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ORIGINAL ARTICLE

On variational cross-examination: a method for postphenomenological multistability

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Abstract
How should we understand postphenomenological methodology? Postphenomenology is a research perspective which builds on phenomenological and pragmatist philosophy to explore human–technology relations, but one with open methodological questions. Here, I offer some thoughts on the epistemological processes that should be (and often implicitly may be) at work in this research. In particular, I am concerned with postphenomenological research on technological "multistability," i.e., a device's ever-present capacity to be used for a variety of purposes, and to always be meaningful in multiple ways. I develop a methodology called "variational cross-examination," which entails the critical contrast of a device's various stabilities. As a set of instructive examples, I draw on my own line of research on the politics of public spaces, and especially the critique of anti-homeless design.

Keywords Multistability · Ihde · Postphenomenology · Philosophy of technology · Homelessness · Design · Hostile design

1 Introduction

Back in 2017, the city of Seattle installed eighteen bicycle racks, tightly spaced, under an overpass. But the purpose of the racks—simple metal arches attached to the ground—was not primarily for providing a place to lock up a bike. As Heidi Groover reports, "The city installed the racks in September after officials conducted a homeless encampment sweep in the area. SDOT considered the racks 'part of the Homelessness Emergency Response effort' and they were meant to discourage camping" (2017). The space under the overpass was being used by people living unhoused. The overpass provided some protection from the elements, and thus served as a good place to put up a tent. In an effort to drive out these unhoused campers from this space, the bike racks were installed in such a way to obstruct the ability to camp there. They were effective in this function.

Looking at this example through the lens of the fields of philosophy of technology and Science and Technology Studies, one thing that jumps forward is the way these events turn upon the usage of technologies for purposes other than those for which they were designed. The overpass is used as a form of shelter. It provides part of a living space. The bike racks are then installed as a disruption to the use of that space for camping. This raises questions about the roles of the materiality of objects in contributing to how they may be used, changed, and developed. If technologies exist as not only "for" the purpose for which they were designed, but also as things that are potentially meaningful in other ways, then we cannot conceive of them in merely instrumental terms. And if they are taken up as a part of survival strategies by some of society's most vulnerable members—the "unhoused," in this example—then the nature of technology itself is implicated in the snarl of competing social strands, political agendas, and systems of advantage and disadvantage. And more, if they are taken up as a part of efforts to control vulnerable members of society—the bike racks driving away the unhoused, in this example—then their potential roles in these politics are even more fraught.

One way to approach these questions is through the postphenomenological perspective, and in particular through the notion of "multistability." Postphenomenology is the name of a school of thought in the philosophy of technology that addresses issues of user experience through a practical lens. This perspective brings together ideas from phenomenological and American pragmatic philosophy to develop conceptual tools for the deep description of

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human–technology relations (see Ihde 2009, 2016a; Verbeek 2011; Rosenberger and Verbeek 2015; Hasse 2015). A central tool in this conceptual framework is the notion of "multistability." First developed by Don Ihde, the founder of postphenomenology, this is the idea that any given technology can be used to do many things, and can be interpreted in many ways. Ihde writes, "I have argued that technologies are non-neutral and essentially, but structurally, ambiguous… Further, I have argued that at the complex level of cultural hermeneutics, technologies may be variantly embedded; the 'same' technology in another cultural context becomes quite a 'different' technology" (1990, p 144). According to postphenomenological thinking, and in tune with American pragmatism, a technology is never understood to have one fixed or true essence. There are many experientially "stable" ways for a person to take up a particular technology. A technology can thus develop along different trajectories. And the potential uses and meanings never reduce to only those intended by the device's designer. For some recent examples of concrete case studies on the multistability of a variety of contemporary technologies, see: smartphones (Wellner 2016), radiological imaging (Friis 2017), selfies (Lewis 2017; Warfield 2017), digital video (Irwin 2017), mammography (de Boer and Slatman 2018), educational technologies (Aagaard 2018), robots in eldercare (Blond 2019), paths toward sustainability (Botin 2019), and electronic health records (Moerenhout et al. 2020).

We can see these issues at work in the case of the Seattle overpass. The overpass is multistable in this story; while the overpass has been built as part of transit infrastructure, it then gets used as part of a strategy to find shelter. We also see these dynamics to be at work in the case of the bike racks installed to deter camping. While the bike racks may have been designed for temporary bicycle storage, we see them here put to another purpose entirely. In this way, the bike racks are shown in practice to be multistable. There is a common stable usage for locking up one's bike. But there is an alternative stable usage in which the racks are used as a form of camping deterrence.

The anti-camping bike racks are an example of a contemporary phenomenon that can be referred to as "hostile design" (Rosenberger 2020b). (This goes by many other names in this still developing discussion, such as "hostile architecture," "unpleasant design," "defensive architecture," and others). This refers, roughly, to the control of public spaces through the redesign of public-space objects (see Savicic and Savic 2013; Schindler 2015; Petty 2016; Jensen 2017; Rosenberger 2017a, c; Smith and Walters 2018; Chellew 2019; Lorini and Moroni 2020). There is often a critical connotation, explicit or implicit, in the use of these ideas; they are often used in the condemnation or defense of these things. And the anti-camping bike racks are also an example of a subspecies of hostile design: anti-homeless design. The unhoused are one of the populations most frequently targeted by hostile design. Just a few of the most common examples include benches fitted with armrests or dividers to discourage sleeping, garbage can lids built in a way that deters trash picking, and spikes installed into a ledge to dissuade people from sitting there.

These seemingly simple examples—benches, garbage cans, ledges—are loaded with complication. There are issues of sociality and politics: whose interests are served? There are also issues of perception: who notices these designs and political agendas, and who does not? I suggest that it is possible to draw out some of these issues in a productive way through the application of a postphenomenological conception of technological multistability.

To consider these issues here, I will review and expand on postphenomenological research methodology. In particular, I develop "variational cross-examination," an investigative method that I suggest is implicitly at work in much of the concrete postphenomenological research and should be a more explicit part of this approach. This method involves identifying multiple stabilities of an object of study and then critically contrasting them against one another. To articulate this approach, I build on ideas about multistability I've been exploring across a series of papers over the last decade here in *AI & Society* (Rosenberger 2009, 2013, 2017c).

2 Postphenomenology and method

Under the postphenomenological perspective, technologies are not conceived as mere instruments in the world that do their jobs in a passive manner. Technologies are understood as active mediators of experience. As Peter-Paul Verbeek puts it, "Technologies help to shape human actions and decisions by mediating our interpretations of the world and the practices we are involved in" (2011, p 153). A device is not merely one of the things that we might perceive, or one of the things we might act upon, just sitting there among all the others we encounter. Technology usage is transformative. It transforms a user's capacities to perceive and act, and transforms the world's potential to be perceived or acted on. It transforms users into who they are, and the world into the way it is. As Sabrina Hauser and her colleagues summarize, "The postphenomenological approach sees technology as *transformative mediators* of human–world relations rather than separated functional or instrumental objects or alienating entities" (Hauser et al. 2018, p 460). In this way, technology usage is conceived in terms of "human-technology relations." This focus on relations, rather than separately upon either humans or technologies, as Marjolein de Boer and Jenny Slatman put it, "reveals the fundamental embeddedness of humans and technologies, of how technologies transform and materialize selves and bodies and, in turn, the

ways in which humans affect and appropriate these technological mediations" (2018, p 290).

One of the central notions offered by the postphenomenological perspective is what Ihde has called "multistability." He writes, "To term a phenomenon multistable is already to have recognized it for its ambiguity and multiple dimensions" (1990, p 150). In tune with postphenomenology's commitment to pragmatist philosophy, this notion helps to capture technology's situatedness and variability. No technology reduces to one usage, meaning, context, or potential line of development. At the same time, this notion also attempts to capture something about the material specificity of a given device, and the role of that materiality in limiting how it may be taken up. A technology cannot simply be used for anything; it is limited to particular stabilities. As mentioned above, the notion of multistability has become central to much of the concrete case study work in postphenomenological research. There are explorations of its relevance to culture (Hasse 2013, 2015; Tripathi 2017), ethics (Verbeek 2011), and politics (Rosenberger 2017a, c). As Yoni Van Den Eede puts it, postphenomenology "might even be conceived as nothing less than a plea for multistability or, more precisely, an openness to and search for multistabilities" (2015, p 152).

Ihde uses the term "variational analysis" to refer to the process of identifying multiple possible stabilities for a given technology. Through imaginative brainstorming and through empirical investigation, one can always identify multiple possible meanings and usages, multiple possible human–technology relations that a particular device could support, multiple possible lines of development. This method is an adaptation of Edmund Husserl's practice of conducting "imaginative variations," but with a twist. As Ihde explains, "Husserl's use of variations aimed at producing *invariants*, or essences. Postphenomenology—using variational method—often finds *multistabilities* instead" (2016a, p 85). Husserl sought an object of study's essence, and argued that it could be grasped by investigating the object from multiple angles. According to Husserl, such a practice could expose what was merely contingent upon perspective, and thus reveal what is essential. In contrast, postphenomenology, in its commitment to American pragmatist thought, eschews essentialism. Variational analysis reveals an object of study *to be multistable*.

For example, we can perform variational analysis on a simple ink pen. The normal use of the pen is for writing on paper. In postphenomenological vocabulary, this is sometimes noted as the "dominant stability," the one for which it was designed and manufactured, and the usage for which it tends to be taken up. (Ihde has sometimes used this term—e.g., he has referred to the stability that is "dominantly used" in 1993, p 37—and I have run with this term in my own work.) But we can imagine many alternative stabilities to the dominant one. One might tap out a rhythm on a table with the pen like a drumstick. One could attempt to use a pen as a stabbing weapon. (In fact, Ihde has recently recounted a time from his childhood when someone stabbed him in the hand with a pencil, 2016b). A specific pen might take on special meaning and become a family heirloom, passed down from generation to generation, or may become a national treasure like the pen used by Lyndon B. Johnson to sign the Civil Rights Act held by the Smithsonian National Museum of African American History and Culture. Because of the different trainings and use contexts involved, we might consider a pen used for shorthand notetaking, or pen and ink artwork, or calligraphy to all constitute different stabilities. When I was a kid, we would take apart disposable pens and use the central plastic tube as a blowgun for spitballs. (I have come to sometimes use an "X-as-Y" hyphenated notation when there is a need to name individual stabilities. For example, we could distinguish between, say, a pen-as-writing-implement stability verses a pen-as-spitball-blowgun stability.)

Let's return to the examples of hostile design from the introduction to consider some of their various possible stabilities.

Take, for example, a typical public-space bench, the kind found in parks, plazas, bus stops, and subway platforms (e.g., Fig. 1).

A bench's dominant stability is its usage as a place to sit, what we could call a bench-as-seat stability. Other stabilities can be identified. Perhaps instead of sitting, a jogger leans against the bench as a place to stretch. A cyclist might chain a bike to it. However, the alternative usage of concern here is a stability sometimes taken up by those living unhoused, namely, the usage of the bench as a place to sleep, or what we could call a bench-as-bed stability. We can thus also understand an armrest added to the middle of a bench to at least in part serve an anti-sleep function, having an effect of deterring the act of lying across the bench. The armrest is just one example of a modification that closes off a bench-as-bed stability. Others include things like the addition of seat dividers, gaps, and bucket seating schemes.

Another case comes in the form of anti-homeless spikes added to a ledge (e.g., Fig. 2). The spikes are a somewhat atypical example of hostile design in general, and anti-homeless design in particular, since they are conspicuous in this hostile function. They cannot easily pass for merely serving some other purpose (as can the bench armrests). Insofar as a ledge is something that can support multiple stabilities, such as someone loitering by resting on it, the spikes shut down such options.

Garbage cans are another multistable public-space device. If the dominant stability is their usage as a place to deposit trash or recyclables, what we could call a can-as-receptacle stability, then another stability we can see in practice is as a resource for discarded food or valuable recyclable

Fig. 1 Park bench with armrest, Philadelphia, USA. Photo by Author

Fig. 2 Ledge set with spikes, Amsterdam, the Netherlands. Photo by Author

material, a can-as-resource stability. Garbage can lids come in many forms, and can play many roles. They can serve as rain hoods, animal deterrence, and the shape of their opening can indicate what should go inside (a slot for recyclable paper, etc.).

In addition, certain lid shapes can have an effect of making it difficult to reach down inside. Sometimes such restricted lid openings are combined with outer casings around the can that are fit with built-in locking mechanisms (e.g., Fig. 3). I suggest that these modifications that have an

Fig. 3 Garbage and recycling cans, New York City, USA. Photo by Author

effect of deterring trash "picking" and should be understood as a form of anti-homeless design.

It is beyond the scope of this paper to go into much more detail here, but anti-homeless design is an issue that should be on the radar of critics in the philosophy of technology (see Rosenberger 2017a). There are many other examples, from fences that close off underpasses, to automatic sprinklers that wet down sleeping areas at night, to noise machines that deter people from spending time in parks after hours. Also, a lack of expected features could be conceived as forms of anti-homeless design, such as an absence of seating, or shade, or public restrooms. And to truly understand anti-homeless design, we'd have to consider it in conjunction with the wider place of homelessness within cities, and the place of anti-homeless design within larger anti-homeless efforts across cities, including laws that target the unhoused. My claim is that anti-homeless agendas in general, and anti-homeless design in particular, is a pattern that can be seen to hold—though in different ways and to different extents—across many cities throughout the world. And it's a condemnable one.

Back to theory. This basic framework of multistability, variational analysis, and dominant stabilities is ripe for expansion. I have spent much of my career further developing and refining this postphenomenological framework, considering its implications for politics and methodology, connecting it to other work, including social theory, feminist theory, and critical theory, and instantiating it with case studies on everything from ubiquitous computing, to hostile design and architecture, to educational simulations, to laboratory imaging in the fields of neurobiology and space science.[1] These lines of research join the increasing body of scholarship on postphenomenology and methodology, much of which integrates postphenomenological insights into the empirical methods of other fields, especially anthropology, psychology, HCI, education, and design (e.g., Hasse 2015; Whyte 2015; Aagaard 2017; Hauser et al. 2018; Jensen and Aagaard 2018; Aagaard et al. 2018; Hasse 2020).

This has brought me to a series of questions I believe should be central for postphenomenological theory. As stated above, Ihde stipulates that variational analysis establishes an object of study's status as multistable. This can be useful at times, especially if your aim is to dispute some account that holds that technology can only be one way. However, much of the postphenomenological research that takes up the notion of multistability is doing something more.[2] Much of this work explores the concrete multistability of specific

[1] My self-citation in the References section of this article is already more than self-indulgent. For references to the cases referred to in this paragraph, see: https://rosenberger.spp.gatech.edu/publications/.

[2] Elsewhere I have articulated this point in terms of a distinction between a "positive" and "negative" usage of multistability (e.g., Rosenberger 2010, 2017b). The idea is that the notion of multistability is used "negatively" when wielded as part of an effort to show that some other theory does not recognize the fundamental pragmatic relationality of technology, and thus that that other theory is somehow essentializing, or foundational, or over-generalizing. The notion of multistability is taken up in a "positive" manner when it is used as part of an investigation into the world, spelling out and exploring

cases. So what, precisely, do we learn about technology when we investigate its multistability? When new things are revealed about an object of study by considering it in terms of its multistability, by what process do these revelations occur? All of this is to ask: What is the practical value of the notion of multistability?

One way to approach these questions is to expand on the method of variational analysis. If variational analysis results in the exposure of the multistable status of an object of study, and if it identifies some of that object's stabilities, then we can ask: What's next? We have come to recognize that a given technology *is* multistable. Now what?

I suggest that a next step after variational analysis could be called "variational cross-examination." This refers to the critical contrast of stabilities against each other (e.g., Rosenberger 2014, 2017b; Aagaard 2017). We can learn things *about particular stabilities* through their comparison *with one another*. I recommend that postphenomenology adopt variational cross-examination as an explicit second methodological step after variational analysis. And I suggest that this method is already implicitly at work in many of the positive, concrete case studies in postphenomenological research that utilize the notion of multistability.

Any stability of a multistable technology may be elucidated in its critical contrast with others. However, the dominant stability is the one best positioned to have things revealed about it. There are several reasons for this. Since the dominant stability typically represents the usage for which a device was made, and the primary way it tends to be taken up in practice, it can be easy for a person to simply and unreflexively believe that this is what this technology "is for," or that this is what it "really means." And it can sometimes be difficult to step out of this kind of thinking. For those who primarily relate to a technology's dominant stability, these relations to it will often be steeped in normalcy. A given device may be experienced simply and uncomplicatedly as the thing that "is for" (and only for) that dominant purpose. There are embodied dimensions to this normalcy. In this technology's everydayness, in the very way that it is encountered *as* normal, one's relation to a device in its dominant stability can become set within bodily-perceptual habituation. Through these kinds of habits, the device will be encountered in terms of pre-perceptual expectations that enable it to be experienced as immediately meaningful in this dominant context. Add to this the fact that the device itself—while multistable and open to other meanings and uses—has likely been designed in a way that optimizes its usage in terms of the dominant stability. Since this is often the stability for which it was designed and manufactured, it has been made to be well-suited for these dominant terms. Add to this too that it is not only the device itself that has been optimized for the dominant stability, but often its larger use context has also been optimized this way; any number of other things—spaces, industries, rules, other objects, societal patterns of behavior—can come together in support of an inclination to use a particular technology in a particular manner.

Thus, for all these reasons and more, it can be especially difficult to investigate a dominant stability (whether through postphenomenology or any other perspective). It calls for an effort to see through normalcy, to extract things from their contexts (at least provisionally), to look past many specific design elements, and to break potentially deeply-ingrained habits of perception and understanding. The postphenomenological method of variational cross-examination can be useful for this kind of project.

There can also be a political dimension to dominant stabilities that makes them challenging to study. This can be seen in examples of hostile design. A stability may be dominant as part of a concerted political scheme. In the case of anti-homeless design, we can see an effort to push unhoused people out of public spaces. Working in conjunction with other anti-homeless undertakings (such as anti-homeless law), anti-homeless designs shut down particular stabilities of public-space devices. If these efforts are successful, and if the unhoused are less present in public spaces, then it may be more difficult for someone who lives through the dominant stabilities of public-space objects to recognize their anti-homeless features as such. And remember too that elements of hostile design are often crafted specifically with the intention of keeping their hostile function less obvious to those who are not targeted. Anti-sleep features on benches often double as armrests or dividers. Anti-pick garbage can lids often also double as rain hoods or as features for keeping out animals. Security cameras are sometimes hidden. And so on. A city's anti-homeless agenda—enacted through design, law, and other means—aims not only to push the unhoused out of public space, but also to hide the problem of homelessness entirely, and that includes concealing the anti-homeless effort itself.

Thus, another reason why dominant stabilities can be difficult to study is because sometimes political work has taken place in effort to keep certain elements less visible to certain populations that may include the investigators themselves. Again, the postphenomenological method of variational cross-examination can sometimes be useful for drawing out these political elements of dominant strategies. However, it should be noted that the postphenomenological perspective—which itself is of course as politically situated as any other perspective—is not itself a political theory. But it certainly can be useful in some ways to politically-relevant

Footnote 2 (continued)

something's multiplicity and the implications of that multiplicity. Whyte develops a related set of distinctions in (2015).

investigations. To help address these shortcomings, in my own work I have tended to combine postphenomenology with insights from critical theory, feminist standpoint epistemology, and STS accounts, especially the work of Sandra Harding, Andrew Feenberg, Donna Haraway, and Bruno Latour, although of course other fruitful combinations are also possible.[3]

One thing set up by the theory of variational cross-examination is the project of elaborating just what features of a technology's various stabilities should be subject to cross comparison. Exactly *what* about these stabilities should we be looking to contrast? In my own work, I have elaborated three different categories of features of stabilities that can be subject to cross-examination: "comportments and habits," "networks and co-shapings," and "material tailorings." These categories provide places to expand parts of postphenomenological theory, and to elaborate connections to sister schools of thought. And of course this is by no means an exhaustive list. Developing this categorization of the kinds of things about stabilities that can be productively subject to cross comparison is a potential line of future development for postphenomenology. Let's consider these categories here.

Comportments and habits The notion of multistability prompts us to think about the role of materiality in the facilitation and restriction of the various meanings and uses available for a given technology. However, we must additionally keep a close eye on the human side of human–technology relations with regard to issues of technological multistability. Through a series of papers here in *AI & Society*, I've been developing the notion of the "relational strategy" (Rosenberger 2009, 2013, 2017c). This refers to the particular ways a user approaches a technology, and the particular ways they understand it, that enable them to engage the device *in terms of one specific stability*. To take up a technology in terms of one particular stability, rather than other possible stabilities, how must one physically comport oneself with respect to the device? What must one know about it? (For example, if one is taking up an alternative stability, one must at minimum be aware of this possibility.) What kind of habits are accessed as part of this person's human–technology relation? Are they well-developed ones? Or perhaps the opposite? Perhaps there is a habitual inclination otherwise, and in order for this person to take up this particular stability they must resist these habitual inclinations?

In the example of the multistability of the pen, we can consider the different relational strategies that could accompany different stabilities. In most of the stabilities identified, the pen is engaged by holding it in the hand. But the finger comportment on the pen may be different for the shorthand notetaker compared to the artist using an inkwell pen upon a watercolor painting. The grip would of course be entirely different for the pen-as-stabbing weapon or pen-as-spitball-blowgun stabilities.

We can see how examples of anti-homeless design function to disrupt particular bodily engagements with public-space devices, and to allow for certain others. The anti-pick garbage cans allow for a dominant can-as-receptacle stability, and, at the same time, they interrupt a bodily relation in which someone might want to reach inside to get something out. The anti-sleep bench allows for a dominant bench-as-seat stability, and at the same time gets in the way the possibility of lying down across the bench. What's more, in the case of many of these anti-homeless features, but not all (e.g., the spikes), these designs not only close off specific alternative stabilities and maintain the dominant stability, but they do so in an inconspicuous manner. It would be possible for someone living through the dominant stabilities of these objects to fail to recognize their anti-homeless design functions. And more, this person could develop relational strategies through which these dominant relations are encountered as normal. As such, this user could come to internalize this conception of public space in the form of learned pre-perceptive habituation.

Networks and co-shapings We can contrast a technology's various stabilities in terms of the corresponding contexts of objects and people that are associated with each. There are many theoretical frameworks through which we can attempt to draw out these various associations so that they may be subject to cross comparison, each with its own advantages and limitations. Two helpful options can be found by looking over to the conception of extended social collectives of humans and artifacts in the actor-network perspective, and looking forward to Peter-Paul Verbeek's postphenomenological conception of co-constitution.

To go beyond the level of individual user experience, we can attempt to combine postphenomenological insights with those of social theory and sociological and anthropological practice. In my own work, I have appealed to actor-network theory (ANT), and especially to the account of technology developed by Bruno Latour back in the 1990s (e.g., Rosenberger 2014, 2017a, c). Latour conceives of technology in terms of its role within a network of other people and things. Humans and technologies are both understood as "actors" which join together "networks" that enact "programs of action" (e.g., Latour 1992, 1999). As he puts it, "Responsibility for action must be shared among the various actants" (1999, p 180). In this way, we can think about the role that a technology plays in the social agenda put forth by a collective of actors. And I suggest that one productive way to investigate technology is to conceive of its multistability, and then to contrast the various stabilities in terms of the different social networks to which they could contribute.

[3] E.g., Rosenberger 2014, 2017a, c, 2020a.

For example, we could think again of the subway platform and contrast the different networks with which the bench-as-seat and a bench-as-bed stabilities could be associated. The bench-as-seat usage, as the dominant stability, is enrolled into a network of the transit system, one that includes human travelers and transit workers, the institutions and conventions of the private or government transit agency (or "authority"), as well as artifactual spaces, architecture, infrastructure, and transportation vehicles. The bench-as-bed stability is instead enlisted into an alternative program of action, one that makes use of the bench as a place to sleep in public. Such a comparison reveals these alterative programs to be not merely ones that involve different enlistments of this same device, but social programs that are at least potentially at odds. This helps to reveal the bench-as-bed stability to be one that runs counter to the program of the dominant network. It may even help to point out other aspects of the dominant network, such as the larger institutions that target behaviors of the unhoused, such as anti-homeless laws, surveillance tech in the subway system, anti-homeless policies of the transit authority, and the anti-homeless designs of the benches and other public-space devices.

Following Peter-Paul Verbeek's postphenomenological work, we should consider how the humans, devices, and their world are all co-shaped by technological mediation (e.g., Verbeek 2011; see also Dorrestijn 2017; de Boer et al. 2018; Aydin et al. 2019). According to Verbeek, technologies "help to shape human actions, interpretations, and decisions that would have been different without these technologies" (2011, p 57). Thus, we cannot think of humans as actors, interpreters, and decision makers without considering their relationships to their devices. He writes, "we need to replace the 'prime mover' status of the human subject with technologically mediated intentions. In our technological culture, humans and technologies do not have separate existences anymore but help to shape each other in myriad ways" (2011, p 16). This is especially important in cases of moral and political decision-making; Verbeek makes clear that the context of our decision-making, the constitution of the options we decide between, and the authority of decision makers are all co-shaped by technological mediation. We can integrate our ideas about multistability and variational cross-examination into this body of postphenomenological thought on mediation and co-constitution. As we spell out a technology's various stabilities, we can critically cross-examine these stabilities as cases of technological mediation that each co-constitute humans and the world differently.

The example of the technology of the subway platform, and the issue of anti-homeless design in general, are cases-in-point. We can think about the dominant stability of public-space devices like the subway bench, and the interlocking network (in the ANT-sense of the word) of dominant usages of devices, perceived norms, and rules and laws. We can see the way that so much of what gestalts as the appropriate, proper, and reasonable usage of public space is actively co-shaped by the technological mediation of these spaces. For those living through these dominant stabilities of public-space, this technological mediation could contribute to an impression that the dominant usages of this space are the proper ones, and that alternate stabilities are inappropriate, abnormal, or objectionable. This same technological mediation also sets the context for political resistance.

Material tailoring Another aspect of stabilities subject to critical comparison is the concrete ways they have been altered to better serve a specific function. We can build on thinking in several fields on this topic, including STS and the philosophy of technology. One seminal line of thought is Madeleine Akrich's articulation of a "script theory" of technological development in conjunction with ANT (1992). Akrich extends the "actor" metaphor of ANT, conceiving of both humans and nonhumans as following a social "script." She uses the term "inscription" to refer to the material modifications made to devices so they better follow the social script of the network. Andrew Feenberg has similarly discussed the material alterations made to technology, not only in terms of a social network, but also a larger political system. He uses the term "systematization" to refer to the changes made to a device so that it better fits its larger socio-political purposes (Feenberg 1999). We can contrast a technology's various stabilities in terms of these issues of material specificity identified by Akrich, Feenberg, and others.[4]

I have offered the term "material tailoring" to refer to the concrete ways a device may be altered to better fit *a particular stability*. We can imagine a technology used for its dominant stability, and then consider how it has been changed to better serve that usage. Or we could imagine someone that adopts a technology for an alternative stability, and then consider how they might alter the device to better execute this alternate usage.

A simple example is that story from my childhood about taking apart a pen to make a tube for shooting spitballs. First, we'd take the pen into pieces, extracting its outer barrel to use as the blowgun. Then we'd have to add paper balls to use as ammo. We can conceive of these changes as material tailorings made to the pen in order for it to be used for a pen-as-spitball-blowgun stability. Or we could also survey the variations between brands of pens, and consider the

[4] These issues become complicated quite quickly when we address complex technologies with enclosed interiors, such as digital devices. Scholars in the philosophy of technology such as Heather Wiltse, Alberto Romele, Yoni Van Den Eede, and others are bringing together a variety of perspectives (including but not limited to post-phenomenology) to address these challenges (e.g., Wiltse 2014; Van Den Eede 2017; Romele 2020; Romele et al. 2020; Wiltse 2020).

various ways their caps, grip schemes, and ink and tip types (gel, ballpoint, rollerball, etc.) may all constitute material tailorings that differently serve the dominant pen-as-writing-implement stability.

We get a complicated case in our examples of hostile design. At least part of the definition of hostile design should include the material tailoring of public-space objects in a way that shuts down stabilities preferred by vulnerable groups. For example, we can conceive of many anti-homeless designs as hostile instances of material tailorings. Armrests, seat dividers, and other design modifications that serve an anti-sleep function all provide a socially and experientially complex example. Straightforwardly, the armrests or dividers tailor a bench to enable it to better serve the bench-as-seat stability, respectively, providing a place to rest an arm or a division to the seat areas. But they additionally serve an agenda of deterring usage of the bench-as-bed stability. The anti-sleep features represent instances of material tailorings for the sake of an anti-homeless agenda. The garbage can lids tailor this device to better serve a can-as-receptacle stability by doing things like keeping out the rain, deterring animals, and providing openings that nudge users to insert only particular kinds of objects (as in the case of aluminum recycling bins with small circular openings for cylindrical can deposits). However, these lids can simultaneously serve an anti-pick function, thus constituting a tailoring that shuts down a can-as-resource stability, and enlisting it into a larger agenda targeting the unhoused.

Importantly, all of this together also points to possibilities for resistance. The story does not always end with the addition of hostile designs. Even technologies which have been altered by hostile design remain multistable. Resistance to hostile agendas can come in many forms, such as through consciousness raising efforts that call attention to otherwise inconspicuous hostile designs. However, it can also come in the form of concrete counter-inscriptive efforts, i.e., material re-modifications that open a technology up to the stability that had formerly been closed off by hostile design.[5] For example, there are various forms of vandalism performed to anti-homeless designs by activists and others, physically destroying or removing the hostile design element. Artists develop alterative designs that reopen stabilities closed by hostile anti-homeless alterations, welcoming usage in terms of the stability that the hostile design had deterred. These counter-inscriptive changes can also be conceived as material tailorings, but ones that challenge the socially dominant program of action, and that reopen formerly closed off stabilities.

3 A clarification on epistemology

We should take a moment to clarify the epistemological basis of claims to new knowledge made through the method of variational cross-examination. Since postphenomenology is committed to the antiessentialism and non-foundationalism of American pragmatist thought, its claims cannot appeal to essences or foundations for such a basis. That is, postphenomenologists cannot justify our claims by virtue of our method's special grasp of a thing's true essence. We can't stake our claims on the basis of a foundational conception of truth. What, then, is the basis of claims to new knowledge made through variational cross-examination?

When variational cross-examination is used to elucidate something about the world, such a claim is made *about a particular stability* of a multistable technology. And this claim is made on the basis of the contrast established *between stabilities*.[6] This remains a within-lifeworld methodology. (Again, I take this formulation to ultimately make explicit what has already been implicit in at least some postphenomenological work already.) As Peter-Paul Verbeek puts it, "It is therefore more in accordance with the actual history of phenomenology to see phenomenology as a philosophical movement that seeks to analyze *the relations between human beings and their world* rather than as a *method* for describing reality" (2011, p 15).

This clarification can help to provide some response to critics who are already committed some variety transcendental essence, and who resist postphenomenology's connection to pragmatism. Such critics sometimes suggest that postphenomenology's claims must find a basis in an understanding of technology's essential nature, or that any claims about technology are inherently incoherent without such an understanding, or that elucidating claims about our world are impossible without the perspective provided by some assertion about fundamental truth. This account of variational cross-examination provides some level of response to these criticisms. Elucidating claims about human–technology relations can be made through postphenomenology without an appeal to essences or foundations.

4 A note on situatedness

An ineliminable element of any knowledge-creating project is that it is always conducted from a situated position. It is important to remain cognizant of the distinct position from which any investigation is conducted. And feminist theory has made clear just how deeply these insights apply.

[5] Several examples designs and art projects that critique anti-homeless design can be found in (Rosenberger 2017a: chap. 5).

[6] For a more fully-developed version of the argument of this subsection, see Rosenberger 2017b.

Even science itself is inherently saddled with situatedness (see, e.g., Harding 1986, 2015; Haraway 1988; Code 1991; Collins 2000). These insights are no less applicable to postphenomenological investigations in general, and variational cross-examination in particular. They refract through postphenomenological thought in distinct ways.

Issues of dominance One place in which these insights are operant are issues pertaining to the notion of dominant stabilities. As feminist theorists teach us, a person's knowledge is shaped and limited by their social position, their individual or their group's epistemological standpoint. If you are a member of a socially dominant group, then your privileged status colors what you know, impeding recognition of particular things, especially things pertaining to those very privileges.

This is all relevant to the postphenomenological studies that focus on technological multistability. An investigator's particular concrete embodied epistemological standpoint bears on how they may conduct variational analysis, that is, which particular stabilities they might be able to imagine for a given device, and which they may be able to identify in practice. And which particular stabilities are identified will have some consequence on what may be revealed through the process of variational cross-examination.

For example, if an investigator is a member of a dominant societal group, and as such also primarily relates to an object of study in terms of that object's dominant stability, then this relationship will structurally color this investigation. Through variational cross-examination, *something* might be revealed about this dominant stability, things possibly otherwise occluded by this stability's dominance. However, exactly what is revealed will be related to whichever specific alternative stabilities are subject to critical contrast. And which particular non-dominant stabilities this investigator includes in their analysis are of course limited by the reach of their own experiences, and by their powers of inference, observation, and empathy.

These experiences can be extended, of course. Following the prescriptions of feminist standpoint theory, we can recognize that investigations can be enriched by taking seriously the perspectives of people who live lives different from our own. Scientific and philosophical investigations should take on board the perspectives of different people. Diversity is thus an epistemic virtue. This is especially true for the investigation of technological dominance. Culturally marginalized perspectives may have a special vantage point on dominant technological stabilities. This is not because marginalized perspectives possess some special epistemological access to the essential truth of technology; it is because dominant technological stabilities may take part in systems of marginalization. Those in marginalized positions have a special view of these mechanisms, and those in dominant positions may fail to recognize them due to their own privilege.

Anti-homeless technology is once again a case-in-point example. We can imagine an investigator who is unaware of the phenomenon of anti-homeless design, and who is exploring the multistability of public-space objects. If this investigator is unfamiliar with issues of homelessness, and if they live their life largely in relation to the dominant stabilities of public space, then their variational analysis may not include stabilities preferred by some unhoused users, and their variational cross-examination may not reveal the details of anti-homeless design.

Issues of axes and pivots Another place in which these insights are operant is in Kyle Powys Whyte's reflections on the nature of the notion of multistability (2015). He points out that any postphenomenological investigation that makes central use of this concept must strive to be clear about just what kind of multistability is at issue. He offers the notion of the "pivot" to help articulate this idea. A pivot is that which "remains constant" as we consider its various stabilities (Whyte 2015, p 76). Any investigation should identify its pivot point, the more explicitly the better. I have developed a similar notion of the "axis" of multistability (Rosenberger 2008, 2020a). And I've now come to use Whyte's notion of the "pivot" to refer to that central multistable object of investigation (the object which we are considering in terms of its various stabilities, just as Whyte proposes), and then use the term "axis" to refer to the different individual angles of multistability for that pivot object that are identified. So, if the multistability of technology X can be thought of in two different manners—manner Y and manner Z—then technology X is the pivot point of the investigations, and it can be understood as multistable along an "axis of Y," and an "axis of Z."

Let's apply all this to examples of public-space technologies. If we consider the devices and areas of public space, then we can identify a variety of different potential pivot points for these potential objects of study. For example, if we continue to focus on issues of homelessness and exclusion, then one potential pivot point is individual physical things, what we could call an "axis of objects." Following our discussion above, we can identify, say, an individual bench design, and we can consider its various stabilities. We can contrast a bench-as-seat stability with a bench-as-bed stability. And we can notice how anti-sleep design features, such as armrests or seat dividers, close off the bench-as-bed stability and thus work to discriminate against those who may prefer this usage. But in our explorations of the topic of homelessness and exclusion, we may also step back and take up a different, wider investigative pivot.

We could consider a particular area (a subway platform, a park, a section of a city, etc.) as the pivot point of our inquiry, i.e., as the thing we analyze in its multistability.

We can refer to this as an "axis of space." We could identify the dominant stabilities of such spaces and cross-examine them with respect to their relation to usages of those spaces preferred by the unhoused. For example, we could contrast a dominant recreational stability of a park (which might include playing sports, dog walking, jogging, picnicking, etc.) with an alternative stability in which the park serves as a living space. A device like the anti-sleep bench might be one among many examples of hostile design that could be found within a park that function to shut down this alternative stability (anti-pick trashcans, anti-homeless spikes, etc.), especially as they work in conjunction with a network of further actors enforcing this hostility, including anti-homeless laws, police presence, surveillance technology, and norms of conduct. The anti-sleep design of a bench in this case would not merely be an instance of material tailoring that closes off the bench; the pattern of anti-sleep benches across the area would constitute one example of material tailoring that contributes to an effort to close off a stability otherwise afforded by the park as a form of space.

Continuing with this theme of discrimination and spatial injustice, we could consider different axes of exclusion that pertain to the same investigative pivot. Continue with the example of an entire park as our pivot point. In our examples of anti-homeless design, we see a particular "kind" of multistability at issue, one in which each stability is constituted by a different usage. For instance, we've cross-analyzed the bench *used as* a place to sleep with the same device *used as* a place to sit. We could call this kind of multistability an "axis of usage." However, another axis can be found in the way different users may approach differently the same device for the same purpose. As opposed to an "axis of usage," we could consider an "axis of difference." Along an axis of difference, technological discrimination could occur not as someone tries to use an object for a different purpose than that for which is was designed (e.g., sleeping on the bench), but instead as people who are somehow different from the dominant user group are discriminated against as they attempt to take up the device for the same purpose.

For example, we could think about the experience of someone with a physical disability, let's say someone with mobility issues, who looks to use the park in terms of the dominant, recreational stability. And we could imagine park designs that would be better or more poorly suited for this usage for this person. Were the park to contain, say, a large and unavoidable staircase as a central feature, then this could function to discriminate against those with mobility issues. A recent account of just these kinds of experiences has been offered by the philosopher of technology Ashley Shew (see 2017, 2020). She writes, "27 years after the passage of the Americans With Disabilities Act, larger structural and planning issues still seem to discount access… These things need front-end planning and priority, rather than 'oopsy' after millions of dollars are spent" (Shew 2017: n.p.).[7]

These are just a few first reflections on the methodological issues relevant to questions of situatedness and technological multistability. The path is wide open for work reconciling the multistability of technology with feminist standpoint insights, epistemic injustice, expertise, and hostile design.

5 Conclusion: the theory and the case

As a concluding set of thoughts, I'd like to draw some recommendations from the above reflections on postphenomenology and methodology. And I'd like to take these recommendations in two separate directions: from the theory to suggestions for future development of the postphenomenological perspective, and from the case to prescriptions about public-space design and policy.

First, the theory. Above, I have attempted to develop a second step for postphenomenological study, and, in particular, research that utilizes the notion of multistability. Ihde has offered the term "variational analysis" to refer to the process of following out a technology's various stabilities. I have suggested that postphenomenologists should next explicitly take up a second methodological step that can be called "variational cross-examination," which entails the critical contrast of these stabilities. And I've offered some initial reflections about how this methodology raises issues for postphenomenology over epistemology and the political positionality of its investigations.

These thoughts point to some general directions for the future development of postphenomenological theory, and provide a particular playing field through which these developments could take place in distinctive ways. Above, I have identified a few categories of features of stabilities that can be subject to potentially productive cross-examination (comportments and habits; networks and co-shapings; and material tailoring). But these categories themselves should not be understood to exhaust the possible list of things about stabilities that could be contrasted usefully against other stabilities. And even the categories that have already been identified are open to further refinement. For example, in my own work these categories have been developed in part through the exploration of

[7] I first identified the distinction between an "axis of usage" and an "axis of difference" within work in the philosophy of technology on the topic of discrimination in Rosenberger (2020a). For more on what I've been calling an "axis of difference" pattern of discrimination that happens through technology, I'd like to direct you to the work of Dylan Wittkower. It is my opinion that his writings on the phenomenology of discrimination and technology should find their way into everyone's philosophy of technology syllabi (Wittkower 2016, 2017).

connections that can be made between postphenomenology and perspectives such as actor-network theory and critical theory. This represents one specific point in the postphenomenological framework—the issue of aspects of stabilities of multistable technologies that are subject to potential critical contrast—where it may be productive to connect up with other bodies of theory and method.

Stepping back, another direction of future development for postphenomenological theory is to further explicate the nature of its philosophical commitments, such as its commitments to a relational ontology, embodied situatedness, and pragmatist antiessentialism and non-foundationalism. This is part of what I am trying to do with the development of the method of variational cross-examination. As postphenomenologists further develop this conceptual framework, we should continue to draw out the implications of our developments for what they mean for the nature of technology's fundamental relationality.

Second, the case. In this paper, I have mainly used the case of hostile design, and anti-homeless design in particular, as a set of examples for exploring issues of postphenomenology and method. However, in other parts of my work I do not always treat this case so parasitically. And I want to take the opportunity here to push for why I believe the issue of anti-homeless design is an important one.

Anti-homeless design is *not* somehow itself the cause of the problem of homelessness. And the removal of anti-homeless designs from public spaces will *not* somehow by itself solve the problem. However, these objects are important for several reasons. The first reason is the most simple and straightforward: they do cause harm to an already vulnerable population. They should be opposed for this reason alone. But there is an opportunity here too. The multistability of technology is non-innocent, in a Harawayan sense. The recognition of multiple stabilities can at times have the potential to expose power structures, and even to reappropriate technologies for programs that challenge societal dominance. The very hostility of anti-homeless design introduces a potential weak point in the larger anti-homeless agenda.

My claim is that anti-homeless design is a leading edge in a larger anti-homeless agenda including anti-homeless law, one that can be found across the world, but one that also of course varies in its kind and degree. One crucial aspect of this pattern is that it often goes unnoticed by those not targeted by it. This interlocking pattern of stable designs: (1) affords a dominant set of uses and meanings for public space; (2) at the same time contributes to the systematic discrimination against the unhoused; and (3) is one that also often remains invisible to those unaware of it. And therein lies the non-innocent potential of anti-homeless design. Its hidden nature at once keeps these power dynamics largely unseen by the non-targeted, and at the same time sets up these dynamics as something that can potentially be unmasked.

The exposure of the anti-homeless designs all around us has the potential to enlighten at least some sympathetic citizens to the struggle of the unhoused. The unmasking of anti-homeless design is a specific, and sometimes powerful, form of argumentation. It not only informs citizens of a pervasive anti-homeless agenda, it demonstrates it—perceptually and viscerally. Of course not everyone who has their eyes opened to this agenda will experience sympathy or political agreement. But I have found it to be an effective form of outreach to some. This can be an important mechanism for coalition building. The spikes, and anti-sleep benches, and fences, and other anti-homeless designs can be turned around and used as an indicator of the depths and pervasiveness of the politics of anti-homelessness. Like the faulty cover-up mechanism that inadvertently reveals the crime, the anti-homeless efforts, in their effectiveness at remaining invisible, become all the more striking when they are revealed.

In such moments, it is important to then advance positive steps forward, such as the promotion of local day centers and other support systems for the unhoused. We should look to "housing first" programs that seek to provide housing as a primary step. And we should support legislative efforts to enact Homeless Bills of Rights and Right to Rest initiatives that would make anti-homeless laws themselves illegal.

When we consider the multistability of technologies, we should follow those considerations with the question: stable for whom?

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