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Everything is a prototype, but not at all in the same way

Towards an ecology of prototyping

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Abstract

In this article I reflect on discussions from the 2022 DASTS conference around the shifting nature of prototyping in design research. Specifically, I reflect on Ruth Neubauer and colleagues' work on 'prototyping living spaces' (2022, and this volume), and Simy Gahoonia and Christopher Gad's (Forthcoming; 2022) study of the Danish Technical Comprehension experiment. I also reflect on an element of my own design-research that has involved developing speculative prototypes, namely a tandem bicycle that was designed as an 'interview machine' for gathering research on the Calais Jungle refugee camp in France (Healy, 2021). I go on to develop what I refer to as a prototyping ecology to underpin the above and to consider the different modes and methods involved in different kinds of prototyping practices, and the ways they stabilise and destabilise the situations they enter into. Finally, I 'test' this ecology by revisiting the aforementioned examples to explore the forms of 'stirring' that prototypes participate in, how they straddle the ecology, and the ways they produce and encourage research events where I argue for the importance of how one might become attuned to the ways they encourage the unexpected by forming new relations and events through material intervention.

Keywords

prototyping, ecology, participatory design, speculative and critical design, cosmopolitical prototyping, design-research

Introduction

When I initially trained as a designer, prototypes seemed to me to be fairly straightforward — some*thing* that is mocked up and tested so that another can be made that is *better*. It had to do with incrementalism and iteration. But it now seems that 'prototype' can be used to describe all manner of objects, things, and practices. Not least, at the most recent Danish Association for Science and Technology Studies (DASTS) conference, where the prototype was evoked to describe a house, government policy, interfaces, and engineering education. This prompted a consideration of the multiplicity of different prototyping practices, how or when something ceases to be a prototype, their particular methods and politics, and whether there is a concern that the term prototype could begin to lose meaning and specificity. I found the discussion compelling enough to think through some different conceptions of prototyping, and by thinking with my colleagues in the panel I hope that this paper offers a way of understanding what some of these conceptions are, what they do, and what they might become capable of[1].

Since training in design, I have gone onto become engaged in STS research, which has alerted me to an expanded understanding of prototyping and provided some methodological tools for un-blackboxing the kinds of political, temporal and social relations they have a hand in assembling, disturbing, or stabilising. In the article I propose to view

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1   In keeping with this I want to point to Ruth Neubauer's warm suggestion made in the review stage of this article, that by working in dialogue with colleagues across disciplines we might escape some of the ways that design theories have historically been used in battle against one another. Neubauer suggests following Claudia Mareis (2019), Theorien des Designs zur Einführung, that theories themselves can be tools with which to stabilise and destabilise the makeup of the world (218), reminding us that 'theories can only claim validity at particular places and points in time, particular people and communities' (29). She warns that 'theories are also instruments of disciplining and domination, and it is not uncommon for the search for theoretical structure and order to be combined with the striving for idealisation, abstraction and purification' (generously translated by Neubauer — alas my German is poor). What I would like to learn from this suggestion is to think and practice theories of design for conversation and dialogue with one another, to address a given problem at hand, rather than trying to lay claim to, or stake out one particular position or theory.

prototypes as a matter of concern in order to consider the different ways they are proposed, designed, and go onto behave, where I take inspiration from Bruno Latour's (2007) argument that 'yes, "everything is (cosmo)political" but not at all in the same way' (818). When I started this process, I began to define a 'taxonomy' of prototypes, but quickly came to realise that there are some issues with this mode of categorising that are not particularly well-suited to this project, because it seemed to fix prototypes into different boxes, amounting to little more than a 'quick guide' for designers to pick different kinds of prototyping practice. My aim instead is to think with what it is that prototypes do, and how designers and researchers might become attuned towards how they behave and affect given research events, based on how they are designed, what they are 'made of', where and how they operate, and how they are observed.

Therefore, I have proposed an *ecology* of prototyping practices referring to Isabelle Stengers' ecology of practice — to insist that 'no practice be defined as being "like any other"' (2013: 184). This is important because while I recognise that prototypes are not static and entirely pre-programmed, they do have certain particularities to be attended to. In conducting this exercise then, I want to strike a careful balance to acknowledge that while prototypes are in process, risky, and multiple, they do have differences. Having said this, the aim is not to set out arbitrary 'rules' for what a prototype is, can, or should be, and I do not suggest that identifying with one aspect of the ecology means something is forever stuck in a classification (as a social constructivist or designer might be tempted to). Prototypes almost always exceed intention; to adapt a Deleuzian phrase, 'we don't know what a [prototype] can do' (1988: 17), or what it might become capable of. Prototypes are slippery and shift (or perhaps they 'dance' - Pickering, 2010) based on their design, use, deployment, re-design, observation, and so on, which (as I will find later) is important because it brings to bear on how one (designer, researcher) might pay attention to the ways prototypes, users, settings (and so on) transform as part of a research practice (Danholt, 2005).

The article will proceed in three parts, the first outlines a selection of different prototyping practices that sparked this debate from the 2022 DASTS conference, where I delve into some of the methodological implications of the different forms of prototypes that were evoked. The second looks to various literatures and practices to build the ecology of prototypes summarised in Table 1 (see later). The third and final part looks to the ways prototypes stabilise or destabilise situations where I draw from speculative thought to consider the ways prototypes encourage, expand, and at times destabilise relations, rather than fixing them (which is arguably the focus of 'classical' approaches to prototyping), which I find requires a certain attention to the particular ways that they come to matter.

Part 1: A story of the shifting nature of a prototype

The conference session that prompted this paper began with Ruth Neubauer et al.'s *Prototyping living spaces: How design as a sociomaterial practice can create sustainable worlds*. The paper included a rich set of stories about how building a 'house' (or is that a prototype?) begins to pre-figure and script (Akrich, 1992) use in the process of building and living with and in it (Figure 1). Presenting at the conference, Neubauer went on to describe how the design and build of a house that she would eventually live in inscribe future use scenarios through various negotiations with both humans (like builders, plumbers and designers) and non-humans (like pipes, concrete, soil, and trees).

Figure 1. Photograph of the foundations forming part of Neubauer's 3000m2 prototype. Image credit: Ruth Neubauer.

This process proved to be very difficult, and the authors found was especially problematic when trying to negotiate the status of the house with contractors tasked with realising the designer's imagination and requirements. For Neubauer the house is a *3000m2 Prototype*, which has two jobs. First, to eventually provide shelter, and second (which is the 'strange' one for her builders), to problematise how to configure and script alternative ways of living and being.

In my reading then, there was a problem of language; or a translation issue between the builders and design-researcher. The builders do not understand this object is a prototype — they understand it as a house, with all of the expectations, requirements and codes that are intrinsically tied to that kind of object. It is perhaps this problem of language that is expressed very clearly in the differing temporal expectations between design-researcher and contractor. Neubauer explained that the builders work towards a house that will last 100

years, but that the researcher — understanding the house as a prototype — sees things very differently, telling us:

> 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. Who knows what is then...? And if I need to continue needing this house, I can renew it' (Neubauer et. al., this volume p. 8).

In my reading, Neubauer's concerns about the building as a prototype are two-fold. The first is that 'going over the top' and making a building to last so long in the face of the climate disaster seems to use a lot more resources than is necessary. Second, and more pertinent to this conversation, that building in this way delimits future possibilities for the space, and the capabilities of the house to be a prototype — 'it becomes a monument or a tomb, rather than an object through which to draft living spaces' (Neubauer, personal communication). Through design and material choices Neubauer argues for a material future that cannot (should not?) necessarily be controlled or staked out by concrete infrastructures, such as a bathroom where the pipes and wires are set in concrete, limiting what may be changed in future. Neubauer proposes an architecture that is a perpetual prototype. As a model this idea of the prototype is somewhat familiar to co-design (Akama and Prendiville, 2013) and software, but perhaps less so in buildings (though perhaps in campervans, Desjardins and Wakkary, 2016).

The requirements of building and architecture, and architects' use of prototypes seem to differ to those typical of co-design literature. One could argue that architecture is not able to employ prototypes in the same ways that, for example, product or digital design does — it is far more difficult, expensive and risky to prototype and iterate at the architectural scale, meaning the final building may be the first and only iteration of a 'prototype' aside from scale models (see Yaneva, 2009 on architectural models). However, what Neubauer is doing is not only

prototyping the structure of a building, but prototyping living spaces, which is to say that the entanglement of architecture and social practices surrounding it are the subject of her practice[2]. The concern then is not only the concrete infrastructures, but the possible ways of living that these enable or delimit. In which case there is another temporal dimension to this practice, whereby, the design of the structure is not done once, and completed, but 'enables the practice of design as a part of everyday life' (Neubauer, personal communication). Or if I can put it another way, the house and design studio are in a state of becoming — the house a design studio and the design studio a house, which simultaneously act upon one another, and point to emergent ways of being, doing and living as a certain kind of design practice.

Simy Gahoonia and Christopher Gad's *Prototyping the future, prototyping citizens – the Danish trial of 'technology comprehension'* in public school presented a multiplicity of a prototype in the form of a Danish initiative to improve the understanding of everyday technologies such as computing. In their presentation the technology comprehension (TC) scheme that was rolled out by the Danish Ministry for Education is conceptualised as a mass prototype that was deployed to test the effectiveness of a new form of technical education. Here, the prototype is evoked in three keys ways which are approached from multiple perspectives: First, students are taught prototyping skills using materials and processes typical in Scandinavian Participatory Design (PD), e.g. paper, card and pens, as well as Microbit controllers Figure 2 Photograph of one of the pupil's prototypes. Image credit: Simy Gahoonia., with the idea being that pupils would achieve both critical and creative digital competencies by engaging in and experimenting with design processes and prototyping' (Gahoonia and Gad, 2022). This is what those running the scheme will refer to as the prototyping. This brings us onto the second, which is the author's notion of 'prototyping

Figure 2. Photograph of one of the pupil's prototypes. Image credit: Simy Gahoonia.

citizens', referring to the students themselves as prototypes in ongoing practices of making and learning, becoming 'inhabitants of future societies' (ibid.). Here, the authors bring their own STS-informed notion of prototyping to understand the experiment as producing children *as prototypical citizen-subjects,* becoming 'more ideal' digital citizens. Third, that the process of rolling out TC was seen by the Ministry for Education as a mass prototype itself, deployed to test whether or not the scheme could make the students better at comprehending technology.

In this case there are various meta-levels of prototyping acting in different ways. The authors explained at the conference that in the classroom prototyping informed the teaching and learning, becoming an organising concept for articulating and making shareable teachers' and pupils' experiences of conducting new activities. However, the authors also point to some interesting issues surrounding these multiple layers of prototyping. The first is that the Ministry was unable to make claims about the scheme's overall effectiveness due to methodological issues inherent to the scheme; the roll out of the initiative was not observed or reflected upon particularly closely so that its effectiveness could be judged. Second, that the multiple uses of the word prototype caused

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2   Arguably, this is often true of self-built architectures, where designer and user are one and the same, but again would be quite different to the majority of architectural approaches. See for example Walter Segal's self-built architecture (Grahame and McKean, 2020).

confusion around what was being referred to. For example, the authors explain that the term 'didactic prototypes' caused confusion among school staff, because the pupils were also making prototypes in the lessons. I will pick up on these two problems later in the paper, and this 'confusion' is something that I hope to address by providing some different ways of describing different kinds of prototyping practice, as well as the ways they overlap, borrow from, and at times contradict each other.

In the meantime, I have been thinking with a project that I worked on in 2016/17 involving a tandem bicycle (Figure 3) prototype/research device/play thing. The bicycle was used in the Calais Jungle refugee camp to research the ways that agency over image-making practices (Figure 4) in the highly asymmetric setting of the European borderscape could be manipulated, or re-designed. The project was motivated by a concern over who could and could not produce images of the camp, and how they were framed and went on to be used. For example, members of the right-wing press (and some politicians) in the UK often set out to produce and publish violent and sensationalist images of the camp to stigmatise the camp's residents (Ibrahim, 2011, 2016; Trilling, 2019). Equally, images were produced to enforce the border, for example through CCTV imagery and identification documents, but were also used to help identify certain needs in the camp, for example in mapping the camp's infrastructures and architectures in order to understand its needs and mitigate against hazards such as fire.

In the tandem example my understanding of prototyping was also layered and multiple. The device was designed, made, and used through a process of iteration and adjustment, but became different to a typical conception of the prototype, because it was not designed to produce, new, or better bikes, but was concerned with another practice; that of disturbing the relations of image-making (and therefore meaning-making) practices, and observing the new arrangements of people and things that this fostered. I have previously described this bike as a speculative research device (following Wilkie et al., 2015: 80), which is conceived by drawing on speculative design as a process of

designing and deploying objects to elicit new, unexpected behaviours, for example by establishing atypical relations between its different riders (Healy, 2020).

Figure 3. The tandem bicycle photographed with its audio and film collecting 'rigs'. Image credit: the author.

Clearly prototypes are not so simple after all, and of course have previously been conceptualised in several different ways in design and STS/ANT literature (Bødker and Grønbæk, 1992; Jiménez, 2014; Kelty et al., 2010). I now want to dive into some more of the prototyping literature to think through what some of these differences are and what they do in order to then revisit the above examples with a richer set of conceptual tools.

Part 2: An ecology of prototyping

The table below outlines four kinds of prototyping process. In the first column I have formulated a name based on the literature it is drawn from. These names should not be read as an attempt to lay claim over a field but are there to get a handle on what the different

methods employed are, and their histories. The second column lists where these ideas have been drawn from. Third, suggests the kinds of 'question' that these different practices ask. The fourth and fifth columns outline their different methodological operations. The fourth looks to the notion of stabilisation, and where these sit on the axis of stabilising or de-stabilising a situation, and the fifth traces the ways agency is expressed by the multiple actors involved in their processes. Devising this table is an analytical exercise to understand how things behave and is not intended to impose rules. Indeed (as we will see in the following section) prototypes shift and sit between types, or merge and become in different ways and at different times[3]. I am sure that it would be possible to keep expanding the table, or to detail a set of subheadings for each. The reason that I list these four is that I find these versions helpful to think through the examples I outline in this paper. In addition to this, I have not found literature that positions these particular versions of prototyping in relation to each other to consider their differences and shared concerns, and I hope this offers the reader some analytic tools for considering the modes of operation of each approach.

What is it called?	Where does it come from?	What kind of question does it ask?	Where does it sit on the stabilising/de-stabilising axis?	How is agency expressed?
1) First strike prototype	Traditional, 'normative' or technical design practices	Does this thing work? How might it be improved?	Stabilising	Designers interpret use and feedback for new iterations
2) Speculative prop	Speculative and critical design	What do you think about the implications of this future design or technology?	De-stabilising imaginaries in a materially stable setting	Designers retain agency in the making; audience invited to debate future implications
3) Participatory design things	Scandinavian PD and its intersection with ANT	How can users take control over a design?	De-stabilise an existing situation, and then stabilise it with an accepted design through co-operation	Future users and designers in dialogue during the design process
4) Cosmopolitical prototyping	ANT and design research's engagement with speculative philosophy	What are you capable of?	De-stabilising	In a multiple, ongoing relation between use, setting, and prototype

Table 1.

The first version — first strike prototypes — work towards an 'improved' version of designed objects through iteration (often rapidly assembled from existing parts) towards the stabilisation of an object and a putative user. The naming of this version follows Michael Guggenheim's (2010) argument in *The Long History of Prototypes*, that '"prototyping" has always existed and probably, for most of human history, has been more important than its opposite, orderly science and planning' (no pagination). This is arguably an integral part of most design (as well as other creative) practices, where prototypes are worked out through making and iterating. This might also be understood as ongoing processes of 'designing through making' (Bunnell, 2000), testing and improving in the myriad ways and contexts that this takes place. As I suggested in the

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3   Others have provided their own prototyping typologies, for example Grønbæk (1989) has outlined three kinds of prototyping approach: prototype becomes the system, executable specification approaches, and exploratory approaches. All three of these approaches mainly relate to interaction design, and in my reading broadly fit within what I have called participatory design things, whereby prototyping is employed to finalise a single design. Therefore, I find that these three are not able to account for the multiple ways prototyping has recently been taken up.

introduction, this kind of evaluative prototyping is the most commonly understood version in design— where an object is made and tested to evaluate and adjust a design in development. This version can also be seen through Human Computer Interaction (HCI) literature (Helander, 2014: 860) used to define subsequent iterations.

The second version of the prototype I have listed is what I call a speculative prop. This idea is informed by Speculative and Critical Design (SCD) and is concerned with producing objects to engage people in debate around technological development. The practice of SCD has historically centred around Dunne and Raby's (Dunne, 1999; Dunne and Raby, 2014) work at the Royal College of Art (RCA) in London, as well as that of their students. Prototypes (sometimes referred to as 'diegetic prototypes' following Kirby, 2010, 2013) for SCD often act as props to mediate or develop discussions, mainly in galleries and museum exhibitions among a public. Perhaps one of the more famous and most successful examples of this practice (and one which went on to escape the confines of the gallery) is Loizeau and Auger's (2001) *Audio Tooth Implant* — a fictional proposal for a permanently implanted, digitally connected 'audio tooth' (imagine an always-connected phone receiver permanently fixed in your mouth). In this example the image and story of the tooth was taken up in the media (perhaps 'went viral') and spawned a number of articles, reactions, and opinion pieces, as well as personal messages to the designers from people concerned about the implications of the technology on society. Typically, the prototype for SCD exists as a cognitive version of speculation concerned with provoking and considering the implications of objects *in the future,* rather than as an unfolding, material practice. Therefore, these props attempt to destabilise a discourse (it is suggested they provoke debate and democratise technological developments by its proponents, e.g. Auger, 2010; c.f. Kerridge, 2015) but are themselves very stable and not particularly well suited to, or open to change (Healy, 2020: 105). In the examples I have discussed so far in this paper, this approach has not yet figured, but I include it here to consider later in the paper how this approach might be taken up.

Third, what I have called participatory-design-things (following Ehn, 2008), is a prototyping practice closely aligned with the Scandinavian PD tradition (and PD's engagement with Actor Network Theory [ANT]), whereby prototypes are used in the exploration of new practices and arrangements of people and things by deploying working artefacts that activate new possibilities through co-operative design (Greenbaum and Kyng, 1991; Suchman et al., 2002: 172). Pelle Ehn (2008) tells us that PD focuses 'on people participating in the design process as co-designers […] to meet the challenge of anticipating, or at least envisioning, and designing for use before it actually has taken place – design for use before use' (ibid, 2). In this literature the prototype is used first to destabilise a given setting (to open up possibilities through co-operating), becoming focussed towards the stabilisation of a finalised design. Therefore, Scandinavian PD's engagement with prototyping is an inventive process exploring new *practices* with artefacts that are discovered through an unfolding activity of co-operative design-in-use (Suchman et al., 2002). For an often cited example, when designing new proofing processes and practices for graphic production Ehn (2008) explains that in the development of PD a new type of 'language' was required so that 'future use situations could be explored together' (Ehn, 2017: 11). Here, the designers deployed cardboard boxes that could be imagined into new proofing practices (Ehn and Kyng, 1992). 'Language' in this sense is a material practice whereby a user expresses their agency as an active creator in the design process rather than a passive instrument for evaluation, whereby the introduction of prototypes configures new socio-material arrangements (Wilkie, 2010: 33).

The fourth type that has emerged recently is the 'cosmopolitical prototype'. This has arguably been informed by developments in PD (type 3) put into dialogue with ANT's engagement with speculative philosophy and is a mode that I will spend some time unpacking. The reason for this is that in my view developing a cosmopolitical design process is difficult, risky, and makes some important divergences from the other types listed here.

Rubio & Fogué (2014: 143) describe cosmopolitical prototyping, as a process that is

> not focused on the capacity of design to pre-scribe codes into action and thought, but on its capacity to propose and open up the possibility of new forms of action and thought. [...] what we call the 'unfolding' capacities of design[4].

This follows Stengers' (2005: 1003) thinking in the *Cosmopolitical Proposal,* which she argues 'has nothing to do with the miracle of decisions that "put everyone into agreement"'. From this, I take the first key difference between types 3 and 4, that cosmopolitical prototyping does not necessarily reach an end point, or consensus where a design, prototype, or project can be said to be finished, or an end product to be stabilised.

In her introduction to cosmopolitical design, Albena Yaneva has proposed that 'design is a cosmopolitical activity that relates to the search for, as well as the domestication and accommodation of, new entities seeking to find their place in the collective in addition to that of humans' (2016: 5). Again, this builds on Stengers' concern with how different (more-than-human) entities participate in a politics of the cosmos (and perhaps invokes Stengers' (2005) conceptual character of the idiot who 'does not have, cannot have or does not want to have a political voice'). Yaneva makes this specific to design to suggest that cosmopolitical design is to do with how designers make explicit 'the connection of humans to a variety of entities with differing ontologies: rivers, species, air pollution, objects, materials and divinities' (Yaneva and Zaera-Polo, 2016: 5). This then points to my understanding of the second major difference between types 3 and 4, where PD has typically been associated with a human-centred (HCD) approach to design. Importantly, (and I admit this is a controversial characterisation) this

is not to conflate PD with HCD, or to say the practice is only capable of prioritising the human, but that historically this is how the practice has come to matter.

To summarise then, in cosmopolitical prototyping, the prototype seeks to create new more-than-human arrangements, without moving towards a finalised, fixed, or stabilised end-point[5]. This suggests a different methodological concern for a prototype to the first three types, which remains unsettled, and may be deployed to find something (else) out by way of material intervention, that is not only concerned with the object itself, or of achieving some kind of consensus. This is a novel conception of the prototype, whereby the introduction of new objects to a setting is unfolding new (more-than-human) relations; to disturb or 'stir' (Haraway, 2016) a situation, and to bring about new arrangements (that can be analysed).

From another corner of sociological scholarship, I find some shared methodological concerns with what Back & Puwar (2012: 9) call 'live methods', suggesting that design can contribute to (or become-with? Wilkie, 2019) sociological methods by making and deploying devices that produce affects and reactions "that re-invent relations to the social and environmental". My reading of Donna Haraway's argument that "our task is to make trouble, to stir up potent response to devastating events" (2016: 16) suggests an invitation to this (albeit more forcefully and politically). It is in this introduction of speculations — of things where the context, that thing, and the questions it is asking might be simultaneously transformed. One could argue that as a practice this has become somewhat familiar to design-research (Gaver et al., 2004; Wilkie et al., 2015), where designed things are materialised to transform given research situations.

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4   See also Alberto Corsín Jiménez's (2014) work unpacking prototyping and compossibility (p. 384 – 386).

5   Rubio and Fogué distinguish between the enfolding and unfolding capacity of design. Enfolding refers to the ways that design inscribes or solidifies politics in material artefacts for example, Latour's (1999: 186) speed bumps, or Foucault's school chairs (1977). Unfolding capacities refer to an attitude towards design that spawns new relations to generate new ways of thinking about political problems as opposed to trying to 'solve' them.

There are also important practicalities inherent to this prototyping practice and the co-becoming of design and social research (Wilkie, 2019), whereby it is possible to draw from the skills and training of designers in producing and mobilising interventions, and therefore what it is possible for design-research to investigate. The production of research devices and cosmopolitical prototypes represents a space where designers can collaborate with and make a contribution to the social sciences through designing, making and deploying things, and therefore to potentially find *different* things out as a result. There is also a symmetry to the becoming of these two disciplines: whereas a normative design logic might not recognise these objects as 'design' (for example they are not concerned with making 'better' objects for an industrial market) the methods and concepts from the social sciences contribute to, and give an alternative set of logics for how design can be done and understood in order to conduct research[6].

An example of cosmopolitical design

To thicken the above with an example: in a zoo in Chile, Martin Tironi and his colleagues (2016) describe developing prototyping practices with chimpanzees as a 'cosmopolitical operation' whereby the object-subject or, designer-user relationship is not given, or fixed, and emerges through prototyping encounters. Working with design students and chimpanzees, the authors describe how different social worlds (the students, the chimps, the zoo-keepers) are assembled in order to realise new practices, objects and relations to produce 'better' living conditions in the zoo's cage. They argue that this process of prototyping goes beyond typical conceptions of the prototype as a political tool (e.g. by Henderson, 1995) and is instead a 'cosmopolitical device' that is open to 'uncertainty and ontological enquiry' — for example, it is argued that the chimps 'hack' and co-opt the objects that are then absorbed back into further design iterations. I remain

somewhat unconvinced by the argument that the chimps 'hack' the objects, or that this in itself is particularly novel. As it stands in the paper, the design process follows a relatively conventional three-part process culminating in a third, stabilised 'product' (Tironi et al., 2016: 12) that is installed in the cage, and it is not particularly clear if, or how this is any different to a 'normal' co-design process (type 3), only involving animals as well as humans. The difference in my view is that the project resembles a cosmopolitical operation when taking a broader, longer-term view. The project does not in fact end here, and is not only about making this object, but is an open-ended and ongoing investigation into proposing ways for the zoo (its employees, cage designers, etc.) to take the chimps seriously, or as Vincianne Despret might put it; that they have 'opinions' (2006) — and in doing so the chimpanzees might begin to contribute to the political arrangement of the zoo. The problem for Tironi and his colleagues is that the chimps cannot speak and the authors' proposition is that designers can work to design things that disturb the existing cosmopolitical relationships in the zoo in order to provide 'voice', or become a spokesperson for the chimps in design decisions so that they might also participate as designers (c.f. Murphy, 2018)[7]. A key theme in the cosmopolitical version of the prototype is enactment, or how life is 'given' to something through various practices (Mol and Law, 2004: 45; Wilkie, 2014). This suggests that the authors give voice to the chimps by way of an ongoing engagement, whereby objects are designed and deployed so that the chimps can express agency. In my view the key to this practice is that it is not pre-figured towards a certain kind of outcome but is accompanied in an ongoing relation with the designers who watch and listen carefully to what that might be telling them.

In summary, these four conceptions of the prototype operate in multiple (though often overlapping) ways, with different political

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6   This also echoes Dunne and Raby's (2009) proposal for critical design as a mode that does not seek to necessarily 'solve problems' or serve industry.

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7   As an aside, something I find missing in Tironi's account of the cosmopolitical design process and its analysis are the voices and interests of the designers — that clearly are present but mostly remain unaccounted for, which would be fascinating to hear more of.

commitments, different methods of intervention and operating in the world, and different ways of producing knowledge. In the next section I plan to draw from (and critique) the above ecology, and in order to test its usefulness I will look back to the examples I introduced in part one.

Part 3: Stabilising and de-stabilising speculative prototypes

In his account of the history of the bicycle, Bijker (1997) describes the ways different designs (and their related technologies) achieve stabilisation and close down other possible versions of the bicycle. 'Closure leads to a decrease of interpretive flexibility — to one artefact becoming dominant and others ceasing to exist. As part of the same movement, the dominant artefact will develop an increasing degree of stabilisation within one (and possibly more) relevant social groups' (ibid, 87). Bijker's is a historical study, and it appears quite clear to trace how a bicycle (specifically the familiar double-diamond, or 'safety bicycle' design) achieves stabilisation through a process of reflection, and with the benefit of hindsight. In prototyping literature and practice, objects are conceived differently — they are (arguably) always) future-oriented towards new, unknown objects, knowledge, and events.

However, though I do not want to take up a constructivist's standpoint, there is a scale to this in my view, which I have described in column four as sitting on an axis of stabilising and de-stabilising. As I argued above, prototype types 1 and 3 tend to work towards a stabilised version of both a user and an object (either through evaluation, or co-design processes). Type 2 purports to be concerned with destabilising objects and futures, to produce 'debate', but is often realised in a highly structured environment where what a prototype is capable of becoming is highly constrained. Type 4 however, is almost the reverse — it is concerned with how a prototype might destabilise (e.g. by intentionally inviting interpretation, alternative uses, and potentially

nonsensical input) given sociotechnical relations and produce other possibilities, and arrangements.
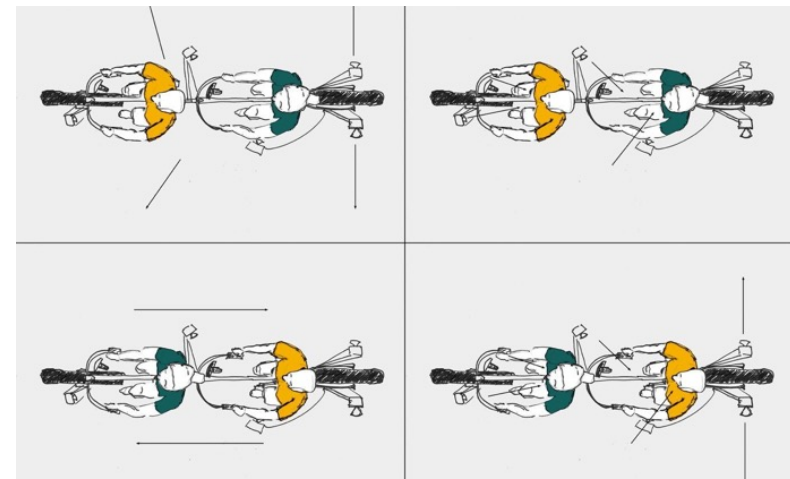

Figure 4 Diagram of different relationships on the tandem. Image credit: the author.

Having said this, clearly there is an inevitable process of fixing or inscribing the possibilities of objects in producing them, and this is where certain kinds of agency surrounding a design becomes restricted. As Neubauer argues with her house, pouring concrete over the top of the bathroom pipes fixes them in a more permanent way to a screwed down timber floor, thereby precluding other alternative futures for that space. Arguably this is inevitable when making — design decisions lead to a 'defuturing' (Fry, 2020) of other possibilities. In the same way, when I designed the tandem bicycle several decisions were baked into it, some of which turned out to be problematic, for example we unintentionally designed the front 'pilot' section of the bike so that it was too large, which severely limited who could use it, for example children and shorter adults. This meant that it was mainly used by adult men, meaning that what we were able to learn from these engagements was limited to a particular male positionality.

This serves as a reminder then that even in the most explicitly open conceptions of prototyping, it is not possible for complete openness, and mundane (and political) decisions will inevitably dictate prototyping futures. In which case, when we begin to see the ways in which prototyping practices begin to overlap, interweave, and generate new possibilities, we could think in the terms set out by Marilyn Strathern (1992) and Donna Haraway (2016: 12): that it matters which prototypes prototype prototypes.

This points then to a practice that moves between stabilisation, de-stabilisation and back again, or in Neubauer's words describing her practice, to maintain 'a permanent state as a user-designer' (personal communication). But this movement is clearly not always plain sailing, and when we come up against the requirements and obligations of, say a building or a house, leaving things open to possibles and uncertainty can be extremely difficult, as Neubauer found:

> 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.

Neubauer goes on to suggest in building practices, 'the requirements of the work could only be given once – at the beginning – and then, ideally, the work was done hidden away from the client (and future user)' (Neubauer, this volume). In this kind of prototyping the practice of leaving things open was not compatible with the practices of the builders who wanted certainty and found it difficult to understand this object as a prototype.

Straddling typologies

As described previously, in Gahoonia et al.'s study, the deployment of the TC education occupies multiple forms of prototyping, but first and foremost may be understood as an evaluative prototype, whereby it was deployed as a first stab; 'bricolaged' from existing materials, ideas, and processes to figure out if the system could work (though as the authors pointed out, we are somewhat in the dark around what 'working' would have meant for the Danish Education Ministry). However, when we look further, one could argue that to some extent the prototype (the scheme as a whole) was left open to interpretive speculation but still had to fulfil certain obligations. Here, I would argue that cosmopolitical prototyping could be taken up, not only in an instrumental way (to test and evaluate), but as a mode that remains open in use and deployment with the students. Indeed, this could be an exciting way of utilising different modes of prototyping to co-author education policy with the students by designing and deploying prototypes that prototype prototypes (especially when considering how to decolonise design curriculums). A (cosmopolitical) education prototype invite open questions around how else large governmental systems address previously unknown questions? How might they begin to ask more interesting questions of their students and the other actors involved? It is important to state here though that this relies on not only sending a prototype out into a given world, but a commitment to seeing how it comes to matter — to accompanying it into the worlds that the prototype worlds. As Gahoonia argues, this was not the case for those responsible for prototyping the TC, and we are left with unknowns around what constituted its failures and successes, and how it will go on to inform future prototyping practices. What is at stake when it comes to the methodologies surrounding this process of invention is that there is the possibility to radically shift who or what gets to act and think the prototype, suggesting an approach to prototyping which gives agency directly to those that are affected. For example, this approach to decolonising a curriculum might begin to incorporate marginalised voices by designing, developing, and learning a curriculum simultaneously. Perhaps speculative props could be used to open forms of debate with students that researchers could then pay attention to. Of course, this is far from simple, and the problem with developing this approach may be that it is not possible (or even fair?)

to fully destabilise what a design or technical education is with, and among students.

The tandem my colleagues and I designed also straddles several kinds of prototyping and enlists elements of them at different points. At one point it was shown in an exhibition and became a kind of speculative prop inviting discussions around what it does and the kinds of 'futures' it might partake in. In making the tandem bicycle 'first strike' prototyping was key, but whereas a typical logic might aim towards designing *better* (perhaps faster, cheaper) bikes, the concern was not only about refining and building fully realised objects — the object is left open in order to conduct research with people. The tandem was not designed with the 'end-users', and it is not made of cardboard. It is both the prototype *and* finished object — in deploying it the aim was not to test and improve it, nor invite user feedback on the way it might function, but to see it as an object to *find something else out* in the present by way of a situated material intervention.

In straddling these conceptions of the prototype, the tandem shifts between different moments and kinds of stabilisation and de-stabilisation. When the tandem enters the camp as a way of investigating the agency (and asymmetry) of image-making and voice it is concerned with enacting new relations. The interest is in changing the situation more generally, rather than only improving on the specific objects and practices being tested — not to make more refined bicycles, or a stand-in for a future version of a co-designed bicycle. Therefore, the concern is not only about making another object but about producing other kinds of knowledge and practice. This is a key methodological concern whereby the aim is to understand how speculation might be mobilised, and the prototype becomes a *vehicle* (in multiple senses) to enact new arrangements and possibilities by inviting others (whom are not always invited) to speculate on how it ought to be used, and what might come next (if anything). We found for example, that the tandem enabled unexpected relations (or enactment) to form, like small moments of joy in an otherwise desperate situation, as well as a somewhat altered relationship between researchers, displaced people

and the CRS riot police (who were more typically associated with enacting violence upon those living in the camp), as well relations of trust between different riders of the bike (Healy, 2021: 19).

Attuning to prototyping events

Arguably in all prototyping practices, there is something akin to this process of enactment; of drawing multiple things together to modify a situation. This produces what Michael (2012) calls a 'research event', and Wilkie (2014) a 'prototyping event'. Drawing on Fraser (2012) and in turn, Latour, Whitehead and Deleuze, these conceptualisations of event describe when a number of things are drawn together (e.g. site, device, researcher and researched) and combine. Methodologically, the notion of event has two key features, and operates in two distinct ways. First, being-with, where a network is stable and elements within it co-exist and retain their identities without fundamental changes. Second, where elements co-become and in so doing mutually affect one another. The second is more pertinent to the examples discussed here, because the settings in which the different cases discussed exist in different states (and kinds) of flux and change. For example, the camp where the tandem was taken was not materially stable, but it did have stable elements, for example the policing of the border is a consistent condition of Calais. Arguably, the house that Neubauer describes is reluctantly moving towards some kinds of stability (in the ways design decisions affect its concrete and other material elements), but the aim of this particular living space is to enable fluctuations and provide the researcher a prototype to investigate the potential for living-with and embracing change (for example to live in a closer relationship with different weather conditions). On the other hand, the TC education system is working towards a larger, stabilised, and somewhat universalised education system. But in this example, the different aspects of prototyping practice do not seem able to affect each other — the kind of prototyping that the students do in the classroom is not concerned with the prototype of the education system itself and

vice versa, nor is it affected by the other 'meta-layers' of prototyping around it, and instead acts as a discrete element within.

A co-becoming (design-)research event recognises instability and gives the opportunity to ask different or perhaps more relevant questions (what Fraser calls 'inventive problem making' 2009). But of course, there are problems when this notion of the prototype meets the demands of say, a house, that needs to remain stable so that it doesn't fall over, or a large education system where to fail would be to leave a hole in a group of students' knowledges. Having said this, I'm convinced that borrowing aspects from speculative and cosmopolitical prototypes that actively attempt to de-stabilise could be mobilised in this kind of setting, but they require ongoing and careful attention to their enactments and the ways new networks co-become together. It exceeds the scope of this paper, but I would suggest that this could be done by centring another kind of training for designers whereby they are actively concerned with looking to the multiplicity of consequences and mutual transformations of speculative and cosmopolitical prototypes in a research event, and this is where I see the exciting co-becoming of ANT, speculation and design research playing out (Wilkie, 2019). Attuning towards these objects and accompanying them is a kind of 'response-ability' (Haraway, 2007: 71) towards them, and to their effects, or to Stengers' words once more, it requires the art of relearning to pay attention (Savransky and Stengers, 2018: 136; Stengers, 2015: 62).

Response-able stirring

Earlier, I briefly mentioned Haraway's (2016) concept of 'stirring' and staying with the trouble as a way for both thinking about and conducting prototyping practices. I also argued that a prototype that sets out to stabilise designs of objects cannot tell us enough about the *potential* role of design in places, situations or events that are unstable and in different states of flux (for example the European borderscape, or even in technical education). Instead — and to extend the metaphor — this attitude towards prototyping might be thought of as a stick, designed to

stir and intervene in the flux. The stick-design-process still operates in an iterative manner — it is used, reflected on and begins to produce new relations, objects, settings, inspiration and alternative designs. However, this process is not necessarily employed to produce a better or more efficient stick, but to produce new arrangements of people and things with altered capacities and relations that the designer is embedded in and pays attention to, often developed in tandem with reflections from deploying and observing previous devices and things. The prototype in this sense produces 'events' that act as 'lures' (Savransky et al., 2017: 12). They draw new networks, thereby luring people and things into the research, and simultaneously luring us (as designers and researchers) towards new questions, connections and possibilities that go on to shift the course of the research. Clearly, the metaphorical stick has some basic constraints for what it should be able to do and not do (for example, be safe and usable) but leaves other possibilities open. In addition, the prototype invites other questions, both of the researcher and of the researched that are not necessarily related to the original stick or the original problem. This is another departure from previous accounts of the prototype and design processes (e.g. Schön, 2013: 100) that often change incrementally and do not transform into other objects or practices altogether, but I would argue could, and in doing so begin to invite more pertinent questions.

Conclusion

I have looked to build on the discussion around design research and prototyping at this year's DASTS conference where I felt a rich and productive confusion around the different notions and uses of the term prototype. In doing so I have begun to set out an ecology of prototyping practices —first strike, speculative prop, participatory design thing, and cosmopolitical prototype — which I have drawn from to discuss the projects presented at the conference, and another of my own. I find that prototypes work with and within different forms of stabilisation and destabilisation, which is often set out by the conditions that they are

realised in, and the ways they are answerable to different obligations and requirements.

I have also argued that the cosmopolitical and speculative version of prototyping could (with some work) be taken up in spaces that have very specific demands (like education policy or building a house), but that they require careful observation to attune to and understand the kinds of worlds (and future prototypes) that they suggest. Here I look to design-research's recent co-becomings with ANT and speculative philosophy and the notion of event which embraces the ways that objects and things co-become together and are affected in doing so.

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