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Making the 3000m2 Prototype

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Making the 3000m2 Prototype

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Abstract

The paper reveals insights from the project 3000m2 Prototype, a project where the design researcher investigates the making of her own house as a site of negotiation between professional building practices, use practices and material resources. The research draws on science and technology studies (STS) as the point of analytical departure alongside a material–reflective approach of practice–based design. The design of everyday living technologies, like the warm water and bathroom installations, is negotiated between the users, the professional builders, and the environmental forces, which inscribe the future use of these technologies. These emerging scripts are presented and discussed, revealing tension and misalignment between programmes of action in which builders are enrolled and those where the future user wants to design her house use in a resource-conscious way. This paper proposes the alignment of professional, use and resource considerations as a form of co–design of everyday living technologies. It argues that a more collaborative designing incorporating professional, use and resource considerations can produce technologies that lead to more sustainable living.

Keywords

Design, STS, Making, Use, Consumption, DIY

Introduction

Everyday living technologies such as heating, electricity or water supply systems are a major cause of wasteful human behaviour (Kuijer, 2014; Shove, Pantzar, & Watson, 2012). The amount of resources that these technologies require is not sustainable – both in producing and in using them. This paper reveals insights from the project *3000m2 Prototype* in which the design researcher investigates the making of her house as a site of manual, social and use practices. We refer to her as the user–designer. The house and the land are proposed to be a prototype that is made of various found resources such as meadows, soil, trees, a stream, as well as built technologies such as foundations, walls, heating, electricity and water installations… . A living prototype that is made, kept stable and changed by the user–designer and her practices, by existing building practices, and by environmental considerations that surround the site. The 3000m2 refers to the land where the house is built, with the footprint of the house being mere 30m2.

We investigate the making of the house as a co–design process between users, professionals and their material practices, and ask, "How are everyday living technologies made? How is the makeup of these technologies negotiated and constituted?"

Understanding the make-up of these emerging everyday living technologies through a lens of STS (science and technology studies) can allow us to open, unseal, demystify, and potentially make available these practices of making, for a more reflective use of resources which supports more sustainable living. We understand sustainable living as engaging in everyday practices with minimal exploitative impact on the environment, whilst maximising use of renewable resources (Tao & Vyas, 2021). This is in line with the maker movements, DIY (Raeva, Usenyuk-Kravchuk, Raev, Surina, & Fionova, 2021) and sustainable placemaking research that discusses the everyday making and living practices (e.g. through the use of economical, local materials, and through fixing and repairing) as better alternatives to resource–intensive consumerism (Berglund & Kohtala, 2020). And yet, the investigation of making the

house goes beyond the exploration of sustainable placemaking. It attempts to look at the larger network of the resource–aware user, the material resources involved in everyday technologies, as well as professional actors and their resource practices. We aim to make available the insights from this local project to enable and inform other projects with resource–aware user–designers.

For the purpose of this investigation we propose that the 3000 m2 site is a permanently fluid, unfinished prototype, that temporarily stabilises as living objects such as the house, in the interaction between the builders and their building practices, the occupants and their use practices, and the nonhuman environmental forces. Our insights invite a rethinking of these making practices as a material–reflective co–design practice.

Methodology

In the work of STS, much consideration has been given to how technological infrastructures mediate social practices (Latour, 1994). STS approaches highlight the relationality of things, and how the world is a product of the relations of humans and nonhuman participants of all kinds (Law, 2004). This relational constitution of (human) being allows us to read technologies as products of social practices, as much as we can read social practices as inscribed by these technologies.

An important contribution which we are seeking to make, is the methodological approach which combines concepts of STS with the material–reflective approach of design (Neubauer, 2022; Neubauer & Wecht, in press), hereby proposing that the scripts that inscribe technologies and social practices, can be reflected upon, and can also be reinvented, redesigned and remade.

We reflect on the design of everyday living practices through the researcher's participation as a user–designer in the practice. This process draws on design anthropology methods (Akama, Pink, & Sumartojo, 2018), where the user–designer becomes a part of the practices of making, not only as a designer but specifically as a user being the expert on their own use practices (Stappers & Giaccardi, 2017). Knowledge and expertise are here understood as practical accomplishments and as experiences in practice (Gherardi, 2012).

The user–designer works on building her own house, with the help of contractors, family and friends, during the course of two years. She is many participants in one: a researcher, a maker, a client, and a user of the technologies that make up the living space. She employs methods of sensory ethnography, particularly visual ethnography (Pink, 2009), to create notes and other documents of the work. Visual ethnography is a method of research where the researcher participates in an activity through video or still images. Image-making is treated as multisensorial and embodied events of knowing. The notes and images are then used to create vignettes; visual and textual accounts of the data. In this paper, these vignettes are used to thematically organise the data, as we present in the following section, "Examining the everyday technologies". For the building site to be researched with design anthropology methods it needs to evolve as a real–world phenomenon (Singh, Herrera, van Dijk, Keyson, & Strating, 2021). To this end, the researcher forms the relationships with the carpenters and the other craftspeople in response to (and as she experiences) the design and the building of the house in the real–world context, rather than as a sampled set of relationships bounded by a research project. The rapport between the researcher and her team varies as those involved are introduced to the aim of the research. Many are not familiar with research in practice, and whilst some readily go along viewing the project as research, others continue to treat the encounters as a normal building project with the researcher as a mere client of professional services. The interactions between the researcher, the team and the site that arise from the overlap of the real–world and research contexts are part of this methodological approach and are recorded in the vignettes below.

Ethical considerations are given utmost importance in this project. Because of the above–mentioned fluctuating boundaries between personal and research encounters, ethics standards have carefully

been assessed in respect to the given situation, e.g. providing informal (verbal) or formal (written) information about the research, and receiving consent informally (saying yes) or formally (signing of a form). An assessment is made carefully each time whether an interaction warrants formal action or not.

Even for the researcher, boundaries that demarcate the research may shift quickly. Something may seem to be an unrelated interaction at first and later turn out to be a relevant event for the research. In the case that such an event ends up being used for the research, it is treated as data sourced from auto–ethnography (Czarniawska-Joerges, 2007). Similarly, personal encounters with friends and family are treated as auto–ethnographical.

Whilst the general approach is to give people the information about the research and to ask for formal consent, formal procedures are refrained from during clearly personal interactions, or when information and consent about the research were not easily moveable to a formal stage either through disengagement or through a lack of access for various reasons, for example, if a person participated in an unplanned way and is then difficult to reach. In any case, adhering to best practice research standards, acting responsibly and bringing no risk or harm upon participants, and protecting anonymity and personal details are a core element of all interactions surrounding the project.

Examining the everyday technologies

Getting to know the land

The position of the house changes a few times on the grassland. The field must be mowed at least twice a year. Doing it with a scythe is a laborious task that requires the right timing. It must be done when the grass is fresh in the early morning, and when there are sunny days lined up so the grass can be dried and made into hay. I use this activity to explore the land and to consider various positions for the house. I consider views (to the outside and also from the outside in), sunlight, trees, slopes, proximity to the stream, the sounds and other impressions from the various corners of the 3000m2 land.

Figure 1: Making hay and exploring the 3000m2 site

I choose the position in a kind of nook on the base of a slope where the views are not wide but green. This enclosed corner is a little to the side of everything, not centre stage. It is also not far from the stream, which I have come to enjoy during the summer heat. I plan to have a small 'farm yard' at the back of the house later, with a root cellar for storing crops. The foot of the steep slope at the back of the house is ideal for this.

Over the course of that summer, I test the position of the house by camping there, and building a basic infrastructure – a small 3m2 hut housing basic kitchen utensils and a toilet – with a porch for shelter where I can sit and even sleep. I also bring fresh water to the site with a water hose, creating a "well" made of a basic tap and a bucket.

Future-proofing

The works on the house begin with the concrete slab foundation. I initially wanted a more economical point foundation with a wooden base. But the carpenter, and everyone who had building experience, warned me that a wooden base would be too exposed to the damp and the cold, and that mice and snakes would "love" the space in between the soil and the house base. I finally agree to the slab foundation. The excavation goes about a meter each side beyond the small foundation, and also below it, in order to create a drainage made of gravel between the soil and the concrete. It is important, I learn, to keep the water and the concrete apart from each other, in order to create dry conditions. The work is extensive and the dimensions given to the concrete slab and to the drainage seem massive to me. "We do it in a way so you will not need to touch this ever again." It caters for all the weathers and any future conditions to come. It sounds to me that they are very proud that this work will stay in place for at least 100 years, and I think to myself that this is way over the top. 10 or 20 years would suffice, for now. It pains me to know that all this concrete might turn to waste if I do not need this place any longer. Also, it would have been cheaper to build a point foundation.

Damp-proofing

The 30m2 house is made of a wooden frame construction. The connection between the wood and the concrete is insulated with a bitumen layer to create another barrier against any dampness.

Figure 2: The wooden frame construction sitting on the concrete foundation

On top of the concrete floor an additional layer of bitumen is welded, as a protection against any dampness coming from below. Multiplied amounts of resources, time and effort are needed in order to protect beyond the expected threats. The concrete foundation is more massive than needed. The iron steel in the concrete foundation is a bit more than required. The gravel underneath and around the foundation is more than necessary. The bitumen sealing is being done to be on the safe side, in the case that water comes through to the foundation despite the gravel drainage.

Technologies are proofed and sealed against weather, dampness and unforeseeable futures. The sentence "you will not need to touch this again" was uttered several times. It means, that you go a little over the top in the making of a technology, so that it caters for all the weathers, for many years to come, and any possible future situations. The house is understood as a value object that can be used when it is finished and eventually passed on or sold. It has

a solidness and stability that does not require – actually, not permit – an undoing and re-doing. The house is sought to be sealed as a finished object.

Sealing knowledge

But not only the technologies themselves are sealed shut. Even the activity of making the technologies is shielded from interference, as it seems. Among the craftspeople, I hear the stories about home owners asking for impossible things to be built. It frustrates the professionals that they are sometimes asked to make things that are very hard to implement. But they grudgingly conclude that the one who pays is allowed to command the work. I also hear the tale about home owners who continuously change their mind, which does eventually not only frustrate the professionals, as they lose time and the quality of their work suffers, but also the home owners, because the work takes longer and it costs more.

As a digital product designer, I can relate to the frustration of negotiating with people from outside the practice. For many years I was faced with clients or colleagues from different departments who did not understand the craft of the digital, but who nevertheless wanted to have a say in the design of it. It was a painful process, having to deal with design requests that did not make sense from the craft's material perspective, having to defend design decisions to people who didn't understand the technologies involved, or presenting beautiful solutions to people who couldn't appreciate the art of making it.

I can understand that professionals seek to shut out anything that jeopardises the quality of their work. I continuously feel being shut out from the work, encountering many different contractors, and I experience that non-professionals are generally not welcome on the building sites. I also hear that a building site is no place for a woman. But since I also hear many surprised expressions about being a woman who does building work, I place this comment within the larger picture of the situation, that there is a fear of outsiders interfering.

I experienced various strategies of the contractors to shut me out, with varying levels of aggression. I noticed that contractors tended to arrange work without consideration of my schedule, despite my expressed wish to be present, only calling to gain access to the site. The carpenters were very cooperative once they realised I wanted to join them in the work. A more aggressive strategy, which I experienced with another contractor, was the demanding of a plan. When I produced the plan, and explained that the plan contained inaccuracies on purpose, so we could agree on the details during the work (together), I was met with anger and frustration. It seemed to me that the plan was supposed to be a safe space for the professional, defining exactly the requirements. A tame artefact, replacing, what Suchman would call, "unruly sites and subjects" (2007, p. 189). It is messy to discuss requirements with the (inexperienced) user as the work unfolds, and not all professionals want to do that. Work and the knowledge how to do it tend to be sealed away and made hard to access for outsiders.

Responsibility and accountability

Here we see actual seals with copper wire that the electrician has made. Those circuits that are already safe are open, and those that are not have a seal on them. The seals are for the protection of the users of the house from unsecure electric installations. But it is also for the protection of the electrician, as he tells me. He takes a photo

so he has proof that he has left no insecure circuits behind. The photo is a protection against being made responsible for anything the electrician cannot account for. Of course, if I remove a seal – because I may have completed another electric installation with my friend who teaches me the basics of electric installations – it is my own responsibility as the user and client. This practice of sealing work is also about responsibility and accountability. The seal securing the professional's responsibility, accountability, and, by extension, also his reputation that relies on the object and its quality (and safety).

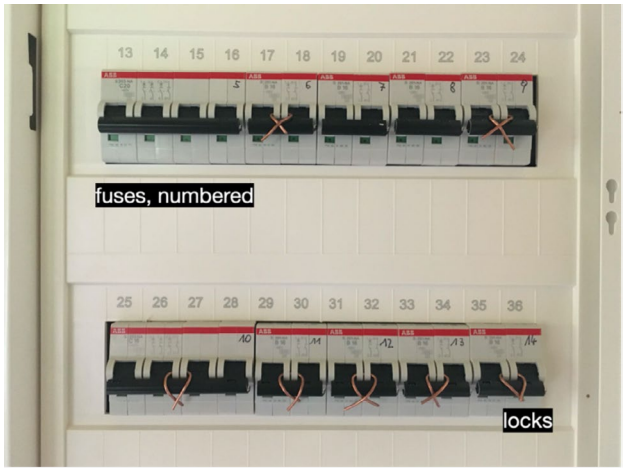

Figure 3: Electric fuses, some sealed with copper wire

The bathroom floor is usually made of concrete. Common practices involve pouring a layer of concrete over the pipes and drains on the floor, effectively sealing them shut. I decide not to use concrete, but to put a wooden floor on top of the drains. Everyone involved is very concerned that this area of the house could get damp. But I cannot see the benefit of concrete on top of an already damp-proof bitumen layer. Concrete would not seem to add more protection against water from below. And it would also not protect against a possible drain leak, as the concrete would merely hide it. And if the wood floor gets wet from above, it would dry up. Concrete would certainly prohibit me from changing the water pipes and drains if I want to change the bathroom layout. It would have sealed the bathroom layout in place. The tiny bathroom layout is an experiment, and I am not sure it will stay like this. Also, I think that my needs might change, or that new inhabitants with new needs might come, and so I prefer to keep the bathroom layout flexible for future changes.

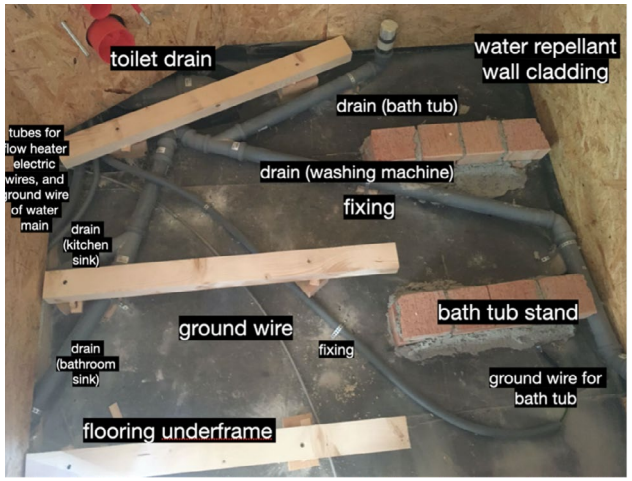

Figure 4: The inner workings of the bathroom floor, defining the bathroom layout

I wonder whether there is a different perception between myself and the contractors, about the dangers of water in my future use practice. To me, very little danger comes from my washing practices, as I do not splash around in the bathroom but have a rather careful practice of washing. Nothing that cannot dry up easily through opening the

window for ventilation. More danger comes in my eyes from the pipes and the drains themselves. I would want to check occasionally if they are still intact, and be able to act quickly if they are not.

This time I stand up against the general advice of using concrete. I do not want the professionals' perceptions about my washing practice to lock my future capacities to use my bathroom.

However, the reoccurring stories about proofing against natural forces, such as the damp and the cold, left me uneasy. By resisting the common practices, and by insisting on low-resource solutions, am I risking the existence of my house? Will it lead to my wooden house rotting away without me noticing…?!

Subjects of knowledge

Amongst the professionals being a good professional, establishing hierarchies and positions of authority is a common practice, as the following illustrates. I soon discover that things with damp–proofing are not as critical as they seem. The knowledge around how houses need to be proofed against the natural forces also depends on the knower. The professionals emphasise to me the important function of the bitumen layer which proofs against water from underneath, and that every hole needs to be repaired. But when another professional, a friend, shows me how to drill the holes in the concrete floor (with the bitumen layer), in order to fix the electric tubes, he said that I should not worry too much about the holes made by the screw fixings. They are not usually repaired. He added that if I want to, I can buy a tar paste and put it on top of the screw holes. When indeed I go to the builders' shop to buy the tar paste, I am told off for having holes in the bitumen layer. But by now I am aware that the knowledge of damp-proofing and defining the boundaries of 'damp–proof enough' is sensitive and relative to the subject who knows. This knowledge will be used to assert a hierarchy, and place me in a position of the inexperienced and thus outside of building practices.

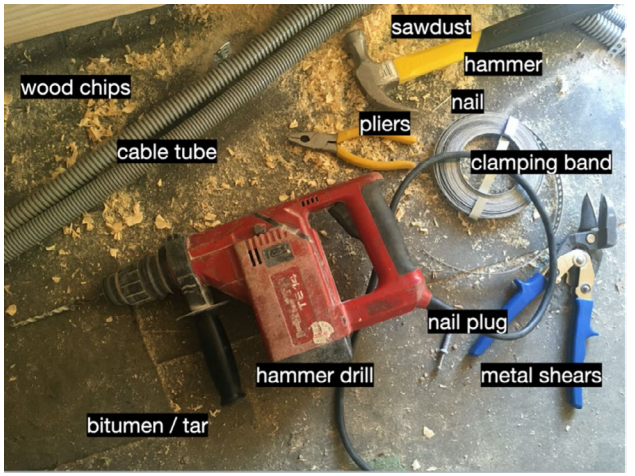

Figure 5: The tools needed to fix the electric tubes to the concrete floor covered in black bitumen foil barrier

On another occasion, the builders discuss amongst themselves the course of the sewage pipe. As they agree on a course, they further discuss whether an additional access point was needed between the sewage system connection and the sewage pipe. An access point would provide two benefits: access for maintenance and avoiding a sharp bend in the course of the pipe. As they discuss, I mention my wish that as little as possible of the still intact soil will be dug up, given that there were already so many trenches dug, which could be reused. I say this because I mean to protect the soil and its established microcosm, and to save money, as any additional work will be charged. But they insist that

the function of the sewage is so critical that a straight line must be prioritised. They assert their knowledge decisively over my considerations. All the details about courses of trenches, access points, depth of frost penetration, … are celebrated as important details to consider in order to come to a good solution. Impact of the work on the land, and on my budget are seemingly unimportant. The discussions of important and unimportant details are also negotiations about who is a "good craftsman" (a phrase I heard often), and thus who has more credibility and influence in the decision of what will happen.

Figure 6: The sewage pipe leading out of the concrete foundation, to be connected to the main sewage system

This practice of creating hierarchies does not only serve to exclude me, the user and client, the resource-aware, but it also serves to create a hierarchy amongst the professionals themselves. How fluid this position-taking is in the decision process becomes obvious when an old friend, a plumber with many years of experience, visits us on the building site. We ask him whether he thinks the extra access point is necessary. He dismisses the concern immediately. "A good maintenance tool can go around any bend, even around a 90-degree bend". He easily trumped the other professionals who earlier dismissed my idea to reuse the trenches that were already dug, to save soil and money. Their knowledge about 'having a course as straight as possible' was trumped with the plumber's knowledge that 'any good tool could deal with bends'. I wish he had been here earlier, when I tried to negotiate. This argument would have helped my cause in the negotiation.

Adaptation for future use

If adaptation for future use is an aim, like in my case, the practice of "sealing" is not helpful. If technology is sealed in place, it cannot be easily adapted. And if the work on the technology is hidden away, it is more difficult to know how to change a technology. As a DIY maker in Raeva et al., research says "Everything breaks sooner or later, but a good machine lets you fix it" (2021, p. 18). If I was able to watch how something is done, I could try to change, repair and maintain it in the future. Is it the aim to avoid non-professionals touching the technology? The electrician, for example, warns me gravely (and surely in part rightfully) that doing electrical work is very dangerous and should be left to electricians. But how to gain some agency in adjusting a living space? Not always will design requirements be clear from the start, according to a "plan". Mine were not. Design sometimes must be done slowly over time. Many requirements will only emerge with the course of time, and some might dissolve. If the technology is sealed, designing it slowly will not be possible.

A friend who is a plumber tells me the story about his own bathroom. He says that he won't change it even though his

needs have changed and it is a bit unpractical now. But changing it would mean to rip everything out, including the tiles on the walls and the concrete floor. I think to myself that if not even a professional plumber is willing to update the technology to fit his needs, because it is too much work, wouldn't it be time then to make technology more flexible?

The carpenter explains to me that normally in a wooden house, there is an 8cm installation layer behind the wall cladding, which houses all the pipes and tubes. The cladding is normally done as a layer of plasterboard. I ask the carpenter for possible alternatives to plasterboard, which would seal the walls and all the technical installations within them. I would like to keep the access to the installations without destroying the wall, and I would like to use a material for the cladding that I can reuse. The carpenter tells me about a solution he has seen when an architect once used rough sawn timber as a cladding for the walls. I immediately like the idea, and I decide to use this "modular" technique where walls remain accessible and adaptable.

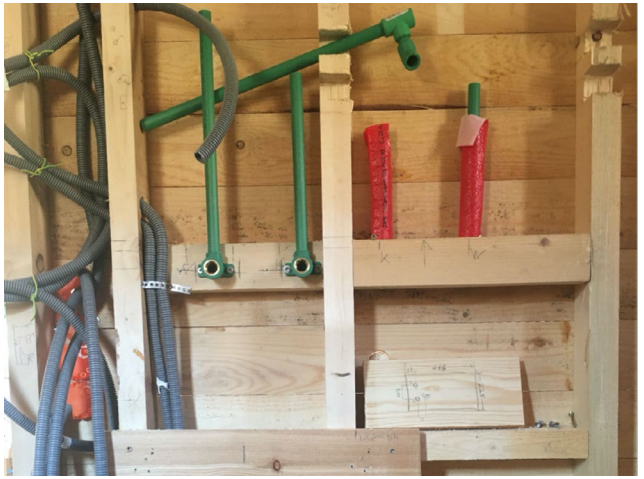

Figure 7: A bathroom wall, containing water pipes and electric tubes

Creative designing and making

I have the help of several friends, making this wall and the installations. I am grateful, being able to work with people who let me be a part of the work. I learn a lot, and they are patient enough to listen to me telling them about my use practices, so it may inform our work. The design decisions in making this wall (between bathroom and kitchen) have much impact on how it emerges in its finished state. Last minute, the water tap is moved further to the right. Also, we have the idea to make a little side wall of 15cm, in a 90-degree angle. We all find it's a great solution as it will accommodate all the electric switches and sockets facing away from the sink, making it safer. As we work, we have these little ideas and act on them. Little drawings, as seen in the picture, support this creative process.

In my own work with friends, and in watching the builders, carpenters and other professionals, I realise, that they are very creative when challenges pop up. Everyone knows, "things never go according to plan". I hear this sentence often. But they do not call these deviations from the plan "creative improvisations" but they call them "technical necessities". They explain that these are normal technical issues that arise and need solving. Nevertheless, I realise that much of what the professionals do is designing and making technological systems in highly creative ways, in effect making lots of small design decisions.

I think that use practices should be a part in these design negotiations. I am the expert on how I use this technology. And I will know when my own use practices change, and I will want to adapt the technology. Also, if something breaks it will be me who is faced with this technology; the professionals will have moved on. It should be me who can do something about it.

Using use practices as considerations in design

The professionals have particular ways of doing things. Their expertise is defined through the familiarly with the material. As I decide between an electric flow heater and a water boiler for warm water, most people warn me about the cost of an electric flow heater. It requires so much electricity in the moment of use, they say, that it is much more expensive than a water boiler, which keeps water hot permanently with little electricity use. I think about my use practices. I know that I will not need so much hot water daily. I will not even need 50 litres, which would be a very small boiler. Our washing practices are defined by quick washes by the sink, and the occasional bath. For washing up, I often use hot water that is a by-product of the kitchen stove, where I keep a 10-litre pot of hot water, ready to be used at all times when the stove is in use, which is daily, for heating and cooking. I further install a water tap that operates cold and hot water separately. I anticipate that the conscious decision to turn on the hot water will make me more aware of my hot-water-consumption and nudge me to consume less. For me, it is about saving energy and about saving money.

I notice the electrician's discomfort with the flow heater, as they are extremely rarely used in this area. He says that he cannot guarantee I will be satisfied with it. I decide to try nevertheless. My first experiences with it are good and as expected.

Discussing everyday-living technology as a *material-reflective co–design practice* between users, professionals and materials

The 3000m2 prototype project studies the making and using of the house and its technologies as a diverse set of practices. With the thematically organised reflections of the user–designer in the previous section, we seek to illuminate practices of making and using everyday living technologies.

We encounter practices of sealing – sealing technologies as stabilised objects, and sealing professional knowledge in knowing subjects (and their positions); there are highly creative crafting practices; and finally, there are practices of being use-aware, resource-aware and cost-aware. We propose a reconfiguration of the practices of designing everyday living technologies to support a more use–aligned and resourceful co–design practice. In this project, the future–users use–awareness invites low–resource solutions. She deems an 'over-the top' infrastructure as not necessary, and she would like use practices to be kept open for future changes, as understood in the literature on maker movements, DIY and sustainable placemaking.

Drawing on concepts from co–design we open and rethink the design of everyday technologies as a realigned material-reflective practice that includes diverse considerations around use and resources, or nonhuman actors. Co–design is often understood as a complex staged series of events, where events have a pre-defined structure, tasks and facilitation (Vaajakallio & Mattelmäki, 2014), underpinned by a shift from designing *for* to co–designing *with*. Here, however, co–designing is mainly associated with: involving of users in the design activity of exploring, envisioning and developing solutions; bringing the political dimension aspect of empowering those that are usually excluded from the design process; and in general, a tool for collaborative engagement (Mattelmäki & Visser, 2011). Including users is particularly important if design is understood as a continuous activity and an ongoing process of transformation (Akama & Prendiville, 2013):

> Co-designing can be described as a mode of awareness that is receptive and open to events as they happen, apprehending an engagement directly. It unlocks tacit knowledge that can be holistic, non-verbal, non-linear and intuitive. Co–designing is an interconnected process, moving freely among person to person, deepening each person's awareness and understanding as it unfolds. (p. 34)

Design activity can be understood as a reflective conversation with the material, where the designer engages in a dialogue with the material consequences of making. The designer is faced with the continuous "back talk" of each of their design "moves", assessing and dealing with the unintended, unexpected new situations arising (Schön, 1983). This material-reflective positioning of design suggests that practitioners are able to reflect on their renewed positions during the interaction with technologies, and that new ways of action are possible through reorganising the material relations of interaction between them and the technologies.

In an STS view, technologies are the effects (the products, the results) of relations between people and things (Latour, 1990). The sociomaterial network of actors around everyday living technologies might be described as the "apparatus" that designs them (Barad, 1998). Thinking this backwards for design means that we need to focus on the relations between people and things and the practices involved, in order to be able to intervene in the design of technologies.

Latour writes about "programmes of action" that generate the functioning of technology. A road bumper generates the agency to slow down car drivers. Slowing down is the script that inscribes that agency in the road bumper–car–driver interaction. Technologies' inscriptions are powerful; scripts prescribe how participants can move within practices (Akrich, 1994). The aforementioned material–reflective approach makes these scripts visible, and the way they affect a practice.

Design can be practiced as a material–reflective activity (Neubauer, 2019, 2022), in which action is interspersed with reflections on one's own renewed position through the design action (Neubauer & Wecht, in press). The design of a technology can thus be reviewed in an ongoing reflective process of stabilising (acting) and destabilising (reflecting) it. The object of design becomes a draft; a prototype which can be attempted and stabilised, and then reflected upon and destabilised, in continuous cycles of stabilisation and reflective destabilisation.

A material–reflective co–design practice might hence be understood as an oscillating activity in which stable and possible states of technology alternate, and are subject to the negotiation practice between the involved actors.

Opening design processes

Design is a sociomaterial negotiation between people and materials (Eriksen, 2012). Designing in collaboration requires many voices to be included, highlighting Sanders & Stappers' view on co–design involving people's ideas, desires and dreams (2008). In our project, the researcher is simultaneously the user of the house, and it becomes obvious in the house project how hard it is to make her voice heard. The hierarchy of positions played out through professional knowledge puts the user of the house in a marginalised position. But it is the user who will continue a close relationship with the technologies on an everyday basis, as opposed to the building professionals who will move on to the next project. It is the user and her surroundings who have to carry the material consequences, also financially, for the design decisions that are made.

The scripts that inscribe everyday living technologies are mainly defined by professional building practices. These currently attempt to control natural forces such as the damp and the cold, or the mice and the snakes. The striving for control also protects the experts who are made accountable and responsible for their professional doing, as we see with the electrician applying locks to the fuse box. Things are done over the top with materials and dimensions, like the concrete

slab foundation that will stay in place for a long time.

The scripts also seal knowledge within professional practices; they protect the professionals' existence as experts and negotiate the experts' hierarchical positions giving them varying weights in the decisions that are made. This becomes visible, for example, in the negotiations around the trench line for the sewage pipe, or in proofing against damp.

Future uses tend to be sealed when the technologies are built, often inadvertently, as we see with the bathroom drains which were going to be poured in concrete, sealing possible layouts. This sealing of future uses generates material and financial consequences for the user.

The building of the technologies is reserved for the professionals, and it is difficult to raise a voice in the design negotiations as a user. The scripts lock roles – the experts are in, and negotiate their influence in design decisions, while the users are out. Barad states that subjects and objects are always the products of sociomaterial relations in action (Barad, 2007). For example, a user is made a user by being locked out of touching the inner workings of the technology (Woolgar, 1991). Or an engineer can define the functionality because they follow their own understanding of use rather than asking real users (Cooper, 2004). Assuming that roles taken up in social practices are never naturally given, but rather the product of relationships, the co–design process needs to be viewed more comprehensively: Both the technologies (the objects) and the people (the professionals, the users), can be understood as the result of inscription. The material–reflective co–design process should begin with opening the roles that people take up, and continue with opening the technologies. The design of technologies and who gets to design them should be more sensitive and reflective to the situation.

Considering environments and use practices

We argue for the process of designing everyday living technologies to become more sensitive to questions of use requirement and of resources. Through this, design has the potential to be less invasive, for example if use requirements are frugal or if resources are scarce.

When building something as resource–intensive as a house, many things need to be considered. Not only manual and professional practices, but also the material resources, such as the soil, trees, concrete, timber, money. The user–designer tried to save concrete, soil and money, but the building practices did not allow for a more frugal use of resources. Reusing the existing trenches or excavating less soil for the slab foundation would have saved soil and money. Practices that go over the top, just to be on the safe side, cost more resources.

Future use practices are uncertain and difficult to anticipate; they are highly dependent on context (Kuutti & Bannon, 2014). In more participatory approaches to design, the roles between designers and users become blurred, and "the production, reproduction, and transformation of sociomaterial assemblages" is left open to evolve in use practices (McCarthy & Wright, 2015). The researcher is aware of the "reciprocal shaping" between user and environment (Desjardins & Wakkary, 2016). User and environment co-evolve as situations look differently and future design decisions cannot be anticipated until the user has "lived" in an environment (p. 5278). Everyday technological infrastructures (such as bathrooms, kitchens, or electronically powered devices, …) define their use practices, thus locking users into particular ways of living (Gram-Hanssen, 2009; Hand & Shove, 2004; Kuijer, 2014; Shove, Watson, Hand, & Ingram, 2007). As material infrastructures inscribe use practices, it becomes key to being aware of how they might fit together. The researcher, as a researcher and as a designer, is used to inquire use practices, like her own, and map these to functions in the technology, tying the inscription process of technology closely to use requirements. The user-designer is aware of her own use practices and how these fit with the assemblage of the bathroom, for example. She realises that she will not need additional damp-proofing on the bathroom floor, because she uses water carefully in the bathroom. She knows she does not need a hot water boiler because she is familiar with her hot water–use. She therefore makes the bold decision to decide

against the concrete floor and against the water boiler. But she is also aware that her needs might change or that future inhabitants might have different needs. Even more so, she requires the bathroom layout to remain flexible, awaiting future insights about use to emerge. Likewise, her considerations about using heating, hot water, or electricity inform the design decisions of these technologies.

Many other considerations are inspired by this research, that could be discussed, such as skills and capacities. The user-designer has the ambition to design her own house; she has the willingness, time and financial resources to negotiate with the professionals and learn from them. What would need to change to give more people access to this kind of project?

And how would professional roles need to change without threatening their livelihoods? These are some of the many questions that we look forward to thinking about in future papers on the 3000m2 project.

Conclusion

Design is a making process; a process of material speculation on the future (Gaver et al., 2006). In this project, the future user of the technology engages in the practice of co–design with the material asking 'what if' her use practice is X or Y in the future with 'what should' or must be designed in the present.. What should or must happen is not fixed. Instead, when the design is open between the inhabitant and their use practices and material resources, and the professionals and their manual skills, the design can be continuously reconfigured.

Design solutions do not need to be complete or fixed. They can offer the possibility to change over the course of time and use. It is essential for design processes to reflect and continuously update expectations for possible results.

The material–reflective design practice that we envisage treats their objects of design as objects that trigger a continuous de/re–stabilisation, a designing as a kind of cosmopolitical prototyping (See Healy this volume). As user–designers in this project we attempt drafts of future use, that can be redrafted any time. The scripts that inscribe technologies such as foundations, walls, electricity, water installations, … should remain reconfigurable and open to considerations of resources, which may be low-tech, found or reused materials, and the use practices, which may be frugal, and how these all fit in relation to each other. In material–reflective design, technologies could be continuously evolving prototypes of low-resource, frugal–use, sustainable living spaces.

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