Beyond the Individual: The Contextual Wheel of Practice as a Research Framework for Sustainable HCI

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ABSTRACT
Addressing human impact on the environment by focusing on shared everyday practices, rather than just individual behavior is an approach that shows promise. However, it can be challenging to put this approach into concrete use, especially in teams unfamiliar with the practice orientation. To support the practice approach, we introduce the Contextual Wheel of Practice (COWOP), a framework that can: 1) help researchers and designers to better understand practices, 2) design effective interventions, and 3) facilitate collaboration between team members from different disciplines, who may not be familiar with the practice orientation. We describe how COWOP was developed, and our experiences using COWOP in three different cases. We then position COWOP as part of the "turn to practice" in HCI, and discuss how it can be useful to HCI researchers and be applied in domains beyond sustainability, such as healthcare and privacy.

Author Keywords
Energy; practice; practice-orientation; design; sustainable HCI; framework; collaboration

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
A dominant paradigm in addressing sustainability challenges through technology has focused on the individual. For example, electricity feedback devices are intended to reduce energy consumption by making users aware of how much electricity they use [6, 13]. Strengers describes this perspective as designing for Resource Man, an archetype for the user who is empowered by feedback and desires to control energy use through technology [39]. This perspective treats individuals as consumers of energy, believing that providing more information about energy use will result in the individual making informed decisions and thus using less energy.

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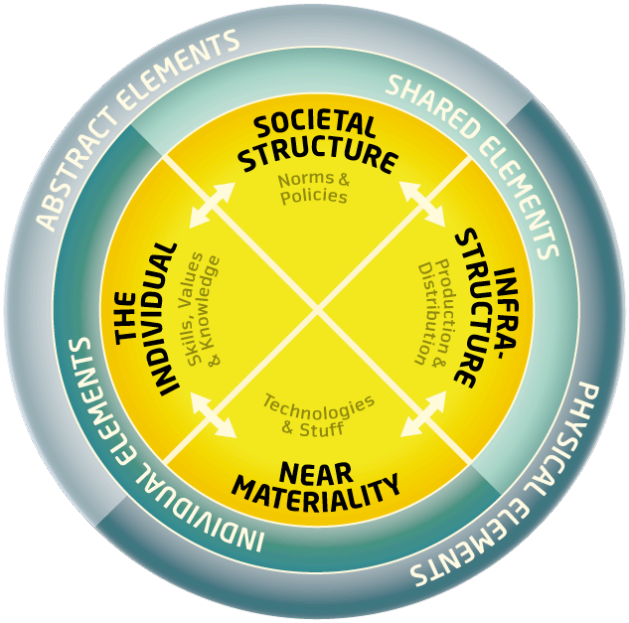

Figure 1: The Contextual Wheel of Practice.

However, a more practice-oriented worldview suggests that people do not act in the world, or think of themselves as consumers of energy. As put by Røpke, "People are practitioners who indirectly, through the performance of various practices, draw on resources" [31]. Therefore, what we should be focusing on is how people engage in the practices of everyday life, which as a *consequence* leads to the consumption of energy, if we are to truly affect their behaviors through technology. Indeed, this insight is not new to the sustainable HCI community, as there is a shift from understanding individual behaviors towards a practice-based research approach that criticizes the use of persuasive technology [5]. Aligned with this view, researchers from the sustainable HCI community have embraced a practice approach [14, 21, 26, 40] that uses practice as a unit of analysis or design for sustainable ICT rather than focusing on analyzing individual actions or changing behavior [25].

Nevertheless, we have experienced difficulties when introducing the practice orientation to colleagues on our

multidisciplinary teams who are used to designing for Resource Man. Therefore, we developed the Contextual Wheel of Practice (COWOP, shown graphically in Figure 1), both as a framework for understanding practices, and as a useful point of reference to explain the practice orientation to those unfamiliar with it. COWOP is based on our experiences in multiple projects studying energy consumption, designing interventions to change energy consuming practices, and collaborating with other disciplines. COWOP lays out four constitutive elements of practices, each of which is represented as a quadrant in the wheel: *Societal Structure*, *Infrastructure*, *Near Materiality*, and *The Individual.*

Recently, Kuutti and Bannon noted that methodological tools and guidelines are needed to move towards a more practice-based research approach in HCI [22]. We aim to contribute to this turn to practice in HCI by describing our experiences understanding everyday practices with COWOP as a research framework for sustainable HCI. As such, COWOP can be seen as an *exploratory and explanatory conceptual framework*—and not as a prescriptive tool—to support HCI researchers and designers in identifying, analyzing, and understanding practices to support system design. Moreover, COWOP also serves as a useful *boundary object* [37], providing a broader overview of the practice approach when applied to a multidisciplinary research project, enabling team members from different backgrounds to come to a common understanding of the need for a broad perspective that goes beyond the usual Interaction paradigm [22] to change people's practices. Thus, the associated research questions are: how can we understand everyday practices to support system design while working on multidisciplinary project teams, and how can we support sustainable HCI researchers and designers from multiple disciplines to get this understanding?

To answer these questions, we have introduced the practice theoretical approach to multidisciplinary research projects, and iteratively developed COWOP over the last few years. These research projects are focused on energy and sustainability, and in particular, on how to foster changes in practices. Our multidisciplinary team includes anthropologists, software engineers, HCI practitioners, and designers. This multidisciplinary team enables us to base technological developments on user studies and user involvement. Through our collaboration and initial user studies, it has become clear that not all team members bought in to the practice orientation. Furthermore, we initially lacked the tools necessary to facilitate our cross-disciplinary knowledge exchange and negotiation of meaning [43] that could mediate or bridge our different perspectives.

In the following sections, we summarize practice theory and the origin of COWOP, followed by a description of the framework and its elements. We then describe our experiences using COWOP in three projects including the practices of residents at a student dormitory, and the design of new services in the energy sector. We end with a discussion on how the COWOP framework is positioned in HCI and its limitations, and how it could be used beyond the energy domain, such as in healthcare and privacy.

BACKGROUND AND RELATED WORK

During the so-called third wave HCI [2], an in-depth understanding of practices outside the workplace has become more prominent, in which the design of ICT should take into account most aspects of people's everyday life as a whole and not only isolated work practices. Rogers has named the theories in this generation as "contemporary" such as the turn to design, the turn to culture, the turn to the wild, the turn to embodiment, etc. [30]. One common theme across these different research areas is the exploration of the concept of practice that also includes interests in appropriation, digital ecologies, materiality and attempts to solve complex real-world problems [22]. Indeed, Kuutti and Bannon [22] have reported the turn to practice in HCI as the "Practice paradigm" as opposed to the traditional—so called—"Interaction paradigm" that has focused on the interaction with technology where context of use and work practice are seen as separate and static variables. In contrast to the Interaction paradigm, Kuutti and Bannon highlight the need for a more holistic practice approach in HCI that considers the importance of understanding the dynamics of new practices that emerge due to the use of technology.

Practice Theory

Practice theory evolved in the social sciences in the 1970s and 1980s [3, 16]. The main objective was to find new ways to overcome existing dualisms between actor and structure, by finding ways to give voice to human agency without neglecting structural constraints. However, these early theories did not pay much attention to the material artifacts, infrastructures, and products that shaped practices, which has later been argued as a substantial weakness [35]. Newer approaches to practice theory pay closer attention to the material and contextual dimensions of practices. Influential theorists of this movement include Reckwitz [29] and Schatzki [32] whose definitions of practice, and views on what shapes behavior, have inspired consumer research and environmental studies [26, 31, 35, 40, 42]. What these theories have in common is that they move their attention away from the individual as the focus of analysis.

While psychology and behavioral economics typically focus on individual behavior and motivation in their analyses, the practice approach looks at practices as the main unit of analysis. In particular, Reckwitz describes practices as "a routinized type of behavior which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, "things" and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge*"* [29:249]. Building on this

definition, Shove et al. suggest that practices combine three types of elements: materials, competences and meanings, and that it is the connections among these elements that make, sustain, or transform practices [36:14]. Practices only exist as long as they continue to be carried out in everyday life, and therefore, we need to pay close attention to these seemingly mundane performances of everyday practices if we wish to understand them more fully [36].

Furthermore, practices are relational and contextual as "practices do not float free of technological, institutional and infrastructural contexts*"* [27:229]. Therefore, to study practices we need an empirical approach that takes structural, historical, and contextual elements into account and pays attention to the ways in which practices relate to each other.

To this end, several frameworks and tools have been proposed to facilitate such understandings of practice that go beyond the individual and focus on the connections between elements of practices and how they are made, sustained or broken. We will detail some of these efforts in the following subsections.

Frameworks, Concepts, and Tools

The ISM (Individual Social Material) tool is one of these models that shows how multiple contexts (the Individual, Social, and Material) affect and influence people's behavior [7]. While the individual context includes individual factors such as values, attitudes, and skills, the social context involves factors beyond the individual such as social norms, people's network and relationships as well as meanings and institutions that influence social behavior. The material context in the ISM model takes into account the existing infrastructure and technology in the environment as well as time and scheduling [7]. Although the multiple factors across the three different contexts provide a practical conceptual model for understanding people's behavior, it is a prescriptive tool that might suffer from shortcomings such as an overemphasis on the individual factors as central focus of attention.

As described in the previous section, Shove et al. propose a conceptual framework to understand social practice based on three specific elements: material, competences and meanings [36]. While the material elements encompass all the "stuff" embedded in, for example, technologies and physical objects, the meanings elements include "symbolic meanings, ideas and aspirations" and competences involve the "skill[s], know-how and technique[s]" [36]. Although this framework moves the focus of attention to practice, we argue in this paper that it might not be sufficient to fully account for the material dimensions of practices, at least in relation to energy consumption.

The Application of Practice Theory to Sustainable HCI

The theory of practice has been applied in HCI research, especially in the sustainability domain taking practices as a unit of analysis or design (e.g., [14, 21]). In particular, some researchers have used Shove's framework of social practice described above to further investigate: everyday bathing practices through "Experiments in Practice" [34], everyday repair and green-DIY practices [41], and the possible conflicts between emerging and existing heating practices [20].

Rather than applying practice theory in a prescriptive way (e.g., [21]), we aim to provide a concrete tool for applying practice theory in a more exploratory and explanatory way to support designer's reflective practices. As such, our work is aligned with the shift from "prescription to reflection" in HCI research as presented by Rogers [30]. Furthermore, we extend the related work by providing a useful boundary object for introducing and discussing practice theory with people unfamiliar with it—the COWOP framework. In the following, we describe the origin of COWOP and how it helps us understand everyday practices.

DEVELOPING THE COWOP FRAMEWORK

Based on a recent approach called Computational Environmental Ethnography (CEE) [1], we engage in multidisciplinary research projects to understand and reduce or shift energy consumption. Using CEE, we engage with qualitative data from anthropological studies, quantitative data from questionnaires, and technical data from sensors. Despite using this mixed approach (CEE), we still needed a way to help us communicate our empirical findings to project partners with a different academic background in a way that they could relate to, as well as further challenge the existing individual-focused paradigm. Yet, the findings from our anthropological field studies did not support the existing dominating assumptions about behavior and energy consumption among our partners.

Through our exploratory work with the empirical data, it became clear that practice theory would lead us to a more focused analysis [4] of specific aspects of the empirical data, such as the focus on the shifting relationships between the different constitutive elements of practices and how they can be studied from an empirical perspective.

To this end, we developed COWOP as a graphical representation of our understanding of what affects practices in relation to energy consumption (see Figure 1). In particular, we found that our analyses would benefit from a separation of material elements into two distinct categories, Near Materiality and Infrastructure, to enable us to account for the complex relationship between these elements and the different ways in which they affect practices.

COWOP has been shaped and adapted for different uses and target groups: it is still a work in progress as it evolves with the situation at hand. The current version has four elements that form a conceptual framework described in the following section.

THE CONTEXTUAL WHEEL OF PRACTICE

The Contextual Wheel of Practice shown in Figure 1 is a graphical outline of how practice theory attempts to mediate between structure and agency, the human and nonhuman, and the concrete and abstract elements that shape our daily practices. COWOP lays out four specific elements that are important for understanding practices, each of which is represented as a quadrant in the wheel. The four quadrants are (clockwise from the top): 1) *Societal Structure*, 2) *Infrastructure*, 3) *Near Materiality*, and 4) *The Individual*.

Societal Structure includes legislation, or broadly accepted social norms such as expected standards of cleanliness. The definition of Societal Structure is thus comparable with Randle and Warde's *Institutions* [27:229] and Shove et al.'s *Meanings* [36:14].

Infrastructure refers to the aspects of the physical environment that shape behavior, but are not under individual control, such as the architecture and automated processes of a building, or the means by which electricity is generated.

The Near Materiality quadrant refers to the close physical environment or technologies that are under individual control, such as a radiator in a room or the appliances plugged into wall outlets. These two categories are inspired by Geels' *technical systems* [15], and Randles and Warde's distinction between *technology* and *infrastructure* [27:229].

The last quadrant, The Individual, encompasses personal values such as a desire to live sustainably and the knowledge and skills required for that lifestyle. This category thus resembles the individual context in the ISM tool [7] and *competences* in the framework presented by Shove et al. [36].

The word *Contextual* is included in the name of the framework to stress that our actions are contextualized by the social, cultural, and material setting, and that these contexts need to be taken into account when trying to understand or affect behavior in different situations. This inclusion also helps us to better understand the scope we have for changing practices, and to design better interventions. As described in the previous section, practices are not free floating, but interrelated and affected by structural elements as well as individual motivations.

The four elements of the framework can be grouped in different ways as shown in Table 1. Societal Structure and Infrastructure deal with the elements shared across communities. On the individual level we find Near Materiality and The Individual (skills, values, and knowledge) as constitutive elements of daily practices. Besides the shared/individual groupings, COWOP also combines the elements into two other groupings. Infrastructure and Near Materiality cover the concrete physical elements that shape practices. Societal Structure and The Individual can be grouped as the abstract elements that shape practices on different levels. Therefore, COWOP mediates and encompasses elements from the very concrete to the very abstract as significant constituents of the practices that have energy consumption as a consequence.

	Shared	**Individual**
Abstract	Societal Structure	The Individual
Physical	Infrastructure	Near Materiality

Table 1: Two groupings of the elements in COWOP

COWOP helps us see what shapes practices and how changes in practices can occur through changes in any of the four quadrants. When using COWOP to understand practices and design interventions, it is important to appreciate how the four elements are highly interdependent For example, the state of Infrastructure will very much rely on the state of institutions and legislation (Societal Structure), and legislation will depend on Individuals' values and knowledge, but also on technological advances. Although individuals' values and knowledge are personal and internalized, they are also very much grounded in and affected by shared culture and societal structures, and as such, it becomes clear that the introduction of change is never a simple cause and effect process. Furthermore, introducing changes in one quadrant may not have the intended effect, if the targeted practice was more significantly affected and structured by elements from other quadrants. Therefore, it is crucial to look at the relationship between the different elements and how they structure practices in different situations.

USING COWOP FOR UNDERSTANDING, DESIGN, AND MULTIDISCIPLINARY COLLABORATION

In this section, we present our experiences using COWOP to understand practices, design technological interventions, and support multidisciplinary team collaboration. We present COWOP in practical use, illustrating different insights that the framework provided from three cases.

The Grundfos Dormitory Lab: Understanding Practices and Collaborating with Multidisciplinary Teams

One of our projects is built around the "Grundfos Dormitory Lab" (GDL), a highly instrumented dormitory for university students. Each of the 159 apartments in the GDL contains sensors that monitor indoor climate (temperature, humidity, CO_2 concentration), electricity, heating, and water use. The addition of sensors to the dormitory was intended to create a "living laboratory" to study how the residents use different resources, and how their behavior and the building itself could adapt to generate fewer greenhouse gas emissions. The GDL collects measurements from over 3000 sensor endpoints at approximately 5-second intervals.

To accomplish the goal of reduced emissions, we are designing interventions (such as mobile apps and physical design provocations) that will make use of the sensor data.

They will encourage the residents to reduce their carbon footprint by changing their practices. These interventions are informed by a qualitative and quantitative study of residents at the GDL [28]. We conducted two workshops with 30-60 residents, an online survey of the residents (67 valid responses), one overnight stay at the dorm, and semi-structured interviews with 20 of the residents. Through the workshops, we engaged the residents in discussions about their everyday practices and values, and their interests and attitudes towards the dorm. The online survey touched upon the same topics, and the stay gave us an impression of living at the GDL. Additional semi-structured interviews allowed us to get a deeper understanding of these themes and the practices surrounding them [28].

In the following sections, we present two types of practices we observe residents engaging in at the dorm, and how COWOP helped us to better understand these practices.

Understanding Cooking Practices at GDL

One of the main practices we try to understand is cooking. This practice is particularly interesting because it consumes so much energy that the so-called "cooking peak" strains the electricity grid in the early evening. In our studies, we have found that cooking cannot be understood as an isolated practice, but needs to be seen as part of a greater nexus of practices that constitute residents' daily lives. In this sense, cooking can be termed a "non-negotiable" practice [40] for the residents, one that is related to other practices in a way that must take place at a specific time of day, or have a certain frequency or duration.

Residents explicitly state that the energy consumption of their cooking is not a major concern for them. They have the *individual and shared knowledge* that this practice consumes energy, but they do not really see how that can be changed in any profound way without compromising the service they are trying to obtain. Therefore, they choose to use energy to obtain this service, perhaps saving elsewhere instead. Judging from these types of statements, the energy consumption related to cooking seems highly shaped by individual and shared values, and by their understandings of what is normal or desirable for them in their daily lives.

The practice of cooking, however, also has more structural and material elements that need to be considered. Cooking is perceived as highly interconnected with other practices such as physical exercise practices, and it is also impacted by Societal Structures such as educational institutions that decide when classes are held and thereby indirectly dictate when cooking is possible. Furthermore, the cooking practices in the dorm are also structured by the Infrastructure and the Near Materiality of the building. Each resident has his/her own kitchen, which offers the opportunity to cook alone in their apartment instead of together in the common room. This structural and material context potentially affects their behavior, and it affects the scope we have for change when it comes to the practice of cooking. These elements, therefore, also need to be taken into account. Even though informants might tell us that it is simply a matter of choice, the material elements affect their behaviors and thus energy consumption.

Understanding Laundry Practices at GDL

Another practice that we have examined is laundry. While cooking is considered difficult for people to shift in time due to its interconnectedness with other everyday practices, laundry is viewed as a more simple or detached practice, and therefore, easier to change. Either having the option of a postponed start on the washer or allowing people who stay up late to do their laundry during the night, would not only shift the electrical load to avoid peak load (and thereby emit fewer greenhouse gasses), it could also give the residents a greater sense of freedom. But regardless of the potential of encouraging people to do their laundry during the night, and people's apparent willingness to do so, there are structural obstacles that make such an initiative difficult in the particular context of the dormitory. The dorm rules (which are Societal Structures in this case) state that the laundry room in the dorm can only be used from 8 AM to 9 PM, because there are apartments situated above the laundry room, and they would be disturbed by the sound of laundry at night. Furthermore, even though the residents express that they are willing to air dry their clothes instead of using the dryer, this option is not available to them because the Infrastructure of the building leaves no room for air drying and they are not allowed to dry clothes in their apartments due to concerns about mold growth. This example shows us how the practice of laundry in the case of the GDL is highly structured by the *shared* elements (Societal Structure and Infrastructure) when it comes to shaping what time of day laundry is being done. Even if the residents are motivated to change their "laundry practices" they will not be able to because of shared structural constraints.

The multidisciplinary projects we come across within the IT and energy sector often take the premise that changing behavior (e.g., changing the time or way of cooking/doing laundry) is in the hands of the individual. The individual "just" needs to be motivated according to his/her personality or preferences. This understanding has been challenged by others [5] and both of our examples show that an individual's behavior is not entirely in their hands. Practices are social and negotiated, as well as structured by the physical and material context in which they unfold. Therefore, it is important to broaden the scope and take these other factors into consideration when we try to understand and affect people's practices (and energy consumption). COWOP helps us to meet this challenge in a very concrete way when developing ICT interventions in the sustainability domain. It makes it clear when such technologies may be limited in their impact and when other interventions, for example, changes in social norms and expectations or policies, need to be considered instead.

Collaborating Using the COWOP Framework

The introduction of COWOP to the dorm project with its visual and often physical manifestation in reports, presentations, internal workshops, and meetings has meant that essential changes are being introduced to both our common teamwork, but also to planned ICT interventions developed by the multidisciplinary research group.

Initially, interventions planed for the dorm were to be evaluated by simply measuring changes in energy consumption. The assumption being that if the intervention worked, energy consumption would go down and if it did not work, energy consumption would stay the same, or go up. However, this simplistic approach to effect measurement does not study how this effect (or lack of effect) comes about, and therefore, this type of effect measurement has no chance of explaining *what* actually caused an effect for *whom* and under *which* circumstances. This particular knowledge is necessary if we want to conclude anything about the effect of an intervention, just as it is essential if we want to replicate or improve an intervention. This type of knowledge is qualitative in nature and implies looking at the practice level, to *what* people actually do that consumes energy as a consequence, and *why* they do what they do? The introduction of COWOP made it clear to team members that understanding the practice level was necessary, and it is now accepted that the framework should be used for future effect measurement and cross-disciplinary analysis as suggested by CEE [1].

Furthermore, COWOP has concretely acted as an analytical tool to facilitate both design and cross-disciplinary analysis of questionnaires. The consistent use of COWOP ensures that questions in the questionnaire cover all four elements, to gain a deeper understanding of the specific context in which we engage. In the multidisciplinary CEE analysis, the hypotheses are based on the understanding that practices, and therefore, energy consumption, are shaped by all elements. Through COWOP, the combinations of questions covering different elements are being correlated with sensor data of the actual energy consumption.

Consequently, the framework has become a boundary object, providing a new, shared understanding of how energy consumption comes about, and providing ideas for how we might try to affect it in the future. It has acted as a concrete tool for us to communicate and discuss divergent understandings of human behavior and the unique characteristics of the different contexts in which we engage and given us a common frame to communicate and discuss the results of our field studies. As a consequence, the solutions that we develop in the project will have a stronger rooting in these new insights and understandings.

Developing New Services in the Energy Sector

COWOP has also proven to be valuable outside of a research context. EnergiMidt, a Danish energy company, wanted to innovate the way they approached Energy Service Company (ESCO) projects. ESCOs guarantee their customers a certain reduction in energy consumption through different types of energy reducing initiatives. The customers are often large organizations like hospitals, municipalities, or private companies. The typical assignment brief recognizes the importance of addressing the users of the buildings, but at the same time the briefs divide energy-reducing initiatives into two groups: technological initiatives and behavioral initiatives.

EnergiMidt experiences several challenges with these types of assignment briefs: how to optimize the screening of initiatives to maximize Return On Investment (ROI), how to clarify when and why behavioral initiatives are not optimal, considering the ROI, and how to differentiate EnergiMidt from other ESCOs?

We worked with EnergiMidt to address these challenges from an anthropological perspective. The introduction of COWOP revealed that categorizing initiatives as either technical or behavioral was problematic. The graphical representation of COWOP makes clear that even if an initiative is primarily concerned with technology (represented by Near Materiality or Infrastructure in COWOP depending on context), it is inseparable from the other elements that shape practices. Therefore, it does not make sense to divide energy reducing initiatives into technological and behavioral, since any technological initiative will necessarily involve thinking about behavior and practices.

Having come to this shared understanding, we changed the premise for EnergiMidt's future ESCOs by dividing initiatives into "technological" and non-technical initiatives. Another consequence is that all relevant technological initiatives will now be adapted based on insights about user practices in the buildings in question. This addition is intended to avoid undesirable circumventions of a technological initiative by users who cannot do what they want, or feel the way they want in the building. An anthropologist and an energy advisor/engineer will generate these insights about user practices through field studies.

Furthermore, EnergiMidt's ESCO projects will now divide users into "practice groups" using COWOP, with the anticipation that groups with similar practices will affect the energy consumption in a building similarly, and will also be equally affected by an initiative. To establish which types of initiatives are suitable for each group, the groups are now screened based on questions partly derived from COWOP. This screening results in the selection of categories of initiatives for each group and makes it quite clear when it will not be a good idea to use certain types of initiatives for certain groups. COWOP is also used here, because the different types of energy reducing initiatives map onto COWOP's elements. For example, consider an energy reducing campaign that focuses on The Individual element. If we are dealing with a group of users whose practices are highly structured by shared rules and norms (Societal

Structure) that do not overlap with a conscious focus on energy reduction, then this initiative is less likely to be successful for this group.

In the EnergiMidt case, COWOP was successfully adapted to address the specific needs of the case by adding another dimension into the framework: the *conscious/unconscious* level to each of the four different elements. As an example we can look at the Societal Structures quadrant (see Figure 1), which is made up of both explicit rules and laws, but also more implicit norms. Explicit rules and laws affect our lives in a more or less conscious way, whereas norms usually affect us unconsciously.

Collaborating Using the COWOP Framework

The collaboration on the EnergiMidt project spans three different disciplines: Engineering, Anthropology, and Business Development. We have used the COWOP graphical representation actively in presentations and discussions, referring to it in documents, drawing it on whiteboards, changing and adding to the contents, adapting it into new figures such as tables, etc. COWOP provided a physical manifestation of the abstract and theoretical concepts that were not common knowledge for the engineer and business developer. Working actively with and applying a theory would not have been possible without a boundary object such as COWOP. Initially, our understandings of the interplay between the individual, its context (including technology), and energy consumption were far apart. Through the use of COWOP in presentations and discussions, we have come much closer to a shared understanding that is based on practice theory. The result that speaks for itself is the actual effect that COWOP has had in our collaboration: it has become both the frame for our development process *and* an actual tool used in the new ESCO service. This collaboration has proven fruitful due to a shared curiosity, respect, and an acknowledged need for new perspectives that may not be present in all multidisciplinary teams.

The Proactive Energy Behavior Project

The Proactive Energy Behavior project (Proac) is a Danish project funded by Realdania and the Danish Ministry of Housing, Urban and Rural Affairs. The aim of the project is to develop, test, and evaluate different methods of visualizing energy consumption for residents in social housing [10]. We presented COWOP as part of a bigger development and evaluation framework in the project kick-off workshop to facilitate idea and concept development in the project groups.

Some groups were highly influenced by the contextual and practice focus provided by COWOP and came up with campaigns that aimed at changing actual practices, such as cooking and hygiene (tooth brushing and bathing), through the delivery of things relevant to the practice thus changing their Near Materiality. For example, participants were provided with a showerhead that adds air to the water and thus saves water. This campaign was an add-on to the actual energy feedback technology that was installed in each apartment, and resulted in positive attention and effects such as reduced water consumption.

COWOP also aided in the evaluation of the Proac project. The project group's initial round of evaluation found that when there were problems in a building, such as poor insulation (corresponding to the Infrastructure element), then it was difficult to motivate residents to actively participate in feedback-based initiatives. COWOP underlined the importance of taking Infrastructure into account as well as The Individual, which had initially been the sole focus of the project group.

DISCUSSION

The "Practice paradigm" is gaining currency as a starting point for system design within the HCI community [22]. As there is a need for methodological and practical tools to support the turn to practice in HCI [22] as well as designers reflective practices [38], we have not only provided empirical accounts regarding the aforementioned cases in this paper, but also presented the COWOP framework as a tool for thinking [9] based on the theory of practice to "*expand design thinking but do not prescribe design action*" [38]. In this sense, COWOP is an exploratory and explanatory framework, situated in the contemporary generation of HCI methodologies [30], that aims to support designers and researchers in their reflection and decision-making processes rather than providing a step-by-step approach such as ISM [7].

We believe that COWOP can provide the right level of abstraction of practice theory to support the understanding of everyday practices and the work of designing technical solutions in cross disciplinary teams through four important elements: Societal Structure, Infrastructure, Near Materiality and The Individual. In contrast to the ISM tool [7] that places the individual at the center, COWOP places the individual on equal footing with the other elements intended to support researchers and designers in understanding how practice theory bridges different disciplinary foci (used as a boundary object) and can support the design of sustainable interventions.

Furthermore, COWOP differs from Shove's framework [36] because it divides the material elements into Infrastructure and Near Materiality. Indeed, the COWOP elements are tightly related to previous work in HCI and CSCW that shows their importance when designing interactive technologies e.g., [11, 12, 18, 30]. However, they have not been considered and discussed as a whole for sustainable HCI. All elements establish a socio-technical conceptual framework that takes practice as unit of analysis and design to get further understanding of the dynamics of everyday practices as well as on how "*designed artifacts shape and are shaped by the contexts in which they are used*" [19].

We have shown how COWOP helps us pay attention to the specific demands of the case when understanding practices and developing technological interventions. COWOP helps us identify specific challenges that should be taken into account and provides us with a holistic view of the analyzed cases. In the following sections, we discuss the limitations of the framework, and the opportunities for using COWOP in domains beyond sustainability.

Limitations of COWOP

As a framework, COWOP necessarily simplifies some of the complexities that practice theory introduces. Therefore, COWOP should be considered only a starting point for understanding and incorporating practice theory into HCI research. We hope that COWOP's accessibility can serve as a "gateway" that guides those seeking a more in-depth understanding of practices. When collaborating with people outside HCI who are not familiar with practice theory, COWOP's simplification is an appropriate introduction for individuals who would otherwise not be exposed to this perspective.

Dividing the Wheel into four equally sized quadrants might give the impression that they all affect practices equally. As our examples show, this is not necessarily the case. Some of the elements may be more significant than others depending on the specific case at hand. The configuration of elements is dynamic, not static and this is not easily represented in the graphical representation of COWOP. However, one of the main strengths of COWOP is its representation of these elements, because they allow us to look more closely at the configurations of practices in different contexts, thereby serving as an analytical framework for exploring and explaining a specific domain under investigation beyond its empirical findings [9]. COWOP opens several opportunities to understand and support designers' and researchers' interpretative and reflective practices.

Another limitation of COWOP is that it does not explicitly include the relationship between different practices or the timeliness or contextualization of the practice itself, which is what Schatzki refers to as the "total field of practices" [33]. We believe these are important aspects, and we do work to incorporate them in our practical use of COWOP, but we have not yet found a suitable way to make it part of the graphical representation.

BEYOND SUPPORTING SUSTAINABLE HCI

COWOP is a framework that includes the material and technological surroundings that play a role in the shaping of people's practices. COWOP helps articulate the unusual characteristic of energy consumption: it is often hidden and mediated through materiality and technology. Thus, we find COWOP especially well suited for the energy domain, for which it was developed. However, COWOP is also a framework for understanding and articulating a certain perspective on the world and how people act in it, therefore COWOP is also well suited to domains beyond energy and sustainability. To use COWOP in a domain, it needs to be enriched with concepts and theories specific to that domain as well as relying on empirical studies to see its benefits. For example, for developing technology in the energy domain, COWOP is enriched with concepts from socio-technical systems, the use of scripting, mediated consumption, and non-negotiable practices. We now provide two examples of how COWOP could be used in other domains: opportunities to better understand self-care practices, and understanding privacy in computer science.

COWOP and Healthcare

An in-depth understanding of self-care practices as well as people's experiences is needed when introducing self-care technology into people's everyday life [17]. In a recent review, Fitzpatrick and Ellingsen report that there is a lack of work on conceptualization of frameworks and models for designing healthcare technology [11]. In fact, most of the existing frameworks have been inspired and reported for a specific clinical setting [8, 11]. For non-clinical settings, a conceptual framework has been proposed to understand non-functional aspects of self-monitoring technology [17]. Although this conceptual framework highlights the need to understand the material aspects of interaction and digital artifacts as well as the necessary knowledge required to perform self-care activities, a greater understanding is needed to also consider the Societal Structure and negotiations that take place between the clinical and non-clinical settings. COWOP can offer several opportunities to support designer's reflective practices and the understanding of everyday, self-care and non-negotiable practices: how people interpret and appropriate self-care technology in everyday life as well as the collaborative work among different stakeholders in healthcare; and providing a holistic view of health, disease, settings, and everyday practices to support system design.

COWOP and Privacy

The issue of privacy in computer science is often understood as providing users with the right settings to control privacy or make the individual aware of (undesired) consequences or sharing of his/her data. Thus, applying a practice-oriented approach could potentially widen the scope of understanding by taking into account context outside the individual. That privacy goes beyond the individual is recognized by Palen and Dourish [24] who state that privacy needs to be seen as a social dynamic process and Nissenbaum [23] who emphasizes social norms in privacy behavior. While broadening the scope of privacy research to include norms and social science adds invaluable knowledge to our understanding of privacy, we argue that the Infrastructure and Near Materiality elements of COWOP need to be addressed just as explicitly as the abstract elements, because sometimes the privacy problem can be resolved by drawing on the physical elements of COWOP. Therefore, we propose that COWOP can be used to build a holistic perspective on privacy.

CONCLUSION

In this paper, we presented the Contextual Wheel of Practice—a framework that bridges insights from anthropology, sociology, and HCI to better understand everyday practices, design interventions, and collaborate with others who are not familiar with the practice-oriented approach. COWOP facilitates a broader perspective beyond the individual in sustainable HCI through its four elements: Societal Structure, Infrastructure, Near Materiality, and The Individual. We developed the framework based on our experiences in several energy projects, working in multidisciplinary teams where the practice approach was new to some members and a core part of the worldview for others. These elements affect everyday practices in different ways and all of them have to be taken into account. Finally, we argued that COWOP is a useful framework outside the domain of energy, as part of the turn to practice in HCI.

We hope that COWOP can inspire researchers and designers, and contribute to the current practice-oriented research agenda in HCI. Furthermore, we encourage the HCI community to continue to move away from solutions that only focus on individual behavior towards solutions that consider a more holistic view of everyday practices.

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