Wuschitz,
2023
Textile design: Erika Farina
Contributors/experts: Saad Chinoy
Photo © Janine Schranz

NETWORK OF CONTRIBUTING ALLIES

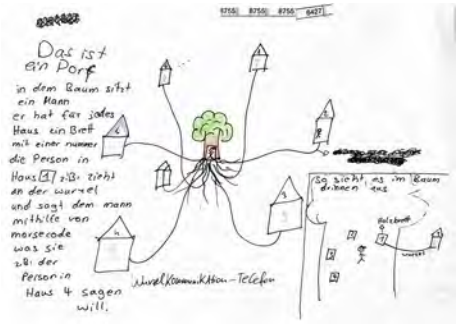
PART 3

CITIZEN SCIENCE WORKSHOPS

How can you make a computer that becomes soil again, one that is biodegradable? This question was the driver behind several citizen science workshops that we held for children and young people. We used the Ethical Hardware Kit as a mini hacklab that we took to different schools, culture centres, the Maker Faire and a summer school for children called 'Kinderuniversität' ('Kids university'). In all workshops, the participants were first invited to play a self-made interactive storytelling game called Salon of Open Secrets. In a playful way, this introduced the gamers to issues related to the manufacturing of electronics and e-waste. Next, when they wanted to, the citizen scientists took apart broken printers to find useful parts and brainstormed about sustainable local materials that could be used instead of the common toxic conflict materials. Some said we could use wax, wood or eggshells as non-conductive and insulating materials. Others said plants or juicy things could become conductive materials in a circuit. Inspired by these conversations, the citizen scientists started to sketch out prototypes. They surprised us with jaw-dropping, fantastic ideas for technology that is sustainable and could be used without access to existing technology or a power source.

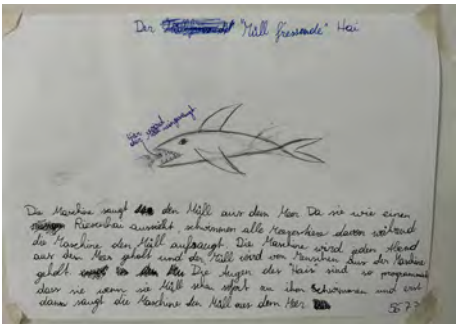
Salon of Open Secrets at BRG Pichelmayergasse. High School in Vienna with Mir* Raggam-Alji, Petra Weixelbraun and Stefanie Wuschitz, 2023
Teacher: Mario Hofmann-Pillai

Salon of Open Secrets at Makerfair Vienna with Patrícia J. Reis, Petra Weixelbraun and Stefanie Wuschitz, 2023

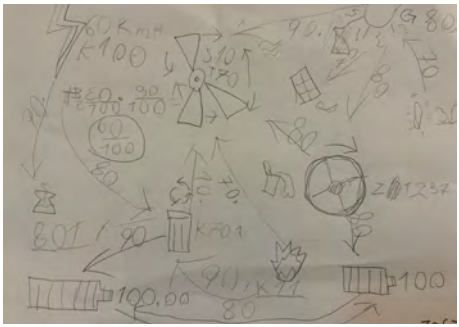


Salon of Open Secrets at HBLVA Rosensteingasse.
High School in Vienna with Mir* Raggam-Alji, Theresa Schütz and Stefanie Wuschitz, 2023
Teacher: Anna Hofmann-Pillai

Salon of Open Secrets at Bildungszentrum Kenyongasse. High School in Vienna with Patrícia J. Reis and Stefanie Wuschitz, 2023
Teacher: Eva Kartusch

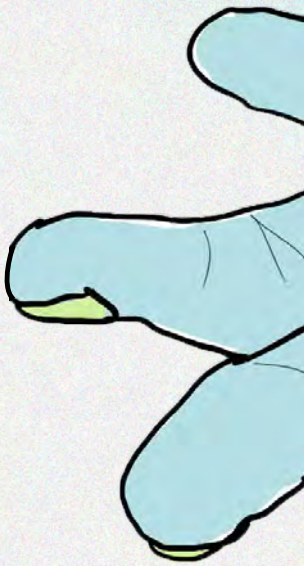


Salon of Open Secrets at Kinderuniversität (Academy of Fine Arts in Vienna) with Mir* Raggam-Alji, Patrícia J. Reis, Theresa Schütz, Petra Weixelbraun and Stefanie Wuschitz, 2023



Salon of Open Secrets at TechLab of Vienna Museum of Science and Technology with Patrícia J. Reis, Theresa Schütz and Stefanie Wuschitz, 2023

GAME



Online game: https://salonofopensecrets.at/

Title: Salon of Open Secrets
Text and illustrations: Stefanie Wuschitz
Voice-over: Franziska Schindler
Programming: Beatriz Lacerda as NOT BZ Studio
Music: Mario Pillai
Sound technician: L.Sound

This game for children was created for the workshop series described above; it was conceptualised as a story that welcomes participants as collaborators at eye level. The game briefly introduces the issues tackled through our main research project. The interactive game structure is represented through multiple threads in the narration. Depending on the gamer's answers, they get to meet one of eight different avatars.

Would you like to know a secret? Yes? Well, it’s not very secret, my secret, more of an open secret, so to speak.

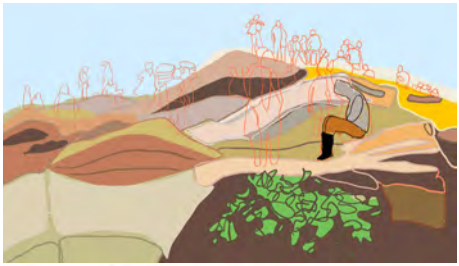
START

The climate crisis is real.

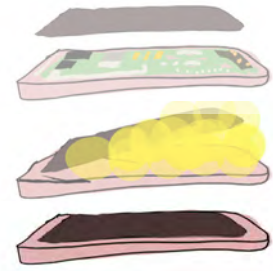
How can you react?

We're about to start doing something about it. Let me just tell you a story first.

The electrical devices we use are real gold mines.

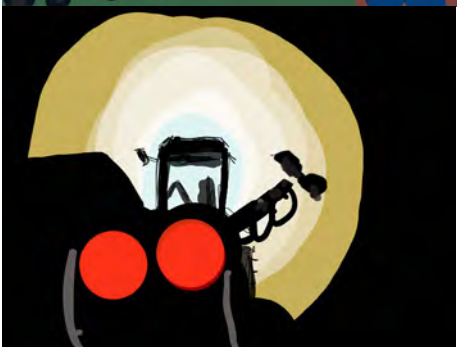


In order to buy and process them as cheaply as possible, no consideration is given to the people who live or work near gold or copper mines.



They contain gold, copper and many rare earths, which are expensive and difficult to find.

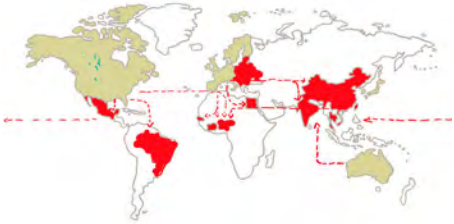
The people who assemble the individual parts that make up our laptops and mobile phones also see little of what you have to pay for the device.



They must fear for their future and the future of their children, often living in regions where they have no say.

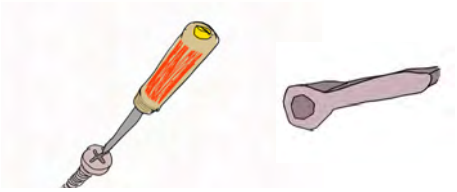
As you unpack your new device, you probably don't think about the production conditions and the resources that went into it.

The main thing is that it works well and doesn't cost too much. Only when it stops working might we start to think about which part is no longer working.

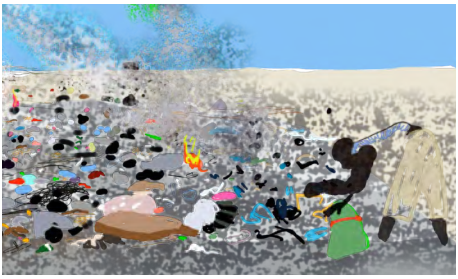


Electronic waste – 90% of all our devices – ends up in places where it shouldn't be.

Most devices are not built in such a way that they can be repaired, so they become electronic waste.



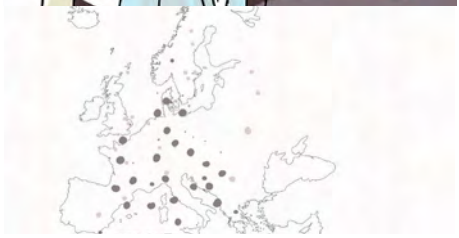
Can it be repaired?



Old computers, scanners and smartphones are thrown into illegal landfill sites.
This releases toxins into the water, into the soil or, if incinerated, into the air.

Your discarded headphones, broken USB stick, old hard drive, games console or printer, but also large pieces of rubble such as fridges, dishwashers and televisions.

Instead of going to school, children often work in these landfills looking for valuable parts in the rubbish.



Although most electronics and electrical appliances are bought here, in countries such as Norway, Germany or Austria, most are shipped to the Global South.

The industry that manufactures electronics is located where people cannot demand much money for their labour, in countries such as Indonesia or China.

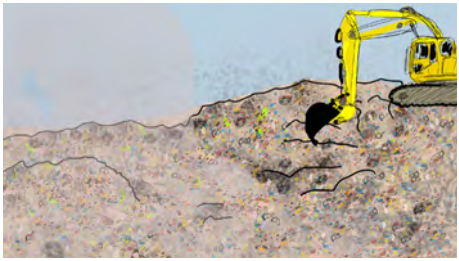
They're trying out new materials and experimenting with electronics, thinking up ways in which we could all repair our devices better and use them for longer.

People all over the world are thinking about how things could be done differently.

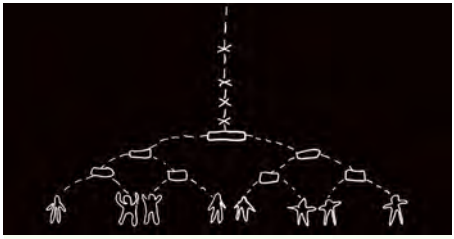
You think that's stupid? You're not alone.

What is really upsetting you at the moment? I'm extremely upset about how resources on our planet are being used.

So, with our natural resources, our clothes, our food, but especially with technology. Out of sheer anger about this, I made up this story and then recorded it.



Look, this is a landfill site in Ghana.



My colleague, Patricia Reis, and I interviewed eight people from all over the world. In the game that was created from the drawings and the interviews, you can now help to decide what happens next.

Almost all broken electronic devices end up in dangerous landfills like this. Many tonnes are shipped to countries such as Ghana, Indonesia or Mexico.

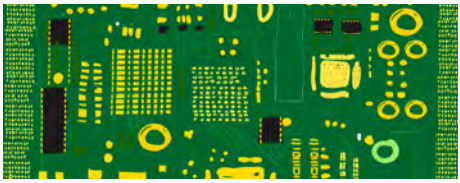
At the e-waste dumps, animals eat parts of it, and other parts are picked up by children or adults and taken apart. But the majority simply decomposes and pollutes the groundwater, drinking water and soil. When the electronic waste is set on fire, toxic gases are produced.

This mountain is not a pile of rubbish but a mountain of goods that are simply no longer cool enough.

Strictly speaking, these electronic devices are not waste at all: many of the items here could still be repaired or even still work.

Nobody knows exactly how many tonnes end up there; 90% of electronic waste is transported there illegally.

They were therefore thrown away by someone, almost certainly someone in Europe, Australia or North America.



Electrical appliances are full of secret treasures such as gold, silver and other rare materials. The people who live near the rubbish tips know this.

However, this is often not particularly good for their health, as they come into contact with toxic substances.

'In Cuba there is no such thing as e-waste, we reuse everything.'

Milton Raggi

'Maybe if they dumped all the garbage in their backyard, they would think twice?'

Seyram Avle

In recent decades they have invented ways to extract valuable parts and save them.

What would you most likely do to solve these problems?

Get active against them?

Have you ever protested against something?

In a democracy, people can publicly say what bothers them, what they are worried about or what offends them. It is often more encouraging to join forces with others. It then becomes easier to find solutions together.

Use sustainable materials?

Go to page 185.

Would you rather go to Germany? Then let us introduce you to Hannah Perner-Wilson.

She has managed to build loudspeakers out of fabric. She has managed to weave fabrics that are also loudspeakers. She makes clothes that have soft, sustainable electronics built into them.

Go to page 192.

Gameli Adzaho lives in Ghana and thinks a lot about how we can involve everyone in the search for solutions.

Go to page 187.

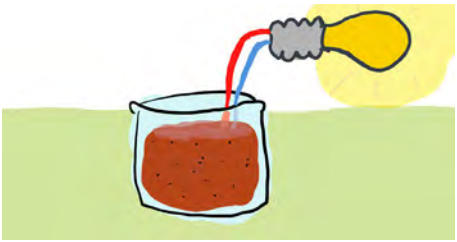
Would you like to talk to the people affected by the problem themselves to hear their point of view?

Go to page 184.

Would you like to meet someone who will try something themselves to improve the situation?

Would you like to talk to the people affected by the problem themselves to hear their point of view?

Saad Chinoy lives in Singapore and knows how you can build a battery out of mud that is completely sustainable.



He has also tried to recreate plastic from natural materials.

Go to page 194.

Our expert in Nepal, Rajina Shresta, works with students [showing them how] to experiment and invent for themselves.

Go to page 196.

Use sustainable materials?

What materials could these be? What would you suggest?

Perhaps materials made from plants or things that we can find everywhere?

Fibres, textiles, liquids, dyes and many other things can be made from plants. The advantage of this is that plants grow back, they are climate-neutral and they become soil again.

We asked an expert in Mexico to tell us more about these advantages. Her name is María Antonia González Valerio.

Go to page 199.

Or again from recycled things?

Go to page 186.

Or would you rather go to Indonesia? We spoke to the expert there, who builds beautiful new things from waste herself. Her name is Irene Agrivina.

Go to page 201.

Or again from recycled things?

Recycling, upcycling, urban mining, reusing – all of this means not declaring goods as 'waste' but seeing them as raw materials for other products. A circular economy is emerging.

Would you like to meet an expert who lives in Cuba? Milton Raggi loves collecting old appliances and turning them into something new.

Go to page 202.

Or would you prefer to talk to Seyram Avle? She's a young professor and wants to tell you something quickly about e-waste in Africa.

Go to page 203.

Interview excerpts

Interview with Gameli Adzaho

Hi, my name is Gameli Adzaho. Right now I live in Ghana — I come from the water region. But I live in Accra, which is the capital city of Ghana. So, in my day job I work as a technical lead on a programme called Research and Innovation Systems for Africa (RISA). I'm also part of the Global Lab Network and Ghana Think Foundation, and these groups are basically looking at issues around education, public participation in science and technology, environmental sustainability and youth participation. Obviously, one of the most important pieces of technology that we have in our world today is the internet. Through the power of the internet, I'm able to connect with my colleagues in different countries in Africa and also around the world. To be able to collaborate and deliver on our projects, to be able to learn new things, to be able to create, and to be able to also engage people on different topics, in a bid to build a better world and a better society, as it were.

Also, in the projects I work on, people are creating new types of technology, or at least using existing technology, in a new way, and they use it to solve problems on different topics, like health, and agriculture, which are very important when it comes to access to food and also economic empowerment. Because then, when we teach people how to use technological tools, they apply it to their own lives and their own businesses. And that increases income and gives them the opportunity to have a better life.

Talking about electronic waste: it is a big problem in developing countries, because of the interaction between people and tech-

nology. So, in a site in Accra called Agbogbloshie, there used to be a huge e-waste dump. Which is also not far from a market, where a lot of people, including young people, are engaged with dismantling electronic equipment. Often, processing this e-waste is not safe. We suspect that some of the contaminants in the electronic waste might find their way into the food chain, affecting people's health and wellbeing. But thankfully the city and other authorities have been working hard to stop this dump and dismantle it. Which means we don't have a big dump at the site where it used to be. The impact of the things that have gone into the ground might linger for a while. But thankfully various individuals and initiatives are working on how to better address it. And I think that's a positive thing.

Different projects are looking at safely recycling electronic waste. As far as I know, their initiatives are around having access to better equipment that can help to extract value out of some of the electronic waste. And around not, for example, burning parts of the electronic waste in an open environment, because that leads to air pollution.

I think air pollution is possibly a new topic. People tend to talk more about the climate crisis, for example, because so much has been said about climate change. And so many people are aware of this compared to a topic like air pollution. We know that air pollution leads to a lot of deaths, but also a lot of different diseases in different countries. And we know that air pollution contributes to around 30,000 deaths a year, which are directly implicated. Looking at this danger on a national level, but also globally, I think it is an important topic that we should pay more attention to. On a global level, we are talking about 7 million people dying from air pollution, so it is a big number.

We need to ask questions about the sourcing of the components of the stuff: we need to ask where these parts come from, where the materials that these parts are made of come from. Because there are some issues with, for example, mining. How to get minerals to make electronic parts that we find in the technology that we use daily. These questions around where these materials come from — for example, were they mined in a sustainable way? — are very important. We can reuse parts from other equipment that we have used before. So, we talked about urban mining, which is getting materials from certain components. We already know there are instances where it is safer and easier to get the materials we are looking for from existing equipment rather than taking it from the ground. So, I think this is something we can explore a bit more. The design of equipment, we can look for more modularity in it. And make the design more open, so that it is possible to repair equipment when it is broken. Either the user themselves or somebody close to them can repair it, rather than relying on manufacturers. Because relying too much on manufacturers, or having an embargo or denying people their right to repair, means they would have to either buy new ones when they are not working or pay an expensive price to have it repaired. Which is not sustainable for the environment: it is not safe in the long run. This is something we can look at.

And the final thing would be the design of this technology, if we are talking about hardware specifically. It should be done in a way that we think, at the end of its life, where it will go and what will be made out of it. If we have a proactive approach to managing e-waste, then it will end up being more sustainable than it currently is. We can think about how long we expect to use this and what parts it would make more sense to include. Is there any use for these parts after the circle of use? And so on. I think those types of question are important in the long run, about how to build more sustainability into products, how we use technol-

ogy and, in particular, how we use hardware. I'm also a member of the Ghana Think Foundation, which runs bar camps where we gather, in particular, young people who we connect with mentors in different fields. It's also a brilliant way to engage with some of these topics, especially when you raise sustainability as a topic, talking about air pollution or plastic pollution. How do we fight it? How do we come up with more practical ways of doing it? And also celebrating some of the individuals who are already using initiatives in these ways and the kind of work they do.

The 'Science Cafe', for example, is basically what it sounds like: 'science' in a 'cafe'. Imagine you go to have a coffee with your friend, but instead of just having a normal conversation, you talk about topics of scientific interest; it can be a practical topic, for example something around design or software development. But it can also be very abstract, like talking about space or something like the COVID-19 crisis. It's just a way to get experts and members of the public discussing a topic that is interesting or valuable to both sides in an open environment. And without the jargon and terms, so that everyone can follow the conversation. I think that for many scientists and the experts that we have engaged in Science Cafes in the past, it is such a wonderful environment to be in. In the sense of the kinds of question they get asked and the input from others. Because there is this scientific phenomenon that you are talking about, but somebody who is a member of the public sees it in a completely different way. It is not just about your technical skills, the flow of knowledge, but also how they see it from their perspective. And for scientists who want to impact society, you give valuable feedback, from the kinds of question you ask. The kind of input they make into conversations. I think it is a very good way of engaging the public with science and technology.

What is more valuable is the kind of mindset you develop about topics, about issues and your ability to solve problems. So, the most important thing is, first, to explore and discover what interests you and what really captures your attention, because that will direct your learning. As much as possible, learn. No knowledge is useless, learn as much as possible, because at the end of the day, the kinds of problem and the issues that we need to solve – even if we look at the kinds of problem we are confronted with in the world right now – and you can only imagine when AI, biotech and the climate crisis all come together in a big explosion, there will be even more complex issues to solve. Therefore, that natural ability to be curious, to solve problems, to pick things apart, to see the big picture, and that interdisciplinary way of looking at things, will become even more important. And that awareness or that skill is important to build while you are still young. To be able to have this focus around it…but, of course, you can't go around chasing everything, which is why I said, be able to identify what moves you. You then bring all these things together to solve different problems in the course of your life, and it is important to know what is important to you at any point in time. I think that would make a difference in the world, and obviously science and technology is not just about the technical side of it. It is also about the people creating this knowledge.

And the innovation we are talking about is the relationship between those people. It's about the effect that this knowledge and innovations will have on other people, and on the world, so it is very important to see it through this human lens, through the perspective of your community and your country and the whole world. To be able to create solutions to problems is incredibly hard, but that is just one step. To be able to carry out these solutions and really make a difference in the world is another problem altogether – to be able to interface. Normally, scientists

and technologists think this is somebody else's problem, but increasingly we see that we need to collaborate to carry out our solutions. We need more and more people working together. To deliver solutions to as many people as possible. And so the ability to collaborate, to communicate, to engage, to understand, to emphasise, to lead, you know, is also crucial. There is so much ahead of you, and you have to identify that question, build it, work hard, enjoy it also and make a difference.

Interview with Hannah Perner-Wilson

My name is Hannah Perner-Wilson. I live in Berlin and I like to tinker with electronics. The fact that my everyday life is so strongly influenced by electronic devices makes me want to know more about them. I also want to create them myself. Yes, that's right, I build my own speakers. First, I took apart existing speakers to see how they worked, because I wasn't sure. I was amazed at how simple they actually are. It's just a coil made of a conductive material, which is wound to turn into an electromagnet. And then there's another permanent magnet inside the speaker. The coil is attached to a membrane, which is made from very light material. When the sound signal is sent through, this permanent magnet and electromagnet either want to repel each other or pull together. This way, the membrane, which is attached to the coil, starts to move. And when the membrane moves, the air moves, and the movement in the air reaches my ear. And when this movement in the air reaches my ear, it sounds like music, or like when you hear me speak. You hear them as sounds.

When I build my own speakers, I look everywhere for materials to build them from. I work a lot with textiles, so I have a lot of soft textile materials lying around. I usually reuse the permanent magnet from an old loudspeaker or from a refrigerator magnet. It is important that it is a very strong magnet. This means that the coil I make doesn't have to have so many turns. What I like

to do is have the membrane and the coil the same. Except that I embroider this coil as a spiral on a textile or even weave a circle by stretching a small weaving frame on a yogurt pot. And then weave all the way round.

The conductive material that is used for this coil is actually an exciting thing. Because you can use different materials. The important thing is that it conducts well. If you look at the back of a loudspeaker, it usually says ‘eight ohms’. And that’s quite a lot of resistance, but not that much for something that’s two metres long. There are copper threads that I use, but sometimes I just use copper wire. And if it’s not insulated or if I pull off the insulation, because I find it aesthetically pleasing when you can see the copper, then I have to make sure there is air between my spiral so that it doesn’t touch. Graphite is also known from pencil lead. It doesn’t conduct as well as copper, but if you had a really soft pencil on a really nice piece of paper, with which you can apply a lot, you could draw a conductive coil and maybe it would have around 100 ohms. Or more.

If the coil has more resistance, then you need even more force to make it oscillate. And this force is the number of volts in your power source. And you connect the grounding to one (that is minus), and you connect your sound signal to the other. And the sound signal doesn’t actually do anything other than go from high (that is plus) to minus. And if it’s high, then current flows through the spiral, and then it becomes magnetic; and if it’s not high, then no current flows and it doesn’t become magnetic. Sound signals are then actually just a vibration. Like an on/off. And when these current signals go on and off very quickly, you hear a high tone. You can also feel the vocal chords. They vibrate very quickly when the tone is high. And lower with a low tone. And that’s what the current does.

So, when I’m crafting, I’m often alone, but I don’t feel alone because the many materials I work with somehow become collaborative, because they bring their own properties with them and inspire me. I also really enjoy making things with other people and often do this at events or hacker camps.

That's also something I really like, this idea of care. That you take care of the objects you have, whether it's a plant or a mobile phone. So, maybe that includes repairing it, but maybe also doing things to keep it in good condition. I think we've lost that habit a bit. You just use things until they're broken, because you can buy them again anyway. But there are so many speakers in so many things. Before you go and buy one, you could think about what else you have lying around to reuse. Other reasons why I would build it myself would be that you can build and design them in a way that they are made from materials you know, and you know a bit more about where they come from. It gives you more options. How loud is it and how big is it? What shape factor does it have? They don't always have to be round: you can make a square spiral. You can also cut the membrane oval or triangular. Now I've just told you so much about how you can make loudspeakers, I'm also interested in whether you'd like to make one.

Interview with Saad Chinoy

My name is Saad, and I live in Singapore. I run a small experimental kitchen-like makerspace, the EdibleMakerspace, where we try out DIY Bio methods. One of the things that an edible makerspace does is to incorporate concepts you would encounter in a typical makerspace – which work with electronics and modules that go with microcontrollers and things like that. And because it is in the same shared space as DIY Bio, what often happens is that things they experiment with in DIY Bio tend to collide in a creative and constructive way with what's happening with microcontrollers and electronics. It lends itself to new ideas that open up new possibilities that would otherwise not happen. It is spontaneous and very creative, and it depends entirely on the energies of the people who are in that space at that time. Whenever you walk into a makerspace, you never know what you are going to get. It changes every single time.

What is my favourite material? That is a very difficult question to answer. It constantly changes as well. My favourite is whatever I'm working on at that given time. Most recently, I have been working with this homemade vegan leather concept. And it turns out it is not as complicated as I thought it was, but I only realised that once I jumped down the rabbit hole of looking things up on Wikipedia and following YouTube channels; this is often the way we get things done in a makerspace. And talking to people who have worked with different lab processes, but seeing how this could be replicated in just a kitchen, so right now my favourite material would be vegan leather that can be made from kombucha SCOBY (symbiotic culture of bacteria and yeast). Kombucha is a fermented tea. It is black tea that is fermented and produces a nice spongy layer of living material, which can then be dehydrated, which turns it into a leathery material: vegan leather.

The mud buttery experiment is an ongoing obsession of mine. My background is in tech; I'm an IT person. I got into this idea of tinkering mostly because I like the hands-on aspect of applying technology you can actually touch and feel. My job involves working with servers, and so playing with systems that you can actually hold is the appeal for me. The mud battery was again an intellectual curiosity I had to run away with… It stems from this one prompt that the number of microbes that we have in our bodies, which don't have human DNA, outnumbers the cells that have human DNA in them by a factor of 10 — depending on how you look at it. There are more microbes in our body and on our skin, which are completely alien to us and do not have human DNA in them, than there are human cells, and this idea was just mind-blowing for me, and I just couldn't wrap my head around it, which led to all kinds of question.

One of these questions was: Are there microbes that can produce electricity? And it turns out the answer is: absolutely yes. Some of these microbes that we have got inside us can produce electricity. If they are isolated. Or you build a nice little environment where they can grow, you can harness some of that

power and electricity for doing something electrical, like making a light blink. Electro-generating microbes prefer to be in an environment away from air, away from oxygen. So, you create an environment that is similar to what we have in our bodies. But the ones I have been experimenting with quite happily exist in mud, and mud that is under water. If you create an environment for those kinds of microbe to flourish, they can be turned into a battery.

in an online interview with Patrícia J. Reis and Stefanie Wuschitz

Interview with Rajina Shresta

I live in Nepal and I have been working with a feminist human rights organisation for more than two years. But for a larger part of my life, I have been really interested in inclusion in science and technology. About ways that there could be intersections between feminism, principles of feminism and science and technology, which is about gender equality in science and technology. I'm getting more and more interested in science advocacy and science diplomacy. And trying to see what that field of work could look like. At my feminist human rights organisation, there are usually young women, starting between the ages of 16 and 25, and they are usually studying at universities, or in their early career. And they are very much embedded in the feminist principles, and many of them are into science and technologies.

We work with several different types of people: there are very, very young rural women and also experienced human rights defenders. The work we do is around their leadership, but also sometimes around their safety and security. The digital world around us, that they operate in, might be beneficial or useful to them. In Nepal many people have access to smartphones, although we are not a very rich country. Several studies show that it is also because Nepal has a lot of migrant workers, who bring back smartphones for the family to use. This has really

increased access to phones, in the last decade…access to the internet has been increasing. Access to the internet for young women in rural settings is quite high. I'm not sure if I would say the same for rural women. That does not mean that there would be privacy, because most young women have a lot of policing on their social media activities. Their brother or father or aunt coming and saying 'Why did you post this? What did you mean? You should not be saying these things on the internet.' Patriarchy is guiding and watching their internet activities.

I think we see technology a lot like magic, you know, it is something that someone else has done. We are considered consumers of it, we didn't make it, it happens to us. So, we move our life around what it gives us. So, for example, we all have smartphones – many of them have location tracking. I have heard from many people how knowledge of being able to share your location on your phone becomes a tool for families to police where their children are going, especially their daughters. Making it mandatory for young girls to share their location with their family at all times. It is more like a tool that comes to us and we eventually move our lives around it. And no matter what – patriarchal, capitalist and other values move around, making the best use of that technology.

We can react in multiple ways, but there are two big ones. One is to work around the technology, for example being able to really support more open source technology, where we know that there is some accountability, and we know what kind of data information they are taking from us, to be able to make an informed decision. Or to go to another software that perhaps does not take as much of that information, for example using Signal more than WhatsApp or other messaging applications. The other big one would be really working around our own community, because we need to change the way people think. Privacy is not regarded as a real thing in the lives of many of us. We are not allowed to put locks on the doors of our houses. We live with our families for a long time and privacy is not a concept that is taken very seriously. To see that translate into digital and

other mediums is not very surprising. So, a lot of work needs to be done within our communities to give importance to privacy and what that means in young people's lives — to live that with their full agency as well. (...) New smartphone cameras can zoom in and really do not consider anyone's consent.

Sometimes we walk out of our houses and there are CCTV cameras everywhere, and we also did not consent to these. I think it needs the involvement of not only more women in the development of these kinds of technology but also more feminist people. Or more people who are aware of the kind of risk that can come with such tech, especially when it comes to surveillance. (...) If perhaps, first of all, there were enough people who cared about this, then perhaps the technology would have been made differently or within our regulation policy. (...) As I said before, in a lot of our cultures privacy is not something people take seriously: we don't lock our rooms, and it is considered rude to do so. The same way I felt like consent in people's private space is not considered to be bigger than capitalist structures. And that's why this device was considered suitable to come to market.

It doesn't mean we just need a regulation for people who work in the phone company. We also need a general understanding among people about not being okay with being filmed from ten houses away without knowing you are being filmed (...). In many computers the webcam is connected to a light near the webcam. Fewer technical skills are required for everyone who uses a computer, but there are enough risks out there from people trying to hack into people's systems to be able to use people's webcam and silently record them, blackmail them, etc. A simple ethical design where it is not possible to switch on the camera without the light also being switched on is a really good example of taking on that responsibility, understanding the risks that come with the product, and minimising those risks. And doing all this even though the product might stop working, in case someone is trying to bypass that level of security. Particularly in devices that a lot of people use without having sufficient technical knowledge.

Interview with María Antonia González Valerio

I am a philosopher. As a full professor at the National Autonomous University of Mexico, I specialise in teachingaesthetics and ontology. My research is centred on the philosophy of nature and art-science. (...)

The production of technology is not ethical. Many of our technological products are fabricated under terrible labour conditions, exploiting workers. We know this. Who produces what we are using? That question cannot be answered. On the one hand, it cannot be pinned down to an actual individual; on the other, the chain of production is normally black-boxed. How many countries, regions and territories are involved in whatever technological product we want to think about as an example? How many seas were traversed to deliver the product and the many pieces it is composed of? How many people are involved in that process? How much pollution? How much exploitation of workers is there at every level, in the factory, the cargo ship, the retail shop and the mines where they extract the raw materials for our fancy tech products? How much?

And about the land, where is this being produced? How were the land, region and territory transformed to host so many factories and industries? How much water is being used by the industry? How many birds are affected by the pollution of this industry or by cutting down trees to build the factory? How many mines have entirely destroyed the environment? How much waste has all this produced? But who is accountable for the exploitation? For the destruction of biodiversity? For the pollution of the waters? Who is accountable for turning the oceans into shipping lanes full of containers and the waste they produce, including the combustibles that they throw in the water? Since almost everything we have, use or come into contact with, almost everything, comes through the oceans. (But who is 'we'? Who is accountable?) The question is not about the consumer. The guilty, stupid, weak consumer that cannot help

themself from buying goods that come from who knows where, that were produced in terrible labour conditions, that destroyed the environment, that impoverished whole 'third world' populations... The question is not about the consumer and their 'carbon footprint' and behaviour, and not being able to be good enough to act with honour, to be fair, to procure the wellbeing of their community and of future generations. The question is not about the consumer. Who can be held accountable? Who is responsible for taking accountability?

The solution is not a 'green economy' that will save 'us' (Who is 'us'?) from doomsday. We shouldn't fool ourselves into thinking that this has to do with consumer behaviour; that is about having sustainable behaviour (How much plastic have you used today, and what about your carbon footprint?) ... What kind of shame and guilt hang upon those who do not comply with the new morality? There is a lot of greenwashing, whitewashing, artwashing... But why should we trust capitalism? It seems that the kind of technology that we have under a capitalist, colonialist, Western patriarchal model is not very ethical. So where to start? What could be a good starting point? Maybe it is not about rushing to invent new solutions (Why should we trust technology?) but about thinking deeply, calmly and with tranquillity. Thinking about what we are instead of avoiding ourselves and throwing ourselves into so much newness, so many new things, ideas, devices and art projects to change the world and save the planet. So many... But what are we? What? Could we think outside technical solutions? Could we? And what would that be? What?

I would contribute with silence and time; that is, invite people to be in silence, to feel what there is, to deeply interrogate what we are (what you are), to breathe with consciousness, to stop talking and rushing into the next question, the next solution, the next... Just stop. What issues are closest to your heart when it comes to your home country? On one side, the deep sorrow because of all the terrible violence that my country is suffering, the deep rage because they are destroying the country,

inflicting much pain on the people, because they (Who are they? Who is accountable for?) want to sell more weapons and make more money to nurture the corrupt banking system, including offshore banking. How to explain the violence inflicted upon us so some can get richer? On the other side, the fantastic food that Mexican gastronomy is so famous for also represents an identity, a relationship with the land, ancestors and tradition. Mexico is so full of colours...

That your truth is not the whole truth, that your viewpoint is not all there is, that whatever you have learned, there is another side to the story, and that it is our moral duty as thinkers to bring about the other stories, the ones that have been buried, the ones that have never been heard. There is more than the mainstream history of the world, your city and even your family. How many stories could be told about any fact or idea?

in written interview with Patrícia J. Reis and Stefanie Wuschitz

Interview with Irene Agrivina

My name is Irene Agrivina, but people call me Ira. The perception of water in Indonesia, where I come from, is very different than in Europe, and mythology plays a part in this perception. I live on Java, where the perception of water is quite distinctive. Water is a holy thing, a gift from heaven. We call it 'Nirvana'. It is part of the way we live. When I was growing up, water increasingly became something that is owned by capitalism, which felt strange. Water became fancy; suddenly, people could no longer afford it. To me, my family and the people around me, the fact that we have to pay for water is strange. It is a gift from nature, according to Javanese philosophy. So my intention is to create access to water. To do this, we have to relate to nature again. Water is just a part of nature actually. Access to clean water is a fundamental human right (...) There are many different types of waste, not just e-waste. Waste is thrown into the ocean, into the sea, in Indonesia. Medical waste is also thrown into the ocean,

which affects the water quality. In the city, in rural areas, this affects food production. When I was in Germany, I think last year, someone even offered me a business — a big business — throwing waste into the ocean in Indonesia. I believe it is thrown from a ship (...).

I think there is one electric circuit, which is really easy, and it can be connected to a sensor. So I always teach people how to make it, and then they can turn it into a water-quality sensor to see whether or not the water contains a lot of metal. It can also lead to an artistic project. And for the kids it's an easy project to start doing bio art or observing other things. If you add one part, you can learn about electro magnetics, which is nice because you can then hear a sound. It's a basic sensor that can lead into everything: artistic projects or science projects, depending on what one needs. It's a fun thing if you want to know more about hardware. You can also connect it to Arduino and program it; it is very easy to detect metal and microorganism contamination (...). We can use it to compare the chemical fertiliser in the rice field with the bio fertiliser. We were working with a Muslim organisation in Indonesia whose vision is food and energy independence in Indonesia. And we are working with several others...who have their own land — a small piece of land — and they are doing DIY to build a sustainable system, which we support. When we were successful, we thought this was actually really good and we could adapt it to other rice fields. But the quality of the rice is really bad. And we have to use these fertilisers that genetically modify the rice plants, which is why I created the project.

Interview with Milton Raggi

I come from Cuba, an island in the middle of the Caribbean Sea. I do art, I also work as a teacher, I organise and curate exhibitions related to media and tech, sometimes I write, but mostly I collect a bunch of trash. We don't really have technology dying, or at least how we would consider technology dying in places like

Europe. Basically, we are very much used to repair, and repair and repair. And when an object can no longer be repaired, then we upcycle or we transform it, so it's in constant mutation basically. We just use it as something else or we transform it into something else or we just decompose and use parts coming from different sources.

But this is not something that only concerns technology. It's also something we apply in our everyday life to basically everything. It's the way we use to subvert reality. We don't have access to many things, because of the political and economic conditions of my country. We are limited to the resources, and therefore we need to put a lot of creativity into the things we already have. If a coffee mug can also serve as a plant potter, then we use it as a plant potter, and so on. Let's say you want to generate a bit of electricity. Just at least for learning how to do it. Because sometimes we take electricity for granted and you just plug something into the wall and there you have a lightbulb going on or a machine working. But knowing how to generate electricity and knowing how electricity works is a very powerful thing. Because then you start realising that you are not so dependent on what is given to you and what you took for granted, and you can actually create it yourself. And I think that empowers you, knowing that you can build things and that you can build your own electric supply. And therefore having light or a machine working, and so on. So, starting with that, I think we should all learn a bit, in a way, because that way we can build a better future. If you are curious and if you want to start exploring this idea, it is as simple as taking a motor…

online interview, Patrícia J. Reis and Stefanie Wuschitz

Interview with Seyram Avle

(…) I care about who makes technologies, especially in places that most people think don't have technology. Think of Africa or (broadly we call it) the Global South. And how people in these

places use the technologies that are produced around the world. So, on the one hand, I think about the entrepreneurs, the designers, the academics, the people who imagine different kinds of technology and what to do with them. And then, on the other hand, (...) how do people come to these technologies and use them? What do they imagine these technologies to be, and what do they want out of them for their futures? It matters where hardware is made. First, locally and, second, in places that are not considered the centre of innovation. For a number of reasons.

One reason is that it is sustainable in terms of the localness of it all. Dext, which is a start-up company in Kumasi, Ghana, initially started making science sets. Which is a kind of mathematical set. You take it to school, you use it to do experiments. They were repurposing local materials. They harvested things from old photocopiers (...) Ghana receives a lot of discarded electronics. So, they wanted to see if they could repurpose and reuse some of these things. (...) They were trying to find local materials to make everything from scratch. It was a very labour-intensive project. But they had the idea to do it, because they knew there were things they could repurpose, and they wanted young people in the area to have jobs. So, they created a company. And they care a lot about science and the teaching of science. So, they wanted to give practical examples to students. Dext designed a very simple science set that they could build from local materials, and for a long time it was really difficult. In part because you don't get everything you need to build the science set. So, they had to be creative. The bigger they got, the harder it got too, because then you need many, many materials, which don't all come through the usual ways. That's the local sustainable aspect of it.

In terms of broader issues – of being in a place that is considered the periphery or not the centre of innovation – it also means that things cost more, you don't get the funding for tech. Companies in Silicon Valley, or even some European-based companies, find it very easy to raise money. But if you

are from Africa, from within your own country, from within the Global Capital Network, people don't believe you have the expertise, they don't trust you, they think you don't know how to do things. (...) For them, being able to succeed in their country without relocating mattered, because it could prove and show that they could do these difficult things where they are. That they could build these incredibly helpful things. And so, in a sense, you could say they are trying to resist a classification of them as a certain kind of producer. Like 'not being able to make technology'. They have been able to reconstruct educational curricula to go along with the science sets. (...) So, in general, I think that example of Dext is really crucial in terms of how the young people who build technologies see themselves, the challenges that they choose to resist, to a certain extent. For me, it's worth telling and understanding. (...)

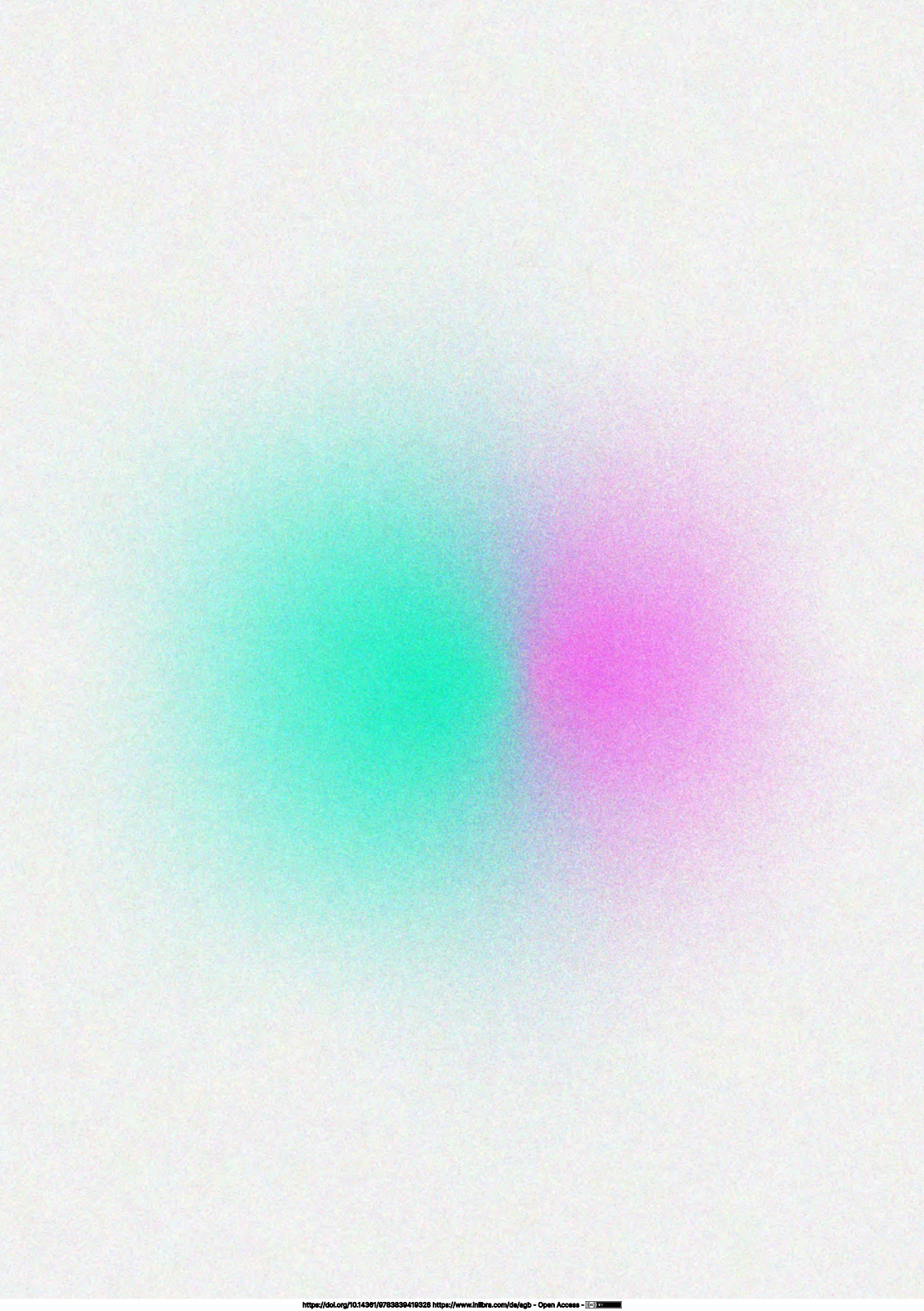
Feminists talk about care as both a way of thinking through community but also as resistance, because capitalism does not WANT you to care. The way that systems are structured inherently creates competitiveness and an ethos of negativity. (...) And so, being able to support one another and build things together, a physical space, is necessary, right? So, you can build this comfort, you need to gather the people you want and need, and have the space to think and reflect on how you might insert some kind of change, right? They do that through their everyday actions. But it is also very intentional, and it is important to insert care and the ethics of care within technological discourse. A lot of how we come to this discourse around technology does not demonstrate care; it's exploitative. From companies taking your data without your permission to being watched — all of these things are not demonstrative of care. So how do you enact care practices within this kind of hostile environment? By designing and building things or even just drinking tea together on a daily basis. We see these community-building practices as essential aspects of thinking about technology, because this is how everyday people respond to these macro-level things like capitalism and geopolitics of technology. (...)

Kwame Nkrumah – Ghanians like to say he was ahead of his time. In the sense that he was the first president of a country that had been under colonial rule for a very long time (...) Ghana was part of a group of countries with leaders who did not want to be forced to align with either the East or the West, because they found this sort of alignment would work against their own progress. And the ideals they had for themselves. Nkrumah had this vision where the new state of Ghana would plot its own path. And that path would be forward for its own people. He was very much about 'How do we as a black African nation prosper in a system that was not designed for us to prosper?' 'Things have been extracted from us for many years, and now there is a war somewhere else and we are forced to join it. How do we resist that?' That is what this quote was about: 'We face forward': for our own purposes, our own improvement and not being forced to participate in a cold war that does not serve us. He was speaking mostly and primarily about Ghana, but also, because he was a Pan-Africanist, Nkrumah was really crucial in getting different African states to unite. He thought unity and collaborative work and community was a strong way to resist these structures that these newly independent nations across Africa were finding themselves in. Nkrumah wanted a united Africa. So, in each of his quotes there was always a double connotation to it, because he would always speak about his own nation state, but also about Africa and black people generally. Nkrumah was a Pan-Africanist and very much cared about black solidarity. But also solidarity in the Global South against colonial powers (...)

This is a problem in Ghana, but also generally and globally, there is this 'revisionist historicism' happening, where people attempt to rewrite history, so Nkrumah is progressively being written out of history in a way that is quite startling. Politics, big politics, always interferes in a way when someone is being really radical in their thinking (...) so his legacy has not continued as much as I would have liked.

in an online interview with Stefanie Wuschitz and Patrícia J. Reis

FEMINIST HARDWARE FESTIVAL



Between May and June 2022, queer, non-binary and female-identified media artists came together to rethink the notion of hardware from a feminist perspective. They extended the ethics of feminist hacking to ecological circuits. Using decentralised, fairly traded, modular, renewable, non-toxic materials, they speculated about future alternative technologies: they created hardware made from water, air, bubbles, waste, body liquids, microbes, glass, soil or plants. In collaboration with Mz* Baltazar's Lab, we proudly presented a diverse selection of local and international artists who generate empathic, eco-sentient and anti-racist soft/hardware. They investigated the use of organic, biodegradable, microbial matter to create ethical technology that helps to unpack the late capitalist industrial complexity of the high tech.

Building their artistic circuits, the artists learnt from biocultural, reciprocal restoration, feminist data science and environmental movements. By doing so, they prototyped models of generative and subsistent commons with human and non-human agents. Through workshops, talks, performances and exhibitions, we debated artistic, anti-colonial alternatives to sexist, toxic and extractivist commodity chains. In this way, we proposed the term 'feminist hardware' as a vehicle to diffract gender equality with sustainable and healing ecologies.

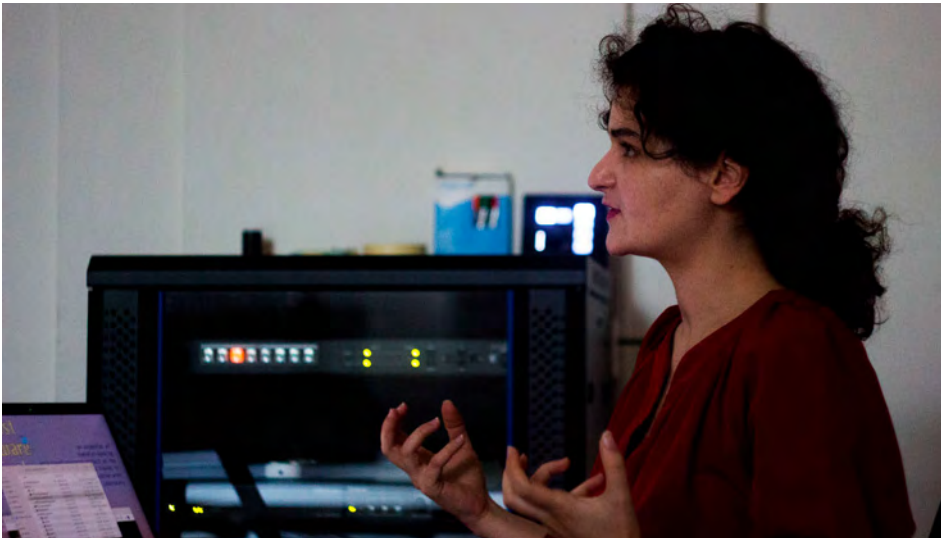
The first Feminist Hardware Festival was a synergetic extension of Feminist Hacking: Building Circuits as an Artistic Practice (PEEK AR580), conducted by Stefanie Wuschitz, Patrícia J. Reis and Taguhi Torosyan at the Academy of Fine Arts Vienna, in collaboration with Mz* Baltazar's Laboratory in Vienna, Austria. Next, we present a summary of all the events and participating artists from the festival.

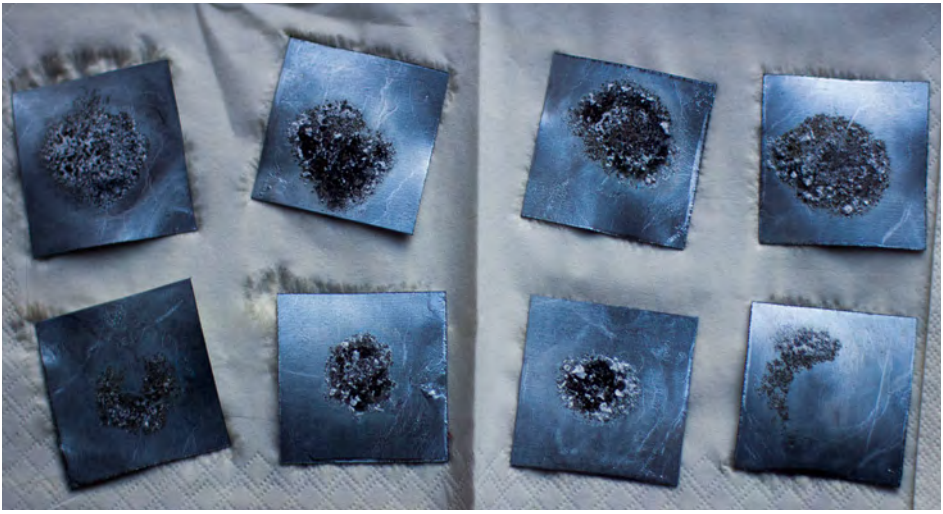
Electronic Pirouettes: sound as movement in circuitry, by Ioana Vreme Moser. Lecture at the Academy of Fine Arts in Vienna and Workshop at Mz* Baltazar's Lab. This lecture followed the pathway of an ex-ballerina through fluid computers, plant es-

pionage, cosmetic synthesisers and electronic lollipops. Vreme Moser tackled the seductive side and hidden narratives of circuitry in relation to natural systems, salty fluids and beauty rituals, and discussed the importance of alternative hardware in the context of a global electronic shortage. During the workshop, participants explored the multifaceted history of semiconducting materials, their presence in electronic devices and environmental decay. Going back to the advent of communication technologies, they looked at early radio devices, both transmitters and receivers built from raw stones. By transmission, we understand the modulation of a carrier signal, a sinusoidal oscillator. The aim of the workshop was to explore the possibilities of building such oscillators as tone generators out of galvanised scrap metal and radio-receptive stones. The participants were guided to produce negative resistance oscillations to understand the methods of reinforcing communication networks out of leftovers.

Lecture Electronic Pirouettes:
sound as movement in circuitry,
by Ioana Vreme Moser at the Academy of
Fine Arts in Vienna, May 2022
Photo © Stefanie Wuschitz

Workshop Electronic Pirouettes:
sound as movement in circuitry, by Ioana
Vreme Moser at Mz* Baltazar's Laboratory,
May 2022
Photo © Taguyi Torosan





PINK. GLITTER. VIOLENCE., by Mirjana Mitrovic

This exhibition at Mz* Baltazar's Laboratory last summer explored two separate cases of minors who had reported being raped by police officers in Mexico City. A 16-year-old girl said it had happened during her internship at the Archivo de la Fotografía museum. And a 17-year-old girl testified that she had been raped on her way home at night by four police officers in their patrol car, just two streets from her home in the north of the city. No proper procedure was followed to record the evidence, preventing a proper trial. And the girl's name was leaked to the press. These were not isolated cases, but they were pivotal. Initially, women gathered in front of the Municipal Security Building in Mexico City to demonstrate against police violence, demanding that the perpetrators be investigated and punished. Pink glitter and the shards of a smashed door collided. Spontaneous and decentralised protests were called for the Friday evening in over thirty cities in Mexico. Pictures of glittering pink fists were sent out and hashtags such as 'They're not protecting me, they're raping me' and 'We want justice!' accompanied the call to action. On the evening of 16 August 2019, shards of glass and pink glitter shone on the asphalt of Mexico City on a completely different scale. The mayor of Mexico City, Claudia Sheinbaum, called the protests a provocation. The connotation of pink glitter changed drastically, and a discussion about violence broke out in society.

On the one hand, it was about the deadly violence in the country, which has cost the lives of several women on average every day for years because of deeply rooted chauvinistic structures in the population, media and state institutions. On the other hand,

the public discourse focused on the destructive violence of the protesting women that evening, which was unleashed at bus stations, monuments and police stations. The predominantly young women, with bags of pink glitter in their hands, smashed every social expectation of them. How can this protest, between pop feminism and destructive violence, be documented, perceived, represented and remembered in both public and private spaces?

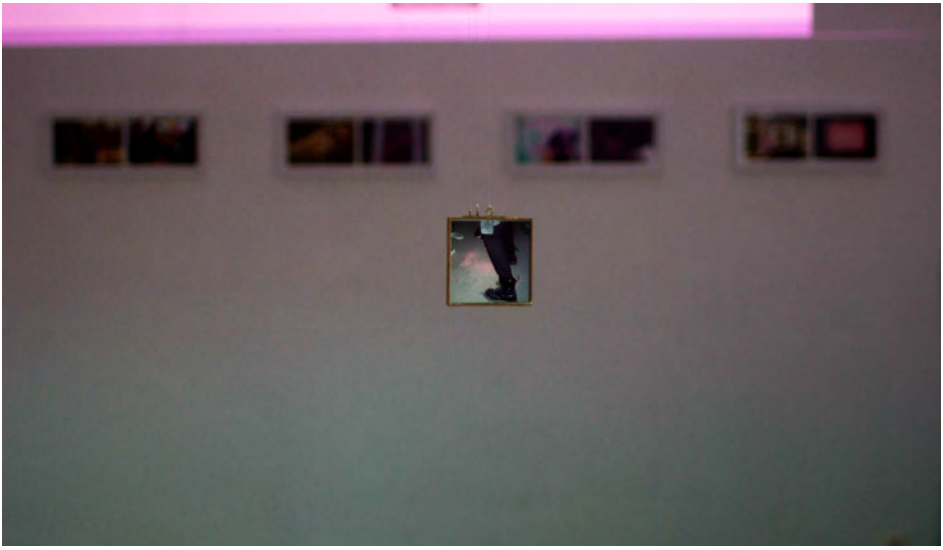
Digital Violence as Affective Disciplining after Feminist Protests,

by Marcela Suárez and Mirjana Mitrovic
Lecture at Mz Baltazar's Laboratory*

The aim of the presentation was to analyse the aesthetic and political practices that emerged during feminist protests in 2019 in Mexico City, sparked by the cases of two young women who had been raped by policemen. The great diversity of aesthetic–political actions accompanying the protests render visible the evocation of rage as a shared collective subjectivity, and thus a renewed feminist agency that is verbalised in the slogan 'Somos malas, podemos ser peores!' ('We are bad, we can be worse!'). The affective interventions, permeated with fury, anger and despair over the devastating situation of gender violence, created shared ways of sensing and being affected by violence. For example, by painting red circles simulating blood outside the police station or graffiti with the slogan #Femicidestate on historical monuments. We argue that intertwining affects and political practices in these performances and protests (characterised by bringing their affects to the political arena) transgressed the hegemonic aesthetic and political imaginary of how women should protest and what kinds of affect they are allowed to bring to public spaces. The response to the protests in the media and social networks resulted in practices

Exhibition PINK. GLITTER. VIOLENCE.
By Mirjana Mitrovic at Mz* Baltazar's Lab,
May 2022
Photo © Olivia Jaques

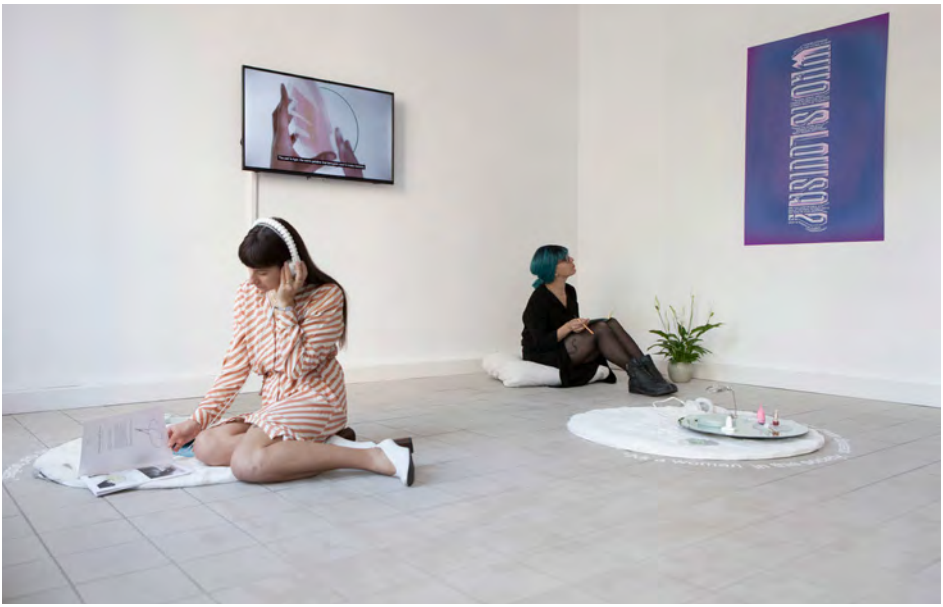
of disciplining their affects – and thus their bodies – as women were condemned for being violent and even irrational. However, the protests showed new repertories of doing affective feminist politics. In this presentation we reflect on the potential of the affective–political practices emerging from these protests to disrupt current cycles of impunity as a form of resistance.



Exhibition Louisa Speaks: intimate dialogues on language, technology and biohacking,

by Giulia Tomasello, curated by Arianna Forte
Exhibition at Mz Baltazar's Lab*

Who is Louisa? Louisa is every woman who has to deal with issues concerning her body and her intimacy every day. How many difficulties does she face in her everyday life, from social stigma to medical bias? How well is she able to find information on her own, or thanks to networking and sisterhood? Can technology, platforms or new tools help her? Louisa is one and more archetypes of people identified by designer Giulia Tomasello and medical anthropologist Isabel Farina during their user research studies and educational processes regarding the contested field of intimate care. Louisa becomes the narrative device for investigating two of Giulia's main projects: Future Flora and ALMA. Both focus on overcoming the taboos related to the female body, its functioning, its genitals and its fluids, creating new tools for claim and exploration in health and (self-) care. The former uses microorganisms and DIY practices, and the latter uses inclusive wearable technologies, both of which imagine new solutions to empower women in relation to their own bodies and are based on research and community care.



Exhibition Louisa Speaks, by Giulia Tomasello at Mz* Baltazar's Lab, May 2022
Photo © Janine Schranz

Artist talk, The wetness of Hacking: a trans-hacking-feminist perspective,

from wetlab Barcelona, by Gaia Leandra and Ce Quimera at AIL — Angewandte Digital Innovation Lab, at the University of Applied Arts in Vienna

Gaia Leandra and Ce Quimera, at the time resident artists at Hangar's wetlab in Barcelona, presented their artistic work and the projects developed within the well-known bioart laboratory. Since 2021, they have been carrying out Bioxeno, a project designed to generate new narratives in the intersection between science and art using different tools, techniques, disciplines and practices. They understand bioart as a place of strength, taking a critical perspective on the movement of knowledge and its production by science. The project is inspired by Lynn Margullis, who for several years studied microorganisms located in the ecosystem of the Catalunya territory.

Initially establishing interspecies relations with bacterial communities, specifically the cyanobacteria of the Ebro Delta (Catalunya, Spain), taking into account our human limitations and the need for technology to mediate interspecies relations, they asked: What artistic formats could show/translate this type of link without reproducing anthropocentric or colonial views? How do we account for biodiversity and the extractivism that is present in the ecosystems we inhabit? How do we think of the bio as life? How do we think of our lives? Or rather, how do we live them?

In these times, in which catastrophe and disaster seem to be the only possible scenarios in the near future, these times in which the visible eco–social alternatives seem to have come to an end, they found it crucial to generate new narratives, new stories about possible liveable futures able to challenge our present ways of living and how we relate to one another and the other living beings that inhabit planet Earth.

Workshop, Coded Biophilia,

by Giulia Tomasello at Mz Baltazar's Lab*

Coded Biophilia is a workshop designed for learning the basics of soft wearables and the exploration of biological textiles. During the workshop, participants explored the potential of bacterial cellulose for textile futures in terms of growing living materials and creating speculative scenarios for second skins, sensors and adaptive, responsive structures. They learnt new methods of making sensory surfaces for wearables and to envision how biotechnology and new materials will shape our environment. At the end of the workshop, participants were able to identify state-of-the-art soft wearable and bio-textile applications.

Technology is getting closer and closer to our skin. What we wear today will soon be forgotten and replaced with biological technologies that are changing and challenging not only how we consume and experience design and fashion but also how we relate to and work with nature, instead of against it. Through Coded Biophilia and within this space, we have the opportunity to rethink the relationship between technology, design and society.

Artist talk, by wetlab at AIL – Angewandte Innovation Lab, University of Applied Arts Vienna, May 2022
Photo © AIL

Workshop, Bioxeno,

by Gaia Leandra and Ce Quimera at Mz Baltazar's Lab*

In this workshop Ce Quimera and Gaia Leandra proposed to collectively explore the diversity of organisms in an ecosystem. Through biological and artistic practices, they questioned how different microorganisms live and co-exist, interacting with the environment. They addressed ecological communities: how to define an ecosystem; how different communities maintain and generate themselves; and why the human body is an ecosystem and not an individual. They shifted our anthropocentric vision, conditioned by the belief that humans are the measure of all things, to a worldly outlook that introduces the invisible: all surfaces are covered with life.

Workshop, Bioxeno, by Gaia Leandra and Ce Quimera at Mz* Baltazar's Lab, Vienna, June 2022
Photo © Patrícia J. Reis

Workshop + Performance, Molecular Queering Agency,

by Mary Maggic in a public garden opposite Mz Baltazar's Lab*

The Molecular Queering Agency is responsible for the industrial alienation of the human, non-human and the planetary. The molecular colonisation of endocrine-disrupting compounds asks us to acknowledge our bodies as changeable, mutable and responsive to the environment. The Molecular Queering Agency invited participants to join a 10-person (socially distanced) disobedience ritual designed to neutralise our eco-heteronormative fears around our collective alien becoming. They asked participants to be loyal representatives of the MQA and to carry out this performance with a sample of their own urine. Participants were also dressed in MQA uniforms and guided through simple choreography that was part-science, part-witchcraft.

Workshop + Performance, Molecular Queering Agency, by Mary Maggic at Mz* Baltazar's Lab Vienna, June 2022
Photo © Verena Tscherner

Artist talk, by Irene Agrivina

at the Academy of Fine Arts in Vienna

Open systems advocate, technologist, artist and educator Irene Agrivina is one of the founding members and current directors of HONF, the Yogyakarta-based arts, science and technology laboratory. Created in 1998, HONF, or the House of Natural Fiber, arose from the social and political turmoil surrounding the nepotism and corruption of the Suharto regime. In 2013 Agrivina co-founded XXLab, an all-female collective focusing on arts, science and free technology as a second generation of HONF's spin-off communities. One of XXLab's projects, SOYA C(O)U(L)-TURE, was awarded [the next idea] Art and Technology Grant voestalpine by Ars Electronica in 2015. In 2019 Agrivina was chosen by Asialink, Australia, as one of six women pioneers from South-East Asia and Australia.

Artist Talk by Irene Agrivina at the
Academy of Fine Arts Vienna, June 2022
Photo © Stefanie Wuschitz

Workshop, Eco-Print on Bio leather,

by Irene Agrivina at Mz Baltazar's Lab*

We got hands-on experience making our own eco-prints using readily available materials such as flowers and leaves. Participants had the opportunity to print on SOYA C(O)U(L)-TURE, a bio leather derived from soy production. SOYA C(O)-U(L)TURE is a project that seeks to combat water pollution and poverty in Indonesia using an innovative process that takes the toxic residues and polluted water — by-products of Indonesia's intensive soy production — and uses them as inputs to manufacture edible cellulose, as well as biofuel and biologically tanned leather.

Workshop, Eco-Print on bio leather, by
Irene Agrivina at Mz* Baltazar's Lab
Vienna, June 2022
Photo © Stefanie Wuschitz

CONCLUSION

PEACEFUL COEXISTENCE

Technology is constructed, promoted and perceived as a white and cis-male-centred domain, particularly hardware production and the architecture of printed circuit boards (PCBs). The global shipment of raw materials such as rare earth and conflict minerals extracted to build our hardware relies on a mining industry that celebrates a culture of toxic masculinity. Approaching mining and hardware production from an artistic background, and looking at it through an eco-feminist lens, help to unpack not only narratives of limitless growth, acceleration, competition and progress, but also the underlying paradigm of an essentialist gender bias, in which labour focusing on caring, reproducing, recycling and maintaining is labelled as feminine, and inventing, making, investing and constructing are labelled as masculine. This book tries to inject trans-feminist principles such as commons, care and consent into this gender bias, opening up towards new or silenced 'herstories' to speculate upon more ethical futures in a circular economy.

How can we knit a tentative narrative of future decolonial hardware? In the first part of this book, we proposed that tech must be created through an entanglement of hacking, science and activism. It is our desire that it leads to the sovereignty of countries that export raw minerals and import toxic waste. It would stop powerful nations preventing peace in regions rich in resources (Yusuff, 2019). But it is not just geopolitical tensions that need to de-escalate. We also need to consider humans and non-humans as being 'in this together— ' as players who are equally essential to collective survival (Braidotti, 2020).

The unorthodox step to abolish status quo hardware opened our minds to more ethical alternatives. Our interlocked gaze at the big five tech companies and their imposed ecologies prevents us from recognising more promising approaches. Artists take on a pioneering role here, because they navigate outside market logic, within a bubble ruled by semiotics and gallerists. A de-growth approach to building electric circuits does not throw us back to the Stone Age. But we should

acknowledge that the way people lived their lives then allowed future generations to thrive. Building technologies in a slow, local, decentralised, transparent way (keeping in mind local experience/wisdom/shortcomings) also helps to implement solutions to site-specific issues, and temporary changes, eventually functioning better than 'one-tech-fits-all' off-the-shelf hardware. Essential for this shift towards a new form of decentralised, de-growth, life-affirming technology is to establish decolonial computing as our new standard.

Our research on feminist hardware has confirmed our hypothesis, that it is in fact possible to create ethical technology. One that rewards peaceful coexistence and not capitalist exploitation.

Biographies

Stefanie Wuschitz

Stefanie Wuschitz is an artist and researcher currently based in Austria. Her projects investigate strategies to demystify and decolonise technology. In her artistic research *Wuschitz* applies critical media practices (feminist hacking, open source technology, peer production) to create interactive installations and animations. She graduated with an MFA in Transmedia Arts in 2006. In 2008 she completed her Master's degree at the Interactive Telecommunications Program of Tisch School of the Arts, New York University. She held research fellowships at Umeå University (Sweden), UdK Berlin, the Weizenbaum Institute, Berlin (Germany), and Michigan University (the US). In 2009 *Wuschitz* founded the feminist hackerspace and art collective Mz* Baltazar's Laboratory, in Vienna, which she co-organised until 2023.

In 2014 she finished her PhD on Feminist Hackerspaces at TU Vienna; she then held postdoctoral positions at the University of Applied Arts Vienna, TU Vienna, Universität der Künste Berlin, TU Berlin and the Academy of Fine Arts Vienna. From 2015 to 2016, Stefanie was part of a research collective (Tech.Culture. Matters.) at the University of Michigan. Between 2018 and 2023, she was principal investigator on three projects: an arts-based research project on ethical hardware titled Feminist Hacking (funded by the FWF); a top citizen science project on e-waste titled Salon of Open Secrets; and, from 2020 to 2021 (funded by FWF), the arts-based research project Coded Feminisms in Indonesia at TU Berlin, within the framework of the DiGiTal programme for Women* in Art and Science.

Wuschitz is currently principal investigator of the arts-based research project Strategies Against Digital Colonialism,

funded by the FWF (Elise Richter PEEK) and affiliated with the Academy of Fine Arts Vienna, in collaboration with Sanata Dharma University in Indonesia. Her artwork has been exhibited and screened at international venues, among others at Ars Electronica Festival in Linz 2024, where she, together with Patrícia J. Reis, received an S+T+ARTS prize nomination. In 2024 she also exhibited at the 38c3 Chaos Communication Conference in Hamburg, together with Patrícia J. Reis, and held a lecture at the conference. Other venues include ART|JOG 8 (Indonesia), Bouillants Vern-Sur-Seiche (France), the Austrian Cultural Forum (the US), the 8th International Sinop Biennial (Turkey) and the 16th International Biennial of Aveiro (Portugal), as well as the Africa-Asia 3 confest 2025 (Senegal). She had solo exhibitions at Kunstraum pro arte in Salzburg (Coded Feminisms in Indonesia), at Galerie 3 in Klagenfurt (Gute Mi[e] ne – Böses Spiel) and, with her artist collective, Mz* Baltazar's Laboratory, at Kunstraum pro arte, VBKÖ, Forum Alpbach and Medienwerkstatt Vienna, among others.

Wuschitz was keynote speaker at the Annual Conference of Arts, Humanities &Technology (Indonesia) and at the Conference on Tangible, Embedded & Embodied Interaction (Austria). She contributed to the track concept, panel moderation and presentation at Politics of the Machines in Berlin (DE) and Trans/Feminist Hacking – Spaces, Communities and Practices at the Einstein Center Digital Future in 2019. She co-organised media art festivals, for example the eclectic tech carnival in Sweden, Space Re:Solutions in Vienna, Napravi Me in Belgrade and the Feminist Hardware Festival, Vienna.

Wuschitz also curated several solo exhibitions at Mz* Baltazar's Laboratory in Vienna, by Reni Hofmüller, Lisa Truttmann and Ulla Rauter, among others. She worked as a lecturer at several national and international universities, including the Academy of Fine Arts Vienna, the University of Applied Arts Vienna, the University of Art and Design Linz, the University of Michigan Ann Arbor, Kunsthochschule Kassel, the Institute of Contemporary Art Moscow, The Bartlett (University College London), Shih

Chien University Taipei, the School of Visual Arts NYC and Umeå Institute of Design, Umeå University. *Wuschitz* served as a jury member for the European Citizen Science Prize of Ars Electronica 2023 and as an advisor for the EU project Arts Formation 2023, among others.

Patrícia J. Reis

Patrícia J. Reis, born in 1981 in Lisbon, Portugal, is an installation media artist and researcher currently based in Vienna, Austria. Her practice encompasses various formats and media to examine human and non-human relationships with technology. In her interactive installations, she often appeals to visitors' sensuality in an intimate, haptic and sensual manner, encouraging them to become active participants of the artwork. She is particularly drawn to perceptual phenomena that challenge conventional scientific explanations, often referred to in technology as glitches. She creatively plays with the agency of diverse materials, taking advantage of their potential aesthetic and electronic qualities. These materials range from paper, crystals and precious metals, such as gold and silver, to resin, styrofoam, wood, metal, foam, textiles and ceramics. *Reis* studied Painting at the Superior School of Art and Design (ESAD) in Caldas da Rainha, Portugal, graduating in 2004. Subsequently, she pursued Media Art, completing a Master's programme at Lusófona University in Lisbon, Portugal, in 2011. She holds a PhD in Art from the University of Évora, Portugal, earned in 2016.

Reis was a PhD Fellow Researcher at the National Science and Technology Foundation of Portugal from 2011 to 2015. Between 2006 and 2012, she worked as full-time Assistant Professor, lecturing on Photography, Video and Digital Arts at the Polytechnic Institute of Beja, Portugal. She held the position of Senior Artist at the Digital Arts Department of the

University of Applied Arts in Vienna, Austria, from 2018 to 2023. Additionally, from 2020 to 2023, she worked as Postdoctoral Researcher at the Academy of Fine Arts in Vienna in the artist-based research project Feminist Hacking: Building Circuits as an Artistic Practice. She was guest Postdoctoral Researcher at the Weizenbau Institut at TU Berlin in 2022; and Lecturer at the Media Design Department at Art University in Linz, Austria, from 2015 to 2023.

Currently, she holds the position of Postdoctoral Senior Researcher and is the leader of the artist-based research project Hacking the body as the black box, at the University of Applied Arts in Vienna, Austria, as part of the Elise Richter Programme (PEEK) grant, from 2023 to 2027. Additionally, since 2015, she has been Lecturer at the Digital Arts Department of the University of Applied Arts in Vienna, Austria. Since 2012, *Reis* has been conducting workshops and exhibitions and giving talks, locally and internationally, in cities such as Brussels, Copenhagen, Lisbon, Madrid, São Paulo, Rio de Janeiro and San Francisco.

Furthermore, Patrícia adopts a feminist approach in her artistic practice, focusing on the representation of assigned female roles in digital imagery and addressing the lack of female participation and visibility in the production of new technologies and art. Since 2012, she has been a board member of Mz* Baltazar's Lab, a feminist collective and artist-run space in Vienna, Austria. In this role, she curates exhibitions and collectively engages in the creation and research of interactive installations at the intersection between art, gender, science and open source technology.

Reis has frequently exhibited her work, nationally and internationally, in solo and group shows. In 2021 she was awarded the Outstanding Artist Award in Media Art by the Austrian Chancellery for Culture, and she was the artist selected for the international exchange programme IMPACT ART between

Austria and San Francisco Bay in the US, awarded by the Arselectronica, BKMÖES and zero1.org. She has participated in several artistic residence programmes: in Canada: Banff Centre for Arts and Creativity, in Banff (2018); in Greece: ResidenceSEA – Sensing your environment through art, in Heraklion (2016); in Germany: Hanse-Wissenschaftskolleg (HWK), in Delmenhorst (2014); and at the Edith-Russ-Haus für Medienkunst, in Oldenburg (2013).

Taguhi Torosyan

Taguhi Torosyan is an artist and researcher based in Yerevan, Armenia. Her focus areas include relational art and pedagogy, community building and healing practices. She was a member of Mz* Baltazar's Laboratory hackerspace from 2019 to 2022. She has been a PEEK Fellow at the Education Department of the Academy of Fine Arts in Vienna since 2020, where she worked with Dr Stefanie Wuschitz and Dr Patrícia J. Reis on art-based research project Feminist Hacking: Building Circuits as an Artistic Practice.

Project external collaborators

Mz Baltazar's Laboratory* (national research partner) is a collective that, since 2009, has been running a feminist hacklab and artist-run space based in Vienna, Austria. Through workshops, exhibitions and events targeted at female* and non-binary artists, *Mz* Baltazar's Lab* cultivates feminist hacking as material and artistic methodology. Artists in this community try to diffract science with activism and open source technology.

https://www.mzbaltazarslaboratory.org/

Erika Farina (*1990, Italy) is a textile artist based in Vienna. Initially trained as a tailor and dressmaker, she gained experience working with several Austrian fashion labels. Since 2017, *Farina* has been exploring the intersection between textiles and fine arts. In her work she encompasses a spectrum ranging from costume design to installation works and participatory projects. *Farina*'s creations serve as a medium for the exploration of emotions, delving into both personal and societal narratives. Currently pursuing studies at the University of Applied Arts Vienna, *Farina* focuses on textile art and art education, further refining her skills and deepening her understanding of the intersection between contemporary art and societal discourse.

Petra Francesca Weixelbraun (MEd) studied Teacher Education for Secondary Education and German Studies. She is Researcher at the University of Vienna in the Department of Digital Education and Learning at the Center for Teacher Education. Her main research interests are computational empowerment and the use of digital tools in formal education. She also works as a freelance educator, photographer and illustrator for cultural organisations.

Mir Raggam-Alji* is an artist, film-maker and art mediator whose work deals with political and social spaces in an artistic and research-based way. They intend to make in_visible, discriminatory mechanisms of society visible from their own post-migrant perspective. *Mir* Raggam-Alji* negotiates themes of belonging, exclusion, exoticisation, othering and immanent power structures in a multidisciplinary way through films, installations and art mediation programmes. By engaging with *Mir* Raggam-Alji*'s works, the participants inevitably position themselves.

Julian Chollet is a researcher/educator/writer/etc. with a background in molecular biology. He is mainly interested in microbes and the role they play within terrestrial ecosystems. As a member of the Global Hackteria Network (https://mikrobiomik.org/en) and founder of the non-profit association the mikroBIOMIK Society (https://mikrobiomik.org/en), *Julian* promotes and engages in an open and participatory culture in the natural sciences and beyond.

Theresa Schütz After graduating in Architecture, Schütz taught and was Assistant at the Vienna University of Technology, the Department of Spatial Planning (2010–14). In 2015 she received a Fellowship at the Akademie der Künste, Berlin. Since then, she has been doing art and action research in transdisciplinary projects about urbanism and public spaces. *Theresa* lives and works in Vienna, is co-founder and curator of T/abor – a space for art and transdisciplinary collaboration (since 2015); co-founder of unos – a studio for architecture and design (since 2011); and co-founder of treecycle – urban eco-solutions (since 2020).

Lilo Viehweg is a designer, researcher, mediator and lecturer with a background in industrial design and cultural studies. In her works *Lilo* investigates material-based design processes, the hierarchies of knowledge production and the related socio-political conditions of design. She teaches design anthropology and develops collaborative formats for science mediation and interdisciplinary research. Her works were exhibited at Ars Electronica Linz, MAK Vienna, the Slovak Design Center, the Design Week Beirut, the Material Archiv Switzerland, the Werkbundarchiv – Museum of Things in Berlin, and the Bauhaus Dessau Foundation, among others. She is currently a PhD researcher in the Make/Sense programme at HGK Basel IXDM and the University of Arts Linz, investigating the becomings of piezo-electric materials – a project looking into critical histories and futures of particular electroactive minerals and their paths between mountain, clean-room, kitchen and archive.

https://liloviehweg.cargo.site/

Karin Reisinger is educated in architecture, visual culture and cultural studies, interested in urban and environmental changes and spatial practices of care and maintenance, especially of feminist, Indigenous and more-than-human practitioners and communities. Her work relies on ethics of co-production, mutual learning and on a feminist critical materialist framework.

She was awarded the FWF Hertha Firnberg Fellowship at the Academy of Fine Arts Vienna, the Institute for Education in the Arts, where she also led the FWF Top Citizen Science project Stories of Post-extractive F*utures.

Cornelia Sollfrank is an artist, researcher and university lecturer based in Berlin. She studied Fine Art at Munich Art Academy and Hamburg University of the Arts and completed a PhD at the University of Dundee (the UK). Recurring subjects in her artistic work in and about digital media and network culture are new forms of (political) organisation, authorship and intellectual property, gender and techno-feminism. A pioneer of internet art, *Cornelia Sollfrank* built her reputation on three central projects: the net. art generator – a web-based art-producing 'machine'; Female Extension – her famous hack of the first competition for internet art; and her activities related to cyberfeminism – such as initiating and running the Old Boys Network (1997–2001). In her PhD, Performing the Paradoxes of Intellectual Property, she investigated the increasingly conflicting relationship between art and copyright, which led to her current interest in digital commons and their aesthetics. Her most recent performance, *À la recherche de l'information perdue*, is about gender stereotypes in the digital underground. She is currently working at Zürich University of the Arts as Associate Researcher on the Creating Commons project. Her projects and lectures have been presented internationally at museums, art festivals, universities and conferences.

Paula Pin is a researcher, artist and activist, who has a strong inclination towards experimental processes with collective and free technologies. Her work spans drawing to abstract video, and circuit bending to performance and lab experiments, always located at the intersection where biology, science and queer art collide. She has participated in the independent trans-hack-feminist laboratories, Pechblenda and Transnoise, and collaborated in the extensive biohacking network, Hackteria, since 2012. Her practical experience in biohacking (body/environment) and health at the Pechblenda laboratory gave way to Biotranslab, an autonomous lab on wheels for experiments and investigations on open science

friction and queer natures on the road. The lab is located within a bus, the CyanoVan, and is now on wheels running participatory workshops and promoting biohacking as a critical site for knowledge production and collaborative queering of the status quo. *Paula* has been Resident Artist at institutions such as Université Pierre et Marie Curie, Paris, the School of Arts (KASK), Ghent, Hangar, Barcelona, and La Gaité Lyrique, Paris, and she participated in Quirky Ecologies at Click Festival, Denmark, and the OSH Open Source Gathering, Shenzhen, China, among others.

https://paulapin.net/

Janne Nora Kummer is a director, performer and multimedia artist, based in Berlin. In their work, they deal with the connection between new media and performance art and the effects of technology and the internet on the individual and society. They teach and research within the Master's degree programme Spiel && Objekt at HfS Ernst Busch. In their research, they deal critically with body images and power relations, based on gender identities and their (re)production in the analogue and digital world. In addition, they work on a contemporary artistic practice to harness the subversive and creative potential of new technologies. Their focus lies on the development of alternative narratives and narrative formats that address the complexity of a technological, digitalised and globalised world, and which operate beyond the structures of established power mechanisms. They are an alumna of the Studienstiftung des Deutschen Volkes and a permanent member of virtuellestheater.

https://www.jannekummer.com/

Giulia Tomasello is an artist and designer committed to female intimate care and its innovation, combining biohacking and interactive wearables. She was the winner of Re-FREAM, the STARTS Prize and the WORTH Partnership, awarded by EU Horizon 2020, for her projects Alma, Future Flora and Rethinking the Bra. And she was recently recognised for her multidisciplinary work with the Japanese World OMOSIROI Award. *Giulia* offers new and deeper knowledge of female wellbeing, developing innovative tools in the intersection between medical and social sciences. She is currently part of the Vision Health Pioneers incubator in Berlin, where she is developing Alma, which co-creates tools for cultural change in female intimate care by combining technology and education. Coded Bodies is her teaching platform, designed for learning the basics of soft wearables and exploring biological textiles. *Tomasello* is currently Visiting Lecturer in Soft Technology at the Royal College of Arts in London and Politecnico in Milano.

https://www.instagram.com/gitomasello/?hl=en

Arianna Forte is an independent curator and researcher based in Rome. Her research looks at the ways in which contemporary art practices critically hybridise with the languages of technologies and sciences, creating opportunities for social imagination. The body, illness and gender identity are constant themes of her investigation, taking an intersectional trans-feminist approach. *Arianna* founded ERINNI, a curatorial platform that brings together art and activism to explore the intersections between science, technology and gender identity. She recently won the award to support curatorial research of the Italian Council 12th edition with the project Casting a spell in computational regimes: ritual practices for a trans-feminist counter-apocalypse.

Anna Watzinger, based in Vienna (AT), has a diploma in sculpture from the Vienna Art School and a Master's degree in digital/media art from the University of Applied Arts Vienna. *Anna* works within various media, subjects and projects, focusing on this liquid space of encounter of different things and phenomena. She has shown her works at many places in Vienna and abroad, including some artists in residence. *Anna Watzinger* received a KÖR award and was/is a member of different art collectives. Currently, she is Lecturer at the University of Applied Arts in Vienna (Art and Communicative Practices Studium) and a member of Mz* Baltazar's Laboratory collective, based in Vienna, Austria.

Olivia Jaques (1986, Vienna) is an artistic researcher with roots in the visual arts, who prefers to work in collective structures. She has been collaborating with Marlies Surtmann for 10 years, with whom she founded the Performatorium after the artist–curator collective Friday Exit in 2017. She is currently Research Affiliate at Tanzquartier Wien. She is also Lecturer at the University of Applied Arts in Vienna (Art and Communicative Practices Studium) and a member of Mz* Baltazar's Laboratory collective, based in Vienna, Austria.

Ana Rita Teixeira is a PhD student in Arts Education at Instituto de Educação, Universidade de Lisboa. She is developing a project, funded by FCT – Fundação para a Ciência e Tecnologia – about symbolic creativity, participative learning processes and the place of the body in education. She participates in artistic communitary projects regarding theatre, music and performance. Recently, she became part of GrETUA – Grupo Experimental de Teatro da Universidade de Aveiro – where she is attending a theatre course and, within a small team, developing volunteer sessions in the pediatric ward at Aveiro Hospital.

Sílvia Maria Freitas Amado was born in 1999 in Portugal. She finished her studies in Music (performance) in 2020 at Universidade de Aveiro, where she encountered GrETUA.

Through GrETUA, she got closer to theatre and writing, having participated in two theatre courses (2019/20, 2022/23, GrETUA), a radiophonic theatre course (2020/21, GrETUA) and a playwriting laboratory (2022) in Teatro Aveirense, where she currently works as an attendant in its plays, concerts, dance shows, movie sessions and other events.

Gameli Adzaho's work and research interests span education, technology, public health and sustainability. He has been involved in a number of community science and innovation initiatives in Ghana and around the world, including Global Lab Network and UNLEASH. Currently, *Gameli* is Country Technical Lead (Ghana) for the Research and Innovation Systems for Africa (RISA) Fund, a UK government initiative aimed at strengthening research and innovation ecosystems for socio-economic development in six African countries. He has received a number of fellowships and awards for his work from several organisations, including the Weizenbaum Institute, the Shuttleworth Foundation and the British Council.

Seyram Avle is Associate Professor of Global Digital Media in the Department of Communication at the University of Massachusetts, Amherst. Her research, funded by various institutions, including the National Science Foundation (the US), focuses on digital technology cultures and innovation across parts of Africa, China and the US. This work primarily takes a critical approach to understanding how digital technologies are made and used, as well as their implications for issues of labour, identity and futures.

Milton Raggi Vinueza (b. 1991) is a Cuban visual artist, curator and art professor. He studied at the National Academy of Fine Arts San Alejandro (2006–10) in Havana and graduated from the Universidad de las Artes de Cuba, ISA (2011–17), where he currently works as Professor of Contemporary Art. In his artistic projects, *Raggi* works with themes and concepts related to the dynamics of power and control, systems and hierarchies. His works use technological platforms and generally take the form of audiovisual performances and immersive installations with a high interactive component. In 2013 Raggi founded AXIS Visual Lab, an interdisciplinary audiovisual experimentation group focused on working with new technologies applied to art. Since 2017, with the support of the Ludwig Foundation of Cuba, he has developed the Laboratories of Art and Technology (LAT) project, to promote actions, workshops and exchange spaces that contribute to training other creators and new audiences.

Saad Chinoy is a Singapore-based geek, maker and coffee epicure. He is co-founder of SpudnikLab, a start-up that works to address the digital divide through digital skills education and low-cost technologies. He also initiated the EdibleMakerspace, which brings together art and citizen science through food and fermentation. *Saad* also initiated the SalvageGarden, a non-profit makerspace for assistive technology. He serves on the advisory boards of the Global Innovation Gathering and r0g_agency for open culture and critical transformation.

Rajina Shresta is a development worker with 12 years of experience working with young women in various capacities. She works in Resource Development and MEL at CREA, one of the very few international women's rights organisations based in the Global South. She is a part of the board of Fun Play Learn, an organisation committed to igniting scientific

curiosity in students in public schools in Nepal, and is on the advisory committee for the FREE STEM Fund, an international fund to support Women in STEM. She co-founded and formerly co-led Women Leaders in Technology (WLiT), an organisation that works with young women in tech in Nepal. She is also a former board chair of Women LEAD Nepal (organisation for young Nepali women's leadership development) and a member of the advisory committee for FRIDA, a young feminist fund. She believes that feminist leadership that is inclusive and intersectional will be the face of the next generation of institutional change.

María Antonia González Valerio has a PhD in Philosophy. She is Full-time Professor at the Faculty of Philosophy and Literature at the National Autonomous University of Mexico (UNAM). Her academic pursuits are situated within the intersection between ontology and aesthetics, as well as the interdisciplinary realm of arts, sciences and humanities, with a specific focus on art involving biomedia. As Director of the Seminar Arte+Ciencia, she facilitates collaborative engagements between artists, academics and scientists, fostering interdisciplinarity that yields graduate education, specialised theoretical research, artistic creations and exhibitions. Additionally, she is a curator and the driving force behind the artistic collective Bios ex Machina. She is the author of the following books (a selection): *Through the Scope of Life. Art and (Bio)Technologies Philosophically Revisited* (Springer, 2023); *Cabe los límites: Escritos sobre filosofía natural desde la ontología estética* (México: UNAM/Herder, 2016); *Un tratado de ficción* (México: Herder, 2010); and *El arte develado* (México: Herder, 2005).

Irene Agrivina is a technologist, artist, educator and open systems advocate based in Indonesia. *Irene* is one of the founding members and current directors of the House of

Natural Fiber (HONF), an arts, science and technology laboratory based in Yogyakarta. Established in 1998, HONF emerged amid the social and political unrest surrounding the nepotism and corruption prevalent during the Suharto authoritarian dictatorship in Indonesia.
In 2013 *Agrivina* co-established XXLab, an all-female collective dedicated to arts, science and open technology, representing the second generation of HONF's spin-off communities. Notably, in 2015 SOYA C(O)U(L)TURE, one of XXLab's initiatives, received the [the next idea] voestalpine Art and Technology Grant from Ars Electronica. In 2019 Asialink – a think tank at the University of Melbourne – selected Irene as one of six pioneering women from South-East Asia and Australia.

Hannah Perner-Wilson's work combines conductive materials and craft techniques to develop new styles of building electronics that emphasise materiality and process. She creates working prototypes to demonstrate the kinds of electronic artefact that we might build for ourselves in a world of electronic diversity. A significant part of her work is documenting and disseminating her techniques so that they can be applied by others.

Céline Struger (*1982, Klagenfurt, Austria) works with sculpture and installation. Her focus lies in the renegotiation of places, and she deals with the main themes of post-capitalism, ecology and mythology. *Struger* recently exhibited at She BAM! and in the MQ Art Box (solo). She has also participated in institutional group exhibitions at TEA Tenerife Espacio de las Artes and Synagoga – Center for Contemporary Art.

https://www.celinestruger.com/

Kristin Weissenberger (*1982, Styria) dedicates her sculptural–installation practice to the question of how we interact with the sphere of matter and organisms that surrounds us. She is increasingly concerned with the overlapping and relinking of so-called natural, technical, digital and manual processes. Her works were most recently exhibited at the MAERZ artists' association, before which a project took her to the sub-Arctic, where she created Probe_Particle_Encounter, an installation in the grounds of a research station.

https://kristinweissenberger.com/

Ioana Vreme Moser (b. 1994) is a Romanian sound artist engaged in hardware electronics, speculative research and tactile experimentation. In her practice she uses rough electronic processes to obtain different materialities of sound. She places electronic components and control voltages in different situations of interaction with her body, organic materials, lost-and-found items and environmental stimuli. From these collisions, synthesised sounds emerge to carry personal narrations and observations on the history of electronics, their production chains and wastelands and entanglements in the natural world. Dominated by alternative circuitry, bits and pieces of leftovers and subtle humour, *Ioana*'s work specialises in installations, sound sculptures, handmade instruments, sound-performance set-ups and workshops.

https://www.ioanavrememoser.com/

Mirjana Mitrovic works between Berlin and Mexico City. She combines her artistic practice with her academic research, focusing on new technologies, especially the internet and smartphones; the lifeworlds of women* and feminist activism; and geographical, physical and mental borders and their transgression. She is currently working on her doctorate

at Berlin University of the Arts, where she is investigating the digitalisation of public urban spaces using the method of strolling from a feminist and post-colonial perspective.

https://mirjana-mitrovic.de/

Ce Quimera, artist and researcher, was born in Argentina and has been resident in Europe since 2000, living between Barcelona and Bourges. She studied social anthropology in Buenos Aires, while doing internships in performing arts. In 2008, together with Kina Madno, she created the *Quimera Rosa laboratory*. From this point on, she focused her corporal and investigative work on post-identity gender policies and corporal, identity and technoscience experimentations from a trans*feminist perspective. Her work currently focuses on the development of performances, transdisciplinary projects and interactive installations, elaborating devices that function through corporal activity and experimentation in biohacking.

https://quimerarosa.net/

Gaia Leandra has a Biology degree. She worked at the Institute for Microelectronics and Microsystems (IMM) of the Italian National Research Council (CNR). Following a university education, she started artistic collaborations with *Paula Pin* through the »Fotosintetika« project. *Gaia* participates in the Maker Faire (Rome). She exhibited sound work at the Flussi media arts festival in Avellino; she collaborates with the »Riot Studio« collective, doing DIY biology workshops; and she works with Mary Maggic's »Hormons« project. Together with artist Oskar Martin, she offers workshops on sound biology and electronics. She is part of the Italian collective »Merda Elettronica«, and she teaches DIY synth workshops with artist Corazón de Robota.

Wetlab The research line on bioart is closely linked to Hangar's wetlab, a space where hybrid interactions that disrupt the limits generally established between art and science take place from a trans-hack-feminist perspective and through a critical revision of science as an institution. Workshops, presentations, research residences, collective work processes and discussions are carried out at the lab. In the context of the current ecological debacle, we want to promote projects that are propositive and which offer perspectives for rethinking other possible futures. The wetlab space is currently coordinated by resident artists *Gaia Leandra* and *Ce Quimera*.

Mary Maggic (b. Los Angeles, 1991) is a non-binary artist working at the intersection between cultural discourse, body and gender politics and ecological alienations. Using biohacking and public amateurism as a critical practice of care, *Maggic* investigates the micro-performativity of hormones and works collaboratively to demystify their molecular colonisation. *Maggic* is a current member of the online network Hackteria: Open Source Biological Art, the laboratory theatre collective Aliens in Green and the Asian artist collective Mai Ling Vienna, and a contributor to the radical syllabus project Pirate Care and the online CyberFeminism Index.

References

Abbate, J. (2012). *Recoding Gender: Women's Changing Participation in Computing*. MIT Press.

Ahmed, S. (2006). *Queer phenomenology: Orientations, objects, others*. Duke University Press.

Alaimo, S., & Hekman, S. (2008). *Material Feminisms*. Indiana University Press.

Anderson, C. (2010). *Makers: The new industrial revolution*. Crown Business.

Armani, A.M., Hurt, D.E., Hwang, D. et al. (2020). Low-tech solutions for the COVID-19 supply chain crisis. *Nat. Rev. Mater*. 5, 403–406. https://doi.org/10.1038/s41578-020-0205-1

Avle, S., & Lindtner, S. (May 2016). Design (ing) 'Here' and 'There' Tech Entrepreneurs, Global Markets, and Reflexivity in Design Processes. In *Proceedings of the 2016 CHI conference on human factors in computing systems* (pp. 2233–2245).

Bair, J. (2005). Second-wave feminist political economy. In *The International Handbook of Political Economy of Gender* (pp. 33–56). Edward Elgar Publishing.

Barad, K. (2003). Posthumanist performativity: Toward an understanding of how matter comes to matter. *Signs: Journal of Women in Culture and Society*, 28(3), 801–831.

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.

Barad, K. (2020). *Agentieller Realismus*. Edition Unseld 45, translation, Berlin: Suhrkamp Verlag.

Barad, K. (n.d.). Diffracting Diffraction: Cutting Together-Apart. https://posthumanities.net/wp-content/uploads/2021/07/Barad_DiffractingDiffraction_CuttingTogetherApart_2007.pdf

Bellacasa, M. P. (2017). *Matters of Care. Speculative Ethics in More Than Human Worlds*. Minnesota: University of Minnesota Press.

Belsunces, A., Valero, L. B., Brandstätter, U., Escudero, C., Lamoncha, F., Pin, P., & Tomás, E. (2017). Diffractive Interfaces: la difracció com a metodologia d'investigació artística. *Artnodes*, (20).

Bennett, J. (2010). *Vibrant matter: a political ecology of things*. Durham and London: Duke University Press.

Bettio, F., & Verashchagina, A. (2008). Gender and the global commodity chain: the case of work in the home. *International Labour Review*, 147(4), 369–388. https://doi.org/10.1111/j.1564-913X.2008.00187.x

Bioethical Inquiry, 17, 465–469 (2020). https://doi.org/10.1007/s11673-020-10017-8

Bishop, C. (2006). The social turn: Collaboration and its discontents. *Artforum*, 44(6), 178–183.

Biyung (2025, June 6) Gerakan Perempuan Bantu Perempuan untuk Keadilan Menstruasi. www.biyung.org

Bosold, B., Fritsch, L., Hofmann, V., Krasny, E., & Lingg, S. (Eds) (2022). *Radicalizing Care*. Vienna: Reihe der Akademie der bildenden Künste Wien bei Sternberg Press. DOI 10.21937/9783956795909

Bourdieu, P. (1993). *The Field of Cultural Production: Essays on Art and Literature*. Polity Press.

Braidotti, R. (1996). *The matrixial borderspace*. Minneapolis, MN: University of Minnesota Press.

Braidotti, R. (2002). *Metamorphoses: towards a materialist theory of becoming*. United Kingdom: Polity Press.

Braidotti, R. (2018). A theoretical framework for the critical posthumanities. *Theory, Culture & Society*, 36(6), 31–61.

Braidotti, R. (2019). *Posthuman Knowledge*. Cambridge: Polity Press.

Braidotti, R. (2020). 'We' Are In This Together, But We Are Not One and the Same. *Bioethical Inquiry*, 17, 465–469. https://doi.org/10.1007/s11673-020-10017-8

Braidotti, R., & Hlavajova, M. (2018). *Posthuman Glossary*. Bloomsbury Academic.

Bundesregierung Deutschland (2021). Greater protection for people and the environment in the global economy.
Available at: https://www.bundesregierung.de/breg-en/service/archive/supply-chain-act-1872076.

Butollo, F., & Nuss, S. (Ed.) (2022). *Marx and the Robots. Networked Production, AI and Human Labour*. London: Pluto Press.

Calvillo, N., Farias, I., & Bocchicchio, R. (2020). 'More than a Resource': On the Challenges, Opportunities and Potentials of Feminist Hacking. In *Making and Hacking: The Meaning of Craftsmanship in Contemporary Societies* (pp. 133–150). Routledge.

Chun, W. H. K. (2013). *Updating to remain the same: Habitual new media*. MIT Press.

Cleaver, H. (1991). The Zapatistas and the electronic fabric of struggle. Retrieved from https://www.researchgate.net/publication/ 248067818_The_Zapatistas_and_the_Electronic_Fabric_of_Struggle

Coleman, G. (2013). *Coding freedom: The ethics and aesthetics of hacking*. Princeton University Press.

Coleman, G. (2014). *Hacker, hoaxer, whistleblower, spy: The many faces of anonymous*. Verso Books.

Coole, D., & Frost, S. (2010). *New materialisms: Ontology, agency, and politics*. Duke University Press.

Crawford, K. (2021). *Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence*. New Haven: Yale University Press.

Criado Perez, C. (2019). *Invisible Women. Exposing Data Bias in a World Designed for Men.* London: Penguin Random House UK.

Day, R. B. (2005). *Gramsci is dead: Anarchist currents in the newest social movements*. Pluto Press.

Deleuze, G. (1994). *Difference and repetition.* Columbia University Press.

Demos, T. J. (2015). *Against the Anthropocene: Visual Culture and Environment Today*. United Kingdom: Sternberg Press.

Demos T. J. (2016). *Decolonizing Nature. Contemporary Art and the Politics of Ecology*. Sternberg Press.

Demos, T. J. (2023). *Radical Futurisms: Ecologies of Collapse, Chronopolitics, and Justice-to-Come*. Germany: MIT Press.

Derieg, A. (2007). *Things Can Break: Tech Women Crashing Computers and Preconceptions*. transversal.

Dietze, M., & Wuschitz, S. (2020). Strategien queer-feministischer Hack-Kollektive, In *Lechts und Rinks – eine Auseinandersetzung mit dem Design der Neuen Rechten*, ADOCS VERLAG, DGTF, ISBN: 978-3943253375

Dombrowski, L., Press, M., & Friedman, B. (2020). Feminist HCI in the #metoo era. *interactions*, 27(3), 72–76.

Dunaway, W. (2014). Rethinking commodity chains: Embeddedness, legitimacy, and governance. *Economic Geography*, 90(1), 1–25. https://doi.org/10.1111/ecge.12082

Dunbar-Hester, C. (2020). *Hacking Diversity: The Politics of inclusion in Open Technology Cultures*. Princeton: Princeton University Press.

D'Ignazio, C., & Klein, L. F. (2020). *Data Feminism*. Cambridge, MA: MIT Press.

Eghbal, N. (2020). *Working in Public: The Making and Maintenance of Open Source Software*. Stipe Press.

EICC (2020). About the EICC.
Retrieved from https://www.eicc.co.uk/about/

Electronics Watch & ICLEI. (2020). Labour and Human Rights in the ICT Supply Chain.

Eubanks, V. (2018). *Automated Inequality, How High-Tech Tools Profile, Police, and Punish the Poor*. New York: St Martin's Press.

Fairphone (2020). About Fairphone.
Retrieved from https://shop.fairphone.com/de/about-us

Federici, S. (2012). *Revolution at point zero: Housework, reproduction, and feminist struggle*. PM Press.

Federici, S. (2019). Re-Enchanting the World: Feminism and the Politics of the Commons. PM Press

Ferguson, J. (2016). *DIY culture: Party and protest in nineties Britain*. Verso Books.

Foster, J. B., & Suwandi, I. (2020). COVID-19 and catastrophe capitalism: Commodity chains and ecological-epidemiological-economic crises. In *Routledge Handbook of Marxism and Post-Marxism* (pp. 545–559). Routledge.

Gandini, A. (2016). *Hacktivism and the humanities: Programming protest in the era of the digital university*. Routledge.

Gandini, A. (2016). How (not) to measure culture. *International Journal of Communicatio*n, 10, 5025–5041.

Garnet, H. (2023). *Art + DIT Electronics*. The MIT Press.

Gatz (2023). Beyond Inclusion: Interrogating the Transformational Potential of Informal STEM Learning. Dissertation, University of Pittsburgh.

Geerts, E. (2025, June 6). *Ethico-onto-epistem-ology*. New Materialism. https://newmaterialism.eu/almanac/e/ethico-onto-epistem-ology.html

Genderchangers (2009). *The Genderchangers Manifesto*. Accessible at https://www.genderchangers.org/index.html (last accessed 12 February 2024).

Gereffi, G., & Korzeniewicz, M. (1994). *Commodity chains and the global economy*. Westport, CT: Praeger.

Global Perspectives, 2(1). https://doi.org/10.1525/gp.2021.24398.

Goriunova, O., & Shulgin, A. (2013). *Readme 100: Temporary software art factory*. Moscow: Ad Marginem Press.

GOSH (2025, June 6). Gathering of Open Source Hardware. www.openhardware.science/about/

Graeber, D. (2013a). *The democracy project: A history, a crisis, a movement*. Spiegel & Grau.

Graeber, D. (2013b). *The utopia of rules: On technology, stupidity, and the secret joys of bureaucracy*. Melville House.

Guérin, D. (1965). *Anarchism: From theory to practice*. Monthly Review Press.

Hall, K. (1996). *Cyberfeminism*. Pragmatics and Beyond New series, 147–172.

Haraway, D. J. (1991). A cyborg manifesto: Science, technology, and socialist-feminism in the late 20th century. In *Simians, cyborgs and women: The reinvention of nature* (pp. 149–181). New York, NY: Routledge.

Haraway, D. (1997). *Modest_Witness@Second_Millenium: FemaleMan_Meets_ OncoMouse: Feminism and Technoscience*. New York, NY: Routledge.

Haraway, D. (2003). *The Companion Species Manifesto*. The University of Chicago Press.

Haraway, D. (2016). *Staying with the Trouble: Making Kin in the Chthulucene*. Duke University Press, 38.

Haraway, D. (n.d.). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. https://commons.princeton.edu/hum583-f21/wp-content/uploads/sites/283/2021/08/Haraway-Situated-Knowledges.pdf

Heron, K. & Eastwood, L. (2024). *Handbook of Degrowth*. Germany: De Gruyter.

Hertanti, R. (2023). Between a mineral and a hard place: Indonesia's export ban on raw minerals. In TNI, 15 June 2023. Available at: https://www.tni.org/en/article/between-a-mineral-and-a-hard-place

Hertz, G. (2023). *Art + DIY Electronics.* MIT Press.

Hess, C., & Ostrom, E. (2007). *Understanding knowledge as a commons: From theory to practice.* MIT Press.

Hidayatin, Juhaetit, & Syariff (2009). Mercury and Cyanide Contaminations in Gold Mine Environment and Possible Solution of Cleaning Up by Using Phytoextraction. *HAYATI Journal of Biosciences*, 16(3), 88. https://doi.org/10.4308/hjb.16.3.88

Higgs, L. (2013). *Punk and the aesthetics of DIY: Do-it-yourself, do-it-with-others, do-it-for-yourself.* Routledge.

Ho, C. Y., & Jensen, N. B. (2018). Ethics in the global electronics industry: towards a responsible supply chain. *Journal of Business Ethics*, 149(4), 793–805.

Hopkins, T. K., & Wallerstein, I. (1977). Commodities and the periphery: A study of commodity chains. *Review (Fernand Braudel Center)*, 1(1), 121–140.

https://doi.org/10.1353/rev.1977.0007
https://doi.org/10.21428/bf6fb269.6690fc2e
https://dx.doi.org/10.1353/aq.2014.0070.
https://scilog.fwf.ac.at/magazin/das-smartphone-als-rohstofflager
https://www.bbc.com/news/articles/cn01k8948v1o

ILO (2018). The Electronics Industry.
Retrieved from https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_641813.pdf

Jack, M., & Avle, S. (2021). A feminist geopolitics of technology. Global Perspectives 2(1). https://www.researchgate.net/publication/352306353_A_Feminist_Geopolitics_of_Technology

Jordan, T. (2008). Hacking and politics. In J. D. Holt & A. V. Siciliano (Eds), *Empires of the mind: I. A. Richards and basic English in China, 1929–1979* (pp. 127–142). Stanford University Press.

Juris, J. S. (2008). *Networking futures: The movements against corporate globalization*. Duke University Press.

Kelty, C. M. (2008). *Two bits: The cultural significance of free software*. Duke University Press.

Kelty, C. M. (2014). The participatory condition in the digital age. In *Critical terms for media studies* (pp. 144–156). University of Chicago Press.
Kimmerer, R. W. (2015). *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants*. Milkweed Editions.

Klein, E. (2019). *Riot grrrl: Revolution girl style now!* Black Dog & Leventhal.

Klein, N. (2020). How big tech plans to profit from the pandemic. *The Guardian*. https://www.theguardian.com/news/2020/may/13/naomi-klein-how-big-tech-plans-to-profit-from-coronavirus-pandemic

Kögler, H. H. (1997). The Communicative Turn in Philosophy: An Analysis of Its Different Interpretations. In T. A. van Dijk (Ed.), *Discourse as Structure and Process* (pp. 105–122). SAGE Publications.

Kohei, S. (2022). *Marx in the Anthropocene. Towards the Idea of Degrowth Communism*. Cambridge University Press.

Kohei, S. (2024). Systemsturtz. Der Sieg der Natur über den Kapitalismus. dtv: München

Kumar, A. (2017a). Hacking the gendered binary: The socio-materiality of gender in an Indian hackathon. *Gender, Technology and Development*, 21(1–2), 99–115.

Kumar, A. (2017b). *Code as activism: Hacking and distributed activism in the digital age*. Routledge.

Kuo, R., Chen, Y., Lin, C., & Avle, S. (2022). Triangulating race, capital, and technology. In CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '22 Extended Abstracts) [C8].

Laczko, J. (2021). The Art of Hacking. Intersections between Hacker Culture and Visual Arts. Hungarian University of Fine Arts Doctoral School.

Latour, B. (2008). Bruno Latour. A Cautious Prometheus? A Few Steps Toward a Philosophy. Reading Design magazine https://www.readingdesign.org/a-cautious-prometheus

Latour, B. (2013) *An Inquiry into the Modes of Existence. An anthropology of the moderns*. Cambridge, Mass.: Harvard University Press.

Lewis, S. (2022). *Abolish the Family: A Manifesto for Care and Liberation*. London: Verso.

Liboiron, M. (2021). *Pollution is Colonialism*. Durham and London: Duke University Press.

Liboiron, M., & Austic, G. (21 July 2025). GOSH Manifesto. Gathering of Open Science Hardware. www.openhardware.science/e.

Lindtner, S., Greenspan, A., & Li, D. (August 2015). Designed in Shenzhen: Shanzhai manufacturing and maker entrepreneurs. In *Proceedings of the fifth decennial Aarhus conference on critical alternatives* (pp. 85–96).

Lorde, A. (2021). *Sister Outsider*. German Translation. München: Carl Hanse Verlag.

L'Huillier, N. (2018). Feminist Hacking and Feminist Maker Culture. In E. Aronson, A. Arteaga, S. A. Trejo, & M. A. Villanueva (Eds), *Affective Computing and Sentiment Analysis: Emotion, Metaphor and Terminology* (pp. 151–166). Springer International Publishing.

Maly, I. (2016). The hidden labor of making: The global value chains of the digital DIY movement. *International Journal of Communication*, 10, 3463–3483. https://ijoc.org/index.php/ijoc/article/view/5733/1695

Mansoux, A., Howell, B., Barok, D., & Heikkilä, V.-M. (2023). Permacomputing Aesthetics: Potential and Limits of Constraints in Computational Art, Design and Culture. Ninth Computing within Limits 2023. LIMITS. https://doi.org/10.21428/bf6fb269.6690fc2e

Marx, K. (1976). *Capital, vol. 1* (B. Fowkes, Trans.). London: Penguin.

Maxigas. (2012). Hacklabs and hackerspaces: Tracing two genealogies. Journal of Peer Production (2), n. p. Retrieved from https://just-tech.ssrc.org/citation/hacklabs-and-hackerspaces-tracing-two-genealogies/

McLuhan, M.(1964). *Understanding Media: The Extensions of Man. In The Medium is the Message*. London: Penguin Books Ltd.

McRobbie, A. (2016). *Be creative: Making a living in the new culture industries*. John Wiley & Sons.

Mies, M. (1986/2021). *Patriarchy and Accumulation on a World Scale. Women in the International Division of Labour*. Zed Books. Bloomsbury Publishing Plc. London. ISBN: 9781350348189

Mies, M. (2014). No Commons without Community. *Community Development Journal*, 49(1), i106–i117.

Miller, C. (2022). Chip War. *The Fight for the World's Most Critical Technology*. Bad Hersfeld: Simon & Schuster. ISBN: 978-1-398-50412-7

Mises, L. V. (1944). *Bureaucracy*. Yale University Press.

Mohanty, C. T. (1991). *Cartographies of Struggle: Third World Women and the Politics of Feminism*. Duke University Press. DOI: https://doi.org/10.1215/9780822384649

Mohanty, C. T. (2003). *Feminism without Borders: Decolonizing Theory, Practicing Solidarity*. Duke University Press. https://doi.org/10.2307/j.ctv11smp7t

Nagbot, S. S. L. (2016). Feminist Hacking/Making: Exploring New Gender Horizons of Possibility. *Journal of Peer Production,* 8, 1–10.

Nakamura, L. (2014). Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture. American Quarterly 66(4), 919–941. https:// www.researchgate.net/publication/ 282933026_Indigenous_Circuits_ Navajo_Women_and_the_Racialization_of_Earl y_Electronic_Manufacture

Nature Reviews Materials, 5(6), 403–406.

Neimanis, A. (2017). *Bodies of Water: Postman Feminist Phenomenology*. London: Bloomsbury Academy.

Newman, S. (2019). Reclaiming Utopia: The Promise of Feminist Hacking. *The Journal of Peer Production*, (14).

Nijhuis, W. (2019). Making (Things) as Ethical Practice. In L. Bogers, & L.

Chiappini (eds), *The Critical Makers Reader: (Un)learning Technology* (p. 138). Amsterdam: Institute of Network Cultures.

Noble, S. U. (2018). *Algorithms of oppression: How search engines reinforce racism*. NYU Press.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.

Ostrom, E. (2002). Common-pool resources and institutions: Toward a revised theory. In *Handbook of Agricultural Economics* (pp. 1315–1339). Elsevier.

Ostrom, E. (2002). Reformulating the commons. *Ambiente & sociedade*, (10), 5–25.

O'Neil, P. (2019). C-Node: Subverting the black boxes of Amazon Web Services in Dublin. In L. Bogers, & L. Chiappini (eds), *The Critical Makers Reader: (Un) learning Technology* (p. 182). Amsterdam: Institute of Network Cultures.

O'Reilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *Communications & Strategies*, (1), 17–37.

Paddock, R. (24 May 2016). The Toxic Toll of Indonesia's Gold Mines. In *National Geographic*,
retrieved from https://www.nationalgeographic.com/science/article/160524-indonesia-toxic-toll (last accessed 19 February 2024).

Precarity Lab (Aristarkhova, I., Chaar-Lopez, I., Fisher, A., Hu, T., Lin, C., Lindtner, S., Kamil, M., & Nakamura, L.) (2019). *Digital Precarity Manifesto. Social Text STX 37.4* (141).
Ratto, M., & Ree, R. (2012). Materializing information: 3D printing and social change. *First Monday,* 17(7).

Ratto, M., & Boler, M. (2014a). *DIY citizenship: Critical making and social media*. MIT Press.

Ratto, M., & Boler, M. (2014b). Introduction: Materializing Web 2.0: Feminist interventions. In M. Ratto & M. Boler (Eds), *DIY citizenship: Critical making and social media* (pp. 1–14). MIT Press.

Reis, P. J., & Wuschitz, S. (2021). Curating Hacking. In B. Bosold, L. Fritsch, V. Hofmann, E. Krasny, & S. Lingg (Eds), *Radicalizing Care, Vienna*. Reihe der Akademie der bildenden Künste Wien bei Sternberg Press.DOI 10.21937/9783956795909

Rodney W. (1972). *How Europe Underdeveloped Africa*. London: Bogle-L'Ouverture Publications.

Rosner, D. K., & Ames, M. G. (2014). Designing for repair? Infrastructures and materialities of breakdown. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 691–700). ACM.

Rosner, D. K., Lindtner, S., Erickson, I., Forlano, L., Jackson, S. J., & Kolko, B. (2014). Making cultures: Building things & building communities. *Proceedings of the Companion Publication of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 113–116. https://doi.org/10.1145/2556420.2556852

Sanders, C. (2018). Feminist Hacking as a Speculative Practice. *Ada: A Journal of Gender, New Media, and Technology*, (13).

Savic, S., & Wuschitz, S. (2018). Feminist Hackerspace as a Place of Infrastructure Production. Ada: A Journal of Gender, New media and Technology
https://irf.fhnw.ch/entities/publication/909f9fb0- f9a9-477b-8899-5d437d0219ee

Schwarz-Stiglbauer, M. (2023). "Das Smartphone als Rohstofflager" Scilog, September 25.
https://scilog.fwf.ac.at/magazin/das-smartphone-als-rohstofflager

Scurto, H., Caramiaux, B., & Bevilacqua, F. (June 2021). Prototyping Machine Learning Through Diffractive Art Practice. In *Designing Interactive Systems Conference 2021* (pp. 2013–2025).

Shirky, C. (2008). *Here comes everybody: The power of organizing without organizations*. Penguin Books.

Shiva, V. (2012). *Making Peace with Earth*. Pluto Press.

Shiva, V. & Mies, M. (2022) "Ecofeminism". Critique influence change Series. Bloomsbury Academic.
Siagan, A. (2016). Lifepatch. *In Open Hardware Europe Summit.*

Sinders, C. (2019). In L. Bogers, & L. Chiappini (Eds), *The Critical Makers Reader: (Un)learning Technology* (p. 128). Amsterdam: Institute of Network Cultures.

Sipos, R. (2023). *Grassroots Innovation in Critical Technical Practice*. Dissertation. Technical University of Berlin.

Sipos, R. Åkerman, M., Saari, H., & Kieslinger, B. (2022). Critical Making Responsibility Framework. Extending an Academic Proposal to Support Reflexivity in Maker Communities. FAB17. In *Proceedings of the MIT FAB17 Fab Fest Bali Academic Conference*. This submission received 'Best Paper Award'.

SSL Nagbot (2008). Feminist Hacking/Making: Exploring New Gender Horizons of Possibility. Journal of Peer Production, (8), Editors' Introduction. http://peerproduction.net/ issues/issue-8-feminism-and-unhacking-2/ feminist-hackingmaking-exploring-new-gender- horizons-of-possibility/

Söderberg, J. (2008). *Hacking capitalism: The free and open source software movement*. Routledge.

Söderberg, J., & Delfanti, A. (2014). Hacking and making as gendered practices. In F. S. Jansson, M. Carpentier, A. Delfanti, & C. Olsson (Eds), *Materializing feminism: Technology, gender, and the politics of the possible* (pp. 87–105). Oxford University Press.

Sollfrank, C. (2002). The truth about cyberfeminism. Old Boys Network. https://obn.org/obn/reading_room/writings/html/truth.html

Statistics Austria. (2021). Frauen und Männer in MINT-Fächern [Women and men in STEM subjects].
Retrieved from https://www.statistik.at/web_de/statistiken/bildung_und_kultur/bildungssystem/hochschulen/studierende_mit_universitaetsabschluss/studierende_nach_studienrichtung_geschlecht/bwl_und_mint_faecher/084570.html

Suryakusuma, J. I. (1988). *State Ibuism: The Social Construction of Womanhood in the Indonesian New Order*. Institute of Social Studies, Depok.

Susik, A. (2019). *Art History Hacked: Art Hack Practice as an Intra-garde. In Art Hack Practice* (pp. 15–22). Routledge.

Tan, E., & Barton, A. C. (2020). Hacking a path into and through STEM: Exploring how youth build connecting pathways between stem-related landscapes. *Teachers College Record,* 122(2), 1–44.

The Care Collective (2022). *The Care Manifesto The Politics of Interdependence*. Apple Books, Brooklyn: New Left Book.
Time code 4:58.
Accessible at: https://andreassiagian.wordpress.com/2016/05/30/symposium-open-source-hardware-european-summit/

Toscano, A. (2006). The open secret of real subsumption: Bordiga, Marx and the autonomia debates. *Historical Materialism*, 14(4), 3–25.

Toupin, S. (2013). Feminist hackerspaces as safer spaces? Feminist Journal of Art and Digital Culture, 27, 14.

Toupin, S. (2014a). Feminist Hackerspaces: The synthesis of feminist and hacker cultures. *Journal of Peer Production,* 5(6).

Toupin, S. (2014b). Encounters between feminism, activism, and hacker culture. *Ada: A Journal of Gender, New Media, and Technology*, (6).

Truong, T. D. (1996). *The realm of gender in international political economy.* In *Gendering world politics: Issues and approaches in the post-cold war era* (pp. 38–64). Columbia University Press.

Tsing, A. (2015). *The Mushroom at the End of the World*. Princeton: Princeton University Press.

Tsing et al. (2017). *Arts of Living on a Damaged Planet. Ghosts and Monsters of the Anthropocen*. Minneapolis: University of Minnesota Press.

Tuck, E., & Yang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society*, 1(1), 1–40.

Tungstall. E. (2023). *Decolonizing Design. A Cultural Justice Guidebook*. Cambridge, Massachusetts: The MIT Press.

Van der Tuin, I., & Dolphijn, R. (2012). N*ew Materialism: Interviews & Cartographies*. Open Humanities Press.

Vergès, F. (2021). *Decolonial Feminism*. London: Pluto Press.

Vincentelli, M. (2002). *Women and ceramics: Gendered Vessels (Studies in Design and Material Culture)*. GB Gardners Books. ISBN-10: 0719038405

Wajcman, J. (2004). *Techno-feminism*. Cambridge, UK: Polity Press.

Wajcman, J., & Rose, E. (2015). Constant connectivity: Rethinking interruptions at work. *Organization Studies*, 36(2), 143–166.

Winger-Bearskin, A. (2022). Decentralized Storytelling. In *Collective Wisdom. Co-creating Media for Equity and Justice*. Cambridge: MIT Press, p. 261.

Wuschitz, S. (2014). Feminist Hackerspaces. A Research on Feminist Space Collectives in Open Culture, at the Vienna University of Technology/Vienna.

Wuschitz, S. (2020). Is this Feminist Hardware? In Haele, Ulrike, Moritsch, Stefan (Eds), Gendersensibles Design, D.E.S.I.G.N. Foundation, New Design University Privatuniversität GesmbH, ISBN 978-3-9503515-7-6

Wuschitz, S. (March 2022). A feminist hacklab's resilience towards anti-democratic forces. *Feminist Theory*. doi:10.1177/14647001221082298

Yusoff, K. (2019). *A Billion Black Anthropocenes or None*. Minnesota: University of Minnesota Press.

Zane, D. (2025 February 5). *Your phone, a rare metal and the war in DR Congo*. BBC. https://www.bbc.com/news/articles/cn01k8948v1o