Revealing Social Infrastructures of Time

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Infrastructures, when they are working smoothly, are largely invisible to wider populations of users. Perhaps none more so than the infrastructures that provide time standards such as Coordinated Universal Time (UTC) – what we generally understand as 'clock time'. Yet, as anthropologist Kevin Birth notes, when discussing the role of the U.S. Naval Observatory's (USNO) in providing standardised time,

> The USNO is a place that every smartphone and GPS user depends upon, a place critical to the functioning of financial markets, a place that provides the precision timing information for the coordination of weapons systems, a place essential to the management of big data and data mining, a place that supplies the astronomical and timing information used in determining religious prayer times for many adherents of many religions (Birth, Time Lords Deserve Better Coffee)

Birth thus helps to highlight the ubiquity of technical infrastructures of time. However, this ubiquity is not the outcome of any 'facts of nature' that would make time consistently applicable across all contexts, but due to significant work by time metrologists and others to produce an infrastructure that meets the needs of key users interested in precise time (Birth, 2018).

The organisations who produce temporal infrastructures also reach beyond the members of the International Bureau of Weights and Measures (BIPM), to include corporations such as Google and Facebook who, when unhappy with aspects of conventional time standards, develop their

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own. Examples include Facebook's Flick, a new unit of time that is more suitable than the

second for editing video across different frame rates,[2] and Google's technique for adding 'leap

seconds' into UTC called a 'leap smear'.[3] This suggests that at certain levels of influence and

global reach, it is possible to create new infrastructures for calculating and understanding time

as needs change or problems are encountered.

In both cases, there has often thought to be little need for speaking for 'the social' since the

adjustments to time are so small as to be largely unnoticeable. While the change from the Julian

calendar to the Gregorian calendar (a staggered process which included a 12 day jump in 1753

in a number of countries) was widely recognized, the redefinition of the second in 1963 or the

adoption of UTC over Greenwich Mean Time (GMT) in 1972 had little effect outside of

specialised communities. Likewise, leap smears and flicks work on the level of microseconds

(millionths of seconds) and so could be introduced without public scrutiny.

One place where 'the social' has appeared most explicitly has been in debates in precision time

keeping circles over whether leap seconds should be retained. Leap seconds are adjustments

made to UTC to account for changes in the speed of the Earth's rotation. While leap seconds are

important for some fields such as astronomy, they can be difficult to implement reliably in

computer systems where they have to be added manually. In 2015, this debate reached the stage

of an international decision being taken at the ITU World Radiocommunication Conference

(WRC-15). As those on various sides of the debate prepared their arguments ahead of the

meeting, the public came clearly into view. Efforts to understand the 'social issues' of precision

time keeping included consultations, such as a UK Public Dialogue on Leap Seconds run by

public consultation specialists Sciencewise,[4] and commissioned social research such as Birth's

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[2] https://www.bbc.co.uk/news/technology-42787529

[3] https://developers.google.com/time/smear

[4] See https://www.gov.uk/government/news/leap-seconds-away-from-having-your-say-on-time-management and http://sciencewise.org.uk/ the latter describing themselves as "helping "to ensure policy is informed by the views and aspirations of the public"

2013 study of potential effects on orthodox religious communities. Speaking for the social in these contexts involved investigating pre-articulated concerns from scientific and industry stakeholders around cultural issues such as links to natural cycles, heritage, religion and spirituality, and intergenerational fairness (Silver et al 2014). In the public dialogue case, experts took members of the public through key issues as identified by specialised stakeholders and at the end of the workshops attendees offered their opinion on whether leap seconds should be retained or not. These responses then fed into the official UK response.

Subsequent to the WRC-15 decision, 'the social' as it relates to technical temporal infrastructures appears to have receded in significance, the divide once again arising between technical users who are regularly engaged with about adjustments and proposals, and the public who are largely unaffected. As a result more open dialogues are neglected, including ones such as the value of adopting these kinds of precision temporal infrastructures in everyday life, the mismatch between the needs of precision time users and many aspects of our social lives, how various social values might contrast with the values embedded in the development of such infrastructures, and, indeed, how time could be designed differently to speak to these issues. In our entry in this catalogue of methods, we thus suggest other ways of unpacking the issues at stake in our forms of timekeeping, ones which shift the understanding of who is the expert on time and how dialogues might be provoked. We describe a design approach that we call Temporal Design and outline three interventions. These interventions were not designed deliberately to speak for the social in the sense that is put forward by this volume, i.e. to bring the social to the consideration of technical experts, but rather to speak against widespread assumptions that time is asocial and engage wider publics in conversations about how their values and needs might be addressed, as technical users have already come to expect. Nevertheless these interventions will be useful for those interested in speaking for the social in regard to technical time infrastructures, particularly in provoking consideration of more varied questions, and being open to seeking more complex responses from those being.

This kind of work of speaking for the social – speaking for the social nature of time – is a necessary step in broadening out conceptions of who the stakeholders are in time-keeping infrastructures, since in everyday life the fact that time can be redefined and remade is largely unknown. Instead, common sense notions of time as uniform, accelerated, external to human practices, and often imposed on people, highly influence understandings of time. When problems arise with time, the option of questioning our definitions of time is not on the table, instead the task is largely to recalibrate *ourselves* to UTC via various time management techniques and self-disciplines (Sharma 2014). The idea that time is a fixed universal is thus both socially problematic and fundamentally inaccurate. Both the technical systems that produce time, and the experiences of time across wider societal landscapes, are far more complex. Time is not neutral but, as the leap second debate demonstrates, is given meaning and embedded with values according to different contexts, social and material relationships.

This temporal imaginary, where time is seen as universal rather than infrastructural, is ripe for challenge, and suggests the need for methods that can confront the reification of critical aspects of our lives as non-social universals, enabling them to be reconceived as social. Just as movements around participatory mapping and critical cartography challenged the exclusion of 'the social', opening up questions around who should make decisions over how space is represented, produced and understood, Temporal Design is a movement that seeks to socialize temporal practices by gathering together wider and more varied groups to explore how time might be represented, produced and understood. We thus seek to attune designers and technical experts to the possibilities of wider social implications for all manner of design decisions that affect time and timing. We also seek to encourage designers to think beyond issues of pace (acceleration), direction (past, future, present), and subjective experience which have so far dominated the discussion. Temporal Design, in contrast, looks at time as emerging out of relations between cultural, social, economic and political forces. This pluralist perspective can help to reveal how some infrastructures of time prevail over others. In this way, the ability to redesign time based on emerging needs opens up beyond corporate giants such as Alphabet,

Google, and Facebook to be explored within more varied social contexts. We thus hope to encourage wider recognition of the fact that time is designed and can be redesigned, while also broadening understandings of who has a stake in how time is defined.

In order for infrastructures of time to be redesigned, however, first it is necessary to recognize that speaking for the social in these contexts cannot rest on educating members of the public in current techniques, or asking them to comment on predetermined topics (as seen in the Leap Seconds dialogue). Instead we would insist that any understanding of the social implications of infrastructural decisions related to time needs to take a significant step back and attend to how time is understood, lived and given context beyond established infrastructures and dominant narratives of time. Crucially, it is important to remember that this rich temporal texture is hard to reveal because the temporal imaginary we discussed above has such a strong hold. For example, when asked about time, people tend to reflect dominant notions of time as asocial rather than the more nuanced and complex experiences that each of us has (Birth, 2004). As a result, we have investigated methods that would allow us to bypass both assumptions about time as asocial and the dominant critiques that mediate the narration of time, exploring the affordances of design 'probes' for revealing habits, practices and insights that often remain implicit in people's negotiation of temporal infrastructures, as described in the following sections.

Probes as a method to explore aspects of Temporal Design
Temporal Design begins as an attempt to reveal differentiating nuances in temporality that are often suppressed by dominant narratives of time that are embedded in infrastructures of temporal precision and universalised clock-time. Here our temporal designs were formulated into three probes designed to generate visibility with regards to temporal formulations that are rarely discussed. Still people navigate interchangeably through varying temporal factors responding to infrastructures designed for, and sometimes despite this, more lived dimension.

Probes have been widely explored as an investigation method in Design. Initially defined as ''Cultural Probes'' by Bill Gaver and colleagues (1999), the method offers an open-ended way to gather insights into the lives of the people for whom one is designing. Rather than attempt to speak for the social, as we saw above, by training members of the public to understand technical infrastructures in certain ways, or trying to elicit feedback on predetermined categories, this approach allows a broader understanding of the social issues involved by asking those being consulted to respond in ways that matter to them and that allow for the unexpected. The gathered insights are then drawn on by the designer as sources of inspiration, in ways quite different to traditional social science methods that might focus on trying to ascertain descriptive truths about the social context. Indeed given that the public largely view time as asocial, we have sought methods for eliciting, and then reflecting on, experiences that participants have largely ignored or dismissed.

In Gaver et al.'s initial experiment, which sought to develop "technologies to increase the presence of the elderly in their local communities" (1999, 24), the cultural probes consisted of a package with a series of creative prompts such as cameras, postcards and maps, which were distributed to a participants as a way to provoke ''inspirational responses''. In the words of the authors.:

> understanding the local cultures was necessary [...] but we didn't want the groups to constrain our designs unduly by focusing on needs or desires they already understood. We wanted to lead a discussion with the groups toward unexpected ideas [...] We were after 'inspirational data' with the probes, to stimulate our imaginations rather than define a set of problems. (Gaver et al 1999, 22)

Since then, the concept has taken many forms addressing a variety of contexts. These range from the development of pieces to gain insights into novel technological designs (Hutchinson et al, 2003), to developing more elaborate ways of exploring nuanced notions of subjectivity and intimacy (Wallace et al., 2013). Boehner et al. (2007) reflect on the different ways in which probes have been employed and adapted in design contexts, particularly in Human Computer Interaction (HCI), drawing attention to the epistemological aspects of the method. According to

the authors, probes should not be seen as a technique for data gathering but as an "alternative account of knowledge production" that values uncertainty over the production of results easily amenable to producing "well-defined set of requirements, themes, or insights" (Boehner et al., 2007, p1078, 1081). The aim is to produce responses, not to produce data (Boehner et al., 2007, 1084). We argue that three aspects of the method are particularly useful for revealing the rich temporal textures of our everyday lives and for stimulating our imagination about what temporal infrastructures might involve:

- **Aim:** probes are meant to generate creative insights into how a particular group interprets their context, in a relatively unstructured way – a way that is also less mediated by judgement, coherence, cultural clichés, and expected narratives and interpretations (from both probe designers and participants).

- **Format:** probes make use of creative formats that are intentionally designed to be ambiguous, open-ended, aiming to 'provoke' reactions (Gaver et al, 1999) and access a creative attitude in the participants.

- **Interpretation:** data generated through this method is meant to be more insightful than representative (Wallace et al., 2013). Rather than accurately expressing the vision of a particular group, probes serve as prompts for a subtle communication between designers and participants.

In contrast to traditional methods of interviews and questionnaires, probes allow design researchers to sidestep more conventional conversations loaded with dominant moral assumptions around technology, such as ideals of efficiency and productivity, and to speak for social issues that reach beyond these frames. In contrast to ethnographic methods of observation and analysis of practices, the interpreter of this data, the designer, is not looking for an explanation of the phenomena, but for inputs that support a creative process that, in our particular case, goes beyond more common narratives of time. In this way, the method is particularly apt for the three main aspects of what we call a Temporal approach to design (Pschetz & Bastian, 2018), which consists of: a) identifying dominant narratives and attempting

to challenge them so as to reveal more nuanced expressions of time; b) revealing nuanced expressions of time, drawing attention to alternative temporalities; and c) tactically exposing networks of times so as to illustrate, multiplicity, variety, but also social constructs and potential inequalities.

In the following sections, we describe three probe interventions that attempt to reveal social aspects of time in more complex ways in line with the design aims of Temporal Design, namely:

A. *Tempocards (2015)*, which revealed the multiple interpretations of clock time that might be held at any one time (design aim [b]).

B. *Memorial for Misused Time (2017)*, which explored associations of concepts, meanings, and lived experiences of 'the best use of time' with ideas of past, present and future, (design aim [b] and [c]) and

C. *Threads of Time (2019)*, which looked at negotiations performed between multiple times so as to question notions of individual time (design aim [a]).

In line with the creative probe approach, which emphasises the specific, unique and intimate nature of probe design, we would not suggest that these interventions could be straightforwardly adopted or repurposed. Instead they are offered as examples that others might draw on if seeking to develop their own.

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Tempocards

TEMPORAL DESIGN · SURFACING EVERYDAY TACTICS OF TIME · WORKSHOP · 28.09.2015 · TALBOT RICE GALLERY · · · · · · · · design *informatics*
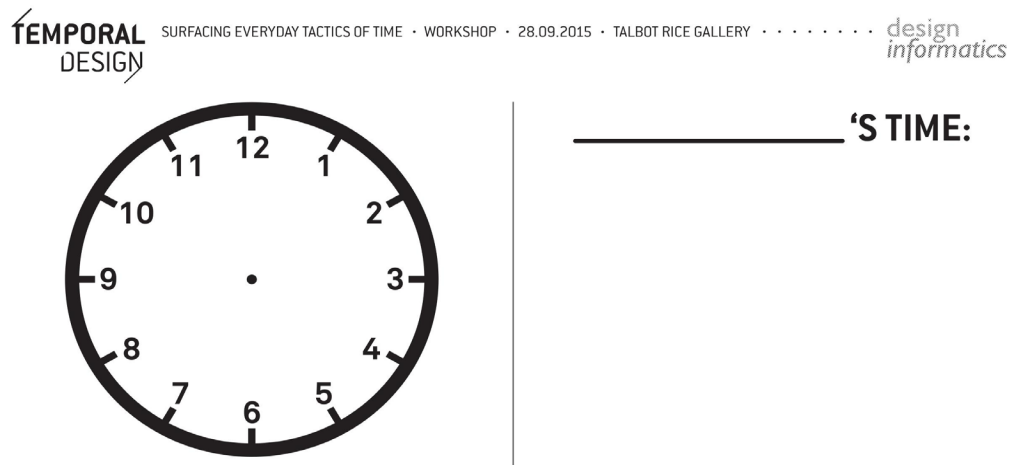
_____ 'S TIME:

Figure 1

The Tempocards (Figure 1) were made available to the general public at an art gallery in Edinburgh during the busy month of August, when the city receives a high number of tourists. They were aimed at producing stimulus for a design workshop in September 2015 called "Temporal Design: Surfacing Everyday Tactics of Time". Relating to the three key aspects of the probe method highlighted above:

- **Aim:** this card exercise aimed to illustrate the multiplicity of responses that connect to one particular point in time, revealing the mesh of activities and characters that are hidden behind large infrastructures of temporality. This aim would be only achieved through the collection of multiple responses.
- **Format:** the Tempocards were printed on one side of a postcard which was divided in two parts: on the left side of the card, we presented an empty clock-face, and on the right, we presented a field that nudged participants to write a word to describe the beholder of a particular time or time more generally. The task was intentionally left open and ambiguous, with the empty clock face serving as a reference to temporality, but a reference that encouraged a range of possibilities for response.

9

- **Interpretation:** Participants contributed more than 500 responses (see a sample in Figure 2 below), which ranged from descriptive actions to creative expressions that depicted reflections on temporal aspects of participants' lives. These included references to cultural symbols, regular activities, states of mind, important moments in participants' lives, protests, etc. They took the form of text and multiple drawings that used the clock-face or not .
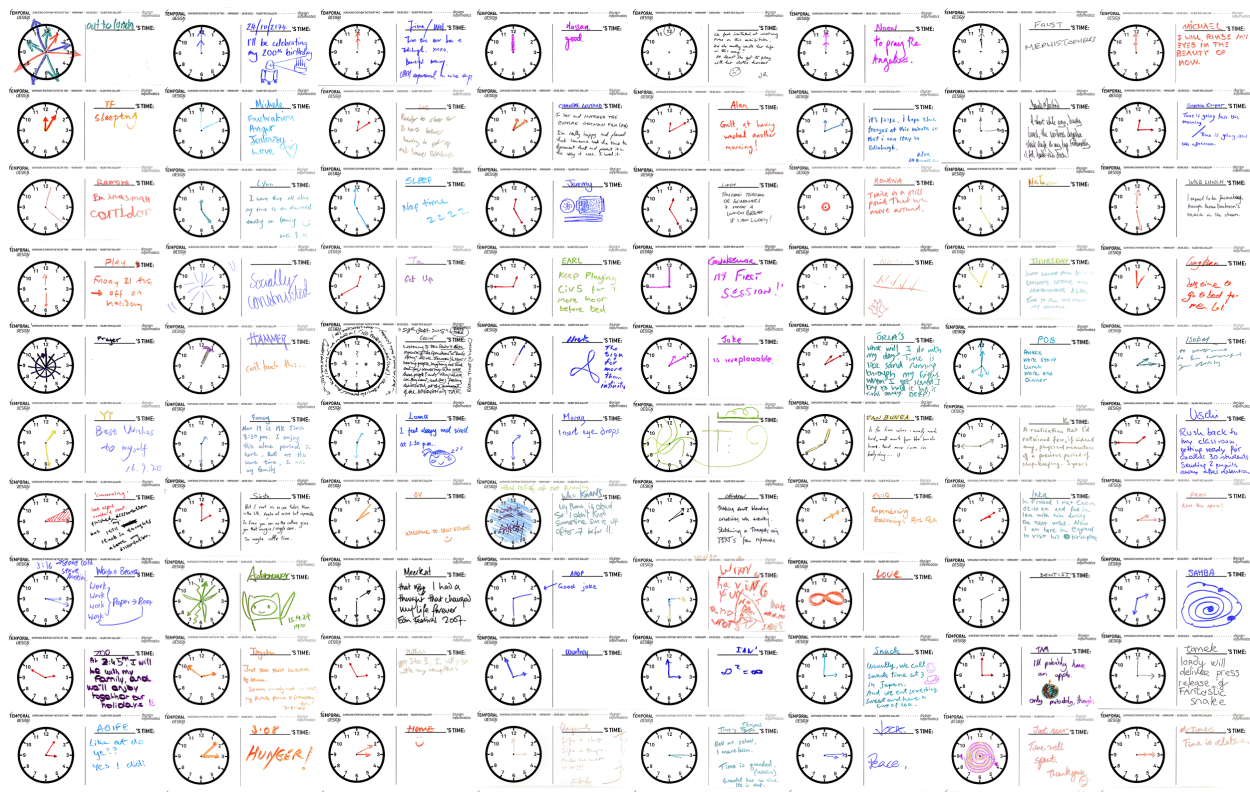

Figure 2

The completed cards were introduced to participants at the Temporal Design workshop,[5] where the material was analyzed in a variety of ways. This included setting out the cards in a large

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[5] *Temporal Design: Surfacing Everyday Tactics of Time*, held in the Talbot Rice Gallery, Edinburgh on the 28th of September 2015.

clock face according to the time indicated, reflecting on patterns or insights this generated, and then developing and proposing playful 'temporal tactics' in response to the issues surfaced by the stimulus provided by the Tempocards (figure 3). These proposals varied from the illustration of a scenario on a bus, where passengers walked under a tunnel to leave old experiences of time behind, to glasses that would promote temporal lenses related to different activities (figure 4). This proposals were speculative in nature, helping other workshop participants to deepen their understandings of the variety of everyday 'tactics' that are, or might be, employed in relation to time.

Figure 3 Image by Larissa Pschetz

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Figure 4 Image by Larissa Pschetz

Memorial for Misused Time

The second probe consisted of an interactive installation carried out during the 2017 LightNight Liverpool arts festival which explored the theme of Time. We called the installation *Memorial for Misused Time*.

- **Aim:** the installation was inspired by the busyness of festival time, when multiple events happened at the same time and visitors invariably miss some of its activities. Seeing something contradictory in efforts to use time well at a festival, which is often understood as a break in conventional time, we hoped to celebrate time's misuse. This initial interest

in the present time of the festival was expanded to notions of past and future in order to invite reflection on other scales of time, and additionally to a reflection and questioning of rules of time that could be self-imposed or understood as defined by an external context. The aim again was to illustrate the multiple associations with ideas of past, present and future held by the people that came together on the same festival night and reflect these back to them in more complex and nuanced ways.

- **Format:** the installation had two key activities. In one activity we prepared three racks with the prompts: "What do you miss... in the past", "What do you miss... in the present" and "What will you miss…in the future" and gave participants ribbons for them to write messages and attach to the respective racks (Figure 5). The ribbons made reference to multiple cultural traditions of tying ribbons to trees with wishes, prayers and hopes written on them in hopes of seeing them materialise. In the other activity, we prepared rolls of paper and invited participants to write the rules of time that they would like to keep and the rules that they would like to throw away (Figure 7). Importantly, the LightNight organisers located our installation within the Hall of Remembrance, part of the Liverpool Town Hall, which memorialises Liverpudlians who died in the First World War, adding further layers of resonance for the participants.

- **Interpretation:** In the evening we collected more than 350 ribbons (108 for past, 135 for present and 121 for future) and more than 50 rules. The majority of ribbons referred to very personal events in participants' lives (Figure 6). Other messages included economic and political concerns, and more mundane aspects of everyday life that change as part of a natural process. The rules of time most often indicated desires for more free time and slower paces of life. Here the responses challenged our assumption that missing other events at the festival would be a concern among participants. Instead they used the installation as a tool to reflect on different periods of their lives and express deep emotional states that are connected to life changes. Participants often spent quite some time looking through the contributions of others, and many described the experience as deeply moving.

Figure 5 Image by Peter Carr

Figure 6 Ribbons representing what participants missed in the past.

14

Figure 7 Image by Peter Carr

Threads of Time

The third probe was designed as a more embodied experience to explore temporal connections and temporal empathy across participants. This included playing with the idea of time as a line, and referenced influential philosophical discussions of time, such as J. Ellis McTaggart's (1908) description of event time as beads on a string,

- **Aim:** the aim was to discuss how participants move between times and what are the forces that influence temporal decisions and understandings of different rhythms. The aim was to challenge assumptions that individuals are solely responsible for defining their own times and rhythms according to better or worse time management skills and to make this more explicit for workshop participants.

- **Format:** the exercise was structured into three parts: *a) Times of the day walking exercise:* Thinking of their routines from five o'clock in the morning of the workshop day to the next day, participants were invited to compress this and walk around the space, increasing or decreasing body motion depending on their pace and speed at that specific moment in time. *b) Times of the day brainstorm*: Broken down into 'Favourite times', 'Times to avoid', 'Times when you forget about time' and 'Irritating times'. Participants wrote situations associated with these four prompts onto post-it notes. Participants then stuck the post-it notes onto circular artefacts, and clustered related concepts. They then placed the circular artefacts on the floor so as to form a larger circle reminiscent of a clock. *c) Walking through times of the day*: Attached by an elasticated string, participants held onto the metaphoric elasticity and tensions of time moving from a focus on their own times of day, to exploring how they had to be negotiated with others (Figure 8). Conforming to a metronome, participants moved into each time of day. If the ticking was slow, they perhaps might spend more time in a circle that stated one of their favourite times. If fast, they might move in and out of the time circles that they wanted to avoid.

- **Interpretation:** insights from the exercise where captured through notes and audio recording. Responses generated offered insights into the negotiations of time that are generated daily. It revealed varying strategies for using temporal rhythm to generate more or less time according to a given situation. For instance, one participant initially declared that they felt in control of speeding up or slowing down time. However, after the exercise, the same participant mentioned being more aware of the "boundaries that you need to negotiate, on a social, familiar or professional path that others also walk" (Participant 1). In relation to waking up in the middle of the night, another participant commented that the "narrative of time can make a person feel segregated" (Participant 2).These insights offer variable and intriguing temporal perspectives that allow new ways of designing and thinking about society and social interactions.

Figure 8 Threads of time exercise. Image by Ryan Bowler

Discussion

Rather than assuming that the public must first be educated about temporal infrastructures in order to contribute meaningfully to debates about their constitution, the probes utilized in these investigations treated the public as already making, remaking and breaking temporal infrastructures in their everyday lives. Our challenge was not to train attendees in obscure technical debates, but to instead counteract the dominance of perceptions that time is asocial. Our work thus focused on designing materials, prompts and interactions which could help participants in our activities to reveal and reflect on the socially-created temporal textures that respond, co-exist and confront larger infrastructures of time. Through the *Tempocards*, participants expressed how clock time was made to make sense within their lives. In the *Memorial for Misused Time*, they expressed deep personal associations relating to notions of past, present and future alongside the reflections of others in ways that spoke strongly to both writers and viewers. In *Threads of Time*, participants discussed how times are negotiated across

17

habits, preferences and power relationships. The probes created a context that encouraged temporal play and conversation, revealing a richness of expressions that complicate and question concepts of clock-time, past-present-future and individual power over time. The probes also created a sense of temporal reflection for participants and researchers alike to consider temporalities that stretch beyond dominant narratives of time.

We would argue that speaking for the social in the temporal realm is not about narrowing down conversations about time to address currently dominant infrastructures, but about recognising the multiplicity of temporal aspects that people encounter in their lives. Temporal Design encourages the acknowledgement of a "differential lived time" (Sharma, 2014, Pg.6) and the potential of these rhythms to challenge and maybe even transform larger infrastructures of time. When speaking for the social, we would invite researchers to experiment with temporal methods, such as the probe approach that we showcase here, to build a language to understand incongruences between peoples' values and values that support these infrastructures. A lack of methods to reveal these alternative notions of time contribute to failures to develop wider social critiques of temporal infrastructures and their incongruences in temporal values beyond dichotomous temporal counter-narratives such as fast versus slow, or short-term versus long-term (see Bastian 2019).

Conclusion

Using probes to explore the unspoken socialities associated with assumed universals enables varying disciplines and social sectors "to start considering the complexity of aspects that sustain the coordination of particular groups" (Pschetz et al, 2016, Pg.1), in this case in the context of temporality. We have seen how within this project, the probes further allowed for temporalities to both be seen as social and to be considered and reconsidered by those often aggregated into 'the social'. Offering an approach for engaging with varying temporalities, Temporal Design provides an example of a practice-based design focused research approach that encourages thought-provoking ways of designing in a continually interchangeable complex system of time,

place and belonging. Looking beyond our examples here, we would suggest that the use of probes as a design method allows for various parts of society from governmental, civil, communal and educational to generate conversations around concepts like temporality and the potential incongruences between people's values and the values embedded in infrastructures of time. The methods call researchers to think beyond clock time, acceleration theories and time squeeze conundrums to further develop research into more complex interwoven dimension of time.

References

Bastian, M. (2019) Retelling Time in Grassroots Sustainable Economy Movements, *GeoHumanities*, 5:1, 36-53, DOI: [10.1080/2373566X.2019.1583589](10.1080/2373566X.2019.1583589)

Birth, K. K. (2004). "Finding Time: Studying the Concepts of Time Used in Daily life." *Field Methods* 16(1): 70-84.

Birth, K. K. (2013). Zmanim, Salāt, Jyotish and UTC: The articulation of religious times and the global timescale. *Requirements for UTC and Civil Timekeeping on Earth Colloquium*, Charlottesville, Virginia, Univelt.

Birth, K. K. (2018). Standards in the shadows for everyone to see: The supranational regulation of time and the concern over temporal pluralism. *Law and Time*. S. Beynon-Jones and E. Grabham. London, Routledge: xx-xx.

Boehner, Kirsten, Janet Vertesi, Phoebe Sengers, and Paul Dourish. (2007). How HCI interprets the probes. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '07). ACM, New York, NY, USA, 1077-1086. DOI: 10.1145/1240624.1240789

Gaver, Bill, Tony Dunne, and Elena Pacenti. "Design: cultural probes." *interactions* 6.1 (1999): 21-29.

Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B.B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H., Hansen, H. and Roussel, N., (2003), April. "Technology

Pschetz, L., Bastian, M., Bowler, R. (forthcoming) Revealing social infrastructures of time. In Knox, H, John, G *Speaking for the Social: A Catalogue of Methods* Punctum Books. **Accepted Version**

probes: inspiring design for and with families". In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 17-24). ACM.

McTaggart, J. Ellis. "The unreality of time." *Mind* (1908): 457-474.

Pschetz, L., et al. (2016). Temporal design: looking at time as social coordination. *DRS 2016 Design+Research+Society: Future-focused thinking* 27-30 June, Brighton, UK.

Pschetz, L., and Michelle B. (2018). "Temporal Design: Rethinking time in design." *Design Studies* 56: 169-184.

Sharma, S. (2014). *In the Meantime: Temporality and Cultural Politics*. Durham and London, Duke University Press.

Silver, K, M Wild, T Bedford (2014) *Leap Seconds Dialogue: Final Report* Report to The National Measurement Office. OPM and RK Partnership: London and Castle Cary, Somerset. Available from: https://web.archive.org/web/20160320062333/http://leapseconds.co.uk/reports-findings-dialogue/ Accessed 27th April 2020.

Wallace, J., McCarthy, J., Wright, P. C., & Olivier, P. (2013, April). Making design probes work. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3441-3450). ACM.