The Importance of Research-Through-Design in Health HCI

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ABSTRACT

This provocation argues that research-through-design processes developing tangible health and wellbeing technologies should be represented within HCI health venues. This research explores the form and materiality health technologies can take beyond screen-based interfaces. I present three of my own examples of tangible research-through-design prototypes, Ambient Cycle, a menstrual cycle tracking device in the form of menstrual mood lighting, Ovum, an ovulation tracking device that facilitates a shared and domestic experience of fertility tracking, and Lull, a therapeutic pacing device for energy limiting conditions. I discuss the knowledge produced through developing and deploying these examples of tangible health technologies and therefore recommend that the dissemination of research-through-design processes and results remain an integral aspect of health HCI.

CCS CONCEPTS

• **Human-centered computing → Participatory design**; **Empirical studies in interaction design**.

KEYWORDS

research-through-design, self-tracking, menstrual cycle tracking, ovulation, fertility, energy-limiting conditions, long COVID, health HCI

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1 INTRODUCTION

As technological developments migrate healthcare away from the human doctor in the clinic and into our homes, considering the form we give to healthcare technologies becomes particularly important. Research-through-design (RtD) is an approach that integrates design practice with academic inquiry, using the creation of artifacts as a method for generating knowledge [6]. RtD typically explores what forms digital technologies can take beyond screen-based interfaces, e.g. [7, 20]. Instead, the form, function, and affordances of the artefact are designed as a whole. I therefore argue for the importance in the inclusion of publications reporting on RtD processes within health and wellbeing related HCI academic venues. In order to do this, I present three of my own RtD projects and how they produced knowledge about the importance of the form we give to healthcare technologies in different ways.

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2 RESEARCH-THROUGH-DESIGN

Rooted in design disciplines, RtD differs from traditional scientific research by prioritizing iterative making and reflective practice to explore complex real-world problems and scenarios. Efforts to synthesize and formalise RtD emerged in response to the fact that many HCI researchers viewed design as providing surface structure or decoration to technologies [31]. RtD uses designed objects, whether physical, digital, or conceptual, as a means of inquiry, where insights arise through the process of making, testing, and refining [21].

RtD is a practice-based inquiry that generates transferable knowledge that is often provisional, tacit, situated, and emergent [5]. Höök and Löwgren suggest the term "strong concept" to describe how this knowledge is as an intermediate level of knowledge between general theories and specific instances of technology in real-world contexts [16].

Key themes in RtD literature include the importance of material engagement when designing technology [29], the reflective nature of the design process itself [28], and the importance of reporting on the design process as an act of knowledge dissemination through pictorial-based publications [6]. RtD is a generative, rather than descriptive research method that explores and proposes possible and preferable futures for the design of technologies [6]. In order to do this, RtD often employs speculative and critical design methods to probe alternative futures and challenge existing assumptions [4]. Unlike conventional user-centered design, which focuses on problem-solving, RtD embraces ambiguity and exploration, seeking to generate new perspectives rather than definitive answers [8]. This makes it well-suited for addressing open-ended questions within the rapidly developing domain of healthcare, where RtD supports us in understanding what we want from futures of healthcare through the interplay of design practice and theoretical reflection. Deploying and user testing the results of RtD processes can produce further knowledge on what these technologies propose as possible and preferable futures [22].

3 RESEARCH-THROUGH-DESIGN ARTEFACTS

In order to argue that RtD is an important aspect to include within health HCI domains, I will present three design artefacts and their related research studies.

4 AMBIENT CYCLE

The first example, Ambient Cycle, was the result of a RtD process informed by phenomenological theories that reject medicalising approaches to menstrual cycle tracking [15, 18]. Ambient Cycle incorporates menstrual cycle data into the user's home environment in an

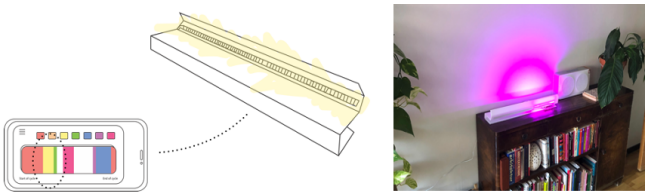
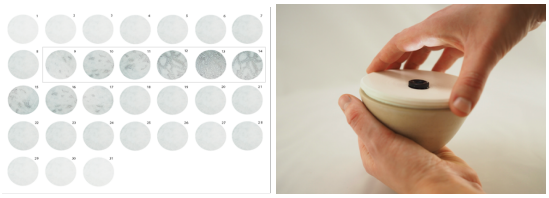
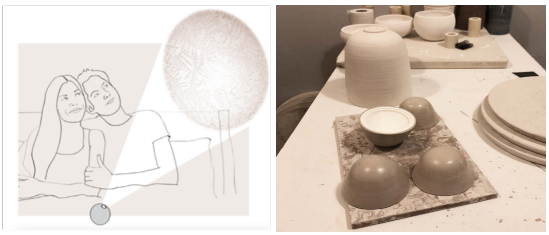


Figure 1: Ambient cycle in use in the home



(a) **(b)**

Figure 2: 2a. Saliva samples changing over the menstrual cycle, 2b. The final Ovum prototype



(a) **(b)**

Figure 3: 3a. An illustration of a couple using Ovum, 3b. The ceramic workshop

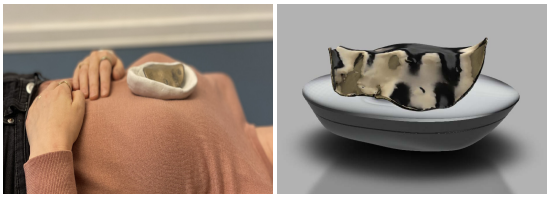
ambient form that reflects that the body is constantly in a state of flux, rather than reflecting the medical model of the menstrual cycle as a series of distinct events. Designing Ambient Cycle led to reflections on the tensions between not wanting to re-enforce taboos around menstrual cycle data by *not* displaying it in the home environment, versus causing users to feel emotional discomfort from a lack of data privacy, and risking "menstrual surveillance" due to other people reading their behaviours through the menstrual data being shown [27]. In order to mitigate these risks, Ambient Cycle is a menstrual tracking technology in the form of an ambiguous colour-changing lamp (Figure 1.). A web interface is used to select colours to represent different phases of the menstrual cycle, which the lamp then projects as ambient lighting onto the walls of the home. The colours change from one to the other slowly as the user progresses through their cycle. Using projected coloured light to represent the menstrual cycle mitigated the risks around other people being able to recognise the true purpose of the device and the subjective meaning of the colours being shown. This was validated in our user study when one participant laughed at the idea of telling her parent's-in-law, who had been visiting, what the lamp was for, whereas she had posted about being part of the study and a picture of her Ambient Cycle lamp on social media.

By choosing colours based on their own preferences, we found that users engaged with their menstrual cycle data more subjectively. During the 4 month deployment of Ambient Cycle in the homes of 5 users, we found many different uses of Ambient Cycle, outside of using it to simply alert them to oncoming menstruation. For example, participants chose colours to counteract emotional lows, such as using pink lighting to uplift themselves during PMS. Others selected colours to communicate their emotional state to those around them, like using blue to indicate PMS, indirectly requesting understanding and patience from family members. Other examples included highlighting more positive aspects of the cycle, such as when they would have more energy after menstruation. This use of menstrual data extends more traditional forms of menstrual cycle tracking and point to future openings for design, for example, by designing menstrual cycle data-sharing tools, ambient displays of health data and menstrual cycle tracking tools that enhance awareness of the "positive" aspects of the menstrual cycle.

5 OVUM

The second prototype, Ovum, is the result of a RtD process on the topic of ovulation tracking when trying to conceive [11, 12]. Based on a critique of current ovulation tracking methods, we wanted to explore how we could design for experiential qualities of ovulation tracking as 1. a co-constructive, rather than prescriptive experience where the user engages their own skills in reading the data provided, 2., a non-medicalising and domestic experience, since it takes place in the home, and 3., a shared experience, since there are typically two people involved in trying to conceive.

In relation to the co-constructive experiential quality, we selected the saliva tracking method of ovulation tracking [25]. As a user becomes fertile, salt crystals form in their saliva sample, signalling ovulation (Figure 2a). In relation to the domestic context, we collaborated with a ceramicist to hand-throw ceramic bases for the device that would better suit the bedroom environment (Figure 3b.). Ceramic materials transform the feeling of holding and using technological devices as ceramics creates a heavier weight and a cooler and more organic feel in the hand. When we deployed Ovum with seven couples trying to conceive for three months, we found this also afforded them to "hide the device in plain sight", rather than communicate to others visiting the home that they were trying to conceive. In order to attempt to offer a shared experience of fertility tracking, Ovum uses a strong LED to project the crystal pattern from the saliva sample on the magnifying lens out into the room, allowing couples to share in this intimate experience (Figure 3a). By creating a crystallising, moon-like projection, Ovum transforms fertility tracking from a clinical activity into a romantic setting, inviting partners to view and appreciate the data together. This RtD process highlighted how tracking can be transformed from a private, utilitarian practice to a shared and meaningful experience, better suiting the context for intimate engagement through biodata as ovulation waxes and wanes.



(a) (b)

Figure 4: 4a. Using our bodies in the prototyping process. 4b. a 3D model of the final form of the Lull pacing device

Figure 5: The bronze cast of a palm

6 LULL

Lull is a pacing technology designed for people with energy limiting conditions (ELC) such as long COVID and myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) amongst others [2]. ELC are characterized by symptoms such as extreme fatigue, and can include symptoms such as cognitive limitations, pain and sensory sensitivities. In an effort to manage limited energy levels, people with an ELC limit activity and balance exertion with periods of rest. This practice is known as "pacing" [9].

In recent years, people with ELC have adopted commercially available fitness self-tracking technologies and are using them in unanticipated and unintended ways to inform their pacing decisions [3, 14]. However, these technologies are designed to increase, rather than pace, exertion and activity with the aim of optimising health for people without an ELC. Informed by crip theory, which emphasises the social and political factors relating to disability and chronic illnesses, we therefore conducted a co-design study with people with ELC to inform our RtD process exploring what pacing technologies specifically designed for ELC [13].

In response to findings that screens and complex information can cause fatigue and be inaccessible for people with ELC [23], we explored how we could communicate information about energy exertion through vibrotactile feedback. The Lull prototype is still in development, but uses a vibration motor to convert data from fitness wearables, such as heart rate, steps walked and sleep score, to a vibration pattern that communicates the amount of energy remaining before resting is required. When the user has a high capacity for exertion, the vibration pattern is fast, and when the user has used up their energy resources, the pattern slows down.

A key criticism of current tracking devices "mis-used" by people with ELC, and a key topic in our co-design process, is the inaccuracy of fitness tracking devices in understanding ELC and the dominance of quantitative definitions over qualitative and subjective definitions of health [14, 23, 26]. We are therefore exploring how we could offer a more co-constructive experience of pacing through using a piezo sensor to detect when the user taps out their own understanding of their energy levels on the Lull device. This pattern will then be used to calibrate the speed of the vibrotactile feedback.

Lull is both a stand-alone device that the user can check in with by placing their hand on the device, as well as a therapeutic device when placed on the body. During our co-design research, it became clear that our participants wanted more than a device that would tell them when to rest. Vibrations can stimulate the vagus nerve, thus increasing the benefit of resting and possibly even improving the ELC condition (Figure 4a) [1].

In order to give form to Lull, we collaborated with a jewellery designer to explore non-screen based forms our device could take. Inspired by the relationship between the device and the body it was in dialogue with, the jewellery designer began exploring how to cast body parts into metals, namely bronze (Figure 5.). Bronze has particular properties that make it an interesting material to integrate into a device that will interact with the body. It is cold to the touch but warms up as heat is transferred from the body. Bronze also develops a shiny patina over time when in repeated contact with skin. The jewellery designer explored creating casts of her hands in wax and later casting these in bronze to integrate into the device. This revealed the important balance we needed to reach between making it evident that the bronze was cast on the body but avoiding the feeling of touching a stranger's hand. Whilst we are still in the final stages of prototyping, we were inspired by using the metaphor of a boat bobbing on waves for the device and intend to replicate this final form through 3D printing and will explore using 3D printed materials such as bamboo and ceramics (Figure 4b).

7 THE CONSEQUENCES OF GIVING TANGIBLE FORM TO HEALTH HCI

As well as producing knowledge through the design process itself, user deployments of these artefacts raise questions about how we perceive the accuracy and effectiveness of health technologies once data is used as a design material in non-medicalizing and non-utilitarian ways. User testing is yet to take place with Lull, but both Ambient Cycle and Ovum were deployed with users for long-term studies, and some participants saw them as less accurate than traditional apps due to their non-traditional forms [12, 15]. For instance, while Ambient Cycle uses the same system as conventional cycle-tracking apps, some participants initially assumed its lighting-based display would be less accurate. Similarly, despite using the same microscope lens as in clinical saliva tracking, one user described Ovum as a "soft science project" due to its sculptural form. Another aspect that challenged conceptions of accuracy was the non-prescriptive approach to data as something to be read by the user themselves. Ambient Cycle, while digital, still requires that users interpret data through the colour shown. This caused one participant to described negatively having "to do all the work" of interpreting where they were in their menstrual cycle. In the case of Ovum, participants of the study communicated that they were insecure about their own readings of the crystal projections, and turned to us designers as the expert, the opposite of the designed intention of the device. How Lull compares

to existing pacing technologies will be explored in future studies, but some risks are user's potential concerns that the non-medical and non-fitness-gadget aesthetic of the device, the use of non-numerical or graphical representations of data, and the user's agency to calibrate the pacing data to their own felt sense of energy and fatigue could mitigate conceptions of its accuracy and effectiveness.

These insights suggest that non-traditional, and particularly tangible, forms and representations of self-tracked data can influence user trust of health technologies. This highlights areas for further research in relation to balancing the untapped potential in exploring the various experiential qualities and material forms health technologies could take, with the threats to conceptions of accuracy and effectiveness they pose.

This is a factor particularly important in relation to the design of health technologies and this becomes particularly pertinent when we consider the growing introduction of AI into the healthcare domain [19]. When human healthcare professionals are replaced by AI agents and healthcare literally becomes "more-than-human", designers must find new ways of delivering healthcare to patients through technologies [10]. This makes new experiences of healthcare possible, since *"AI need not be embodied. Like the gods and goddesses of all the religions of the world, AI will be able to take on whatever form is appropriate; to build its own body and discard it"* [30]. Human healthcare providers gain trust from patients on the grounds of their medical licensing, their social status, and the positive experiences of patients [17]. How the form designers give to health and wellbeing technologies impacts patient experience of healthcare is less understood but is an urgent and vitally important task since negative patient experiences risk health recommendations and information being ignored or rejected, which would reduce health and quality of life and increase the burden on the healthcare system [24]. It is therefore the responsibility of HCI researchers to study the impact of our design decisions on the experience of healthcare.

Through presenting these examples, I hope I have illustrated the idiosyncrasies of knowledge produced through RtD, both relating to the design of technologies, as well as domains of health and wellbeing. My examples of RtD in the domain of healthcare technologies have surfaced fundamental questions about what is both possible and desirable from the future of health technologies that would not have been available through other, less generative or materially-based methods. I therefore recommend that the dissemination of RtD processes and results remain an integral aspect of health HCI. I also recommend that, in order to support these types of contributions [6], pictorial formats currently accepted by design-focused HCI venues, are an accepted publication format within Health HCI.

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