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Introduction to the special issue on time and HCI

Amon Rapp [a], William Odom[b], Larissa Pschetz[c], and Daniela Petrelli [d]

[a]Computer Science Department, University of Torino, Torino, Italy; [b]School of Interactive Arts and Technology, Simon Fraser University, Surrey, Canada; [c]University of Edinburgh, Edinburgh, UK; [d]Art, Design and Media Research Centre, Sheffield Hallam University, Sheffield, UK

ABSTRACT

This special issue focuses on new perspectives of time within HCI research. We begin by explicating how HCI's views of time have broadened over the years, going beyond the traditional subjective-objective dichotomy. We describe how the HCI community was originally anchored to clock time, but more recently the field has begun to incorporate the existential, social, and cultural dimensions of time. We introduce the papers in this special issue by contextualizing them according to different research areas. We conclude by identifying open issues and opportunities that should be explored in future HCI research and practice.

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1. Introduction

To anchor our discussion, and before discussing Human-Computer Interaction (HCI) and time, we review related literature from philosophy and the social sciences that provides multiple conceptualizations of time. We begin by explicating a simple dichotomy between objective and subjective perspectives, moving on to modern views that suggest a plurality of perspectives and experiences of time. Then, we outline how HCI research has moved from a "clock time" conceptualization to the idea that time cannot be reduced to the time of the machine, diversifying perspectives on temporality. We introduce emerging strands of HCI research that view time in three distinct ways: as existential concern, as socially constructed, and as cultural phenomenon. Subsequently, we highlight how the papers accepted in this special issue incorporate this multifaceted nature of time. We conclude by proposing opportunities to explore in future HCI research and practice.

2. Historical and conceptual perspectives of time

It appears almost axiomatic that time is a fundamental dimension of the human condition. Nevertheless, the concept of "time" can be difficult to grasp and describe. Time connects with ideas of "change," experienced in the world and within individual and collective consciousness; with "events," which can be seen as contained "in" time and ordered "through" it; and with "duration," which can be measured through clocks and other technological artifacts (Bardon, 2020). All this said, although elusive in its interpretations, time's understanding and related practices deeply affect individuals and societies.

Two opposing views, one subjective, and one objective recur throughout the history of Western thought about time. On the one hand, the objective perspective is connected to the rise of science and the development of technology in modern society. Newton (1687/1934) emphasized this

CONTACT Amon Rapp amon.rapp@unito.it University of Torino - Computer Science Department - C.so Svizzera, 185 – 10149 Torino, Italy

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perspective, conceptualizing time as an absolute dimension that contains objects and events, a sort of "thing" that has its own reality and stability. Time is the time of the clock, a mechanical instrument that can record its exact quantity, making it measurable, uniform, progressive and predictable (Starkey, 1989). Until recently this idea dominated the ways Western societies viewed time (McGrath, 1988).

On the other hand, a subjective perspective of time was embraced by medieval and modern philosophers like Augustine and Kant, who believed that time exists only in the mind. This is also the perspective of several more recent philosophers. First Bergson (1913), and then Husserl (1962), the founder of phenomenology, strictly connected time to the "self": our stream of consciousness has a temporal character and even the givenness of our present experience cannot be comprehended without considering time. From this perspective, time is a characteristic of our consciousness, and it is a moot question to ask whether or not it "really" exists.

While this Manichean perspective on time is still highly influential, academic research has moved beyond this dichotomy in the past few decades. Time and temporality have started to be studied by different disciplines to unpack key domain-specific issues in biology (Feldman et al.,), culture (Fabian, 1983), ecology (Egri & Pinfield, 1996), management (Du Gay & Vikkelsø, 2012), organizations (Ancona et al., 2001), physical reality (Rovelli, 2019), politics (Greenhouse, 1996), and society (Elias, 1993), among others. In particular, research in the social sciences has criticized both objective clock-time and subjective viewpoints, suggesting that time should be seen as the product of specific social practices (Nowotny, 1992; Orlikowski & Yates, 2002). Likewise, cultural approaches draw attention to negotiations of time within cultures (e.g., Brislin & Kim, 2003; Levine & Norenzayan, 1999) and challenge assumptions of linear time. They indicate that conceptions of time can be tied to time-space formulas of nations, states and citizenship, which in turn reproduce Western canons about life and social order.

The proliferation of lenses through which time is being investigated demonstrates a broad shift from the question about "what time is," to the exploration of multiple times and how they work. These perspectives have enriched conceptualizations of "time" by showing that time is profoundly entangled with the fabrics of our organizational, social, cultural and political life. Next we turn to the field of Human-Computer Interaction and examine how perspectives of time have influenced past and current research.

3. Time and hci

Despite these newer, diverse perspectives, time in Western societies still remains anchored to objective clock time. Time is seen as viscerally connected with technology and science, offering a means both to measure phenomena and support the creation of "precise" machines.

It is no wonder, therefore, that initial HCI research was closely focused on clock time, paying most attention to time management, scheduling, and tracking. Time has been framed either as a descriptive feature of interaction (Card et al., 1980), or from a functional point of view (Hildebrandt et al., 2004), e.g., in the form of system and user response times (Dabrowski & Munson, 2011). Traditionally, HCI and design research has focused on the development of systems, interfaces, artifacts and devices that support individual productive activities and maximize efficiency, often reinforcing dominant narratives of objective time, including ideas of universal acceleration (Pschetz & Bastian, 2018). Some recent research has focused on supporting flexi-time, including the development of systems that automatically adapt users' schedules to ongoing changes in their context, e.g., Kairoscope (Martin & Holtzman, 2011) by combining the scheduling power of other users and software. However, that work still promotes optimization, reifying time as an objective quantity to be processed by computer algorithms, while at the same time being outside individuals' influence and contributing to yet more pressure than traditional clocks (Pschetz & Bastian, 2018).

Early attempts to counteract this viewpoint were expressed in the slow technology movement (Hallnäs & Redström, 2001), which proposes slowness as encouragement for reflection (Odom et al.,

2012), and slow design, which induces contemplation and reflective consumption (Strauss & Fuad-Luke, 2008). JuicyMo, for instance, is a centrifugal juicer that embeds the principles of slow design, supporting the creation of rituals as well as reflection on users' actions: the juice jar is made of white glass, encouraging the person to handle it carefully, taking the time and paying attention during serving (Grosse-Hering et al., 2013). Developments of critical design (Dunne & Raby, 2001) approaches in HCI (Pierce et al., 2015) have also promoted interfaces that are less utility-driven being less focused on efficiency and more on value-oriented perspectives. Similarly, Memonile, Anja, Woody and Seaweed, are 4 artifacts designed to embed the Wabi-Sabi philosophy, which acknowledges that nothing lasts, nothing is finished, and nothing is perfect, encouraging people to experience the impermanence of time, while challenging assumptions of timeless perfection, longevity and endurance that encompasses traditional industrial design (Tsaknaki & Fernaeus, 2016). Here, time is shaped by design, aiming to support temporal experiences that challenge dominant perspectives. These approaches stand in direct contrast to designs that display "objective" temporal representations, such as timelines (Di Bartolomeo et al., 2020) or temporal trajectories (Benford & Giannachi, 2008).

There is consistent recent support within HCI for the idea that time cannot be reduced to the time of the machine, diversifying perspectives on temporality (Liikkanen & Gómez, 2013; Pschetz, 2015). Here we define three emerging strands of research that embody these widened perspectives.

3.1. *Time as an existential concern*

A first strand of this research in HCI relates to the idea of time as an existential concern. HCI work on aging (e.g., Loup et al., 2017), legacy (Banks, 2011; Gulotta et al., 2014) and death (Gulotta et al., 2017; Moncur et al., 2012) is tied to fundamental existential issues, like the desire for longevity and immortality, the relentless flow of time, the need to be remembered in the future, as well as the frailty of the material and the digital as they decay over the years. Likewise, research on personal (e.g., Elsden et al., 2016; Van Gennip et al., 2015), family (Petrelli & Whittaker, 2010) and social (Jones & Ackerman, 2018) memories highlights how our present is intrinsically tied to the way we make sense of our pasts. Along the same lines, the exploration of opportunities to design for human dynamics of change (Rapp et al., 2019), the fundamental temporality of the self (Rapp & Tirassa, 2017), and the future self (Petrelli et al., 2009) connects a phenomenological interest in the subjectivity of time to matters that unfold in people's actual existence. For instance, Rapp et al. (2019) argued that human change does not simply follow the time of the clock: it takes multiple, non-linear, often unforeseeable, trajectories, which arise from the unpredictability of the individuals' life courses. In this process, technology may play a minor, if any, role and should be capable of accounting for the uncertainty of time.

3.2. *Social organization of time*

A second line of research deals with the social organization of time, and how it is constructed through the practices of players (Rapp, 2021), through festivities (Petrelli & Light, 2014), and rituals (Uriu & Odom, 2016). For example, Petrelli and Light (2014) explored the time of personal and family rituals carried out at Christmas in Northern England. By recurring year after year, Christmas celebrations form a trajectory in time: while each instance of Christmas is a moment in time, its repetitions, linked together, make visible changes in the celebrations and the passing of time. This trajectory creates a chain of memories of the past, anticipations of the future, and a sense of the present as meaningful in its connection back and forward, which intersects with the lives of others to whom people are connected. Rapp (2021) investigated how players in World of Warcraft collectively construct the temporality of play following, rearranging and resisting the time that is wired into the design of the game. Here, time is produced within the social practices which players participate in,

through the continuous "work" that they perform during play. Along the same lines, HCI and Computer-Supported Cooperative Work (CSCW) studies on the formation and routinization of temporal rhythms in organizations (e.g., Jackson et al., 2011; Reddy et al., 2006), on collaborative scheduling of work tasks (e.g., Whittaker & Schwarz, 1995, 1999), and on time and task management (e.g., Bellotti et al., 2004) tackle the socially constructed nature of time. Mazmanian et al. (2015), for instance, explored alternative temporal logics to the socially legitimated, shared assumptions about time that are embedded in institutional and societal norms. They identified four porous ways of orienting to time that are spectral, mosaic, rhythmic, and obligated: these ways show that lived time is the byproduct of constant social negotiations, in which people struggle to define a sense of self in alignment with prevalent norms around time, work, and productivity.

3.3. *Cultural approaches to time*

A third strand of research connects to cultural approaches to time. There has been much research focused on capturing cultural differences that affect people's behavior in dealing with time-related aspects of their everyday life, e.g., by defining taxonomies of cultures with respect to technology usage, for instance, of online scheduling tools (Reinecke et al., 2013) or technologies for time management (Chalot et al., 2016). There has also been recent research that explores how technologies contribute to the inclusion and exclusion of groups by supporting certain cultures of time. Research on technologies for the workplace in Kenya, for instance, demonstrates that Internet technologies that promote "access anytime and anywhere" embed cultural biases, perpetuate power asymmetries and negatively affect local rhythms (Wyche et al., 2010). Taylor et al. (2017) suggest that digital technologies which encourage values of scheduling and planning may not fit with particular cultures that do not hold these values. Such technologies may "breach" cultural protocols about information management, failing to accurately reflect the "real" timing of a situation, while conveying implicit "common knowledge" that is not useful for community members. Pschetz and Bastian (2018) analyze how time may legitimize some and manage others, as well as work to support systems of inclusion and exclusion and become a form of social power. They propose the idea of Temporal Design, an approach to time in design that shifts toward a pluralist and politicized perspective on time, recognizing that everyday rhythms exist in multiple and sometimes conflicting temporalities. This approach aims to empower "alternative temporalities that are neglected by the dominant narratives, and suggests that designers start looking at time as something that emerges out of the complex relations between material, cultural, social, economic and political forces" (p. 174).

In these three perspectives, time can take the form of the objective clock time, captured by machines, but its meaning exceeds simple quantification. On the one hand, time becomes a phenomenon that concerns fundamental aspects of existence, being related to what Henri Bergson called duration, namely, the time of consciousness, a time that is multiple, heterogeneous, qualitative and mobile. On the other hand, time becomes a social and cultural concern, as it unfolds through practices among individuals, groups, and societies. In other words, time becomes fundamentally plural, rather than reduced to a single essence, and, as such, it should be accounted for in its multifaceted nature.

4. The multifaceted nature of time: papers appearing in this special issue

In this special issue we focus on how HCI research might account for the phenomenon of time as an existential, social, cultural, and design matter. We received more than 40 thought-provoking abstracts that conveyed multifaceted aspects of time, emphasizing how the "temporal problem" seeps into various domains that are central for the HCI community.

The six accepted papers illustrate this multifaceted, contemporary research perspective, revealing its focus and diversity. Produced during the challenging outbreak of COVID-19, they tackle "time" from different angles, stressing that it cannot be reduced to a single essence. Methodologically, they

include experiments, artifact and social analyses, design fictions, theoretical surveys, interviews and research through design.

We summarize the articles by briefly contextualizing each in broader HCI research on time, so as to highlight its multifaceted nature.

Uhde Alarith and Marc Hassenzahl's work (Alarith & Hassenzahl, this issue) connects with HCI research on how people personally and meaningfully construct personal memories (Petrelli et al., 2008; Van den Hoven et al., 2012; Van Gennip et al., 2015), as well as studies exploring how digital tools support the recollection of past episodes (e.g., Cosley et al., 2012; Rapp, 2018; Sellen & Whittaker, 2010), or impact the act of remembering itself (Konrad et al., 2016a, 2016b). The authors look at the impact of reminiscing on well-being. They present two comparative online studies that analyze the effect of different modes of reminiscing according to whether people see their past as more positive or negative, based on time perspective theory. In the studies, they ask participants to record and classify positive memories, and invite them to immerse themselves in four fictional scenarios of reminiscing, which, following an experimental vignette methodology, varied according to level of "mediation" (technology-mediated vs. unmediated reminiscing) and "trigger" (external trigger vs. intentional reminiscing). In the first study, they found that technological mediation had a generally positive effect, particularly for participants who tend to have a negative view of their past experiences. They then derive three explanations for this result, which were tested in a second study. The first assumed that a representation of the experience rather than the mental memory would help participants deal with negative aspects of past experiences. The second assumed that involuntary mind-wandering may be problematic for people with a negative past perspective. The third, was that mediation could disturb existing positive practices of reminiscing. The second study shows that, although technological mediation had an overall positive impact on the well-being of participants, it may negatively affect "rosy views" of past experiences. Overall, the studies suggest that participants with different time perspectives experience reminiscing technologies in different ways, which is particularly relevant to the development of these technologies.

Michal Rinott and Noam Tractinsky's article (Rinott & Tractinsky, this issue) relates to HCI research concerned with rhythms of the body (Brazauskayte, 2020; Stepanova et al., 2020) and connects with embodied approaches to design, like somesthetic appreciation design (Alfaras et al., 2020; Höök et al., 2016), body-centered design (Svanæs & Barkhuus, 2020), and biofeedback research (Frey et al., 2018; Neidlinger et al., 2017). Motivated by behavioral research findings that time-based alignment of people's movement can support sociability, the authors provide a thorough analysis of Interpersonal Motor Synchronization (IMS), and its potential for HCI. The authors reflect on challenges and opportunities presented by an interesting installation called Two Riders, in which two people sit on bicycles facing each other and can influence a musical output by synchronizing their peddling. From the analysis of similar experimental projects and review of literature, the authors derive and discuss eleven dimensions that can support the study and application of IMS, they are: Temporality, Movement, Information Exchange, Object Involvement and Constriction, Entrainment, Stimuli, Intentionality, Number of Participants, Participant Relationship, Participant Profiles, Synchronization Outcomes, and Breadth of the Effect. The authors then move to analyze synchronization experiences in terms of affordances, signifiers, constraints, mappings, and feedback. They conclude by discussing the potential of IMS particularly in the context of remote synchronization, and how this might better support experiences of togetherness, group cohesion, and conflict resolution – experiences that may be particularly relevant in times of global pandemics.

Frederick van Amstel and Rodrigo Freese Gonzatto's article (van Amstel & Freese Gonzatto, this issue) can be related to approaches to design that question the status quo (Blythe et al., 2018) imagining alternative pasts (e.g., Eriksson & Pargman, 2018; Huybrechts et al., 2017), or proposing alternative futures through provocative and fictional prototypes (Pschetz et al., 2019; Purpura et al., 2011; Rapp, 2019, 2020a). The authors present the concept of existential time as introduced by Brazilian philosopher Alvaro Vieira Pinto, which focuses on historicity and the "production of

existence." Existential here refers to a socio-political perspective that understands time as unfolding through existential challenges that involve "choices, decisions, ethical dilemmas, and politics." The authors discuss Vieira Pinto's view of a process of colonization of the future, particularly in what the philosopher defines as underdeveloped nations. In this case, underdevelopment refers to a condition that results from a past of colonial oppression that reduces the future to what is seen as a continuity of this oppressive condition, and presents technology as the engine that pushes underdeveloped nations toward the assumed developed state. The authors explore these concepts in the context of interaction design education in Brazil. They turn to a critical form of design fiction to encourage students to problematize the historicity of their realities. Historicity according to Vieira Pinto can be a way to challenge this colonization of the future, as it is humans, not technology, that make history. They report on the challenges of producing design fictions "from" their realities, and their approach to introducing conjunctural artifacts, or artifacts that bring together multiple aspects of a historical situation, for which mockumentaries would be particularly suitable.

William Odom, Erik Stolterman, and Amy Chen's article (Odom et al., this issue) connects with HCI research that seeks to amplify time presence and reflection, supporting e.g., long-term use of objects (Pschetz & Banks, 2013), reminiscence (Tsai et al., 2014), storytelling (Heshmat et al., 2020), and contemplation (Odom, 2015). The authors contribute to this approach by proposing to extend the theory of slow technology through the analysis of seven design examples that aim to support "longer-term human-technology" relations. The paper is based on their artifact analysis approach, which starts with a tentative definition of slow technology and the selection of related artifacts. It proceeds with an iterative process that examines potentially "slow" properties of each artifact, at each step revising the tentative definition based on their analysis, until the generation of new insights slows down. Their process concludes by revisiting and extending the initial theory. The approach leads the authors to identify eight key qualities of slow technologies: implicit slowness, explicit slowness, ongoingness, temporal drift, pre-interaction, temporal modality, temporal interconnectedness, and temporal granularity. The description of these qualities, supported by concrete design examples, provide a way to help designers and researchers to re-interpret the original slow technology proposal and extend it through the creation of new kinds of slow technologies.

Jörgen Rahm-Skågeby and Lina Rahm's article (Rahm-Skågeby & Rahm, this issue) relates to the recent interest in HCI for sustainable practices that embrace a posthuman perspective on nature (Smith et al., 2017), where humans and nonhumans may find new form of relations (J. Liu et al., 2018) that are not characterized by domination and exploitation (S.Y. Liu et al., 2019) and time becomes stretched to millions, or even billions of years. The authors bring together this discussion on temporality, materiality and sustainability in HCI to develop a renewed temporal sensibility toward what they call "deep time design thinking." Framing their discussion around media theorist Jussi Parikka's concept of deep time, the authors draw attention to the problems of conflating media and earth history, and displacing geological materials from their strata while re-placing them in media artifacts. They assess the impact of technical infrastructures not only on people's lives and artifact ecologies but also on broader ecologies. This approach to deep time design thinking stresses the need for considering the interplay between the mundanity of everyday life and geological timescales, and could expand HCI's research on time.

Jocelyn Spence, Dimitrios Darzentas, Harriet Cameron, Yitong Huang, Matt Adams, Ju Farr, Nick Tandavanitj, and Steve Benford's article (Spence et al., this issue) relates to HCI work that attempts to tie together personal and collective pasts, extended forms of present, and imaginations and concerns about the future, like research on digital legacy (Gulotta et al., 2017), digital mementos (Bowen & Petrelli, 2011), museums (Claisse et al., 2020), and time capsules (Petrelli et al., 2009). The authors look at the effect of past and future engagement in the present through two case studies of virtual gifting in museums. The first is based on the Gift app that invites visitors to create audio-visual gifts with chosen museum objects and send them to friends or family members. The second is based on a virtual reality installation called VRtefacts, which serves as a medium for visitors to describe personal stories about an object that they would choose to donate to the museum's collection. In the first case, the gift is directed toward a person

and in the second, toward the museum. The case studies are examined through the lenses of storytelling's performance continuum, Performative Experience Design (PEM) analysis, and Hagerstrand's notion of time-space. They find that the more an object invites mental and emotional investment in the past and future, the more users engage in their experience of the "now." This key finding leads to the development of a framework of temporal experience that anchors past and future in the present moment, and can potentially support stronger engagement with participants' current experiences.

5. Issues and opportunities for future research

The work included in this special issue demonstrates that the concept of time cannot be reduced to the classical opposition between subjective and objective time. Time is a multifaceted phenomenon. Although its ultimate essence may be seen as elusive and mysterious, features of "times" can be captured by different lenses, which can help make its intrinsically complex nature emerge. The papers in this special issue illustrate different ways of studying and conceptualizing time in relation to technology. Here we indicate how their temporal subjects relate and/or extend the three strands of research defined in Section 2, and propose future directions for exploration.

5.1. *Time as an existential concern*

Current research that approaches **time as an existential concern** is supported by *Odom, Stolterman and Chen*'s analysis. Their proposed artifact analysis framework suggests future designs of artifacts that may amplify people's experiences of time. At the same time it may also offer practical hints for extending the initial proposal of slow technology (Hallnäs & Redström, 2001) through design practice. Supporting awareness of time can promote reflection on one's contexts, relationships, and ultimate mode of being in the world. *Spence* et al. analyze how the experience of the "now" can be amplified through museum interventions that support people's orientation to both pasts and futures. Through a controlled study, *Alarith and Hassenzahl* provide evidence of how different reminiscing conditions may impact individual well-being. This demonstrates value, while also supporting the development of future design-led approaches that invite reflection on one's experiences and ultimate existence.

Future work could benefit from ***analytical approaches*** *that focus on contextual and design practice*. This could examine other practice-based frameworks that aim to support the design of interactive systems to tackle temporal issues that currently seem abstract. Other quantitative and qualitative work could explore the impact of various situations and designs on different individuals. In particular, in-depth qualitative research, using e.g., diary studies and autoethnography, could uncover how the experience of time is lived by the person, connecting it to her existential concerns.

5.2. *Social organization of time*

Research into the social organization of time is extended here by *Rinott and Tractinsky*'s analysis. They focus on bodily movement, definition of dimensions and elements of experience of synchronization providing a timely discussion on how syncing bodies can lead to extended sociability. This research theme gains a new perspective from *Rahm-Skågeby and Rahm*'s discussion of deep time, specifically as they attempt to place it within the context of human practices. *Van Amstel and Freese Gonzatto*'s work with students in Brazil offers a new take on critical fictions, in the form of discussions and mockumentaries which demonstrate the value of situated practices in design.

Future research on social organization of time could ***revisit the scale and scope of social practices***. This might take the form of novel explorations of situated conditions of the body in time, helping to understand how practices materialize, possibly leading to renewed social conditions. Another

direction might examine practices through larger scales of time and consider temporal lenses for other entities beyond the human. In this perspective, researchers may look at "society" as composed of both human and non-human actors, like objects and natural environments, and explore how people "collaborate" with these non-human entities to construct "time."

Such widening of perspectives could also be extended by theories that ***connect time to the dimension of space***. Spence et al.'s article builds on Hägerstrand's conception of time-space (Hägerstrand, 1970). In relativistic physics, time and space are replaced by space-time, a sort of four-dimensional block that contains the universe of objects and events (Bardon, 2020). Human geography and social science also highlight that space and time are strictly intertwined (Giddens, 1990; Thrift, 2006). Theorizing time in connection with space, thus, appears to be a promising line of research for HCI.

5.3. *Cultural approaches to time*

Work on cultural approaches to time is here extended through *Van Amstel and Gonzatto*'s introduction to Viera Pinto's politicized take on visions of the future. This approach counteracts grand narratives through facts of life, as well as demonstrations of how these ideas could be translated into practical design exercises. *Rinott and Tractinsky*'s discussion on the potential for synchronization of bodies in time, both face to face and remotely, indicates how technology can lead groups to potentially redress divisive aspects of culture and resolve conflicts. *Spence* et al.'s analysis of Gift App and VRtefacts shows that museums are holders of sociocultural pasts reinterpreted in contemporary culture, possibly influencing and shaping future generations.

Future research on cultural aspects of time could benefit from ***practical approaches that look beyond grand narratives from the global north***. It could help diversify the portfolio of cases and reveal hidden assumptions that shape current temporal orders. It could also extend views of culture beyond assumed narratives of histories and futures, by exploring a wider range of thinkers, especially from the global south. It could further take advantage of practical approaches and work that examines issues emerging from inequalities of time in any context. Exploring alternative takes on time beyond Westernized temporal assumptions, that extend perspectives beyond "our" and "other" temporal practices, could support identification, inclusion, acceptance and empathy toward the multiple temporalities that are part of our lives.

5.4. *Further aspects of time*

Beyond these future opportunities that concern the existential, social, and cultural aspects of time, we think that the HCI community could extend time and technology studies by tackling other, more general, issues.

Firstly, most work on time in HCI seems to rely on theoretical frameworks derived from other domains. While HCI research often "imports" theories to produce relevant insights, during this "transfer," applications may focus exclusively on particular parts of the theory, thus simplifying its original scope. This likely happens because specific theoretical aspects translate more easily into design features (Hekler et al., 2013). However, the design of systems based on such specific concepts may only work when paired with other concepts, making designers lose sight of the whole picture. The articles included in this special issue explore both theory-inspired research questions and produce theoretical knowledge about how time and technology interact. *Further research on time in HCI could benefit from* ***theories of technology and time that are motivated by specific HCI needs***. This would allow us to better understand the role that specific technologies (e.g., wearable devices, virtual or augmented reality, etc.) and design features may have in affecting and being affected by time, and how this knowledge may be turned into effective designs.

Secondly, the design of interfaces and systems may shape the ability of a system to encourage certain experiences or behaviors in users, as in the slow technology movement which attempts to

promote reflection and contemplation. However, HCI design practices are still largely driven by productivity, speed, and efficiency, and often aim to increase engagement and retention, or to encourage people to give up ties to their real world and its timings, in favor of online activities (Rapp, 2020b). Schüll (2014) showed how certain devices can be specifically designed to engender a suspension of time, which may promote addictive behaviors and continuous engagement. The effects of time design, therefore, cannot be exempt from a thorough ethical reflection. *Research could also embrace the multifaceted characteristics of time by* ***investigating and designing diverse "time forms,"*** beyond a focus on acceleration or slowness. For instance, the consideration of cyclic time, which is common in myth (De Santillana & Von Dechend, 1969), could produce rich experiences and interfaces (Rapp, 2021).

Furthermore, *future research should also* ***ask ethical questions*** such as: Are there side-effects arising from shaping the temporality of people through technology, and how can we deal with them? How can we account for and respect the different times that characterize different societies and cultures without imposing a unique design-based temporality? What if novel, pervasive, extremely effective, temporal design could be enacted, capable of profoundly affecting people's experience of time? These questions will continue to intrigue us, and we look forward to seeing more investigation in these areas in future research.

Articles in this special issue

Odom, W., Stolterman, E., Chen, A. (this issue). Extending a Theory of Slow Technology for Design through Artifact Analysis. Human–Computer Interaction. https://doi.org/10.1080/07370024.2021.1913416

Rahm-Skågeby, J., Rahm, L. (this issue). HCI and deep time: toward deep time design thinking. Human–Computer Interaction. https://doi.org/10.1080/07370024.2021.1902328

Rinott, M., Tractinsky, N. (this issue). Designing for Interpersonal Motor Synchronization. Human–Computer Interaction. https://doi.org/10.1080/07370024.2021.1912608

Spence, J., Darzentas, D., Cameron, H., Huang, Y., Adams, M., Farr, J., Tandavanitj, N. Benford, S. (this issue). Gifting in Museums: Using Multiple Time Orientations to Heighten Present-Moment Engagement. Human–Computer Interaction. https://doi.org/10.1080/07370024.2021.1923496

Uhde, A., Hassenzahl, M. (this issue). Time Perspectives in Technology-mediated Reminiscing: Effects of Basic Design Decisions on Subjective Well-being. Human–Computer Interaction. https://doi.org/10.1080/07370024.2021.1913415

van Amstel, F., Freese Gonzatto, R. (this issue). Existential time and historicity in interaction design. Human–Computer Interaction. https://doi.org/10.1080/07370024.2021.1955681

Notes on contributors

Amon Rapp (amon.rapp@unito.it) is a human–computer interaction scientist with an interest in self-tracking and wearable devices, behavior change technologies, intelligent agents, and video games; he is an Assistant Professor in the Computer Science Department at the University of Torino.

William Odom (wodom@sfu.ca, www.willodom.com) is a human-computer interaction researcher with an interest in slow technology, temporality, and design for everyday life; he is an Assistant Professor in the School of Interactive Arts and Technology at Simon Fraser University.

Larissa Pschetz (l.pschetz@ed.ac.uk) is an interaction designer with an interest in Temporal Design, socio-technological narratives, and technological inclusion; she is a Lecturer in Design Informatics and Edinburgh Futures Institute Fellow at the University of Edinburgh.

Daniela Petrelli (d.petrelli@shu.ac.uk) is a human-computer interaction scholar with an interest in personal and collective memories, digital heritage, immersive experiences, tangible and embodied interaction; she is Professor of Interaction Design in the Art, Design and Media Research Centre at Sheffield Hallam University.

ORCID

Amon Rapp http://orcid.org/0000-0003-3855-9961
Daniela Petrelli http://orcid.org/0000-0003-4103-3565

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