

A Postphenomenological Method for HCI Research

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ABSTRACT

This paper presents an analysis of the presence and potential of a postphenomenology as a research method in human-computer interaction (HCI). Specifically, we introduce Rosenberger's method of variational cross-examination; an empirical approach that explores technological mediation through a critical comparison of *multiple stabilities* of a given technological artifact. With this outset, we revisit and analyze two existing HCI projects, a shape-changing bench and digitized sticky notes, and illustrate how a postphenomenological perspective may supplement these projects. Based on this analysis, we highlight the strengths and benefits of a postphenomenological approach to HCI research. Finally, we propose strategies for applying such an approach in future research.

CCS CONCEPTS

• **Human-centered computing** → HCI theory, concepts and models

KEYWORDS

Embodiment; multistability; postphenomenology; mediation theory; remediation; shape-changing interfaces; concrete tailoring; habits; roles; comparative analysis

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1 INTRODUCTION

The evolution of the field of human-computer interaction (HCI) is often portrayed as having occurred in three successive waves (or paradigms), where the first wave was based on cognitive science and analyzed individual human factors, while the second wave went on to study groups of people working collectively with artifacts and thereby shifted its analytical focus from *human factors to human actors* [6]. In this second wave of HCI, situated action, distributed cognition and activity theory were important sources of theoretical reflection [5]. In the third wave, digital technologies have moved even further into our everyday lives and are now situated in everything from avantgarde artworks to mundane kitchen appliances. Harrison, Tatar, and Sengers have argued that the central metaphor for this third wave is *interaction as phenomenologically situated* [11]. Since technologies come in all shapes and sizes and are increasingly incorporated in every dimension of the human lifeworld, however, we have witnessed a growing concern as to whether the theoretical resources from the earlier waves sufficiently take matters of user embodiment and technological materiality into account. As a response to these developments, this paper proposes to use a branch of philosophy known as *postphenomenology* as a theoretical inspiration when analyzing technologies.

The purpose of this paper is to offer a postphenomenological research method to the HCI community and illustrate the potential of applying this framework in general HCI research. The rest of the article is structured as follows: We first introduce postphenomenology as a philosophy of technology and describe its technical concepts. Using Robert Rosenberger's distinctly postphenomenological *variational cross-examination* [26], we then convert these philosophical insights into a research method for HCI research. To demonstrate the potentials of this framework, we apply this research method to two existing case studies in the field of HCI. The first case is a shape-changing bench [9] that illustrates the consequences of augmenting existing material artifacts with additional technology. The second case is digitized sticky notes [15,16], which illustrates the consequences of converting an artifact from an analog to a digital material substrate. Finally, we discuss what postphenomenology adds to these analyses and to HCI research in general, and propose directions for future work.

2 POSTPHENOMENOLOGY AS A PHILOSOPHY OF TECHNOLOGY

Postphenomenology was originally conceived by philosopher Don Ihde as a philosophy of technology that was designed to explore the technologies of science, but the approach has since expanded to many other fields of research. Postphenomenology takes its departure in the phenomenological concept of *intentionality*, which is the idea that human beings are always directed toward the world: Hearing is always the 'hearing-of-a-sound', remembering is always the 'remembering-of-an-event' and so on. While naked human perception involves a direct and unmediated relation to our surroundings, however, the use of technologies often extends this intentional relation so that there no longer exists a direct relation between humans and world, but only an "indirect" one in which technologies function as mediators of our being-in-the-world [31]. Postphenomenology is concerned with exploring such *human-technology relations*: How does our use of material technologies shape our relation to the world? In this endeavor, the approach draws on classical phenomenology in that it takes departure in human experience, but as implied by the prefix *post-*, it also moves away from or 'beyond' classical phenomenology in at least three aspects:

First, on the human side of the human-technology relation, postphenomenology replaces the classic Husserlian notion of consciousness with *embodiment* [12]. Human existence is inescapably embodied and postphenomenology therefore follows Merleau-Ponty in conceptualizing the human subject as a living, breathing entity made of flesh and blood. As a result, it treats the perceiver as fully embodied, agentic, and mobile [1]. Postphenomenology also takes seriously the role of habits in everyday comportment: Through repetition, the human body gradually becomes so familiar with performing certain activities that this performance eventually recedes from conscious awareness and occurs prereflectively. Like other praxis theories, postphenomenology thus emphasizes the importance of ongoing, prereflective activity over the more deliberate forms of practice that occur in cases of breakdown [20].

Secondly, on the technological side of the human-technology relation, postphenomenology insists on empirical specificity and on exploring how *concrete material artifacts* affect human perception and action. This position stands in stark contrast to earlier philosophies of technology, which often addressed "Technology" as an overarching system with univocal effects. Martin Heidegger, for instance, famously interpreted technology as a way of revealing every aspect of the world – including ourselves – as resources to be utilized with maximal efficiency. Postphenomenology eschews such 'one-size-fits-all' accounts of technology and focuses on the unique contribution of specific technologies [14].

Finally, postphenomenology relies on a *relational ontology*, which means that its smallest unit of analysis is the concrete relation between embodied humans and material artifacts. This

relation, however, is not to be understood as a monolithic entity, and we have different forms of relations to different kinds of technological artifacts: Some artifacts become partially transparent extensions of our bodies (embodiment relations), others are encountered as displays of signs that we must interpret (hermeneutic relations), and yet others are confronted as quasi-living beings with whom we interact (alterity relations) [12]. More forms of human-technology relations can be described, but the basic point here is twofold: Our relations to technologies vary in accordance with the characteristics of those artifacts and all human-technology relations are relations between human bodies (i.e., not disembodied minds) and material artifacts.

2.1 Analytical concepts

When analyzing human-technology relations, postphenomenology brings two important analytical concepts to the table: Multistability and mediation.

Arguably, postphenomenology's key tenet is the notion of *multistability*, which alludes to an artifact's various partially determined trajectories in different contexts [27]. The notion of multistability points to the fact that even the simplest of technologies has no singular, stable essence, but can be taken up for different purposes or 'stabilities' in different contexts. A lighter, for instance, is usually used to light things like candles or cigarettes, but can also be used to open bottles. There is thus no 'essential' use of the lighter. Newer digital technologies like laptops, tablets, and smartphones are even designed to incorporate such multistability. The concept of multistability thereby acts as an antidote to analyses that solely interpret technologies in terms of their intended use, or what is also known as the designer fallacy [13]. While inescapably malleable, however, a technology cannot simply mean or do *anything*. The materiality of a device constrains its potential relations to certain uses and meanings. Multistability, in other words, is not 'indefinitely extendable' [27]. As we shall describe later, multistability not only refers to the multiple possible stabilities within the same technological artifact, but may also refer to stabilities across different artifacts with the same dominant purpose [26:385].

Another key postphenomenological tenet is the concept of *mediation*. While the anti-essentialist concept of multistability points to what things *are* (their ontology), the concept of mediation points to what things *do* (their agency). We often speak of things and technologies as neutral means to human ends. According to this technologically instrumentalist view, human subjects are active and intentional, while material objects are passive and mute. Postphenomenology argues that this characterization is in fact incorrect and that technologies actively mediate our being-in-the-world: Any technology that amplifies certain aspects of human perception will, however subtly, reduce others [12]. A dentist's use of a sickle probe, for

instance, allows her to encounter the tooth in another way than were she simply to touch it: Surface features like texture and hardness are amplified, whereas features like moisture and temperature are reduced [13]. Technologies not only transform our perceptions, however, they also translate our actions by inviting [31] and facilitating [26] certain actions, while inhibiting and foreclosing others. Technologies therefore do not afford action possibilities to preexisting subjects with fixed goals, but subtly guide, nudge, and steer human intentionality in certain directions. Accordingly, the concept of mediation designates how the two entities ‘human’ and ‘world’ emerge only in their mutual intertwinement [31].

In summary, the concept of multistability signifies that technological artifacts are always capable of serving multiple different purposes or stabilities, while the concept of mediation stresses that each of these stabilities does something specific to the human-world relation. What that ‘something’ consists of, however, is an important question that can only be answered empirically. On the one hand, its marked emphasis on technological agency means that postphenomenology is related to other strands of new materialism. On the other hand, its pronounced emphasis on human experience also means that it differs radically from these approaches. Actor-network theory, for instance, deliberately downplays people’s lived experiences in order to treat humans and technologies (or, in its own vocabulary, ‘nonhuman actants’) symmetrically [29]. In the field of HCI, however, this willful depreciation of user experience may seem somewhat unhelpful. Postphenomenology circumvents this issue by reinstating human beings at the core of its theoretical framework, albeit in a renewed, posthumanist sense: Against the modernist image of an autonomous subject, post-phenomenology emphasizes an amodern, heteronomous subject whose comportment is always closely interwoven with the material environment in which it plays out [32]. This move allows the postphenomenological approach to analyze the sensuous dimensions of lived experience from ‘within’ [28].

3 POSTPHENOMENOLOGY IN HCI

Despite its focus on the lived experience of interacting with and around technology, postphenomenology has only gained limited traction within the HCI community. A search in the ACM Digital Library on ‘postphenomenology’, ‘post-phenomenology’ and ‘post phenomenology’ at the time of writing only results in eight distinct papers. Many of these papers take outset in limited parts of the postphenomenological framework, particularly the aforementioned forms of human-technology relations (embodied, hermeneutic, alterity, etc.) as presented by Ihde [12] and Verbeek [31]. One example is Verbeek’s own key note from DIS 2014, where he argues for expanding these relations to better encompass newer ways of interacting with technologies, e.g. immersion, fusion and enhancement (for additional details see [33]). Ohlin and Olsson present a tentative framework [22], where they apply the human-technology relations to ubiquitous technologies (a running application) in order to escape the

strong focus on utility that they argue is currently dominating personal informatics research. They suggest that postphenomenology should be embraced by ubiquitous computing and personal informatics research for a broader understanding of lived experience. Also, Kocaballi et al.’s work on *Wearable Environments* [18,19], which combines wearable computing and smart environment approaches, uses the human-technology relations for understanding and evaluating workshop outcomes. These examples suggest that there is a potential for applying postphenomenology to HCI research, but it is currently underexplored.

Other HCI researchers have used a postphenomenological outset for creating concepts and theories. Oogies and Wakkary’s work, *Videos of Things* [23,24], are video prototypes of computational artifacts that are informed by postphenomenology and technological mediation in particular. In their work on *Morse Things*, i.e., Internet of Things connected cups and bowls that communicate using Morse code, Wakkary, Oogies and colleagues also situate their work within postphenomenology [34]. Similarly, Wiltse and Stolterman draw on a postphenomenological mediation theory when proposing an architectural perspective on interaction design [35].

All of these works draw on postphenomenology as a philosophy of technology. They do so by picking out and using postphenomenological ideas about human-technology relations as sensitizing concepts that help the researchers reveal important aspects of the technologies in question. In the present article, however, we wish to do something slightly different, namely to introduce the approach as a distinct *research method*.

4 POSTPHENOMENOLOGY AS A RESEARCH METHOD

How can empirical researchers convert postphenomenology’s philosophical insights into concrete methodological guidelines? As we see it, there are at least two distinct ways of doing so: Either by elaborately exploring the typical use of a single technology (“interviewing the object”) or by comparing multiple versions of a given artifact (“variational cross-examination”) [2]. While we will outline both of these approaches, the latter approach will be the focal point for the remainder of this paper.

4.1 Interviewing Objects

The first approach is inspired by Adams and Thompson’s work on *interviewing objects* [3]. The somewhat peculiar notion of interviewing objects is based on the etymological roots of the word *interview*, which is derived from *entre-*, mutual or between, and *voir*, to see, and thus translates into “catching insightful glimpses” of an artifact in action. To assist researchers in catching such insightful glimpses of objects, Adams and Thompson provide a list of eight research heuristics drawn from theoretical sources like postphenomenology, actor-network theory, and media ecology. These heuristics include helpful suggestions like discerning the spectrum of human-technology

relations, recognizing the amplification/reduction structure of human-technology relations, and listening to the invitational quality of things. Adhering to these postphenomenologically inspired guidelines may assist empirical researchers interested in exploring (or ‘interviewing’) a given technological artifact. Note that the idea of elaborately exploring a particular artifact is close to a classic ethnographic approach in which a researcher delves into great descriptive detail with the analytical object in question and its manifold relations to other elements in situated practice. Accordingly, we shall not go into further detail with this form of analysis here, but advise the reader to consult Adams and Thompson’s book-length publication on posthuman inquiry [4].

4.2 Variational Cross-Examination

The second approach is based on the distinctly postphenomenological method of *variational cross-examination* that Rosenberger develops in his paper, *Multistability and the Agency of Mundane Artifact* [26]. In this paper, we aim to transfer this analytical approach to the field of HCI by applying it to concrete examples and discussing the implications of doing so. Rosenberger’s method builds on and in an important sense expands Ihde’s use of Husserlian variational analysis, which can be characterized as a creative brainstorm that identifies a given technology’s different potential stabilities (e.g., a knife can be used for cutting bread, it can be used as a makeshift screwdriver, or it can be used for stabbing). Rosenberger argues that for such a postphenomenological methodology to be used constructively, “multistability must become a starting point, rather than the end point, of analysis” [26]. He therefore develops an analytical process in which variational analysis (i.e., identifying the artifact’s multiple possible stabilities) constitutes only the first step in the analytical process, which is followed by a second step that consists of contrasting various features of these different stabilities. Such features may include (but are not limited to) (1) compartment and habits, (2) role within a program and (3) concrete tailoring.

First, *compartment and habits* refer to bodily behaviors and habits that are related to the specific stability of a given technological artifact. Are there any particular habits related to the different stabilities? Are some stabilities transparent to the user, whereas others are not? Secondly, drawing on concepts from actor-network theory, *role within a program* refers to the role a certain technological stability plays within a specific context and network of actors. Do the different stabilities have different roles in relation to different actors in different settings (and in different networks)? What is the social purpose of the given technology? Finally, *concrete tailoring* refers to physical changes and modifications, the ways in which a technology has been appropriated to a specific stability, and how that affects the other stabilities. Concrete tailoring is strongly related to the materiality of the technology. Why were particular customizations made and what is their impact on other usages? If looking at two different artifacts designed with the same

purpose, how does the concrete tailoring and material of those artifacts impact the interaction and usage? Of course, a major tenet of postphenomenology is that bodies and technologies belong to the same plane of existence, so these analytical categories naturally overlap and intertwine.

As a working example of variational cross-examination, Rosenberger analyzes two versions of a public bench: A traditional bench and a sleep-prevention bench. The traditional public bench has a long horizontal surface, which makes it a perfect example of a multistable technology on which humans may both sit and lie down. The recent addition of vertical dividers to many benches, however, has created a new version of the public bench that precludes lying down and thereby forecloses the possibility of sleeping on the bench. Rosenberger calls such benches ‘sleep-prevention benches’ and argues that these objects have been purposefully designed to prevent homeless people from using them as makeshift beds. Since such sleep-prevention benches still allow for sitting, however, and because this is what most people tend to use benches for, these discriminatory effects may go unnoticed by the larger population. By drawing out and contrasting these two versions of a public bench, however, Rosenberger manages to make this development explicit and raises critical awareness of how sleep-prevention benches affect the homeless population.

5 VARIATIONAL CROSS-EXAMINATIONS IN HCI

In the following, we aim to follow Rosenberger’s example and apply the method of variational cross-examination to two existing technological projects and prototypes within the HCI community: 1) A shape-changing bench that demonstrates the potential consequences of adding technology to existing mundane artifacts, and 2) digitized sticky notes that illustrate the potential consequences of changing the materiality of an artifact. The reason for engaging with existing research is twofold: First, we want to illustrate how building interactive prototypes and introducing technology in the world involves both embodiment, roles, and materiality. We want to argue that variational cross-examination is a well-suited method for conducting comparative analysis, highlighting implications of introducing technology. Second, we believe that HCI may benefit from using postphenomenology as a theoretical framework that may help us explore how things are physically present, handled, utilized, perceived and appropriated in everyday practice. Applying a method like variational cross-examination provides a tool for analyzing prototypes in which embodiment, roles, and materiality are interconnected focal points. Since ubiquitous technologies are located all over the world (and not just on our desktops), this is an important scope. According to Iain Thomson, the first law of phenomenology states that what is closest to us in our everyday practices remains furthest from us in terms of our ability to take it up and understand it [30]. By

doing variational cross-examination, we aim to bring these obvious but unnoticed aspects into focus.

5.1 Augmentation: A Shape-Changing Bench

A good starting point for introducing variational cross-examination is to continue Rosenberger's exploration of the public bench in an HCI context. Grönvall et al. [9] and Kinch et al. [17] have studied the coMotion bench, which is a shape-changing bench that is designed to help researchers understand how people experience shape-changing interfaces in their everyday lives. In general, a shape-changing interface is an object that 1) uses physical change of its shape as input or output, 2) relies on controllable, self-actuated change, and 3) has the ability to return to its initial state and repeat these changes [25]. More specifically, the coMotion bench is a technologically augmented rectangular bench, which consists of three interconnected sections that can alter the bench's shape from flat to slanted by moving up and down. Through these movements, the bench can either encourage people to move together (when the bench assumes a V-shape) or to move apart (when the bench assumes an A-shape), but the coMotion bench was primarily designed to spark and facilitate social encounters between strangers [9]. In postphenomenological terms, we might therefore say that the shape-changing bench was designed to *mediate* people's experiences and social encounters in specific ways. Finally, to understand how the contextual embedment of the shape-changing bench influenced people's experiences, Grönvall et al. studied the bench in three different locations: In a concert hall foyer, an airport departure hall, and a shopping mall (see Figure 1). The authors draw on McCarthy and Wright's *Technology as Experience* framework [21] to analyze their empirical data. They use this framework to argue that people make sense of their encounters with the bench by *anticipating, connecting, interpreting, reflecting, appropriating, and recounting*. In the following, we will cross-examine the coMotion bench by comparing it to a public bench.

5.1.1 The Bench: Comportment and Habits. In its static state, the coMotion bench invites the same types of behavior as a regular public bench. However, the bench's ability to move changes people's experience of sitting on it. One participant states, "I sat quite comfortable, but when it moved, it was like an underlying feeling of unease suffused my body. I was scared that somebody would come from behind" [9]. Several similar quotes are presented in the paper, which demonstrates that people begin to feel uneasy, alert, and uncomfortable when the bench begins to move. As this shape-changing stability of a public bench presents them with an unexpected behavior, it strongly affects their well-being. This is exemplified by a woman, who

had recently suffered a balance disorder caused by a virus and feared that her condition had begun to flare up. The empirical study shows that people's habits and bodily expectations towards known objects are so deeply sedimented that when their experiences stray from this ordinary state, they tend to question their own sensory inputs. They simply cannot conceive that the bench is moving and instead believe that they are *going crazy* and wonder whether it is *the room that is changing or me?* These statements show us how deeply people's comportment and habits are embodied and solidified when using a regular bench. The authors recognize the influence of their design and acknowledge that "*the consequences of hiding the shape-changing capabilities in the coMotion bench, is an obstruction of the embodied habituation process*" [9]. From Grönvall et al.'s empirical study [9], we clearly see how this stability challenges the embodied habits and comportment of users, compared to the traditional public bench. The addition of digital technology challenges people's habits and make them question their mental well-being as well as their sensory inputs.

5.1.2 The Bench: Role Within a Program. At first glance, determining the coMotion bench's role within a program is somewhat perplexing for both analysts and users. For analysts, it is difficult to discern the bench's purpose because it is less clear-cut than in the case of a sleep-prevention bench. The authors' goal was to study people's experiences of shape-changing technologies in the wild, and part of this experiment was simply to get people to discuss and reflect on their engagement with the technology in question. For the actual users, however, this was also a difficult task since the bench's ability to move had deliberately been hidden by its design and the users therefore approached the bench as if it were an ordinary public bench. Compare this to the sleep-prevention bench, which clearly visually indicates that sleeping on it is uncomfortable or impossible. Nevertheless, the bench's sudden movements were seldom experienced as outright senseless, but were instead interpreted as playing a role within some sort of larger program. One participant thought the bench had moved to warn her not to sit on it, another thought he had taken part in a *hidden camera show* [9]. In other words, the role of the bench was often conceived differently. At the airport, for example, some people believed that the role of the bench was to get their blood circulation going before boarding a plane. These examples show that people have learned that all technologies serve some sort of purpose in our world. When things start to act unexpectedly – but not until then! – we want to make sense of the intention behind this activity, and as this study indicates, such sense-making is essentially context-dependent.



Figure 1. The coMotion bench placed in three different contexts, showing both individual and collective experiences. From Kinch et al. *Encounters on a Shape-changing Bench* [17] (Use of the picture has been authorized by the authors).

5.1.3 The Bench: Concrete Tailoring. The concrete tailoring of the bench makes it an interesting object of analysis, because the designers have deliberately aimed to disguise its additional functionality and behavior. Although it does not look *exactly* like a traditional public bench, it is designed to invite sitting and resting. The only telltale sign of the bench's shape-changing ability is a small cord that goes from the back of the bench to a nearby socket. Additionally, the bench is programmed to wait 30 seconds from someone sits on it before it starts to move, which further solidifies people's perception of it as a just another public bench. This enhances people's experience of the bench's shape-change and it becomes "a bodily and quite emotional experience" [9] for those who encounter it. In other words, the bench is concretely tailored in a somewhat deceptive manner and its intentions are expressed through its *abilities* rather than its *appearance*. For the sake of provoking an experience and an unexpected technological encounter, which was the purpose with the coMotion bench, this is a strong design approach, but it comes with the risk of promoting uncomfortable and distressing experiences.

5.1.4 The Bench: Summary. Our analysis emphasizes the vital role of human embodiment when encountering technologies in unexpected places or situations. This becomes particularly evident in examples where users being to question the veracity of their own sensory inputs due to deeply sedimented habits. In other words, the concrete tailoring of the shape-changing bench is paramount in shaping users' expectations towards the encounter and influenced their bodily experiences. The postphenomenological framework shows that the primary aspect of our experiences of benches is one of immediate material presence. Benches are simply there to be sat upon and interpretive sense-making occurs only when such habitual comportment is disturbed (e.g., by an unexpectedly moving bench). We also noted that users assumed that the moving bench played a specific role within some program of

action and thus made sense of their experiences as being part of a bigger picture.

5.2 Remediation: Digitizing Sticky Notes

Another branch of technologies to study through a postphenomenological lens are digital versions of existing analog tools. Such digitizations are often called *remediations* since they focus on building new digital artifacts that mediate the same activity as existing artifacts [15]. Emails, for example, remediate many of the activities traditionally that are associated with physical letters, while online newspapers and magazines seek to remediate the activity afforded by their analog counterparts. Once again returning to the postphenomenological vocabulary, we can say that remediations take departure in the material *multistability* of technological artifacts. As an example here, we want to look at a study in which Jensen et al. explored how the remediation of sticky notes influenced a group of designers' creativity, collaboration, and user experiences. In this experiment, the authors aimed to design and develop an *as-close-as-possible* digital remediation of analog sticky notes based on observations of live sessions in a design company. The authors subsequently conducted a user study comparing digital and analog sticky notes (see Figure 2), which makes this experiment an interesting object of variational cross-examination. Jensen et al. applied the activity-theoretical Human-Artifact Model [7] as a tool for analyzing their empirical data, i.e., observations and retrospective interviews focusing on user experiences. In the following, we will perform a variational cross-examination on the two sticky note stabilities.

5.2.1 Sticky Notes: Comportment and Habits. The project of creating a digital remediation of sticky notes points in two contrasting directions. On the one hand, the project aimed to challenge the assumption that the physical tangibility of sticky notes is indispensable for users. Hence, the project in itself was about questioning the users' embodied relationship with sticky

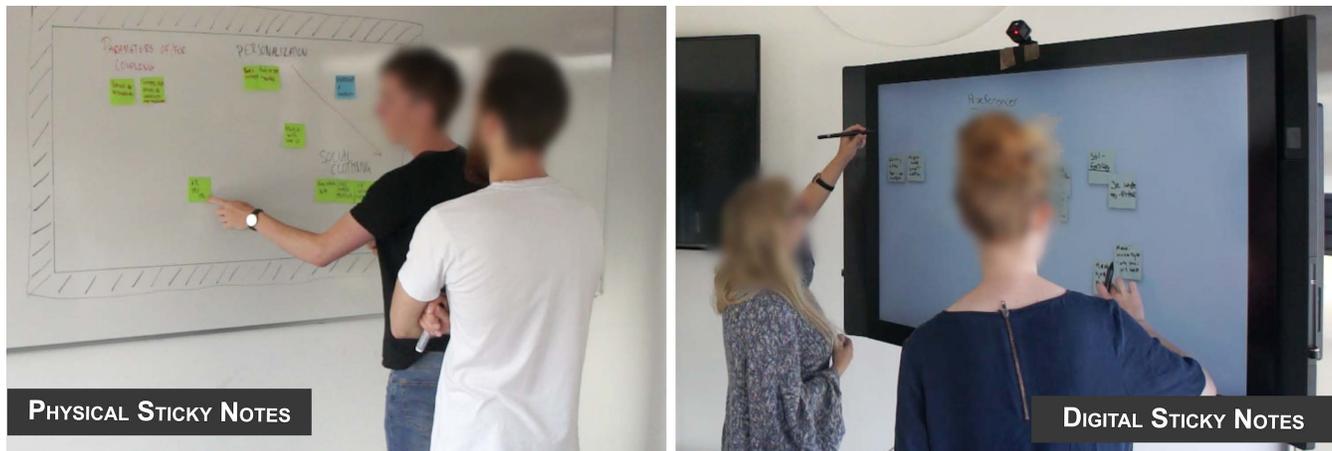


Figure 2. Pictures from the user study by Jensen et al., showing the digital and the analog stability of sticky notes as a design tool. (Use of the picture has been authorized by the authors).

notes and the importance of their specific materiality. On the other hand, the direct mapping from analog to digital sticky notes was done so “users can apply their pre-existing practices without the need to learn how to use another system” [15], i.e., to preserve existing work habits. We therefore see a schism between change and stability, the known and the unknown. Results of the study likewise pointed in two directions. First, users physically handled the notes quite differently: Posting analog notes was a deeply habituated move that worked quite seamlessly, while transferring notes from a digital device to the screen tended to cause a breakdown for some participants. Second, users used different comportments when discussing the two different kinds of notes: In the analog setup, they would either point to a note or hold it in their hands, while in the digital setup they would drag around the note on the screen while discussing it, which significantly increased note interactions. Furthermore, users found it easier to sort and cluster the digital notes. Accordingly, the study emphasized the benefits of *posting* analog notes, while simultaneously highlighting the merits of *interacting* with digital notes. Furthermore, it seems like digital notes somehow preserved and supported users’ regular ways of collaborating in ideation sessions in the sense that the majority of users reported feeling equally creative and productive when using either of the stabilities. These findings show us that the comportment and habits across the stabilities vary since the two media invite different ways of interacting, but the two stabilities still seemed to support participants’ existing practices and successfully mediated the same activity.

5.2.2 Sticky Notes: Role Within a Program. At first glance, the two stabilities fulfilled the same role, namely to support creativity and design processes by enabling externalizations of ideas and representing requirements. This is the role intended by their design. Nevertheless, analog sticky notes pose a wide array of challenges [10] such as documenting the design process and the results of a creative session as well as distributing or

transporting the sticky notes to clients’ offices. The task of documenting the design process can be troublesome and may have unintentional consequences for the person assigned to do so, because this person suddenly has ownership and responsibility of the form and correctness of the document despite it being the result of a collaborative process (ideation, sorting, and discussing). Participants in the user study favored the use of digital sticky notes because of their digital properties, which made them easier to store/document, share and move, and this happened despite the fact that such features were neither explicitly mentioned as design features nor necessary for the tasks participants were asked to solve. This shows both the multistability of digitized sticky notes (they can do more than one thing) and the importance of avoiding the designer fallacy in HCI (these additional stabilities were not intentional design features). In other words, users tacitly relied on their typical use of digital entities to come to this conclusion. This is another example of comportment and habits guiding our technology use. What participants did with this habit, however, is remarkable: They assigned the task of documenting the process to the digital sticky notes themselves, because they perceived these notes to be persistent and distributable. The digital materials’ potential for overtaking this role were intriguing for participants, and their attitude towards such possibilities indicates that remediated tools are expected to fulfill certain roles even without these roles being explicit. The digital notes’ fulfillment of the analog notes’ roles of representing requirements, externalizing ideas and mediating the ideation task were the object of study in [15], however, an analysis of their results indicate that using the digital medium implicitly leads users to anticipate that the technology manages additional roles.

5.2.3 Sticky Notes: Concrete Tailoring. The authors aimed to design two setups where the materiality of the two types of notes, i.e., analog versus digital, was the only difference. However, it is arguably impossible to create a direct one-to-one mapping between analog and digital media and multiple design

choices were made in the design and development process. Moreover, despite the fact that a traditional setup includes both a pen and a whiteboard marker, hardware conditions like having two different styluses (one for the iPad and one for the Surface Hub) were confusing to users. The difference between traditional pens and their usual applications are well-known to most users, whereas grasping the difference between an active and a capacitive stylus is not so straightforward. Even if we accept the premise of the materiality being the only difference between the two conditions, our analysis emphasize how the concrete material affects the habits of users and the role of the stability. Furthermore, the materiality holds certain limitation that were not discussed by Jensen et al., namely the pre-study setup and preparations done by the researchers to make sure participants are presented with turned-on and fully charged iPads with WiFi-access and the necessary applications installed and running, as well as a turned-on, on-line Microsoft Surface Hub with the application open and ready to use. In other words, the ecological validity of analog versus digital comparison may be called into question. However, with respect to the authors' intention of exploring and understanding how the materials mediate the collaborative ideation, this is negligible. Nevertheless, we must acknowledge that the concrete materiality of the sticky notes does influence the holistic experience and their applicability in real-world contexts. The side-effects of the digital materiality might be one reason that we have yet to see a widespread use of digital sticky note systems. Jensen et al.'s study shows that digital notes can mediate the same activity, but perhaps it is currently easier to pick up a pad of sticky notes and a pen than to turn on, charge, update, and configure a number of digital devices.

5.2.4 Sticky Notes: Summary. Our analysis shows that even if a digital technology successfully mediates the same activity as an analog medium, it influences the habits and embodied actions of users. Since the entry point for using digital technologies is generally higher than for analog material, digital technologies further present certain ecological concerns. Finally, we pointed to the fact that users have certain expectations regarding the capabilities of digital artifacts, which makes them assign certain roles to such technologies, e.g., as being responsible for documentation.

6 DISCUSSION

First of all, our aim here is not to criticize the two studies we have analyzed. In our opinion, they are both methodologically well-executed and theoretically sound. Secondly, our examples are post-hoc analyses that have been conducted *after* the experiments have been thought up, carried out, and written down. This limits the extent to which our analyses can add to the original projects. Our approach may be able to generate new interpretations of existing data, but it cannot generate new data. Accordingly, there is much to be gained by considering the use of variational cross-examination *beforehand*, that is, when

planning and conducting empirical studies. Nevertheless, we still believe that there is something to be gained by applying a postphenomenological framework to these studies. As Rosenberger argues, it is fruitful to study technologies by considering "their relations to users' bodies, their places within larger social assemblages, and their concrete material configurations" [26:388]. With our analysis, we illustrated how applying this research method led to new valuable insights through the comparison to well-known stabilities and strong postphenomenological concepts.

6.1 Comportment and Habits

First of all, it is worth noting that both studies work with a kind of 'implicit embodiment' in the sense that they revolve around embodied perceivers that handle material technologies, but never explicitly comment upon or acknowledge this fact. In the bench experiment, for instance, the researchers repeatedly emphasize the importance of 'embodied habituation' without ever specifying what this concept means or how it is acquired. Similarly, in the sticky note study one user explicitly states that it is confusing to use two pens because "there are suddenly many things, well, too many to hold in the hand. So, you have to find somewhere to put one down and take the other in order to write something" [15:7]. As such, despite the similarities between the analog and digital setups in the study, there is still a pronounced discrepancy in terms of bodily interactions. Postphenomenology helps us draw out this embodiment and cast a spotlight upon it. As such, the *comportment and habits* category of the variational cross-examination points to bodily aspects of technology use as an important category for questioning and comparison when analyzing different stabilities and technologies in third wave HCI.

6.2 Role Within a Program

In both cases, users have certain expectations about the usual roles of these ordinary objects that are challenged and altered by the redesign of the technologies in question. When looking at the role of the shape-changing bench, for instance, we must first analyze the bodily relations that we normally have to public benches, or their 'dominant stability'. Harold Garfinkel taught us that breaching the unwritten rules of everyday conduct gives us important information about how these activities are ordinarily produced and maintained [8]. This idea is also relevant when it comes to the use of material objects. In the case of the coMotion bench, it becomes evident that the ordinary bench is such an omnipresent, mundane and stable object in our everyday worlds that many users are prepared to ascribe the haptic sensations caused by the moving bench to psychological delusions. "It must be my head", one of them says. "I must be going crazy", says another [9:2563]. As such, the role of the mundane public bench is so well-established that unexpected changes immediately lead people to look for or reason about the intentionality of the technology. As the authors argue, the bench is generally

positioned in peoples' background awareness, but when the coMotion bench begins to move, it immediately shifts into their focal awareness and they try to figure out what it 'wants'. Their perception of the bench is that it is trying to tell them something (move on, get ready, engage with strangers) and for some participants the bench provokes strong bodily responses. Likewise, users of the digital sticky notes expect the digital notes to take on a specific role of labor without this role being an intentional aspect of the design, and the remediated sticky notes thereby transform participants' understanding of their roles within the team. By focusing on these intentional and unintentional roles of different stabilities, we get a firmer grasp of users' expectations and understanding of the technologies in question, which is essential when analyzing lived experiences of a given technology.

6.3 Concrete Tailoring

In order to understand the importance of concrete tailoring, we need to understand the multistability of an ordinary bench: Just as its long horizontal surface permits people to lie down on it, it also allows for flexible seating arrangements. The concrete tailoring of the shape-changing bench may help initiate conversations between random people that would otherwise never have spoken together. Its deceptive design sustains the uncertainty and puzzling behavior for users, ultimately making amplifying their feelings and need for making sense. Also, the context in which the bench was placed clearly influenced the experience of users. As such, our analysis emphasizes how concrete tailoring and context of a technology influences the lived experience of using it. This view emphasizes the need for focusing on the concrete tailoring and materiality of the technologies as well as analyzing and comparing multiple stabilities. As such, variational cross-examination seems to resonate with established design research.

7 FUTURE WORK

We see potential for using postphenomenology as a foundation for doing HCI research and for applying variational cross-examination as a method for doing qualitative comparative analysis. The next step in establishing this potential is to apply a postphenomenological mindset in an entire research process, including planning and conducting studies, and not just in post-hoc analysis, as we have done in this paper.

Further, we believe that there is a potential for using variational cross-examination in ideation processes as a framework for creating, transforming, and improving ideas. Many of the digital technologies and prototypes we design and develop in the HCI community can be viewed as new versions of existing technologies. We suggest that thinking about the three categories in design processes could take designs in new directions, e.g., by thinking about; 1) bodily engagement and existing user habits and how to challenge, change or leverage them, 2) the role that the technology plays or could play and

who or what currently manages that role, and 3) the material and the concrete tailoring and design, which ultimately will affect both embodied actions and users' expectations and understanding of the technology. However, as this is currently unexplored, more work is needed for creating a full-fledged postphenomenological design tool, but we believe that the potential for having the theory and concepts working actively is present.

8 CONCLUSION

In this paper, we have proposed a postphenomenological method as a viable analytical approach in third wave HCI research. We have outlined postphenomenology as a philosophy of technology with an emphasis on the concepts of multistability and mediation, and we have presented Rosenberger's postphenomenological research method known as variational cross-examination. We have analyzed two existing HCI research projects; a shape-changing bench and digitized sticky notes using the proposed method. From these ad-hoc analyses, we identified new findings in terms of embodiment, roles of the technologies and materiality and tailoring. Finally, we discussed the categories and the findings in relation to existing research, and proposed directions for future work. With this work, we hope to have drawn attention to the strengths and benefits of applying postphenomenology as a foundation in future HCI research.

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