Activity as the Ultimate Particular of Interaction Design

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ABSTRACT
In the turn towards practice-oriented research in interaction design, one of the most important proposals has been the emphasis on the 'ultimate particulars' produced by design, as embodiments of design knowledge. In current HCI research, those particulars are almost always taken to be 'things' – artefacts or singular systems. We argue that this emphasis may have come at a cost that can be described as a loss of identity; interaction design research was never primarily concerned with the design of artefacts, but with how humans act and interact with each other with and through artefacts.

We propose a complementary perspective by looking at design projects and traditions where the 'ultimate particulars' can be considered to be *activities* rather than things. The article is concerned with how knowledge needs to be articulated in the scholarly engagement with such design practices. We argue that engagement with activity-centric design gets design research one step closer towards understanding salient contemporary design practices and what Buchanan calls 'environmental design'.

Author Keywords
Research through design; third wave HCI; ultimate particular; activity-centric design; second order design; environmental design

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

INTRODUCTION
The pragmatic approach to design theory in HCI has contributed with a necessary and fruitful shift from a positivistic perspective on design as science, towards a focus on design conceptualisations that are particular and generative [55,64]. Storni [56] summarises this perspective as "RtD [Research through Design] is rigorous when it is modest, accountable, and generative." One of the central realisations has been the role of actual designs, the "ultimate particulars", as embodiment of design knowledge.

This has led to an increased focus on *things*, in the form of singular systems, interfaces, and artefacts. They are designed in research projects, studied in field studies, and brought forth at conferences as demonstrations. In this article, we argue that this may have come at a non-negligible cost, the risk of losing focus on *what it is that interaction designers design*. Buchanan described interaction design as fundamentally concerned with "how human beings relate to other human beings through the mediating influence of products" [15]. But this relationship is varying as well as ephemeral, it emerges in changing practices as well as in the momentary activity, and it is not necessarily circumscribed by a singular "thing". We argue that a strongly artefact-centric approach to design imbues a level of technology-determinism in third wave HCI.

Three trends in society makes this an important thing to address. Firstly, interactive systems are getting increasingly integrated within all aspects of everyday life [14]and hence, designing and evaluating them in isolation is not sufficient. Secondly, less and less are systems designed as stable products: they are continuously updated and maintained as online services in dialogue with use [33], making it a problematic idea that a design project ends with a product being produced. Thirdly, information technology is becoming an essential part of both local and broader societal infrastructures [2] and it becomes essential to understand how such structures are being designed. Buchanan calls the latter 'environmental design', the design of such complex and pervasive systems that increasingly influence our everyday life.

In this article, we explore an alternative design paradigm in which the ultimate particular is not a thing, but an *activity*. There exist design traditions that strive to directly design what people do, using multiple resources to influence people's activity. We propose that by focussing on the performed activity, activity-centric design is able to take on design tasks that span multiple design resources and levels. We investigate how activity-centric design knowledge can be articulated and communicated within a designer community and in a scholarly context, and draw upon work

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within HCI and adjacent fields to develop an understanding of knowledge articulations for activity-centric design.

BACKGROUND

The ultimate particular

While research through design (RtD) has a long history within HCI, it is only during the last decade that we have seen an ontological debate concerning what knowledge is meaningfully produced by it [16,23,40,49,55,64]. This ontological problem arises from the observation lucidly expressed already by Simon [52]: that design is not about what is, but about what *could, or ought to, be*.

The concept of the 'ultimate particular' was first articulated Stolterman [68], as a way to highlight the role of concrete design solutions as articulations of design knowledge. Stolterman argued that design is different from science in that while science is concerned with general truths, design is concerned with creating specific solutions to particular problems - *the ultimate particulars*. Gaver [23] further argued that theory always will underspecify design, in that "practitioners will be faced by innumerable decisions whatever theory they use", while many of the aspects of a successful design will not be captured by any specific theory. In relation to the Popperian ideals of science, Gaver [23] argues that design knowledge is unlikely to be falsifiable (as it builds on the fact that something was constructed), but rather is inspirational and generative of new designs. Furthermore, the strife of design is to constantly look for new opportunities and expansions to what is considered 'possible', making also convergence an unlikely and to some extent undesirable development. Stolteman's identification of the ultimate particular as well as Gaver's critique of attempts to scientize design, raise intricate questions about what knowledge is meaningfully produced in RtD.

In a meta-level analysis of the research production from the field, Löwgren [40] proposed the concept of *intermediate level knowledge* as an all-encompassing term for articulations of design knowledge that go beyond the singular artifact, but is less universal than a grand theory. Intermediate level knowledge is characterized by its practical usefulness in design, but it is underspecified in the sense that it will not always hold, and the conditions under which it will hold are not easily articulated. Löwgren included a wide range of knowledge contributions (such as methods and evaluation frameworks, design concepts and patterns, and design critique) as forms of intermediary knowledge. Later work has focused more specifically on concepts that abstract on particular design solutions. Examples include *strong concepts* as "design elements abstracted beyond particular instances which have the potential to be appropriated by designers and researchers to extend their repertoires and enable new particulars instantiations" [30], *bridging concepts* as theoretically founded articulations supported by multiple design exemplars [16], and *experiential qualities* as characterizations of interaction experiences that emerge from the use of a range of designs [53]. In a meta-analysis of these contributions, Pierce identifies them as *concept-things*, combining a collection of artifacts with a description that articulate their common features [22].

The concept of annotated portfolios as suggested by Gaver and Bowers [21], is particularly radical. These comprise a collection of designed artefacts, with annotations done by the designer to highlight what they consider to be particularly interesting properties and design choices. In contrast to the previously mentioned forms of intermediate level knowledge, the annotated portfolios need not be framed by an overarching concept. Rather, it is the designers' choice to present them together that shapes their connection and establishes the lens through which they can be attributed with a commonality. The result is a nuanced communication of an aesthetic approach, rather than an articulation of an abstract concept.

Bardzell et al [7] have highlighted that the production on knowledge as concept-things prioritizes the designers' intentions and interpretations over those of a user or a critical reader. While this certainly is a valid critique, it can also be seen as a defining feature on the articulation of knowledge that is generative of design: the pragmatic approach to RtD in third way HCI privileges the designer's perspective over that of users.

The debate summarized above has served to shape a foundational and pragmatic perspective on RtD that is not questioned in this article. But here, we wish to highlight that in all of this work the 'ultimate particulars' that are being annotated, that work as exemplars of concepts, or even read by critics, are almost always assumed to be *things*.

Activity-Centric HCI research

A focus on activity was brought forwards early in HCI, as an alternative to the at the time dominant paradigm of approaches based on human factors such as theories of cognition [44]. This "second wave HCI" [14] is represented both by situational approaches [58,57] and by the development and use of activity theory as a tool in interaction design [44,35]. The focus lies on "understanding technology as part of the larger scope of human activities" [35:5]. This body of work has largely been holistic and analytical in nature, looking at the social practices with and around technology. A central argument is that activity manifests within a complex meshwork of practices, material properties, and human actors, and that the use and effect of an interactive system cannot be understood in isolation without taking this meshwork into account.

There are strong methodological contributions from this field. Originating in the recognition of interaction as a situated and complex activity, researchers emphasized the need for iterative design and for involving users throughout the design process [6], and advocated a shift towards

considering users less as novices, and more as skilled experts in their own work practice [20]. Recently, theories of materiality have been brought into this perspective, questioning in particular the very notion of design processes as something separate from use [13]: an artefact in use is not shaped just by its design but also by its use and its users.

Second Wave Critique of Third Wave

In her scrutiny of third wave HCI [14], Bødker frames the third wave as a counter-movement, "the focus of the third wave, to some extent, seems to be defined in terms of what the second wave is not". Based on this observation, she argues that some important perspectives from second wave may have been lost. To illustrate what has been missed, Bødker brings forward first the "multiplicity of interaction", and the work that "humans do to make multiple objects work together". Bødker brings forward the plethora of work situation studies from the second wave, that highlight the complexity of any concrete work situation. While the overarching ambitions of the third paradigm (at least as expressed by Harrison et al [27]) certainly take this into account, it persists as an adequate critique of the artefact-centred approach to articulating design knowledge.

Bødker acknowledges that third wave HCI has been apt to adopt new forms of interaction, in particular physical and tangible interaction but also bringing about a material perspective even on "immaterials", the kinds of technologies which typically are not rendered visible and controllable to user [2]. However, she argues, this comes at the cost of focussing primarily on the interactions with a designed system or artefact. The everyday work of ""making-do", creating bricolage solutions to everyday or work challenges, is not easily accommodated by this approach [62].

A related critique has recently been articulated by Taylor [61]. In a study of an urban bike rental system, Taylor developed a deep understanding of what features of the system design contribute to shape its use. His conclusion is that the instances of human computer interaction, such as in what way the user identifies herself to the bike, has a very marginal effect on the use patterns. Instead, the patterns of use emerge from the rules and regulations implemented in the system infrastructure (in particular how one pays for the service), together with the location of bike stations in the city. Taylor argues that if we are to understand anything about the design of such complex and pervasive systems, we cannot restrict ourselves to looking at the design of interactions.

Indeed, much of the technologies that pervade through life do so through infrastructuring; they provide frameworks for activity that are rendered meaningful through the uses, changes and additions that users develop within and around the technology. As pointed out by Björgvinsson et al. [13], the design project for such technology is only part of the lifecycle of a product, and "both the beginning and end of a designed device is open and hardly ever constrained to the limits of the project". Björgvinsson et al. argue that interaction design must shift focus from the design of things to the "kinds of socio-material assemblies that Bruno Latour so strikingly has characterized as collectives of humans and nonhumans" [13], and from this perspective advocate a more embedded perspective on design. In particular, they argue that participation in design can take place both during the design project (as advocated by classical participatory design) but also in use, what the authors call *design after design*.

While Björgvinsson et al. bring forward this argument to highlight the users' role in shaping infrastructures over time, the emergence of online connectivity also has had the effect that *designers need not leave products over to users*. The Internet has made production of the ultimate particular a perpetually on-going process, in constant dialogue with end user practices. Today, few interactive products are stable: instead, they (at least in part) have become services that are maintained online, and where functionalities and interaction models are continuously updated. Examples are legion in the area of online games and social media as illustrated by the concept of "Perpetual Beta" [33], and include online software updates of consumer devices including phones and portable computers. In Ehn's words, project-time extends over most of use-time [13] creating an ongoing interaction between designers and users that is ripe with possibility but also with tension. With online services, the designers (or at least their companies) tend to never let go of their products: they continuously monitor and react to emerging uses, and often retain the final say in what uses will be encouraged or prohibited [48].

To summarise, the focus on artefacts as the ultimate particulars produced by RtD can be criticised from multiple perspectives: that it takes focus from the complexity of a use situation and the work humans do in creating bricolage solutions, that artefacts may not adequately represent design solutions integrating multiple resources and levels of design, and that the view of artefacts as the end product of design does not capture the potentially complex interplay between designers and users in design after design.

CONSEQUENCES OF ARTIFACT FOCUSSED DESIGN RESEARCH

As previously discussed, the pragmatic approach to design research in HCI has developed a focus on research that is particular and generative. Here, we retain that perspective, looking for ways to articulate design knowledge that are directly generative of design.

Buchanan described interaction design as fundamentally concerned with "how human beings relate to other human beings through the mediating influence of products" [15]. This is a relationship that is variable and fundamentally ephemeral, manifest in in-the-moment actions and social activities, and emerging as persistent practices only over time.

This is acknowledged also in artefact-centric approaches to RtD, in how context, use and subjective experience is foregrounded in empirical work. However, anchoring such discussions in the design of specific artefacts opens up for a form of technology determinism. In studies, the observations will typically be focussed, filtered or limited to concern the technology on trial. Very often they will primarily concern interactions with the technology in use (rather than, say, the work related to carrying, installing, or configuring the technology [47]). Secondly, trials typically focus on identifying re-occurring behaviours that reasonably can be attributed to the artefact. It is taken for granted that the only interesting effects are those that reoccur, and therefore can be argued to be semi-generic effects of introducing the artefact. Taken together, these perspectives create a view of design knowledge that is technology-deterministic, in the way it expects the technology to shape its use.

It should be emphasised that many of the prioritised design qualities in third wave HCI, including e.g. design for ambiguity [24], design for appropriation [18,29] and design for interactional empowerment [31,53], strive to circumvent technology determinism through opening up for uses that were not preconceived by the designer. In a brief meta-reflection on such design strategies, Höök [28] argues that what these design concepts do, is to propose a balance between the role of the designer and the user, leaving a carefully crafted room for meaning-making in interpretation and use. This does not mean that these approaches negate the very idea of technology determinism, but they present strategies to open up for appropriation by deliberately underspecifying use.

ACTIVITY-CENTRIC DESIGN

The key feature of activity-centric design is that it aims to influence (and sometimes control) what people *do*. But since the activities are performed by the people participating in them, this influence is indirect, through the creation of *something* (combinations of objects, spaces, instructions, interactive systems, etcetera [42]) that contribute to shaping the activity at hand. Activity-centric design considers these as secondary and mutable, meaning that they may change over time if the design-project time overlaps with use time.

Since activities are performed by the participants, they are not under full control by designers. In this sense, activity-centric design is always *second order* design: while the design goal is related to the activity, designed artefacts constitute the only possible means to achieve it.

Activity-centric design knowledge thus comes across as both more indirect and more designer-centric than artefact-centric design. A way to understand the difference is through Redström's distinction between defining use "through design" or "through use"[49]. In artefact-centric design these are alternative and complementary perspectives, where the role of participatory design is to put them in dialogue with each other in other ways than through a final, designed, artefact. The activity-centric perspective privileges the designer's intention (the definition of use through design), but sees it only as a way of *influencing* the definition of use through use. (Also, the very concept of 'use' becomes problematic in activity-centric design, as the designed activity is not necessarily directed towards a designed artefact.)

The perspective on activity-centric design as second order has been developed primarily within game design studies, and origins in how games typically allow for a wide variability in play. Salen and Zimmerman [50] express this as

"The goal of successful design is meaningful play, but play is something that emerges from the functioning of the rules. As a game designer, you can never directly design play."

This perspective guides our framing of activity-centric design. However, the game analytical take on second order design lacks one important consideration that must be taken into account in interaction design research. In game design, it is commonly understood that a design fully frames the space of possible play activities. Early game studies would sometimes consider games to be closed formal systems, but also informal methodologies such as the MDA ('Mechanics Dynamics Aesthetics') framework [32] will typically consider the play (dynamics) of a game to be a property of the *system* and as such completely specified by its rules (mechanics). Game design studies basically considers the definition of use through use to be *caused*, rather than influenced, by definition of use through design. This again gives rise to a form of artefact determinism: while game design studies will appreciate, and study the full range of possible behaviors offered in play, this space is still typically seen as completely circumscribed by the composite, designed artefact that is the game.

This simplification arises from how playing a game can be characterized by the voluntary submission to a set of rules [59]. It has been criticized for prioritizing a mode of analysis that leaves out the work done by players in collectively establishing and maintaining such rules [11]. In most interaction design research, we cannot assume that the participant activities are fully determined by any given design [4].

Delimiting the concept of activity

The proposed perspective is inspired by more holistic approaches towards understanding and designing for activity including situated and activity theory approaches [12,26,35]. In particular, we subscribe to the usefulness of the concept of (collective) activity as an intermediate level of analysis above the level of singular actions. Just as in activity theory [35], we consider an activity to be made up of multiple in-the-moment actions by individual participants – a collection of things that *people and things do*. Actions of this kind are to some extent observable

allowing for a third person perspective [38], even if mere observation will not capture the reasons for, or the experiences in, doing them.

But where activity theorists defines an activity as "a form of doing directed to an object" (or objective) [36], we instead look upon activities as framed by a conscious design effort. In the following, we will talk about (designed) activity as collections of actions united by the fact that they are influenced by one and the same design solution and as such can be considered an effect of deliberate design.

The reason for this scope is the aim to approach the articulation of design knowledge. While activity theory is well suited to capture the everyday bricolage solutions that shape much human activity, it primarily presents an analytical perspective. Design research in this tradition has primarily contributed with process and method knowledge (see e.g. [17,62]). By framing activity instead through the lens of deliberate design, we maintain the RtD aim to privilege the designer perspective, and to express knowledge in relation to design aims. However, it should be noted that in activity design, one must never lose track of that design only influences and does not determine the activity. Within the scope of actions influenced by a design solution, some are actions that are not interactions with design itself. For example, the decision to *not* engage with a design is also influenced by its existence.

In the same line, we do not see activities as collections of interactions with technology. In this, we follow Buchanan [15] who argues that interaction design should not be taken as always including information technology, but instead is fundamentally concerned with action as such. Buchanan argues that the products that interaction designers design are "experiences or activities or services".

Our core motivation for moving away from interaction design as interaction with and through technology originates in observations such as Taylor's [61]. We are moving into a society where information technology is increasingly becoming part of the infrastructure of life, integrated into our every movement and activity. The use of technology is increasingly being influenced by a range of phenomena and factors that lie outside its reach. Factors that influence our everyday engagement with technology include such diverse aspects as physical space, rules and regulations, cultural habits, and physical information sources. Activity-centric design opens up for considering all of them materials available for design. This is one important way in which looking at activities as the ultimate particular of interaction design may take us one step closer towards what Buchanan discusses as environmental design [15]; the design of such complex and pervasive systems that increasingly influence our everyday life.

Activities are Unique and Emphemeral

If we are to consider activities as the ultimate particulars of interaction design, we must embrace their uniqueness and ephemerality [52]. Whereas artifacts can be copied and the copies can for all intent and purposes be identical to the original, an activity is always unique. Activities cannot be packaged and shipped. Even when activities are tightly scripted to be repeatable, the same actors under the exact same conditions cannot perform the exact same activity twice – it is different in the very least in that it is performed a second time and that the experiences from already having performed it influence how it is performed.

DESIGN KNOWLEDGE AS CONCEPT—ACTIVITIES

In this section, we look into existing design practices and previous work in HCI to develop an understanding of how activity-centric design knowledge can be articulated. In this, we are not looking for process knowledge– ways of designing – but for how intermediate level knowledge about design solutions can be articulated and communicated. We retain a pragmatic RtD perspective in that we are looking for ways to articulate design knowledge that are, in Storni's words, modest, accountable and generative [56].

While activity-centric design practices exist in a variety of fields, we have in this article chosen to highlight practices within the fields of game and performance design. The main reason for this lies in that such designs are relatively well contained – their purpose is to influence a coherent experience that takes place over a set time interval and often in a particular setting or location. The level of control that designers have over the staging of such activities present ample design opportunities and as such, they form a useful resource in understanding the design opportunities also in less constrained settings. Finally, relevant theory has been developed in these fields. It also matters to the authors that they are predominantly voluntary activities: players and audiences (and to some extent also performers) are free to engage and disengage from such activities.

In the quest for activity-centric design knowledge, Pierce's [46] characterization of design knowledge as concept-things is less appropriate. A pragmatic perspective on activity-centric design will instead need to package and communicate knowledge as *concept-activities*. This change of perspective affects both what concepts are put in focus, and how the design examples are constructed and made available. Here, we first discuss how activity-centric design is documented, to then look into activity-centric design concepts and finally how activities can be made available, as ultimate particulars.

Scripting Activity

As discussed above, activity-centric design is done indirectly, through the design of other things. In many forms of activity-centric design and in particular in performance arts that thing is a *script*: a designed artefact that instructs the participants to do certain actions, and by this serves to guide the execution of an activity so that it can be seen as an instance of it. Scripts can be considered artefacts generated by artefact-centric design: they are persistent, and their completion ends (a distinctive part of)

the design process. A script will often also delimit the designer's control over the resulting activity, by leaving its execution to somebody else. Scripts are not the sole way in which activity-centric design manifests, but they are common.

Scripts are legion in art: theatre scripts and music scores are just two examples. They also feature in live performance art, such as when Loke et al [37] reflect on how "the scripting of the entire process is an important aspect, with care being given to timing, cues and transitions". Through the development of technology supported live art and pervasive games, scripts have featured in design studies within third wave HCI as well as game studies [10,34,37,54].

However, scripts do not function in the way we typically think of artefacts in artefact-centric design. Scripts are in one way or another instructions; they are not acted on or through, but serve as guidance for action. Furthermore, scripts do not "generate" activities or experiences; they always underspecify the activity and there is a level of creativity involved in interpreting a script. In many scripted art forms, there are specific roles in this process including directors, conductors, performance artists, performers, and documenters (e.g. photographers). The circumstances and variations of interpreting a script are always unique.

Scripts can also specify activity more or less precisely. For example, the classic western music score specify the activity in great detail and in a uniform manner that is understandable by the suitably trained performer while still giving room for creative interpretation [41]. By contrast, table-top role-playing is supported by loosely constructed diegetic world construction and rule systems [24], that require a facilitator in the form of a game-master who creates specific challenges, determines conflict outcome, and creates interesting narratives to control the dramatic curve. Within the Nordic larp community, recent attempts to create 'scenarios' present even more open ways to script activity [23]. Even board games, with their rules and goals and intended forms of engagement, can be interpreted as a form of scripting.

Human facilitation, as in the example of the theatre director or the game-master, opens up for approaches to scripting that leave ample room for participants to influence the activity as it develops [44]. Some scripting techniques have been developed with this in mind, such as the concept of "story beats" that was developed for the alternate reality game *Conspiracy for good* [66]. These were pre-scripted scenes that were not designed to play out at a particular point in time or space. Instead, the game-masters (who in this case also were the designers) would select a suitable occasion for triggering a beat depending on what the participants were doing. Using scripting methods such as beats can enable designs where different participants can experience very different storylines; all beats may not even play out during a singular event.

Finally, while scripting often works as a way to commodify and communicate activity-centric design, scripts are not always created for this purpose. The "careful scripting" that Loke et al discuss [48] was most likely never communicated outside the designer team. Its primary role was to synchronize the performing team and fine-tune the experience for participants. Such scripts can be under constant refinement over multiple instances, and might not ever manifest in a stable form of documentation. These forms of scripting are typical when artists or designers stay in control over the activity, and never leave their art over to performers, conductors, or participants.

To conclude, scripts function as way to develop, document and communicate activity-centric design and could be appropriated also as a way to articulate activity-centric design knowledge produced by RtD. However, the form of scripting and the intended functions and roles involved in interpreting a script, will greatly influence the type of control that designers exert over the actual activity. In light of this, investigating and developing *forms* of scripting emerges as an interesting research topic within activity-centric design research.

Activity-centric concepts in HCI

Notable examples of activity-centric design concepts have been brought forward within HCI. The examples below have been selected as they represent ways to conceptualize activity-centric design knowledge at a more abstract level: they focus on what participants do, rather than on specific aspects of the designed artefacts. The selection is intended to be illuminative rather than exhaustive, as the approaches present rather different perspectives on activity.

Affordances

The concept of affordances [33–35,56] represents one of the earliest and still most influential approaches to activity-centric design. While affordances are properties of the world they are relational; they speak of how objects can be acted upon by specific actors. Broadly speaking, the set of affordances offered for a particular actor in a particular context delimits the set of activities possible in that context. Gibson [33] emphasizes how our learned understanding of physical affordances is functional – we learn how to act on an affordance directly, not how to recognize it through passive perception.

In HCI, the concept has been used in design research as properties of interfaces. HCI distinguishes between perceived and functional affordances [31,56]. The related design ideal states that users should be able to perceive what they can do in an interface. This means that the concept has been reinterpreted as a property of interface itself, rather than a relation between interface and user.

From the activity-centric design perspective, affordance is still a first-order construct. It describes a design as actions enabled by the designed artefact. The concept of affordances may serve to anchor a second-order activity-

centric design in some of the artefacts supporting it, but it is not sufficient to express all aspects of second order design. For example, it is not particularly meaningful to analyze scripts in terms of affordances.

Trajectories

The trajectories framework [9,10] presents a way to analyze and describe various paths through a designed experience, with a focus on trans-medial experiences involving multiple resources. The framework highlights in particular the transitions between different forms of engagement or interaction (e.g. moving from physical to online participation). It is particularly interesting in that it takes into account how all participants may not experience the designed trajectory, or the even same trajectory as any other participant. The participant's individual trajectory is acknowledged to be potentially unique.

Loke et al [48] articulate a similar but more abstract perspective, in their approach to scripted participatory experiences. Based in ritual theory [8], they describe the overarching path through such experiences as an initial entry, the journey through the experience, and a post-event debrief which functions to reconnect to the outer world. This perspective is much more high-level and generic, and presents less support for acknowledging or documenting the uniqueness of an individual experience.

Verbs

Trajectories are primarily temporally organized, and function less well to articulate design concepts and features where controlling the temporal sequence is not a central aspect of the design. We have already discussed a variant of scripting that is less temporally oriented, the story beats approach from Conspiracy for Good [54]. The story beats were however tightly connected to the type of experience designed (a pervasive game-mastered roleplaying experience) and are less suitable as a generic approach to expressing activity-centric design knowledge.

A framework that shows potential for a less temporally oriented approach to expressing activity-centric design knowledge has been suggested by Paulos and Pierce [45]. Their design domain is sustainable energy consumption, and the authors do not develop their approach into a generic method of expressing design knowledge. What Paulos and Pierce do is to create a vocabulary of actions, expressed as *verbs*, that reflect what people can do with micro-amounts of energy. Their precise vocabulary includes the verbs 'collect/harvest', 'store/keep', 'share/distribute' and 'activate/express'. This collection of verbs has a number of properties that makes it very different from other articulations of activity-centric design knowledge.

Firstly, these verbs could be seen as a form of affordances: they express a relation between human actors and energy in terms of how humans can act on energy, that is made visible/tangible through the design of interactive artefacts that have modes of sensing and visualizing the energy flow. The strategy of making the invisible visible or tangible has also been explored in participatory design investigations of infrastructuring [17], but Paulos and Pierce go further in how they suggest a particular set of verbs, with a clear goal of guiding activity in a particular direction.

Note that energy is present in everything that humans do and every object that humans use. It is possible to conceive using the same verbs to describe interactions that do not manifest at all in interactive technology or designed artefacts. A large stone will work to store energy independently of if this capacity is measured or recorded in any way. A person can share micro-amounts of energy with another by holding their hands to warm them. Even if these are not measured by built-in technology, they could be made accessible to a system through human facilitation.

The verb collection that Paulos and Peirce proposes is transitive – it consists of verbs that express that something is *acted upon*. This is what makes it possible to talk about them as affordances (in relation to something intangible) and why they can be designed as interactions of interactive technology. In general, a verb collection may express anything that people are supposed to do as part of an activity. Some forms of scripting, such as the training schema that a trainer uses for an aerobics class (Bend! Jump!), consist primarily of sequences of verbs.

It is also interesting to notice how Paulos and Peirce conceive their space of verbs as implementable in a range of devices, where a singular device would only implement a few. It is only taken together, merging the interactions over all of these devices, that the actions create the activity of sustainable energy management.

The collection of verbs is in itself important. It is very clear that it realizes a coherent design intent; it is at the same time constraining and liberating. While it is clearly possible to conceive other things that could be done to energy (such as the wider verb 'consume'), the authors deliberately limit their verbs to things that make practical sense in the context of very small amounts of energy. At the same time, the concept of 'sharing' energy is novel, and different from what we typically think of something we do with energy. The set of verbs shape a space of activity that is different than what we are used to do with energy today, and by that, has the potential to change our relation to energy.

In this sense, the verbs are similar to what in game design theory is called *core mechanics*, the central modes of action that a player can use to influence the game state. Zimmerman [63] argues that the structures that delimit play work at the same time to restrict and enable the play activity. Constraints work to inspire participants to activities they may not think of on their own, and engaging within given constraints can foster experiences and insights that otherwise would be inaccessible. The collection of verbs that Paulos and Peirce present share these properties.

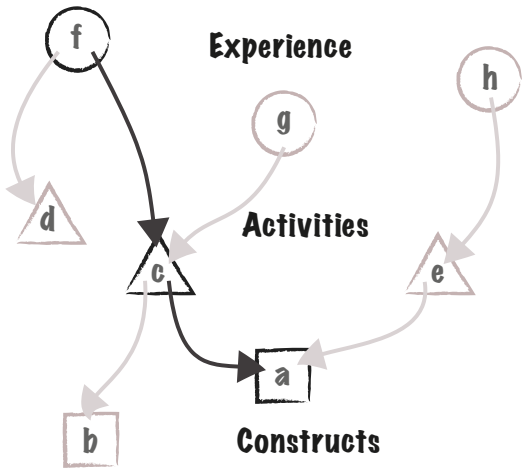

Figure 1. A FaTE representation of a designed activity. An activity (c) is supported by two different constructs (a and b) of which only a is part of the design. The sought participant experience (f), related to multiple activities (c and d), and the designed activity (c) may contribute also to an unintended experience (g). Adapted from [4], reprinted with permission.

But the verb collection by Paulos and Pierce go one step further, as the emerging activity of energy consumption is one that the singular user would never fully experience. It would be a phenomenon emerging at the level of a community of users. In this sense, Paulos and Peirce take an important step towards what Buchanan calls 'environmental design' [15], addressing design of the world we live in rather than the individual's experience of a specific product.

FaTE

One of the pitfalls with artefact-centered design concepts lies in 'design determinism' - a tendency to assume that it is the design that generate an activity. As discussed above, this has sometimes been done in game design theory.

The FaTE framework [4] was proposed in direct dialogue with the MDA framework [32] as a way to address design determinism. FaTE proposes a way to look upon participant activity as supported, but not generated or constrained by, by the design at hand. The activity is influenced by the design, but also by a large range of factors that designers have no control over and may not even be aware of (see figure 1, and notice in particular how the arrows are directed in line with the actors' intent of use).

The FaTE framework assumes that a design can be divided into small units, constructs, representing the collection of designed elements that are created to support a specific designed activity. These are appropriated by actors in their activities, and the latter contribute to their experiences[1].

[1] FaTE is based on a holistic perspective on experience. For example, the expectations that participants bring with them into the activity is considered part of the experience, in that they affect how participants chose to engage.

Back [4] argues that design knowledge is usefully articulated as relationships between adjacent layers of constructs. Design knowledge can for example articulate how participants with certain types of former experience will act, or how a particular activity can be encouraged or discouraged by a design construct.

Conceptualizing activity, a summary

The selected conceptualizations represent ways that activity-centric design knowledge has been articulated in interaction design research. All have been used to express what actors do, or can do. With the exception of affordances, they also represent collections of actions at a more abstract level, which makes it possible to talk about them as articulations of activity-centric design.

In order to represent design knowledge, this is however not quite sufficient. There must also be some kind of reason for advocating that some activity should follow this pattern, such as when Paulos and Peirce develop their particular set of verbs as a step towards more sustainable energy consumption [45]. In their work, the desirable effect (energy saving) is itself a high-level activity concept, but the effects could just as well be related to e.g. actor experiences.

Documenting Activity

If activities are the ultimate particulars of activity-centric design, they too should be made available as means of communicating design. There must be a way to *show* the activity itself, as part of the communication within the design and research communities, in a way that can carry the same weight as the artefact does in artefact-centric design.

The uniqueness of activity

The most obvious way that activities can be shown is by offering ways to engage in the activity first-hand. Just as playing a game is an essential part of play research [1], activity-centric design scholars need to be given ways to engage with other people's activity designs.

However, this is not quite enough, as relying on the subjective experience does not take into account that activities are ephemeral and unique. In the context of event design, it is not uncommon to spend considerable resources on the design of events that only happen once (see e.g. [34,54]). But even when activity-centric design is directed towards activities that can be considered repeatable (e.g. through scripting), every instance is still a unique activity, both in more or less subtle differences in how it plays out, and in what the participants experience. Furthermore, if there is a particular intended audience for a design, there is no guarantee that a participating scholar or designer behaves in any way similar to that audience, and this will affect the experience for the scholar and potentially also for other participants.

For these reasons, the articulation of activity design knowledge must rely on offering ways to participate in the

activity, but also on documentation of activity design *as it plays out*. Documentation is not just a needed as part of the evaluation process, but constitutes a central way to *show* the activity to other designers and scholars.

In the actual performance of an activity, it is no longer the designer but the participants that have the final say in how the activity plays out. This means that it becomes important to embrace the *uniqueness* of activity. For example, it can be important to document how a particular group of participants manages to re-invent an activity, especially if this represents a significant co-design event with lasting effects on later activities. (There are historic chess matches have done [51].) It may be equally important to bring out large-scale but unique patterns of change, especially for large-scale persistent services. An example of the latter is when game scholars study how the meta-game changes over time in online games [19].

In embracing uniqueness, it is for the same reason also important to embrace *subjectivity*. The documentation of activities will often require that something of the participant's attitudes and experiences towards the activity are captured, as they are effectively co-designers of their own activity. Sundström et al [60] report on an interesting way of encouraging participants themselves record video of their in-situ activities. While this group used the method to document use of a designed artefact, the method is alo suitable for documenting designed activities [5], as long as these are reasonably contained in time and space.

Showing time and temporal flow

While activity design need not be focused on sequencing actions, the activity itself takes place over time. In showing an activity it thus is always important to also document the flow of time. The most obvious way to do this is through recording it, e.g. by filming from multiple perspectives and/or logging data from as many sources as possible.

This approach is however problematic. The most obvious problem is that such a data set will be unwieldy and for all practical purposes un-shareable. Where a designed artefact typically can be picked up and manipulated and interacted with immediately, navigating raw data set will often require hours and hours of investigation for it to even begin to make sense. Recordings fall short of *showing* the activity in the same immediate way as a designed artefact.

While this obstacle can potentially be overcome through adequate navigation tools, the data set will still not adequately represent time as experienced by the participants [10]. Again, we meet with issues related to representing not only an outsider perspective of 'what happened', but also the subjective perspective of what the participants felt that they were doing, what they were engaged with, and what they experienced [41]. In the personal experience, some events will be considered more significant, whereas others will be entirely disregarded as unimportant. Some events will be perceived as related to each other; through design or coincidence. The experience of time will vary, so that the same 'objective' amount can sometimes be experienced as long and sometimes as short.

Hence, more curated forms of documentation may not only be more easily digested, but also provide more insight into the activity. Carefully cut and annotated video presents one such opportunity [39,41]. An interesting alternative is to represent time using layout and narration techniques from comics [43]. This format was used by Back [3,4] in documenting street performers shows to uncover some of their design strategies and tools. The comic layout allows for complex ways to represent time and space. In particular, the space between individual images (the gutter) typically represents flow of time, but in an indeterminate and vague way that allows for representing subjective time experiences [43].

Back uses the format to present an outsider perspective of the observed activity. The presentation is based on a careful transcription of video data and subsequent interaction analysis, placing emphasis on spatial movement and non-verbal interactions. The comic book layout is based on images captured from the original video, using original quotes as speech bubbles. The gutter between images is used to illustrate central transitions in the configuration of the show and the participants. This is just one possible use of comics as a format for representing activity; the same form could be used to capture the designer's intent and salient design decisions.

Such curated forms of documentation will by necessity include a level of analysis. They will highlight specific aspects of the activity and hide others. They reflect both the activity as a designed particular, and a subjective interpretation of it. It is possible to combine multiple forms of documentation to highlight multiple perspectives on a design: one could be created by the participants to represent their subjective experience of the activity, other by journalists and critics. If curated by designers, they fulfil a very similar purpose to annotated portfolios [21].

DISCUSSION

The articulation of design knowledge at an activity level liberates interaction design research from considering interactive technology design as its ultimate outcome. Though most of the projects discussed above include some technological aspect, they draw upon a wide range of design resources and lead to the design of a wide range of systems, environments, rules and scripts. This way, the articulations of activity-centric design knowledge can serve to address domains in which multiple levels of design interact, and avoid the technology-determinism that often feature in artefact-centric design studies. Activity-centric design is also inherently open to the option to *not* designing any technology intervention [8].

Furthermore, our case examples show that the articulation of design knowledge at the activity level is well suited for

capturing knowledge in domains where the design project time extends over use time. The 'story beats' approach to scripting, the trajectories framework [9,10] and the more abstract liminal path design described by Loke et al [37] have been developed as tools to capture the design of activities that are, while ongoing, orchestrated by artists.

Finally, activity-centric design presents some tools towards what Buchanan calls 'environmental design' [15]. In this article, this is represented by the work by Paulos and Peirce [45] on energy consumption, indicating that activity-centric design could be a viable way to, or at least an element of, articulating environmental design. However, as this article limits its discussion to examples of activity-centric design that are reasonably contained, none of our examples address the complex bricolage practices that Bødker emphasize in her criticism of third wave HCI.

There is however a risk involved with activity-centric design, related to the role of the designer. In striving for predictability and repeatability, designers and theorists alike may gravitate towards modes of articulation that exert high levels of control.

That this does happen (and also that it sometimes is a perfectly viable approach) can be seen in many forms of scripting in performative art practices, such as in music scores. Most formats for scripting exert much more detailed control over the designed activity than what is done by notable examples from third wave HCI (such as ludic or inquisitive design [16,22,25]). Compared to music scores, the trajectories framework is more open for variation, but it is still based on the assumption that there is *some* kind of designed trajectory through the experience. From this perspective, the concepts of story beats from Conspiracy for Good [54] and the verbs from Citizen energy [45] represent design articulations that are more open for participants to shape their own activity. To some extent, activity-centric design *must* impose constraints on activity in order to design anything at all. Consider how Suits as well as Zimmerman [59,63] talk about the constraints of a game as simultaneously "liberating and constraining" the activity.

In light of this, the authors would like to emphasize the importance of participatory design. Ehn [13] has discussed strategies for bringing participatory design principles forth into the domain of infrastructuring and most of these can be adopted in activity design. The goal should be to maintain a dialogue between the designer and audience communities, where the latter are seen as legitimate participants in the design community and vice versa.

The authors wish to again emphasize the importance of designing, documenting and analyzing activities as *unique*. If a design that is done to be repeatable plays out very differently in every instance, this is not necessarily a sign of bad design. Instead, it may be a sign of a design that is open for appropriation and adaptation by the participants. We consider it an important challenge for RtD in third wave HCI, to find articulations of activity-centric design knowledge that present rich opportunities for co-design and appropriation.

CONCLUSION

This article argues that it is possible to consider activities as the ultimate particulars produced by interaction design. While the proposal to consider activities as ultimate particulars is inspired by previous activity-centric approaches to HCI, it is different in that it specifically targets the articulation of design knowledge within the designer community of practice. This motivates our perspective on activity as circumscribed by a specific design intervention.

Grounded in an analysis of multiple examples of activity-centric design knowledge, we argue that this is a viable approach. It opens up ways to discuss design practices and objectives that do not manifest in products, but in singular events as well as in more persistent activities or recurring practices. Articulating design knowledge at the activity level opens up opportunities for addressing domains where design uses a multitude of resources, and where design and use are aligned and intermixed in a joint creative process.

Much remains to be done. Research challenges arise from understanding forms of scripting, and how these relate to other design resources as well as to the designed activity. We have further highlighted the importance of finding ways to document and analyze activities as ephemeral and unique, and to develop forms of representation that are accepted within the designer and scholarly community as reflective of the phenomenon at hand. We have emphasized the need to find articulations of activity-centric design knowledge that present rich opportunities for co-design and appropriation.

Finally, we wish to bring attention to how we have scoped the concept of activity as circumscribed by design. As with all design-related knowledge, this scope is limited and may not always be well-defined. Many of our examples are taken from the domains of play and experience design; domains that have the advantage of being reasonably contained. When we move towards infrastructuring and environmental design, it becomes much more difficult to draw this line. The challenge in addressing such domains arise from delimiting activity in a way still allows for the articulation of generative design knowledge.

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